Valuing the Environment

Methods

Introduction

Exxon Valdez oil tanker ran aground on the Bligh Reef in Prince William Sound off the coast of Alaska on March 24, 1989.

11 million gallons of crude oil

The liability:

(1) the cost of cleaning up the spilled oil.

(2) compensation for the damage caused to the local ecology.

Approximately $2.1 billion was spent in cleanup efforts and Exxon also spent approximately $303 million to compensate fishermen whose livelihoods were greatly damaged for the 5 years following the spill.[1] Litigation on environmental damages settled with Exxon agreeing to pay $900 million over 10 years.

Types of Values

(1) use value, (2) option value, and (3) nonuse or passive-use values.

(1) *Use value:*

Reflects the direct use of the environmental resource.

Ex: include fish harvested from the sea, timber harvested from the forest, water extracted from a stream for irrigation

(2) Option value:

*R*eflects the value people place on a future ability to use the environment.

It reflects the willingness to pay to preserve the option to use the environment in the future even if one is not currently using it. Are you planning to go to Yellowstone National Park next summer? Perhaps not, but would you like to preserve the option to go someday?

(3) Passive-use or *non-consumptive use values:*

When the resource is not actually consumed while experiencing it. These types of values reflect the common observation that people are more than willing to pay for improving or preserving resources that they will never use.

*Th*ese categories of value can be combined to produce the total willingness to pay (TWP):

TWP = Use Value + Option Value + Nonuse Value

Classifying Valuation Methods

Table 4.1 Economic Methods for Measuring Environmental and Resource Values

Methods	*Revealed Preference*	*Stated Preference*
Direct	Market Price Simulated Markets	Contingent Valuation
Indirect	Travel Cost Hedonic Property Values Hedonic Wage Values Avoidance Expenditures	Choice Experiments Conjoint Analysis Attribute-Based Models Contingent Ranking

Source: Modified by the authors from Mitchell and Carson, 1989.

Contingent Valuation Method (CVM)

The steps involved in applying the CVM can be stated as follows:

1. Creating a survey instrument for the elicitation of individuals' WTP/WTA. This can be broken down into three distinct, but related, components:
(a) designing the hypothetical scenario,
(b) deciding whether to ask about WTP or WTA,
(c) creating a scenario about the means of payment or compensation.

2. Using the survey instrument with a sample of the population of interest.

3. Analyzing the responses to the survey.

(a) using the sample data on WTP/WTA to estimate the average WTP/WTA for the population,
(b) assessing the survey results so as to judge the accuracy of this estimate.

4. Computing total WTP/WTA for the population of interest for use in an ECBA.

5. Conducting sensitivity analysis.

Example of Contingent Valuation Method (CVM)

Exxon Corporation, mobile, 1989 “Spilling oil on Prince William Sound-Alaska.

Using the CVM to estimate damages from the *Exxon Valdez* oil spill

Environmental and Resource Economics **25:** 257–286, 2003.

Contingent Valuation and Lost Passive Use: Damages from the Exxon Valdez Oil Spill

The particle has attached here :
Using CVM to Estimate Damage from Exxon Oil

Think about an example you can use CVM to estimate damages!!!

Stated Preference:

Choice Experiments

Indirect hypothetical stated preference methods include several attribute-based methods.

Attribute-based methods,

such as choice experiments, are useful when project options *have multiple levels of different attributes*. Like contingent valuation.

choice experiments ar **survey-based, but instead of asking respondents to state a willingness to pay, they are asked to choose among alternate bundles of goods**

(NO WTP questions)

The choice experiment included five attributes:

The preservation zone, the availability of public programs and whether or not there was a walking, virtual, or diving trail.

Sample Choice Experiment Question

I: Here is the first voting opportunity
(Please chose one of the four options below by putting an "X" in one of the empty boxes)

26.		**Program 1**		**Program 2**		**Program 3**		**Status Quo**
Preservation Zone		Yellow Zone		Yellow Zone		Red Zone		Red Zone
Public Programs		Large Investment		No Investment		Large Investment		No Investment
Walking Trails		Yes		No		No		No
Virtual Trails		No		Yes		Yes		No
SCUBA Diving Trails		Yes		No		No		No
One-time Tax		$12		$55		$145		$0
*put an "X" in **one** of the boxes to the right*		☐		☐		☐		☐

27. How confident are you about this choice from these options? (Please select one)
❍ Very Certain ❍ Somewhat Certain ❍ Somewhat Uncertain ❍ Very Uncertain ❍ Don't Know

