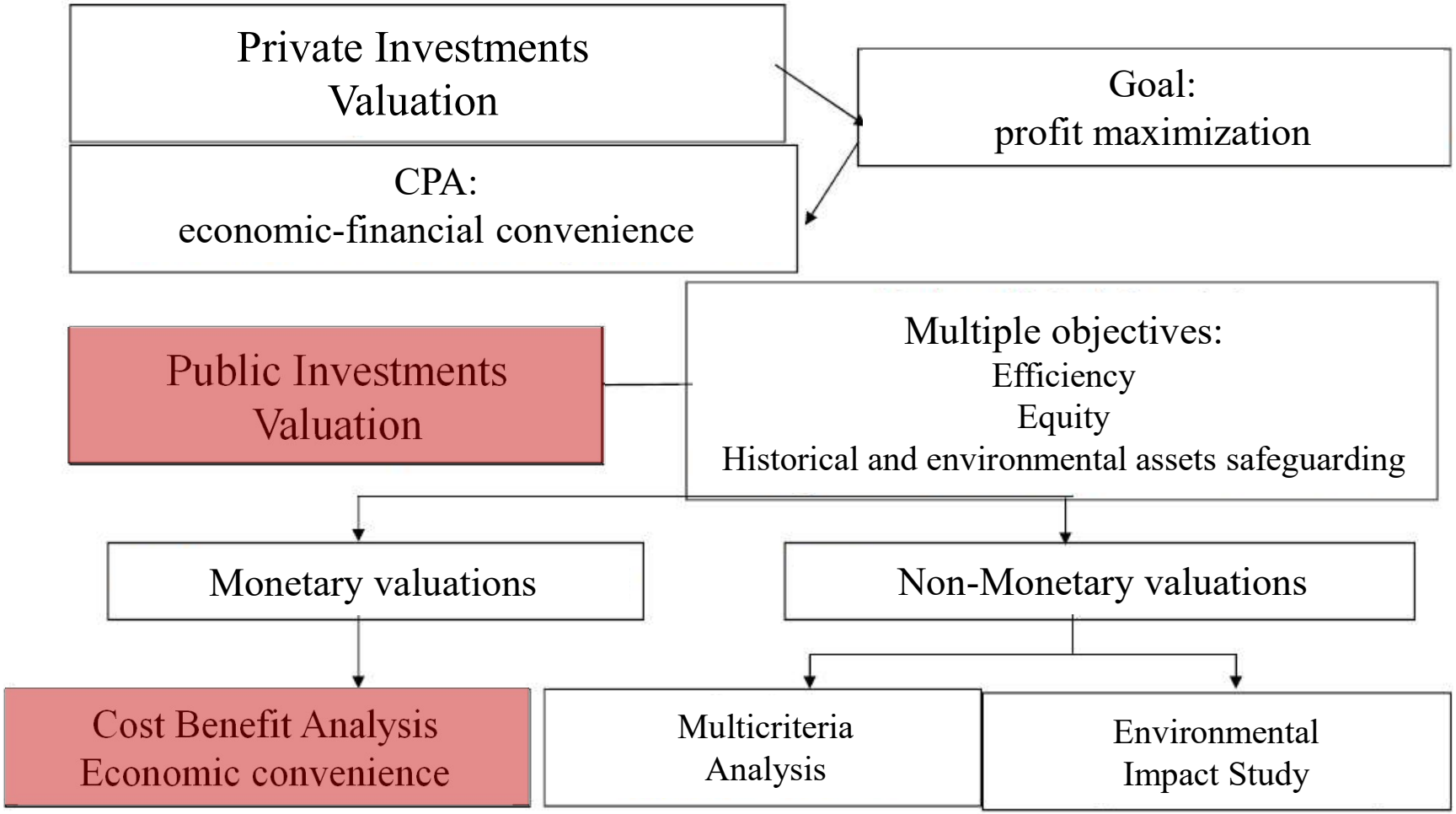
COST BENEFIT ANALYSIS (CBA)

CBA


Private Investments
Valuation
Goal:
profit maximization
CPA:
economic-financial convenience
Public Investments
Valuation
Multiple objectives:
Efficiency
Equity
Historical and environmental assets safeguarding
Monetary valuations
Non-Monetary valuations
Cost Benefit Analysis
Economic convenience
Multicriteria
Analysis
Environmental
Impact Study

CBA

CBA is an evaluation technique used to estimate the “**efficiency**" of a project, program, plan, investment, policy in order to verify its net social benefits and derives its rationality from the concept of "**Pareto Efficiency improvement**".

The economic-social evaluation (cost-benefit analysis), has the objective of identifying the **economic convenience of investment projects**, trying to:

- measure the **gains and losses** of individuals, using money as a unit of measurement (monetization process);
- aggregate the monetary evaluations of the gains and losses of individuals in order to express them as **social gains and losses** (functional aggregation of individual situations).

CBA

- CBA relates to any public decision that has implication for the use of resources
- Identification and valuation of social cost and social benefit generated by a public decision involving a change in resource allocation
- Maximization of social net benefits
- Distribution effects
- Calculation of the Net Present Value of a public investment project, based on estimation of future social costs and social benefits generated by the investment (CBA shows the increase in ‘the size of the economic pie’)

CBA

Public choices also concern the so-called **current activities, including the implementation of projects.**

It is about **deciding which project to prefer among various alternatives** (including the status quo – as-is situation)

Before proceeding with the actual offer of a public good or service, **a planning and a managing activity is required**

The benefit-cost analysis (or cost-benefit) is part of this activity and serves:

- to establish the convenience of the different projects
- to compare them

CBA

- In economic terms: calculation of the net social benefits resulting from a public decision that changes the allocation of resources

- **Maximization of the social welfare function**

- Distributive/allocation considerations

- The net present value of a public investment project is calculated starting from forecasts of the benefits and costs generated by the project

CBA

CPA

- Private-entrepreneurial approach
- The economic-financial costs and revenues generated by the project are considered
- Cash flows are considered
- Market prices are applied
- Definition of an appropriate discount rate
- Eligibility of investments established on the basis of the private operator's preferences
- Selection of alternative projects carried out through economic investment indicators

CBA

- Public approach (strictly public perspective)
- In addition to the economic costs and revenues of the project, the benefits and costs relating to the entire community are also considered
- Cash flows are considered (considers the temporal evolution of social costs and social benefits)
- Shadow prices are applied
- Definition of an appropriate discount rate
- Eligibility of investments established by the public decision maker on the basis of the preferences of the community
- Selection of alternative projects achieved through the maximization of social welfare functions

Sourse: D. Aspromonte, "Le valutazioni economiche e finanziarie nella prefattibilità", in "Fattibilità e progetto. Territorio, economia e diritto nella valutazione preventiva degli investimenti pubblici" Franco Angeli 2011

CBA

CBA is a fundamental tool in Welfare Economics: **it allows to evaluate whether a change in the allocation of resources produces an increase in social well-being**, i.e. whether it is efficient

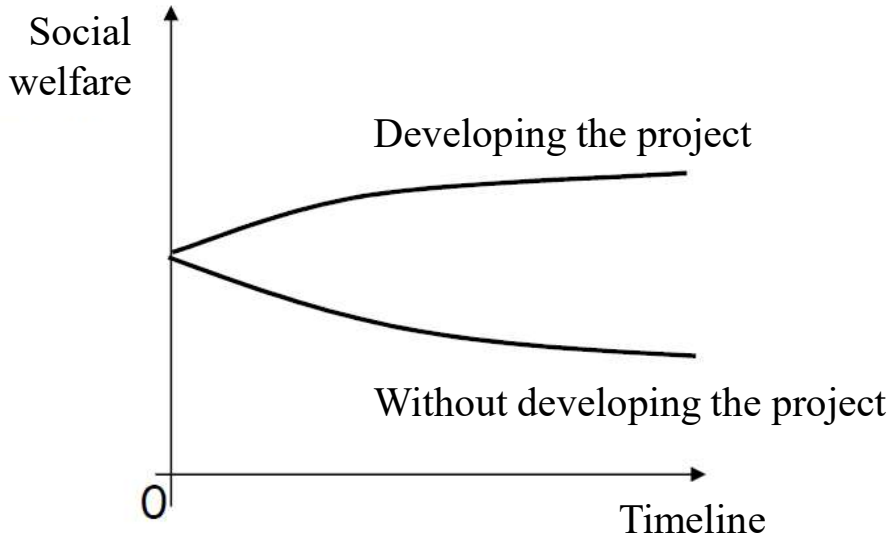
Applications:

