제 10차 공공투자연구 포럼

10.22

조건부 가치측정법 (Contingent Valuation Method) 의 이해와 적용
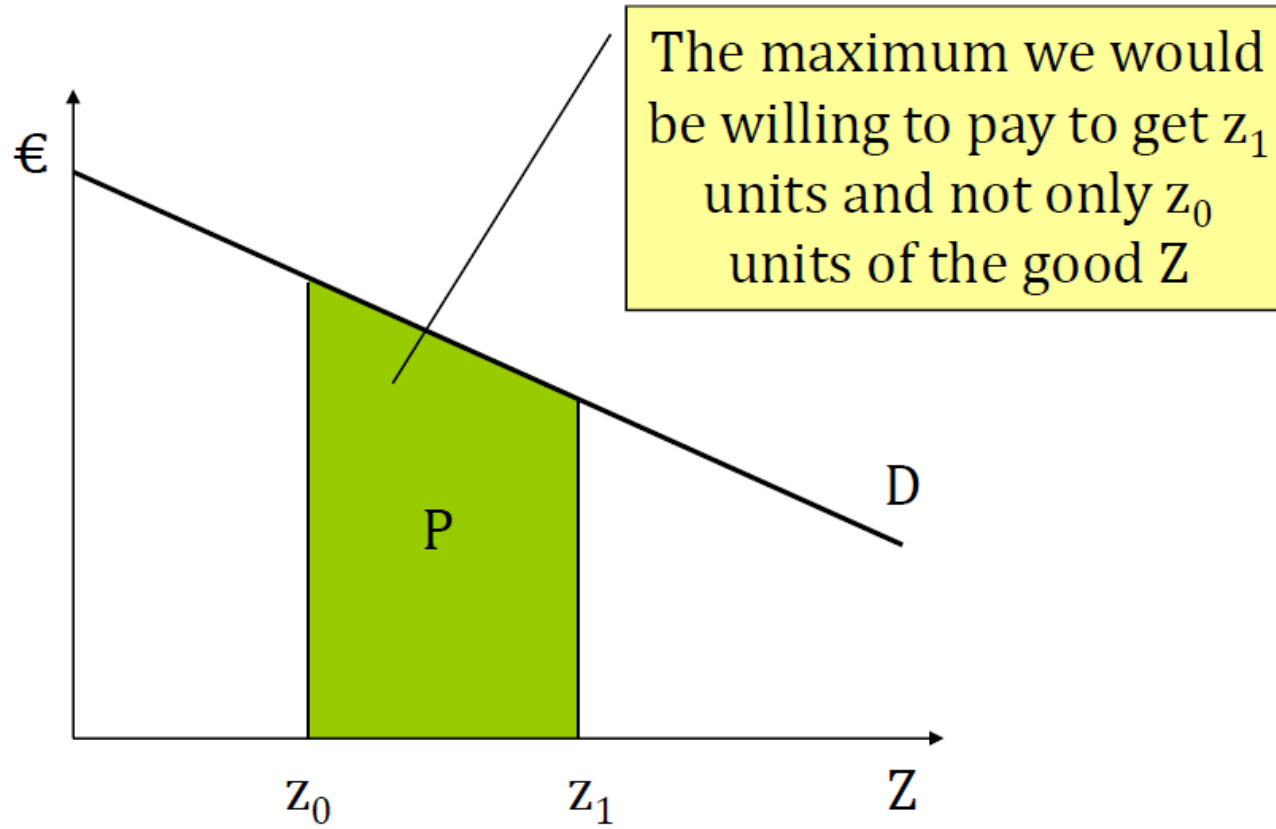
충남연구원

목차

조건부 가치 측정법(CVM)의 이론과 개념

사고에 대한 보상 (compensation) 인가? 아니면 지불 (payment)인가?

The maximum we would be willing to pay to get z_1 units and not only z_0 units of the good Z

Source: European Forest Institute –Mediterranean regional office workshop series on

사고에 대한 보상 (compensation) 인가? 아니면 지불 (payment)인가?

