Ambiguity aversion and the expected cost of nuclear power accidents

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Romain Bizet, François Lévêque

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Research questions

1. How should rare but catastrophic accidents be taken into account in energy policy decisions?
2. Can cost-benefit analysis be applied to projects or policies that entail potential catastrophes?
3. Can we combine technical expertise and public perceptions of the risks of large-scale technological disasters?

Two streams of literature

Expertise regarding the risks of nuclear accidents:

- Statistical analysis of past events (Hofert, 2011; Rangel, 2014; Wheatley, 2016)
- Probabilistic risk assessments (ExternE, 1995; EPRI, 2008)

Public perceptions and uncertainty:

- Risk-aversion and nuclear accidents (Eeckhoudt, 2000)
- Policy-making under uncertainty (Henry, 2002; Crès, 2011)

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Probabilities of nuclear accidents are ambiguous

PRAs for a large accident in an EPR: 10^{-7}

Observed frequency of large accidents: 10^{-4}

Perceptions: $> 10^{-4}$

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PRAs assume perfect compliance with safety standards

Accident frequencies are not objective probabilities

Public perceptions are distorted

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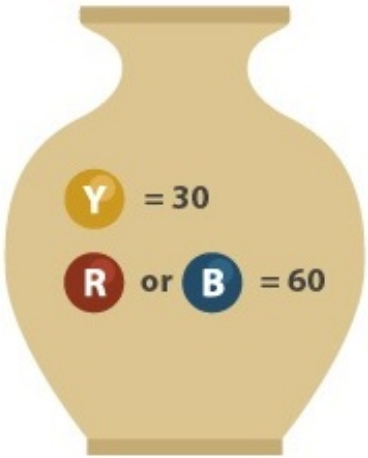
How can good decisions be made in these situations?

Risk, uncertainty and decision

The one-urn Ellsberg paradox



Situation A

Bet Y or R

Most bet

Y

Situation B

Bet R / B or Y / B

R / B

Risk: Various outcomes measured by a probability.

Ambiguity: Various outcomes without attached probabilities.

The expected cost of nuclear accidents

A theoretical decision criterion : Ghirardato (2004)

1. Ambiguity is embodied by multiple probability distributions
2. Ambiguity-aversion is represented by $\alpha \in [0; 1]$
3. Decisions should minimize an α-maxmin expected cost

$$\alpha \mathbb{E}_{\textit{worst case}}[C] + (1 - \alpha)\, \mathbb{E}_{\textit{best case}}[C]$$

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Applied to rare nuclear disasters :

- Multiple sources of information suggest different probabilities of occurrence
- Ambiguity aversion: increased level of pessimism

An application to nuclear new-builds

	Damage (b€$_{2014}$)	$P_{best-case}$	$P_{worst-case}$
Core damage	2.6	10^{-6}	10^{-3}
Large releases	180/360	10^{-7}	10^{-4}

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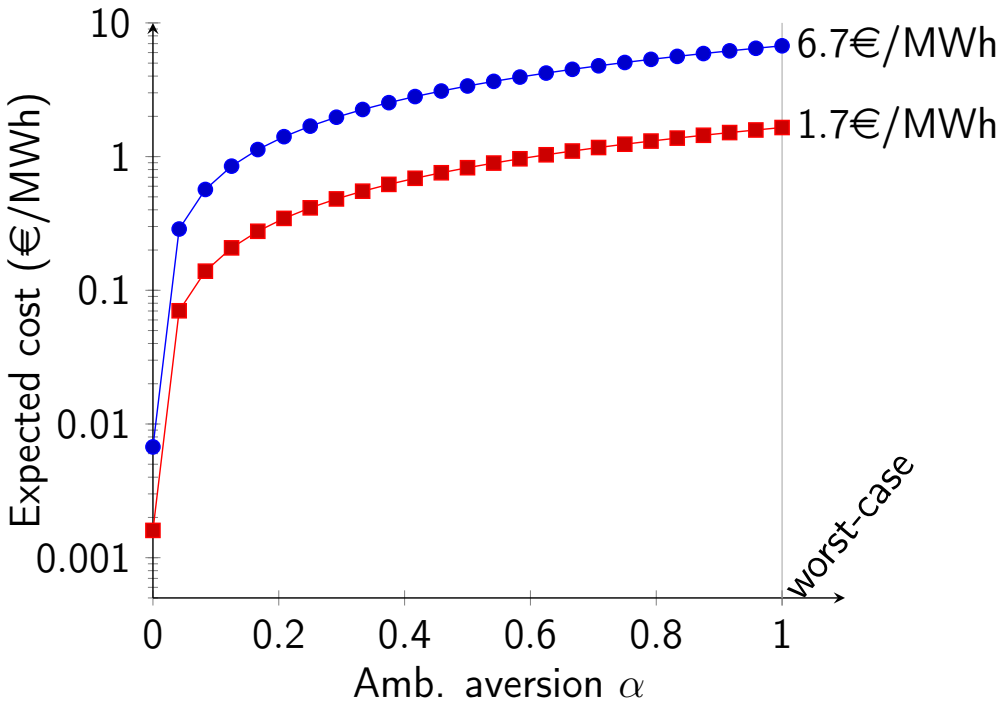

including image costs

no image cost

load factor: 90%

nom. power: 1650 MW

Policy implications

Nuclear policies :

The expected cost of nuclear accidents ought to reflect public perceptions as well as technical expertise

Under our set of hypotheses, the expected cost of accidents is small when compared to the LCOE of new builds

The method :

Other rare disasters: oil spills, dam failures...

Policy analysis: compare new safety standards or mitigation plans

Thank you for your attention !

Presentation materials and references :

- www.cerna.mines-paristech.fr/fr/recherche/economics-nuclear
- www.cerna.mines-paristech.fr/fr/bizet/

References I

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