Doctoral course
Climate Economics for Engineers

Valuation methods (2)

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30 September 2020

PREFERENCE-BASED ASSESSMENT METHODS

Principles

Assessment is

- centred on people
- based on their preferences
- monetary

Key concepts for translating preferences into money are

- willingness to pay (WTP) and willingness to accept (WTA)
- *similarly, compensating variation (CV) and equivalent variation (EV)*

WTP and WTA

"good" environment —*deterioration*→ "bad" environment

WTP to avoid this
WTA in compensation for this

"good" environment ←*improvement*— "bad" environment

WTP to get this
WTA in compensation for not getting this

In general, these WTP and WTA are close, but they need not be equal, because paying and accepting money are not equivalent, and because the starting point is not the same

Personal improvements and deteriorations

Improvement	Deterioration
To enjoy more of a natural resource	To be deprived of part of a natural resource
To be better protected from pollution	To be exposed to more pollution
To be allowed to discharge more	To be forced to clean up

In green: environmental "goods", in orange: environmental "bads"
This shows that for every “bad” there is a “good”

Two families of assessment methods

- Revealed Preferences approach (RP)

  Observation of people buying or selling on a market

  Observation of people in a controlled experimental setting

- Stated Preferences approach (SP)

  People's responses to hypothetical questions about their willingness to pay or willingness to accept a compensation for a change in the state of the world (environmental change, policy change, etc.)

Further decomposition of method

	Indirect	Direct
Revealed Preferences (RP) → Surrogate Market	▪ Household Production Function (HPF) Approach: - **Travel Cost (TC)** - **Averting Costs (AC)** ▪ **Hedonic Price (HP) method**	▪ Simulated markets ▪ Market prices ▪ Replacement Costs (RC)
Stated Preferences (SP) → Hypothetical Market	▪ Contingent Ranking (CR) ▪ Choice Modelling (CM)	▪ **Contingent Valuation (CV) method**

Bold faced = methods that will be presented hereafter

REVEALED PREFERENCES

Revealed preferences

- There is no market for environmental goods, but there are markets for related products. Hence these methods:
  - Avoidance or averting costs
  - Market price of related products
  - Travel cost method
  - Hedonic method
- Revealed preference methods generally get their data at much lower costs than stated preference approaches, so they use much larger data sets

Averting costs

- E.g. spending on double-glass windows against noise
- Buying bottled water when drinking water is contaminated
- Limitations
  - there may be many ways to avoid suffering from a nuisance
  - the measure taken to avoid a nuisance can have other positive effects (e.g. double-glass windows reduce heating energy need, bottled water is sparkling)

TRAVEL COST METHOD (TCM)

Origin and principles

- In the 1940s, the US National Park Service asked eminent economists to help value its parks
- Harold Hotelling outlined the travel cost method in 1947
- This method only estimates a **use value**
- It uses travel costs as prices paid for use of service and estimates a demand function; WTP for use of site is **consumer surplus**
- E.g.: individual A who lives close to the site spends P_A to visit once and B who lives far away spends P_B, with $P_B > P_A$; if we may assume that A and B have the same preferences, then A would have been willing to spend P_B; his surplus is $P_B - P_A$

HEDONIC PRICE METHOD (HPM)