		Occurs	
		Yes	No
Change	+	**Payment**	**Compensation**
	-	**Compensation**	**Payment**

Source: European Forest Institute –Mediterranean regional office workshop series on

조건부 가치 측정법(CVM)이란?

- **CVM** 은 사람들에게 재화나 서비스에 대해 "얼마나 지불할 수 있느냐?"라는 질문을 기초로 함

- 조건부 가치 측정법(CVM)은 시장에서 거래될 수 없는 유형재화나 무형재화에 대해 경제적 가치(economic value)를 측정하는 방법
  - 초기에는 환경재나 환경서비스에 대해서만 경제적 가치를 측정하였으나, 기타 무형재화 뿐만 아니라 유형재화까지 적용범위가 확대됨.
  - 사용가치(use value)와 비사용가치 (non-use value)를 포함한 총 가치를 측정할 수 있음.

- **CVM**는 가상의 시나리오와 재화에 대한 조건 묘사에 기반한 **(contingent) 가치측정 (valuation).**
  - 사람들은 환경재나 무형재화로 부터 얻는 이익에 대해 지불의사능력(WTP)이 있음. 그러나 이러한 이득은 경제적 가치로 환산되지 않는 이상 0 이라고 볼 수 있음.
  - 가상의 시나리오와 조건을 제공하고 질문을 하는 방식으로 그들의 WTP를 물어보고 이러한 기초자료를 통해 경제적 가치 (편익)을 추정할 수 있음.

조건부 가치 측정법(CVM)이란?

- **질문을 (asking)을 하여 가치측정을 하는 것은 이론적, 실증적인 문제들을 발생시킴**
  - 가상 조건과 시나리오에 가상질문을 답하는 것에 대한 문제는 경제학에서 자주 논의되고 있는 사항임.
  - 많은 경제학자, 사회학자, 심리학자들은 CVM으로 도출되는 금전가치(monetary value)에 대해 매우 적은 신뢰도를 보이고 있음.

조건부 가치 측정법(CVM)에 대한 이론

- **확률효용모형 (Random Utility Model)**
  - 확률효용이론(random utility theory)에 기초
  - 총효용 = 결정적 효용 (관측 가능) + 확률적 효용 (관측 불가능)
  - 효용은 확률함수(random function)임을 가정, 의사결정주체는 가장 높은 효용(maximum utility)을 가진 대안을 선택

