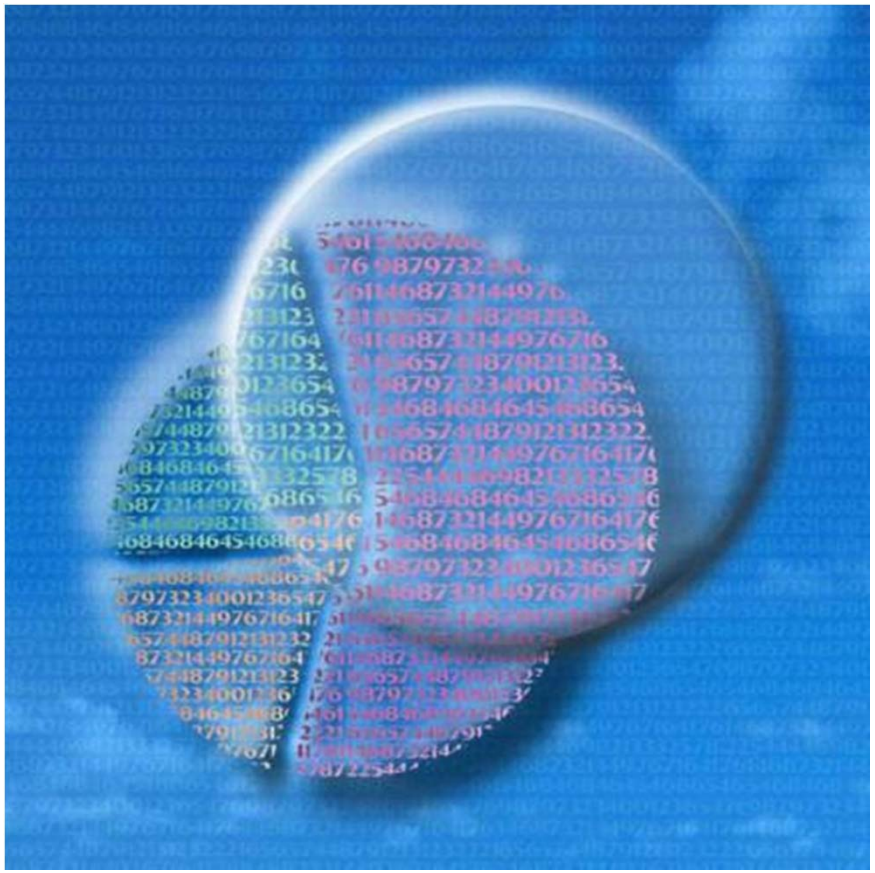


Sensitivity auditing

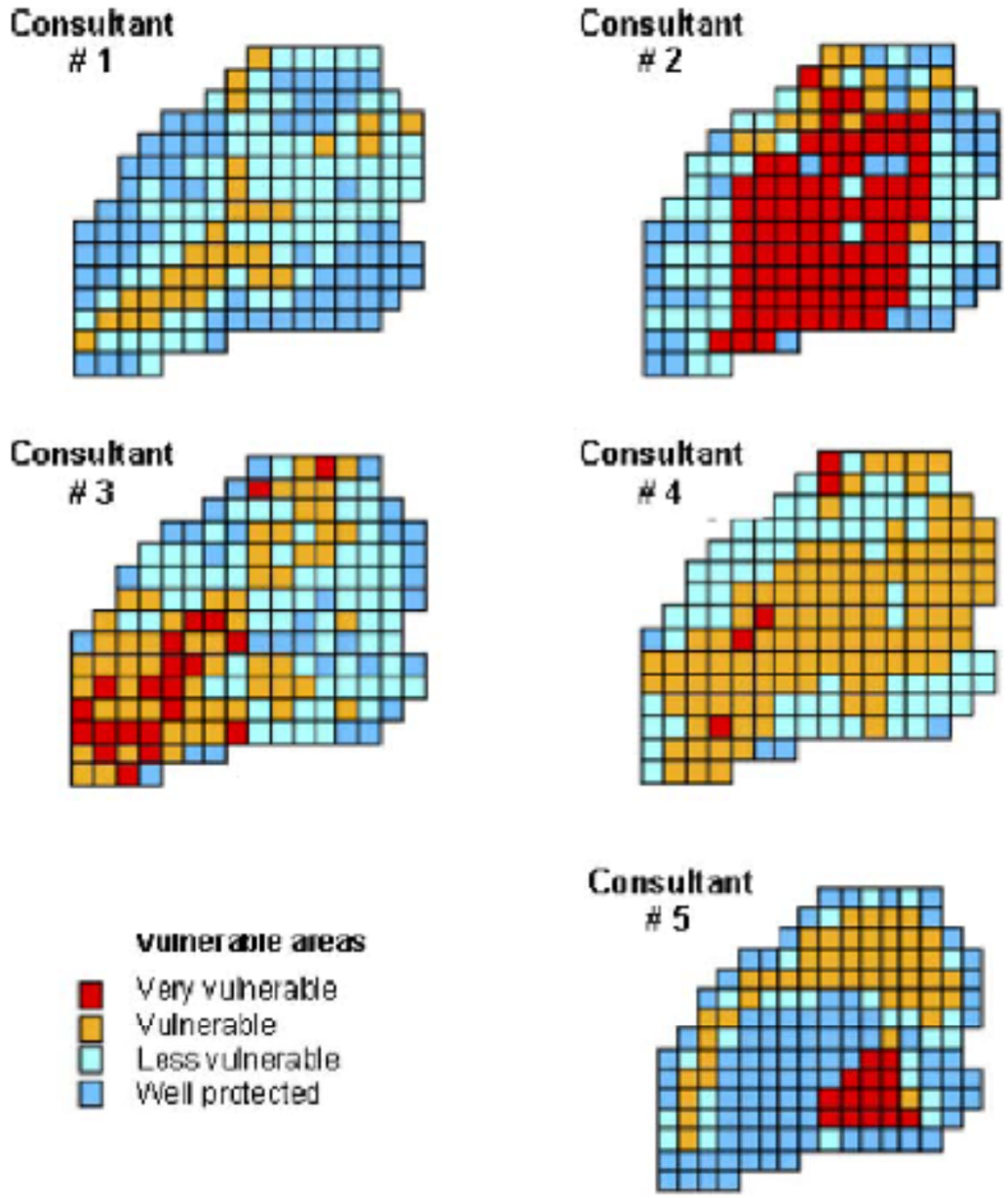
5th Impact Assessment Course by JRC and Sec Gen
January 20_ 21, Brussels

Andrea Saltelli
European Commission - Joint Research Centre (JRC)
Unit of Econometric Analysis and Statistics
andrea.saltelli@jrc.ec.europa.eu

Model structure uncertainty…

5 consultants, each using a different model were given the same question:
"which parts of this particular area are most vulnerable to pollution and need to be protected?"

(Refsgaard et al, 2006)



Courtesy of Dr. Jeroen P. van der Sluijs, Centre for the Studies of the Sciences and the Humanities (SVT), University of Bergen (NO)

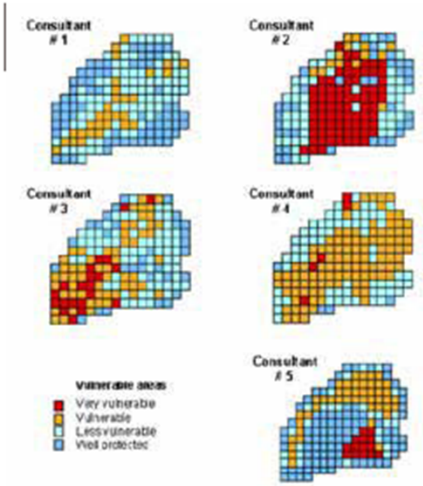


Fig. 1. Model predictions on aquifer vulnerability towards nitrate pollution for a 175 km^2 area west of Copenhagen [11].