Basic idea

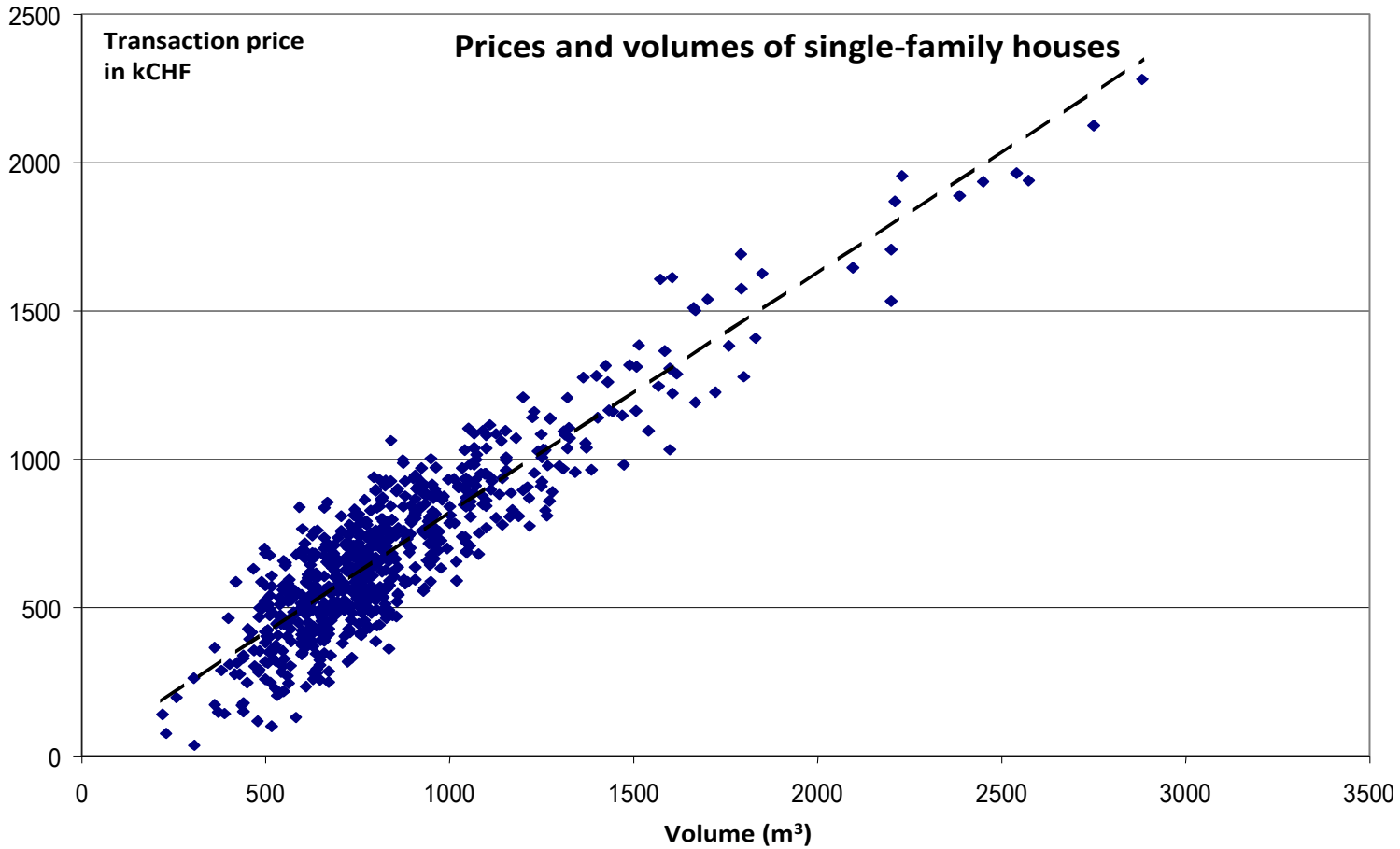
- Real estate markets: nuisances are compensated by lower prices or rents or hotel room rates (WTA); nice locations command a premium (WTP)
- Labour market: risks of sickness, injury or loss of life are compensated by higher wages (WTA)
- Separate the premium from the other determinants of rent, price or wage

Basic method

- When we buy a heterogeneous good, we buy a **bundle of attributes** or characteristics
- Our willingness to pay reflects the value to us of these attributes
- The production cost also depends on these attributes
- Hence the price of the good is a combination of the implicit (shadow) prices of the various attributes
- The HPM is a statistical method designed for identifying the relevant attributes of heterogeneous goods and for estimating the implicit prices of these attributes

Example (1)

