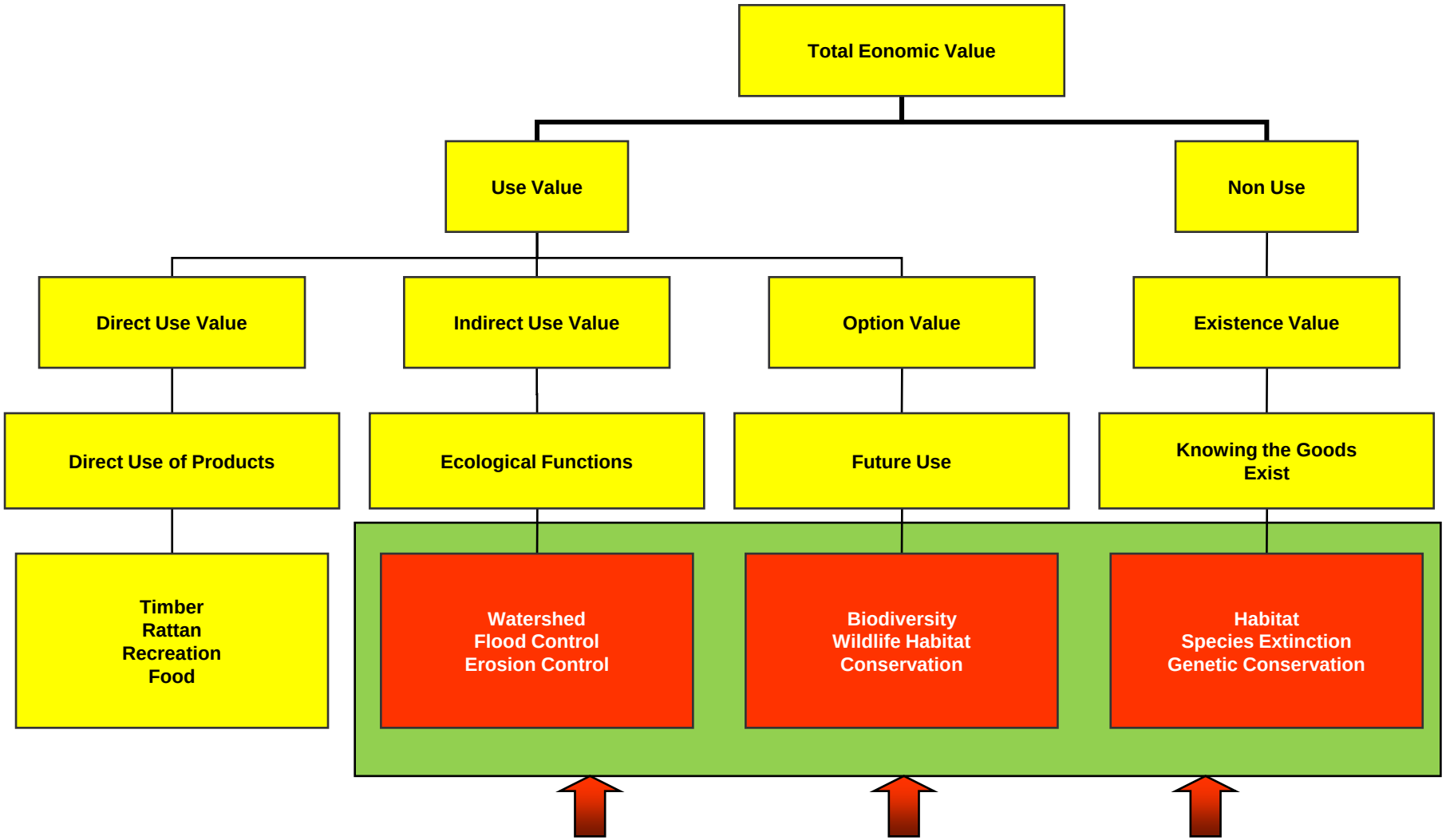
SUSTAINABLE USE OF FOREST ECOSYSTEM SERVICES

CONTINGENT VALUATION METHOD (CVM)

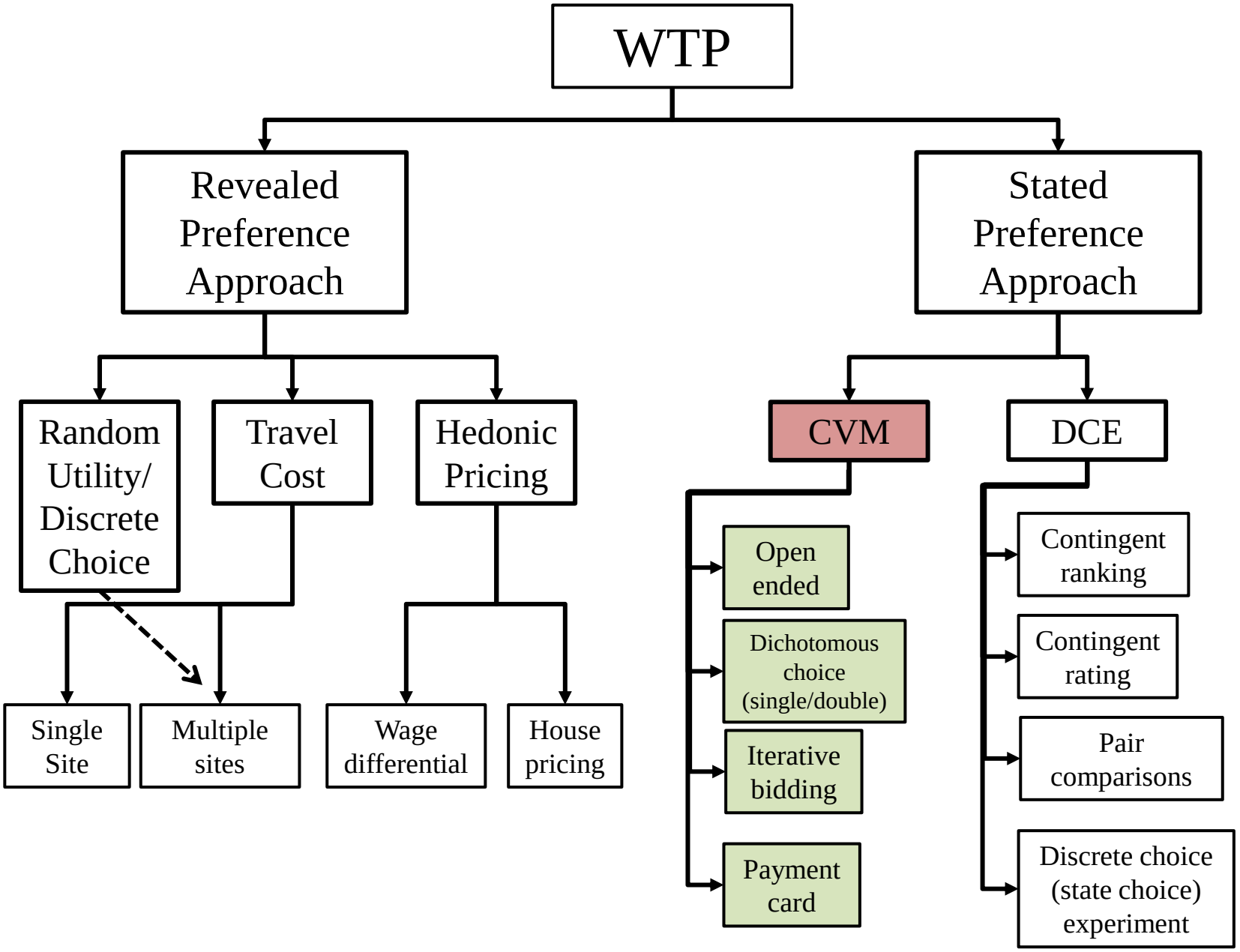
CVM: history

- First applied in the U.S. in the 1960s
- Became prominent in early 1990s, due to use in Exxon *Valdez* lawsuits
- Survived review by blue-ribbon panel formed by U.S. government
- Number of studies:
  - Mid-1990: X studies in X countries
  - 2001: X studies in X countries

