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# Incidental and Joint Consumption in Recreation Demand

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A theory for analyzing incidental consumption in a single site recreation demand model is presented. We show that incidental consumption on a recreation trip, such as a visit to see friends or a visit to a second recreation site, can be treated as a complementary good and analyzed using conventional theory. We also show that the analysis applies whether the side trips are incidental or joint. In a simple application we find that failing to account for incidental consumption appears to create little bias in valuing recreation sites.

In a single site recreation demand model the following equation is estimated:

$$(1) \quad x = f(p, s).$$

The dependent variable  $x$  is the number of trips taken by an individual to a specific recreation site during a season. The independent variable  $p$  is the travel plus time cost of reaching the site—the price of a trip. The vector  $s$  is a set of demand shifters including household characteristics such as family size and income, prices of other recreation sites and, if a pooled model is being estimated, site characteristics such as environmental quality. (See Bockstael 1995; Freeman 1993, ch. 13; Smith 1989; and Bockstael, McConnell, and Strand 1991 for more on the travel cost model.)

If the trips measured by the variable  $x$  are made for the sole purpose of recreation at the site, the interpretation and analysis of the demand equation is rather unambiguous. If the measured trips include multiple purposes, such as a side trip to see family and friends or to engage in business, the dependent variable  $x$  is capturing something beyond simple recreation use of the site and the interpretation of the demand equation is no longer straightforward. For this reason, most authors claim that “sole purpose” is a basic assumption underlying the model. For example, Freeman writes that “it is assumed that each trip to the site is for the sole purpose of visiting the site. If the purpose of the trip is to visit two or more sites or to visit a relative en route, then at least part of the

travel cost would be joint cost that cannot be properly allocated among different purposes” (1993, p. 447). Smith and Kopp note: “The travel cost method assumes that the trip is intended for the use of the recreation site only and not to serve multiple objectives” (1980, p. 64). Haspel and Johnson state: “The travel cost method assumes among other things, that all travel costs are incurred exclusively to obtain access to the single specific recreation site” (1982, p. 364).

The purpose of this article is to present a theory for incorporating incidental consumption into a single site recreation demand model. By *incidental consumption*, we mean that trips are taken primarily for the purpose of visiting a designated recreation site but also include some incidental side trips for other purposes. If the recreation trips are not made, the side trips are necessarily foregone. We treat incidental consumption as a good that complements the recreation trip and then analyze the problem using conventional demand theory. The assumption that the side trips are incidental allows us to allocate total trip cost to recreation and side trip consumption. We also show that the theory of incidental consumption may be applied in cases where the side trips are jointly consumed with recreation. By *joint consumption* we mean a trip taken for dual purposes, in which, if either of the purposes is lost, the trip is not taken at all.

Using the theory as a guide, we then estimate a simple model of recreational fishing in Maine, first accounting for incidental consumption and then not. The results suggest that there is little bias created by ignoring incidental consumption. Consumer surplus estimates for the value of a lost site when incidental consumption is not accounted for in the analysis tend to understate (although only

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slightly) the estimates obtained when incidental consumption is accounted for in the analysis.

### A Theory of Incidental Consumption

Consider the following model of recreation demand. An individual has three choice variables:  $x$  is the number of recreation trips in a given season to a specific site,  $y$  is the number of trips incidental to the recreation trips, and  $z$  is all other goods and services. For now, assume that the incidental trips are side trips to visit friends who live near the recreation site. The individual behaves according to

$$(2) \quad \text{Maximize } \{U(x, y, z) | p_x x + p_y y + p_z z = I \text{ and } x \geq y\}.$$

The usual binding budget constraint is accompanied by the inequality constraint  $x \geq y$ . This constraint follows from the assumption that  $y$  is incidental to  $x$ . Since incidental trips are taken only if a recreation trip is also taken, the individual can at most take only as many incidental trips as recreation trips. The price of the recreation trip,  $p_x$ , is the usual sum of travel and time cost to reach the recreation site and return to the person's home. The price of the incidental trip,  $p_y$ , is the sum of travel and time cost beyond that required to reach the recreation site. The incidental trip cost is, after all, just the added cost of making the side trip.

We assume no more than one side trip on each recreation trip. This abstraction has no effect on the intrinsic theory and eases the presentation considerably. We also assume the person takes no trips for the primary purpose of visiting friends who live near the recreation site. To relax this assumption, we need only include two types of trips to visit friends in the model:  $y$  for incidental trips and  $y'$  for sole purpose trips. The relevant prices would be  $p_y$ , as in model (2) and  $p_{y'}$ , the travel plus time cost of reaching the friend's home from the primary residence.