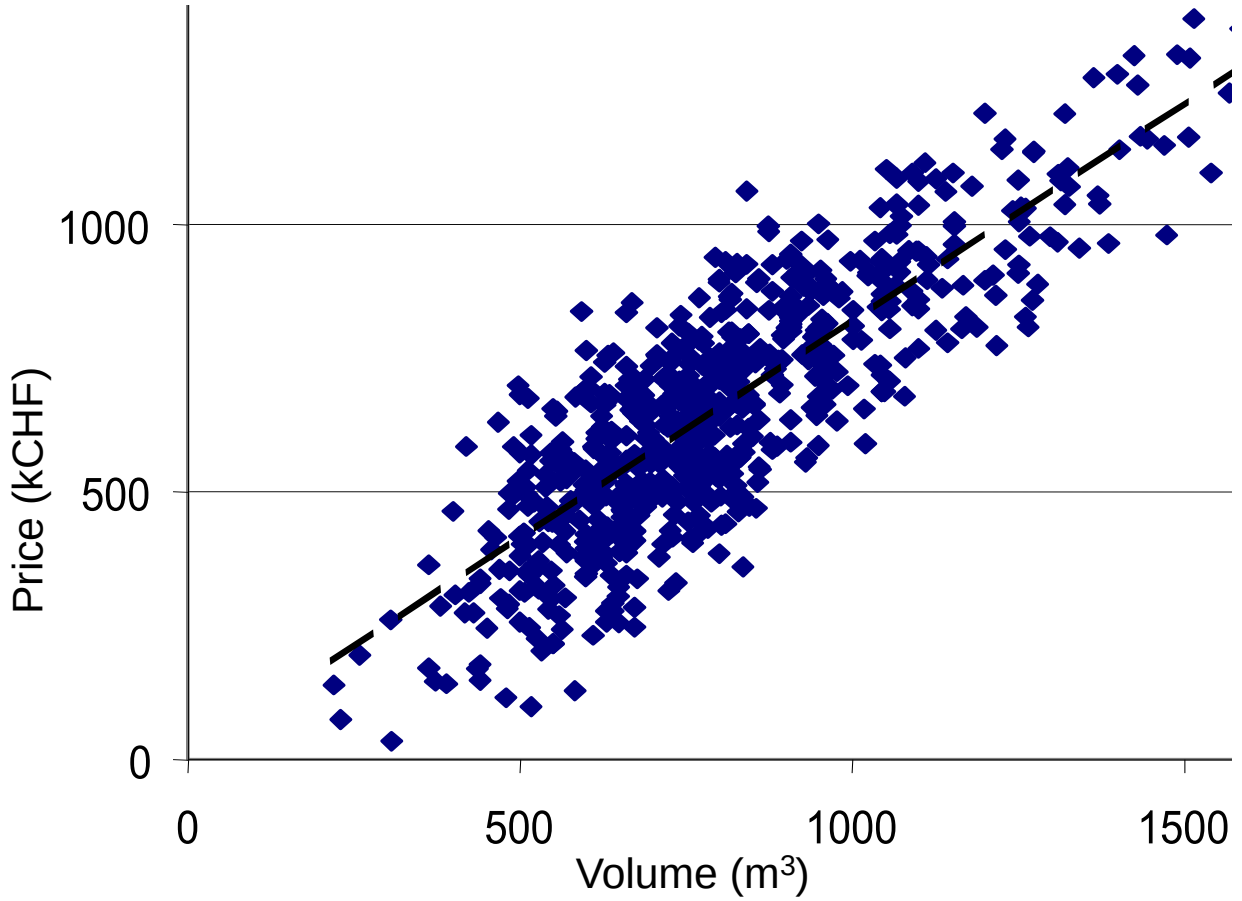
The price of single-family houses explained by their volume:
price = 814 CHF × volume



CIFI-Centre d'Information et de Formation Immobilières SA

Example (2)

The price of single-family houses explained by their volume:
price = 814 CHF × volume



A closer look shows:
The fit is not that good!

Example (3)

- Price explained by the volume of each house
  - ► Price = 814 CHF × volume
- Price explained by the volume and the age of each house
  - ► Price = 843 CHF × volume – 8'730 CHF × age
- Price explained by the volume and the age of each house and by the surface of land
  - ► Price = 468 CHF × volume – 8'560 CHF × age
    + 662 CHF × surface of land
- Etc.

