Valuation Methods

Basic Concepts of Economic Value

Economic value is one of many possible ways to define and measure value. Although other types of value are often important, economic values are useful to consider when making economic choices – choices that involve tradeoffs in allocating resources.

Measures of economic value are based on what people want – their preferences. Economists generally assume that individuals, not the government, are the best judges of what they want. Thus, the theory of economic valuation is based on individual preferences and choices. People express their preferences through the choices and tradeoffs that they make, given certain constraints, such as those on income or available time.

The economic value of a particular item, or good, for example a loaf of bread, is measured by the maximum amount of other things that a person is willing to give up to have that loaf of bread. If we simplify our example "economy" so that the person only has two goods to choose from, bread and pasta, the value of a loaf of bread would be measured by the most pasta that the person is willing to give up to have one more loaf of bread.

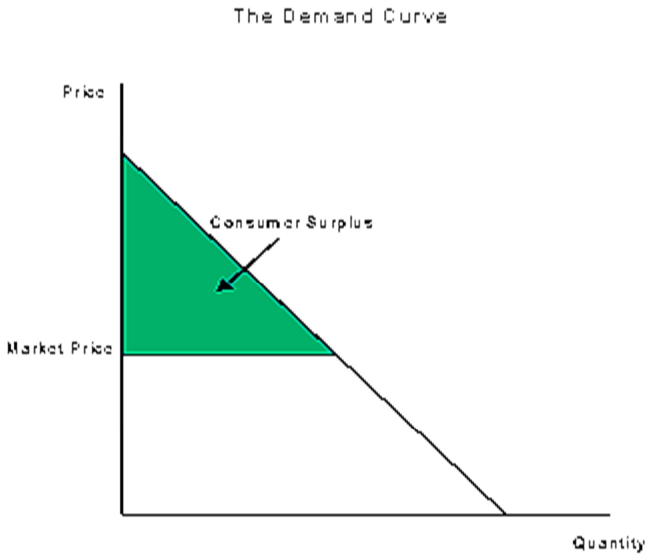
Thus, economic value is measured by the most someone is willing to give up in other goods and services in order to obtain a good, service, or state of the world. In a market economy, dollars (or some other currency) are a universally accepted measure of economic value, because the number of dollars that a person is willing to pay for something tells how much of all other goods and services they are willing to give up to get that item. This is often referred to as "willingness to pay."

In general, when the price of a good increases, people will purchase less of that good. This is referred to as the law of demand—people demand less of something when it is more expensive (assuming prices of other goods and peoples' incomes have not changed). By relating the quantity demanded and the price of a good, we can estimate the demand function for that good. From this, we can draw the demand curve, the graphical representation of the demand function.

It is often incorrectly assumed that a good's market price measures its economic value. However, the market price only tells us the *minimum* amount that people who buy the good are willing to pay for it. When people purchase a marketed good, they compare the amount they would be willing to pay for that good with its market price. They will only purchase the good if their willingness to pay is equal to or greater than the price. Many people are actually willing to pay more than the market price for a good, and thus their values exceed the market price.

In order to make resource allocation decisions based on economic values, what we really want to measure is the net economic benefit from a good or service. For individuals, this is measured by the amount that people are willing to pay, *beyond* what they actually pay. Thus, two goods that sell for the same price may have different net benefits. For example, I may have a choice between wheat and multi-grain bread, which both sell for $2.00 per loaf. Because I prefer multi-grain, I am willing to pay up to $3.00 for a loaf. However, I would only pay $2.50 at the most for the wheat bread. Therefore, the net economic benefit I receive for the multi-grain bread is $1.00, and for the wheat bread is only $.50.

The economic benefit to individuals is often measured by consumer surplus. This is graphically represented by the area under the demand curve for a good, above its price.



The economic benefit to individuals, or consumer surplus, received from a good will change if its price or quality changes. For example, if the price of a good increases, but people's willingness to pay remains the same, the benefit received (maximum willingness to pay minus price) will be less than before. If the quality of a good increases, but price remains the same, people's willingness to pay may increase and thus the benefit received will also increase.

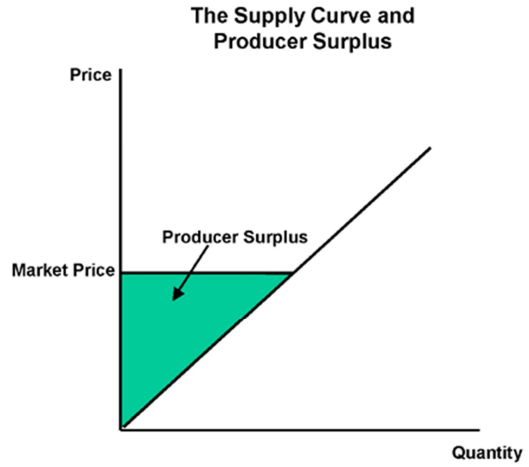
Economic values are also affected by the changes in price or quality of substitute goods or complementary goods. If the price of a substitute good changes, the economic value for the good in question will change in the same direction. For example, wheat bread is a close substitute for multi-grain bread. So, if the price of multi-grain bread goes up, while the price of wheat bread remains the same, some people will switch, or substitute, from multi-grain to wheat bread. Therefore, more wheat bread is demanded and its demand function shifts upward, making the area under it, the consumer surplus, greater.

