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Comparability of Market and Nonmarket Valuations of Forest and Rangeland Outputs

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This note discusses the comparability of market prices that measure marginal willingness to pay, and nonmarket evaluations that often measure average willingness to pay. It is concluded that the two are often directly comparable. The Travel Cost Model for evaluating recreation use is discussed as a case in point, and some implications regarding the application of this model are noted. The conclusions drawn support the use of fixed marginal benefit coefficients in forest planning models (in particular, linear programs).

Keywords: Nonmarket valuation, Travel Cost Model, underpriced goods, excess demand

Introduction

Evaluation of the benefits of goods and services provided from National Forests (NF) is required in both the Resources Planning Act of 1974 and the National Forest Management Act of 1976. The benefits of alternative levels of NF-based outputs or alternative mixes of NF-based outputs can be compared to the costs to determine what level or mix is most efficient or beneficial. This requirement appears relatively easy to meet with respect to outputs sold in markets. However, many outputs of National Forests, other than timber, are not traded in any organized market or are not sold to the highest "bidding" users. The problem of comparing marketed with nonmarketed resources is not unique to National Forest economic evaluation. Several government agencies, such as the Bureau of Land Management, U.S. Army Corps of Engineers, Bureau of Reclamation, and Soil Conservation Service, face similar challenges.

In forest and rangeland planning, some confusion exists regarding the comparability of market good valuations, usually based on a market price, and nonmarket good valuations, usually based on techniques such as the Contingent Valuation Method (bidding games) or the Travel Cost Method. If one views the primary purpose of this planning to be selection of the output mix to be produced, then the information provided by economic valuation is a very important input to planning decisions, provided that the values of the various outputs are consistent and comparable. This paper attempts to clear up some nagging issues related to this comparability.

General Concepts of Economic Evaluation

In discussions regarding the comparability of market and nonmarket economic values, the fundamental question is often phrased like this:

> Are the economic evaluations of nonmarket goods, which are based on willingness to pay, consistent with the more concrete economic evaluations of market goods, which are based on market price?

To an applied welfare economist, this question is actually phrased in a somewhat backward manner. The only reason that market price has anything to do with economic value is that it measures marginal[3] willingness to

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[3] *In reading the next section, it is important to remember that market price measures marginal willingness to pay—that is, willingness to pay for the last quantity unit—for whatever quantity the consumer chooses to purchase at that price.*

pay (Harberger 1971). Thus, at the fundamental, theoretical level, there is no inconsistency between market price-based valuations and nonmarket valuations based on willingness to pay.[4] They are both based on observation of consumer preferences (willingness to pay). Aside from questions regarding measurement errors, the issue that seems to be the most troublesome involves the comparability of marginal and nonmarginal values.

Marginal Values Versus Nonmarginal Values

It is often stated that because market prices are measures of marginal willingness to pay while nonmarket valuation techniques tend to yield measures of average or total willingness to pay, the two are inconsistent. This is not necessarily true. The discussion that follows will compare timber stumpage values and recreation campground values. However, it would also apply to other resources.

The point has been made before (for example, Binkley 1980) that a marginal quantity change for timber might be one cubic foot while a marginal quantity change for recreation campgrounds may be an entire site, supporting a number of visits or recreation visitor days (RVD's) each year. If this is the case, then the total annual willingness to pay to use a proposed campground can be interpreted as the marginal value for the marginal campground.[5] In this sense, it is consistent with a market price.

To go one step further, the suggestion is made in this paper that even if one wished to value a marginal recreational visit or RVD at a given site, the appropriate value would often be the average willingness to pay, and that this would be comparable to the marginal willingness to pay (the market price) for a marginal unit of timber. This point relies heavily on the logic developed by Mumy and Hanke (1975). They establish an appealing rationale for valuing underpriced or zero-priced commodities at the margin, by average willingness to pay instead of marginal willingness to pay when conditions of excess demand are present. An empirical example of an application of Mumy and Hanke's logic to a lottery-rationed recreation area is available in Loomis (1982).

