A LANCASTERIAN APPROACH FOR SPECIFYING DERIVED DEMANDS FOR RECREATIONAL ACTIVITIES*

Sandra S. Batie, Robert B. Jensen and Linda G. Hogue

Accurate estimations of recreational demand schedules are important for projecting attendance at new facilities. Projecting future demand levels and calculating social benefits of additional facilities can be biased, however, if an analyst does not consider the influence of recreational opportunities. The Lancasterian theory of household behavior provides a framework for exploring implications of the influence of such recreational opportunities on demand estimations, projections, and consumer surplus measures. A case study of boating demand is presented to empirically investigate this framework.

CONSIDERATIONS IN ESTIMATING RECREATIONAL DEMAND FUNCTIONS

Improperly specified demand functions can result from numerous conceptual errors. A resulting analysis can be similarly faulty. If benefits from increased recreational opportunities are estimated from improperly specified demand equations, the conclusion could be faulty. Namely, it might suggest that greatest benefits are obtained by provision of services in geographical areas already served by similar facilities, rather than by provision of opportunities in creationally deficient regions. For instance, if outdoor water recreation benefits were estimated using projections of past gross attendance as evidence of "willingness to pay," a region already well-endowed with water facilities could be considered as having a greater "willingness to pay" for an additional water facility than a water deficient region. This improper reasoning results from failure to consider the social value of an additional facility, as represented by the intersection of demand and supply functions.

An additional problem can result from failure to consider the effect of supply availability *per se* on the demand for recreation. This neglect can bias both projections of future attendance at various prices, and estimations of benefits from the provision of additional facilities. People tend not to engage in water-based recreational activities if facilities are not easily accessible. However, once these become accessible and people begin to participate, their realized enjoyment often exceeds their expectations. As a result, demand for facilities will tend to increase.

Moreover, skill is often required for enjoyment of these activities. Skills will not and cannot be developed when facilities are not readily available. Consequently, there may be little desire to participate in the activities. Opportunities to acquire skill increase if facilities are made available, and user demand tends to rise rapidly over time as individuals use the facilities and gain skills in the activities [2].

"The learning process requires a supply to exist and be accessible; therefore, one should *a priori* expect changes (shifts) in demand to be related positively to changes (shifts) in supply" [1, pp. 49-50]. These shifts can be further accentuated by the "neighborhood" effect. That is, individuals observe others enjoying a sport and are thereby motivated to participate themselves.[1] Ignoring these relationships could result in underestimation of future use rates of the facility at any given price level, as well as affecting consumer surplus estimates.

Sandra S. Batie and Robert B. Jensen are Assistant Professors of Agricultural Economics and Linda G. Hogue is a former Agricultural Economics Graduate Student at Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

*The authors wish to express appreciation to Leonard A. Shabman for his helpful comments concerning this article.

[1] This suggests some interdependence of utility functions between households.

A LANCASTERIAN FRAMEWORK AND RECREATIONAL DEMAND FUNCTIONS

Lancasterian theory of consumer behavior [3] suggests a framework for the estimation of recreation demand functions and therefore for recreation projection and benefit measures. Following Lancasterian theory, the household's decision-making process operates under two stages, production and consumption. In the production stage, commodities are used as inputs into the production process whereby the household, "given its knowledge of the production process determines the input combinations that produce a given level of the i^{th} commodity at least cost for given input prices . . . In the consumption stage, the household determines the levels of the produced commodities so as to maximize utility subject to its budget constraint."

Combining these two stages "by substituting the demand functions for the produced commodities, derived in the consumption stage, into the constant output demand functions for inputs, derived in the production stage," household derived demand functions for goods can be formulated [4, p. 341]. Further, large price increases (decreases) result in shifts in the consumer's production function due to adoption of new technologies, thus causing derived demand functions to shift leftward (rightward). For example, a large price increase in a commodity such as coffee may result in technological efficiency improvements for the consumption of coffee, e.g., longer brewing time, fewer coffee beans, etc., and thus result in a shift of the demand for coffee to the left.