How to act upon such uncertainty?

- **Bayesian** approach: 5 priors. Average and update likelihood of each grid-cell being red with data (but oooops, there is no data and we need decisions now)
- IPCC approach: Lock the 5 consultants up in a room and don't release them before they have **consensus**
- **Nihilist** approach: Dump the science and decide on an other basis
- **Precautionary** robustness approach: protect all grid-cells
- **Academic bureaucrat** approach: Weigh by citation index (or H-index) of consultant.
- Select the consultant that you **trust** most
- Real life approach: Select the consultant that best fits your **policy agenda**
- Post normal: explore the relevance of our ignorance: **working deliberatively within imperfections**

3 framings of uncertainty

'deficit view'

- Uncertainty is provisional
- Reduce uncertainty, make ever more complex models
- *Tools:* quantification, Monte Carlo, Bayesian belief networks

  - ***Speaking truth to power***

'evidence evaluation view'

- Comparative evaluations of research results
- *Tools:* Scientific consensus building; multi disciplinary expert panels
- focus on robust findings

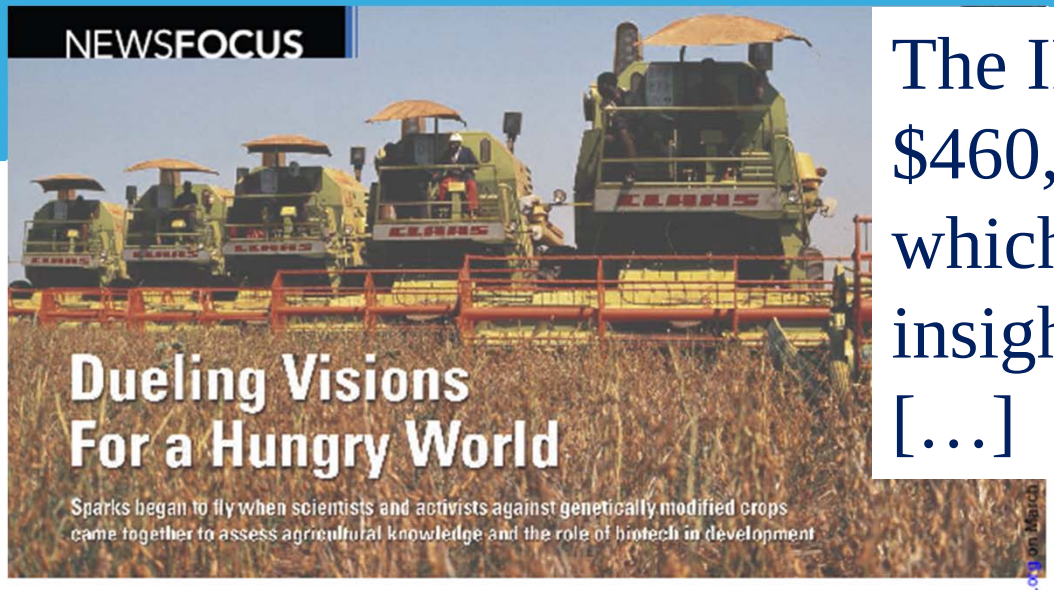
  - ***Speaking [consensus] to power***

'complex systems view / *post-normal* view'

- Uncertainty is intrinsic to complex systems
- Openly deal with deeper dimensions of uncertainty
- *Tools:* Knowledge Quality Assessment

  - ***Working deliberatively within imperfections***

The IFPRI had raised about $460,000 for the modeling, which would have provided insights to help policymakers […]



NEWSFOCUS

Dueling Visions For a Hungry World

Sparks began to fly when scientists and activists against genetically modified crops came together to assess agricultural knowledge and the role of biotech in development

When economist Carl Pray heard about plans for the first international assessment of agricultural research, a gold standard sprang to mind: the Intergovernmental Panel on Climate Change (IPCC). But things didn't turn out the way he expected.

IPCC has been pivotal in proving that climate change is real and linking it to human activities. As an agricultural economist at Rutgers University who has worked in many poor countries, Pray is convinced that agricultural research—and genetic modification in

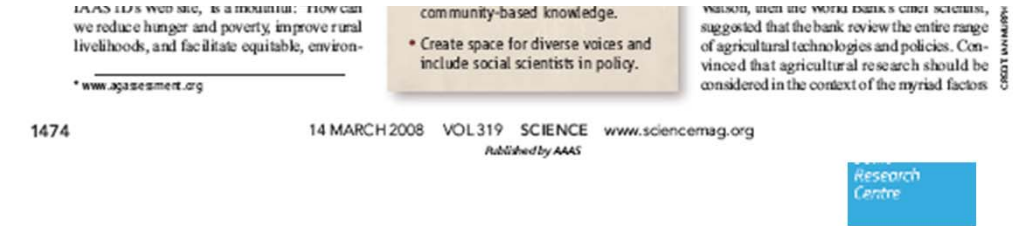
mentally, socially and economically sustainable development through the generation, access to, and use of agricultural knowledge, science and technology?" Critics say this broad mandate made conflict inevitable and stunted the assessment's analytical rigor.

On several key issues, consensus proved elusive. Industry scientists and some academics—mainly agricultural economists and plant biologists—believe the assessment was "hijacked" by participants who oppose genetically modified (GM) crops and other common

the outcome. They note that the voice and experience of small-scale farmers, particularly women, have finally been brought to the fore by the assessment. "It really deals with issues of power, influence, and benefits," says Marcia Ishii-Eiteman of the Pesticide Action Network North America in San Francisco, California. Toby Kiers, who studies sustainable agriculture at Vrije University in Amsterdam, the Netherlands, agrees. "For technology to be most effective, farmers must be at the center, influencing how it is developed, delivered, and

[…] But Greenpeace […] objected that the models were not "transparent".

Source: Dueling visions for an hungry world, Erik Stokstad, 14 MARCH 2008, 319 SCIENCE



we reduce hunger and poverty, improve rural livelihoods, and facilitate equitable, environ-

* www.agassessment.org

community-based knowledge.

- Create space for diverse voices and include social scientists in policy.

suggested that the bank review the entire range of agricultural technologies and policies. Convinced that agricultural research should be considered in the context of the myriad factors

CREDIT: WWW.IRRI.ORG

1474 14 MARCH 2008 VOL 319 SCIENCE www.sciencemag.org

Published by AAAS

Research Centre

We just can’t predict, says N. N. Taleb, and we are victims of the ludic fallacy, of delusion of uncertainty, and so on. Modelling is just another attempt to ‘Platonify’ reality…

