Risk Analysis of Research Infrastructure Projects

Programming Period 2014-2020

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Sensitivity vs. risk analysis

- Sensitivity analysis: study of the possible effects that changes in critical variables affecting forecasted prices could have on IRR and NPV.

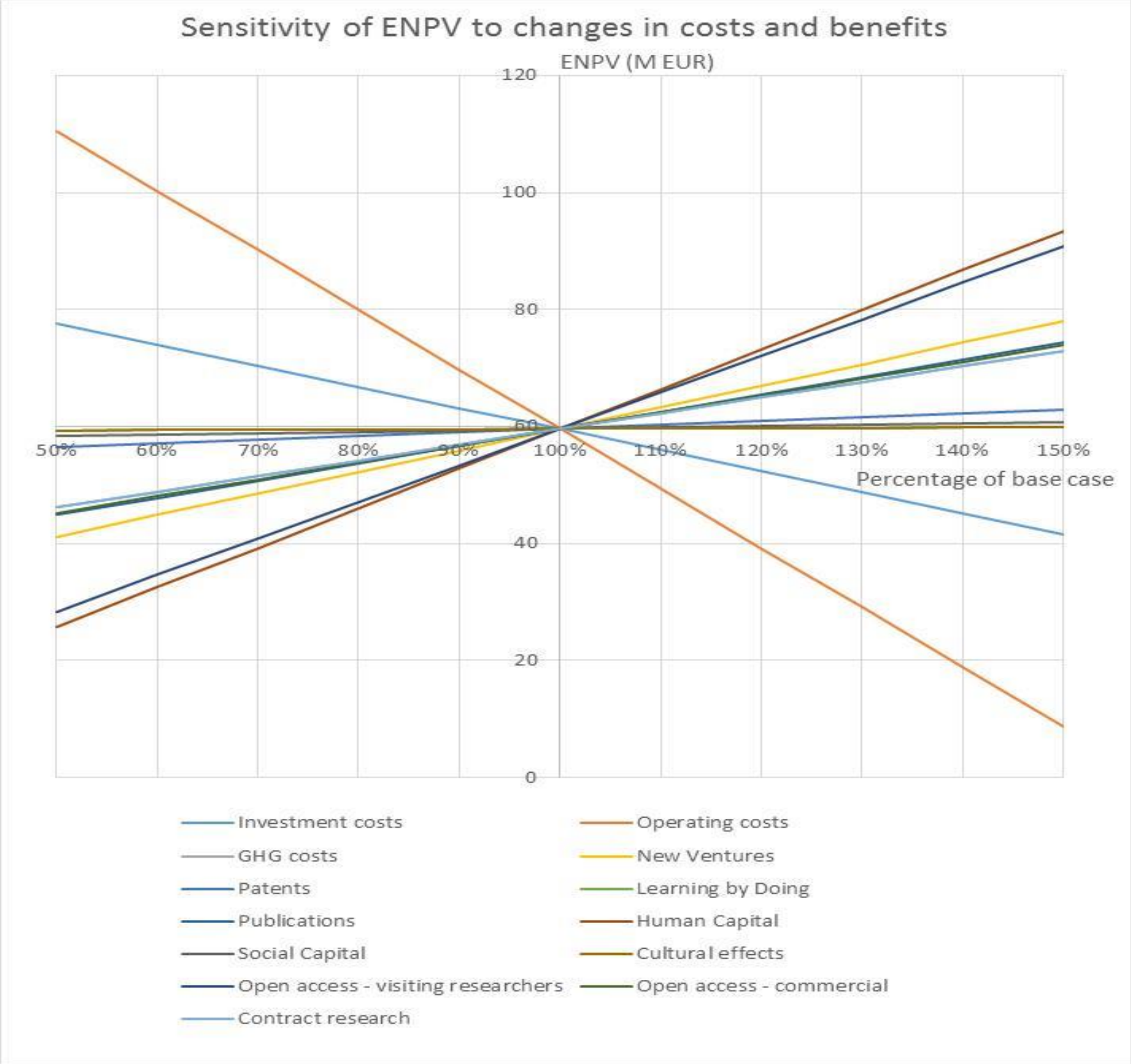
- Risk analysis: It studies the probability that the project will achieve a good performance in terms of IRR and NPV, and the result variability compared to the best estimate.