- **효용 (Utility) = 복지 (welfare) = 만족 (satisfaction)**

- **효용 (Utility)은 재화 소비와 함께 증가**
  - $u = u(x)$

- 그렇다면 우리는 이러한 재화를 얼마나 소비할 수 있을까**?**
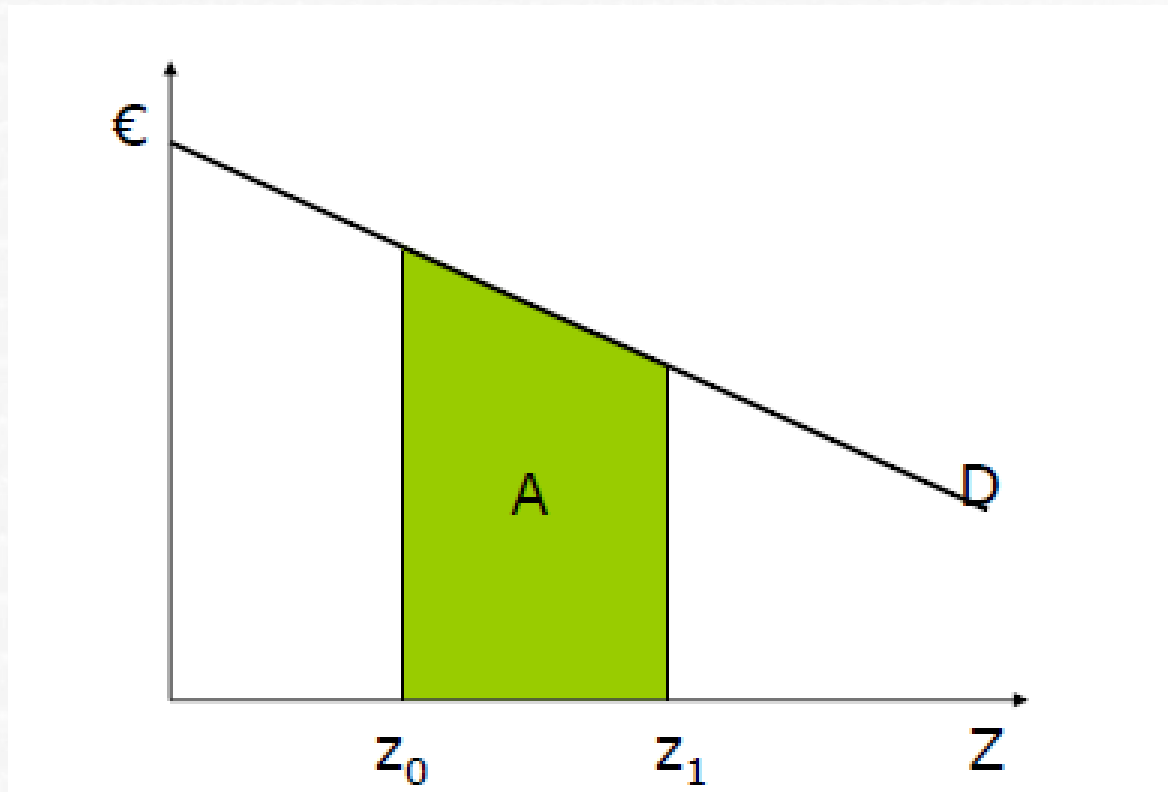
- 재화의 가격과 우리의 소득에 달려 있음**.**
  - $x = x(p_x, y)$

- 그래서 우리의 효용은 다음과 같이 표현됨
  - $u = v(p_x, y)$

WTP 추정 및 편익 산정

- 여기에 특정재화가 추가 될 수 있다. 이를테면, 환경재 **(z)**
  - $u = v(p_x, \textbf{\textit{z}}, y)$

WTP 추정 및 편익 산정

- 여기에 특정재화가 추가 될 수 있음. 이를테면, 환경재 **(z)**
  - $u=v(p_x, z, y)$

- 여기에 **z0**가 있으므로,
  - $u=v(p_x, z0, y)$

- 그러나 **A** 를 지불함으로써 우리는 **z1** 을 얻을 수 있음
  - z1 은 z0 보다 크므로, z0 < z1

- 이를 대입하여 계산해보면
  - $u=v(p_x, z1, y-A)$

WTP 추정 및 편익 산정

- 우리가 기꺼이 지불하는 금액은 지속적으로 상승하나, 언제까지 오를 것인가?
  - If $v(p_x, \mathbf{z0}, y) < v(p_x, \mathbf{z1}, y\text{-}A)$
  - If $v(p_x, \mathbf{z0}, y) = v(p_x, \mathbf{z1}, y\text{-}A)$
  - If $v(p_x, \mathbf{z0}, y) > v(p_x, \mathbf{z1}, y\text{-}A)$

- 답을 하자면
  - A < WTP z1 를 얻기위해 A를 지불
  - A = WTP 차이가 없음
  - A > WTP z1를 얻기 위해 A를 지불하지 않음

지불의사 금액 함수 설정

- 지불의사금액은 응답자들이 처한 환경과 경제적 상황에 의해서 영향을 받을 뿐만 아니라 개인적 특성이나 선호에 의해서 달라짐
  - 개인 및 가구의 사회경제적 특성
  - 재화나 서비스에 대한 인지나 태도

- **따라서, 다음과 같은 형태를 띰.**
  - Y는 소득, SOCIOECON은 사회경제적 특성, GEN은 성별, RECOG는 인지도

$$WTPi = \beta_0 + \beta_1 Y_i + \beta_2 SOCIOECON_i + \beta_3 GEN_i + \beta_6 RECOG + \varepsilon_i$$