- ✓ **Public investment projects** *(e.g. Green infrastructures, dams, Levee Systems, Retention and Detention Basins, Wetland Restoration, Riparian Buffer Zones)*
- ✓ **Projects that only imply definition of strategies** *(e.g. changing a school curriculum, Developing and implementing emergency response plans for flooding and water contamination incidents)*
- ✓ **Evaluation of strictly regulatory measures** *(e.g. obligation to wear helmets)*
- ✓ **Investment projects in the private sector**, when the profitability assessed on the market is very distant from the social profitability *(e.g. World Bank)*

CBA

In particular, the CBA is used when:

- ✓ There are externalities
- ✓ Prices exist but are strongly distorted, that is, they diverge from marginal costs
- ✓ Resources are distributed over time (Mid-Long-Term Agenda)



CBA

PHASES of the decision (as for the private entrepreneur):

1. Precise identification of the **alternatives** (including the ***status quo***)
2. Specification of the consequences of the various alternatives in physical terms (inputs and outputs) for each period in the time horizon considered
3. **Identification and evaluation of the expected costs and benefits** (current and future)
    - ✓ quantification in monetary terms
    - ✓ temporal placement
1. Temporal homogenization of costs and revenues, through actualization (**choice of the discount rate**)
2. Elaboration of the decision criteria and formulation of the choice

C-B quantification

In general, every public project has both **direct** and **indirect effects**:

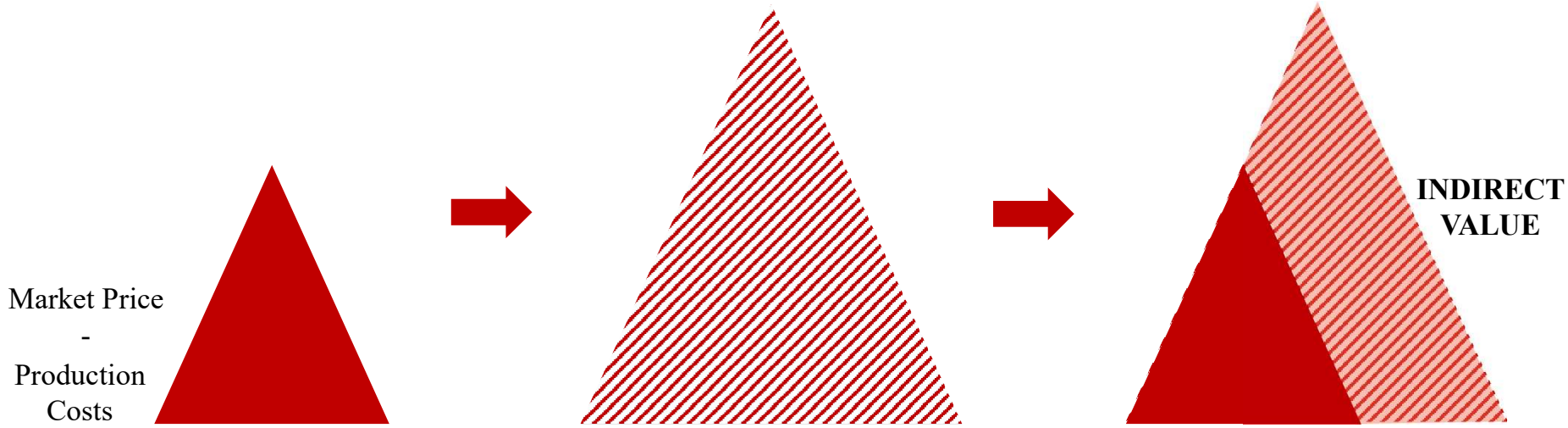
- ***DIRECT EFFECTS*** concern the **demand for inputs** necessary for the realization of the project and the **supply of outputs** generated by the project
- ***INDIRECT EFFECTS*** concern the changes that the project determines in **complementary or substitutive activities** with respect to those of the project itself. Indirect effects are **not** part of a **private investor's valuation**

Example: traffic reduction effects caused by the construction of a subway

CBA

DIRECT VS INDIRECT COSTS

Economic activity creates value both directly and indirectly.



DIRECT COST

Direct creation occurs during the production of the product, in a limited area, almost exclusively attributable to the perimeter of the manufacturing company, without taking into account all the other sectors activated indirectly.

TOTAL BENEFITS

Direct and Indirect impact on the area: Benefit given by the overall value created by direct and indirect production. In practice, it represents how many euros are generated by all sectors of the economic system for each euro spent on the production and exchange of the product.

SHARED VALUE

The "shared value" is the value created and shared in the territory net of the costs incurred.

CBA

Benefits: direct, indirect, business, social, environmental

Costs: direct, indirect, business, social, environmental

Their evaluation is carried out through:

- Market prices
- **Shadow prices**
- **Absence of prices?**

} *In the presence of* ***market failures*** → **INTANGIBLE PRICES**

Absence of competition:

- ✓ ***Monopoly****:* producers are not price takers but can influence prices, imposing a price higher than the marginal cost and offering a smaller quantity than in a competitive market condition

Presence of:

- ✓ ***Asymmetric information***: agents operating on the market do not have the same information on the good to be exchanged
- ✓ ***Public goods***: individuals do not declare their real preferences since these are goods whose consumption is non-rival and non-excludable (*free-rider problem*)
- ✓ ***Externalities:*** the behaviour of one individual affects the well-being of another without this being reflected in existing market prices. A correct signal regarding the opportunity cost is not provided

MARKET PRICES VALUATION

- In a competitive market, prices reflect both the marginal costs of production and the marginal value that consumers attribute to goods

- When market imperfections **are modest, it is preferable to use market prices**

CBA

SHADOW PRICES' ASSESMENT

- **Shadow prices** are prices that reflect the **social opportunity cost of goods and services**

- **They are used when market imperfections are such that real prices are unreliable** as indicators of social costs and benefits, that is, when:

  - ✓ prices do not reveal the real WTP of the consumer
  - ✓ prices do not correspond to the marginal cost of production
  - ✓ taxation influences the price system

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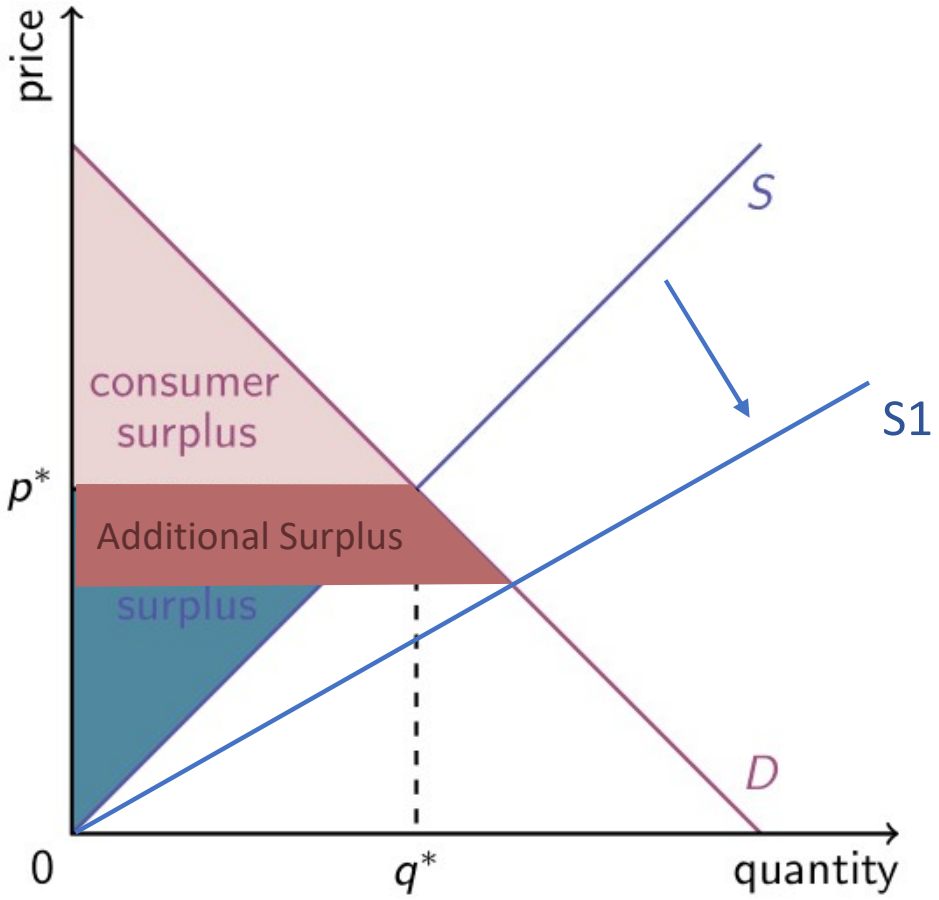
BUILDING A DAM



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COST AND BENEFIT ASSESMENT

- Correction of market prices (estimated in the context of the financial analysis) for fiscal effects;

- Definition of a system of "shadow prices“ that reflect the opportunity cost, and the value of the resources used, and the goods and services produced by the project have for the community;

- Estimation of external effects.