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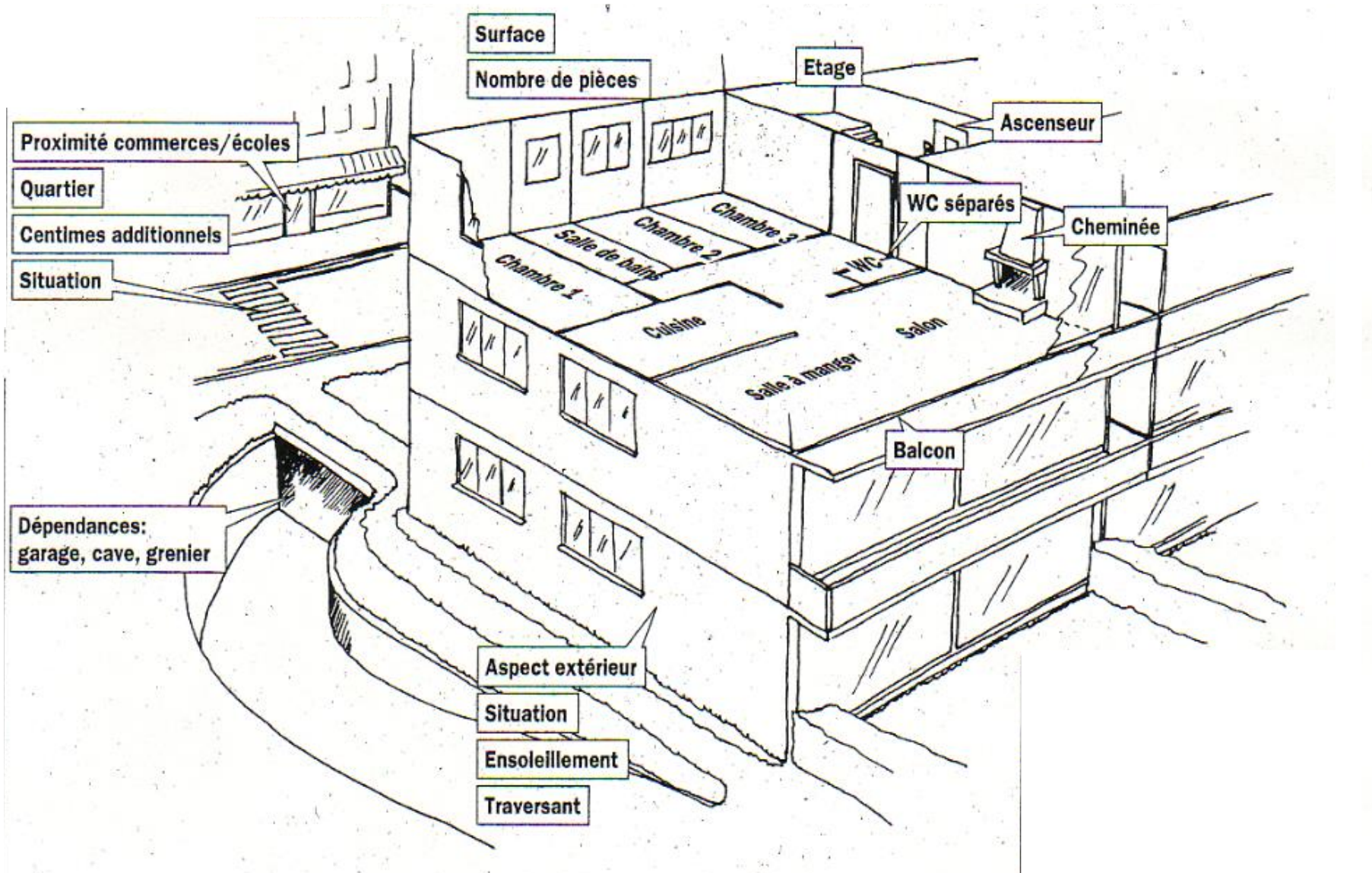
More generally, for housing