CVM 의 분석과정

CVM 측정과정

1. 가치 추정 측정 대상 및 설문대상 설정	• 가치추정 측정 대상 (가치를 추정할 구체적 재화) • 설문대상 (지역주민, 국민, 방문자, 재화 이용자 등)
1. 설문 방법에 대한 구체적 결정	• 가치추정 측정 대상 (가치추정할 구체적 재화) • 설문대상 (지역주민, 국민, 방문자, 재화 이용자 등)
1. 시나리오 구성 및 설문지 설계	• 재화나 서비스의 특성, 이용 및 WTP을 답할 수 있는 환경 제시
2. 사전 설문조사	• 소규모 표본 (50인~100인) 대상으로 가치추정 대상에 대해 WTP 범위를 알아보는 설문조사 진행
2. 본 설문조사	• 사전 설문조사를 바탕으로 WTP의 범위 조정하여 본 설문조사 실시
3. WTP 도출	• 지불의사금액 함수 설정 및 추정과 함께 재화의 가치 도출

CVM 의 주요 설문 방법

- **직접 질문 방법 (Direct elicitation method)**
  - 정책이나 재화에 대해 직접 지불의사(willingness to pay)를 묻는 방법

- **직접 지불의사 방법 (Direct payment method).**
  - 가격에 대해 직접 물어보는 방법

- **경매법 (bidding method)**
  - 임의의 WTP에 대해 지불의사를 질문하는 과정을 되풀이하고 일정 금액에 수렴하면 질문을 중지

- **지불카드법 (paying card method)**
  - 다른 항목의 가구당 평균적인 지출 목록을 함께 제시하면서 연구대상 재화에 대한 지출액을 답

- **양분선택방법 (Dichotomous choice (referendum) method).**
  - 일정금액을 지불할 의삭 있는지 여부를 묻고 예/아니오로 대답
  - 가격을 제공하고 피설문자가 선택하는 방법

직접 질문 방법 (Direct elicitation (non-referendum) method)

Idea: ask people to state their willingness to pay for a policy or good.

Open ended: state your WTP. Period. Works well.

Close-ended: would you pay X? If so, then would you pay X+1? X+2? X+3? If not, would you pay X-1? Etc. Sensitive to initial value of X.

Ranking method: rank combinations of good and payment (e.g. low taxes and low water quality, high tax and high quality). WTP must be inferred.

양자선택방법 (Dichotomous choice (referendum) method)

Similar to close-ended approach, but bid amounts are varied across the sample, rather than adjusted for individuals.

Resulting data gives accept/reject probabilities for each bid price.

See Figure 14.1 (histogram=demand curve)

Data are typically used to derive WTP for various sub-groups in the population.

Drawback: sample size must be large to minimize influence of outliers (true WTP may be far from individual valuations)

직접 지불의사 방법 (Direct payment method)

Similar to previous approaches, but individuals are asked to actually pay for the good.

Example: Road removal on North rim of Grand Canyon

      218 miles to be removed
      $1 donation = 8" of road removal

      result = lower bound on WTP

Source: Champ, P.A., R.C. Bishop, T.C. Brown, and D.W. McCollum. 1997. "Using Donation Mechanisms to Value Nonuse Benefits from Public Goods." *Journal of Environmental Economics and Management* 33(2):151-162.

설문 항목의 구성

- **응답자에 대한 정보**

  - 응답자의 재화에 대한 과거, 현재, 미래의 기대되는 사용정도

- **가상 시나리오 설명**

  - 응답자가 사업의 특성을 잘 이해할 수 있도록 사업에 대한 내용 (서비스 내용, 대체/보완재) 설명 필요하며, **평가되는 재화의 변화를 설명**