Similarly, if the price of a complementary good, one that is purchased in conjunction with the good in question, changes, the economic benefit from the good will change in the opposite

direction. For example, if the price of butter increases, people may buy less of both bread and butter. If less bread is demanded, then the demand function shifts downward, and the area under it, the consumer surplus, decreases.

Producers of goods also receive economic benefits, based on the profits they make when selling the good. Economic benefits to producers are measured by producer surplus, the area above the supply curve and below the market price. The supply function tells how many units of a good producers are willing to produce and sell at a given price. The supply curve is the graphical representation of the supply function. Because producers would like to sell more at higher prices, the supply curve slopes upward.

If producers receive a higher price than the minimum price they would sell their output for, they receive a benefit from the sale—the producer surplus. Thus, benefits to producers are similar to benefits to consumers, because they measure the gains to the producer from receiving a price higher than the price they would have been willing to sell the good for.



When measuring economic benefits of a policy or initiative that affects an ecosystem, economists measure the total net economic benefit. This is the sum of consumer surplus plus producer surplus, less any costs associated with the policy or initiative.

Valuation of Ecosystem Services

Ecosystem valuation can be a difficult and controversial task, and economists have often been criticized for trying to put a "pricetag" on nature. However, agencies in charge of protecting and managing natural resources must often make difficult spending decisions that involve

tradeoffs in allocating resources. These types of decisions are economic decisions, and thus are based, either explicitly or implicitly, on society's values. Therefore, economic valuation can be useful, by providing a way to justify and set priorities for programs, policies, or actions that protect or restore ecosystems and their services (see The Big Picture for more information).

In order to understand how economists approach ecosystem valuation, it is useful to review some important definitions and concepts.

Ecosystem Functions and Services

Ecosystem functions are the physical, chemical, and biological processes or attributes that contribute to the self-maintenance of an ecosystem; in other words, what the ecosystem does. Some examples of ecosystem functions are provision of wildlife habitat, carbon cycling, or the trapping of nutrients. Thus, ecosystems, such as wetlands, forests, or estuaries, can be characterized by the processes, or functions, that occur within them.

Ecosystem services are the beneficial outcomes, for the natural environment or people, that result from ecosystem functions. Some examples of ecosystem services are support of the food chain, harvesting of animals or plants, and the provision of clean water or scenic views. In order for an ecosystem to provide services to humans, some interaction with, or at least some appreciation by, humans is required. Thus, functions of ecosystems are value-neutral, while their services have value to society.

Some Factors that Complicate Ecosystem Management Decisions

Decisions about ecosystem management are complicated by the fact that various types of market failure are associated with natural resources and the environment. Market failures occur when markets do not reflect the full social costs or benefits of a good. For example, the price of gasoline does not fully reflect the costs, in terms of pollution, that are imposed on society by burning gasoline. Market failures related to ecosystems include the facts that: (i) many ecosystems provide services that are public goods; (ii) many ecosystem services are affected by externalities; and (iii) property rights related to ecosystems and their services are often not clearly defined.

Ecosystem services are often public goods, which means that they may be enjoyed by any number of people without affecting other peoples' enjoyment. For example, an aesthetic view is a pure public good. No matter how many people enjoy the view, others can also enjoy it. Other services may be quasi-public goods, where at a certain level of use, others' enjoyment may be diminished. For example, a public recreation area may be open to everyone. However, crowding can decrease peoples' enjoyment of the area. The problem with public goods is that, although people value them, no one person has an incentive to pay to maintain the good. Thus, collective action is required in order to produce the most beneficial quantity.

Ecosystem services may be affected by externalities, or uncompensated side effects of human actions. For example, if a stream is polluted by runoff from agricultural land, the people downstream experience a negative externality. The problem with negative externalities is that the people (or ecosystems) they are imposed upon are generally not compensated for the damages they suffer.

Finally, if property rights for natural resources are not clearly defined, they may be overused, because there is no incentive to conserve them. For example, unregulated fisheries are an open-access resource – anyone who wants to harvest fish can do so. Because no one person or group "owns" the resource, open access can lead to severe over-harvesting and potentially severe declines in fish abundance over time.

Ecosystem valuation can help resource managers deal with the effects of market failures, by measuring their costs to society, in terms of lost economic benefits. The costs to society can then be imposed, in various ways, on those who are responsible, or can be used to determine the value of actions to reduce or eliminate environmental impacts. For example, in the case of the crowded public recreation area, benefits to the public could be increased by reducing the crowding. This might be done by expanding the area or by limiting the number of visitors. The costs of implementing different options can be compared to the increased economic benefits of reduced crowding.

In the case of a stream polluted by agricultural runoff, the benefits from eliminating the pollution can be compared to costs of actions to reduce the runoff, or can be used to determine the appropriate fines or taxes to be levied on those who are responsible. In the case of open-access fisheries, the benefits from reducing overfishing can be compared to regulatory costs or costs to the commercial fishing industry if access is restricted.

Ecosystem Values

Ecosystem values are measures of how important ecosystem services are to people – what they are worth. Economists measure the value of ecosystem services to people by estimating the amount people are willing to pay to preserve or enhance the services (see Basic Concepts of Economic Value for more detailed information). However, this is not always straightforward, for a variety of reasons.