Mumy and Hanke analyze the situation where a demand curve has been estimated through some means, but at the price actually being charged (often zero), the quantity demanded is greater than the quantity actually being produced and consumed. In other words, the output is underpriced and there is excess demand. They argue that if quantities are rationed in some manner other than pricing, then any of the individuals with a marginal willingness to pay equal to or higher than the price actually being charged might be the consumer of an additional (or the last) unit produced. Mumy and Hanke reasonably assume that many nonprice rationing systems give all individuals an equal probability of consuming an additional (or the last) unit. Thus, the expected value (in the probability sense) of the marginal benefit of an additional unit is the average of the marginal willingnesses to pay of all the potential consumers. The essential ramification of nonprice rationing is that the ordering (or sorting) of users with high and low values (relative to the price) is destroyed. As Mumy and Hanke (1975, p. 719) summarize: "Our analysis suggests that benefit-cost analysis cannot be conducted independently of the pricing policy chosen to allocate an undertaking's capacity."

As a simple example, consider figure 1. This example assumes a linear demand curve for simplicity in exposition and a zero price. The logic developed by Mumy and Hanke applies to any functional form. The current quantity being produced and consumed is Q°, but this is being rationed by some means other than a market price. Because a zero price is being charged, an additional unit might be consumed by any individual with a marginal willingness to pay between zero and P'. If all individuals have an equal chance of consuming the additional unit (say the quantity is being rationed by a lottery or on a random first-come, first-served basis), then the expected value of the marginal benefit of that additional unit would be "the average demand price" (ADP), or $P'/2$. This ADP would be applicable up to Q_m, at which point the appropriate value drops immediately to zero (Mumy and Hanke 1975). When the estimated demand curve is not linear, the expected value of the marginal benefit (ADP) is no longer $P'/2$ but can be calculated by taking the area under the demand curve and dividing by Q_m. This amounts to a weighted average demand price (or weighted average consumer surplus).

This conclusion should provide some comfort to the local planner (for example, in a National Forest). Since timber demand functions are generally defined over a relatively large geographic area (Adams and Haynes 1980), small local planning units generally do not affect timber market prices. And, by the logic of Mumy and Hanke, for underpriced nonmarket goods, a fixed average demand price is the appropriate marginal value up to a point such as Q_m. Thus, at the local level, use of fixed, single-value estimates for each recreation site (especially in linear program objective functions) will often be theoretically correct and comparable with the fixed, single-value estimates for timber.

The Travel Cost Model—A Case in Point

In the early presentations of the Travel Cost Model (Clawson 1959, Clawson and Knetsch 1966), the consumer was assumed to be producing recreation expe-

[4]Economic theory indicates that when a consumer faces any particular price set, the individual will consume quantities such that relative price ratios equal relative ratios of marginal utilities gained from such consumption. The conversion of this condition based on ordinal utility to a cardinal valuation measure (willingness to pay) is equally heroic for market and nonmarket goods. Likewise, the rather esoteric discussions concerning the uniqueness of the consumer surplus under Marshallian demand curves apply equally to market and nonmarket goods.

[5]Notice, however, that the timber market price only applies to small (defined relative to the scale of the timber demand function) quantity changes. If decisions are being made that would change timber output enough to alter the market price, then the valuations of timber would have to be based on changing marginal willingness to pay rather than a fixed market price.

riences from a number of production factors—especially travel and the recreation resource (site). The "first-stage" (Dwyer et al. 1977) travel cost demand curve was viewed as the demand for the recreation experience. Clawson and Knetsch also presented a second-stage model, which they discussed as a derived demand curve for the recreation resource. The second-stage demand curve plots net willingness to pay (i.e., willingness to pay over and above travel costs and actual entrance fees paid) as a function of annual trips taken.