- **가상적인 지불 시스템 제공**

  - 가상적인 지불 시스템과 연관되는 여러 가정과 제한 사항들을 설명

- **가상 지불 시스템 제공**

  - 설문대상 (세대주, 배우자 대상), 지불수단 및 기간 (5년간 소득세), 지불의사

- **지불의사(WTP)에 대한 직접적 질문**

- **응답자의 구체적 정보**

  - 사회경제적 정보, 지불수단 및 기간, 대체제 가능성, 예산의 한계 등

CVM 적용에 있어 주의사항 및 필요사항

CVM 적용에 있어 필요사항

- **적용가능한 편익추정 가치평가 기법 검토 (KDI 공공투자관리센터, 2015)**
  - 사업시행에 따른 효과범위와 편익의 유형을 고려하여 적용 가능한 편익추정기법들을 충분히 비교검토하고 난 후, CVM 만이 대한이라고 판단되는 경우에 적용

- **이중계산 (Double Counting)에 대한 주의 필요 (KDI 공공투자관리센터, 2015)**
  - 개별 편익과목을 합산하는 과정에서 이중계산(Double Counting)의 문제가 발생가능성. 항목간 중복성에 대한 주의 필요

- **복수 평가기법을 사용한 검토 권장 (K야 공공투자관리센터, 2015)**
  - 박물관 사업의 경우, 방문수요 및 방문 비용, 입장료를 고려한 여행비용 접근법을 사용하여 편익산정 가능 → CVM 방법과 결과 비교

적용에서 유의 사항

- **일반적으로 재화에 있어 양의 변화와 질적 변화에 대해 얼마나 지불할 것인지를 물음**
  - 가치 변화에 대해 정확히 물어아아함 (Z0와 z1의 범위와 차이)
  - 예를 들어, 공원이 하나 더 생기면 얼마나 지불할 것입니까? 라는 질문은 불충분함
  - 시간적으로 언제 들어오는지 물어보아야 하며, 지불의사(WTP) 와 보상에 대한 수용의사 (WTA)를 정확히 물어보아야 함.
  - 그렇게 하지 않으면 구체적인 가치를 측정할 수 없음

Guidelines for Designing CV Surveys

1. Do respondents understand the good being valued?

2. Do respondents have experiences in valuation and choice?

3. Are the details of the project clear?

4. Does the survey ask for WTP rather than WTA?

5. Does the survey instrument avoid anchoring and starting point bias?

Guidelines for Using WTP from CVM

- Specify which studies and estimates are being used

- Specify assumptions made in extrapolating

- Specify any quality changes involved

- Specify distinctions between use and nonuse values

- Perform sensitivity analysis

- Specify any potential biases

General Survey Issues

Survey administration:

- In person (expensive and subject to interviewer bias)

- Telephone (most common method)

- Mail (low cost but response rate is low)

- Internet (impossible to obtain random samples

- sample should reflect those with standing

- CV samples need to be large to deal with the problem of WTP being skewed by a small number of extreme values

- avoid respondents who can't or won't provide values

CVM Problems

1. Meaning and context problems:
    Do respondents understand the policy or good?

2. Neutrality
    Does the interviewer elicit a neutral response?
    Do the respondents have special interests?

3. Judgment Biases
    Noncommitment bias: *bid > true WTP*
    Order effects: *income and substitution effects*
    Embedding: *similar values for large and small changes*
    Anchoring: *final bid depends on starting point*

WTP vs. WTA

In theory, WTP should equal WTA…

…but people generally have loss aversion (i.e. they require more compensation to give up things they possess than they are willing to pay to acquire the same item).

Studies suggest WTA amounts are 4-15 times greater than WTP amounts.

Strategic Response Problem

Will people be honest? Or will they act strategically?

People overestimate WTP if they think provision of the good depends on aggregate WTP.

People underestimate WTP if they think their cost will be based on their stated WTP.

Best CV design is one in which respondents have a single binary decision (take it or leave it).

Assessing CVM Accuracy

Accuracy can be assessed in three ways:

1. Compare values from CVM to those obtained via other methods (Travel Costs, Hedonic regressions, market prices)

2. Compare respondents' statements with actual behavior (often using an experiment)

3. Compare CV values over time

In general CVM seems fairly valid for use values, but its use in estimating nonuse values is highly contentious.