Most importantly, while some services of ecosystems, like fish or lumber, are bought and sold in markets, many ecosystem services, like a day of wildlife viewing or a view of the ocean, are not traded in markets. Thus, people do not pay directly for many ecosystem services. Additionally, because people are not familiar with purchasing such goods, their willingness to pay may not be clearly defined. However, this does not mean that ecosystems or their services have no value, or cannot be valued in dollar terms.

It is not necessary for ecosystem services to be bought and sold in markets in order to measure their value in dollars. What is required is a measure of how much purchasing power

(dollars) people are willing to give up to get the service of the ecosystem, or how much people would need to be paid in order to give it up, if they were asked to make a choice similar to one they would make in a market. (Overview of Methods to Estimate Dollar Values gives an overview of, and Dollar-Based Ecosystem Valuation Methods describes in more detail, the methods that economists use to estimate dollar values for ecosystems and their services.)

Types of Values

Economists classify ecosystem values into several types. The two main categories are use values and non-use, or "passive use" values. Whereas use values are based on actual use of the environment, non-use values are values that are not associated with actual use, or even an option to use, an ecosystem or its services.

Thus, use value is defined as the value derived from the actual use of a good or service, such as hunting, fishing, birdwatching, or hiking. Use values may also include indirect uses. For example, an Alaskan wilderness area provides direct use values to the people who visit the area. Other people might enjoy watching a television show about the area and its wildlife, thus receiving indirect use values. People may also receive indirect use values from an input that helps to produce something else that people use directly. For example, the lower organisms on the aquatic food chain provide indirect use values to recreational anglers who catch the fish that eat them.

Option value is the value that people place on having the option to enjoy something in the future, although they may not currently use it. Thus, it is a type of use value. For example, a person may hope to visit the Alaskan wilderness area sometime in the future, and thus would be willing to pay something to preserve the area in order to maintain that option.

Similarly, bequest value is the value that people place on knowing that future generations will have the option to enjoy something. Thus, bequest value is measured by peoples' willingness to pay to preserve the natural environment for future generations. For example, a person may be willing to pay to protect the Alaskan wilderness area so that future generations will have the opportunity to enjoy it.

Non-use values, also referred to as "passive use" values, are values that are not associated with actual use, or even the option to use a good or service. Existence value is the non-use value that people place on simply knowing that something exists, even if they will never see it or use it. For example, a person might be willing to pay to protect the Alaskan wilderness area, even though he or she never expects or even wants to go there, but simply because he or she values the fact that it exists.

It is clear that a single person may benefit in more than one way from the same ecosystem. Thus, total economic value is the sum of all the relevant use and non-use values

for a good or service.
Hedonic Pricing Method

Overview

The hedonic pricing method is used to estimate economic values for ecosystem or environmental services that directly affect market prices. It is most commonly applied to variations in housing prices that reflect the value of local environmental attributes.

It can be used to estimate economic benefits or costs associated with:

- environmental quality, including air pollution, water pollution, or noise
- environmental amenities, such as aesthetic views or proximity to recreational sites

The basic premise of the hedonic pricing method is that the price of a marketed good is related to its characteristics, or the services it provides. For example, the price of a car reflects the characteristics of that car—transportation, comfort, style, luxury, fuel economy, etc. Therefore, we can value the individual characteristics of a car or other good by looking at how the price people are willing to pay for it changes when the characteristics change. The hedonic pricing method is most often used to value environmental amenities that affect the price of residential properties.

This section continues with an example application of the hedonic pricing method, followed by a more complete technical description of the method and its advantages and limitations.

Hypothetical Situation:
Agency staff want to measure the benefits of an open space preservation program in a region where open land is rapidly being developed.

Why is the Hedonic Pricing Method used?

The hedonic pricing method was selected in this case because:

1. Housing prices in the area appear to be related to proximity to open space.
2. Data on real estate transactions and open space parcels are readily available, thus making this the least expensive and least complicated approach.

Alternative Approaches:

If the open space of concern is used mainly for recreation, the travel cost method might be used. Alternatively, survey-based methods, like contingent valuation or contingent choice,

might be used. However, these methods would generally be more difficult and expensive to apply.

Application of the Hedonic Pricing Method:

Step 1:

The first step is to collect data on residential property sales in the region for a specific time period (usually one year). The required data include:

- selling prices and locations of residential properties
- property characteristics that affect selling prices, such as lot size, number and size of rooms, and number of bathrooms
- neighbourhood characteristics that affect selling prices, such as property taxes, crime rates, and quality of schools
- accessibility characteristics that affect prices, such as distances to work and shopping centers, and availability of public transportation
- environmental characteristics that affect prices

In this case, the environmental characteristic of concern is the proximity to open space. The researcher might collect data on the amount and type of open space within a given radius of each property, and might also note whether a property is directly adjacent to open space. Often, this type of data may be obtained from computer-based GIS (geographical information systems) maps. Data on housing prices and characteristics are available from municipal offices, multiple listing services, and other sources.

Step 2:

Once the data are collected and compiled, the next step is to statistically estimate a function that relates property values to the property characteristics, including the distance to open space. The resulting function measures the portion of the property price that is attributable to each characteristic. Thus, the researcher can estimate the value of preserving open space by looking at how the value of the average home changes when the amount of open space nearby changes.

