RESOURCE VALUATION AND DCISION MAKING METHODS – MODULE 1

LECTURE 1

Two main questions:

1. How to make decisions?
   There a re several context in which we have to come down a decision such as: a new hydroelectric dam, offshore wind farm…
2. How to give a value to non market goods and services?
   Air quality, human health conditions, a forest, environmental damage (Air quality, Bathing water, in Europe reports.)
   Environmental damage → Floods, global warming, temperature growing.

How to make a decision? There are lots of decisions we could operate: a ew hydroelectric dam, a new sewage system, water price variation and so on.

We need to estimate value for some goods without a specified price, such as air quility, human life, water quality. We define the value of some of these project for people and we should analize the financial implication and the environmental implication, too.

In decision with scarse resources we can have an individual or a social point of view:
Individual → considers own costs and benefits of the people
Social → considers all of the costs and benefits to society as a whole

In order to make a decision we must consider three important elements: money, time and alternative courses of action (more difficult).

COST-BENEFIT ANALISYS : analytical tool that helps decision – makers in choosing between two or more options (or deciding not to invest and maintaining a status quo).

→ Costs = reductions in human well-being
→ Benefits: increases in human well being

Cost-benefit analysis is a policy assessment method that quantifies in monetary terms all the consequences to all member of society.

- **The net social benefits** measure the value of the policy and it's obtained

  NSB (net social benefits) = B (benefits) – C (costs)

The CBA has a very simple logic: estimate costs and benefits from a social policy.
f the NSB is positive, the project is "good", otherwise NSB < 0 and the policy is not "good" → B>C
The NB of the proposal is relative to the status quo (the counter factual = no change in government policy).

To start, we need to list all the benefits and the costs, then, evaluate each one and so compute the NSB and see the result. When we consider the NSB obtained, we have to compare it with the status quo (the present situation).

Economic valuation or appraisal can be done for policies, projects, programs, regulations.

- **A project** is something that changes the resource balance in a community/society. It implies a small change with the respect of the status quo. Otherwise, policy and programs have a wider effect.
  Example 1 → stretch of a river used either for white-water canoening or to generate electic power. We need to consider the opportunity cost so what would have resulted from the other alternative.

the opportunity cost = the forgone net benefit that would hace resulted from the alternatives.

Example 2 → We have a underdeveloped but ecologically significant piece of land which becomes a candidate for development. A development of this area could improve the benefits for workers, wealth for owners and good for consumer but it may also degrade the ecosystem, possibly in irreversible way? And if the ecosystem is preserved what's the opportunity cost? In many situations we have to decide to build a new thing which could decrease the environmental value and ecosystem value. We must consider the opportunity cost.

the opportunity cost:

- the forgone net benefit that would have resulted from the alternatives.
- the opportunity cost of using an input to implement a policy/project is its value in its best alternative use.
- Opportunity cost measures the value of what society must forget to use the input to implement the policy/project.

We need to consider the best alternative case of money which represents the value of policy/project.
When someone builds a new apartament he has to take into account not only the financial costs due to the building of rooms, kitchens but also the opportunity cost of losing lands, ecosystem, and so on.
CBA are important both for project/policy which directly affects the environment but also project which apparently are not related.

Willingness to pay

Honest revelation of the assessments of people of the value of the output

It is the maximum amount of money that a person is willing to spend to obtain a specific good or service, or to avoid something undesirable (like pollution or risk). It reflects the value that an individual places on that good, service, or outcome.

Measure of Value: WTP is used to gauge how much people value a product or service. For example, if someone is willing to pay $50 for a concert ticket, that means they value the experience of attending the concert at least $50.

In the economic way of reasoning we consider all the social costs and not only the financial cost and benefits.

Types of CBA:

- ex ante CBA → before the realization, while a policy or project is under consideration

- ex post CBA → after the realization: we cannot recover the money we spent and the cost we meet
- in media res CBA → during the course of the life of the project.

Basic Steps of CBA:

1.Specify the set of alternative projects
2. Decide whose benefits and costs count
3. Catalogue the impacts and select measurement indicators
4. Predict the impacts quantitatively over the life of the project
5. Monetize (attach dollar values to) all impacts
6. Discount benefits and costs to obtain present values
7. Compute the Net Present Value (NPV) of each alternative
8. Perform sensitivity analysis
9. Make a recommendation based on the NPV and sensitivity analysis

The influence of bureaucrats and politicians is huge and many of the common mistakes in CBA are due to the fact that guardians tend to have a bottom-line budgetary orientation and because spenders tend to favor large, irreversible, capital-intensive projects.

- Example of a project → we have two options: two alternative projects.
    1. to build a bridge which costs 10 and has total benefits of 30
    2. buy 30 ferries which costs 1 and has 5 as benefits.

According to NSB we should choose the bridge because the difference gives us a NSB of 20. But if we consider the revenues for each euro invested we have two ratios: 3 over 1 in bridge case and 5 over 1 in 30 ferries-case.

Moreover, we denote that, if we decide to build the bridge we have 9 of opportunity cost for other purposes.

Is it better to use the ratio or the difference? The order of magnitude is very different in this two cases.

Another importan fact is that we should consider the time (the life of the bridge,the time to build it). Costs & Benefits could be different considering the order of magnitude and the time and costs over a time could be longer than the benefits time period. Then, we should include also the environmental costs and benefits if we want to evaluate a project from a social point of view.

REMEMBER → In financial analysis = benefits and costs are represented by revenues and expenditure;
In economic analysis = benefits and costs are not always (directly) represented by monetary amounts.

Cost–benefit analysis, CBA, is the social appraisal of marginal investment projects, and policies, which have consequences over time. It uses criteria derived from **welfare economics**, rather than commercial criteria. CBA seeks to correct project appraisal for market failure *(includere nella valutazione anche quei costi e benefici che non sono correttamente riflessi nei prezzi di mercato a causa di distorsioni o inefficienze).*

Project appraisal

- Private project appraisal → Expenditures and receipts, NPV test
- Social project appraisal → Externalities are taken into account, NPV test
- Environmental cost benefit analysis → Environmental impacts considered, NPV test

Decision Rule in Practice

independent policies → the adoption of one doesn't influence the costs and benefits of the other

Decision Rule → you have to adopt all the policies that have a positive net benefit and choose the combination of policies that maximizes net benefits.

Project with different scales can confuse the choice process but we have to avoid using benefit-cost ratio. (we have to choose project B)

TABLE 2.1 Choosing among Projects: Net Benefits versus Benefit-Cost Ratios

	Costs (millions of dollars)	*Benefits (millions of dollars)*	*Net Benefits (millions of dollars)*	*Benefits/Costs*
No project	0	0	0	—
Project A	1	10	9	10
Project B	10	30	20	3
Project C	4	8	4	2
Project D	3	5	2	1.7
Projects C and D	7	21	14	3
Project E	10	8	–2	0.8

Environmental impacts of projects/policies are frequently externalities, both negative and positive. CBA seeks to attach monetary values to external effects so that they can be taken account of along with the effects on ordinary inputs and outputs to the project/policy.

Case of environmental damage : **Exxon Valdez oil spill (monetary estimation of the compensation)**

In 1989, the Exxon Valdez ran into submerged rocks shortly after leaving the port of Valdez loaded with crude oil, and 11 million gallons of its cargo flowed from ruptured tanks into the waters of Prince William Sound off the coast of Alaska. This was the largest oil spill in US waters, and was widely regarded as a major environmental disaster, occurring as it did in a wilderness area of outstanding natural beauty. In anticipation of legal action against the ship's owners, the Government of Alaska commissioned a team of economists to conduct a CV study to estimate the damages from the oil spill.