CVM의 장점

CVM의 장점

- **모형의 융통성, 간결성, 범용성**
  - 존재하는 모든 사물에 대한 가치 평가 가능하며, 분석에 있어 어렵지 않으며, 많은 분야에서 쓰이고 있음.
  - 그러나 사용자 (응답자)가 직접 사용하고 소비하여 잘 이해하고 있는 재화에 대한 평가가 이루어져야 함

- **총 경제적 가치 평가**
  - 사용적 가치와 비사용적 가치에 대한 총 경제적 가치 평가 가능

- **지불의사(WTP)와 수용의사(WTA)는 효영변화에 대한 정확한 경제적 가치 측정**
  - 그러나 WTP와 WTA의 선택은 다를 수 있음
  - Hammack & Brown (1974) 에 의하면, WTA = 4 * WTP → 다른 연구에서도 비슷한 결과를 가져옴
  - 이러한 결과는 본인이 처한 예산제약에 따라 지불(paying)에 대해서만 생각하는 것이 익숙하기 때문

CVM의 한계

- **Although the CVM has been widely used for the past two decades, there is considerable controversy over whether it adequately measures people's WTP/WTA for environmental quality.**

CVM-Limitations

- **People have practice making choices with market goods, so their purchasing decisions in markets are likely to reflect their true willingness to pay. CV assumes that people understand the good in question and will reveal their preferences in the contingent market just as they would in a real market. However, most people are unfamiliar with placing monetary values on environmental goods and services. Therefore, they may not have an adequate basis for stating their true value ("hypothetical bias)**

CVM-Limitations

- **The expressed answers to a WTP/WTA question in a CV format may be biased because the respondent is actually answering a different question than the surveyor had intended. Rather than expressing value for the good, the respondent might actually be expressing their feelings about the scenario or the valuation exercise itself.**

CVM-Limitations

- **For example, respondents may express a positive WTP because they feel good about the act of giving for a social good (referred to as the "warm glow" effect), although they believe that the good itself is unimportant.**

- **Respondents may state a positive WTP in order to signal that they place importance on improved environmental quality in general.**

CVM-Limitations

- **Alternatively, some respondents may value the good, but state that they are not WTP for it, because they are protesting some aspect of the scenario, such as increased taxes or the means of providing the good.**

- **Respondents may make associations among environmental goods that the researcher had not intended. For example, if asked for WTP for improved visibility (through reduced pollution), the respondent may actually answer based on the health risks that he or she associates with dirty air.**

- **Some researchers argue that there is a fundamental difference in the way that people make hypothetical decisions relative to the way they make actual decisions.**

- **For example, respondents may fail to take questions seriously because they will not actually be required to pay the stated amount.**

- **Responses may be unrealistically high if respondents believe they will not have to pay for the good or service and that their answer may influence the resulting supply of the good.**

- **Conversely, responses may be unrealistically low if respondents believe they will have to pay (free-riding).**

CVM-Limitations

- The payment question can either be phrased as the conventional 'What are you WTP to receive this environmental asset?', or in the less usual form, 'What are you WTA in compensation for giving up this environmental asset?'

- In theory, the results should be very close. However, when the two formats have been compared, WTA very significantly exceeds WTP. Critics have claimed that this result invalidates the CVM approach.

CVM-Limitations

- **If people are first asked for their WTP for one part of an environmental asset and then asked to value the whole asset, the amounts stated may be similar. This is referred to as the "embedding effect."**

- **In some cases, people's expressed WTP for something has been found to depend on where it is placed on a list of things being valued. This is referred to as the "ordering problem."**

CVM-Limitations

- **Respondents may give different WTP amounts, depending on the specific payment vehicle chosen.**

- **For example, some payment vehicles, such as taxes, may lead to protest responses from people who do not want increased taxes.**

- **Others, such as a contribution or donation, may lead people to answer in terms of how much they think their "fair share" contribution is, rather than expressing their actual value for the good.**

