Le doute est désagréable,
mais la certitude est ridicule
(Voltaire)

BASICS of ECONOMIC EVALUATION OF INVESTMENTS

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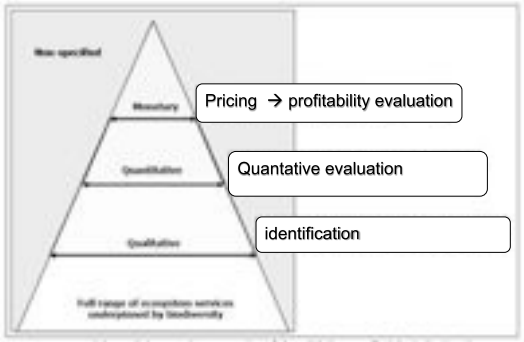
The evaluation pyramid



Source: P. ten Brink, workshop on the Economics of the Global Loss of Biological Diversity, 5-6 March 2008, Brussels.

Contents

- Timing, scale and distributional effects
- With-without approach
- *Discounting*
- Profitability indicators: NPV, C/B ratio, IRR
- Discount rate selection
- *Risk and uncertainty*
- *SW use (S.A. and normalization)*
- Financial and economic analysis

Timing of the evaluation

- *Ex post* evaluation: relatively easy, but not frequent
- *In itinere* evaluation → monitoring
- *Ex ante* evaluation: normally quite complex, esp. With project providing public goods

To avoid to be misled by the so-called money illusion keep in mind the differences (Klemperer p. 134 and seg.):

Inflation is included	*Inflation is not included*
Nominal	Real
Current prices	Constant prices
Inflated	Un-inflated or deflated
Actual prices	Relative prices

Scale: who benefits where? (from Kettunen, et al., 2009)

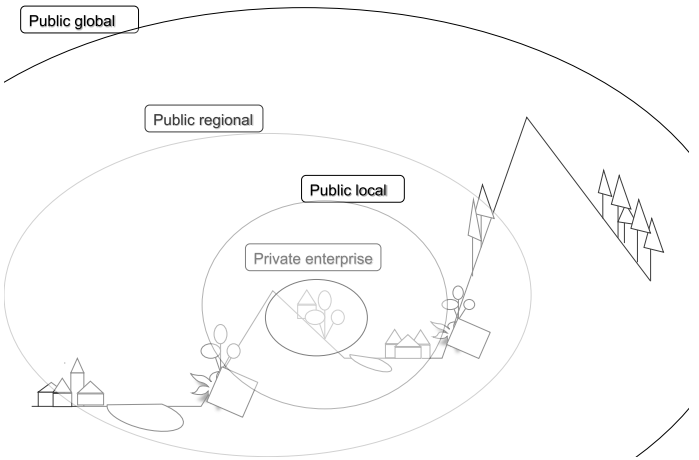
Benefits from forest activities are received at multiple levels:

- **local private benefits: water purification resulting in lower pre-treatment costs to the local water supply company, etc.;**
- **local public benefits: supporting local identity, local non-market forest products, etc.;**
- **regional public sector benefits: mitigating floods resulting to lower public investment in flood control and / or flood damage, etc.;**
- **regional and cross-border benefits: regulation of climate and floods, mitigation of wild fires, provisioning and purification of water in transnational river basins, etc.;**
- **international / global public benefits: provision of habitat for a migratory species at some point in its annual cycle, carbon capture and storage, maintenance of genetic diversity), etc.;**
- **international private benefits: new pharmaceutical or medicinal product derived via bioprospecting, etc.**

A quite weak point of CBA tools

Re-distribution aspects are not normally considered (equity considerations), i.e. gainers and losers at:

- different actors/social groups living in the same context/the same level
- different geographical scales (however, it is possible to refer the costs and benefits evaluation to different scales)



An example: main potential functions and services of a watershed

Source: Masiero, 2009 - modified from Smith *et al.*, 2006.

