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The Road Less Traveled: Revealed Preference and Using the Travel Cost Model to Value Environmental Changes

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> *"So you see, this guy wouldn't bother driving all the way to that forest land and back if the value of his hiking experience there wasn't as least as big as his cost of doing that."*

In the early 1990s, a lot of environmental or resource economists found themselves saying something like the above to state and federal government officials, politicians, lawyers, physical scientists, and other noneconomists. They were, of course, trying to communicate the essential idea behind the values obtained with the travel cost model without exactly technically explaining what consumers' surplus is (hoping against hope that their audience would not be put straight to sleep!). The latter and complete explanation of and wrangling over consumers' surplus measures, which are essentially estimated maximum willingness to pay (WTP) or minimum willingness to accept compensation (WTA), often had to be done in the context of the politics surrounding controversial issues, and accompanied the boom period for large natural resource damage assessment (NRDA) cases in America, such as the Exxon Valdez oil spill. These types of applications are discussed a bit in the last portion of this paper, after the reader has had a chance to learn what travel cost modeling is all about.

The travel cost model (TCM), or recreation demand modeling approach, is a revealed preference method that fundamentally depends on observing actual behavior (trips taken over some period) rather than on answers to hypothetical questions. Let's say you just like to take a Sunday drive to look at the country, smell some fresh air, or whatever. Maybe this countryside view is of agricultural land and maybe there is a picnic area out there and you stop and enjoy the view and all the amenities while eating your lunch. Is that scenic drive and picnic worth something? Most certainly it is, or we assume you would not do it. Economists assume that a rational person evaluates the costs of the drive in gasoline and motor vehicle costs, along with the opportunity cost of time, as one could always be doing something else with that precious time. The essence of revealed preference is in making the choice to take the drive and get the benefits from the picnic, or not. It is one approach to valuing nonmarket goods.

In contrast, the stated preference valuation approach [e.g., contingent valuation method (CVM) questions] just asks how much people are willing to pay to restore resources to a healthier condition. This stated preference approach is easy for a noneconomist to understand, but revealed preference concepts are much less, so the TCM is indeed the less traveled road in nonmarket valuation. As I will demonstrate below, despite the simplicity of the CVM, many economists believe the TCM has some obvious advantages over often controversial stated preference approaches; perhaps we can most easily glean the truth in what we see people actually doing, not from listening to what they say they will do. In other words, the recall a person has for the trips she takes is perhaps not laden with as many difficulties that may underlie the answer to a valuation question.

> In a revealed preference valuation exercise, one examines the valuation of a resource by studying observed travel behavior and expenses or other forms of expenditures incurred in visiting and using the resource.

The idea for the TCM is not new. Its origin is in a letter from the economist Harold Hotelling, to the director of the National Park Service, in the late 1940s. Using the TCM, one can examine what people do and infer the value for a resource from observing their trips to and from recreation destinations. At first, economists wanting to implement Hotelling's idea simply collected information from automobile license tags, especially when the tag numbers and letters could be used to identify the state and county from which the driver came. With this information only, one could infer that at least one trip was taken from the country of origin, or *zone*, and the approximate distance the driver traveled could be estimated. Using an estimate of the per-mile cost of driving the automobile, the economists could then assign a cost to each trip coming from any particular county. This cost is assumed to be the price of that trip. This basic idea was used by many early travel cost modelers who applied data and actually estimated the value of recreation destinations.

Putting it simply, values from the TCM are extracted as areas under recreation demand functions, where the quantities demanded are trips taken to the recreation destination, be it a lake, river, or some public land, and the prices are basically measured using the travel costs incurred on the trip. With costs serving as trip prices on the vertical axis (see Figure 1) and trips on the horizontal axis, we see the trip demand curve. With enough data to provide variation in trip and cost combinations, economists can estimate the shape of the demand curve for something like the countryside area depicted above.

The TCM has come a long way since it was originally proposed by Hotelling. Early regional and aggregated travel cost models (those that used all of the reported trips from a county or origin zone) in vogue in the 1970s have almost completely been abandoned in favor of the individual-specific brand of models. Using more complete data collected using mail or other kinds of survey questionnaires, economists model an individual's demand for one or perhaps many recreation destinations. Data on the time spent while traveling and at the recreation destination led to incorporation of time into recreation demand models by several scholars in the late 1970s. The exact role that time plays in travel cost models is still debated by recreation researchers today, but most agree it has an important one.