To illlustrate the details of applying the Mumy-Hanke logic to measurement of marginal benefits of the "last" trip to a recreation site, consider the following simple example: A "zonal" first-stage demand curve is estimated for site A. The dependent variable is visits per capita (actually per 1000 population) from three zones of origin visiting site A. Each recreationist is assumed to make one visit per year or season, a pattern of visitation that often occurs for remote recreation sites or when state or federal agencies constrain visitation to once a year as in the case of hunting some big game species such as elk, antelope, and bighorn sheep.[6]

Figure 2 depicts a first-stage demand curve based on visits per 1000 population along with the current prices (travel costs plus fees) "faced" by each zone. Assume (strictly for simplicity) that each zone has a population of 1000. Given current prices (fees and travel costs),

[6]Dealing with multiple visits by the same recreationist introduces some subtle differences in the way the expected value (ADP) is calculated from the second-stage demand curve. This topic will be discussed at some length in a forthcoming paper by Hof and Loomis.

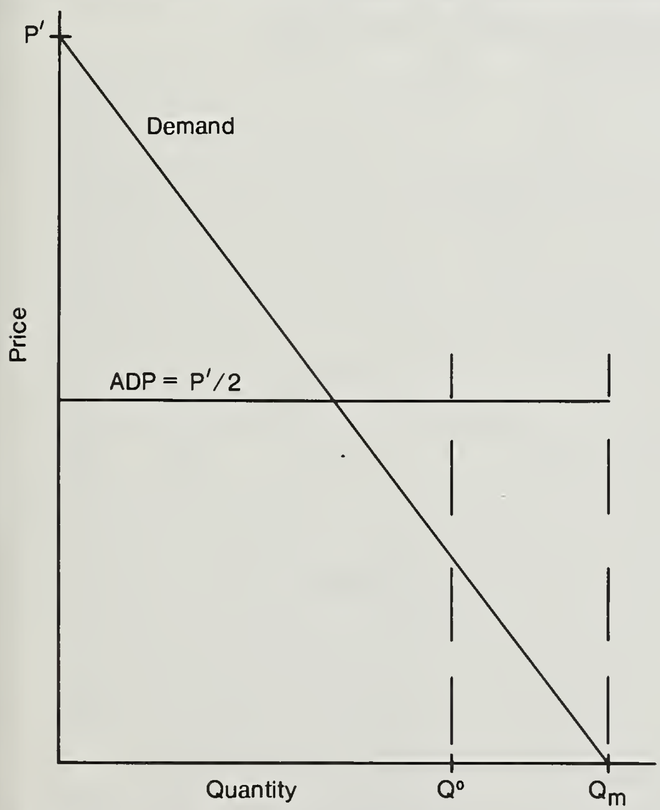

Figure 1—A demand function and average demand price for a zero-priced commodity.

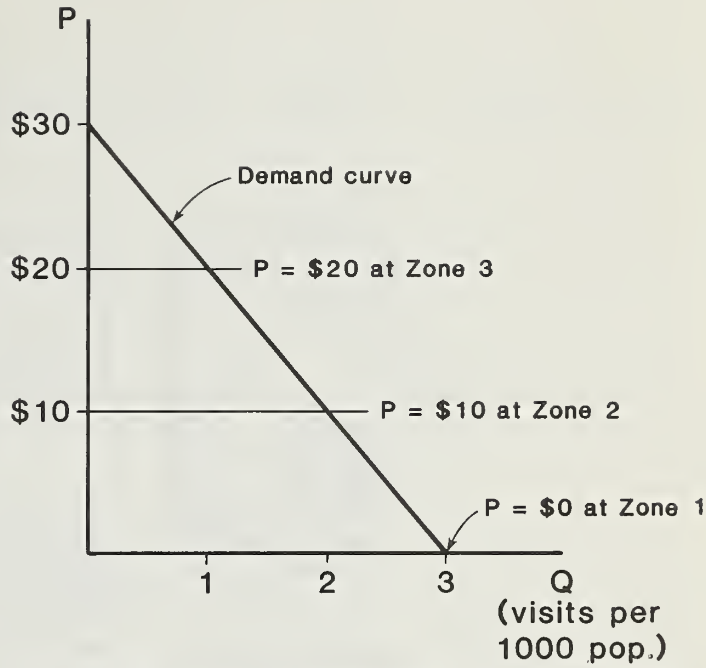

Figure 2—First-stage demand curve for site A, with different zonal prices.