- *What is the value of the environmental damage ? (RV)*
- *Are there some policies to avoid/reduce the incident, are these worthwhile, what are their costs and benefits? (DM, CBA)*

The development of the survey instrument used took place over a period of 18 months, and involved initially focus groups, followed by trial interviews and pilot surveys. The form that it finally took was as follows. After being asked about their views on various kinds of public goods and knowledge of the Exxon Valdez incident, respondents were presented with information about Prince William Sound, the port of Valdez, the spill and its environmental effects, and a programme to prevent damage from another spill. The programme would involve two coastguard vessels escorting each loaded tanker on its passage through Prince William Sound. These vessels would have two functions: first, reducing the likelihood of a grounding or collision, and second, should an accident occur, keeping the spill from spreading beyond the tanker. ***The interviewer then stated that the programme would be funded by a one-off tax on oil companies using the port of Valdez and that all households would also pay a one-off tax levy****. Before asking about willingness to pay this tax, the interviewer presented material about the reasons why a respondent might not want to pay such a tax, so as to make it clear that a 'no' vote was socially acceptable.*

The WTP question was whether the respondent would vote for the programme, given that the one-off household tax would be an amount $x. The survey involved four different treatments in which the amount x varied as shown in Table 12.3 in the column headed A-15, which was the first WTP question number in the survey instrument.

Depending on the answer to that question, a second WTP question was put to the interviewee.

If the A-15 answer was 'yes', the respondent was asked whether he or she would vote for the programme if the tax cost were to be the higher amount shown in the column headed A-16.

If the answer at A-15 was 'no, the interviewee was asked about voting given a tax cost at the lower amount shown in the column headed A-17.

The second column of Table 12.4 gives the proportion of 'yes' responses to the first WTP question, A-15, across the four treatments. The next four columns give the proportions for response patterns over the two WTP questions that all respondents were asked. Thus, for example, in the third column 45.08% of respondents asked initially about $10 said 'yes' to it and to the $30 that they were subsequently asked about.

- *response proportion*

Treatment	Yes	Yes–Yes	Yes–No	No–Yes	No–No
A ($10, 30, 5)	67.42	45.08	22.35	3.03	29.55
B ($30, 60, 10)	51.69	26.04	26.04	11.32	36.60
C ($60, 120, 30)	50.59	21.26	29.13	9.84	39.76
D ($120, 250, 60)	34.24	13.62	20.62	11.67	54.09

Estimating the parameters by maximum likelihood gave estimates of

$30.30 (95% confidence interval $26.18–$35.08) for median WTP

$97.18 (95% confidence interval $85.82–$108.54) for mean WTP

Using the median $30.30 and multiplying by the number of English-speaking US households gives total WTP for the escort ship programme of $2.75 billion. This was interpreted as an estimate of the lower bound for the TEV lost as a result of the oil spill.

Urban regeneration project example → Rimini Sea Wellness Park
Both prevent water to go in the city and it's green so it's an environmental good.

LECTURE 2

The foundations of CBA are on the concept of Pareto efficiency or allocative efficiency.

- An allocation of goods is Pareto efficient if no alternative allocation can make at least one person better off without making anyone else worse off. Otherwise, an allocation of goods is inefficient if an alternative allocation can be found that would make at least one person better off without making anyone worse off. If it's possible to find a new solution which is better for at least one and which that does not deteriorate the other's situations.
- The link between positive Net Benefit and Pareto efficiency consist in policy with positive net benefits leads to a set of transfers or side payments which aim to make at least one person better off without making anyone worse off.
- It requires to consider **WTP** to value the output of a policy and the **Opportunity Cost** to value the resource required (inputs) to implement the policy.

- Example of WTP → A policy with outputs of relevance to 3 people.
The people make honest revelations of their assessment of the values of the outputs.
With questions we elicit the payments each person would have to make or to receive under the policy so that he or she would be indifferent between the status quo, on one hand, and the policy with the payments, on the other

The values for person 1 and 2 are WTP1 =100€ and WTP2=200€

Assume the third person doesn't like the impacts of the proposed policy so he would have a payment of 250€ to feel just as well of as he did under the status quo.

$$NB= 100 + 200 – 250 = 50€$$

Without the payment to P3 the solution would not be pareto efficient → P3 would be made worse off with respect to the status quo.

After the policy → P3 receives 75 and 175 from P1 and P2 (compensation)

Key point = If and only if, the aggregate net benefits of the policy as measured by the willingness to pay of all affected individuals are positive then there exist sets of contributions and payments that would make the policy a Pareto improvement over the status quo.

- If the net benefits of a policy are positive, then it is potentially a Pareto improvement

*(la politica può essere considerata **socialmente desiderabile** se i benefici superano i costi e se c'è un modo per fare in modo che tutti ne traggano vantaggio, o almeno non subiscano perdite.)*

The policy's required inputs have an opportunity cost of 75€ → NB < 0
The policy does not generate enough net benefits to the three persons to allow them to compensate who bear the costs.

- The sign (+ or -) of net benefits indicates whether or not it would be possible to compensate those who bear costs sufficiently (no one is made worse off in case of positive sign)

CBA for Decision making is however difficult to apply in practice for many reasons:

1. Great informational burdens (to measure aggregate costs and benefits; costs and benefits for each person)
2. If costs and benefits at individual level were known we have high administration costs to make specific transfers
3. Compensation payments could distort the behaviour of households
4. Compensation payments would create incentive for people to overstate the costs and understates the benefits

Disagreements → Social critics (some economists, philosophers) have discussed the fundamental utilitarian assumption of CBA that the sum of individual utilities should be maximized and that it is possible to trade off utility gains for some against utility losses for others. Participant in the public policy-making process (bureaucrats, politicians) discussed the practical issues (whether certain impacts are costs or benefits; how to monetize them; how to make tradeoffs between the present and the future).

COST – EFFECTIVENESS ANALYSIS (Simplified model)

Ex → Transport Problem: Supposing that we have estimated the costs of alternative options and a list of effects.
Suppose that there are two towns linked by a four-lane highway built before both grew rapidly in population. The highway is frequently affected by severe traffic jams, and the government is considering three options for dealing with this problem.

The results of the impact assessment are:

Table 11.10 Options for reducing traffic delays

	A. Highway	B. Highway and buses	C. Railway
Cost 10^6£	250	300	500
Time saving 10^6 hours per year	10 000	8000	6000
CO_2 emissions 10^3 tonnes per year	1000	800	200
Wildlife and amenity qualitative	Bad	Bad	Moderate

The CEA gives priority to one aspect of performance – select the option that achieves specified objective at least cost.

In CB Analysis → All the costs and benefits are estimated in monetary terms but need to be discounted if we want to consider time as a factor.

	Benefits (B)	Costs (C)	Net Benefits (B-C)
2024		5.5	- 5.5
2025		5.2	- 5.2
2026		5.7	- 5.7
2027		7.0	- 7
2028		4.5	- 4.5
2029		3.7	- 3.7
2030	4.6	0.2	4.4
2031	5.1	0.2	4.9
2032	6.2	0.2	6.0
2033	7.5	0.4	7.1
2034	7.7	0.5	7.2
...	...	...	...
2040	6.7	1.1	5.6

Discounting the future → considering the time horizon of the project
- Nominal value = not discounted
- Present vale = discounted

People prefer to have money very close to the present, instead of very far from the present because of: uncertainty, present availability and cost of living changing during time.

[The nominal values (not discounted) of one cost or one benefit in the future today is the same as in the future while if we apply the discounting process a benefit or a cost of the future now has a bigger value.]