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MARKET PRICES CORRECTIONS FOR TAX EFFECTS

Corrective coefficients allow market prices to be corrected from the distortions that characterise them and distance them from the long-term equilibrium value (transfers, state aid, etc.):

- Tax burdens on production (Value Added Tax - VAT);
- tax burdens on individuals (IRPEF) and legal entities (IRPES-IRAP);
- taxes on specific products;
- fees for services produced by third parties;
- excise duties.

CBA

MARKET PRICES CORRECTIONS FOR TAX EFFECTS

The calculation technique involves:

- identifying categories of resources with similar transfer charges;
- defining for each work/good/service category, the impact of the above categories (previous slide);
- calculating the impact of transfers on each category of resources and on the entire project.

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EXAMPLE

RESOURCES		TRANSFERS				NET COST
Item	*%*	*Profit*	*VAT*	*Other Taxes**	*Total Taxes*	*Total*
Labor	0.4	0.033	0.067	0.010	**0.11**	0.956
Materials	0.44	0.0367	0.0733	0.0115	**0.122**	0.946
Transport	0.06	0.005	0.01	0.00157	**0.0166**	0.999
Rental	0.1	0.00433	0.0566	0.00136	**0.062**	0.994
TOTAL	**1.00**	**0.079**	**0.2069**	**0.02443**	**0.316**	**0.684**

**(IRES + IRAP)*

Conversion factor

CBA Regional NUUV (Regional evaluation units)

ITEM	Conversion factor
1. Investment costs	
1.1 Civil works (examples)	
Aqueducts	1.0032
Sewerage networks, collectors, purification plants	0.9982
Roads, green areas, sports facilities and open-air markets	1.0254
Buildings, sports facilities and covered markets	0.9334
Lighting systems, power lines	0.4600
1.2 Plant works	0.8850
1.3 Labor	**0,537***
1.4 Other costs (management, testing)	0.8820
1.5 Extraordinary maintenance	1.0182
2. Management costs	
2.1 Purchases	0.6480
2.2 Ordinary maintenance	1.0182
2.3 Other costs	0.7144
2.4 Labor	0.5994
3. Financial returns	0.560

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LABOR* (SHADOW SALARY)

As regards the conversion factors for LABOR expenses, the indications of DG Regio were followed regarding the assumption of a shadow salary that takes into account the regional unemployment rate, calculated according to the following formula:

$Ss = Sf*(1- d)*(1- i) = Sf * \mathbf{0.537}$

Where:

- Ss is the shadow salary
- Sf is the financial salary (project)
- *d* is the regional unemployment rate (in Calabria equal to 11.9%)
- *i* is the rate of social security contributions and taxes (39%)

8 DG Regio, Sviluppo tematico Impatto, Valutazione e Azioni innovatrici, Documento di lavoro n. 4, Orientamenti metodologici per la realizzazione dell'analisi costi benefici. N. 8/2006.

SHADOW PRICES

The shadow price represents the increase in social welfare resulting from a marginal variation in the availability of goods.

It reflects the social evaluation of the variation in the endowment of a good or resource:

$$P_S = \frac{\Delta\, Social\ Welfare}{\Delta\, Quantity}$$

CBA

Valuation in the Absence of Prices

Often among the consequences of a public project there are individual and social benefits that cannot be estimated through prices of any kind, e.g.:

- **time gains**
- **reduction of mortality**
- **externalities**

From an operational point of view:

- the benefits are calculated on the basis of the WTP of those who benefit from their advantages
- the costs are calculated on the basis of the WTA of those who suffer their disadvantages

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PHASES:

- **CASH FLOWS BUILD-UP,** time horizon choice
- **DISCOUNT RATE CHOICE:**

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

Discount rate that reflects the prices prevailing on the capital market, to evaluate public investment projects in terms of strict market efficiency. Public projects are in competition with private ones and therefore must be put on the same level. Private efficiency criterion as a yardstick

SOCIAL DISCOUNT RATE (Social Rate of Time Preference)

CBA

SOCIAL DISCOUNT RATE

- Represents the **social opportunity cost of capital**
- Represents the **SOCIAL rate of TIME PREFERENCE** that also involves future generations
- Takes into account the distribution of risk across the entire community
- Corrects market inefficiencies (externalities)

The concept of discount seems to be inconsistent with the concept of SUSTAINABILITY

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~~SOCIAL~~ DISCOUNT RATE

Factors that influence the discount rate or cost of capital in **PRIVATE INVESTMENTS**:

- *the risk-free discount rate*
- *inflation*
- *risk premium (investment riskiness)*

SOCIAL DISCOUNT RATE

To assess the social discount rate, one of the two following criteria can be adopted:

1. ***econometric method***, discount rate is linked to a series of cyclical economic factors, e.g.:

   - the long-term growth rate of the economy, approximated, according to the Harrod-Domar model, by the sum of the growth rate of labour productivity and the population growth rate.
   - the pure time preference rate.

2. ***synthetic method***, adopting the value of the social discount rate suggested by the European Commission and used in practice when one is at initial planning levels (pre-feasibility and feasibility).

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SOCIAL DISCOUNT RATE

- The Ministry of Economy and Finance and the Ministry of the Treasury have proposed an SSS to be applied to public projects that varies between 8% and 12%, with the possibility of using one equal to 5% for the South.
- Guidelines issued by the Regional Evaluation Units of public projects define, within the drafting of Feasibility Studies, the use of a discount rate equal to 5% for the calculation of the NPV and the IRR.
- The Guide to the C-B analysis of EU investment projects proposes an SSS equal to approximately 5%
- Base rates for the 27 Member States and the UK:

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SOCIAL DISCOUNT RATE

Base rates calculated in accordance with the Communication from the Commission on the revision of the method for setting the reference and discount rates (OJ C 14, 19.1.2008, p.6.). Depending on the use of the reference rate, the appropriate margins have still to be added as defined in this communication. **For the discount rate this means that a margin of 100 basispoints has to be added.** The Commission regulation (EC) No 271/2008 of 30 January 2008 amending the implementing regulation (EC) No 794/2004 foresees that, unless otherwise provided for in a specific decision, the recovery rate will also be calculated by adding 100 basispoints to the base rate.