Legend:

1. Forest sedimentation control
2. Recreation, swimming, fishing, camping and water storage
3. Hydroelectric station
4. Municipal water supply
5. City and industrial waste treatment plant
6. Pump to equalizing reservoir for irrigation
7. Diversion dam and lake
8. High-level irrigation canal
9. Levees for flood control
10. Erosion control: stream drams, contour terracing and wetland restoration
11. Regulating basin for irrigation
12. Wildlife refugee
13. Low level irrigation canal
14. Gravity irrigation
15. Contour ploughing
16. Sprinkler irrigation
17. Community Water Treatment Plan
18. Navigation: barge, trains, locks
19. Re-regulating reservoir with locks
20. Farm pond with pisciculture

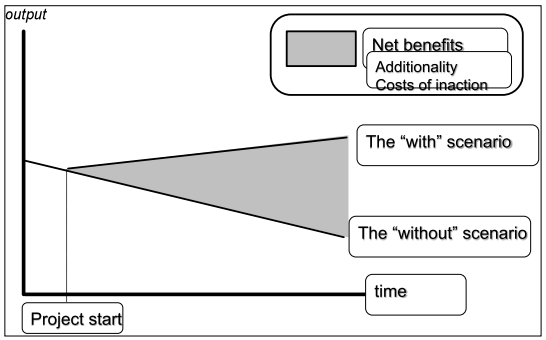
"With-without" approach

When our site is undergoing some (positive or negative) changes, the w.w.a is needed:

= consider the missed costs and benefits

→2 forecasting exercises

- the baseline
- the "with project" scenario



Cash flow for the financial analysis

		costs	revenues	net revenues
2003	0	-2000	0	-2000
2004	1	-3700	5	-3695
2005	2	-1800	5	-1795
2006	3	-100	75	-25
2007	4	-50	150	100
2008	5	-50	700	650
2009	6	-50	1200	1150
2010	7	-50	1500	1450
2011	8	-50	1800	1750
2012	9	-50	1800	1750
2013	10	-50	1800	1750
		-7950	9035	1085

Cost input a	400
Cost input b	600
Cost input c	800
Cost input d	200

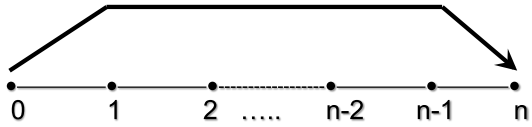
?

Cash flow for the economic anaylsis

Costs for input a	400
Costs for input b	600*0.8=480
Costs for input c	800*0.7=560
Costs for input d	200

		costs	benefits	net benefits
2003	0	-1640	0	-1640
2004	1	-3400	5	-3395
2005	2	-1700	5	-1695
2006	3	-80	80	0
2007	4	-45	160	115
2008	5	-45	800	755
2009	6	-45	1300	1255
2010	7	-45	1600	1555
2011	8	-45	1900	1855
2012	9	-45	1900	1855
2013	10	-45	1900	1855

Compounding and discounting



$I = C_n - C_0$ (with $n \geq 0$)

How you find the value of C_n ?

r = 20% → 0.20

Year	*Capital*	=	*Capital*	+	*Interest*
0	100	=	100	+	0
1	120	=	100	+	100 0.2
2	144	=	120	+	120 0.2
3	172.8	=	144	+	144 0.2

0	C_o	$= C_o$
1	C_1	$= C_o + (C_o \ r) = C_o (1 + r)$
2	C_2	$= C_1 + (C_1 \ r) = C_1 (1 + r)$
		$= C_0 (1 + r) (1 + r)$
3	C_3	$= C_2 + (C_2 \ r) = C_0 (1 + r) (1 + r) (1 + r)$