there are three persons desiring to visit site A from zone 1, two persons from zone 2, and one person from zone 3. Following standards procedures, the per capita demand curve (price-quantity relationship) would be statistically estimated accounting for site quality (e.g., congestion), prices of substitutes, income, etc. From the per capita demand curve, a second-stage demand curve for each of the three zones and for the site as a whole is constructed (see Dwyer et al. (1977) for detailed treatment of the mechanics involved). These four demand curves are illustrated in figure 3. The upper graphs actually depict the consumer surplus for each zone, from the first stage demand curve. The aggregate second-stage demand curve is actually the horizontal summation of these zonal consumer surpluses (Burt and Brewer 1971). The lower graph is the recreation site second-stage demand curve. The vertical axis of all of these curves is "added" dollars per trip over and above existing travel costs and entrance fees (if any).

The downward slope to the second-stage site demand curve arises from the traditional assumption associated with price rationing: the lower the price, the more consumers there are that are willing to pay it, and those not willing to pay it do not consume. Applying the Mumy and Hanke logic is best explained using the individual zonal graphs, since individual person's visits are not identifiable in the aggregate model. It will be shown below that the aggregate second-stage demand curve can also be used.

For the Mumy-Hanke logic to apply, there must be excess demand. In this example, six recreationists are competing for available capacity. For purposes of illustration, let us assume that capacity is four units (trips). The desired marginal benefit of the fourth ("last") trip would be the benefits lost if capacity was reduced to three trips. With price rationing, the