Basic Model – fundamental assumptions

- The quality of a market good can be described by a set of measurable characteristics
- These characteristics are the explanatory variables of the hedonic price function that explains the (relative) prices of the different varieties of this market good:

$$P_j = \alpha_0 + \alpha_1 X_{1j} + \alpha_2 X_{2j} + \ldots + \alpha_n X_{nj} + \varepsilon_j$$

$$P_j = \beta_0 X_{1j}^{\beta_1} \times X_{2j}^{\beta_2} \times \ldots \times X_{nj}^{\beta_n} \times (1 + \varepsilon_j)$$

- P_j is the price of variety j of the good, X_{ij} is the value for variety j of characteristic i, and α_i is the implicit price of that characteristic to be estimated using econometric techniques (regression analysis)
- In the multiplicative model, β_i measures the proportional change in the price of the good for a 1% change in X_i
- ε_j is the part of the price of variety j that cannot be explained by the model; the statistical analysis aims at minimizing ε_j

Estimated housing hedonic price function (Neuchâtel 1989)

Variables indépendantes		*Paramètres estimés*	
Structure de l'immeuble			
BUAN	variable binaire : buanderie commune = 1, sinon = 0	0,209 *	(2,026)
ln CHPRO	nombre d'années depuis le dernier changement de propriétaire	-0,132 **	(-6,663)
CONC	variable binaire : service de conciergerie = 1, sinon = 0	0,0824 *	(2,340)
COOP	variable binaire : l'immeuble appartient à une coopérative = 1, sinon = 0	-0,202 **	(-3,008)
GER	variable binaire : immeuble administré par une gérance = 1, sinon = 0	-0,155 **	(7,314)
LIFT	variable binaire : ascenseur = 1, sinon = 0	0,216 **	(8,291)
MAIN	variable binaire : maintenance de l'immeuble au cours des 10 dernières années = 1, sinon = 0	0,0919 **	(3,463)
ln NBAP	nombre d'appartements	-0,210 **	(-8,442)
Structure de l'appartement			
ATTIQ	variable binaire : appartement en attique = 1, sinon = 0	0,485 **	(4,316)
BALC	variable binaire : balcon ou terrasse = 1, sinon = 0	0,0875 *	(2,533)
ln CHLOC	nombre d'années depuis le dernier changement de locataire	-0,0568 **	(-5,241)
ISOL	variable binaire : isolation particulière des fenêtres contre le bruit = 1, sinon = 0	0,105 *	(2,407)
ln NIV	niveau sur lequel se situe l'appartement, rez-de-chaussée = 1	0,0555 **	(3,074)
ln PIECE	nombre de pièces, sans cuisine, ni salle de bain ou toilettes	0,577 **	(18,986)
RENOV	variable binaire : appartement rénové au cours des dix dernières années = 1, sinon = 0	0,0836 *	(2,536)
Localisation			
BRUIT	niveau de bruit diurne, en *dB(A)*	-0,00914 **	(-5,183)
ln CEN	distance jusqu'au centre-ville, en mètres	-0,0682 **	(-3,978)
Constante		7,334 **	(36,796)
R^2 corrigé		0,797	

Soguel N. (1994), *Evaluation monétaire des atteintes à l'environnement : une étude hédoniste et contingente sur l'impact des transports.* Neuchâtel: EDES-Editions de la Division économique et sociale, p.6.

Hedonic assessment of WTA risk in wages

Estimate equation of individual wages with characteristics of:

- employee (education, experience, nationality, gender)
- employer (size, region, public sector)
- job (responsibility, stability, schedules, overtime)
- and a measure of risk of death (#death/10 000 employees)

Estimated coefficient suggests wage premium of CHF 600 at mean risk of one dead/15 600 employees

⇒ **Value of statistical life = CHF 9.4 mio** (= 600×15 600)

Baranzini, Andrea et Giovanni Ferro Luzzi (2001) "The economic value of risks to live and health: Evidence from the Swiss labour market", *Swiss Journal of Economics and Statistics* 137(2): 149-170

CONTINGENT VALUATION METHOD (CVM)

Basic Idea (1)

- Survey people and ask them directly about their WTP or WTA
- Create hypothetical (contingent) situation in which the environmental good or bad exists or does not exist anymore
  - Wide fields of application and flexible tool
  - Can serve to estimate use value & non-use value
- Information provided in the form of a scenario
- Value building :
  - According to the change in utility
  - According to the budget constraint (disposable income)