The future value of year-n is given by the formula:

(compounding)

$$S_n = K(1+r)^n$$

with n = number of years K = today's value r = interest rate

The Present Value (PV) or Discounted Value of an amount Sn to be received in time n is:

$$PV_n = S_n/(1+r)^n = S_n(1+r)^{-n}$$

PV is smaller because of uncertainty, interest rate and time.

The NET PRESENT VALUE (NPV) of a project is:

$$NPV = \sum_{i=0}^{n}\left[\frac{(B_i - C_i)}{(1+r)^i}\right]$$

If we consider a **private project** we should put the NPV in terms of expenditures and revenues

$$\mathrm{NPV} = \mathrm{PV}_R - \mathrm{PV}_E = \sum_0^T \frac{R_t}{(1+i)^t} - \sum_0^T \frac{E_t}{(1+i)^t}$$

The project should go ahead if and only if the NPV >= 0

The difference between expenditure and receipts each year represents the Net Cash Flow. We should determine a r (discount rate) with which we discount the Net Cash Flow of the years after year-0.

The NPV of a project is the amount by which it increases the firm's net worth. It's the present value of the surplus, after financing the project, at the end of the project lifetime. The choice of the discount rate is one of the most important things.

Example net cash flow 1

Year	Expenditure	Receipts	Net cash flow
0	100	0	–100
1	10	50	40
2	10	50	40
3	10	45.005	35.005
4	0	0	0

at $r = 0.05$, NPV = £ 4.40

at $r = 0.075$, NPV = £ 0.00

at $r = 0.10$, NPV = -£ 3.89

Social project appraisal

CBA use the NPV test and it could be approached in two ways:
– as an extension of private appraisal where externalities are taken into account (private)
– in terms of social welfare enhancement (public).

At the beginning there must be a proper identification and the forecast of all the consequences of the project/policy for all the affected individuals in each year of the project/policy lifetime and then express consequences in monetary terms with an NPV number.

	Time period				
Individual	0	1	2	3	Overall
A	$NB_{A,0}$	$NB_{A,1}$	$NB_{A,2}$	$NB_{A,3}$	NB_A
B	$NB_{B,0}$	$NB_{B,1}$	$NB_{B,2}$	$NB_{B,3}$	NB_{BB}
C	$NB_{C,0}$	$NB_{C,1}$	$NB_{C,2}$	$NB_{C,3}$	NB_C
Society	NB_0	NB_1	NB_2	NB_3	

In this case the NPV is the sum of the NB of each year discounted at present value.

Environmental cost benefit analysis (NPV test)

We should start to consider the ENVIRONMENTAL COST = EC in the case we are projecting a wilderness area development.

Denoting the present value of the benefit Bd and the present value of the cost as Cd we take account of the environmental impact in this way:

NPV = Bd – Cd – EC = NPV' – EC

So the project should go ahead if: NPV' = Bd – Cd > EC So that the **EC* = NPV' = Bd – Cd** defines a threshold value for EC.
The exercises that seek to ascertain EC are typically expensive, and sometimes controversial. Consideration of EC* can put their results in perspective.
Considering EC*/N, where N is the size of the relevant affected population, which is not necessarily restricted to visitors, and may include people from a wider area than the host country, as with an internationally recognised wilderness/conservation area inscribed as 'world heritage'.

ECBA is based on welfare economics which is consequentialist and subjectivist. Essentially it accepts that the natural environment should be subject to consumer sovereignty. Two main classes of objection at the level of principle.
1. Accept that only human interests count, but reject consumer sovereignty as proper guide to those interests on the grounds of their (mainly) inadequate information about consequences
2. The interests of other living entities should be taken into account. Some question the ECBA agenda at the level of practice – can valuation methods (of the following lectures) actually deliver the necessary information?

INVESTMENTS

'A sustainable society is an investing society'

- The goal is to increase the capital (human, environmental, social,tech) of the future generations → An investment generates future benefits on the basis of costs
- Comparison between future benefits and costs (more on thepresent)

SUSTAINABILITY

The most common definition is the World Commission on Environment and Development, chaured by Gro Harlem Brundtland (1987):

- *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:*
  1. *the concept of **needs**, in particular the essential needs of the world's poor, to which overriding priority should be given; and*
  2. *the idea of **limitations** imposed by the state of technology and social organization on the environment's ability to meet present and future needs."*

Issues to be defined: How many generations? For how many generations we have to invest now? Thus by giving up to consume? This topic is strongly connected with the discounting process.

The weight to consider for the net benefits in each period is given by the DISCOUNT FACTOR

$$\text{Discount Factor (DF)} = \frac{1}{(1+r)^t} \qquad \lim_{t\to\infty} \frac{1}{(1+r)^t} = 0$$

THE DISCOUNT RATE

The discount rate is an interest rate used to convert a future income stream to its present value, charged by a central bank on loans to domestic financial institutions.

When conducting cost-benefit analysis or evaluating the present value of future cash flows, two approaches can be used: using a **real discount rate** or a **nominal discount rate**. Although these approaches differ, they can be approximately equivalent under certain conditions.

1. **Constant General Price Level & Real Discount Rate**:
    - If prices are assumed to be **constant over time** (meaning no inflation is affecting the prices of goods and services), then it makes sense to use a **real discount rate**.
    - The real discount rate reflects the time value of money without considering the effects of inflation. It shows how much the purchasing power of money changes over time.
2. **Current Prices & Nominal Discount Rate**:
    - On the other hand, if we use **current prices**, which account for the effects of inflation, we should use a **nominal discount rate**.
    - The nominal rate includes both the real rate (which represents the true return or cost in terms of purchasing power) and the **rate of inflation**.

Nominal Rate = Real Rate+Inflation Rate

- **Use a real discount rate** if you are working with values in terms of constant purchasing power (i.e., inflation-adjusted).
- **Use a nominal discount rate** if you are working with current prices that include inflation.

Thus, under certain conditions, the approach of assuming a **constant general price level** with a **real discount rate** can be approximately equivalent to using **current prices** together with a **nominal discount rate**, where the nominal rate accounts for the real rate plus the rate of inflation

How to choose the discount rate to calculate the NPV ?

- The higher discount rate, the lower the PV of our future cash flow.

Present values of 1,000€ (in blue) for different discount rate and distance from the present (year)

	Discount rate							
Year (t)	0	0.01	0.02	0.03	0.04	0.05	0.06	0.1
1	1000.0	990.1	980.4	970.9	961.5	952.4	943.4	909.1
10	1000.0	905.3	820.3	744.1	675.6	613.9	558.4	385.5
20	1000.0	819.5	673.0	553.7	456.4	376.9	311.8	148.6
30	1000.0	741.9	552.1	412.0	308.3	231.4	174.1	57.3
40	1000.0	671.7	452.9	306.6	208.3	142.0	97.2	22.1
50	1000.0	608.0	371.5	228.1	140.7	87.2	54.3	8.5
100	1000.0	369.7	138.0	52.0	19.8	7.6	2.9	0.1

The tyranny of discounting → Large costs and benefits accruing in the distant future are insignificant in PV terms.
Current activities imposing large costs on future generations may appear insignificant in a cost-benefit analysis. Similarly, actions now that would benefit future generations may not be undertaken in light of a cost-benefit analysis. *(L'Analisi Costi-Benefici, quindi, ha il limite di sottovalutare gli effetti a lungo termine).*

Approaches to discount the future:

1. Ethical approach → Zero discount rate
2. Positive but declining discount rate

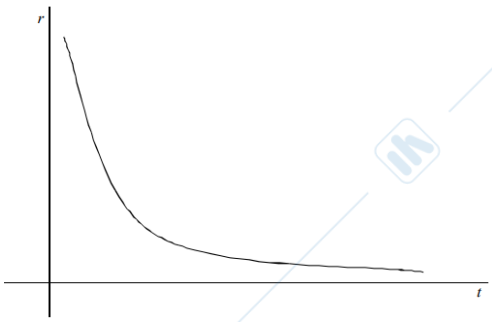
1.ETHICAL APPROACH → "pure time preference within a single life does not imply pure time preference across different lives' (Cowen and Parfit, "against social discount rate"1991). They reject the rationality of basic time preference, at individual and then social level. So that the interest rate = 0.