Compounding

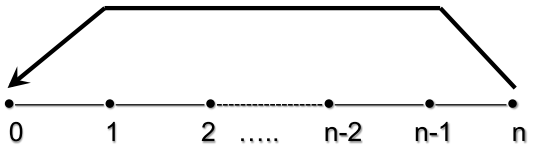
$$C_n = C_o \cdot (1+r)^n$$

Example:
3M in the 2nd year of an investment, compounded to the 10th at 3%

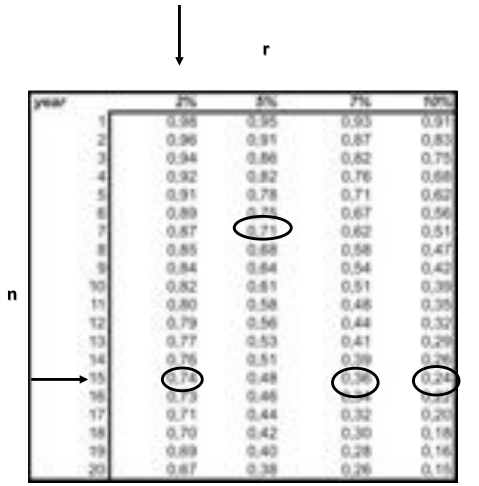
$3M \times (1+0.03)^8 = 3M \times 1.03^8 = 3M \times 1.267 = 3{,}8M$

The opposite procedure is called:

Discounting



$$C_o = C_n \cdot \frac{1}{(1+r)^n}$$



Discounting factors ($1/q^n$)

Discounting

E.g., discounting 1.5 M referred to the 7th at a 5% interest rate:

$1.5\ M \times 1/(1+0.05)^7 = 1.5\ M \times 1/(1.05)^7$

$= 1.5\ M \times 0.71$

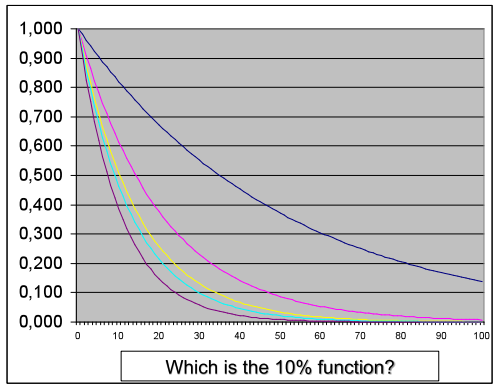
$= 1.065\ M$ (= the present value)

To check our results, let's do the opposite procedure (compounding):

Investing a capital of 1.065 M at 5% for 7 years,
the final value is 1.5 M.

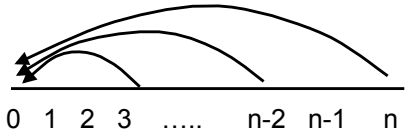
"The positive interest rate is the enemy of long-lived investment projects" (Samuelson, 1976)

$1/q^n$



Profitability indicators

To elaborate profitability indicator discounting is the fundamental operation:



$$C_o = C_n \times \frac{1}{(1 + r)^n}$$

E.g., with r =10%

year	Costs	Benefits
0	-100	0
1	-110	120
2	0	144

-100 (1/1..1^0) = -100 x 1 = -100.0

-110 (1/1.1^1) = -110 x 0.909091 = -100.0

120 (1/1.1^1) = 120 x 0.909091 = 109.0

144 (1/1.1^2) = 144 x 0.826446 = 119.0

NPV = 28.0

Profitability indicators

Net Present Value
or Net Discounted Value

$$NPV = \sum \frac{(B_n - C_n)}{(1 + r)^n}$$

B = benefits (or revenues)
C = costs
r = interest rate
n = year (n = 0…t)