CVM-Limitations

- **Many early studies attempted to prompt respondents by suggesting a starting bid and then increasing or decreasing this bid based upon whether the respondent agreed or refused to pay a such sum. However, it has been shown that the choice of starting bid affects respondents' final WTP response.**

- **Strategic bias arises when the respondent provides a biased answer in order to influence a particular outcome.**

CVM-Limitations

- **Information bias may arise whenever respondents are forced to value attributes with which they have little or no experience. In such cases, the amount and type of information presented to respondents may affect their answers**

- **Non-response bias is a concern when sampling respondents, since individuals who do not respond are likely to have, on average, different values than individuals who do respond.**

CVM-Limitations

- **Estimates of non-use values are difficult to validate externally.**

- **When conducted to the exacting standards of the profession, contingent valuation methods can be very expensive and time-consuming, because of the extensive pre-testing and survey work.**

- **Many people, including jurists policy-makers, economists, and others, do not believe the results of CV.**

CVM 분석의 추정오류를 최소화하기 위한 지침

- **National Oceaninc and Atmospheric Administration (NOAA) 패널의 지침 제시**
  - 전화조사나 우편조사가 아닌 개별적인 면담조사
  - WTA보다는 WTP를 측정하는 것이 바람직
  - 지불수단으로 양분선택법의 사용
  - 고려중인 프로그램의 기대효과를 정확하게 이해할 수 있도록 묘사
  - 응답된 WTP의 지불로 다른 재화에 대한 지출을 줄여야함을 인식
  - 대상재화에 대한 대체제를 알려야 함
  - 응답자가 질문을 제대로 이해하고 이성적으로 대답했는가를 확인할 수 있는 추가질문 필요

CVM 적용 사례

- **Exxon Valdez oil spill (1989) is caused by the oil tanker running into the rocks releasing 11 million gallons of crude oil**

- **Largest oil spill in US waters resulted in environmental damage of unprecedented proportions**

CVM-Example I

- **CVM and non-use (passive use) values entered the dictionary of economics, law and public policy**

- **US court decided that damage claim for environmental losses should also include passive use values**

- **Most of the damages from the spill was passive use since active use of the area was modest**

- **State of Alaska sued Exxon for natural resource damage for lost passive use value**

CVM-Example I

- **The only environmental valuation method that can estimate passive use values is CVM**

- **A CV study was carried out to estimate the loss of passive use value from Exxon Valdez spill**

- **Respondents were asked their WTP to prevent a future accident that would cause an equivalent damage in the same area**

- **1472 respondents randomly sampled from the US population took part in the CV survey**

CVM-Example I

- **CV survey was carefully designed to minimise CV limitations**

  - Use of probability sampling

  - Referendum elicitation format

  - In person interviews with cards photos and maps

  - Accurate description of the valuation scenarios

  - Checks on understanding and acceptance

  - Yes/no follow up questions

  - Careful pre-testing

CVM-Example I

- **Median WTP was found to be $27-46 and mean $67-220**

- **WTP increases with the respondents' income, likelihood of visit to Alaska, environmentalism, attitude for conservation of wilderness, perception of importance of the accident**

- **Total passive use values amount to $2.81-9.33 billion**

CVM-Example I

- **Exxon in fear of the large size of the damage claims being made against it funded a study to discredit CVM**

- **National Oceanic and Atmospheric Administration (NOAA- the government body that is responsible for issuing regulations on the assessment of damage from oil spill) formed a panel consisting of distinguished economists to consider criticisms of CVM and make recommendations to NOAA**

CVM-Example I

- **Panel agreed that CVM is valid if the following recommendations are taken into account:**

  - Dichotomous choice format

  - Minimum response rate of 70%

  - In person interviewing

  - WTP rather than WTA

  - Sensitivity to scope is accounted for

  - Respondents are reminded of their budget constraints

CVM-Example II

- **Cheimaditida wetland is located 40 km Southeast of Florina in Northwest Greece**

- **This wetland includes Lake Cheimaditida, one of the few remaining freshwater lakes in Greece, and constitutes a total catchment area of 168 km^2 surrounded by extensive marshes with reeds**

- **The wetland is very rich in biodiversity**

CVM-Example II

- It supports six habitat types of Annex I of the EU Habitats Directive (92/43/EEC), one of which is a *priority natural habitat* under Article 1

- It is very rich in flora diversity (there are 150 relatively rare plant species in the wetland, 6 of which are listed under CITES).