Taxonomy of Economic Value



Contingent Valuation Method (CVM)/Discrete Choice Experiment (DCE)



WTP Methods (Source: Bateman et al., 2002; Kjaer, 2005

Forms of Contingent Valuation

	Actual WTP	Discrete Choice
Single question	•Open ended •Payment card •Sealed bid	•Referendum •Take-it-or-leave it
Iterated or series of questions	•Bidding game •Auctions	•Take-it-or-leave it with follow up (Double bounded) •N-bounded CVM •Spike CVM •1 ½ bound

Basic Concepts

- Definition: CVM is a technique that allows the estimation of *the value that people attach to a change in the availability* of an environmental good or service by asking directly for their *willingness to pay (WTP)* or their *willingness to accept (WTA)* a compensation

- It is useful eliciting both use and non use values (it is the only technique available for non use values). It has been used for valuing almost everything (air, water, noise pollution, recreational services, biodiversity, protected areas, transport services)

Basic Concepts

- Usually it relies on questionnaire
- CVM studies can be run with different degrees of detail and data can be treated at different levels of complexity, according to time and resource constraints

Basic Concepts

- Willingness to pay (WTP) to secure enhancement of their access to an environmental asset or to avoid a deterioration in supply; or

- Willingness to accept (WTA) compensation for a reduction in supply or willingness to pay for being refused an improvement in the supply

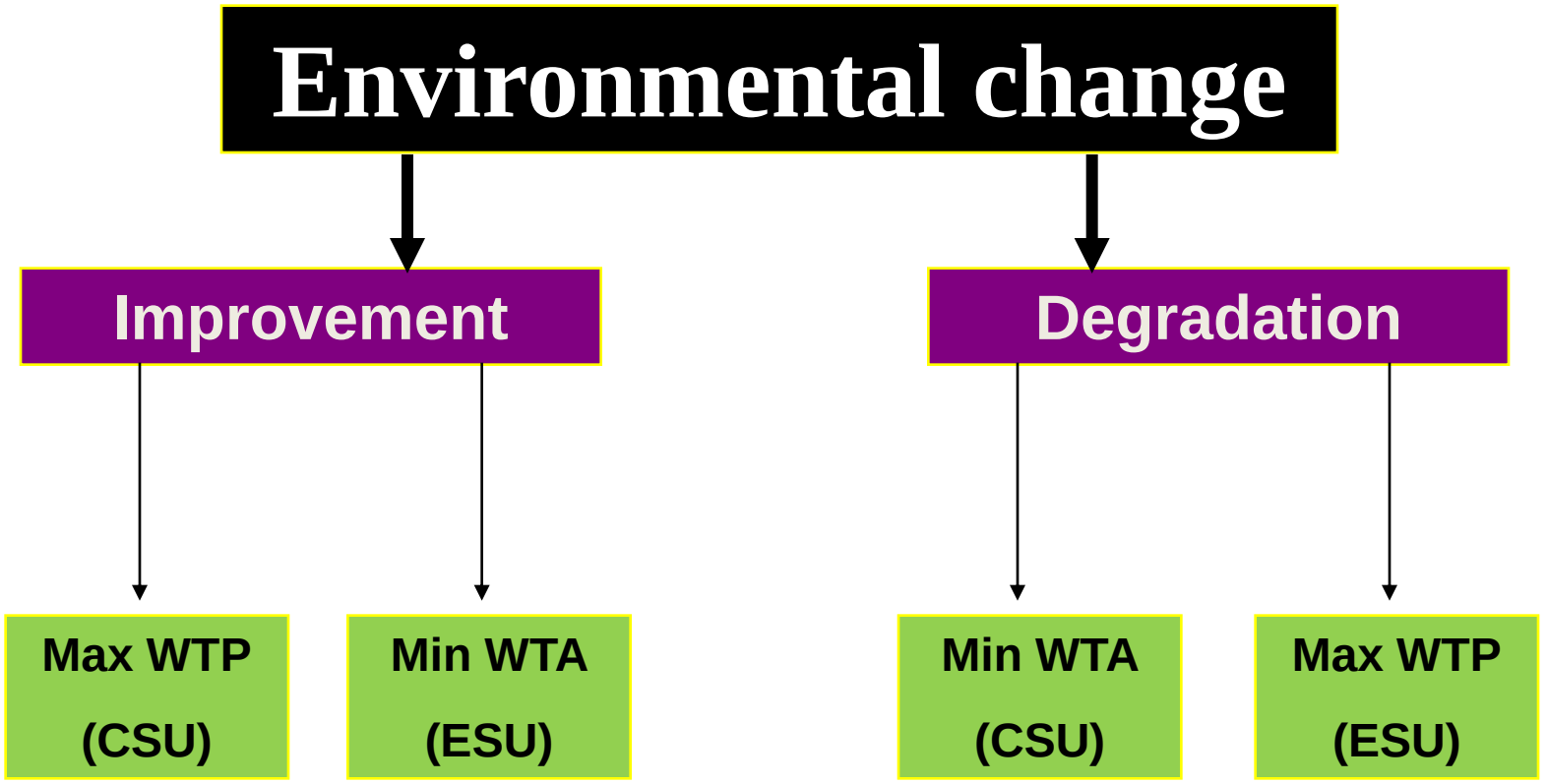
Advantage

- Flexible and seems very easy to do
- Ex ante estimation is possible
- Can be all encompassing
- Acceptance in some legal process (US)
- Seems to be low cost