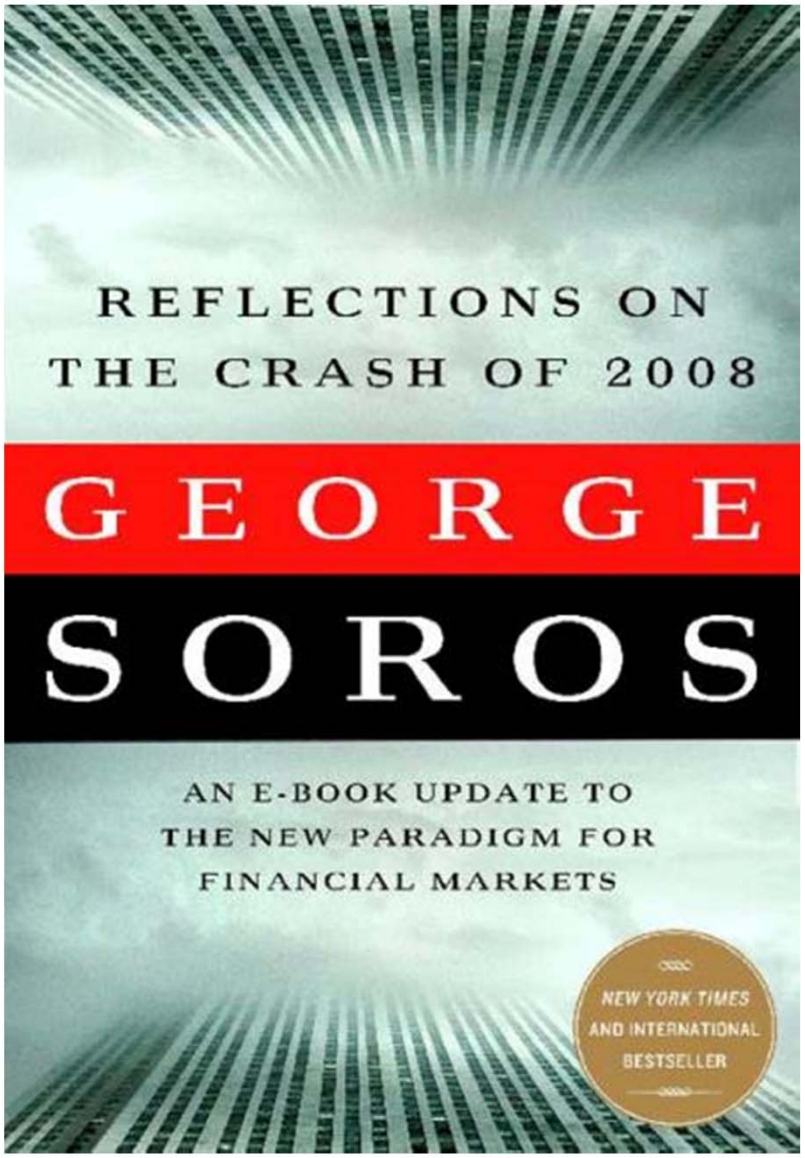
Written before the financial crisis

Nassim Nichola Taleb, The Black Swan, Penguin, London 2007

Postulate of 'radical fallibility':

"Whenever we acquire some useful knowledge, we tend to extend it to areas where it is no longer applicable"

(Taleb's -Platonification')



Models by their nature are like blinders. In leaving out certain things, they focus our attention on other things. They provide a frame through which we see the world.

Joseph E. Stiglitz, 2011, RETHINKING MACROECONOMICS: WHAT FAILED, AND HOW TO REPAIR IT, Journal of the European Economic Association August 2011 9(4):591–645

Caeteris are never paribus!

Keynes' take

The rethorical question Keynes asks is (Keynes, 1940):

"It will be remembered that the seventy translators of the Septuagint were shut up in seventy separate rooms with the Hebrew text and brought out with them, when they emerged, seventy identical translations. Would the same miracle be vouchsafed if seventy multiple correlators were shut up with the same statistical material?"

Keynes, J. M. , 1940, On a Method of Statistical Business-Cycle Research. A Comment, The Economic Journal, Vol. 50, No. 197 (Mar., 1940), 154-156.

Mirowski on DSGE

Philip Mirowski

"…To be fair, DSGE and similar macroeconomic models were first conceived as theorists' tools. But why, then, are they being relied on as the platform upon which so much practical policy advice is formulated? And what has caused them to become, and to stay, so firmly entrenched?"

The quote reported is from Miller, B., 2010, Opening Address, The Hearing Charter of the House Committee on Science and Technology and sworn testimony of economists Sidney Winter, Scott Page, Robert Solow, David Colander and V.V. Chari. See book on this slide..

Crises: The Reinhart and Rogoff affair

THE NEW YORKER

"Carmen Reinhart and Kenneth Rogoff […] famous (now infamous) research that conservative politicians around the world had seized upon to justify pennypinching Policies …"

John Cassidy, April 2013 issue

The Reinhart and Rogoff affair

"… rising levels of government debt are associated with much weaker rates of economic growth, indeed negative ones …"

It was instead a coding error uncovered by three researchers at the university of Michigan.

"In Britain and Europe, great damage has been done as a result."

THE NEW YORKER

Excel horror stories and warnings

"The fact that software is commercial is no guarantee that it does what it's supposed to do" (Philip B. Stark)

http://www.stat.berkeley.edu/~stark/Preprints/auditingPosition09.htm#excel

Philip B. Stark

The Reinhart and Rogoff affair

Perils of placing faith in a thin theory

By Wolfgang Münchau April 21, 2013

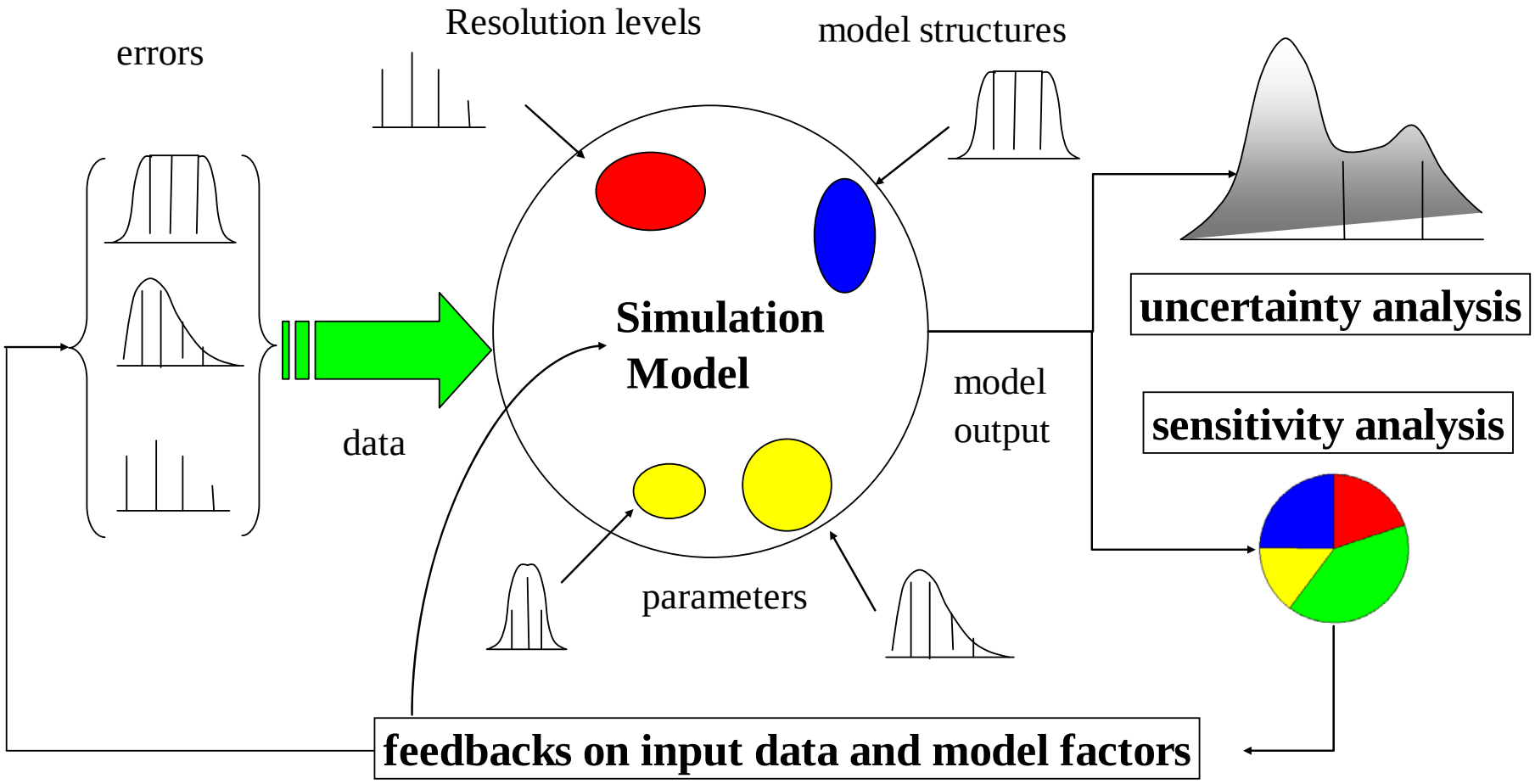
Reinhart and Rogoff told policy makers what they wanted to hear

John Kenneth Galbraith [about] Milton Friedman: "Milton's misfortune was that his policies had been tried." […]

As for Profs Reinhart and Rogoff, I suspect that they, too, will be mostly remembered for the fact that their policies have been tried.