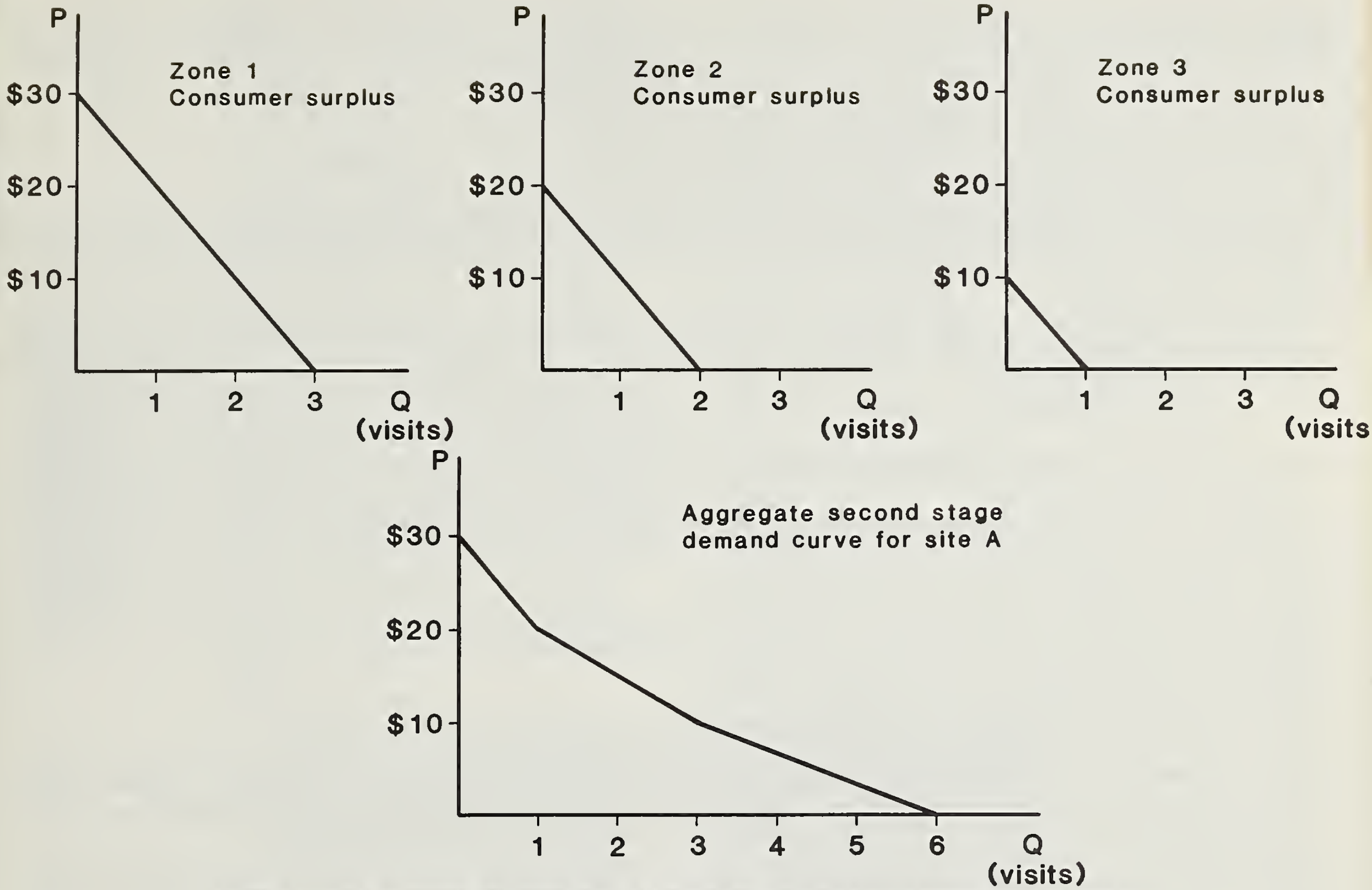

Figure 3—Zonal consumer surpluses and the aggregate second-stage demand curve for site A.

"marginal user" would be the one excluded. With an equal chance (nonprice) rationing system, however, each of the six potential users has an equal chance of consuming the "last" trip.

Under these conditions, the marginal benefits of providing the fourth trip can be calculated by multiplying each individual's net willingness to pay (area under the demand curve) by the probability of that person receiving the trip (in this example 1/6 or 0.1667). This will yield the expected value of the marginal benefit. Using the zonal graphs, this expected value for the three recreationists in zone 1, the two recreationists in zone 2, and the one recreationist in zone 3, respectively, is: [($25 × 0.1667) + ($15 × 0.1667) + ($5 × 0.1667) + ($15 × 0.1667) + ($5 × 0.1667) + ($5 × 0.1667)] or $11.67 per trip. This same calculation would apply to the first, second, third, fifth, and sixth trip capacities as well. Because this second-stage demand curve is not linear, this $11.67 ADP is not one half of the vertical intercept; it is a weighted average consumer surplus.

Now let us examine the benefits from increasing the capacity of the site to allow all six individuals to visit. The ADP is $11.67, as stated above. Total benefits would be 6 × 11.67, or $70. Thus, the ADP (which is equal to the average consumer surplus) is the appropriate marginal value for supplying up to six visits. Providing capacity for seven visits would still have total benefits of $70 because only six visits will be consumed (and ADP for those six visits is still $11.67). The marginal value for the seventh and all additional visits is zero.

In more realistic situations where many individuals are involved, a convenient way to calculate the ADP is simply to divide the total area under the second-stage demand curve by the total number of trips; this is equivalent to the weighted average consumer surplus from the first-stage demand curve. In the example above, the area under the aggregated second-stage demand curve is $70, which, divided by the total number of trips (six) is $11.67, just as before. This identity holds in general.