Disadvantage

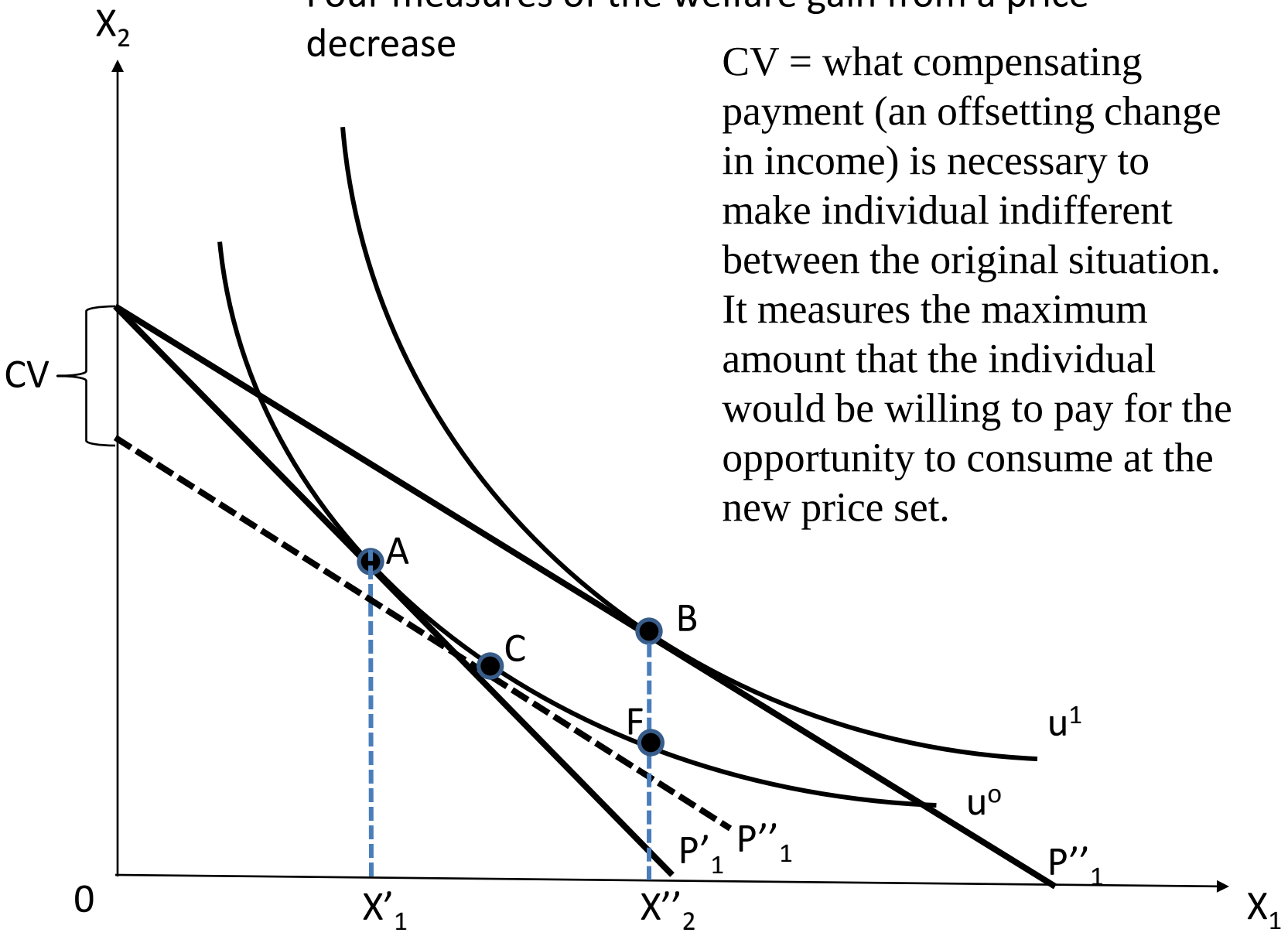
- Deceptively “simple” concept, perhaps too easily applied without appreciation of the complexities, taxing on rspondents
- Not based on market revelations of preference – statements are hypothetical
- Difficult to test validity, data analysis can be very difficult
- Cost can be very high – need survey
- Subject to biases / strategic behaviour

What is to be valued?



Four measures of the welfare gain from a price decrease

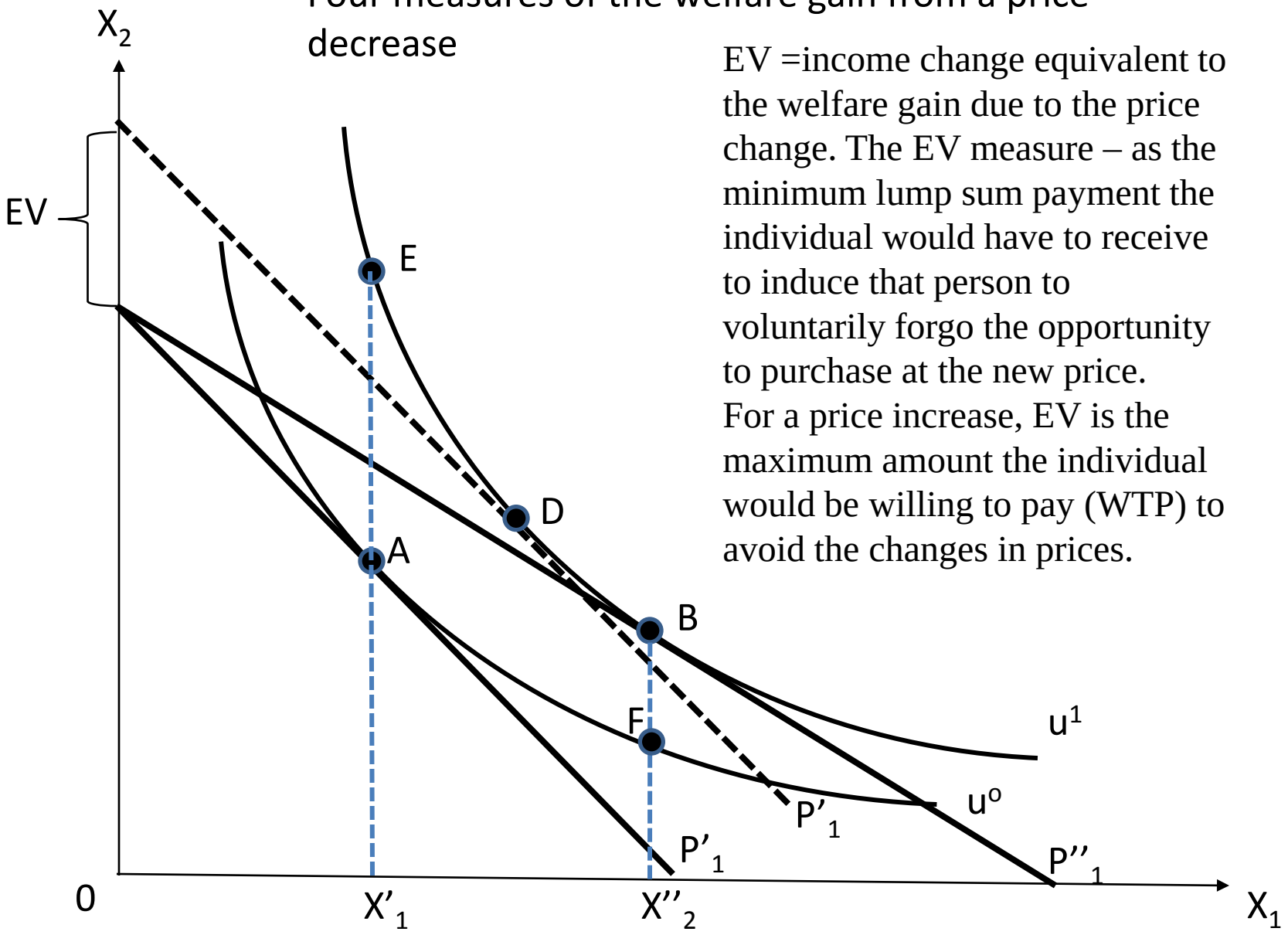
CV = what compensating payment (an offsetting change in income) is necessary to make individual indifferent between the original situation. It measures the maximum amount that the individual would be willing to pay for the opportunity to consume at the new price set.