From sensitivity analysis to sensitivity auditing

Sensitivity Analysis



Sensitivity Analysis

"The study of how the uncertainty in the output of a mathematical model or system (numerical or otherwise) can be apportioned to different sources of uncertainty in its inputs"

Saltelli, A., 2002, Sensitivity analysis for importance assessment. *Risk Analysis*, 22(3):579-590.

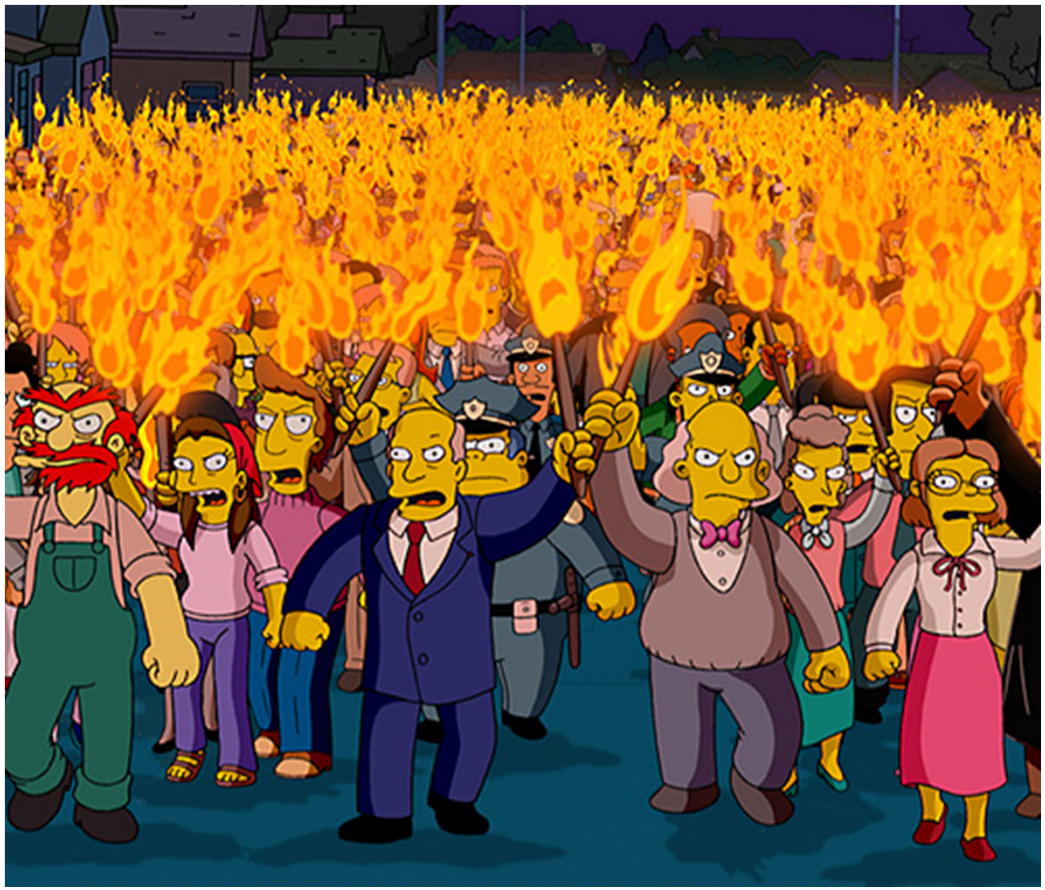
Saltelli, A., Guimarães Pereira, Â., Van der Sluijs, J.P. and Funtowicz, S., 2013, What do I make of your latinorum? Sensitivity auditing of mathematical modelling, *Int. J. Foresight and Innovation Policy*, **9**, 2/3/4, 213–234.

Saltelli, A., Funtowicz, S., When all models are wrong: More stringent quality criteria are needed for models used at the science-policy interface, *Issues in Science and Technology*, Winter 2014, 79-85.

Sensitivity analysis, mandated by existing guidelines as a good practice to use in conjunction to mathematical modelling, is as such insufficient to ensure quality in the treatment of uncertainty of science for policy.

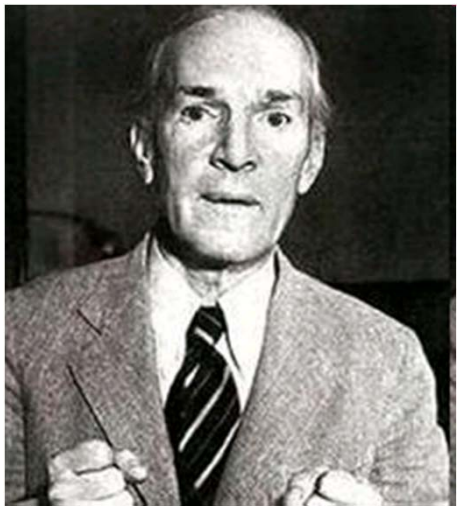
In an adversarial context not only the nature of the evidence, but also the degree of certainty and uncertainty associated to the evidence will be the subject of partisan interests

➔ Extended peer review



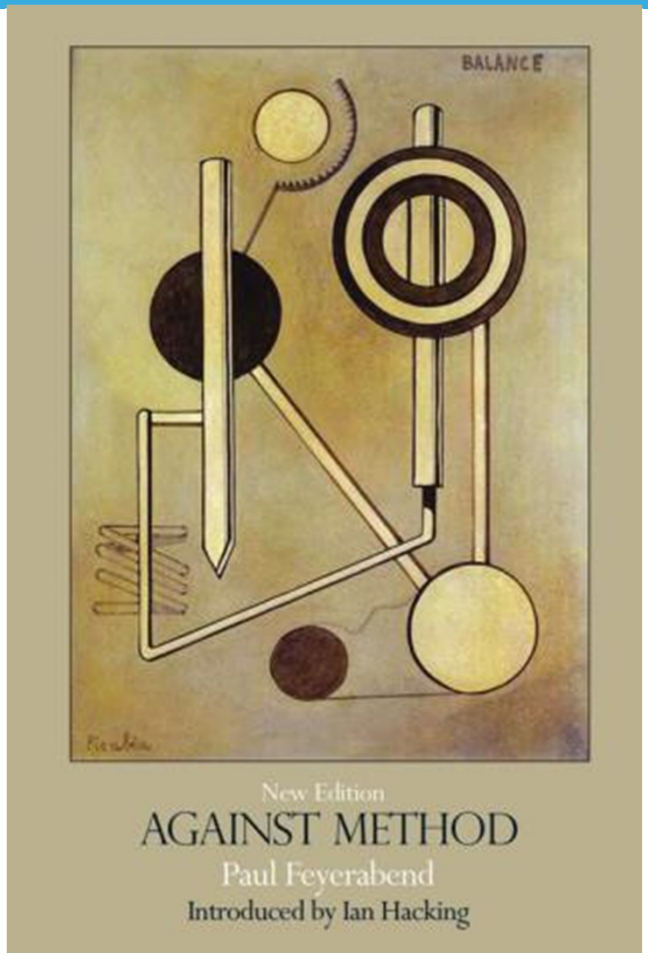
Conflictual evidence

"If is difficult to get a man to understand something when his salary depends upon his not understanding it"