Basic Idea (2)

- Value revealed in monetary terms: "how much would you be willing to **pay** to benefit from this service or this investment?"
- Hence, the CVM allows us to know directly (i.e. without econometrics) the price of the characteristic of interest
- However, econometrics are used to **explain** the WTP/WTA
- This makes it possible to test whether people answered carefully and truthfully or randomly, or even with bias

The wording of the elicitation question

	Change in the state of the world, in the quality or in the quantity of the good	
	Reduction	**Improvement**
WTP	▪ «How much would you be willing to **pay** to avoid a **reduction** in the quality or quantity of the good?» = EV	▪ «How much would you be willing to **pay** to obtain an **improvement** in the quality or quantity of the good?» = CV
WTA	▪ «In exchange for which compensation would you **accept** a **reduction** in the quality or quantity of the good?» =CV	▪ «In exchange for which compensation would you **accept** to forgo an **improvement** in the quality or quantity of the good?» = EV

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Different formats

- Open-ended question: ‘what is the maximum amount you would be willing to pay?’
- Auction format: ‘would you accept to pay 10 €? 20 €? etc.’
- Random numbers: ‘would you accept to pay x €?’, then construct distribution of x
- Referendum format: ‘if policy is implemented, your tax bill would go up by x € : would you accept this?’

Problems of the method

- Designing the contingent scenario to be truthful and complete yet understandable and unbiased
- Can people estimate non-use values, i.e. their WTP for preserving something they will never use?
- WTP may depend on the payment model used
- Inclusion bias if not all the components of the policy are included in the assessment
- Sampling and administration
- Analysis and inference
- Free riders

Problems of the method

- People have difficulty assessing a hypothetical situation
- Strategic answering
- Influence of how questions are phrased (e.g. bug vs. highway) and who asks the questions
- Influence of how payment would be made

Eternuement

● Les Américains sont plus enclins à réclamer des fonds pour la lutte contre la grippe H1N1 si le sondeur qui les interroge éternue, selon une enquête. Une centaine de personnes ont été interrogées au mois de mai dans un centre commercial pour savoir si elles préféraient que le gouvernement investisse 1,3 milliard de dollars dans la mise au point d'un vaccin ou dans la création d'emplois liés à l'environnement. Au cours du sondage, lorsque l'enquêteur faisait semblant d'éternuer, 48% des sondés répondaient qu'il fallait soutenir le vaccin. Contre seulement 17% lorsque l'enquêteur n'éternuait pas. (AFP)

Le Temps 4.11.2009

Exxon Valdez

- On March 24, 1989, Exxon Valdez oil tanker broke apart in Prince Williams Sound, Alaska
- 1800 km of beach were polluted, over 350,000 birds killed, several thousand seals and uncountable fish
- Exxon paid:
  - $2.1 bio for clean up
  - $287 mio in compensation to fishermen
  - $20 mio to natives (these first three largely covered by insurances)
  - $125 mio in fines and compensation to authorities
  - $5 bio in punitive damages (17×287), reduced to $0.5 bio after several Exxon appeals
  - $1 bio in funds for environmental restoration of bay
- Last amount: out-of-court settlement after Alaska produced Carson et al. (1992) CVM estimate of $2.8 bio (amount accepted by Exxon for clean up + restoration)
- About 1000 households expressed median WTP of $31 for spill prevention plan: multiply $31 by 90.8 mio English-speaking US households.

Referenda

- People vote on some environmental protection measure: if they accept it, they value the benefits more than the costs
- Limitations
  - What understanding of benefits and costs?
  - Low and non-representative participation rates
  - Reveals only an upper or lower bound

References and suggested readings

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Weber J. (2003), L'évaluation contingente: les valeurs ont-elles un prix? Consulté le 1er septembre 2011, sur CERI-Sciences Po-CNRS: http://www.sciencespo.fr/ceri/fr/content/levaluation-contingente-les-valeurs-ont-elles-un-prix (vision critique de la monétarisation de biens écologiques)

http://www.ecosystemvaluation.org (very interesting for practical examples and indications on which method is most appropriate for each case)