Risk assessment

- Sensitivity analysis
- Qualitative risk analysis
- Probabilistic risk analysis (*extremely recommended for major projects >50 M Euro*)

Sensitivity analysis

- This shows the change in IRR as a function of the arbitrary change in the random variables (considered one by one) → see if the impact is modest or highly significant.
- Critical variables are those for which a positive or negative growth could mostly affect IRR and NPV, making them vary in a relevant way.
- As general simple criteria: **choose critical variable for which a variation of 1% (+/-) cause 1% (+/-) of NPV.**
- Should be performed on independent variable (e.g. GDP growth to estimate demand level


Sensitivity of ENPV to changes in costs and benefits
ENPV (M EUR)
120
100
80
60
40
20
0
50%
60%
70%
80%
90%
100%
110%
120%
130%
140%
150%
Percentage of base case
Investment costs
Operating costs
GHG costs
New Ventures
Patents
Learning by Doing
Publications
Human Capital
Social Capital
Cultural effects
Open access - visiting researchers
Open access - commercial
Contract research

Scenario analysis

- Scenario analysis is a specific form of sensitivity analysis. While under standard sensitivity analysis the influence of each variable on the project's financial and economic performance is analysed separately, scenario analysis studies the combined impact of determined sets of values assumed by the critical variables.

- In particular, combinations of '**optimistic**' and '**pessimistic**' values of a group of variables could be useful to build different realistic scenarios, under certain hypotheses.

Switching values

- An approach to sensitivity analysis uses switching values.
- The switching value of a variable is that value at which the project's NPV becomes zero or the IRR equals to the discount rate.
- Switching values are usually presented in terms of the percentage change in the value of variable needed to turn the project's NPV equal to zero.

Example from an application form

The switching value of a particular variable is defined as the percentage value at which the NPV/C, NPV/K and ENPV equals 0 (%). The switching values for key variables are presented in the following table:

Critical value	Switching value	
Project investment cost	Maximum decrease before NPV/C equals 0 (%)	90.6%
Project investment cost	Maximum decrease before NPV/K equals 0 (%)	43.7%
Project investment cost	Maximum increase before ENPV equals 0 (%)	15.1%
Revenue scenario	Maximum increase before NPV/C equals 0 (%)	60.1%
Revenue scenario	Maximum increase before NPV/K equals 0 (%)	5.0%
O&M costs	Maximum decrease before NPV/C equals 0 (%)	74.0%
O&M costs	Maximum decrease before NPV/K equals 0 (%)	6.2%
O&M costs	Maximum increase before ENPV equals 0 (%)	15.9%
Environmental benefits	Maximum decrease before ENPV equals 0 (%)	19.8%

Shortcomings

Sensitivity analysis has some major limitations:

- It does not take into account risks related to non-quantitative variables
- It does not take into account the probabilities of occurrence of the events
- It does not take into account the correlations among the variables.

Qualitative risk analysis

- Risk matrix: listing the possible adverse events
- Risk levels

Severity / Probability	I	II	III	IV	V
A	Low	Low	Low	Low	Moderate
B	Low	Low	Moderate	Moderate	High
C	Low	Moderate	Moderate	High	High
D	Low	Moderate	High	Very High	Very High
E	Moderate	High	Very High	Very High	Very High

- Identification of prevention and/or mitigation measures

Severity / Probability	I	II	III	IV	V
A B C	Prevention or mitigation		Mitigation		
D E	Prevention		Prevention and mitigation		

Typical Risks I

Stage	Risk
Demand analysis	- Evolutions in the labour market (demand for university graduates and an impact on the demand for education services in the area) - Insufficient qualified human resources for research activity - Demand of students different than predicted - Demand of industrial users different than predicted - Interest of the general public different than predicted
Design	- Inadequate site selection - Inadequate design cost estimates - Delays in completing the project design - Invention of a new RDI technology making the infrastructure's technology obsolete - Lack of well-established technical engineering expertise
Administrative and procurement	- Delays in obtaining building permits - Unresolved property ownership rights - Delays in the acquisition of intellectual property rights or higher-than-expected costs for their acquisition - Procedural delays to select the supplier and sign the procurement contract - Supply bottlenecks