How do we use the results?

The results can be used to evaluate agency investments in open space preservation. For example, specific parcels may be under consideration for protection. The hedonic value function can be used to determine the benefits of preserving each parcel, which can then be compared to the cost.

Case Study Example of the Hedonic Pricing Method—Values of Environmental Amenities in Southold, Long Island

The Situation:

The town of Southold, Long Island, New York has coastlines on both the Peconic Bay and Long Island Sound. Compared to the rest of Long Island, it is a relatively rural area, with a large amount of farmland. However, population and housing density are rapidly increasing in the town, resulting in development pressures on farmland and other types of open space.

The Challenge:

The Peconic Estuary Program is considering various management actions for the Estuary and surrounding land areas. In order to assess some of the values that may result from these management actions, a hedonic valuation study was conducted, using 1996 housing transactions.

The Analysis:

The study found that the following variables that are relevant for local environmental management had significant effects on property values in Southold:

- Open Space: Properties adjacent to open space had, on average, 12.8% higher per-acre value than similar properties located elsewhere.
- Farmland: Properties located adjacent to farmland had, on average, 13.3% lower per-acre value. Property values increased very slightly with greater distance from farmland.
- Major Roads: Properties located within 20 meters of a major road had, on average, 16.2% lower per-acre value.
- Zoning: Properties located within an area with two- or three-acre zoning had, on average, 16.7% higher per-acre value.
- Wetlands: For every percentage point increase in the percent of a parcel classified as a wetland, the average per-acre value increased by .3%.

The Results:

Based on the results of this study, managers could, for example, calculate the value of preserving a parcel of open space, by calculating the effects on property values adjacent to the parcel. For a hypothetical simple case, the value of preserving a 10 acre parcel of open space, surrounded by 15 “average” properties, was calculated as $410,907.

Summary of the Hedonic Pricing Method:

The hedonic pricing method is used to estimate the value of environmental amenities that affect prices of marketed goods. Most applications use residential housing prices to estimate the value of environmental amenities. The method is based on the assumption that people value the characteristics of a good, or the services it provides, rather than the good itself. Thus, prices will reflect the value of a set of characteristics, including environmental characteristics, that people consider important when purchasing the good.

The hedonic pricing method may be used to estimate economic benefits or costs associated with:

- environmental quality, including air pollution, water pollution, or noise
- environmental amenities, such as aesthetic views or proximity to recreational sites

The hedonic pricing method is relatively straightforward and uncontroversial to apply, because it is based on actual market prices and fairly easily measured data. If data are readily available, it can be relatively inexpensive to apply. If data must be gathered and compiled, the cost of an application can increase substantially.

Applying the Hedonic Pricing Method Using Housing Prices:

In general, the price of a house is related to the characteristics of the house and property itself, the characteristics of the neighbourhood and community, and environmental characteristics. Thus, if non-environmental factors are controlled for, then any remaining differences in price can be attributed to differences in environmental quality. For example, if all characteristics of houses and neighbourhoods throughout an area were the same, except for the level of air pollution, then houses with better air quality would cost more. This higher price reflects the value of cleaner air to people who purchase houses in the area.

To apply the hedonic pricing method, the following information must be collected:

- A measure or index of the environmental amenity of interest.
- Cross-section and/or time-series data on property values and property and household characteristics for a well-defined market area that includes homes with different levels of environmental quality, or different distances to an environmental amenity, such as open space or the coastline.

The data are analyzed using regression analysis , which relates the price of the property to its characteristics and the environmental characteristic(s) of interest. Thus, the effects of different characteristics on price can be estimated. The regression results indicate how much property values will change for a small change in each characteristic, holding all other characteristics constant.

The analysis may be complicated by a number of factors. For example, the relationship between price and characteristics of the property may not be linear – prices may increase at an increasing or decreasing rate when characteristics change. In addition, many of the variables are likely to be correlated, so that their values change in similar ways. This can lead to understating the significance of some variables in the analysis. Thus, different functional forms and model specifications for the analysis must be considered.

Advantages of the Hedonic Pricing Method:

- The method's main strength is that it can be used to estimate values based on actual choices.
- Property markets are relatively efficient in responding to information, so can be good indications of value.
- Property records are typically very reliable.
- Data on property sales and characteristics are readily available through many sources, and can be related to other secondary data sources to obtain descriptive variables for the analysis.
- The method is versatile, and can be adapted to consider several possible interactions between market goods and environmental quality.

Issues and Limitations:

- The scope of environmental benefits that can be measured is limited to things that are related to housing prices.
- The method will only capture people's willingness to pay for perceived differences in environmental attributes, and their direct consequences. Thus, if people aren't aware of the linkages between the environmental attribute and benefits to them or their property, the value will not be reflected in home prices.
- The method assumes that people have the opportunity to select the combination of features they prefer, given their income. However, the housing market may be affected by outside influences, like taxes, interest rates, or other factors.
- The method is relatively complex to implement and interpret, requiring a high degree of statistical expertise.
- The results depend heavily on model specification.
- Large amounts of data must be gathered and manipulated.
- The time and expense to carry out an application depends on the availability and accessibility of data.