Source: Freeman, 1993

Four measures of the welfare gain from a price decrease

EV =income change equivalent to the welfare gain due to the price change. The EV measure – as the minimum lump sum payment the individual would have to receive to induce that person to voluntarily forgo the opportunity to purchase at the new price.
For a price increase, EV is the maximum amount the individual would be willing to pay (WTP) to avoid the changes in prices.



Source: Freeman, 1993

Theoretical Background

V = indirect utility function

y is income, *b* is WTP

WTP is defined as the amount that must be taken away from the person's income while keeping his utility constant

- Indirect Utility Functions
  - Status Quo: $U_o = V(y, q_o) + \varepsilon_o \quad q_o = 0$
  - Proposed program: $U_1 = V(y - b, q_1) + \varepsilon_1 \quad q_1 = 1$
- Assuming linear function: $V = \alpha q + \beta y$
- The probability of voting for the program:

$$\Pr(U_1 > U_o) = \Pr[\alpha q_1 + \beta(y - b) + \varepsilon_1 > \alpha q_o + \beta y + \varepsilon_o]$$

$$\Pr(U_1 > U_o) = \Pr[\alpha - \beta b > \varepsilon_o - \varepsilon_1] = \Pr[\varepsilon^* < \alpha - \beta b]$$

WTP and WTA

- The goal of CVM is to measure the compensating or equivalent variation for the good in question.
- Both compensating and equivalent variation can be elicited by asking a person to report a willingness to pay (WTP) amount. For instance, the person may be asked to report his WTP to obtain the good, or to avoid the loss of the good.
- Formally, **WTP** is defined as the amount that must be taken away from the person's income while keeping his utility constant. This is given as:

$$V(y - WTP, p, q_1; \mathbf{Z}) = V(y, p, q_0; \mathbf{Z})$$

where *V* is the indirect utility function, *y* is income, *p* is a vector of prices faced by the individual, and q_0 and q_1 are the alternative levels of the good or quality indexes (with $q_1 > q_0$, indicating that q_1 refers to improved environmental quality). **Z** is a vector of individual characteristics (e.g. age, gender, marital status, years of education, type of job, etc.)

Note:

- Compensating variation is the appropriate measure when the person must purchase the good, such as an improvement in environmental quality.
- Equivalent variation (EV) is appropriate if the person faces a potential loss of the good, as he would if a proposed policy results in the deterioration of environmental quality.

- **Willingness to accept** (WTA) is defined as the amount of money that must be given to an individual experiencing a deterioration in environmental quality to keep his utility constant:

$$V(y + WTA, p, q_2; \mathbf{Z}) = V(y, p, q_0; \mathbf{Z})$$

- Where q_2 indicates a deterioration in quality compared to the status quo, q_0.
- In the above two equations, utility is allowed to depend on a vector of individual characteristics which influence the tradeoff that the individual is prepared to make between income and environmental quality.
- Important consequence of these two equations: WTP or WTA should, therefore, depend on:
  - (i) the initial and final level of the good in question;
  - (ii) respondent income;
  - (iii) all prices faced by the respondent, including those of substitute goods or activities; (iv) other respondent characteristics.
- **Internal validity** of the WTP responses: this can be checked by regressing WTP on variables (i)-(iv), and showing that WTP correlates in predictable ways with socio-economic variables.

Dichotomous-Choice Contingent Valuation

- When dichotomous choice questions are used, the researcher does not observe WTP directly: at best, he can infer that the respondent's WTP amount is greater than the bid value (if the respondent is in favor of the program) or less than the bid amount (if the respondent votes against the plan), and form broad intervals around the respondent's WTP. To estimate the usual welfare statistics, it is necessary to fit binary data models.
- The simplest such models assume that an individual's response to the WTP question is motivated by an underlying, and unobserved, WTP amount, which is normally (logistically) distributed. Formally, let WTP* be the unobserved WTP:

$$WTP_i^* = \mu + \varepsilon_i$$

Dichotomous-Choice Contingent Valuation

- Where μ is both mean and median WTP, ε is a zero-mean normal (logistic) error with mean zero. The model is completed by specifying the mapping from the latent variable to the observables:

  WTP_i=1 iff WTP_i*>B and WTP_i=0 iff WTP_i*≤B
- where *B* is the bid that was assigned to respondent i, WTP = 1 means that the response is a "YES," and WTP = 0 means that the response to the payment question is a "NO."

The Double Bounded Dichotomous Choice model

- Double bounded models increase efficiency in three ways:
- YN and NY answers bound WTP
- NN and YY answers further constrain WTP
- The number of observation is increased

The log likelihood function becomes:

$$\log L = \sum_{i=1}^{n} \log\left[F(WTP^{H};\theta) - F(WTP^{L};\theta)\right]$$

where WTP^{H} and WTP^{L} are the lower and upper bound of the interval around WTP defined above, $F(\cdot)$ is the cdf of WTP, and θ denotes the vector of parameters that index the distribution of WTP. (Notice that for respondents who give two "yes" responses, the upper bound of WTP may be infinity, or the respondent's income; for respondents who give two "no" responses, the lower bound is either zero (if the distribution of WTP admits only non-negative values) or negative infinity (if the distribution of WTP is a normal or a logistic.))

Elicitation Formats:

Open ended format

- The individual is simply asked to state his max. WTP or min. WTA for a proposed environmental change.
- Advantage: simple to deal with (simple descriptive statistics can be enough, such as sample means and medians).
- Drawbacks: “loose answers” and “strategic bias”.

Elicitation Formats

Bidding Game

- **How much are willing to pay:**
- **British system: Lowest to highest**

- **USD1.00 _____**
- **USD2.00 _____**
- **USD3.00 _____**
- **USD 4.00 _____**
- **……..**
- **……..**

- **How much are willing to pay:**
- **Dutch System: Highest to lowest**

- **USD50.00 ___**
- **USD40.00 ___**
- **…..**
- **…..**
- **…..**
- **USD1.00 _____**

Elicitation Formats

Payment card

"Which of the amounts listed below best describes your maximum willingness to pay for every entry to the reserved forest with the facilities I just described?"

0	USD0.50	USD1	USD2	USD3
	USD4	USD5	USD6	USD8
	USD10	USD15	USD20	USD25
	USD30	USD40	USD50	USD60
	USD80	USD100		

Elicitation Formats

Dichotomous Choice:

- The avoid two biases above, a range of values for the max. WTP (min. WTA) of individuals is pre-set by the analyst.
- The sample is divided in sub-samples.
- A value within the pre-set range is assigned to each sub-sample.
- Each individual within a sub-samples is then asked whether he is willing to pay (to accept) the assigned value to obtain (to give up) the environmental improvement.

Elicitation Formats

Dichotomous Choice:

- He is not asked to state the amount but to “take it or leave it.”
- Data are treated with discrete choice econometric models (Logit, Probit, MLE models) or with some simplified approaches
- Disadvantage: Risk of “starting point bias.”

Elicitation Formats

Two versions of dichotomous Choice:

- Single bounded
- Double bounded (first bid with follow-up question)

Elicitation Format

Single bounded dichotomous choice (SB-DC)

'Would you be prepared to pay USD10 per entry to the reserved forest with the facilities I just described to you?'