Changes are indicated in bold

Base rates as of 1.10.2024

From	To	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
1.10.2024	**31.10.2024**	**3,45**	**3,45**	3,91	**3,45**	4,68	**3,45**	4,29	**3,45**	**3,45**	**3,45**	**3,45**	**3,45**	**3,45**	7,14	**3,45**	**3,45**	**3,45**	**3,45**	**3,45**	**3,45**	**3,45**	5,68	**3,45**	6,56	3,52	**3,45**	**3,45**	5,65
1.9.2024	30.9.2024	4,11	4,11	3,91	4,11	4,68	4,11	4,29	4,11	4,11	4,11	4,11	4,11	4,11	7,14	4,11	4,11	4,11	4,11	4,11	4,11	4,11	5,68	4,11	6,56	**3,52**	4,11	4,11	5,65
1.7.2024	31.08.2024	4,11	4,11	3,91	4,11	**4,68**	4,11	4,29	4,11	4,11	4,11	4,11	4,11	4,11	**7,14**	4,11	4,11	4,11	4,11	4,11	4,11	4,11	5,68	4,11	6,56	4,28	4,11	4,11	5,65
1.4.2024	30.06.2024	4,11	4,11	3,91	4,11	**5,56**	4,11	4,29	4,11	4,11	4,11	4,11	4,11	4,11	**8,72**	4,11	4,11	4,11	4,11	4,11	4,11	4,11	5,68	4,11	6,56	4,28	4,11	4,11	5,65
1.1.2024	31.3.2024	**4,11**	**4,11**	**3,91**	**4,11**	**6,64**	**4,11**	**4,29**	**4,11**	**4,11**	**4,11**	**4,11**	**4,11**	**4,11**	**11,22**	**4,11**	**4,11**	**4,11**	**4,11**	**4,11**	**4,11**	**4,11**	**5,68**	**4,11**	**6,56**	**4,28**	**4,11**	**4,11**	**5,65**
1.11.2023	31.12.2023	3,64	3,64	**3,31**	3,64	7,43	3,64	4,17	3,64	3,64	3,64	3,64	3,64	3,64	**12,79**	3,64	3,64	3,64	3,64	3,64	3,64	3,64	**6,35**	3,64	7,05	3,82	3,64	3,64	5,09
1.9.2023	31.10.2023	3,64	3,64	2,73	3,64	7,43	3,64	**4,17**	3,64	3,64	3,64	3,64	3,64	3,64	15,10	3,64	3,64	3,64	3,64	3,64	3,64	3,64	7,62	3,64	7,05	3,82	3,64	3,64	**5,09**
1.8.2023	31.8.2023	3,64	3,64	**2,73**	3,64	7,43	3,64	3,54	3,64	3,64	3,64	3,64	3,64	3,64	15,10	3,64	3,64	3,64	3,64	3,64	3,64	3,64	7,62	3,64	**7,05**	3,82	3,64	3,64	4,24
1.7.2023	31.7.2023	3,64	3,64	2,15	3,64	7,43	3,64	3,54	3,64	3,64	3,64	3,64	3,64	3,64	15,10	3,64	3,64	3,64	3,64	3,64	3,64	3,64	7,62	3,64	8,31	**3,82**	3,64	3,64	4,24
1.6.2023	30.6.2023	**3,64**	**3,64**	**2,15**	**3,64**	7,43	**3,64**	3,54	**3,64**	**3,64**	**3,64**	**3,64**	**3,64**	**3,64**	15,10	**3,64**	**3,64**	**3,64**	**3,64**	**3,64**	**3,64**	**3,64**	7,62	**3,64**	8,31	3,21	**3,64**	**3,64**	4,24
1.5.2023	31.5.2023	3,06	3,06	**1,80**	3,06	7,43	3,06	3,54	3,06	3,06	3,06	3,06	3,06	3,06	15,10	3,06	3,06	3,06	3,06	3,06	3,06	3,06	7,62	3,06	8,31	3,21	3,06	3,06	**4,24**
1.4.2023	30.4.2023	3,06	3,06	**1,51**	3,06	7,43	3,06	**3,54**	3,06	3,06	3,06	3,06	3,06	3,06	15,10	3,06	3,06	3,06	3,06	3,06	3,06	3,06	7,62	3,06	8,31	**3,21**	3,06	3,06	3,52
1.3.2023	31.3.2023	**3,06**	**3,06**	**1,10**	**3,06**	7,43	**3,06**	2,92	**3,06**	**3,06**	**3,06**	**3,06**	**3,06**	**3,06**	15,10	**3,06**	**3,06**	**3,06**	**3,06**	**3,06**	**3,06**	**3,06**	7,62	**3,06**	8,31	**2,96**	**3,06**	**3,06**	**3,52**
1.2.2023	28.2.2023	2,56	2,56	**0,79**	2,56	7,43	2,56	2,92	2,56	2,56	2,56	2,56	2,56	2,56	15,10	2,56	2,56	2,56	2,56	2,56	2,56	2,56	7,62	2,56	8,31	2,44	2,56	2,56	2,77
1.1.2023	31.1.2023	**2,56**	**2,56**	**0,36**	**2,56**	**7,43**	**2,56**	**2,92**	**2,56**	**2,56**	**2,56**	**2,56**	**2,56**	**2,56**	**15,10**	**2,56**	**2,56**	**2,56**	**2,56**	**2,56**	**2,56**	**2,56**	**7,62**	**2,56**	**8,31**	**2,44**	**2,56**	**2,56**	**2,77**

https://competition-policy.ec.europa.eu/state-aid/legislation/reference-discount-rates-and-recovery-interest-rates/reference-and-discount-rates_en

SOCIAL DISCOUNT RATE CHOICE

Interest Rate Scenarios (with a probability of occurring p=10%)	Discount factors in period (t)				
	10	50	100	200	300
1%	0.9053	0.6080	0.3697	0.1367	0.0505
2%	0.8203	0.3715	0.1380	0.0191	0.0026
3%	0.7441	0.2281	0.0520	0.0027	0.0001
4%	0.6756	0.1407	0.0198	0.0004	0.0000
5%	0.6139	0.0872	0.0076	0.0001	0.0000
6%	0.5584	0.0543	0.0029	0.0000	0.0000
7%	0.5083	0.0339	0.0012	0.0000	0.0000
8%	0.4632	0.0213	0.0005	0.0000	0.0000
9%	0.4224	0.0134	0.0002	0.0000	0.0000
10%	0.3855	0.0085	0.0001	0.0000	0.0000
Certainty-equivalent discount factor (f)	0.6097	0.1567	0.0592	0.0159	0.0053
Certainty-equivalent discount rate* (r)	5.072%	3.776%	2.867%	2.093%	1.760%

*Certainty-equivalent discount rate: $1/(1+r)^{\wedge}t=f_t$

Source: Adapted from Pearce et al (2006)

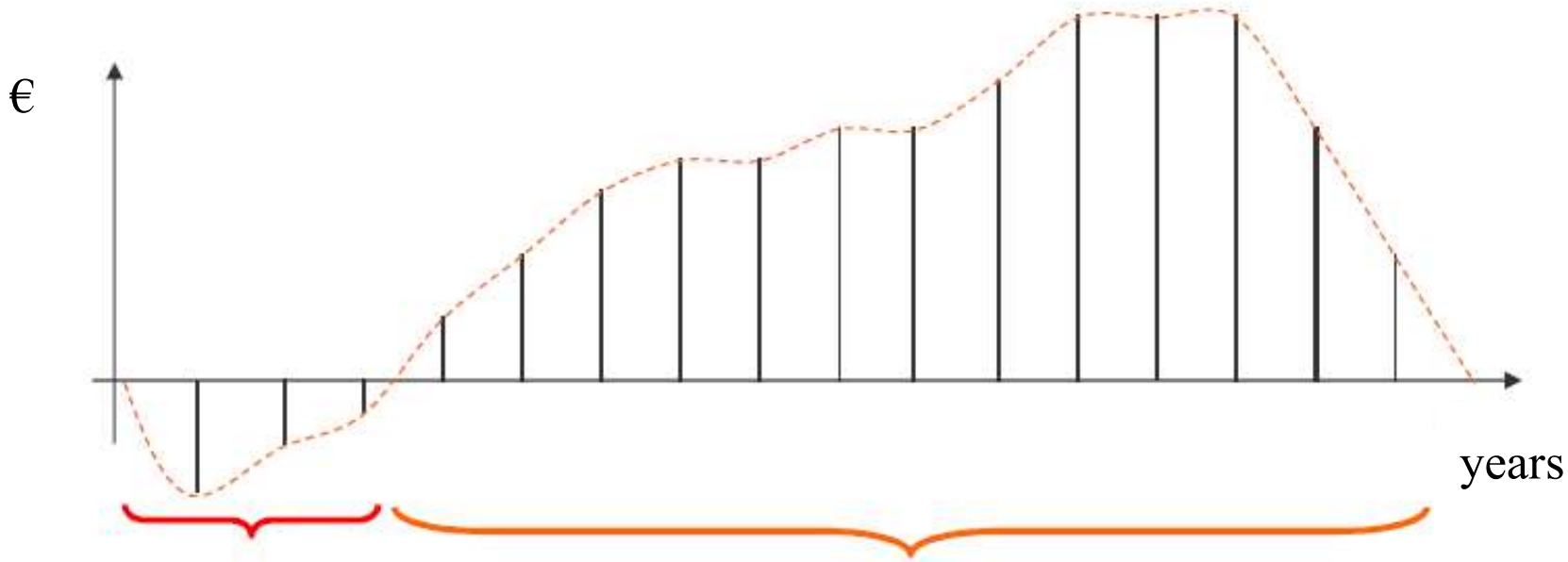
SOCIAL DISCOUNT RATE:

TYRANNY OF DISCOUNTING

- This term indicates discrimination against the future (or future generations) when using standard discounting methods.
- Applying high discount rates encourages temporary benefits through the overexploitation of natural resources.
- Discounting with market rates of return yields very low present values for costs and benefits that take place in the distant future, even when these costs and benefits are monumental relative to the size of the future economy. This phenomenon is called the tyranny of discounting and has been brought to the fore of the research agenda by the economics of climate change.