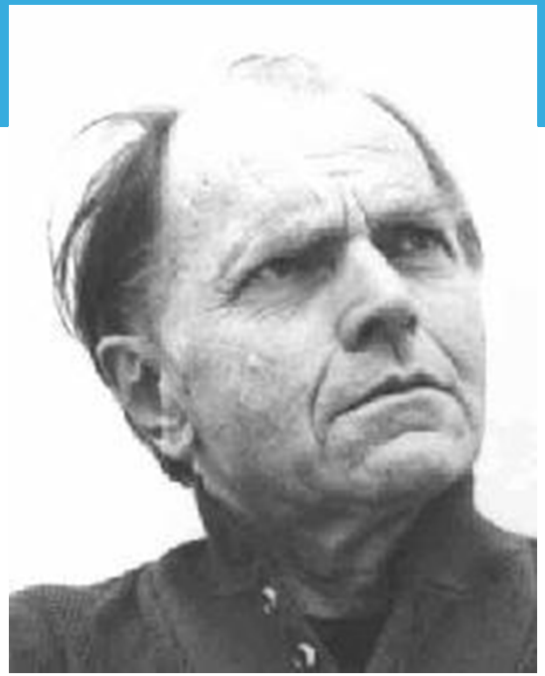


Upton Sinclair

[…] in a democracy local populations not only will, but also should, use the sciences in ways most suitable to them. The objections that citizens do not have the expertise to judge scientific matters overlooks that important problems often lie across the boundaries of various sciences so that scientists within these sciences don't have the needed expertise either.



Moreover doubtful cases always produce experts from one side, experts for the other side, and experts in between. But the competence of the general public could be vastly improved by an education that exposes expert fallibility instead of acting as if it did not exist. (Paul Feyerabend, Against Method)



Paul Feyerabend

Transactions of the Institute of British Geographers
Royal Geographical Society with IBG
Advancing geography and geographical learning

Doing flood risk science differently: an experiment in radical scientific method

S N Lane*, N Odoni*, C Landström**, S J Whatmore**, N Ward† and S Bradley‡

Trans Inst Br Geogr NS 36 15–36 2011
ISSN 0020-2754 © 2010 The Authors.

[…] knowledge regarding flooding was co-produced,
[…] a [new] way of working with experts, both certified (academic natural and social scientists) and noncertified (local people affected by flooding),
[…] deep and distributed understanding of flood hydrology across all experts, certified and uncertified, …

[…] the purpose of our experiment became as much about creating a new public capable of making a political intervention in a situation of impasse, as it was about producing the solution itself. The practice of knowledge generation, the science undertaken, worked with the hybridisation of science and politics rather than trying to extract science from it.

From sensitivity analysis to sensitivity auditing; Seven rules

1. Check against rhetoric use of mathematical modeling [is the m
obfuscate?];

2. Adopt an 'assumption hunting' attitude [what
possibly normative assumptions underlying the

3. Detect Garbage In Garbage C
d in order to achieve
a desired inference at a desired

4. Find sensiti

5. A
ake sense of, and possibly replicate, the results
of t

6.
han 'Do the sums right'; is the viewpoint of a relevant
stakeh

7. Fo
the key question answered by the model, exploring holistically the entire space of
the assumpt
do perfunctory analyses changing one factor at a time].

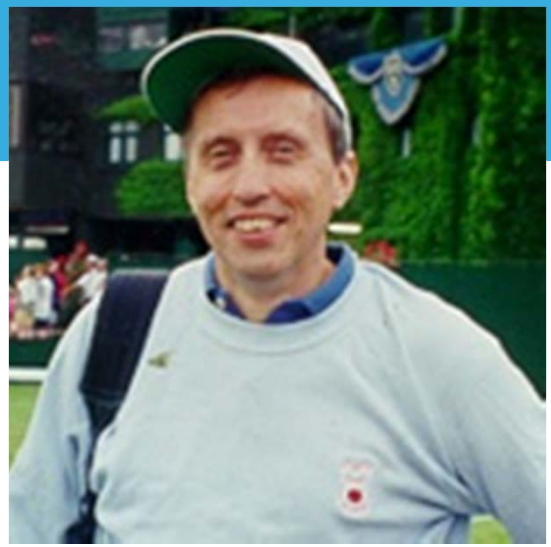
European Commission

Joint Research Centre

RULE ONE: Check against rhetorical use of mathematical modelling

The instrumental use of mathematical modelling to advance one's agenda can be termed rhetorical, or strategic, like the use of Latin by the elites and the clergy in the classic age.

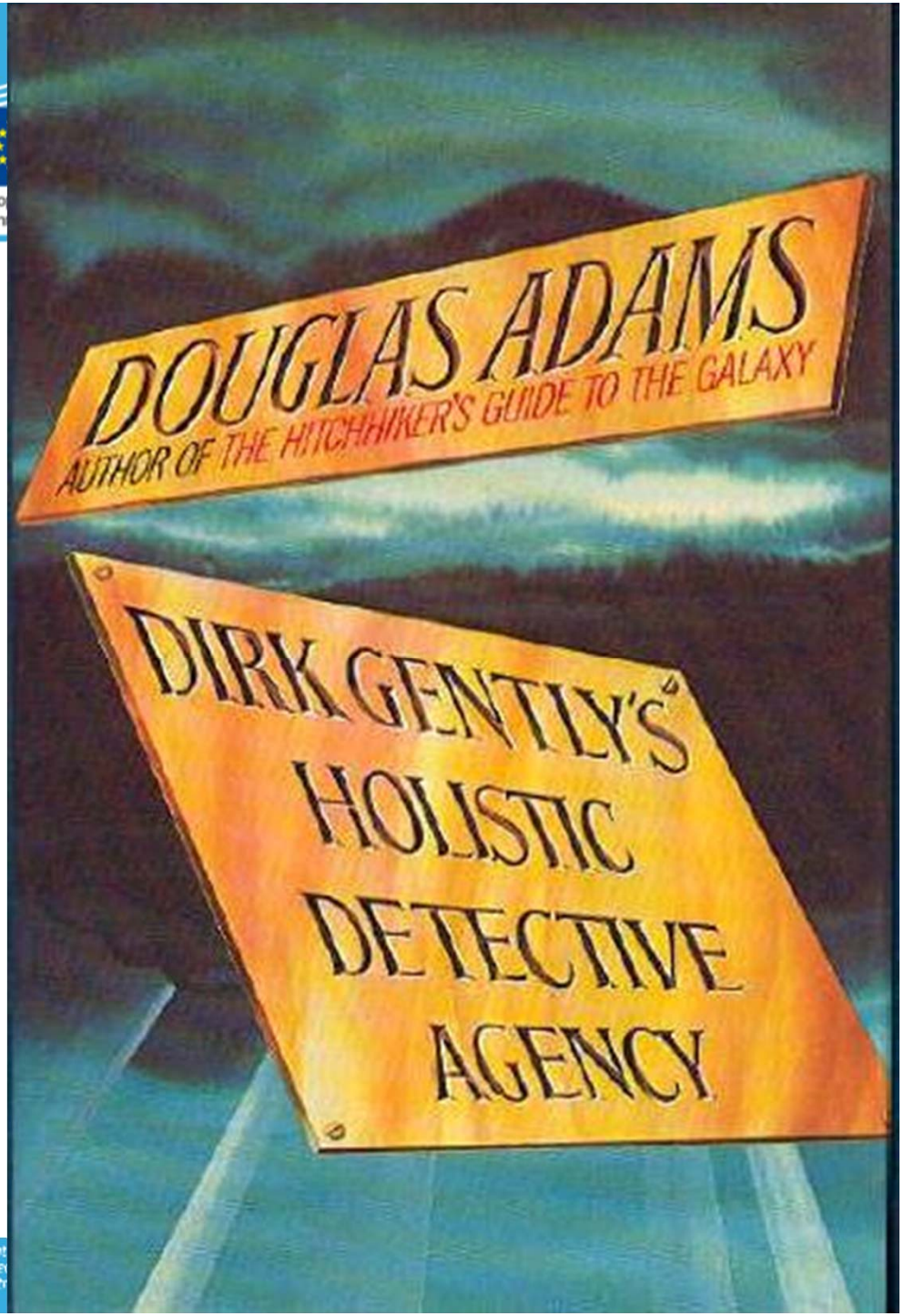
RULE ONE: Check against rhetorical use of mathematical modelling



<<[…] most simulation models will be complex, with many parameters, state-variables and non linear relations. Under the best circumstances, such models have many degrees of freedom and, with judicious fiddling, can be made to produce virtually any desired behaviour, often with both plausible structure and parameter values.>>

HORNBERGER and Spear (1981).