The upshot of this discussion is that the estimates of average willingness to pay (or average consumer surplus) commonly developed for valuing nonmarket goods are often the appropriate values to be directly compared with market (marginal) prices. To a degree, this will simplify resource planning. However, four points should be emphasized. First, a market price is only applicable to relatively small quantity changes, and a fixed average willingness to pay is not appropriate for large quantity changes of marketed goods. Second, for underpriced nonmarket goods, the average willingness to pay is only appropriate up to a point such as Q_m in figure 1. Beyond that point, a value of zero should be used because with excess capacity the marginal value of additional capacity is zero. Third, the logic developed by Mumy and Hanke implies that the marginal value of each unit on a given demand schedule should be valued

by the same average demand price; for example, all trips to a given site might be valued the same. However, this does not imply that all recreation sites have the same value, or that individual trips to different sites should have the same value. Because different sites have different demand curves, they will also have different average demand prices. Fourth, for any given recreation demand curve, site quality is held constant at some predetermined level. Thus, it has been implicitly assumed that site capacity is maintained in a manner to preserve that quality. It has also been assumed that when capacity increases, it creates an increase in the quantity of trips with a given quality (not an increase in quality of the existing quantity).

Application of Nonmarket Valuation Techniques

A variety of approaches are available for applying the Travel Cost Model. The most straightforward approach is direct estimation of the demand function to arrive at existing benefits. Another is the "similar site" approach in which a per capita demand function for an existing site that is believed to be similar to the site to be evaluated is applied, along with the population patterns surrounding the site to be evaluated. Still another approach is the regional Travel Cost Model in which the per capita demand curve includes site characteristic variables, along with measures of substitute site prices and socioeconomic characteristics of the recreationists. By setting the site characteristic variables equal to those at the site to be evaluated (in that region), the analyst can account for qualitative differences between existing sites and the site to be evaluated (e.g., differences in congestion). In all of these approaches, once the second-stage demand curve is derived, the logic discussed above (Mumy and Hanke 1975) applies.

The second-stage demand curve approach can also be made to conform to the Burt and Brewer (1971) and Knetsch (1977) case of introducing a new site that substitutes perfectly for an existing site. In this case, the second-stage demand curve for the new site represents only the additional consumer surplus created by the introduction of the new site.

The Mumy-Hanke logic also applies to demand curves or average consumer surplus estimates derived by the Contingent Valuation Method. This method would be applied to all potential users of a site (i.e., persons desiring to visit the site at the current travel costs and entrance fees). The procedural differences in measuring net willingness to pay (or the demand curve) using Contingent Valuation as compared to the Travel Cost Model should not obscure the fact that the same (Mumy-Hanke) logic applies.

Because the horizontal ADP curve requires equal probability of users with high and low willingness to pay gaining entry, unequal probabilities will rotate the ADP curve. If the nonprice rationing system somehow gives greater probabilities to high valued users than low, the ADP will be slightly downward sloping, though less than that of the demand curve itself. It is left for future empirical work to determine whether this is a significant enough departure from a horizontal ADP for the planner to be concerned.

Conclusion

The main point of this paper is that in cases of zero-priced or underpriced outputs, the appropriate values for use in forest and rangeland efficiency analyses will often be fixed, average demand prices. To the degree that forest and rangeland decisions do not affect market prices, this may justify the use of fixed marginal benefits in planning models such as FORPLAN (Johnson et al.[7]) or other linear programs. It is important to note that in such applications, different recreation sites (with different demand curves and average demand prices) would have to be accounted for as separate outputs. This is analogous to accounting for different timber products (with different market prices) as separate outputs.

[7]Johnson, K. Norman, Daniel B. Jones, and Brian M. Kent. 1980. Forest planning model (FORPLAN) user's guide and operations manual, draft. 258 p. U.S. Department of Agriculture, Forest Service, Land Management Planning, Fort Collins, Colo.

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