CBA

TIMELINE



CBA

CASH-FLOW: SECURING A CONTAMINATED SITE (LANDFILL)

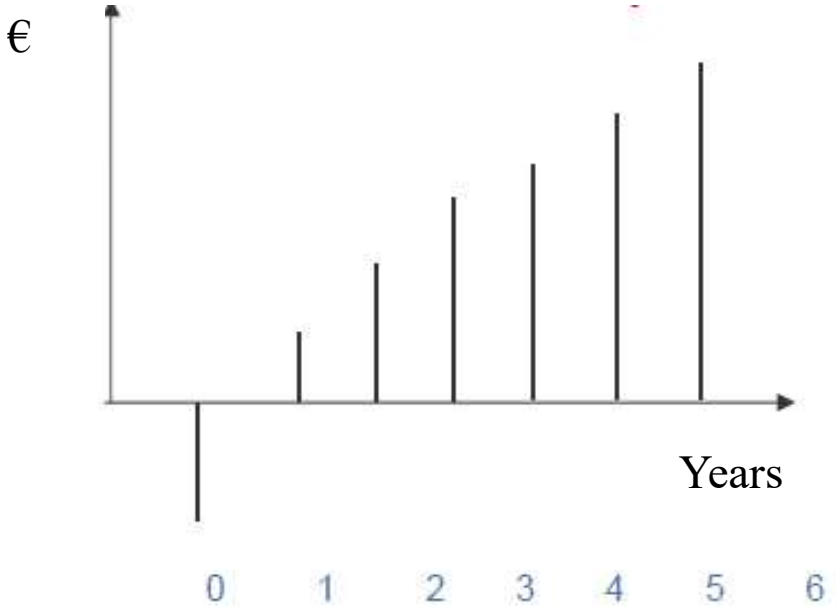
		PHASES		
		1. DESIGN	2. CONSTRUCTION	3. MANAGEMENT
COSTS	EMINENT DOMAIN			
	DESIGN			
	CONSTRUCTION			
	POLLUTION			
BENEFITS	EMPLOYMENT			
	HEALTH			
	ENVIRONMENT			
	LAND VALUES			

	Year 1	Year 2	Year 3	Year 4	Year 5	Year …	Year 30
Costs	10%	15%	20%	25%	5%	1% …	1%
Benefits			15%	20%	15%	2% …	2%

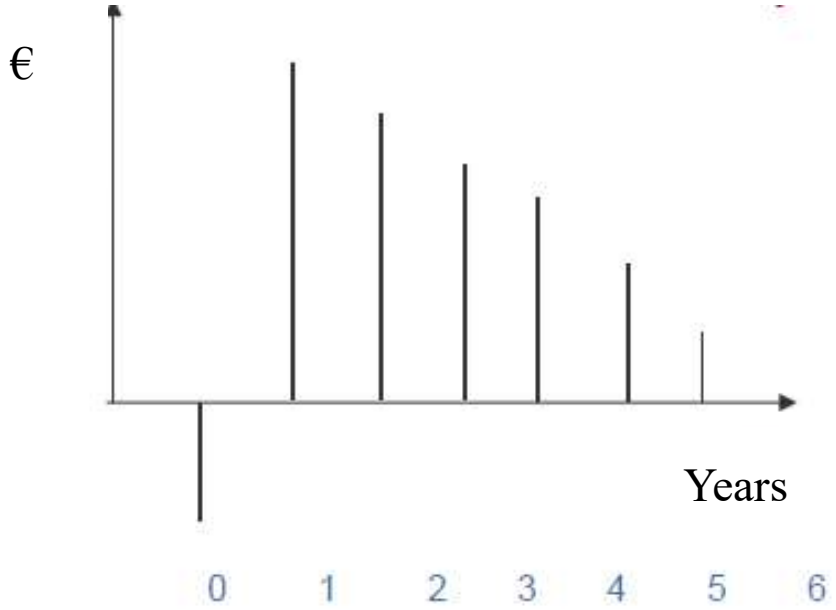
CBA

CASH-FLOW

Which of the different investment projects A and B do you prefer based on economic convenience and why?



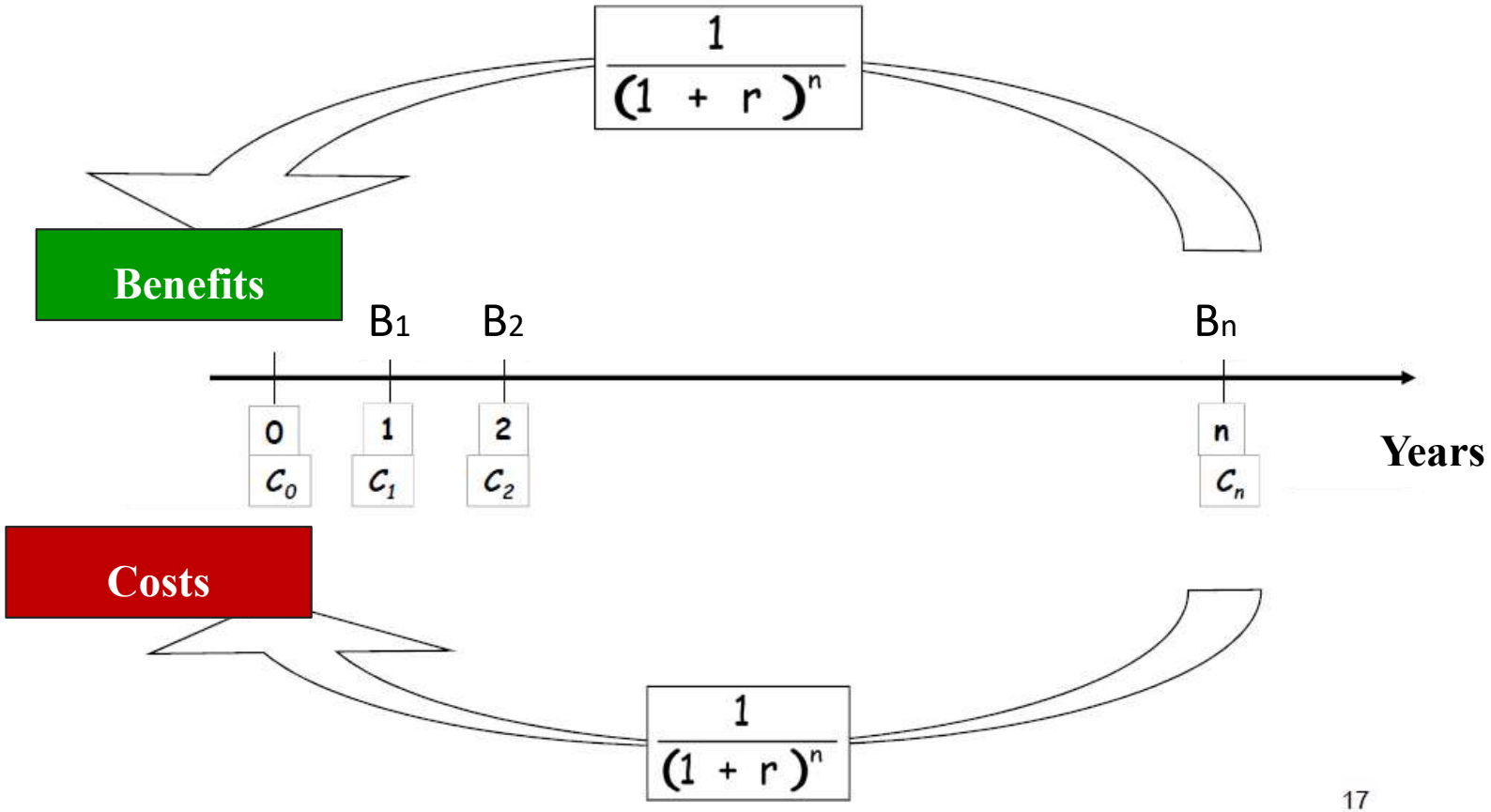
CASE A



CASE B

CBA

DISCOUNTING



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CBA

DECISIONAL CRITERIA

Types of Judgment:

- Admissibility
- Preferability

CRITERIA:

- **NPV**
- **IRR**
- **BENEFIT/COST RATIO (Profitability Index)**

CBA

NPV

Net Present Value – Difference between the present value of cash flows and the initial investment costs. In other words, it is the difference between the discounted revenue stream and the discounted cost stream

$$NPV = B_0-C_0 +(B_1-C_1)/(1+r) + (B_2-C_2)/(1+r)^2 + \dots + +(B_n-C_n)/(1+r)^n$$

- **NPV Eligibility ≥ 0**
- **NPV Preference Maximum**

CBA

NPV

Limitations:

1. difficulty in estimating shadow prices
2. difficulty in identifying ALL costs and benefits
3. uncertainty in defining the social discount rate

Example:

Year (r=11%)	1	2	3	4	5	Total
Cash Flow (B-C)	**(22.115.526)**	**(2.692.813)**	**12.006.932**	**19.745.064**	**2.230.040**	**9.173.697**
Years (n)	1	2	3	4	5	
Discont factor (ia) = 1/(1+r)^n	0,901	0,812	0,731	0,659	0,593	
Discounted Cash-Flow = (B-C) * ia	**(19.923.897)**	**(2.185.547)**	**8.779.365**	**13.006.685**	**1.323.420**	**1.000.026**