YES ____ NO ____

Elicitation Format

Dichotomous Choice – single bounded

- Payment vehicle: Tax/income
- Would you approve of the environmental conservation program if it reduced your income by some dollar amount ($2-50, posted price varied on questionnaires) per year in order to have your preference at current levels (20% or 50%), rather than have your preference reduced to zero because of continued marsh loss? (*Tick one*.)

A. Yes ____ B. No ____

Elicitation Format

Dichotomous Choice - single bounded

- *Payment Vehicle - price*
- If the government is going to charge an entrance fee of $ 10 to the recreational area for the purpose of conserving and maintaining the environment, would you be willing to pay?
- (X may range from $X1 (minimum) to $X2 (maximum), which represents a 'reasonable' amount of entrance fee to a similar conservation areas)

A. Yes ____ B. No ____

Elicitation Format

Double bounded dichotomous choice (DB-DC)

'Would you be prepared to pay USD10 per entry to the reserved forest with the facilities I just described to you?'

YES ____ NO ____

- If YES: 'And would you be willing to pay USD15?'

  YES ___ NO ____

- If NO: 'And would you be willing to pay USD5?'

  YES ___ NO ____

Double Bounded Format: An Example

After describing their illness, the respondent was given the following valuation question:

We are now going to ask you a hypothetical question. Suppose you were told that, within the next few days, you would experience a recurrence of the illness episode that you have just described for us. What would it be worth to you – that is, how much would you pay – to avoid the illness episode entirely?

Remember that you are paying to eliminate all of your pain and suffering, your medical expenditure, the time you spent visiting the doctor or clinic, your missed work, leisure or daily activities.

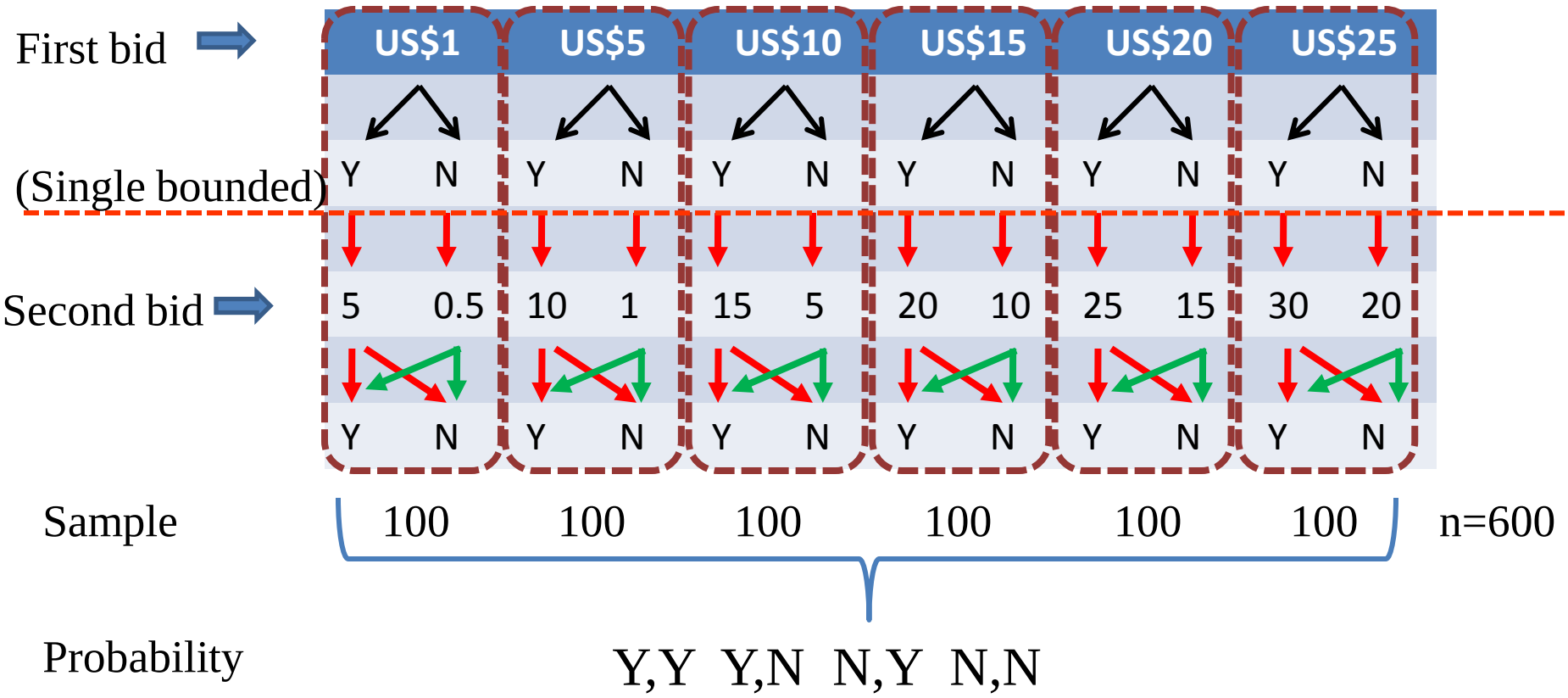
Bear in mind if you pay to completely avoid being ill this time, you have to give up some other use of this money. For example, you may reduce your expenditures for entertainment or education.

Would you pay **US$50** *to avoid being sick at all?*

*[**If NO**] Would you pay* **US$25** *to avoid being sick at all?*

*[**If YES**] Would you pay* **US$100** *to avoid being sick at all?*

Structure of Double Bounded Bid Price



Example

First Bid: US$10 → YES → US$15 (Second bid) → YES (Y,Y) or
First Bid: US$10 → YES → US$15 (Second bid) → NO (Y,N) or
First Bid: US$10 → NO → US$15 (Second bid) → YES (N,Y) or
First Bid: US$10 → NO → US$15 (Second bid) → NO (Y,Y) or

Elicitation Format

Dissonance minimizing (DM): Expands the array of possible answers from just YES/NO options under dichotomous choice.