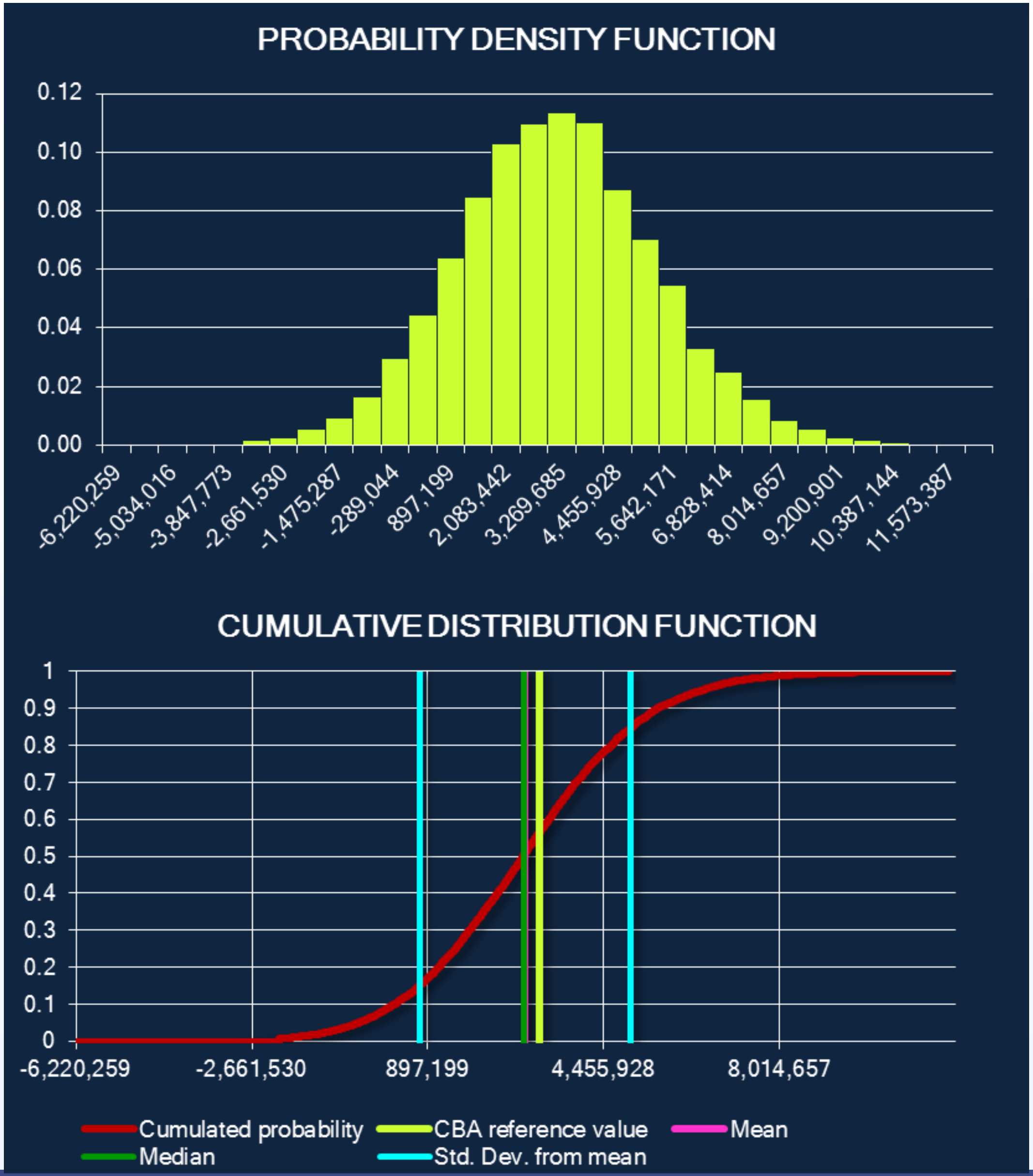
Typical Risks II

Construction	- Lack of ready-made solutions to meet the needs arisen during the construction or operation of the infrastructure - Project cost overruns - Delays in complementary works outside the project promoter's control - Project delays and cost overruns during installation of scientific equipment - Accidents
Operation	- Unexpected complication connected with the installation of specialised equipment - Delays in making the equipment fully and reliably running - Insufficient production of research results - Unexpected environmental impacts/accidents - Lack of academic staff/researchers
Financial	- Inadequate estimate of financial revenues - Insufficient success in obtaining national and international competitive funding - Failure to meet the demand of users - Inadequate system for protection and exploitation of intellectual property - Loss of existing clients/users due to competition from other RDI centres

Risk matrix: example

Risk description	Probability* (P)	Severity* (S)	Risk level* (= P x S)	Risk prevention / mitigation measures	Residual risk
Design risks					
(iv) Inadequate design cost estimates	D	III	High	The consortium is employing a specialist supplier of international standing both to design and oversee the construction of the centre. This specialist company has also been closely involved in costing the technology involved.	Moderate
(v) Inadequate site selection or delays in completing the project design	A	IV	Low	The site is selected, the outline land use planning permissions have been obtained, and the design is largely complete.	Low
(vi) Invention of a new RDI technology making the infrastructure's technology obsolete	C	IV	High	It is planned to upgrade the computing cores employed by the Centre every 3-4 years. Cloud computing solutions (using the spare capacity of providers such as Amazon) exist but represent complementary solutions.	Moderate

Quantitative risk analysis



EXAMPLE OF THE PROBABILITY DISTRIBUTION OF THE NET PRESENT VALUE

ESTIMATED PARAMETERS OF DISTRIBUTION	
Mean	2,855,528
Median	2,825,860
Standard deviation	2,134,763
Minimum	-6,220,259
Maximun	11,573,387
ESTIMATED PROBABILITIES	
Pr. ENPV ≤ 0	0.086

Thank you!

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