Pigou too argued against a positive pure time preference: «our telescopic faculty is defective and we, therefore, see future pleasures, as it were, on a diminished scale... It implies that people distribute the resources between the present, the near future and the remote future on the basis of a wholly irrational preference…the inevitable result is that efforts directed towards the future are starved relatively to efforts directed towards the present»

2. Market approach → It use the market rate.
The opportunity cost of postponed consumption (estimate between 10 and 15 %)
3. Social rate of time preference: Sr is the social or consumption based discount Rate. It's the sum of **intrinsic preference for the present + consumption growth rate* marginal utility of income**. A plausible range is 1-3.
If I'm a public decision maker I should consider the social implications. Some social implications have no monetary value, so the return of the investment consider the social return. And we should consider the Sr below the MKT rate.

4. The "Hyperbolic" discount rate → Weitzman (1998) suggests an additional rationale for using a **decreasing social discount rate** (expecially for fardistant future).
When the period becomes more distant, in the Weitzman opinion, there is necessity to reduce the

discount rate, with an hyperbolic shape. He considers the uncertainty degree about the rate of return of the investment.



Y=r

X= t

Uncertainty about the value to be considered for r more than the doubt about the impossibility for the ex ante knowledge about the true costs and benefits.
So there is the possibility to define a "step by step" different r values from 4% for the investments with a return in the near future (1- 5 years), to 0% for projects in the long term, more than 300 years
Thus, the r values could be:
• 4% for projects 1-5 years ("immediate" future);
• 3% for projects 6-25 years ("near" future);
• 2% for projects 26-75 years ("mean" future); • 1% for projects 76-300 years ("far" future);
• 0% for projects more than 300 years ("very far" future).

The proper time horizon for the appraisal is the date at which the policy's impact cease, NOT the date at which it ceases to serve the purpose for which it was intended.
Ex → For a nuclear fission plant it is not not the 40 years time when it cease to generate elecricity but the time over which it is necessary to devote resources to storing the plant's waste products (hundreds of years).

Discount rate choices in practice:
USA: There is the Office of Management and Budget which established the discount rate of 10% and in 1994 they established a 7% rate.
The Environmental Protection Agency (EPA) makes a distinction between *intragenerational project* r=2-3% and *inter generational projects* (>30 years) with r between 0.5 and 3%:

UK: There is the HM which males appraisal of public sector projects which established in 1991 a 6% rate and in 1998 a 5% rate.
The British Green Book which prescribes for evaluation of long term (> 30 years) cost and benefits declining ('hyperbolic') discount rates stating that "The main rationale for declining long-term discount rates results from uncertainty about the future". Before the 30 years there is a discount interest of around 3.5%. From year 31 to year 300+ there is a decreasing rate from 3.5% to 1%.
Prescriptive basis: r = 2.1% *(tasso di sconto prescritto (o raccomandato) pari al 2,1%.).*

Green Book long term discount rates

Period of years	0–30	31–75	76–125	126–200	201–300	301+
Standard rate as published in the Green Book	3.50%	3.00%	2.50%	2.00%	1.50%	1.00%
Reduced rate where "Pure STP" = 0[1]	3.00%	2.57%	2.14%	1.71%	1.29%	0.86%

The Green Book is guidance issued by HM Treasury on how to appraise policies, programmes and projects. It also provides guidance on the design and use of monitoring and evaluation before, during and after implementation. Appraisal of alternative policy options is an inseparable part of detailed policy development and design. This guidance concerns the provision of objective advice by public servants to decision makers, which in central government means advice to ministers. In arms-length public organisations the decision makers may be appointed board members, and where local authorities are using the method, elected council members. The guidance is for all public servants concerned with proposals for the use of public resources, not just for analysts. The Green Book is not a mechanical or deterministic decision-making device. It provides approved thinking models and methods to support the provision of advice to clarify the social – or public – welfare costs, benefits, and trade-offs of alternative implementation options for the delivery of policy objectives.

Discounting in the public sector allows costs and benefits with different time spans to be compared on a common "present value" basis.

- The public sector discount rate adjusts for **social time preference**, defined as the value society attaches to present, as opposed to future, consumption.
- It is based on comparisons of utility across different points in time or different generations.
- The Green Book discount rate, known as the Social Time Preference Rate (STPR), for use in UK government appraisal is set at 3.5% in real terms.
- This rate has been used in the UK since 2003.

The use of the STPR in public sector appraisal differs from private sector discounting. Decisions about the overall size of public spending and allocation of budgets are taken on a top down basis.

• The costs associated with raising funds (i.e. through taxes or debt issuance) are not used when appraising individual projects, programmes or policies.

• The cost of borrowing is not included as a decision variable on whether to go ahead with an individual project or not.

• In addition, there is no allowance for project specific risk in the STPR as risks should be identified and valued explicitly in appraisal.

• This approach to the STPR contrasts with private sector discounting which incorporates allowances for the cost of raising capital and compensation for risk.

STPR has two components:

1. Time preference (ρ)
   the rate at which consumption and public spending are discounted over time, assuming no change in per capita consumption. This captures the preference for value now rather than later.
2. Wealth effect (μg)
   this reflects expected growth in per capita consumption over time, where future consumption will be higher relative to current consumption and is expected to have a lower utility.

STPR is expressed as → **r = ρ + μg**
• r is the STPR
• ρ (rho) is time preference comprising pure time preference (δ, delta) and catastrophic risk (L)
• μg is the wealth effect. The marginal utility of consumption (μ, mu), multiplied by expected growth rate of future real per capita consumption g

➔ For the purposes of the STPR the estimate of δ is retained at 0.5% and the estimate of L is retained at 1%. The estimate of ρ is therefore 1.5%.

As recognised in the 2003 and 2022 Green Book there are a range of estimates of the individual components of the discount rate.
Research continues to illustrate a range of plausible estimates but concludes that the overall discount rate of 3.5% remains within that range and is justifiable.

The recommended discount rate for risk to health and life values is 1.5%. ('wealth effect', or real per capita consumption growth element, is excluded)

Table 8. Declining Long Term Discount Rate

Year	0 – 30	31 – 75	76 – 125
STPR (standard)	3.50%	3.00%	2.50%
STPR (reduced rate where pure STP = 0)	3.00%	2.57%	2.14%
Health	1.50%	1.29%	1.07%
Health (reduced rate where pure STP = 0)	1.00%	0.86%	0.71%

LECTURE 3

Recommended consumption discount rates

- **Short time discounting** → from 7% to 3.5%
  This discount rate is different across countries (developing vs. developed countries)
  It reflects the judgement of the decision maker for whom the CBA is been conducted
- **Long time discounting** → There is the possibility to define a "step by step" different r values from 3.5% for the investments with a return in the near future (<=30 years), to 1% for projects in the long term, more than 300 years.
  Still different across the countries and still reflects the judgment of the decision maker from whom the CBA is been conducted.

The Green Book prescribes for evaluation of long term cost and benefits declining ('hyperbolic') discount rates stating that "The main rationale for declining long-term discount rates results from uncertainty about the future".