The dual to our utility maximization problem gives the expenditure function

$$(3) \quad e(p_x, p_y, p_z, U^0) = \min\{p_x x + p_y y + p_z z | U(x, y, z) = U^0 \text{ and } x \geq y\}.$$

The welfare loss (compensating variation) associated with losing the recreation site is

$$(4) \quad \omega = e(p_x^*, p_y^0, p_z^0, U^0) - e(p_x^0, p_y^0, p_z^0, U^0)$$

where  $p_x^*$  is the relevant choke price to induce zero trips. The incidental consumption constraint in no

way invalidates this conventional measure. (For more on basic welfare analysis, see Varian 1992 or Just, Hueth, and Schmitz 1982.)

What is important to recognize here is that the expenditure function evaluated at  $p_x^*$  and at  $p_x^0$  assumes an optimal adjustment of  $x$ ,  $y$ , and  $z$ —whatever adjustment is required to minimize cost while satisfying the constraints. At  $p_x^*$ , since  $x = 0$  by definition, it must be the case that  $y = 0$  to satisfy the constraint in equation (3). If the recreation site (the purpose for making the primary trip) is lost, the incidental trip is also lost. The welfare measure  $\omega$  for loss of a recreation site then accounts for the value of lost recreation and lost incidental consumption. Since  $x$  and  $y$  are driven to zero at  $p_x^*$ , it follows that  $\omega$  is just the amount of income needed to raise  $z$  in  $U(0, 0, z)$  until  $U(0, 0, z) = U^0$ .

The incidental consumption constraint in no way violates the derivative property of the expenditure function. It is still the case that

$$\partial e / \partial p_x = h(p_x, p_y, p_z, U^0),$$

where  $h(\cdot)$  is the Hicksian demand curve for recreation trips. It follows that

$$(5) \quad \omega = \int_{p_x^0}^{p_x^*} (\partial e / \partial p_x) dp_x = \int_{p_x^0}^{p_x^*} h(p_x, p_y^0, p_z^0, U^0) dp_x.$$

As usual, the area under a Marshall counterpart to equation (5) is an approximation to  $\omega$ . As is the case for any demand function, the consumer surplus loss  $\omega$  for a price rise implicitly accounts for the adjustment of all other goods and services. In our case incidental consumption  $y$  is necessarily adjusting (it goes to zero). What is interesting about this result is that by using a demand curve for recreation alone, one can compute the correct welfare measure for loss of site even though the trips are being made for multiple purposes. Individuals may substitute sole purpose trips to see friends for the lost side trips. If so, sole purpose trips should be included in the analysis, as discussed in the previous section.

The analysis also points out that in the presence of incidental consumption, the demand function for recreation trips includes the price of incidental consumption as a right-hand side variable, and that price should be accounted for in the analysis. If all else is constant, trip demand increases as the price of incidental consumption falls. "All else" here includes characteristics of the individual (experience, age, income) and, if a pooled model is being estimated, characteristics of the site (quality and

size). Stated differently, as the price of a complementary good (incidental consumption) declines, the demand for trips increases. If a person has an opportunity for a desirable side trip, that opportunity can at worst have no effect on trip welfare and can possibly raise trip welfare.

Hence, the demand curve used to estimate lost recreation value should account for incidental consumption through some shift (and possibly interaction) variables. Otherwise, the demand curve will be estimated with omitted variable bias, which in turn will bias the site value estimates and even values for quality changes. The size and direction of the bias depend on how  $p_y$  is correlated with the included arguments in the estimated demand function, most notably with  $p_x$ . If  $p_y$  is uncorrelated with the included arguments, it can safely be ignored. If  $p_y$  is positively correlated with  $p_x$ , values will tend to be understated, because the estimated demand function will be too flat. If negatively correlated, values will tend to be overstated. The estimated demand function will be too steep.

For valuing changes in site quality, we must *also* be concerned about correlation between  $p_y$  and the right-hand side variable for site quality. If  $p_y$  is excluded from the model, the estimated shift due to differences in quality will pick up differences in incidental consumption cost as well. Since site quality values measure the area between with and without demand curves, bias may arise. Again, the direction and size of the error depend on the direction and degree of correlation. Positive correlation (where quality is measured as a good) leads to understatement, because quality would serve, in part, as a proxy for a bad thing. Negative correlation would lead to overstatement.