- RM10.00 Yes ___ No ____
- Rm15.00 Yes ___ NO ___
- RM20.00 Yes ___ No ____

Elicitation Format

Bidding Game

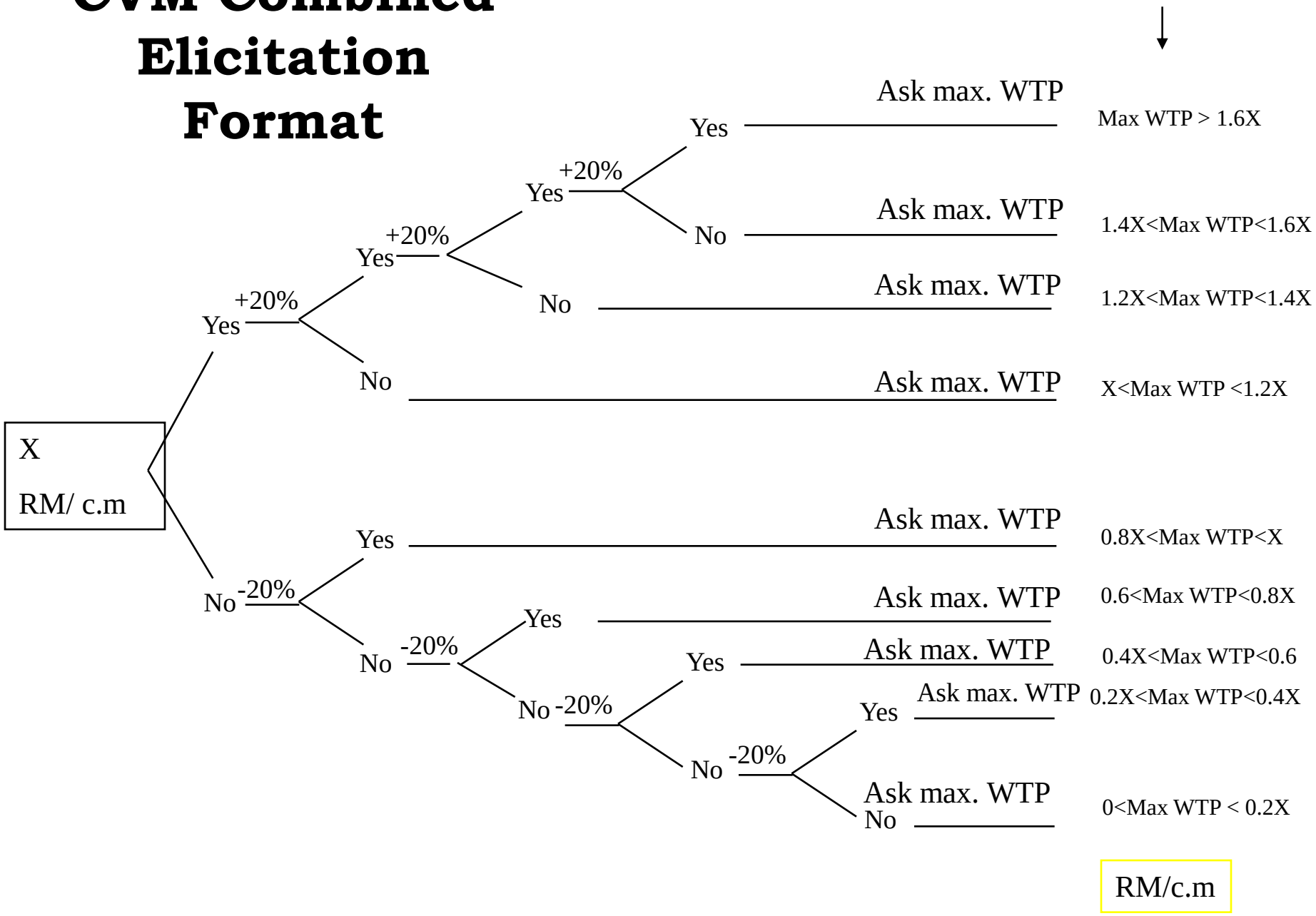
- The individual is asked to pay (accept) X for the environmental change.
- If he refuses, the proposed amount is reduced (increased) by say, 10%.
- The procedure is repeated until the respondent answers “YES”.
- The last amount proposed is taken as his max. WTP (min. WTA) for obtaining (to give up) the environmental improvement. If instead, the individual accepts the proposed amount, it is increased (reduced) by say, 10%.
- The procedure continues until the individual answers “NO”.
- The penultimate amount proposed is taken as his max. WTP (min. WTA) for obtaining (to give up) the environmental improvement.
- No “loose answers”.
- Disadvantage: Risk of “starting point bias.”

Elicitation Format

Combined Approach

- Instead of taking the list or penultimate amount as maximum WTP (minimum WTA) an open ended question is asked.

CVM Combined Elicitation Format



Elicitation Format

Stochastic choice: "Are you willing to pay: (Choose one)

- **RM 5.00 ____**
- **RM10.00 ____**
- **RM15.00 ____**

Steps Involved

Step 1 Identify Valuation (issue)elect interview technique (mail, telephone, personal interviews)

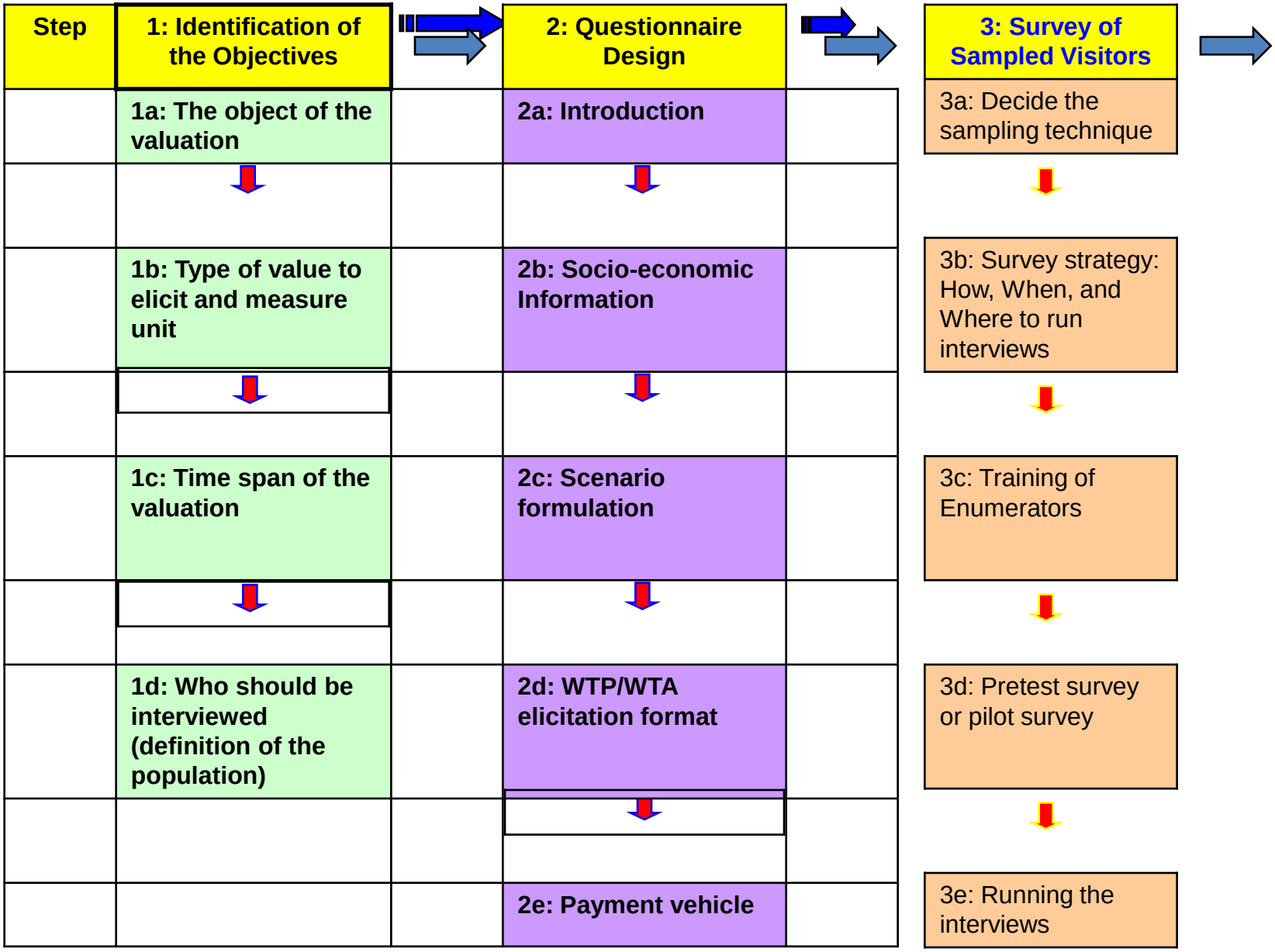
Step 2 Preliminary Decision (survey technique, sample, design questionnaire)