Travel Cost Method

Overview:

The travel cost method is used to estimate economic use values associated with ecosystems or sites that are used for recreation.

The method can be used to estimate the economic benefits or costs resulting from:

- changes in access costs for a recreational site
- elimination of an existing recreational site
- addition of a new recreational site
- changes in environmental quality at a recreational site

The basic premise of the travel cost method is that the time and travel cost expenses that people incur to visit a site represent the "price" of access to the site. Thus, peoples' willingness to pay to visit the site can be estimated based on the number of trips that they make at different travel costs. This is analogous to estimating peoples' willingness to pay for a marketed good based on the quantity demanded at different prices.

This section continues with some example applications of the travel cost method, followed by a more complete technical description of the method and its advantages and limitations.

Hypothetical Situation:

A site used mainly for recreational fishing is threatened by development in the surrounding area. Pollution and other impacts from this development could destroy the fish habitat at the site, resulting in a serious decline in, or total loss of, the site's ability to provide recreational fishing services. Resource agency staff want to determine the value of programs or actions to protect fish habitat at the site.

Why Use the Travel Cost Method?

The travel cost method was selected in this case for two main reasons:

1. The site is primarily valuable to people as a recreational site. There are no endangered species or other highly unique qualities that would make non-use values for the site significant.

2. The expenditures for projects to protect the site are relatively low. Thus, using a relatively inexpensive method like travel cost makes the most sense.

Alternative Approaches:

Contingent valuation or contingent choice methods could also be used in this case. While they might produce more precise estimates of values for specific characteristics of the site,

and also could capture non-use values, they would be considerably more complicated and expensive to apply.

Options for Applying the Travel Cost Method:

There are several ways to approach the problem, using variations of the travel cost method.

These include:

1. A simple zonal travel cost approach, using mostly secondary data, with some simple data collected from visitors.
2. An individual travel cost approach, using a more detailed survey of visitors.
3. A random utility approach using survey and other data, and more complicated statistical techniques.

Application of the Zonal Travel Cost Approach:

The zonal travel cost method is the simplest and least expensive approach. It will estimate a value for recreational services of the site as a whole. It cannot easily be used to value a change in quality of recreation for a site, and may not consider some of the factors that may be important determinants of value.

The zonal travel cost method is applied by collecting information on the number of visits to the site from different distances. Because the travel and time costs will increase with distance, this information allows the researcher to calculate the number of visits "purchased" at different "prices." This information is used to construct the **demand function** for the site, and estimate the **consumer surplus** , or economic benefits, for the recreational services of the site.

Step 1:

The first step is to define a set of zones surrounding the site. These may be defined by concentric circles around the site, or by geographic divisions that make sense, such as metropolitan areas or counties surrounding the site at different distances.

Step 2:

The second step is to collect information on the number of visitors from each zone, and the number of visits made in the last year. For this hypothetical example, assume that staff at the site keep records of the number of visitors and their zipcode, which can be used to calculate total visits per zone over the last year.

Step 3:

The third step is to calculate the visitation rates per 1000 population in each zone. This is simply the total visits per year from the zone, divided by the zone's population in thousands. An example is shown in the table:

Zone	Total Visits/Year	Zone Population	Visits/1000
0	400	1000	400
1	400	2000	200
2	400	4000	100
3	400	8000	50
Beyond 3	0		
Total Visits	1600		

Step 4:

The fourth step is to calculate the average round-trip travel distance and travel time to the site for each zone. Assume that people in Zone 0 have zero travel distance and time. Each other zone will have an increasing travel time and distance. Next, using average cost per mile and per hour of travel time, the researcher can calculate the travel cost per trip. A standard cost per mile for operating an automobile is readily available from AAA or other sources. Assume that this cost per mile is $.30. The cost of time is more complicated. The simplest approach is to use the average hourly wage. Assume that it is $9/hour, or $.15/minute, for all zones, although in practice it is likely to differ by zone. The calculations are shown in the table.

Zone	Round Trip Travel Distance	Round Trip Travel Time	Distance times Cost/Mile ($.30)	Travel Time times Cost/Minute ($.15)	Total Travel Cost/Trip
0	0	0	0	0	0
1	20	30	$6	$4.50	$10.50
2	40	60	$12	$9.00	$21.00

3	80	120	$24	$18.00	$42.00

Step 5:

The fifth step is to estimate, using **regression analysis**, the equation that relates visits per capita to travel costs and other important variables. From this, the researcher can estimate the demand function for the average visitor. In this simple model, the analysis might include demographic variables, such as age, income, gender, and education levels, using the average values for each zone. To maintain the simplest possible model, calculating the equation with only the travel cost and visits/1000, Visits/1000 = 330 – 7.755*(Travel Cost).

Step 6:

The sixth step is to construct the demand function for visits to the site, using the results of the regression analysis. The first point on the demand curve is the total visitors to the site at current access costs (assuming there is no entry fee for the site), which in this example is 1600 visits per year. The other points are found by estimating the number of visitors with different hypothetical entrance fees (assuming that an entrance fee is viewed in the same way as travel costs).