Exercise 1 with no lifetime of the project

Three mutually exclusive projects are being considered for a remote river valley: Project R, a recreational facility, has estimated benefits of $10 million and costs of $8 million; project F, a forest preserve with some recreational facilities, has estimated benefits of $13 million and costs of $10 million; project W, a wilderness area with restricted public access, has estimated benefits of $5 million and costs of $1 million. In addition, a road could be built for a cost of 4 million that would increase the benefits of project R by $8 million, increase the benefits of project F by $5 million, and reduce the befits of project W by 1 million. Even in the absence of any of the other projects, the road has estimated benefits of $2 million.

a. Calculate the net benefits for each possible alternative to the status quo. Note that there are seven possible alternatives to the status quo: R, F, and W with and without the road, and the road alone.

b. If only one of the seven alternatives can be selected, which should be selected according the Cost-Benefit Analysis decision rule?

Ex 2 → with a lifetime of the project

Exercise 2 Mr. Cyrus Clops, the president of Giant Enterprises, has to make a choice between two possible projects:

	Project A		Project B	
Year	Costs	Benefits	Costs	Benefits
0	5,000	0	4,000	0
1	1,000	5,000	500	6,000
2	1,000	5,000	500	6,000
3	1,000	5,000	500	6,000
4	1,000	5,000	500	6,000
5	1,000	10,000	1,000	3,000

The social discount rate is 5%. Which project should Mr. Clops choose? Why?

Ex3

Alternative options, A and B, are both expected to improve the quality of a department's work and reduce staff costs.

Option A requires £10 million in initial capital expenditure to realise benefits of £2.5 million per annum for the following four years (£2 million in reduced staff costs and £0.5 million in quality improvements).

Option B requires £5 million in initial capital expenditure to realise benefits of £1.5 million per annum for the following four years (£1 million reduced staff costs and £0.5 million in quality improvements).

Discount rate by the Green Book
Calculate the discount factors and the NPV

The NB approach (B-C) may be considered in two ways:

1. NPV (van) → $NPV = \sum_{t=0}^{n}\left[\frac{(B_t - C_t)}{(1+r)^t}\right]$
2. IRR (tir) → Internal Rate of Return, given by the r that satisfies : $(NPV =)\sum_{t=0}^{n}\left[\frac{(B_t - C_t)}{(1+r)^t}\right] = 0$

IRR

- every project has its own and may involve multiples solutions
- is the rate at which its net cash flow must be discounted to produce an NPV equal to 0
- the r value for which benefits are equal to costs
- A project has to be considered if its IRR is bigger than the reference rate (r*)
- is a relative indicator and cannot be compared with other projects' IRRs but only with the reference rate.
- Different from NPV which could be compared with NPV of other projects
- If NPV ad IRR give conflicting suggestions, the NPV criterium has to be considered
- the number od IRR is correspondent to the number of changes of the sign of the cash flow
- if there is no change in sign we cannot have a real tir

Having this IRR we have to compare it with the discount MKT rate and the Social Discount Rate (SDR). If:

- IRR > r* → the project should be undertaken
- IRR < SDR → the project is not enough remunerative.
- R* represents the SDR used for public goods. → reference rate
- This r* doesn't have the necessity to be the same of the financial private markets, because in the public (goods) projects a certain amount of the benefits (sometime, a big amount) could not be estimated.

Dealing with public projects we can act in two different ways:

1. to provide an estimate for each benefit of the public project
2. to consider for the public sector a specific discount rate, a social discount rate (smaller than the private market rate) → r* < Mkt discount rate

➔ For long-time discounting we should consider future generations. It's not ethically defensible for pure social time preference to be applied to future cost-benefit calculations

where these involved significant and, for all practical purposes, irreversible wealth transfers from the future to the present.

LECTURE 4

IMPACT ASSESSMENT

It's a huge problem. We need to be supported by specialists like engineers, doctors, environmental scientists, and so on. The choice between two projects should not be left to experts, but should reflects the preferences of the affected population. That's the main problem.

Example → We can do the impact assessment of different projects but at the end we ignore the future consequences of current actions. We should consider risk and uncertainty.

In practice → Environmental Impact Assessment (EIA):

- An EIA is a process that assesses the **potential environmental effects** of a project. This includes examining how the project might affect the environment, human health, biodiversity, air, water, soil, and other natural resources.
- The goal is to **identify and mitigate negative impacts** and ensure sustainable development by integrating environmental considerations into the planning process.
- The EIA assesses the direct and indirect significant impact of a project based on a wide range of environmental factors, including population and human health, Biodiversity, land, sil, water, air, climate, landscape, material assets, cultural heritage.

USA has the Environmental Protection Agency for different sectors

Projects Requiring an EIA

- **Nuclear power stations**
- **Long-distance railways**
- **Motorways**
- **Express roads**
- **Waste disposal installations for hazardous waste**
- **Dams of a certain capacity**

The directive ensures that **environmental protection** is a priority in project planning and approval. By requiring EIAs, the EU aims to **prevent or minimize negative environmental impacts**, ensuring that projects are developed responsibly. It promotes **public awareness and participation**, as the process often involves consulting the public and stakeholders to gather diverse viewpoints and concerns about the project.

USA has the Environmental Protection Agency for different sectors.

- Energy sector → Levelized Cost of Energy (LCOE) = The LCOE method evaluates the costs of producing energy from a single technology. In this method, resources and elements of conversion of the energy system are included, thereby excluding exchange, storage and final demand effects. This method usually calculates costs as €/MWh or a different unit that represents the cost of energy generation.

ALTERNATIVES TO ENVIRONMENTAL COST-BENEFIT ANALYSIS

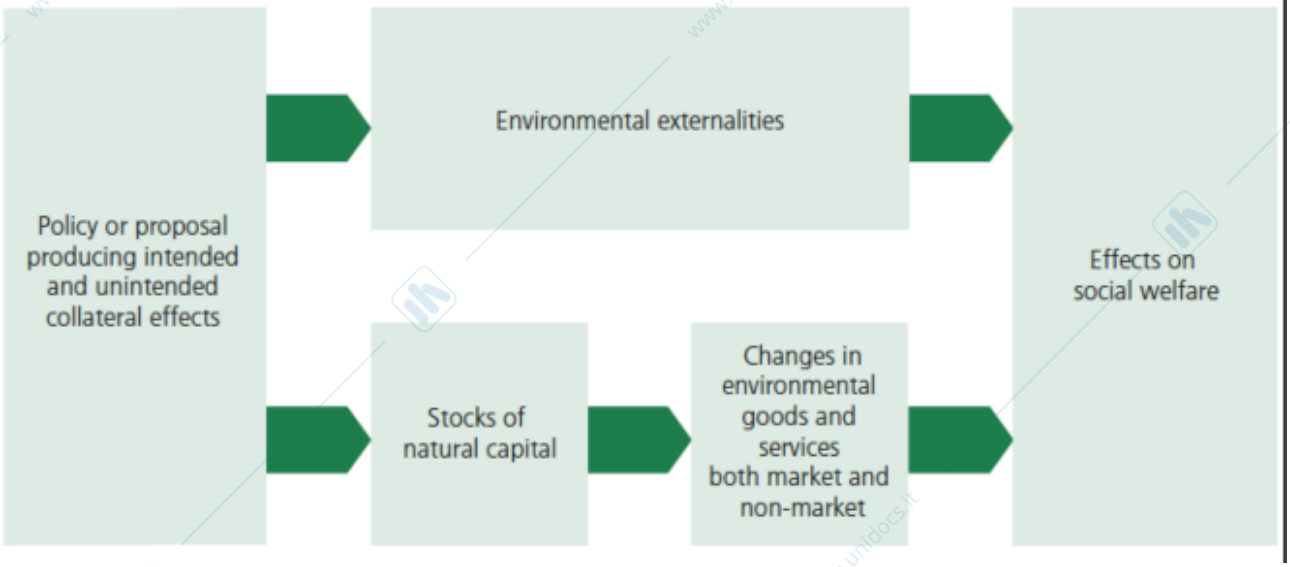
Two-stage processes

1. Assessment of consequences → Environmental Impact Assessment, Impact Assessment, Social Impact Assessment (Assessment = estimation). This can be left to 'experts'.