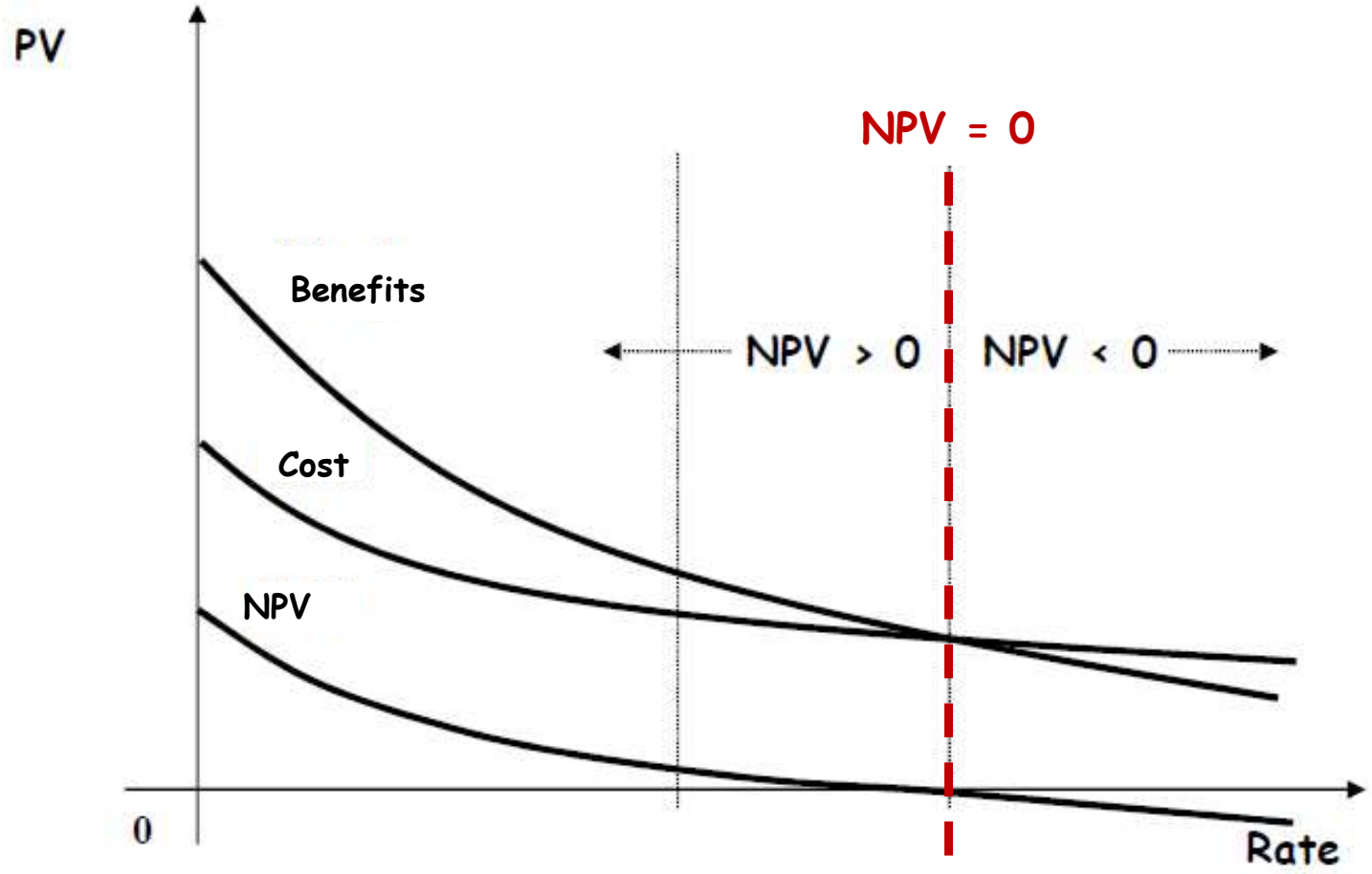
???

NPV ≥ 0

The project is feasible and affordable!

CBA

NPV



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NPV RULE

- About 75% of companies always, almost always, use the NPV rule in making investment decisions

- NPV depends solely on expected cash flows and the opportunity cost of capital

- It is a decision rule that recognizes the time value of money (one Euro today is worth more than one Euro tomorrow)

- If two projects are considered, the NPV of the joint investment is:

$$NPV(A+B)=NPV(A)+NPV(B)$$

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IRR

Internal Rate of Return – Discount rate that nullifies the Net Present Value. It is the annual rate of growth that an investment is expected to generate.

$$B_0-C_0 +(B_1-C_1)/(1+IRR) + (B_2-C_2)/(1+IRR)^2 + \ldots +$$
$$+ (B_n-C_n)/(1+IRR)^n = 0$$

- **Eligibility IRR ≥ IRR_{ref}**
- **Preferability Maximum IRR**

CBA

IRR

Example:

YEAR	1	2	3	4	5	Total
Cash –Flow (B-C)	(22.115.526)	(2.692.813)	12.006.932	19.745.064	2.230.040	9.173.697

$$NPV = \frac{(B_n - C_n)}{(1+r)^n} = 0$$

IRR = 12,92%

IRR > r = 11 %

The project is feasible and affordable!

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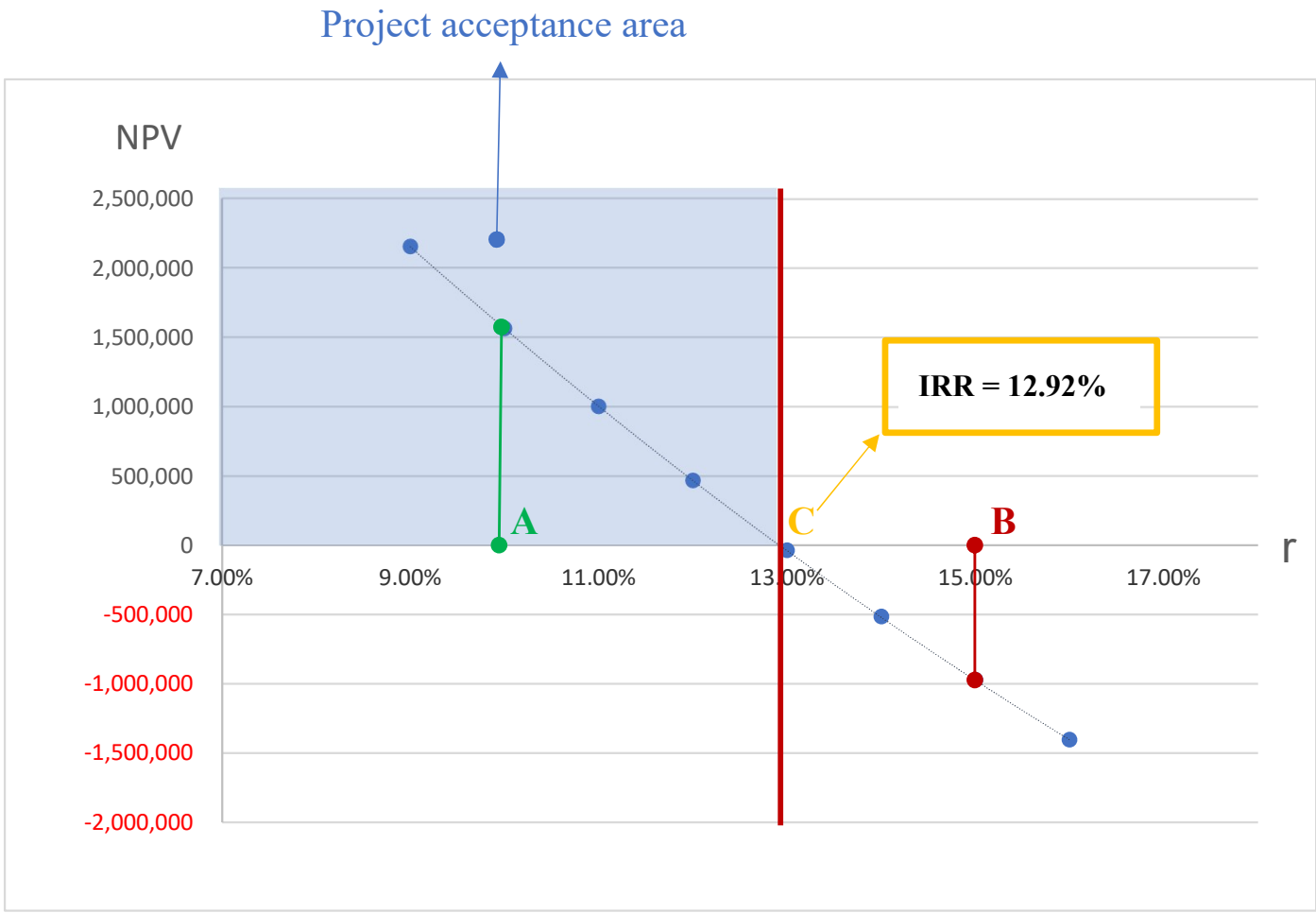
IRR