For the purposes of our example, start by assuming a $10 entrance fee. Plugging this into the estimated regression equation, V = 330 – 7.755C, gives the following:

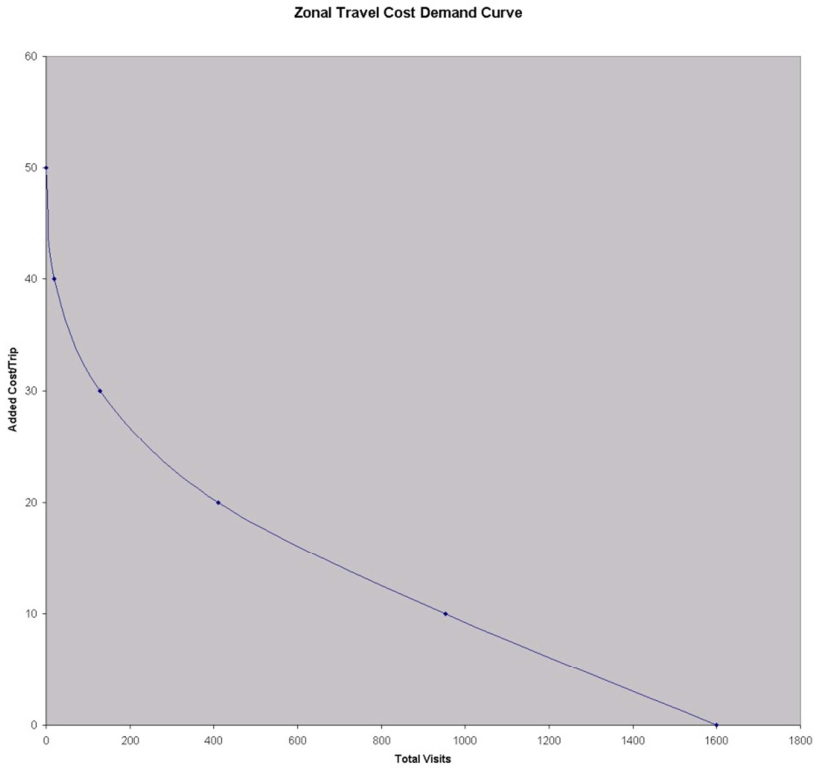
Zone	**Travel Cost plus $10**	**Visits/1000**	**Population**	**Total Visits**
0	$10	252	1000	252
1	$20.50	171	2000	342
2	$31.00	90	4000	360
3	$52.00	0	8000	0
			Total Visits	954

This gives the second point on the demand curve—954 visits at an entry fee of $10. In the same way, the number of visits for increasing entry fees can be calculated, to get:

Entry Fee	**Total Visits**

$20	409
$30	129
$40	20
$50	0

These points give the demand curve for trips to the site.



Step 7:

The final step is to estimate the total economic benefit of the site to visitors by calculating the consumer surplus, or the area under the demand curve. This results in a total estimate of economic benefits from recreational uses of the site of around $23,000 per year, or around $14.38 per visit ($23,000/1,600).

How Do We Use the Results?

Remember that the agency staff's objective was to decide whether it is worthwhile to spend money on programs and actions to protect this site. If the actions cost less than $23,000 per year, the cost will be less than the benefits provided by the site. If the costs are greater than this, the staff will have to decide whether other factors make them worthwhile.

Application of the Individual Travel Cost Approach:

The individual travel cost approach is similar to the zonal approach, but uses survey data from individual visitors in the statistical analysis, rather than data from each zone. This method thus requires more data collection and slightly more complicated analysis, but will give more precise results.

For the hypothetical example of the recreational fishing site, rather than simply collecting information on number of visitors and their zipcodes, the researcher would conduct a survey of visitors. The survey might ask for the following information:

- location of the visitor's home – how far they traveled to the site
- how many times they visited the site in the past year or season
- the length of the trip
- the amount of time spent at the site
- travel expenses
- the person's income or other information on the value of their time
- other socioeconomic characteristics of the visitor
- other locations visited during the same trip, and amount of time spent at each
- other reasons for the trip (is the trip only to visit the site, or for several purposes)
- fishing success at the site (how many fish caught on each trip)
- perceptions of environmental quality or quality of fishing at the site
- substitute sites that the person might visit instead of this site

Using the survey data, the researcher can proceed in a similar way to the zonal model, by estimating, using regression analysis, the relationship between number of visits and travel costs and other relevant variables. This time, the researcher would use individual data, rather than data for each zone. The regression equation gives us the demand function for the "average" visitor to the site, and the area below this demand curve gives the average consumer surplus. This is multiplied by the total relevant population (the population in the region where visitors come from) to estimate the total consumer surplus for the site.

Because additional data about visitors, substitute sites, and quality of the site has been collected, the value estimates can be "fine tuned" by adding these other factors to the statistical model. Including information about the quality of the site allows the researcher to estimate the change in value of the site if its quality changes. To do so, two different demand curves would be estimated—one for each level of quality. The area between these two curves is the estimate of the change in consumer surplus when quality changes.

In the example, the researcher might recognize that development around the site is unlikely to totally destroy the fish population. However, it could diminish the population enough to adversely affect catch rates. By including catch rates in the model, the researcher can estimate the lost recreational benefits from reduced catch rates. However, the random utility model, described in the next section, is a more appropriate approach for this type of estimation.