2. Evaluation of consequence → Cost effectiveness analysis, Multi-criteria analysis (Deliberative polling - Citizen juries).
The Cost Effectiveness Analysis: To select the option which achieves some specified objective at the least cost.
Multi-criteria analysis: we should consider weights and preferences, with deliberative polling (expensive) or citizens juries.

ENVIRONMENTAL VALUATION

Figure 3. The Natural Capital Framework



- What are the principle economic values/uses associated with an environmental good?
- What economic valuation techniques can be used to estimate these monetary values?
- What values can/cannot be estimated in economic (monetary) terms?

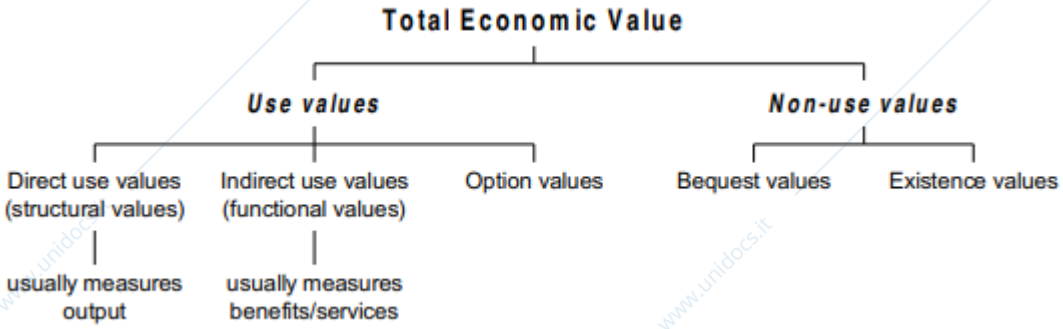
CATEGORIES OF ENVIRONMENTAL BENEFITS/COSTS:

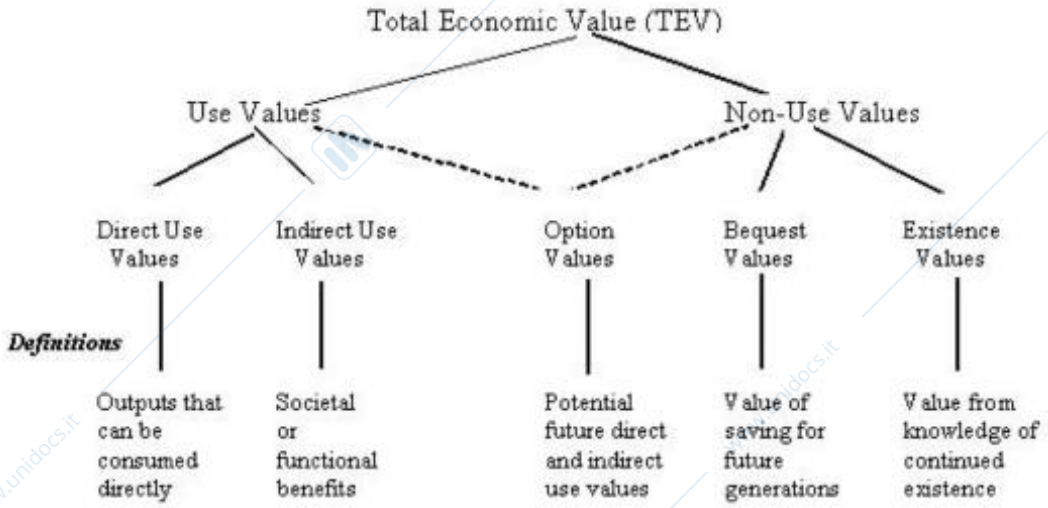
Value of a tropical forest → Animal habit, Indigenous people protection, wood, biodiversity, CO_2 absorption, O_2 production, recreation…

The value of environmental goods is not only connected to direct consumption but we have to consider a much broader definition of value → TOTAL ECONOMIC VALUE (use value + non use value).
Ex: Tropical forest → Consumptive value is wood, Non-consumptive use value is using the forest for recreational purposes, watching documentaries, reading articles, Non – use value is its existence value.

TOTAL ECONOMIC VALUE

- Use and Non – use values
- Quasi – Option value
- Option value
- Active / Passive value
- Existence value





HOW TO VALUE AN ENVIRONEMENTAL GOOD

- MARKET PRICES → prices from the relevant market. In some cases a closely comparable market can be used when a direct market price is unavailable.
- REVEALED PREFERENCE → Techniques which involve inferring the implicit priced placed on a good by consumers by examining their behaviour in a similar or related market. Hedonic pricing is an example, where econometrics techinques are used to estimate values from existing datas.
- GENERIC PRICES → Green Book approved prices applicable to the proposal
- STATED PREFERENCE (WTP) → questionnaires eliciting wtp to receive or avoid an outcome
- STATED PREFERENCE (WTA) → research study by designed questionnaires eliciting the compensation to accept a loss.

- WELL-BEING → direct well being based responses to estimate relative prices of non-market goods (by questionnnarie).
- ESTIMATION OF A CENTRAL REFERENCE VALUE AND RANGE → based on available data.

Valuing Direct – Use Values (consumptive and non - consumptive)

Direct use → hunting, fishing, hiking, photography, tourism/ecotourism, cultural/ historical, scuba diving and other uses.
→ often the easiest to value and the largest single item in a TEV calculation.

Data can be presented at a financial level (e.g. how large is the economic sector dependent on ecotourism), or at a broader social welfare level – usually by measuring the consumers ' surplus or economic rents generated. The former is easier to calculate, the latter is more difficult.

Valuing Indirect – Use Value

Largely composed of ecosystem services such as: wetlands, lakes, deserts, forests, Shoreline protection; water filtration, Pollination
→ lead to Changes in hedonic prices

Valuing non – use values

Non-use values → Option, Bequest and Existence values
→ are usually always measured using some form of valuation (CVM).
→ Cultural values may be very important in non-use values (e.g. Lake Sevan in Armenia)
→Values may be small per person (a few dollars), but large when aggregated (as in Armenia)
→ Non-use values are usually harder to "sell" to decision makers, but for some types of biodiversity (e.g. the panda, the blue whale) non-use values account for almost ALL of the economic value measured in a TEV calculation.

Valuing the non – measurable → Some uses or values associated with biodiversity are impossible to measure. These may include Unknown genetic material, global life support services (an infinite value), Cultural or religious values (e.g. in Hawaii, the native Hawaiians "value" the sea and the "aina", the land, very highly).