II: Now consider another voting opportunity with different choices
(Please choose one of the four options below by putting an "X" in one of the empty boxes)

28.		**Program 4**		**Program 5**		**Program 6**		**Status Quo**
Preservation Zone		Orange Zone		Orange Zone		Yellow Zone		Red Zone
Public Programs		Large Investment		No Investment		No Investment		No Investment
Walking Trails		No		Yes		No		No
Virtual Trails		No		Yes		No		No
SCUBA Diving Trails		Yes		No		Yes		No
One-time Tax		$145		$12		$55		$0
*put on "X" in **one** of the boxes to the right*		☐		☐		☐		☐

29. How confident are you about this choice from these options? (Please select one)
❍ Very Certain ❍ Somewhat Certain ❍ Somewhat Uncertain ❍ Very Uncertain ❍ Don't Know

III: Finally, consider this third opportunity with different choices
(Please chose one of the four options below by putting an "X" in one of the empty boxes)

30.		**Program 7**		**Program 8**		**Program 9**		**Status Quo**
Preservation Zone		Red Zone		Red Zone		Yellow Zone		Red Zone
Public Programs		No Investment		Moderate Investment		Moderate Investment		No Investment
Walking Trails		Yes		No		Yes		No
Virtual Trails		Yes		No		Yes		No
SCUBA Diving Trails		No		Yes		No		No
One-time Tax		$12		$145		$55		$0
*put on "X" in **one** of the boxes to the right*		☐		☐		☐		☐

31. How confident are you about this choice from these options? (Please select one)
❍ Very Certain ❍ Somewhat Certain ❍ Somewhat Uncertain ❍ Very Uncertain ❍ Don't Know

Revealed Preference Methods "TCM & *Hedonic* "

Revealed preference methods are "observable" because they involve actual behavior and expenditures and "indirect" because they infer a value rather than estimate it directly.

Travel-Cost Method.

One way to derive this loss is through *travel-cost* methods. Travel-cost methods may infer the value of a recreational resource (such as a sport fishery, a park, or a wildlife preserve where visitors hunt with a camera) by using the information on how much visitors spend in getting to the site to construct a demand curve representing willingness to pay for a "visitor day."

Freeman et al. (2014) identify two variants:

1st: Analysts examine the number of trips visitors make to a site.

2nd: The analysts examine whether people decide to visit a site and, if so, which site.

In practical terms the first basic assumption for the TCM is that visits to the park are determined by a trip- or visit-generating function

$$V_i = f(C_i, X_{1i}, X_{2i}, \ldots, X_{Ni})$$

where V_i is visits from the ith origin or by the ith individual, C_i is the cost of a visit from origin i or by individual i, and the Xs are other relevant variables.

The second basic assumption is that the cost of a visit comprises both travel costs T_i, varying with i, and admission price, P, constant across i, and that visitors treat travel costs and the price of admission as equivalent elements of the total cost of a visit. where ε_i is the error term.

$f(\cdot)$ is linear in costs, and suppress the role of other variables, this means that the trip generating equation to be estimated is

$$V_i = \alpha + \beta C_i + \varepsilon_i = \alpha + \beta(T_i + P) + \varepsilon_i \qquad (12.8)$$

Differentiation equations:
What is the impact of increasing travel costs on visiting?

Given
the assumption of zero expectation for the error term in equation 12.8, the relationship between expected visits from origin *i* or by individual *i* and the price of access to the park is

$$E[V_i] = \alpha + \beta P + \beta T_i \tag{12.9}$$

where E[ ] is the expectation operator.

There E[*V i* *] is visits when the access price is zero, and *Pi* * is the choke price that drives E[*Vi*] to zero.

Setting *E*[*Vi*] equal to zero in equation 12.9 and solving for *P* gives.

$$P_i^* = -(\alpha/\beta) - T_i \tag{12.10}$$

and for *P* equal to zero:

$$E[V_i^*] = \alpha + \beta T_i \tag{12.11}$$

Marshallian consumer surplus for origin/individual i at P = 0 is given by the area of the triangle OE[Vi *]Pi * in Figure 12.7. The area of a triangle is half base times height, which in this case is 0.5 times OE[Vi *] times Opi*.