Application of the Random Utility Approach:

The random utility approach is the most complicated and expensive of the travel cost approaches. It is also the "state of the art" approach, because it allows for much more flexibility in calculating benefits. It is the best approach to use to estimate benefits for specific characteristics, or quality changes, of sites, rather than for the site as a whole. It is also the most appropriate approach when there are many substitute sites.

In the example, the agency might want to value the economic losses from a decrease in fish populations, rather than from loss of the entire fish stock. The random utility approach would be the best way to do so, because it focuses on choices among alternative sites, which have different quality characteristics.

The random utility approach assumes that individuals will pick the site that they prefer, out of all possible fishing sites. Individuals make tradeoffs between site quality and the price of travel to the site. Hence, this model requires information on all possible sites that a visitor might select, their quality characteristics, and the travel costs to each site.

For the example, the researcher might conduct a telephone survey of randomly selected residents of the state. The survey would ask them if they go fishing or not. If they do, it would then ask a series of questions about how many fishing trips they took over the last year (or season), where they went, the distance to each site, and other information similar to the information collected in our individual travel cost survey. The survey might also ask questions about fish species targeted on each trip, and how many fish were caught.

Using this information, the researcher can estimate a statistical model that can predict both the choice to go fishing or not, and the factors that determine which site is selected. If quality characteristics of sites are included, the model can easily estimate values for changes in site quality, for example the economic losses caused by a decrease in catch rates at the site.

Case Study Examples of the Travel Cost Method:

Case # 1—Environmental Conservation

The Situation:

Hell Canyon on the Snake River separating Oregon and Idaho offers spectacular vistas and outdoor amenities to visitors from around the country and supports important fish and wildlife habitat. It also has economic potential as a site to develop hydropower. Generating hydropower there would require building a dam behind which would form a large lake. The

dam and the resulting lake would significantly and permanently alter the ecological and aesthetic characteristics of Hell Canyon.

The Challenge:

During the 1970's, there were major controversies regarding the future of Hell Canyon. Environmental economists from Resources For The Future in Washington, D.C. were asked to develop an economic analysis to justify preserving Hell Canyon in its natural state in the face of its obvious economic potential as a source of hydropower.

The Analysis:

Researchers estimated that the net economic value (cost savings) of producing hydropower at Hell Canyon was $80,000 higher than at the "next best" site which was not environmentally sensitive. They then conducted a low-cost/low precision travel-cost survey to estimate the recreational value of Hell Canyon and concluded that it was about $900,000. The researchers did not attempt to strongly defend the "scientific" credibility of the valuation method they used or the results. However, at public hearings, they emphasized that, even if the "true value" of recreation at Hell Canyon was ten times less than their estimate, it would still be greater than the $80,000 economic payoff from generating power there as opposed to the other site. They also illustrated that overall demand for outdoor recreation, for which the supply is limited, was going up, while many other sources of energy are available besides Hell Canyon hydropower.

The Results:

Based largely on the results of this non-market valuation study, Congress voted to prohibit further development of Hell Canyon.

Case # 2—Improvements in Water Quality

The Situation:

The costs to farmers and taxpayers of implementing on-farm best management practices to reduce sediment and nutrient runoff to the Chesapeake Bay are well known. Controversies arose during the 1980's, which continue today, over the benefits of resulting improvements in water quality.

The Challenge:

Economists were asked to assess the economic benefits of water quality improvements to beach users in the Chesapeake Bay area. They needed to establish linkages between differences in water quality and differences in willingness to pay for beach use. The hypothesis that to be tested was that average willingness to pay, as reflected in the travel

costs to visitors to particular beaches, was positively correlated with water quality. If the hypothesis was correct the empirical results would allow researchers to estimate the increase in willingness to pay of improving water quality at all beaches.

The Analysis:

Researchers selected the concentration of nitrogen and phosphorous in the water at the monitoring station nearest to the beach as an index of water quality at the beach. This was assumed to reflect the level of objectionable visual and other characteristics that affect the value of beach use. A cross-sectional analysis of travel cost data collected from 484 people at 11 public beaches was used to impute the aggregate willingness to pay for a 20% increase in water quality, which was assumed to be associated with a 20% reduction in total nitrogen and phosphorus.

The Results:

The average annual benefits to all Maryland beach users of the improvements in water quality were estimated to be $35 million in 1984 dollars. These were thought to be conservative for several reasons, including:

- The value of improvements in water quality was only shown to increase the value of current beach use. However, improved water quality can also be expected to increase overall beach use.
- Estimates ignore visitors from outside the Baltimore-Washington statistical metropolitan sampling area.
- The population and incomes in origin zones near the Chesapeake Bay beach areas are increasing, which is likely to increase visitor-days and thus total willingness to pay.

Summary of the Travel Cost Method:

The travel cost method is used to estimate the value of recreational benefits generated by ecosystems. It assumes that the value of the site or its recreational services is reflected in how much people are willing to pay to get there. It is referred to as a "revealed preference" method, because it uses actual behaviour and choices to infer values. Thus, peoples' preferences are revealed by their choices.

The basic premise of the travel cost method is that the time and travel cost expenses that people incur to visit a site represent the "price" of access to the site. Thus, peoples' willingness to pay to visit the site can be estimated based on the number of trips that people make at different travel costs. This is analogous to estimating peoples' willingness to pay for a marketed good based on the quantity demanded at different prices.