Suggested solution → avoid extinction
→ Use of the concept of Safe Minimum Standards to preserve ecosystems and their biodiversity
The **Safe Minimum Standard (SMS)** is a conservation approach that advocates for protecting natural resources and ecosystems by maintaining a minimum level of environmental quality, even when there is uncertainty about the risks and costs. It emphasizes **precaution**, suggesting that critical resources should be preserved unless the economic cost of doing so is excessively high.
→ Creative use of financing to preserve/ protect scarce ecosystems and scarce biodiversity

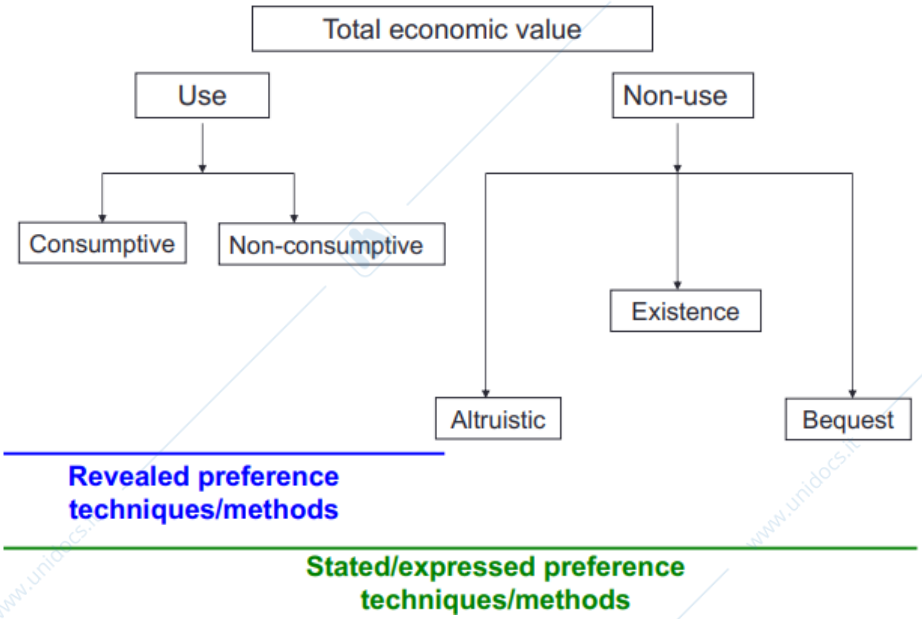
Purposes of Environmental Valuation

- Inclusion of environmental impacts in cost–benefit analysis of projects/policies.
  Ex → to enable environmental impacts to be included in CBA
- Determination of targets for environmental quality standards
  → to define standards (es for PM10 in urban areas) given epidemiological evidence of adverse health impacts.

- Accounting for environment impacts in measuring national economic performance.
  → environmental natural accounting matrix NAMEA (framework that integrates **environmental data** with traditional **economic accounts**. It is used to track the relationship between economic activities and environmental impacts within a country)
- In the USA, fixing compensation by those the courts hold responsible for environmental damage. → Exxon Valdez, oil spoil in 1989

Approaches to valuation

- **Revealed Preference** → The approach assumes that observed behaviour follows form an intrinsic utility maximization process
- **Stated or expressed preference** → Stated preference approaches elicit individual valuations trough surveys (usually sample surveys)
  → Revealed preference approaches primarily allow us to measure the value of consumptive uses, while stated preference approaches generally allow us to measure the value of non consumptive uses (existence or option values)



The main environmental valuation techniques are:

For stated/expressed preferences
→ Contingent Valuation
→ Choice experiments / Choice modelling / Conjoint analysis

For revealed preferences
→ Travel Cost Method
→ Hedonic Pricing

Valuing the environment could be used for :

- Valuation of damages
  → damage to natural resource
  → the environmental costs of a policy/project

Ex: A burnt forest area, the main losses are → wildlife habitat, wood collection, forests fruits, co2 absorption, co2 emission from the fire, air cleaning, air temperature control, recreational value, amenity value, bequest value, existence value…
Stone quarrying → marble dust, river pollution, amenity, landscape, biodiversity
An oilspill → marine life, recreational value (beach), Amenity value, biodiversity.

- Valuation of positive effects (benefits)
  → benefits of a project or policy.
  → wtp
  → Ex: The Rimini safe bathing master Plan, con obiettivi, aperture e divieti di balneazione, flooding risk analysis, lamination tanks

In general, examples of potential negative impacts (adapted from UNEP, 2015) of urban wastewater on human health, the environment and productive activities in a seaside tourist city are:
- increased burden of disease due to reduced bathing water quality,
- increased financial burden on health care,
- decreased ecosystems (e.g. eutrophication),
- bad odours,
- diminished recreational opportunities,
- increased GHG emissions,
- reduced number of tourists, or reduced willingness to pay for recreational services.

WILLINGNESS TO PAY

➔ Method for valuing the outputs (benefits of the outputs)
➔ The algebraic sum of willingness to pay values is the appropriate measure of the benefits of a policy

Limitation:

- Dependence on the distribution of wealth in society
  → The WTP of a person to obtain a desired policy impact will tend to be higher the greater the wealth that he has available
  → The sum of WTP, the benefit measure in CBA, depends on their levels of wealth so with a change in the distribution of wealth the sum would change.
- Standing whose willingness to pay counts in the aggregation of benefits.
  → This is connected to the jurisdictional definition of society, how we consider a nation and if we should consider illegal inhabitant.
  → exclusion of socially unacceptable preferences : Some people would be willing to pay for the opportunity to have sexual relationship with children. Clear and accepted legal sanctions may help identify preferences that should not have standing.
  → The inclusion of the preferences of the future generations: some policies today may have effect on people not yet born, but few policies involve impacts that involve only the future. Anyway most people nowadays care about the well-being of their children, grandchildren …

- Collecting WTP through survey, should we use Median WTP or Mean (average) WTP ??
  The mean involves adding up all values and dividing, while the median is just finding the

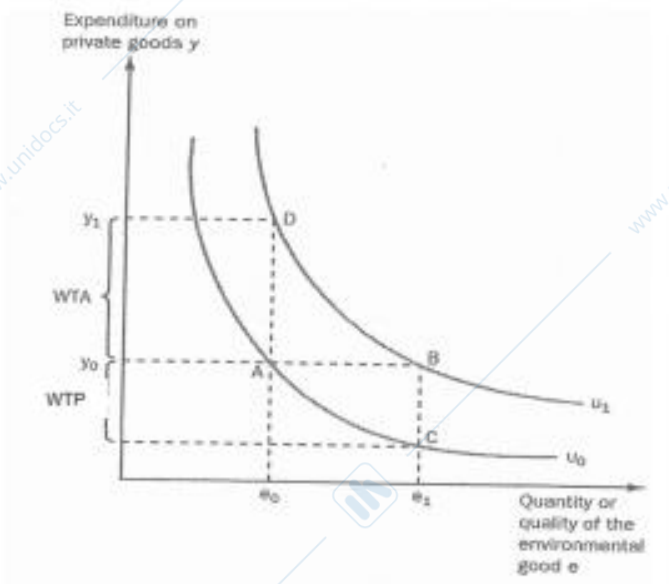
middle value. The **mean** is useful when you want to get an overall average, especially when data points are evenly distributed. The **median** is better when dealing with skewed data or when there are outliers, as it provides a more accurate sense of the "center" of the data.

Estimating environmental values with WTP or WTA

Theorical consideration

Assume that quantity/quality of environmental good e can be treated as an argument in a well-behaved utility function. The individual cannot choose (or adjust the) level of e.

Y is the income



u = u(y, e)

.e0 → e1

A →

Theory predicts that WTA should exceed WTP by a small amount. → In Figure 12.1 consider an individual who starts with private consumption of y1. WTA for an increase in the environmental good from e0 to e1 is DA which is greater than BC.