This concept appears to be equally valid for recreational experiences where large price increases or decreases occur. For example, construction and provision of a large recreational boating reservoir is equivalent to a large boating price decrease for nearby residents. This price change results in a movement down a household's demand curve for boating, and also in a shift of the demand curve to the right. This is due to changes in (1) the consumer's production technology because of the "learning-by-doing" effect and (2) changes in consumption tastes and preferences due to the "neighborhood" effect. Both of these effects result from the large (relative) change in price ratios of boating with respect to substitute activities.

That is, a large price decrease due to the addition of a new reservoir (new boating opportunities) results in a change in the existing consumer's production technology for boating, because of a change in the state of the arts through the accumulation of skills by experience. This shift is further amplified by the "neighborhood" effect. New boaters will participate in this recreational experience because they observe others participating and enjoying the sport, at the same time that there has been a large (relative) price decrease.

Failure to recognize such a demand shift can bias both projection estimates and recreational benefit measures. Assume that a public agency associated with planning and development of water resources for outdoor recreation is concerned with providing such opportunities to a region which originally had few reasonably close available water resources. In the planning process, a demand curve for water based recreation (AC) was estimated for the region at a given time period (Figure 1). The demand estimates were based on traditional variables such as time/distance (a price proxy), income and other socioeconomic variables associated with the region's population. User-days presently taken by the region's population at the nearest water facility were used as a proxy for quantity demanded. Now, as a result of the close proximity of a new reservoir, the public agency recognizes there is substantially lowered (average) total cost per trip (P_1 to P_2),[2] resulting in a movement down demand curve AC. Quantity demanded of boating from this region would thus be

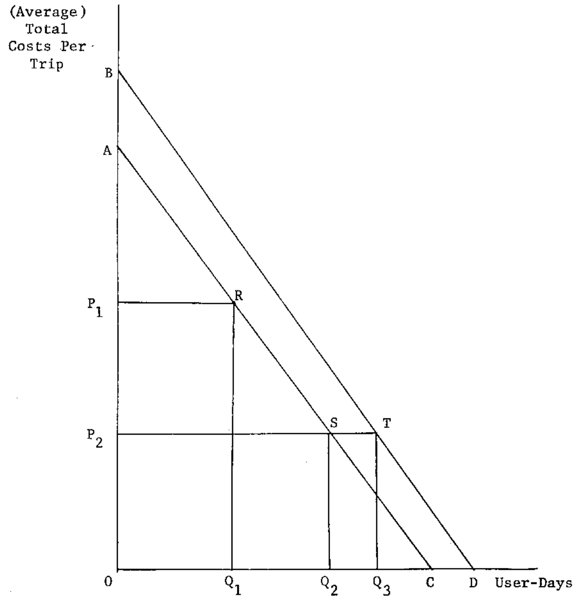

FIGURE 1. DEMAND SHIFTS ASSOCIATED WITH THE PROVISIONS OF NEW WATER-BASED RECREATIONAL FACILITIES

---

[2] Price includes the average time/distance costs plus any entrance fees collected at the site.

projected to increase from Q_1 to Q_2. Consumer surplus benefit estimates increased by the area P_1P_2SR.

The agency, however, is projecting from an improperly specified demand curve. The appropriate curve is BD, which accounts for changes in demand associated with experience. The correct projection of regional boating user-days is Q_3. The public agency, failing to plan for Q_2Q_3 user-days of boating, may find itself faced with pressure to provide more water-based recreational facilities. Also, assuming substitute and complement prices remain constant, the appropriate benefit measure is increased by ASTB [5, p. 41], the area of which depends on shift magnitude and elasticity of the resulting demand curve.

The properly specified derived demand for boating, then, should have been estimated as a function of the consumer's production technology for boating, as well as household tastes and preferences, prices and income.

Obviously, such a derived demand fucntion will be somewhat similar in specification to conventional demand analysis. However, selection of variables for conventional demand analysis is often the result of naive empiricism. The Lancasterian framework provides a meaningful substitute approach that provides specific guidance for the selection of variables representing consumers' production technologies.