Benefit/Cost Ratio

$$R/C = \sum \frac{B_n}{(1 + r)^n} \Big/ \sum \frac{C_n}{(1 + r)^n}$$

E.g., with *r* =10%

year	Costs	Benefits
0	-100	0
1	-110	120
2	0	144

-100 (1/1.1^0) = -100 x 1 = -100,0

-110 (1/1.1^1) = -110 x 0,91 = -100,0 Σ C = 200,0

120 (1/1.1^1) = 120 x 0,91 = 109,0

144 (1/1.1^2) = 144 x 0,83 = 119,0 Σ R = 228,0

R/C = 1.14

Internal Rate of Return

IRR = the discount rate when NPV = 0

year	Costs	Benefits
0	-200	0
1	0	120
2	0	144

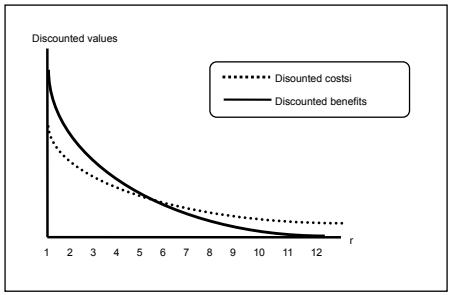
-200 (1/1.2^0) = -200 x 1 = -200

120 (1/1.2^1) = 120 X 0.833 = 100

144 (1/1.2^2) = 144 x 0.694 = 100

IRR= 20%

IRR can be used only in so-called "simple" investments



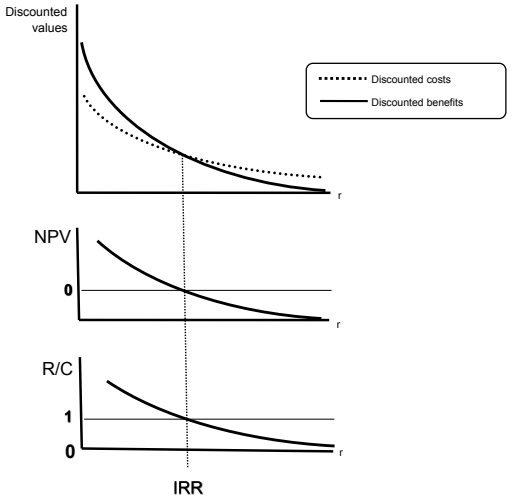
Another, more realistic, example

year	Costs	Benefits
0	-5 000	0
…	0	0
9	0	20 000

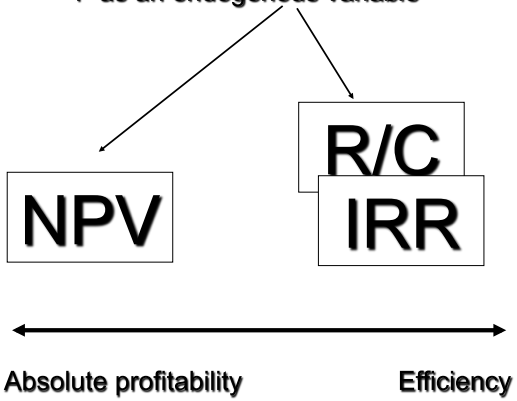
20 000 (1/1.16652^9) =

20 000 0.250 = 5000

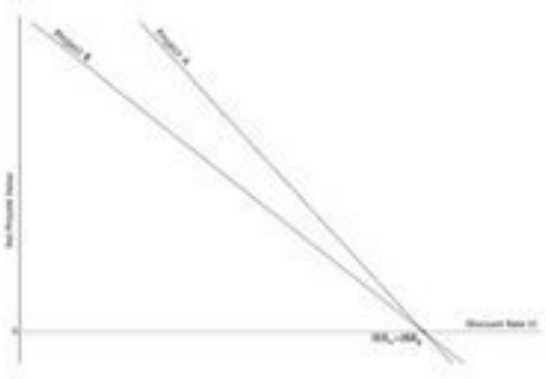
IRR= 16.652%



r as an endogenous variable



The IRR does not necessarily tell which project is better (Zerbe and Evans, 2010)



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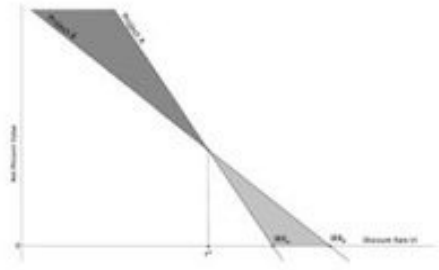


A summary test (r = discount rate)

If I am using NPV, I will consider acceptable all investments with NPV:

> r = 0 **> 0** ≥1 > IRR

If I am using R/C, I will consider acceptable all investments with R/C:

> r = 0 > 0 **≥1** > IRR

If I am using IRR, I will consider acceptable all investments with IRR:

> r = 0 > 0 ≥1

Discount rate selection

A. Rigorous approaches

Financial analysis:

- Opportunity costs of capital (see alternative investments)
- Private time preferences rate

Economic analysis:

- social time preferences rate

B. Pragmatic considerations:

- Internal rate of return of private investments (at the same level of risk)
- Average rate of public bonds (for the same time length of investments)
- A proportion of the GDP growth rate in the long term