George M. Hornberger, Professor at University of Viginia



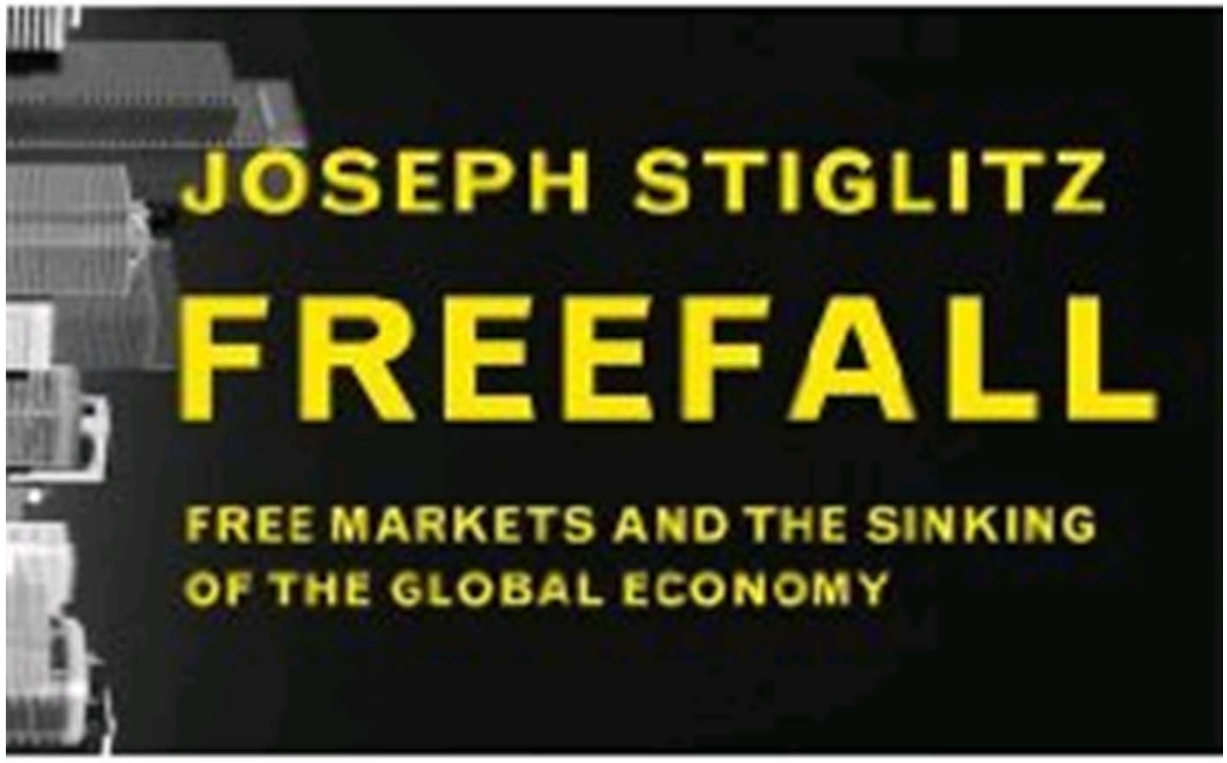
Pocket Books 1987, p.69

RULE ONE: Check against rhetorical use of mathematical modelling

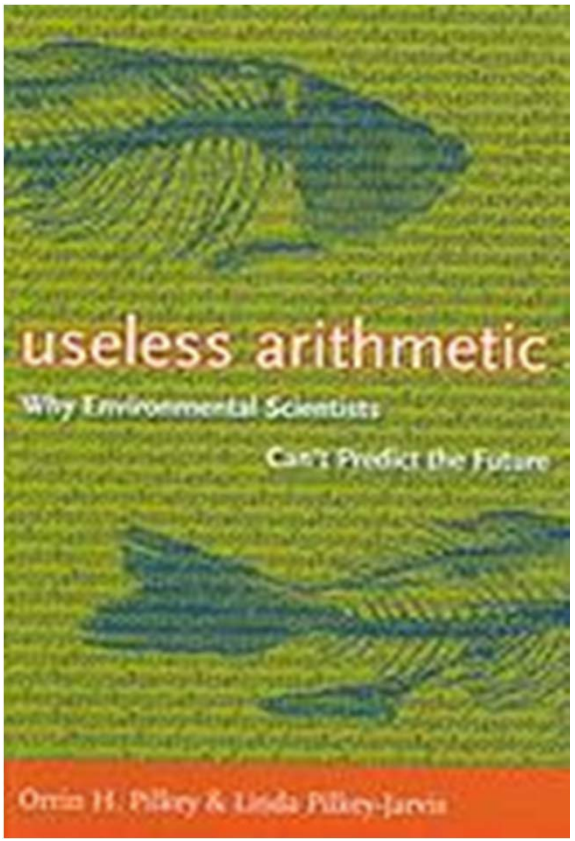
"Well, Gordon's great insight was to design a program which allowed you to specify in advance what decision you wished it to reach, and only then to give it all the facts. The program's task, […], was to construct a plausible series of logical-sounding steps to connect the premises with the conclusion."

‘Perverse incentives and flawed models – accelerated by a race to the bottom’, p. 92

[…] Part of the agenda of computer models was to maximize the fraction of, say, a lousy sub-prime mortgage that could get an AAA rating, then an AA rating, and so forth,[…] This was called rating at the margin, and the solution was still more complexity”, p. 161



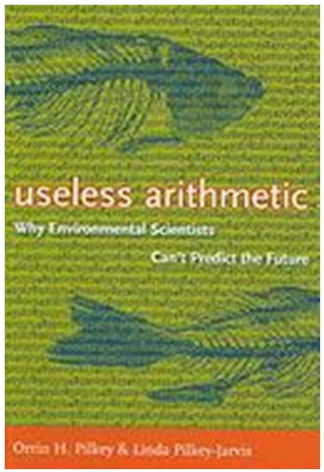
RULE ONE: Check against rhetorical use of mathematical modelling



Useless Arithmetic: Why Environmental Scientists Can't Predict the Future
by Orrin H. Pilkey and Linda Pilkey-Jarvis

'Quantitative mathematical models used by policy makers and government administrators to form environmental policies are seriously flawed'

RULE ONE: Check against rhetorical use of mathematical modelling



TSPA (like any other model) relies on assumptions → one is the low permeability of the geological formation → long time for the water to percolate from surface to disposal.