- It also supports a wide array of fauna diversity including several mammals, amphibians, reptiles and fish, most of which are listed in Annex II and IV of the EU Habitats Directive (92/43/EEC).

- It is a recognised Important Bird Area and approximately 140 bird species have been identified, most of which are under protection and three are globally threatened

CVM-Example II

- **Agriculture is the vital economic activity in the catchment**

- **Water extraction from the lake for irrigation in agriculture and water pollution due to run-off from agricultural practices are adversely affecting water quantity and water quality in the wetland.**

- **These in turn affect the level of biodiversity that the wetland is able to support**

CVM-Example II

- **Previous study have estimated the use values of the various wetland functions (including flood water retention, food web support, ground water recharge, nutrient export, and sediment retention) to the local population by using CVM.**

- **Aim: To estimate the non-use values the wetland generates to the Greek public by using a CVM. To calculate the TEV of the wetland and to carry out a CBA to inform policy makers about efficient and effective means of its restoration, conservation and sustainable management.**

- **To carry out a CE we need to determine**

  - The non-use attributes of the wetland that are important to the public.

  - The relationship between the threats to the wetland's ecological functions and the important wetland attributes

- **We have carried out**

  - Focus groups with Greek public

  - Consultations with scientists

  - Extensive literature review

- **Important non-use attributes of the wetland included**

  - biodiversity

  - open water surface area

  - educational and research extraction

  - local employment

CVM-Example II

- **Three scenarios were constructed**

  - <u>*Scenario A*: No management. BAU, expected conditions in 5 years</u>
    - Biodiversity: Deteriorating to low level i.e., a 10% decline in population, size of habitats, and loss of one endangered species

      OWSA: Declining i.e., a 3-10% reduction in open water surface area.
    - E and R:Deteriorating i.e., a reduction in the educational and research extraction possibilities as a result of a lack of investment in existing facilities.
    - Employment: Loss of 65 agricultural jobs

CVM-Example II

- *Scenario B*: Managing the wetland to maintain current conditions

  - Biodiversity: Maintain the current level (150 rare plants species, 140 bird species -3 are threatened, 11 mammals, 7 amphibians, 7 reptiles, and 8 fish

  - OWSA: Maintain the current open water surface area (20% open water, remaining 80% covered by reed beds).

  - E and R: Maintain the current levels of educational and research extraction (by sustaining existing facilities, which include a small hut and 2 informational posters).

  - Employment: No change

- *Scenario C*: Managing the wetland to improve current conditions

  Biodiversity:Increase to a higher level i.e., a 10% increase in population and size of habitats.

  OWSA: Increase open water surface area to 60%

  - E and R: Improve the level of educational and research extraction by providing better facilities, i.e., larger building, microscopes, books, information leaflets, binoculars, posters etc.

  - Employment: Retraining of 150 farmers

- Respondents were asked if they are WTP to move from A to B and A to C and if yes, how much they are WTP.

- The payment vehicle is a one off donation which will go to a Lake Cheimeditida conservation to be managed by the local NGO

- Respondents were reminded of their budget constraints, substitute sites, were shown photos and maps and were given enough information about the site that is being valued

CVM-Example II

- Data from 100 respondents were collected in face to face surveys in January 2005

- Data on the respondents social and demographic characteristics were collected

- 82% of the respondents indicated that they are WTP to maintain current conditions (move from A to B)

- 74% of the respondents stated that they are WTP to improve the current conditions (move from A to C)

- Regression analyses revealed that
  - Age, income and the education level of the respondents were positively and significantly correlated with their WTP for wetland conservation scenarios

  - The mean WTP to move from scenario A to B was €18 with a median of €10 and the mean WTP to move from scenario A to C was €24, with a median of €12.50

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