Criticism to all the discounting approach

- Pearce's proposal of adopting different *r* for different periods (e.g.: 3.5% for the first 10 years, 3% from 11th al 20th, 2.5% from 21st, …)
- *Modified Discounting Method* (Kula): life expectancy included in the re-definition of *r* (flat discount rate after a period connected with life expectancy)
- Radical abandonment of discounting techniques (when dealing with non renewable resources r=0 (Marglin, Feldstein)

Excel

- **NPV=** +NPV (A1; C2:Z2)+B2

Value of the year 0 in the cash flow

r

The cash flow

- **IRR=** TIR.COST (A2:Z2; 0.05)

The cash flow

r to be used to start

How to include/treat risks and uncertainty?

- Mitigation funds
- *A premium* in the interest rate
- Probabilistic values/functions

  e.g.: not 2000 Euro, but:

  (1700 x 0.2 + 1900 x 0.3 + 2100 x 0.3 + 2300 x 0.2)
- Payback period
- Sensitivity analysis

To analyze r.& u., not to internalize them!

Financial and economic analysis

- Financial analysis: costs and revenues are defined looking at the local market prices → profitability for the private actor(s) ("Business plan")
- Economic analysis: costs and benefits for the community are taken into consideration

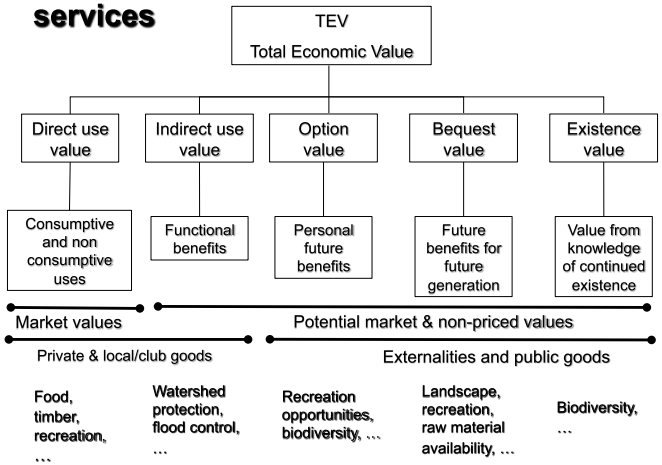
A question: labour costs are higher in the financial or in the economic analysis?

In the economic analysis:

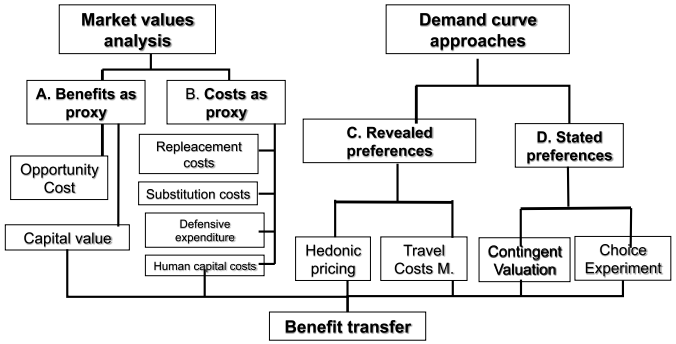
(Markandya, Harou, Bellù e Cistulli, 2002):

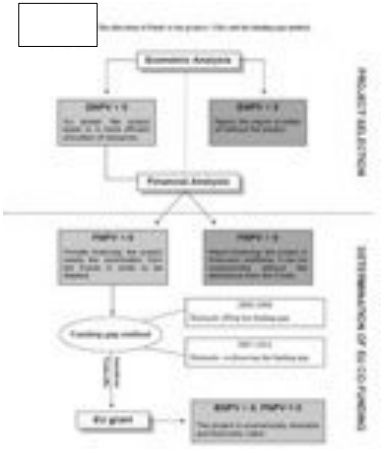
- Input and output prices = international prices ("border" prices)
- Prices changes by the public sector (i.e. taxes and incentives) are not considered
- Extenalities are included ("shadow prices")
- Social discount rates are used in discounting

Economic values of environmental services



Methods for the valuation of non-priced goods





A. Mairate e F. Angelini , 2006