European Commission

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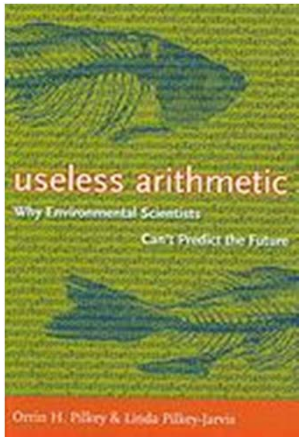

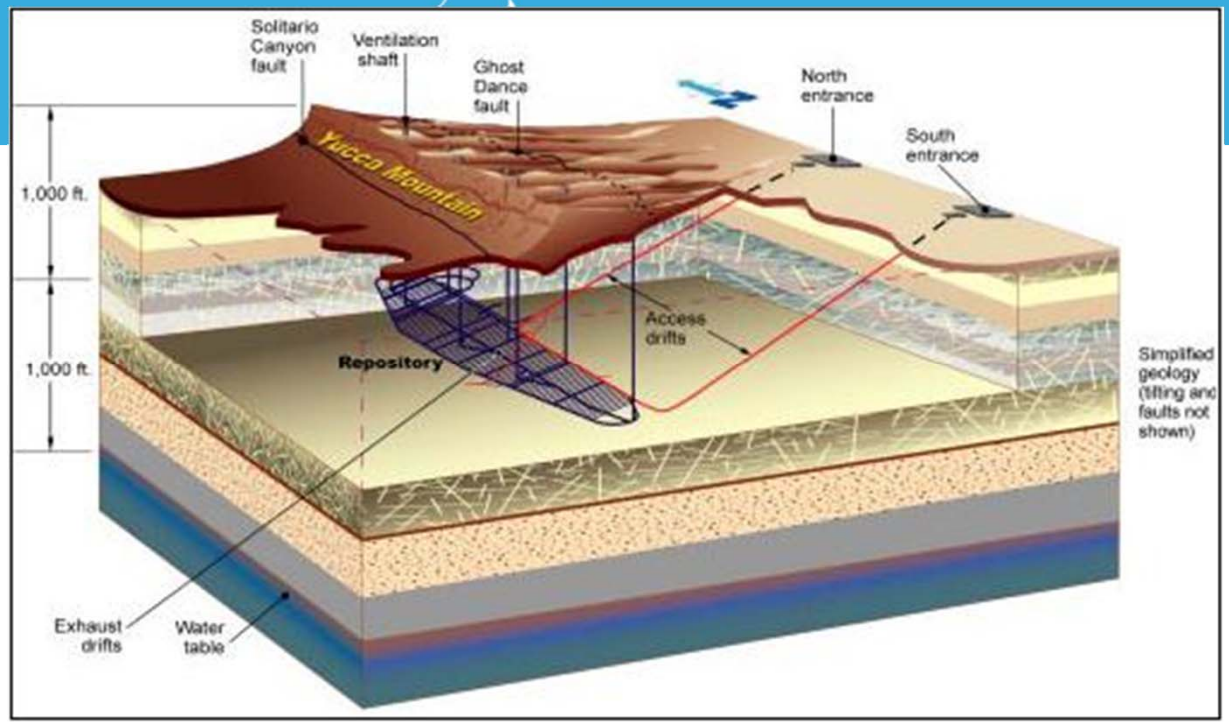

The confidence of the stakeholders in TSPA was not helped when evidence was produced which could lead to an upward revision of 4 orders of magnitude of this parameter
(the 36Cl story)

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RULE ONE: Check against rhetorical use of mathematical modelling

A range of 0.02 to 1 millimetre per year was used for percolation of flux rate.

→… SA useless if it is instead ~ 3,000 millimetres per year.

Joint Research Centre

Why is it so easy to use models rhetorically?

'In many cases, these temporal predictions are treated with the same respect that the hypothetic-deductive model of science accords to logical predictions. But this respect is largely misplaced.'

'[…] to be of value in theory testing, the predictions involved must be capable of refuting the theory that generated them.'

What when the 'theory' is not a law but a mathematical model?

'This is where predictions […] become particularly sticky.'

Oreskes, N., 2000, Why predict? Historical perspectives on prediction in Earth Science, in *Prediction, Science, Decision Making and the future of Nature*, Sarewitz et al., Eds., Island Press, Washington DC

‘[…] models are complex amalgam of theoretical and phenomenological laws (and the governing equations and algorithms that represent them), empirical input parameters, and a model conceptualization.

When a model generates a prediction, of what precisely is the prediction a test? The laws? The input data? The conceptualization? Any part (or several parts) of the model might be in error, and there is no simple way to determine which one it is’.

RULE ONE: Check against rhetorical use of mathematical modelling

The problem of legitimization – quantitative analysis as a rhetorical or ritual device - the story of Arrow

"The commanding general is well aware that the forecasts are no good. However, he needs them for planning purposes"(Szenberg, 1992).

RULE TWO: Adopt an ‘assumption hunting’ attitude;

What was ‘assumed out’? What are the tacit, pre-analytic, possibly normative assumptions underlying the analysis?

E.g. in ‘Bogus Quantification: Uses and Abuses of Models’ John Kay uncovers that the UK transport WebTAG model (the standard for transport policy simulation) needs as input ‘Annual Percentage Change in Car Occupancy up to 2036.’

John Kay, London School Economics, Columnist Financial Times

John Kay’s approach is called ‘Assumptions hunting’ in Dutch circles …

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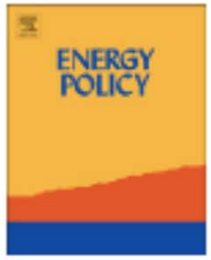
Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol



On the contribution of external cost calculations to energy system governance: The case of a potential large-scale nuclear accident

Erik Laes [a,*], Gaston Meskens [b], Jeroen P. van der Sluijs [c]

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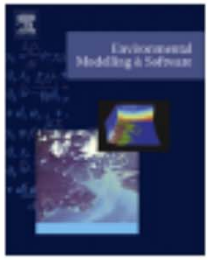
journal homepage: www.elsevier.com/locate/envsoft



A method for the analysis of assumptions in model-based environmental assessments

Penny Kloprogge [a], Jeroen P. van der Sluijs [a,b,*], Arthur C. Petersen [c]

Joint Research Centre

Contents lists available at ScienceDirect

Energy Policy

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On the contribution of external cost calculations to energy system governance: The case of a potential large-scale nuclear accident

Erik Laes [a,*], Gaston Meskens [b], Jeroen P. van der Sluijs [c]

‘[…] calculation of the external costs of a potential large-scale nuclear accident […] ‘An [analysis] resulted in a list of 30 calculation steps and assumptions’ …

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RULE TWO: Adopt an ‘assumption hunting’ attitude;

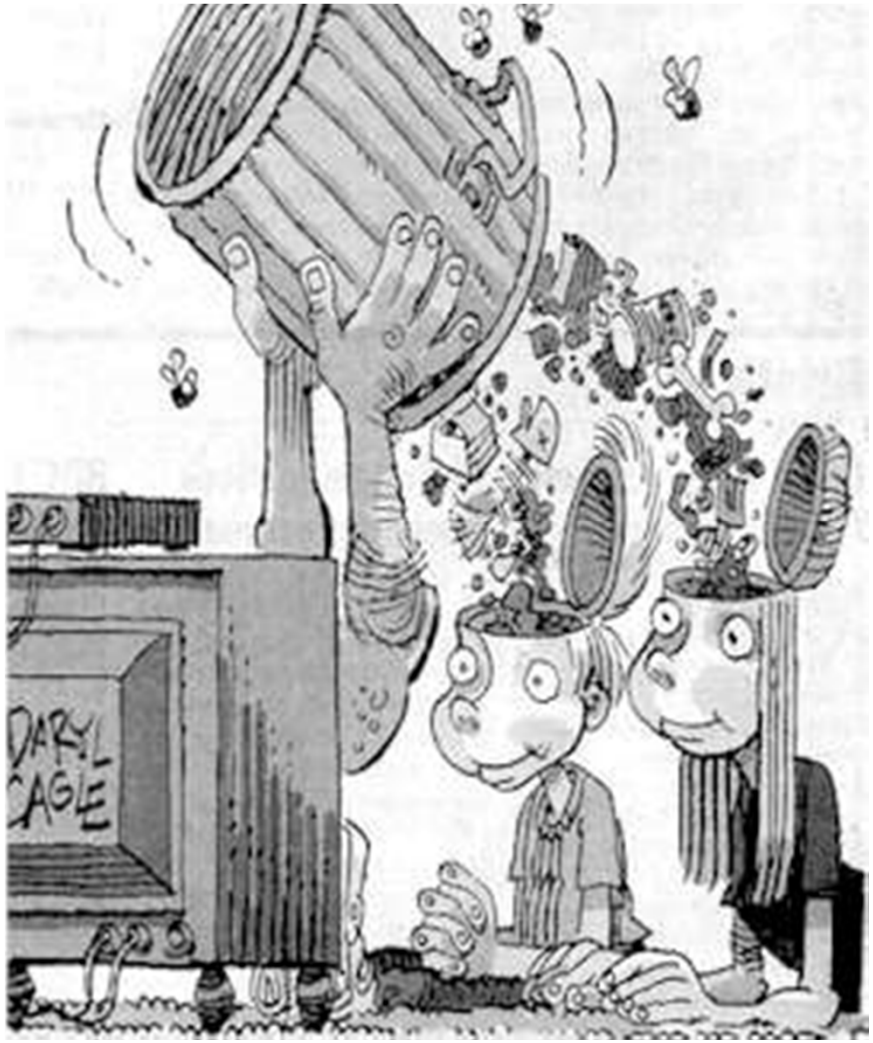
European Commission

Who should do the hunting? Implication of Rule 2 for participatory approaches (Lane et al.’s flooding example)