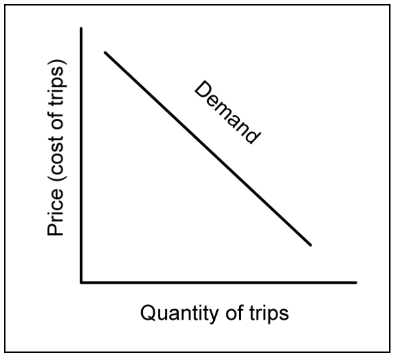

Figure 1. The trip demand function.

At about the same time as the work on time was underway (the late 1970s and early 1980s), two econometric models emerged that more carefully considered the nature of the recreation quantities, the trips, than the use of more basic econometric models would allow. To better handle substitution to other destinations, as well as properties of trips, some economists thought to use discrete choice modeling frameworks within a random utility model of recreation, similar to the way that many transportation economists were already using these models to estimate urban commuting trips. Their innovations led to many advanced statistical approaches. It is fair to say that TCM modelers can compete with almost any applied economist in the complexity of the micro-econometric modeling undertaken.

The travel cost approach certainly is not free from criticisms and I am quite supportive of well-done contingent valuation. To provide a balanced view in the context of valuation, first, it is probably much more difficult for the lay person to understand exactly where the benefits for the recreational resource come from in the application of the TCM, as opposed to the contingent valuation approach. A second point pertains to the recovery of the WTA, as well as the WTP using travel cost models. This can be done in theory, but differences can only be ascertained when the modeler incorporates income effects, which is very rarely done. I'll return to this below. In addition, it is only very recently that any economist has had the notion that revealed preference models can be used to uncover values that are not associated with actual use of the resource (e.g., nonuse or passive use/preservation values). Remember, there is nothing in economic theory that rules out the possibility that we might value the rural countryside even when we stop going to look at it. Though a recent paper suggests new thinking (see Herriges, Kling, & Phaneuf, 2004), all existing empirical estimates of nonuse values have relied on stated preferences for data, not revealed preference data collected in application of the travel cost model. Finally, the exact construction and definition of the ever-important travel cost variable itself is the subject of ongoing debate, particularly as it relates to the appropriate inclusion of time costs.

Some may say that many recreation demand modelers got obsessed with the little details of the travel cost models, econometric and otherwise (e.g., how components of the travel cost variable should be specified; what components can be ignored, if any; what the variance of the count data model is, etc.), in the past ten years or so. So, it is perhaps important to remember that the big attraction to using the travel cost model for environmental economics exists because of the very nice link between recreation and the environment. The hypothesis, which has typically not been rejected in empirical work, is that people who engage in all types of outdoor recreation activities care about environmental conditions. How do we use the TCM to value environmental changes on forests and other public lands? For example, how can the TCM be used to value a loss in agricultural and rural lands? The answer begins in the early 1980s, when a few economists thought to incorporate the use of recreation destination characteristics themselves, allowing estimation of demand and values for changes in those characteristics. We can consider open or green space acreage near the picnic area on our Sunday drive as such a characteristic.

The advantage of the characteristics approach over previous methods is that smaller and more well-defined changes could be examined than in models with no site characteristics. For example, rather than evaluating the addition of an entire new rural area, one could use characteristics in the modeling to evaluate the addition of a few acres of rural land or, conversely, the loss of such acreage. Other important resource characteristics might be acres of habitat for certain species of trees or a particular animal; any feature of public land that can readily be measured and quantified can be incorporated into a travel cost analysis.

Simplifying a bit here, one might think of the value for the environmental change as the area between two recreation demand functions, where a higher function is positioned (the demand is shifted out in Figure 1) because of an improvement in environmental amenities or characteristics at one destination. The TCM was used in the early 1980s to evaluate the change in characteristics at Colorado and Australian ski areas and the characteristics idea quickly caught on, and was applied to evaluate other environmental changes, in other contexts. For example, in my PhD dissertation I considered changes in catch rates for fish that might be affected by acid rain in New York's Adirondack mountains. Using Edward Morey's recreation share equation framework, I obtained consumers' surplus estimates calculated for those changes. Next, aside from making sure that data on these characteristics are collected, how does one really do this evaluation?