The travel cost method can be used to estimate the economic benefits or costs resulting from:

- changes in access costs for a recreational site
- elimination of an existing recreational site
- addition of a new recreational site
- changes in environmental quality at a recreational site

The travel cost method is relatively uncontroversial, because it is modeled on standard economic techniques for measuring value, and it uses information on actual behavior rather than verbal responses to hypothetical scenarios. It is based on the simple and well-founded assumption that travel costs reflect recreational value. It is often relatively inexpensive to apply.

Applying the Travel Cost Method:

On average, people who live farther from a site will visit it less often, because it costs more in terms of actual travel costs and time to reach the site. The number of visits from origin zones at different distances from the site, and travel cost from each zone, are used to derive an aggregate demand curve for visits to the site, and thus for the recreational or scenic services of the site. This demand curve shows how many visits people would make at various travel cost prices, and is used to estimate the willingness to pay for people who visit the site (whether they are charged an admission fee or not).

Other factors may also affect the number of visits to a site. People with higher incomes will usually make more trips. If there are more alternative sites, or substitutes, a person will make less trips. Factors like personal interest in the type of site, or level of recreational experience will affect the number of visits. A more thorough application will take these and other factors into account in the statistical model.

To apply the travel cost method, information must be collected about:

- number of visits from each origin zone (usually defined by zipcode)
- demographic information about people from each zone
- round-trip mileage from each zone
- travel costs per mile
- the value of time spent traveling, or the **opportunity cost** of travel time

More complicated, and thorough, applications may also collect information about:

- exact distance that each individual traveled to the site
- exact travel expenses
- the length of the trip
- the amount of time spent at the site
- other locations visited during the same trip, and amount of time spent at each
- substitute sites that the person might visit instead of this site, and the travel distance to each

- other reasons for the trip (is the trip only to visit the site, or for several purposes)
- quality of the recreational experience at the site, and at other similar sites (e.g., fishing success)
- perceptions of environmental quality at the site
- characteristics of the site and other, substitute, sites

This information is typically collected through surveys—on-site, telephone or mail surveys may be used. In addition, especially for simpler applications, much information may be available from state and county resource agencies, or from federal surveys, such as the National Survey of Fishing, Hunting and Wildlife Associated Recreation, published every five years by the U.S. Fish and Wildlife Service (available at **http://www.nctc.fws.gov/library/pubs3.html**).

The most controversial aspects of the travel cost method include accounting for the opportunity cost of travel time, how to handle multi-purpose and multi-destination trips, and the fact that travel time might not be a cost to some people, but might be part of the recreational experience.

Advantages of the Travel Cost Method:

- The travel cost method closely mimics the more conventional empirical techniques used by economists to estimate economic values based on market prices.
- The method is based on actual behaviour—what people actually do—rather than stated willingness to pay—what people say they would do in a hypothetical situation.
- The method is relatively inexpensive to apply.
- On-site surveys provide opportunities for large sample sizes, as visitors tend to be interested in participating.
- The results are relatively easy to interpret and explain.

Issues and Limitations of the Travel Cost Method:

- The travel cost method assumes that people perceive and respond to changes in travel costs the same way that they would respond to changes in admission price.
- The most simple models assume that individuals take a trip for a single purpose – to visit a specific recreational site. Thus, if a trip has more than one purpose, the value of the site may be overestimated. It can be difficult to apportion the travel costs among the various purposes.
- Defining and measuring the opportunity cost of time, or the value of time spent traveling, can be problematic. Because the time spent traveling could have been used in other ways, it has an "opportunity cost." This should be added to the travel cost, or the value of the site will be underestimated. However, there is no strong consensus on the appropriate measure—the person's wage rate, or some fraction of the wage rate—and the value chosen can have a large effect on benefit estimates. In addition, if

people enjoy the travel itself, then travel time becomes a benefit, not a cost, and the value of the site will be overestimated.

- The availability of substitute sites will affect values. For example, if two people travel the same distance, they are assumed to have the same value. However, if one person has several substitutes available but travels to this site because it is preferred, this person's value is actually higher. Some of the more complicated models account for the availability of substitutes.
- Those who value certain sites may choose to live nearby. If this is the case, they will have low travel costs, but high values for the site that are not captured by the method.
- Interviewing visitors on site can introduce sampling biases to the analysis.
- Measuring recreational quality, and relating recreational quality to environmental quality can be difficult.
- Standard travel cost approaches provides information about current conditions, but not about gains or losses from anticipated changes in resource conditions.
- In order to estimate the demand function, there needs to be enough difference between distances traveled to affect travel costs and for differences in travel costs to affect the number of trips made. Thus, it is not well suited for sites near major population centers where many visitations may be from "origin zones" that are quite close to one another.
- The travel cost method is limited in its scope of application because it requires user participation. It cannot be used to assign values to on-site environmental features and functions that users of the site do not find valuable. It cannot be used to value off-site values supported by the site. Most importantly, it cannot be used to measure nonuse values. Thus, sites that have unique qualities that are valued by non-users will be undervalued.
- As in all statistical methods, certain statistical problems can affect the results. These include choice of the functional form used to estimate the demand curve, choice of the estimating method, and choice of variables included in the model.