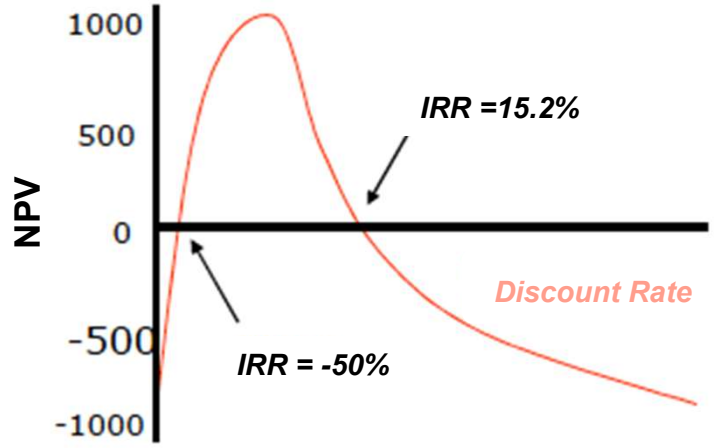

Project acceptance area
NPV
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
-500,000
-1,000,000
-1,500,000
-2,000,000
7.00%
9.00%
11.00%
13.00%
15.00%
17.00%
r
A
B
C
IRR = 12.92%

IRR

Limitations:

When evaluating whether an investment/project is convenient, multiple rates of return can be found. This happens when the cash flows change sign. There can be as many different IRRs in a project as there are changes in the sign of the cash flows.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year7
Cash Flows	- 1.000,00	800,00	150,00	150,00	150,00	150,00	- 150,00



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IRR

Limitations:

There may be cases where there is no IRR

Project	CF(0)	CF(1)	CF(2)	IRR	NPV (@10%)
A	1.000 € -	3.000 €	2.500 €	#NUM!	308,04 €

The **Project A** has a positive NPV for any discount rate

IRR RULE

- The Internal Rate of Return is a measure of profitability that depends solely on the amount and timing of a project's cash flows

- The opportunity cost of capital is determined in the financial markets, it is the expected rate of return offered by other activities with equivalent risk to the project in question

- The IRR rule gives the same answer as the NPV rule whenever the NPV is a monotonically decreasing function of the discount rate

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IRR RULE

- IRR: investment (A) or investment (B)?

Project	CF(0)	CF(1)	IRR	NPV (@10%)
A	-1,000 €	1,500 €	50%	330.58 €
B	1,000 €	-1,500 €	50%	-330.58 €

- In case A, where we initially pay $1,000, we are lending money at 50%, in case B, where we borrow $1,000 at a rate of 50%
- When we lend money, we want a high rate of return; when we borrow money, we want a low rate of return
- Of course, the IRR rule has no value in this case
- IRR does not take into account the sign of the flows

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PROFITABILITY INDEX

PI - The discounted Benefit-Cost Ratio - expresses the ratio between all the economic benefits and costs, internal and external, discounted to year zero.

The Profitability Index is also known as the Profit Investment Ratio (PIR) or the Value Investment Ratio (VIR)

$$PI = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+r)^t}} \longrightarrow PI > 1$$

- **PI > 1**
- **Preferability B/C maximum**

DECISIONAL INVESTMENT CRITERIA - SUMMARY

- The Net Present Value (NPV) rule – Invest if the Net Present Value is non-negative
- The Internal Rate of Return (IRR) rule – Invest if the opportunity cost of capital is less than the Internal Rate of Return
- The Profitability rule – Invest if the PI is grater than 1

DECISIONAL INVESTMENT CRITERIA - SUMMARY

- The **Net Present Value (NPV)** rule – Invest if the Net Present Value is non-negative
- Between two projects/investments, the one with the maximum NPV is preferable

- The **Internal Rate of Return (IRR)** rule – Invest if the opportunity cost of capital is less than the Internal Rate of Return
- Between two projects/investments, the one with the maximum IRR is preferable

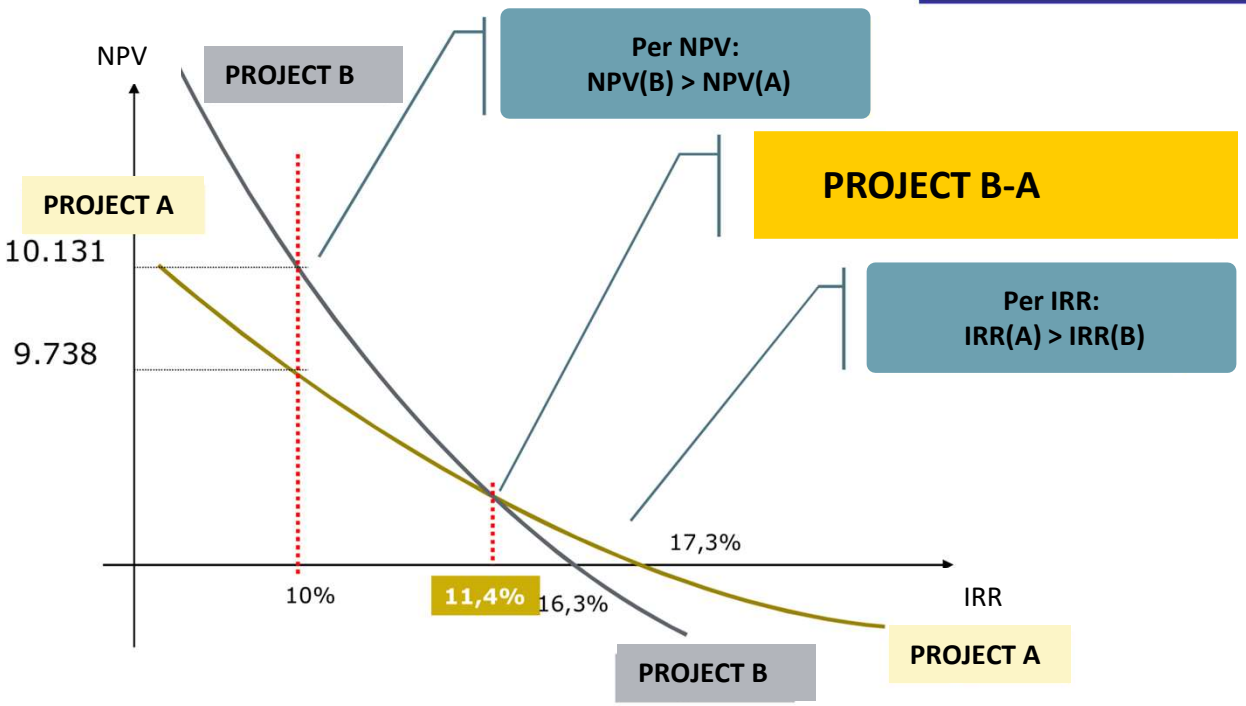
- The **Profitability rule** – Invest if the PI is grater than 1
- Between two projects/investments, the one with the maximum PI is preferable

CHOOSING BETWEEN TWO PROJECTS

Mutually exclusive projects

	PROJECT A	PROJECT B	Δ (B - A)
Initial Investment	60.000,00	73.000,00	13.000,00
Annual Net Revenue	22.000,00	26.225,00	4.225,00
IRR	17,30%	16,30%	11,40%
NPV	9.738,00	10.131,00	393,00

CONFLICTING RANKINGS



HP: 10% discount rate and 4-year lifespan

UNCERTAINTY EVALUATION

In case of uncertainty, ceteris paribus, individuals tend to discard risky investments. In general, the costs and benefits of 'uncertain' investments must be adjusted taking this aspect into account

Possibility of having different scenarios and therefore different NPVs: the different scenarios must be weighed based on their respective probabilities of occurrence

- Benefits and costs of the investment: **the certain equivalent must be calculated,** that is, the certain gain that individuals are willing to exchange for a series of uncertain outcomes deriving from the project, which has a lower value than the expected value. **It is necessary to know the distribution of the returns of the project and the degree of risk aversion of the people involved**

RISK ANALYSIS

Risk assessment can be carried out through two main procedures:

1. **Sensitivity analysis**: It measures the variation of individual risk components (model input) and verifies their impact on the investment profitability indicators in order to identify investment sustainability or profitability thresholds (benchmark).

2. Stochastic simulation techniques (Monte Carlo): A statistical analysis based on an algorithm that generates a series of uncorrelated data that follow the probability distribution that the phenomenon to be investigated is supposed to have.