How to Evaluate Environmental Impacts or Changes

Return to the Sunday drive example presented above. If the *countryside* is at risk of being overrun with condominiums or other houses or buildings, maybe some will make this drive and picnic less, or not at all. How can we use revealed preference to evaluate the loss; should this happen?

As the above indicates, today's most popular specific travel cost methods are the random utility and count data approaches. Most modern TCMs can be used to evaluate the impact of changes in environmental quality on public and rural lands. [Note that the single-site Count Data TCM does not allow revealed preference estimation of the value for environmental changes unless there is a time series of observations because there is no variation in the environmental characteristic at one recreation destination, at one point in time.]

One can usually incorporate recreation destination characteristics that reflect environmental quality by using a model that allows estimation of multiple destination demands (or allows for the probability of taking a trip to more than one recreation destination, and therefore, of course, substitution between such destinations). For forested sites, the amount of total forested acreage, or the amount of acreage in specific species of trees, or in healthy or mature (e.g., *old growth*) acreage, might be used. For other types of land that involve species of wild animals (e.g., targeted species for hunters), the populations of these animals, or acreage of species habitat, might be used.

> Early applications of the travel cost model were to large-scale water projects proposed in the early 1960s, as the U.S. Bureau of Reclamation recognized that there could be recreational benefits accompanying their projects. Conversely, several prominent resource economists in the same era used the method to halt a dam being built on the Snake River, which would have eliminated white water recreation in Hell's Canyon.

The travel cost model is first estimated or calibrated using existing levels of characteristics (i.e., the acreage amounts that exist at each destination). Elasticity estimates can be calculated for any model, though in some cases these are a bit complicated to calculate. After econometric estimation of parameters, formulas for most measures of consumers' surplus can be derived, programmed, and calculated. Using these formulas, one might, for example, estimate the maximum willingness to pay for, or minimum willingness to accept, a change in the characteristics. There is no difference between these when income effects are not present in the model, as in the case of underlying utility functions that are linear in income. However, I can think of many situations where we might suppose that income effects are important, as in evaluating whether low income groups would have the same values for resource changes as high income individuals; think of the urban poor trying to get to a picnic in the rural countryside, versus the wealthy individual who owns a second home in that countryside area.

Suppose the demand for rural areas is shown to be positively related to the amount of bird habitat available on them. The WTP or WTA can in theory be estimated for, say, a one-acre or any acreage increase in the size of this habitat at one or more such parks. Using computer code, one can adjust the original levels of characteristics and use the formula to determine the monetary equivalent of the change in utility that corresponds to this change. In this way, respondents are not asked, at least in strict revealed preference modeling, to state their values for the environmental change.

The volume of travel cost literature is now fairly substantial, although these papers are not as numerous as the ones that apply the contingent valuation approach. Early applications of the TCM (those in the 1970s) most likely do not value environmental changes, but many recent ones do. I suspect, though I have not accurately counted, that most values in the TCM literature are for changes that pertain to aquatic resources: changes in catch rates for species in rivers, or more likely, for lakes that might be the result of environmental improvement or damage, or changes in water quality. That is probably because of the fact that readily available data accompanied the evaluation of controversial water projects in past years. Still, the TCM has been applied to obtain estimates for the value of the more unusual activities of rock climbing, mountaineering, and mountain biking.

Again, perhaps of more interest to readers here, are possible changes affecting public or rural lands, as it is well known such lands are shrinking. Estimates of recreation-related value for changes on forested lands are already in the literature, including recent efforts by some economists to value protection against the risks associated with forest fires, but other estimates need to be obtained for activities such as bird-watching, taking a simple walk. or having a picnic.

The Challenges and the Road Ahead

While stated preference approaches came under vicious attack in the 1990s, raising the cost of doing such studies and perhaps ultimately causing many trustees to shy away from rigorously pursuing NRD cases today by using state-of-the-art valuation approaches, the travel cost method was less objected to by these same parties and their economists. In fact, a recent winner of the coveted Nobel Prize in Economics, and an economist who more or less worked for Exxon in the Exxon Valdez case, coauthored and published a paper in 1995 (see Hausman, Leonard, & McFadden) that uses the travel cost approach to evaluate oil spill impacts. (This TCM study is less known about than the fact that CVM studies played a big part in the Valdez case. The technical approach was essentially the same as that used earlier by other authors. Interestingly, this other paper was published in 1994, in the *Canadian Journal of Agricultural Economics* – see Yen & Adamowicz). Another interesting development in the recent literature is the blend of stated preference and revealed preference within the overall TCM framework, allowing formal tests of validity for the stated preference data. Intuitively, think of it this way. Suppose we ask an individual to provide her stated intentions regarding trips in light of a fixed resource or environmental change. Then, suppose we also develop the TCM in such a way that this change can be incorporated. We can use the revealed preference framework to provide checks on the validity of the stated, intended trips.