CASE STUDY: VIRGINIA'S LEESVILLE-SMITH MOUNTAIN RESERVOIR[3]

An empirical investigation of the implications of such a framework for boating demand estimation was undertaken for the Leesville-Smith Mountain Lake region in the Piedmont region of Southwest Virginia. Construction was undertaken in 1960; the lower portion (Leesville Reservoir) was completed in 1964, the upper portion (Smith Mountain Lake) in 1967. The reservoirs have a combined area of 24,100 acres of water surface and 510 miles of shoreline. They provide boating, camping, fishing, swimming and picnicking activities. The nearest similar water body is Philpott Lake, one with 2,880 acres of water surface completed in 1953 and located approximately 35 miles from Leesville-Smith Mountain Lake.

The demand function for boating in this region was thought to be[4]

$$Q_t = f(P_t, Y_t, I_t, Q_{t-1})$$

where

Q_t = Number of boats registered per 1000 households for each of eight counties from 1961 to 1973. This variable was considered to be a proxy for annual visitations to Leesville-Smith Mountain Lake by county.[5]

P_t = Price proxy measured by (average) total cost (cents/trip) for a household from each of eight counties to arrive at Philpott Lake (1961-1964) or Leesville-Smith Mountain Lake (1964-1973).

Y_t = Percentage of families earning the equivalent of $9,000 or more (1974 dollars) for each of eight counties from 1961 to 1973.

I_t = Index of aggregated physical characteristics associated with each reservoir (1961-1973). This variable consisted of a principal component-formed index of aggregated shoreline miles for Philpott and Leesville-Smith Mountain, aggregated reservoir size (water surface acres), aggregate number of boat ramps and marinas and aggregated number of camping and picnicking sites. The first eigenvector captured 96 percent of the variation in the data set and the factor score of the first eigenvector was utilized as an index number. This variable was representative of the facilities available through time, and because it represented recreational opportunities available, served as the "learning-by-doing" proxy.

Q_{t-1} = One year lagged boat registrations per 1000 households for each of eight counties from 1960 to 1972. This is a "neighborhood" effect proxy. The maintained hypothesis was that experience as reflected by n year's boating influences n+1 year's demand over the period of study.

Neither proxy, Q_{t-1} (the "neighborhood" effect) and I_t (the "learning-by-doing" effect), is a precise

---

[3] The findings of this case study are a part of a larger M.S. thesis study tentatively entitled, "Recreational Facility Provision Effects on the Estimation of Derived Demands for Boating," 1975, by Linda G. Hogue.

[4] It is extremely difficult to identify and quantify probable prices of substitutes and compliments for boating. Is, for instance, tennis a substitute for boating? If so, what is the relevant price to be included in the model? Even if prices of such substitutes and compliments with boating were available, it was felt that their inclusion would not significantly affect the empirical conclusions of this study.

[5] Since visitation by county to the reservoirs was not available, the number of boat registrations per 1000 households for each of the eight counties was used. Simple linear regression of boater registration by eight counties on aggregated annual visitations yielded adjusted R^2s of .73 to .91 and thus implies that boat registrations can serve as a proxy for annual visitations.

measure of the conceptual concepts for which they serve. For example, Q_{t-1} would also reflect some "learning-by-doing" effect; that is, one year's boating activities will involve some individuals' participation who will then register and use new boats the next year because of that participation. These variables (I_t,Q_{t-1}) together are assumed, however, to be sufficiently identified so that their statistical significance can be interpreted as suggesting the importance of supply availability with reference to both the "learning-by-doing" and the "neighborhood" effect.

Because this demand function captures, in part, effects of supply availability *per se*, it can be used to analyze implications of failure to recognize those effects in demand estimations.

The supply function for this reservoir site for a certain quality experience is such that, unless overcrowding occurs, the marginal cost of an additional user-day is zero. Thus, for purposes of this *specific site* study, total output is equal to the amount consumed. Single equation estimations are sufficient. Thus, this study addresses implications of ignoring supply availability effects on demand estimations, not the implications of ignoring aggregate supply interactions with aggregate demand.