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SENSITIVITY ANALISYS

Procedure:

1. the choice of the case study and its evaluation model;
2. the identification of the inputs on which to formulate hypotheses;
3. the choice of a range of values on which to formulate hypotheses;
4. the generation of scenarios;
5. the analysis of scenarios and the graphical representation of the results

(r = 3%)		VARIATION						
		-15%	**-10%**	**-5%**	**0**	**+5%**	**+10%**	**+15%**
Investment Costs	**Ic**	5.950.000,00	6.300.000,00	6.650.000,00	**7.000.000,00**	7.350.000,00	7.700.000,00	8.050.000,00
	NPV	-1.387.307,91	-1.737.307,91	-2.087.307,91	**-2.439.307,91**	-2.787307,91	-3.137.307,91	-3.487307,91
	IRR	1.6%	1.34%	1.06%	**0,80%**	0.55%	0.3%	0.054%
Management Costs	**Mc**	13.502.505,00	14.296.770,00	15.128.857,14	**15.885.300,00**	16.679565,00	17.473.830,00	18.268.095
	NPV	-158167,41	-789.283,06	-1.545.213,74	**-2.439.307,91**	-3.382.630,02	-4.113.745,67	-4.844.861,32
	IRR	2,25%	1,87%	1,36%	**0,80%**	0,30%	-0,05%	-0,31%
Benefits	**B**	22.210.134.47	23.219.686,04	24.325.385,37	**25.541.654,64**	26.818.737,37	28.095.820,10	29.372.902,84
	NPV	-5.108.452,44	-4.299.014,44	-3.412.487,11	**-2.439.307,91**	-1.413.368,27	-389.428,90	**634.510,18**
	IRR	-1.68%	-0.89%	0.064%	0.80%	1.70%	2.50%	**3.29%**

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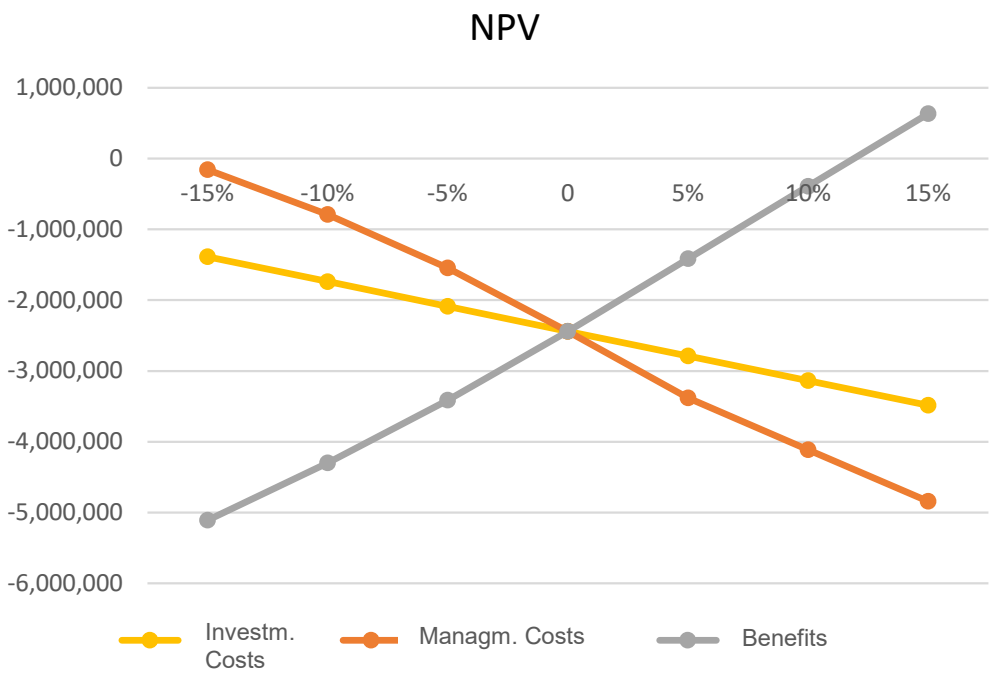
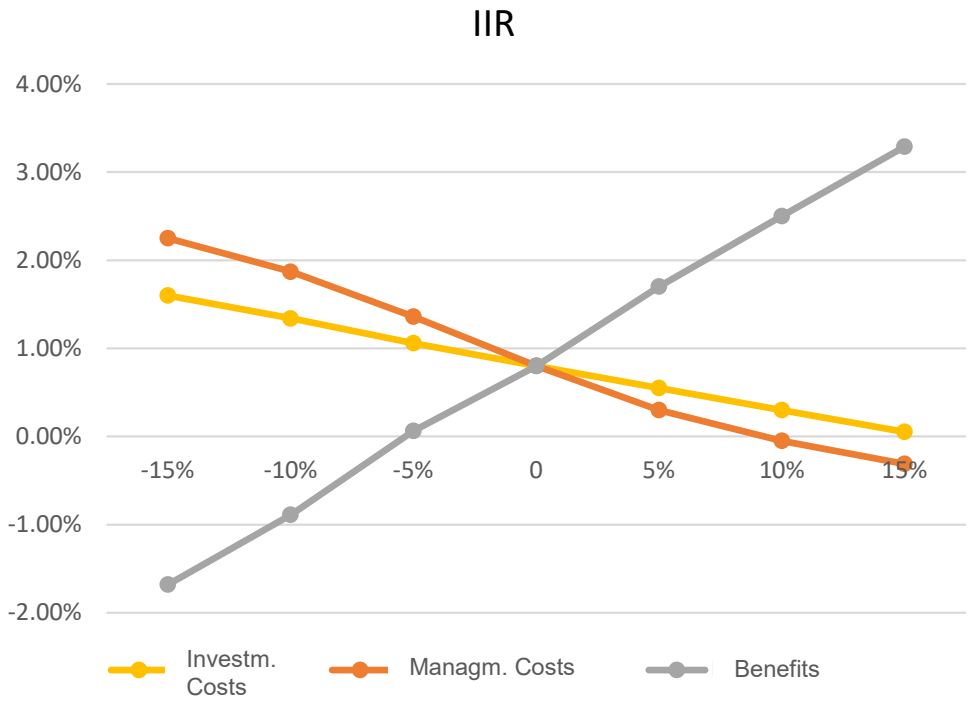
SENSITIVITY ANALISYS





1. The graphs show the sensitivity of the output (VAN or IRR) to percentage deviations from the base case (or best estimate) of the model inputs (sales prices, area cost, construction cost)

2. The slope of the curves provides an indication of the relative level of sensitivity (the steeper the curve, the greater the sensitivity)

CONTROVERSIAL ASPECTS OF COST-BENEFIT ANALYSIS

The rigorous solution to the problem of CBA based on the use of shadow prices, involves three steps:

- *Construction of a social welfare function;*
- *Identification of the existing constraints to the maximization of this function;*
- *Solution of the optimization problem, through the identification of a system of relative prices that expresses the exchange ratios between goods that maximize the socially weighted utility of the agents.*

CONTROVERSIAL ASPECTS OF COST-BENEFIT ANALYSIS

The main criticisms that have been levelled at the evaluation of public investments using shadow prices are the following:

a) ***Shadow prices*** *should incorporate* ***all the interrelationships*** *between objectives and constraints that characterize a given economy, but our knowledge about them is too limited.*

b) Even if we knew these relationships, simulating them all is practically impossible;

c) Assuming we overcome a) and b), if objectives and constraints change over time, as they do, a shadow price vector estimated ***today is not necessarily valid for tomorrow****. It would be necessary to readjust not only a few national parameters, but given the interrelations, all the estimated prices could change. This can be very costly.*

d) The use of two ***parallel price systems****, the current* ***market price system and the shadow price system****, can often appear artificial. The current prices, although distorted, are often so because they incorporate specific objectives, e.g. high taxation, tax exemption of social charges in areas of high unemployment, etc.*

e) Difficulty or impossibility of expressing ***non-economic quantities****.*

*f) The problem of the "****tyranny of the discounting****"*

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WHY USE CBA FOR WATER-RELATED HAZARDS?

- **Quantifying Risk Reduction**: Water hazards like floods or droughts can cause substantial economic and human losses. CBA helps quantify the benefits of risk-reduction measures, such as building levees or enhancing irrigation systems.
- **Resource Allocation**: Public budgets for hazard mitigation are often limited. CBA assists policymakers in deciding where to invest resources by comparing the expected return on investment (in terms of risk reduction) across different measures or projects.
- **Long-Term Perspective**: Climate change is exacerbating water-related hazards. CBA encourages a long-term view, considering future scenarios of hazard frequency and intensity, allowing for more resilient infrastructure and adaptive management strategies.

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