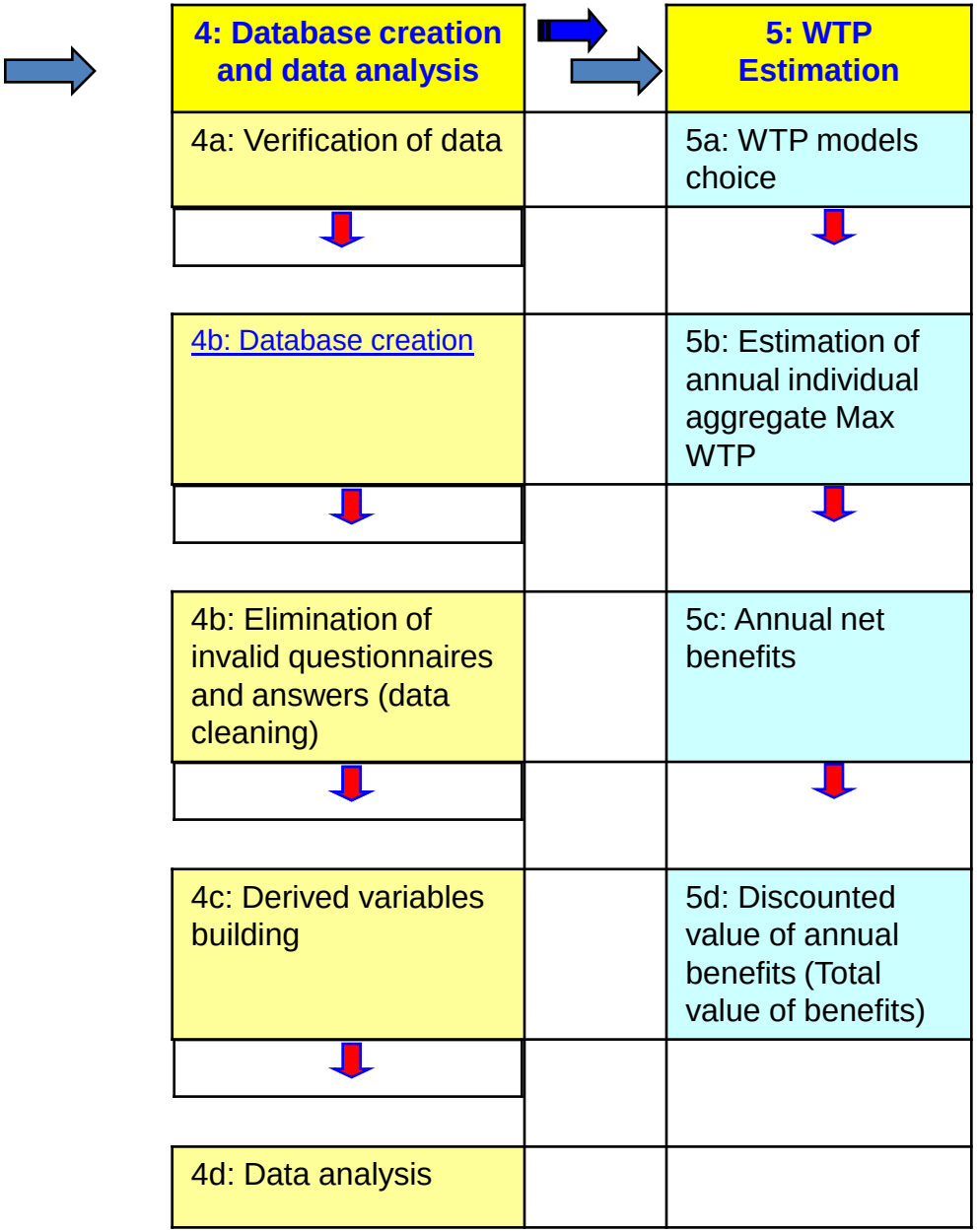
Step 3 Preliminary survey (questionnaire, focus group, final focus group, final questionnaire, payment vehicle)

Step 4 Actual Survey (method of survey, sampling, sample selection)

Step 5 Data Analysis (open-ended, dichotomous choice, stochastic, etc)

Step 6 Draw inferences from results


Step
1: Identification of the Objectives
2: Questionnaire Design
3: Survey of Sampled Visitors
1a: The object of the valuation
1b: Type of value to elicit and measure unit
1c: Time span of the valuation
1d: Who should be interviewed (definition of the population)
2a: Introduction
2b: Socio-economic Information
2c: Scenario formulation
2d: WTP/WTA elicitation format
2e: Payment vehicle
3a: Decide the sampling technique
3b: Survey strategy: How, When, and Where to run interviews
3c: Training of Enumerators
3d: Pretest survey or pilot survey
3e: Running the interviews


4: Database creation and data analysis
5: WTP Estimation
4a: Verification of data
5a: WTP models choice
4b: Database creation
5b: Estimation of annual individual aggregate Max WTP
4b: Elimination of invalid questionnaires and answers (data cleaning)
5c: Annual net benefits
4c: Derived variables building
5d: Discounted value of annual benefits (Total value of benefits)
4d: Data analysis

The Survey Questionnaire

Framing the good

- Reminder of other goods
- Framing statement

Information regarding the proposed change

- Clear, concise
- Sequential
- Visual aids (with caution)

Outline of a CV Questionnaire

- **Attitudes**
  - general views and attitudes (on environment, culture, etc)
  - Specific views and attitudes (on national park)
- **Current Situation**
  - eg. Existing infrastructure – road, facilities, lodging, etc.
- **Proposed Scenario**
  - eg. Chalets, exhibition hall on fauna and flora, pipe water, electric supply, etc.
- **Value Elicitation**
  - Elicitation format (open ended, iterative bidding, single bound, double bound, payment card, stochastic choice, etc)
  - Payment vehicle (entrance fee, conservation fund, utility bill, tax), vehicle and frequency, *reminders*
- **Follow-up Questions**
  - motivation behind WTP or zero-WTP answer
  - Scenario credible/understandable
- **Socio-economic Characteristics**
  - eg. Income/occupation, gender, age, education, etc
- **Interviewer Questions**

Research Design

- Need 4, or 5 bid values spread across the range of WTP values already established in the preliminary survey
- Need at least 30 valid respondents in each group
- Sampling depends on the population being investigated

Example
5 bid prices; 50 respondents for each bid

Set 1	Set 2	Set 3	Set 4	Set 5
US$1	US$5	US$10	US$15	US$20
50 respondents	50 respondents	50 respondents	50 respondents	50 respondents
Total: 250 respondents				

Bias in CVM

Information Bias

- It is the misstatement of the WTP/WTA by the respondent due to a lack of relevant information to correctly state his value judgement.