If the individual is richer, he is typically willing and able to spend more in order to increase the level of the environmental good. The difference between y1 and y0 is the same as WTA for a reduction from e1 to e0. Large divergences between WTA and WTP are therefore possible only if an individual's WTP would change significantly if his income were augmented by an amount equal to WTA. Such an effect is likely to occur only if:
(a) WTA accounts for a significant share of the individual's income and
(b) WTP is highly income elastic.

As an example of the orders of magnitude involved, suppose that each 1 percent increase in income leads to a 1 percent increase in WTP. Then if WTA is equal to 1 percent of an individual's income, the ratio of WTA to WTP is 1.01. But, in most applications, WTA will be much less than 1 percent of income. And most empirical evidence appears to suggest that the income elasticity of WTP for environmental goods is quite low as well.

Together this suggests that the difference between WTP and WTA should be small. But, in rather many studies, WTA frequently exceeds WTP by an order of magnitude or more.

Hanemann (1991) showed that utility theory actually predicts that for commodities where there are limited possibilities for substitution, WTA could be much larger than WTP. In the limiting case, where there is perfect substitution between the composite commodity and the environmental good, the indifference curves become straight lines and the difference between WTP and WTA disappears.

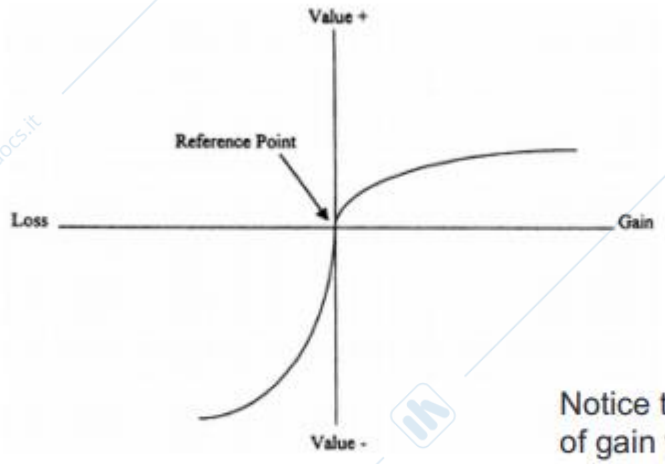
Other explanations of the WTP/WTA disparity include the possibility that this is a consequence of individual's lack of familiarity with WTP/WTA questions.

Prospect theory

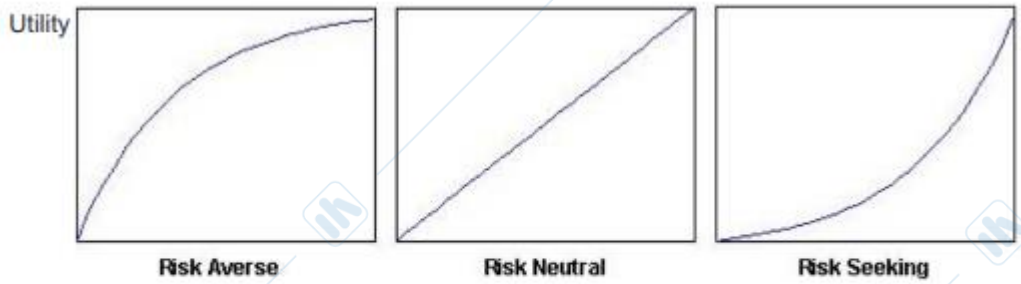
Another possible explanation for the WTP/WTA disparity is provided by prospect theory.

As outlined in Kahneman and Tversky (1979) it has three elements:
1. An individual views things in terms of changes from a reference level, usually the status quo
2. Gains and losses are subject to diminishing returns
3. Loss aversion – the value function is steeper for losses than gains Hence an endowment effect. People value a good or service more once their property right to it has been established, place a higher value on a thing that they own than on the same thing that they do not own.

If WTP and WTA answers can be very different, then it matters which one is used, since it could make the difference between approving and rejecting a project. The choice between WTP and WTA is really a decision about property rights.
→ If property rights are considered to be defined by the current level of environmental quality, then improvements in environmental quality should be valued using WTP and reductions in environmental quality should be valued using WTA.



Notice that a given amount of gain yields less extra satisfaction than the decline in satisfaction incurred from a similar value of total loss



It simply implies that the marginal utility of wealth is decreasing with wealth: one values a one-euro increase in wealth more when one is poorer than when one is richer.

LECTURE 5

GROSS DOMESTIC PRODUCT (GDP) → basic measure of the overall size of a country's economy

Gross Domestic Product (GDP) is an aggregate measure of production that represents the total economic output of a country. It is calculated as the sum of the gross value added by all resident institutional units engaged in production. To this total, any taxes on products are added, and subsidies on products are subtracted.
It is one of the main indicators of the National system of national and regional accounts.

- → the sum of the final uses of goods and services (all uses except intermediate consumption) measured in purchasers' prices, minus the value of imports of goods and services;
- → the sum of primary incomes distributed by resident producer units

.**Gross value added (GVA)** is the difference between the total output produced and the intermediate consumption (the goods and services used up in the production process).

Green Gross Domestic Product (Green GDP) is an economic indicator designed to integrate a country's income, well-being and socio-economic value generated exclusively from green and sustainable growth resulting from structural transformation, infrastructure development, technological change, bioenergy and bioproduct production, entrepreneurial networks and public policies, among other sustainability-focused actions. For several decades, numerous methodological and conceptual approaches have been carried out to conceptualize green GDP for the transition towards a circular bioeconomy and sustainability.

VALUATION TECHNIQUES

CONTINGENT VALUATION METHOS (CVM)

- CV is a survey stated preference technique
- CV can measure both use and non-use values

CV provides theoretically correct WTP and WTA measures of utility change and is the most widely used valuation technique.

Application: air and water quality improvement, preservation benefits of wilderness, benefits of outdoor recreation opportunities, benefits of reduced transport risks benefits of improvements in public utility reliability, environmental damages.

It involves 6 steps:

1. Creating a survey instrument (questionnaire): broken down into a number of tasks
   (a)identifying possible uses of and attitudes towards the environmental good in question,
   (b) constructing the hypothetical scenario,
   (c) deciding whether to ask about WTP or WTA,
   (d) determining an appropriate payment vehicle,
   (e) selecting an appropriate elicitation method
   (f) collecting auxiliary information about the respondent.
2. Choosing an appropriate survey technique
3. Identifying the population of interest and developing a sampling strategy
4. Analysing the responses to the survey
5. Aggregating the WTP or WTA responses over the population of interest
6. Evaluating ex post the success of the CV exercise

Creating a survey

a typical CV survey would include the following parts:

1. Explanation of the purpose of the exercise
2. Questions about respondent's knowledge and attitudes
3. Description of problem
4. Statement of payment vehicle
6. Reminders about substitutes in income constraints.
7. Ask about WTP via one elicitation method:

- open ended question → ask 'what is your maximum WTP for...?' Avoids giving respondents cues, but difficult for them.
- bidding game → the respondent is asked if WTP a sequence of increasing amounts until says 'no'. Anchoring
- payment ladder → the respondent is asked to tick amount would be WTP, cross amounts not WTP. Anchoring
- referendum (single or doubled dichotomous choice)

→ single bounded dichotomous choice = tell respondent if referendum supports project it goes ahead and costs each $x, which is varied across respondents. Incentive compatible. Easy to understand. Large sample needed.

→ double bounded dichotomous choice = if respondent says ' yes ' to $x, $x + $y? If ' no ' to $x, $x - $y?. Is statistically more efficient than single bounded, which is important given costs of survey.

→ Ex : Exxon Valdez oil spill

8. Follow-up question
9. Question about respondent characteristics (socio economics).

Different methods produce different result.