### What If Recreation Is Incidental?

In this case an individual has the same three choice variables:  $x$ ,  $y$ , and,  $z$ . But now,  $x$  is incidental to  $y$ . The individual behaves according to

$$(6) \text{ Maximize } \{U(x, y, z) | p_x x + p_y y + p_z z = I \text{ and } y \geq x\}.$$

The problem has changed in two ways. First, the incidental consumption constraint has  $y \geq x$  instead of  $x \geq y$ . Since recreation trips are now incidental, the individual at most takes only as many recreation trips as trips to visit friends in the area. Second, the price of a recreation trip is now the incremental travel and time cost required to reach the recreation site while visiting friends.

The expenditure function is

$$(7) \quad e(p_x, p_y, p_z, U^0) =$$

$$\min\{p_x x + p_y y + p_z z | U(x, y, z) = U^0 \text{ and } y \geq x\}.$$

with the new incidental consumption constraint and definition for recreation trip price. The welfare loss for losing the site is

$$(8) \quad \omega = e(p_x^*, p_y^0, p_z^0, U^0) - e(p_x^0, p_y^0, p_z^0, U^0)$$

where  $p_x^*$  is the choke price that induces zero recreation trips. Notice now that as  $x$  is driven to zero by the choke price,  $y$  need not go to zero or for that matter change at all, since the constraint now has the form  $y \geq x$ . Once again, the derivative property of the expenditure function still holds, so we can write

$$(9) \quad \omega = \int_{p_x^0}^{p_x^*} (\partial e / \partial p_x) dp_x = \int_{p_x^0}^{p_x^*} h(p_x, p_y^0, p_z^0, U^0) dp_x.$$

Again, the value of a site is just the area under its Hicksian demand curve.

The following dynamic should be evident in the model. If a person has a low primary purpose trip price, we expect that person to make more primary purpose trips and hence to have more opportunities to make side trips to the recreation site at price  $p_x$ . If the primary purpose trip price is raised, these opportunities are lost or become much more costly. Indeed, the demand curve for recreation trips will be kinked (become very inelastic) at  $x = y^*$ .

The implication for empirical analysis once again is that the value of a lost recreation site is captured fully in the recreation demand function. In the estimation it is important to adjust trip price and to account for the cost of getting to the primary purpose site. Ignoring the primary purpose trip price will introduce omitted variable bias.

### A Theory of Joint Consumption

Now consider the same basic three-good model, but assume that recreation trips  $x$  and visits to friends  $y$  are consumed jointly. The trip is taken for dual purposes. If either of the purposes is lost, the trip is not taken. This circumstance turns out to be of little consequence for the method in the previous section. Assume for now that all trips are joint. Again, this simplifies the exposition with no loss in the intrinsic theory. Let  $p_\omega$  be total trip cost and  $\omega$  be the number of joint trips. The model becomes

$$(10) \text{ Maximize } \{U(\omega, z) | p_\omega \omega + p_z z = I\}.$$

This redefines the trip as a single joint commod-

ity—a bundle of  $x$  and  $y$ . This version of the model is the same as Mendelsohn et al.'s model (1992)—wherein multiple purpose trips are treated as sole purpose bundled trips.

To see how the joint model fits our method in the previous section, consider the following decomposition. Let  $p_\omega = p_x + p_{y'} - p_d$ , where  $p_x$  is the cost of a sole purpose trip for recreation,  $p_{y'}$  is the cost of a sole purpose trip to visit friends, and  $p_d$  is the discount one receives if  $x$  and  $y$  are consumed jointly instead of separately. By assumption, it follows that  $\omega = y = x$ .

Rewrite the joint model as

$$(11) \quad \text{Maximize } \{U(x, y, z) | p_x x + p_{y'} y - p_d \omega + p_z z = I \text{ and } \omega = x = y\}.$$

Substitute  $y$  for  $\omega$ , and the problem becomes

$$(12) \quad \text{Maximize } \{U(x, y, z) | p_x x + (p_{y'} - p_d)y + p_z z = I \text{ and } x = y\}.$$

The price of  $y$  is  $p_{y'} - p_d$ , which is just the incremental cost of consuming  $y$  while on the recreation trip. The model treats  $y$  as incidental to  $x$  with the incidental consumption constraint always binding.