Recreational Boating Equations

The demand model above was specified in equations of semi-log form.[6] The equations were estimated using ordinary least squares across eight counties for the years 1960-1973.

Construction of the Leesville-Smith Mountain Reservoir was started in 1964 and completed in 1967. The choice of 1960-1973 as observation years provided an opportunity to analyze the impact of a new reservoir (i.e., a large boating price decrease) on number of boats registered per year. The equation was estimated first without the "learning-by-doing" effect (I_t) or the "neighborhood" effect (Q_{t-1}). Each of the two effects were then added to the original equation: individually and then together. The "neighborhood" effect was expected *a priori* to be significant with a positive sign. That is, new boaters participate in the recreational activity because they have observed (or recreated with) others participating in the sport. At the same time, they are faced with new opportunities for boating by reason of a new reservoir (i.e., a lower price associated with boating). Also, it was expected *a priori* that the index of physical attributes, the "learning-by-doing" proxy, I_t, would have a significant and positive sign. This variable (I_t) captures the effect of addition of physical facilities on lower and upper lakes in this region, and increases positively and nonincrementally in 1964 and 1967 (less dramatic positive increases were also present on other years).

The equations estimated are shown in Table 1. Equation 1 can be interpreted as a benchmark equation from which to gain perspective of significance of the addition of the "learning-by-doing" proxy, I_t in equation 2; the "neighborhood" effect proxy, Q_{t-1} in equation 3; or both proxies together in equation 4.

Results suggest that both the "learning-by-doing" effect, as captured by the physical characteristics of the reservoir, and the "neighborhood" effect, as

TABLE 1. ESTIMATED COEFFICIENTS OF ALTERNATIVE MODEL SPECIFICATIONS

Equation Number	Number of Observations	Dependent Variable	Constant	Variables				
				P_t	Y_t	I_t	Q_{t-1}	Adj. R^2
(1)	108	$\ln Q_t$	2.425	- .01075 (-9.18)[a]	.03408 (10.13)			62%
(2)	108	$\ln Q_t$	3.354	- .01006 (-10.00)	.01557 (3.82)	.38562 (6.42)		72%
(3)	96	$\ln Q_t$	2.309	- .00475 (-5.78)	.01737 (7.76)		.01525 (14.36)	86%
(4)	96	$\ln Q_t$	2.686	- .00524 (-6.53)	.01216 (4.48)	.14029 (3.13)	.01353 (11.70)	87%

[a] Values in parentheses are t values.

---

[6] The semi-log form was selected over linear and double log forms as it consistently yielded superior fits and coefficients consistent with theorectical expectations.

captured in the lagged dependent variable, are indeed significant positive influences on the demand for boating. The addition of variable I_t to the benchmarket equation has increased the adjusted R^2 from 62 percent to 72 percent. Furthermore, the addition of variable Q_{t-1} to equation 1 resulted in an increase of adjusted R^2 to 86 percent (equation 3). Finally, the addition of both variables, I_t and Q_{t-1}, to equation 1 resulted in an adjusted R^2 of 87 percent. Thus, equation 4 has accounted for a larger proportion of the total variation of registered boats per 1000 households than any of the other three specifications.

Coefficients of all variables in all equations are significant at the 1 percent level, but significant differences exist between the magnitude of coefficients of variables between equations. For example, the price coefficient changed markedly between equation 1 and 4, from —.01075 to —.00524. These coefficients result in a more inelastic price elasticity of demand from —.946 to —.455 at a mean value of P when using equation 4 rather than equation 1 (Table 2).