- Particularly important on these grounds is the scenario misspecification occuring when the respondent does not correctly understand the choice situation represented by the interviewer.

- Use debriefing questions and reject observations showing the existence of misunderstandings

Bias in CVM

Anchoring bias

- It is a misstatement of the WTP/WTA by the respondent due to the attempt of the respondent to tie his judgement to some known or presumed “reference point” such as existing charges (taxes) for similar public good or misunderstood hints in the scenario description (implied clues), or the proposed value of the dichotomous choice format (consenting aptitude)

Bias in CVM

Vehicle bias

- It is a misrepresentation of the WTP/WTA by the respondent due to specific payment vehicle hypothesized (e.g. increase of taxes, specific charges for each environmental service, price increase of some goods, voluntary work time, direct consumption reduction).

- The WTP/WTA can be influenced by way of transaction, i.e. the transfer of purchasing power from the individual to the public administration is designed.

Bias in CVM

Hypothetical Bias

- Refers to all misspecification of the true WTP/WTA by the respondent due to the fact that the individual; is not acting in an actual context.

- Some behavioural aptitudes currently operating in the real life are not operating when faced with hypotheses, such as: seeking for better information, care in comparing alternatives, risk averting due to actual risk bearing.

Data Analysis

- Dichotomous Choice
  - Code all YES as “1”, all other as “0”
  - Use logit Model:

$$Log\left(\frac{\Pr(Yes)}{1-\Pr(Yes)}\right) = f(bid, income, age, education, etc)$$

- Mean WTP = Area under logistic function
- Median WTP = Bid where proportion equals 0.5 (50%)

- Analysis
  - Weighted Logit Model
  - Maximum Likelihood

Contingent valuation: the blue ribbon panel's guidelines

- The contingent valuation method (CVM) has been the subject of much debate, largely revolving around potential biases inherent in the technique and the controversial nature of the non-use values to which it has been applied. Recently, a 'blue ribbon' panel deliberated over the validity of CVM and cautiously ruled in favour of its limited use in such circumstances as judicial proceedings involving natural resource damages, but only if a series of guidelines were followed (Arrow et al., 1993). The guidelines are the following:

Guiding Principles

1. For a single dichotomous questions (yes-no type) format, a total sample size of at least 1000 respondents is required. Clustering and stratification should be accounted for and tests for interviewer and wording biases are needed.

2. High non-response rates would render the survey unreliable

3. Face-to-face interviewing is likely to yield the most reliable results

4. Full reporting of data and questionnaire is a good practice

Guiding Principles

5. Pilot surveying and pre-testing are essential in any CVM study

6. Conservative design more likely to underestimate WTP/WTA is to be preferred to one likely to overestimate WTP/WTA

7. WTP format is preferred

8. The valuation question should be posed as no vote on a referendum, i.e. a dichotomous choice question related to the payment of a particular level of taxation

Guiding Principles

9. Accurate information on the valuation situation must be presented to respondents, particular care is required over the use of photographs.

10. Respondents must be reminded of the status of any undamaged possible substitute commodities

11. Time-dependent measurement noise should be reduced by averaging across independently-drawn samples taken at different points in time.

12. A “NO-answer” option should be explicitly allowed in addition to the “YES” and “NO” vote options on the main valuation question

13. “YES” and “NO” respondents should be followed up by the open-ended question “why did you vote YES/NO”

Guiding Principles

14. On cross-tabulations, the survey should include a variety of other questions that help to interpret the responses to the primary valuation question, i.e., income, distance to the site, prior knowledge of the site, etc.

15. Respondents must be reminded of alternative expenditure possibilities, to contain cases of moral satisfaction through the act of charitable giving

16. In YES/NO elicitation format, there should be a “NO REPLY” possibility “why” follow-up question.

Empirical Model

- Indirect utility function Price (P), income (M), quality (Q) and socio-characteristics (S). The respondent is asked if he would pay to help restore the environment at the given price, P.

$$V(M-P,Q^1,S) > V(M-0,Q^0,S)$$

respondent will answer yes if his utility deriving from improved forest restoration quality (Q^1) and paying the price (P) is higher than not having improved environment quality (Q^0) and not paying the price (P=0).

Empirical Model – The Logit Model

- If the observable component of the utility, the probability of the respondent saying yes is

$$\Pr(Yes) = \Pr[V(M-P, Q^1, S) + \varepsilon_1 > V(M-0, Q^0, S) + \varepsilon_0]$$

- Logistic probability distribution

$$\frac{1}{1+e^{-(V_{i1}-V_{io})}} = \frac{1}{1+e^{-\Delta V}} = \frac{1}{1+e^{-(\alpha-\beta b)}}$$

- The log likelihood function: $Log\, L = \sum_{i=1}^{n} Y_i \ln(p_i)$
- In logit regression we estimate α and $-\beta$

$$V(M - WTP, Q^1, S) > V(M - 0, Q^0, S)$$

If $V(M - P, Q, S)$ is linearly specified, then the probability of the respondent saying yes is

Log $$[\frac{\Pr ob(yes)}{1 - \Pr ob(yes)}] = \alpha_0 + \beta_1 P + \beta_2 Q + \sum \beta_i S_i$$

This can also be written as follows:

$$P_i = P(Y = 1/X_i) = \frac{1}{1 + e^{-(\alpha + \beta_1 P + \beta_2 Q + \sum \beta_i S_i}}$$

Introducing variables into the model

- What if we want to test whether income affect the WTP?
- We set the utility functions

$$U_0 = \alpha q_0 + \beta y + \gamma y q_0 + \varepsilon_0 \qquad q_0 = 0$$

$$U_1 = \alpha q_1 + \beta (y - b) + \gamma y q_1 + \varepsilon_1 \qquad q_1 = 1$$

- The probability of voting

$$\Pr(U_1 > U_0) = \Pr(\varepsilon_1 - \varepsilon_0 < V_1 - V_0) = \Pr\left[\varepsilon^* < \alpha - \beta b + \gamma y\right]$$

In Stata

```
. logit choice bid income

Iteration 0:   log likelihood = -1669.9785
Iteration 1:   log likelihood = -1490.3123
Iteration 2:   log likelihood = -1481.8858
Iteration 3:   log likelihood = -1481.7368
Iteration 4:   log likelihood = -1481.7367

Logistic regression                               Number of obs   =       2456
                                                  LR chi2(2)      =     376.48
                                                  Prob > chi2     =     0.0000
Log likelihood = -1481.7367                       Pseudo R2       =     0.1127

------------------------------------------------------------------------------
      choice |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         bid |  -.4427898     .02754   -16.08   0.000    -.4967673   -.3888123
      income |   .0006368   .0001169     5.45   0.000     .0004077    .0008658
       _cons |   .0980285   .0643574     1.52   0.128    -.0281098    .2241667
------------------------------------------------------------------------------
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$$\text{Mean WTP} = \frac{1}{-\beta_1}[\ln(e^{\alpha+\beta_2 I\overline{NCOME}+\beta_2\overline{AGE}} + 1)]$$

(an example of bid price, income and age as independent variables)

$$\text{Median WTP} = \frac{1}{-\beta_1}[\alpha + \beta_2\overline{INCOME} + \beta_3\overline{AGE}]$$

The mean WTP is evaluated at the mean value of other explanatory variables