The expenditure function is just

$$(13) \quad e(p_x, p_{y'}, -p_d, p_z, U^0) =$$

$$\min\{p_x x + p_{y'} y - p_d y + p_z z | U(x, y, z) = U^0 \text{ and } y = x\}.$$

The welfare loss for loss of the recreation site is now

$$(14) \quad v = e(p_x^*, p_{y'}^0, -p_d^0, p_z^0, U^0) - e(p_x^0, p_{y'}^0, -p_d^0, p_z^0, U^0).$$

As before, the expenditure function evaluated at  $p_x^0$  and  $p_x^*$  assumes an optimal adjustment of  $x$ ,  $y$ , and  $z$ . At the choke price  $p_x^*$ , since  $x = 0$  by definition, it follows that  $y = 0$  as well. If the recreation trip is lost, so is the joint consumption good. The welfare loss is just the value of  $z$  needed to set  $U(0, 0, z) = U^0$ .

Using the Hicksian demand curve (the derivative property is still intact), it follows that

$$(15) \quad v = \int_{p_x^0}^{p_x^*} h(p_x, p_{y'}^0, -p_d^0, p_z^0, U^0) dp_x.$$

Again, the value of the lost recreation site is fully captured under the demand curve for recreation trips even though the trip is made for multiple purposes. And again, the demand curve has the price

of the incidental (or now joint) consumption good as an argument on the right-hand side. Therefore the equation we estimated in the previous section still follows from the theory, even if the consumption is joint instead of incidental.

It may be somewhat puzzling that the entire value of the joint trip can be captured under the demand curve for just one part (recreation) of the trip. For an intuitive explanation, consider a simple example. Sam never eats eggs without ham, and never eats ham without eggs. If one calculates Sam's total consumer surplus for eggs, it will capture his full value of eggs and ham over the designated time period. In calculating the egg consumer surplus, as the price of eggs moves up toward its choke value, Sam is simultaneously reducing egg and ham consumption. The consumer surplus, thereby, picks up implicitly the value of the joint or complementary good. It is a fundamental result in welfare economics—the area under a single demand equation accounts for the adjustment of all other goods and services. The egg demand equation, by the way, will include the price of ham as an argument with a negative coefficient. It also stands to reason that the same consumer surplus, exactly, resides under the ham demand equation. The same logic applies to recreation and its side trips.

## An Empirical Example

We now turn to a data set that includes two types of recreation trips: sole purpose recreation trips and recreation trips with incidental consumption. We estimated three pooled demand models using the data. Two account for incidental consumption, and the other does not. The data are for persons making day-trips for fishing in Maine during the summer of 1989 and are part of a larger data set collected for the purpose of measuring aquatic damages caused by acid rain.

The data were gathered by phone survey and cover a random draw of residents from Maine, New Hampshire, New York, and Vermont. An initial screener survey identified respondents having made or planning to make trips to water-based sites during the year and collected the usual demographic data. The screener was followed by two detailed surveys covering specific trips taken for boating, fishing, swimming, and viewing. These two surveys were the same except that one was given in the middle of the season and the other late in the season. There were several pretests in the spring and early summer. The overall response rate was 75%. Shankel (1990) gives a detailed descrip-

tion of the data. Some other applications with the data include Englin and Shonkwiler (1995) and Cameron and Englin (forthcoming). Our analysis focuses on Maine residents making fishing trips.

Respondents were asked to provide detailed information on trips made primarily for the purpose of recreational fishing. After reporting the number of trips made to each lake or river visited, the respondent was asked (among other things) if his or her trips were influenced by the presence of (1) friends living in the area, (2) relatives living in the area, (3) business associates located in the area, or (4) other general destinations in the area. Over half of the respondents said yes to at least one of these questions. Since all trips were being made primarily for the purpose of recreation, it appears that incidental consumption for day-trip fishing in Maine is rather common.

To account for the effects of incidental consumption, we estimate the following demand equation:

$$\ln(x) = \alpha p_x + \beta s + \gamma D$$

where  $x$  is number of trips. From the theory above, we know the equation should include the price of reaching the site and the price of incidental consumption. The term  $p_x$  is the travel plus time cost of reaching the site, and  $D$  is a dummy variable intended to capture the effect of incidental consumption (a proxy for  $p_y$ ). The term  $s$  is a vector of shift variables such as income. The price  $p_x$  is measured exclusive of side trip costs. It includes travel and time cost. (The travel cost is computed as thirty cents times the round-trip travel time of reaching the site. The time cost is computed as one-third the wage rate. For individuals on fixed income, we assume the wage is annual income divided by 2080. Retirees and students are assumed to have a time cost of ten dollars per hour.)  $D = 1$  if the respondent indicates that his or her typical trip to the site is influenced by incidental consumption (see the four categories in the previous paragraph). Given the different types of incidental consumption and the difficulty in measuring these incremental costs, we decided that using a dummy variable as a proxy for price was a reasonable strategy. In this way we expect to capture average shifts in recreation demand due to incidental consumption. We expect  $\gamma > 0$ . In addition to the basic model of equation (16), we estimated a (less restrictive) model in which  $D$  was interacted with all of the arguments in the demand equation.