Table 3 provides some evidence that equation 4 is the more appropriate equation for prediction purposes. It also displays estimated values of boat registrations per household versus actual registrations for each of the four equations for 1965 and 1970. In 1965, Leesville Reservoir had been open only one year; there was not yet time for the "learning-by-doing" or "neighborhood" effect to influence demand. Equation 1 slightly overestimated actual 1965 registrations; equations 2-4 underestimated the actual figure. This is not the situation in 1970, however. Now, a large relative price decrease due to the construction of a new reservoir has resulted in a consumption-technology shift through the "learning-by-doing" effect. This, coupled with the "neighborhood" effect, has resulted in the less sophisticated equation 1 substantially underestimating the actual registrations. In contrast, equation 4 which reflects these structural changes, is quite accurate in predicting actual registrations.

TABLE 2. ESTIMATED PRICE ELASTICITIES OF DEMAND

Equation Number	Elasticities When Price is Equal to:		
	Mean Value	1965 Value	1970 Value
(1)	-.946	-.830	-.866
(2)	-.886	-.777	-.835
(3)	-.413	-.367	-.394
(4)	-.455	-.405	-.435

The difference between these two equations is best illustrated in Figure 2. The supply availability effects (I_t,Q_{t-1}) suggest a shifting demand curve (4A to 4B).[7] The ex ante planning demand curve (1) which predicts well in the early years, consistently underestimates after the "learning-by-doing" and "neighborhood" effects have influenced demand to such an extent as to cause boating demand to shift. These results also suggest that any estimate of consumer surplus from the first estimation would underestimate the more accurate consumer surplus from the fully specified demand equation. Thus, benefits from the provision of a new reservoir in an area with few previous facilities could easily be underestimated if the increased demand from "learning-by-doing" and the "neighborhood" effect were ignored.

SUPPLY AVAILABILITY AND RECREATIONAL RESOURCE ALLOCATION

The Lancasterian framework, as applied to recreational derived demand studies, suggests a need for including demand variables that reflect the existing consumer's production technology associated with

TABLE 3. ESTIMATED VERSUS ACTUAL BOAT REGISTRATIONS PER 1000 HOUSEHOLDS

Equation Number	Boat Registrations When Independent Variables are at:					
	1965 Values			1970 Values		
	Actual	Estimated	Difference	Actual	Estimated	Difference
(1)	24.2	26.5	+2.3	44.7	34.3	-10.4
(2)	24.2	20.3	-3.9	44.7	46.4	+ 1.7
(3)	24.2	22.1	-2.1	44.7	40.9	- 3.8
(4)	24.2	20.6	-3.6	44.7	45.0	+ .3

---

[7] Demand equations 4A and 4B were plotted by using 1965 and 1970 data, respectively.