As I suggested above, there are many issues in travel cost modeling that remain rather thorny ones. With certainty, there will be many more PhD dissertations that push econometric frontiers, seeking the most elegant way of using various types of data. And, applications of the TCM to activities and geographical areas (particularly in other countries, where there are few or no applications), for which there are no estimates, will broaden what we know about these activities in other countries.

The road ahead is really many roads (see the Introductory and other chapters in Hanley, Shaw, & Wright, 2003). I think one very attractive avenue of research involves integrating recreation demand models into larger or more general equilibrium models. For example, one of my former colleagues integrated demands for lakes into his computable general equilibrium model and was able to link changes in water quantities with changes in the demands for local goods and services. This has also been done by economists at New Mexico State and elsewhere, in efforts to assess climate change impacts. There is no reason why this cannot be done with other large scale environmental changes that impact rural and public lands.

Another future interesting avenue involves risky changes. Most everything discussed above assumes that changes are going to happen, or not, with certainty. Alas, much of the world isn't operating in this simple manner. There is often a good deal of uncertainty attached to any event being contemplated, or to any policy-relevant change. Uncertainty can be incorporated into recreation demand models to handle things like uncertain concentrations of toxic chemicals, or the health risks that stem from these chemicals. Perhaps taking a hint from a PhD dissertation at the University of Maryland many years ago by Doug Larson, economists have begun to look at people who do risky sports, specifically with the risks they take in mind. Others have also recently examined the risks associated with eating contaminated fish and the role that fish consumption advisories play. Still others have incorporated risks into hunting via the lottery that big game permits often involve and I am sure that others will join in and do some work along these lines.

Last, big and high profile NRDA cases do not seem that commonplace in the United States today, with the exception of a few cases, such as the State of New York's suit against various polluters of the Hudson River. Today the CVM appears to be an approach abandoned by federal agencies that are supposedly trustees of public resources, in lieu of such approaches as habitat equivalency and restoration cost analysis. But the TCM played an integral role in settlement of damages resulting from mining wastes in the Clark Fork Basin of Montana (the nation's largest Superfund site), and as shown above, in the Exxon Valdez case. Perhaps federal agencies will have cause to use the TCM again in future cases.

Much less contentious arenas than NRDA exist where the calculation of the loss or gain of benefits from use or preservation of public and rural lands is nevertheless still very important, and here again the TCM can be applied to obtain values. Obvious situations involve many resources: the growing use of rural land for housing developments; generally shrinking agricultural and undeveloped lands and diminished animal habitat; siting nuclear and other unwanted industry and household wastes, and other conflicts between urban and nonurban or undeveloped lands. In the case of all lands under federal jurisdiction, proposed projects require a formal assessment of the change in economic benefits that would accompany project implementation. These assessments stem from presidential executive orders or federal regulatory statutes.

In other, less formal situations, the public may simply wish to be informed of the magnitude of their dollar loss or gain. Many environmental economists believe that, failing such calculations, the winners will be those real estate and business developers with the usual claim "look how many jobs we will create." Of course our calculations might also demonstrate that such development is warranted.

The calculation of losses or gains with changes in environmental conditions on public lands will no doubt be increasingly important as growing populations put pressure on such lands. The once vast and open spaces of the West and elsewhere are smaller, and increasingly, people in large urban centers rely on only a small amount of public land to recreate and enjoy rural amenities. One stone still largely unturned in use of the TCM relates to handling congestion effects in revealed preference models, and congestion will likely become even more important at recreational resources in close proximity to heavily populated areas (i.e., does one even want to go to California's Yosemite Valley on a crowded Saturday in the summer?). Work on recreation demand modeling will continue in hopes of answering such questions, often through generations of economists that can be traced back to some of the pioneers.

For More Information

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