The results are presented in table 1. All models were estimated using a truncated Poisson regression. The data are truncated because we include only participants in the analysis,  $x \geq 1$  for each observation. In model 1 we ignore the effects of

**Table 1. Truncated Poisson Recreation Demand Equations for Fishing Trips in Maine, 1989**

Variable	Model 1	Model 2	Model 3
Constant	1.8 (.06)	1.4 (.07)	1.6 (.13)
Price	-.017 (.001)	-.016 (.001)	-.013 (.002)
Income	.002 (.0007)	.003 (.0007)	-.013 (.002)
Expert	.14 (.04)	.19 (.04)	.72 (.08)
Big Lake	.099 (.007)	.10 (.007)	.11 (.01)
Big River	.26 (.09)	.21 (.09)	.07 (.18)
Eutro	-.45 (.04)	-.47 (.04)	-.76 (.09)
D	—	.62 (.04)	.50 (.15)
D * Price	—	—	-.006 (.002)
D * Income	—	—	.02 (.002)
D * Expert	—	—	-.83 (.09)
D * Big Lake	—	—	-.03 (.01)
D * Big River	—	—	.15 (.21)
D * Equality	—	—	—
n	341	341	341
Mean of Dependent Variable	1.11	1.11	1.11
Mean Consumer Surplus for Loss of Site	\$412	\$442	\$433

Standard errors are in parentheses.

Variable Definitions:

Price = travel + time cost; Income = reported annual family income; Expert = 1 if respondent indicated that he or she was an experienced angler; Big Lake = logarithm of acres of lake if site was a lake; Big River = 1 if site was a major river in Maine; Eutro = 1 if site was eutrophic; D = 1 if trip involved incidental consumption.

incidental consumption. It is our business-as-usual regression. In model 2 we account for the effects of incidental consumption using a dummy variable. In model 3 we account for the effects using a fully interacted model. The latter two corrected models performed much as expected—incidental consumption worked like a complementary good.

The mean consumer surplus in the sample for a loss of site is presented for each model. As shown, the bias due to ignoring the effects of incidental consumption appears to be rather small. In all cases, ignoring incidental consumption leads to an underestimate of site value on the order of 4–8%.

**Conclusion**

Incidental consumption in a single site recreation demand model may be handled by treating incidental purposes as goods that complement the recreation trip. The incidental purposes may be side trips (to visit family, friends, or a shopping mall) or trips to other recreation sites, or may involve dif-

ferent types of recreation on the same trip (fishing with an incidental swimming trip).

The price of incidental consumption is just the incremental trip cost of making a side trip while visiting the recreation site. That price is an argument in the recreation demand function that shifts the function as any complementary good does. We have four important theoretical findings: (1) The model shows that loss of the recreation site involves the dual loss of access to the site and incidental consumption while visiting the site. Incidental consumption in this sense is not unwanted baggage being picked up by the model; it is a part of the real loss. (2) At the same time, the model shows that this total value is fully captured in the consumer surplus in a recreation demand function that accounts for incidental purposes. (3) The model also shows that failing to account for incidental purposes is equivalent to omitted variable bias—omitting the price of the complementary good. (4) Finally, the results apply to cases where recreation is consumed jointly with other purposes.

We estimated a pooled model using a simple dummy variable for incidental consumption. The dummy variable was intended to capture average shifts in recreation demand due to incidental consumption. The incidental consumption effect worked as anticipated, like a complementary good. Given our imprecise measure of the price of incidental consumption, the empirical model is best viewed as a rough first approximation.

The results of the welfare calculation for loss of site were favorable for business-as-usual models that ignore the effects of incidental consumption—good news since such effects are widely ignored. Our data set has an incidental consumption rate of over 50%, yet accounting the effects changed our welfare estimates for loss of site only slightly. The business-as-usual model underestimated site loss by about 4–8%.

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