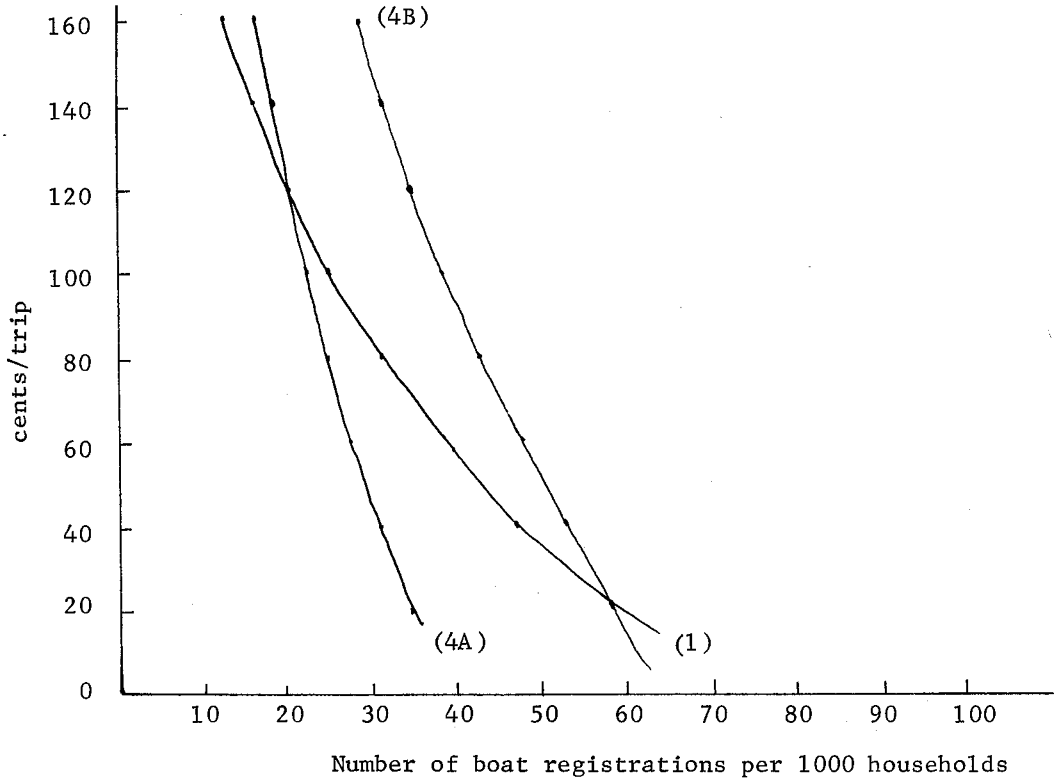

FIGURE 2. ESTIMATED DEMAND SHIFTS (4A, 4B), ASSOCIATED WITH ADDITIONAL SUPPLY AVAILABILITIES AS CONTRASTED WITH EX ANTE DEMAND ESTIMATIONS (1)

the recreational activity as well as conventional demand variables. These technology variables for boating include the "learning-by-doing" and the "neighborhood" effect, when there has been a large (relative) price decrease associated with participating in a recreational activity. In many recreational studies, where only limited recreational facilities exist, the influences of large price changes on consumer production technologies might best be managed by considering supply characteristics and availabilities *per se.*

The case study reported here suggests that failure to consider these effects may result in faulty projections of future attendance and in underestimating the benefits (consumer surpluses) associated with the provision of additional facilities. Such omission may also result in overestimating (absolute) price elasticity measures. These biased estimations, in turn, may misguide resource planners in their attempts to optimally allocate recreational resources.

The case study did not, however, suggest the precise nature of these supply-availability related effects over time. For example, it is reasonable to believe that the "learning-by-doing" effect is not a linear function of time over very many years. Rather, the greatest demand curve shifting associated with this effect should occur the first few years after a new facility is built in a region. After several years, this effect will probably dampen and no further increases in quantity taken will be observed.

Similarly, the effect will be greatest on the first few such facilities built in a region and less for an additional construction. The implications of findings reported here for resource allocation are most significant for predicting short run adjustments to new facilities. Yet, failure to be cognizant of the "learning-by-doing" and "neighborhood" effects, and their relationship to demand, could cause smaller-than-actual benefits to be estimated for new construction in regions with a paucity of such facilities. Attendance at such recreational areas could also be underestimated and therefore there might be insufficient physical facilities.

These considerations suggest that further investigation of the implications of the Lancasterian framework to the projection of use and estimation of benefits stemming from recreational activities would have a high payoff.

REFERENCES

[1] Cicchetti, C., J. S. Seneca and P. Davidson. *The Demand and Supply of Outdoor Recreation: An Econometric Analysis*, Bureau of Economic Research, Rutgers, New Brunswick, N.J., 1969.

[2] Clawson, M. and J. L. Knetsch. *Economics of Outdoor Recreation*, Baltimore: John Hopkins Press, 1966.

[3] Lancaster, Kelvin J. "A New Approach to Consumer Theory," *The Journal of Political Economy*, Volume 74, Number 3, pp. 133-157.

[4] Mackay, Robert J. and T. F. Hogarty. "Some Implications of the 'New Theory of Consumer Behavior' for Interpreting Estimated Demand Elasticities," *American Journal of Agricultural Economics*, Volume 57, Number 2, pp. 340-343, 1975.

[5] Mishan, E. J. *Cost Benefit Analysis: An Introduction*, Praeger Publishers, Inc., 1971.