Using equations 12.10 and 12.11 that is

$$0.5\{\alpha + \beta T_i\}\{-(\frac{\alpha}{\beta}) - T_i\}$$

$$\{-0.5/\beta\}\{\alpha + \beta T_i\}\{\alpha + \beta T_i\}$$

so that using equation 12.11 again we have

$$\text{MCS}_i = \frac{-(\text{E}[V_i^*])^2}{2\beta} \qquad (12.12)$$

$$\text{MCS} = \frac{-\sum_i(\text{E}[V_i^*])^2}{2\beta} \qquad (12.13)$$

In some applications of the TCM, surplus for $P = 0$ is calculated across i using the actual observed visits for each origin/individual, as in:

$$\text{MCS} = \frac{-\sum_i V_i^2}{2\beta} \qquad (12.14)$$

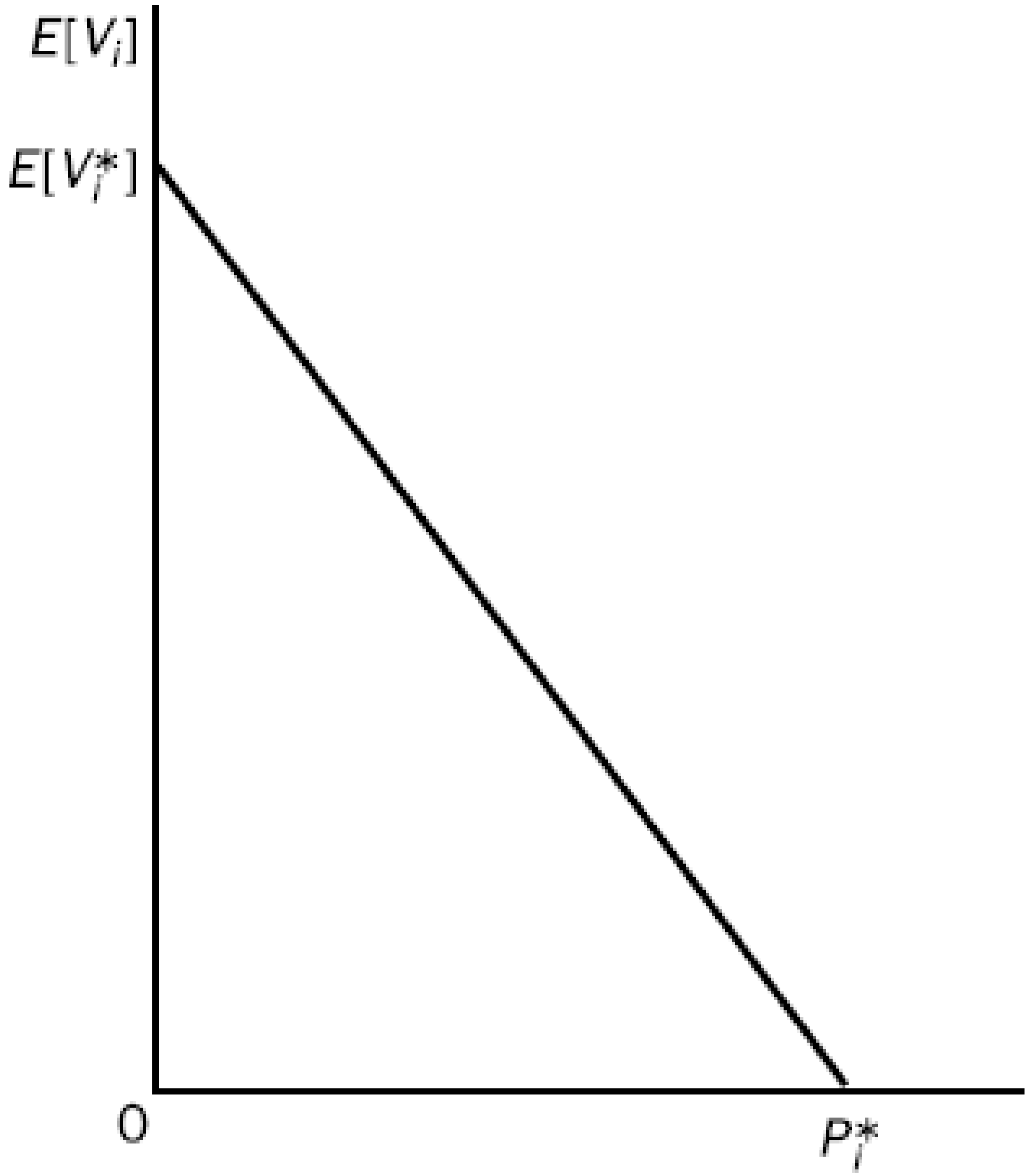

Figure 12.7 The linear trip-generating functi

Example: zonal average, TCM application

Box 12.1 An illustrative zonal average TCM example

The basic data for a national park with no admission charge are:

Zone	Visits	Population (thousands)	Distance (miles)
1	15 000	2 000	10
2	48 000	8 000	15
3	11 250	2 500	20
4	45 000	15 000	25
5	34 000	22 660	30

where distance is measured from the centre of the zone, and we are assuming, in the interest of keeping the story simple, that we know the total number of visits in the year from each zone. We will also assume that we know the travel cost per mile to be £1. The first step is to estimate the parameters of the trip generating function

$$v_i = \alpha + \beta(T_i + P) + \varepsilon_i$$

where v_i is visits per thousand population from the ith zone, T_i is travel cost from the ith zone, P is the admission price which is zero, and ε_i is the error term. We get ordinary least squares estimates for α and β using:

$$\hat{\beta} = \frac{\sum_i (v_i - \bar{v})(T_i - \bar{T})}{\sum_i (T_i - \bar{T})^2}$$

and

$$\hat{\alpha} = \bar{v} - \hat{\beta}\bar{T}$$

Box 12.1 ***continued***

From

	v_i	T_i	$v_i - \bar{v}$	$T_i - \bar{T}$	$(v_i - \bar{v})^2$	$(T_i - \bar{T})^2$	$(v_i - \bar{v})(T_i - \bar{T})$
	7.5	10	3	–10	9	100	–30
	6	15	1.5	–5	2.25	25	–7.5
	4.5	20	0	0	0	0	0
	3	25	–1.5	5	2.25	25	–7.5
	1.5	30	–3	10	9	100	–30
Sum	22.5	100				250	–75
Mean	4.5	20					

we get the estimated trip generating equation as

$$\hat{v}_i = 10.5 - 0.3(T_i + P)$$

The second step is to use this estimate to derive the relationship between visits and the price of admission, which is often referred to in the literature as the surrogate demand function. We will consider P varying in steps of £5. For $P = £5$ predicted visits from each zone, $\hat{V}_i$, and total predicted visits are calculated using the estimated trip generating function as follows:

Zone	$C_i = T_i + P$	$\hat{v}_i = 10.5 - 0.3C_i$	$\hat{V}_i$
1	10	6	12 000
2	15	4.5	36 000
3	20	3	7 500
4	25	1.5	22 500
5	30	0	0
Total			78 000

Proceeding in the same way for $P = £10$ and so on, we get the following simulated price/visits data for the surrogate demand function:

P	V
0	153 250
5	78 000
10	36 750
15	18 000
20	3 000
25	0

Figure 12.8 shows the surrogate demand function. The third step is to get from this the estimate of consumers' surplus for the year. Given that in fact $P = 0$, total consumers' surplus is the total area under this demand function, which is

[(153 250 – 78 000) × 5 × 0.5] + [78 000 × 5]

plus

[(78 000 – 36 750) × 5 × 0.5] + [36 750 × 5]

plus

[(36 750 – 18 000) × 5 × 0.5] + [18 000 × 5]

plus

[(18 000 – 3000) × 5 × 0.5] + [3000 × 5]

plus

[3000 × 5 × 0.5]

which is £1 061 875.

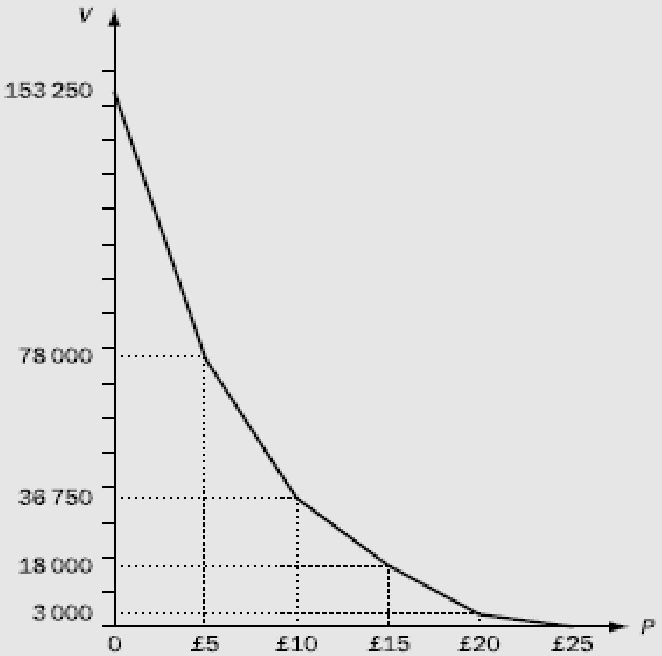

Figure 12.8 An illustrative surrogate demand function

The Hedonic Method
“ Market Price”