Joint Research Centre

RULE THREE: detect GIGO (Garbage In, Garbage Out) Science or pseudo-science

European Commission



Joint Research Centre

RULE THREE: detect GIGO (Garbage In, Garbage Out) Science or pseudo-science

"where uncertainties in inputs must be suppressed lest outputs become indeterminate"

From: Uncertainty and Quality in Science for Policy
by Silvio Funtowicz and Jerry Ravetz, Springer 1990.

Edward E. Leamer, 1990, Let's Take the Con Out of Econometrics, American Economics Review, 73 (March 1983), 31-43.

<<I have proposed a form of organised sensitivity analysis that I call “global sensitivity analysis” in which a neighborhood of alternative assumptions is selected and the corresponding interval of inferences is identified.
Conclusions are judged to be sturdy only if the neighborhood of assumptions is wide enough to be credible and the corresponding interval of inferences is narrow enough to be useful.>>

RULE FOUR: find sensitivities before sensitivities find you;

European Commission

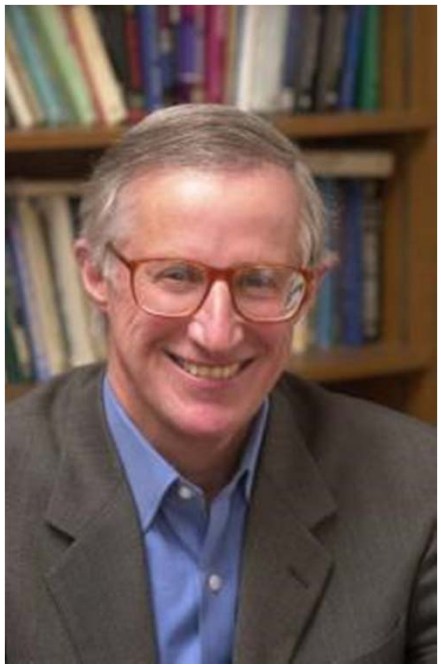
Joint Research Centre

RULE FOUR : find sensitivities before sensitivities find you;

From: Saltelli, A., D'Hombres, 2010, Sensitivity analysis didn't help. A practitioner's critique of the Stern review, *GLOBAL ENVIRONMENTAL CHANGE*, 20, 298-302.

The case of Stern's Review – Technical Annex to postscript

Nicholas Stern, London School of Economics



William Nordhaus, University of Yale

Stern, N., Stern Review on the Economics of Climate Change. UK Government Economic Service, London, www.sternreview.org.uk.

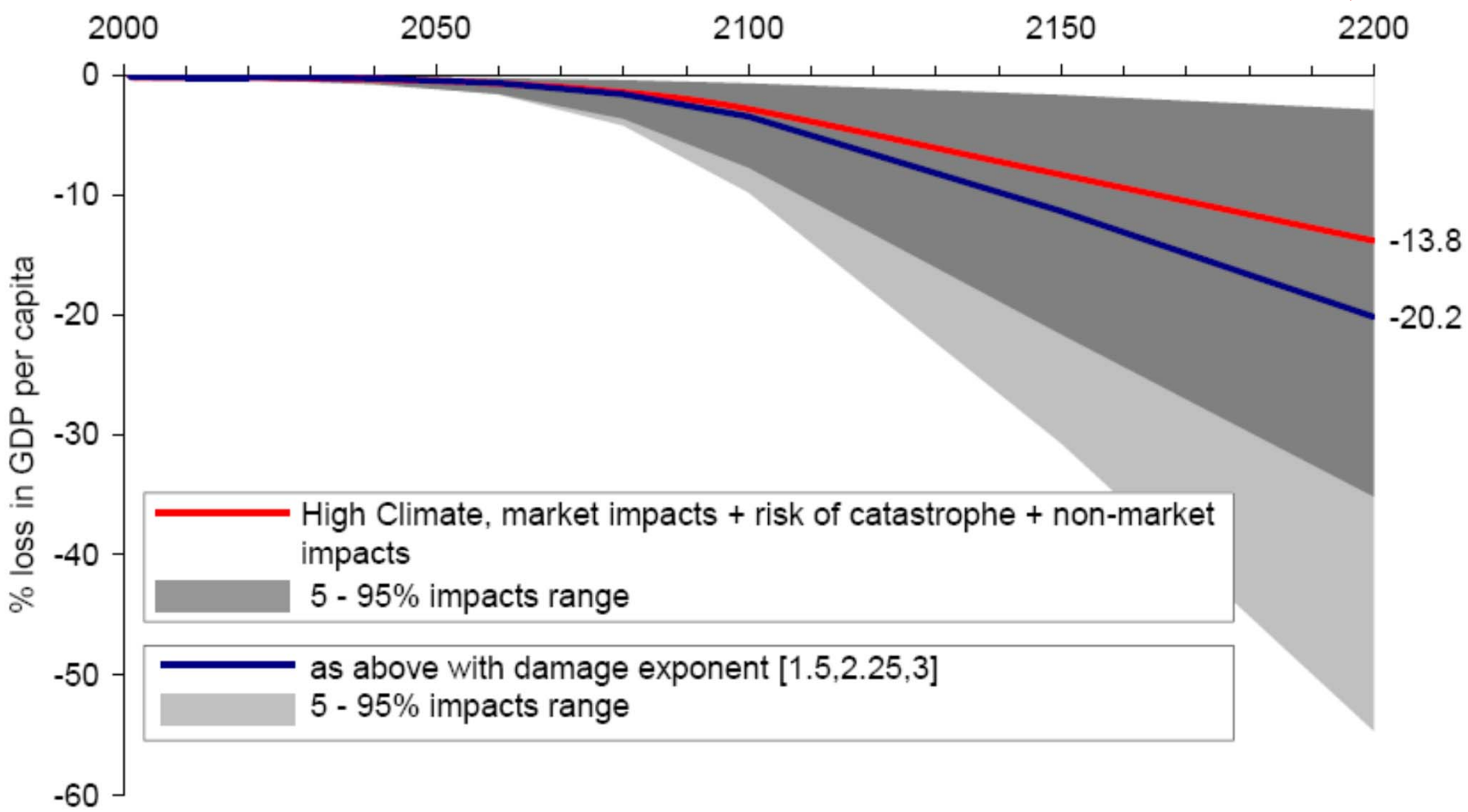
Nordhaus W., Critical Assumptions in the Stern Review on Climate Change, SCIENCE, 317, 201-202, (2007).

RULE FOUR : find sensitivities before sensitivities find you;

Stern's Review – Technical Annex to postscript (a sensitivity analysis of a cost benefit analysis)

The Stern - Nordhaus exchange on *SCIENCE*
Nordhaus → falsifies Stern based on 'wrong' range of discount rate (~ you GIGOing)
Stern → 'My analysis shows robustness'

My problems with it:

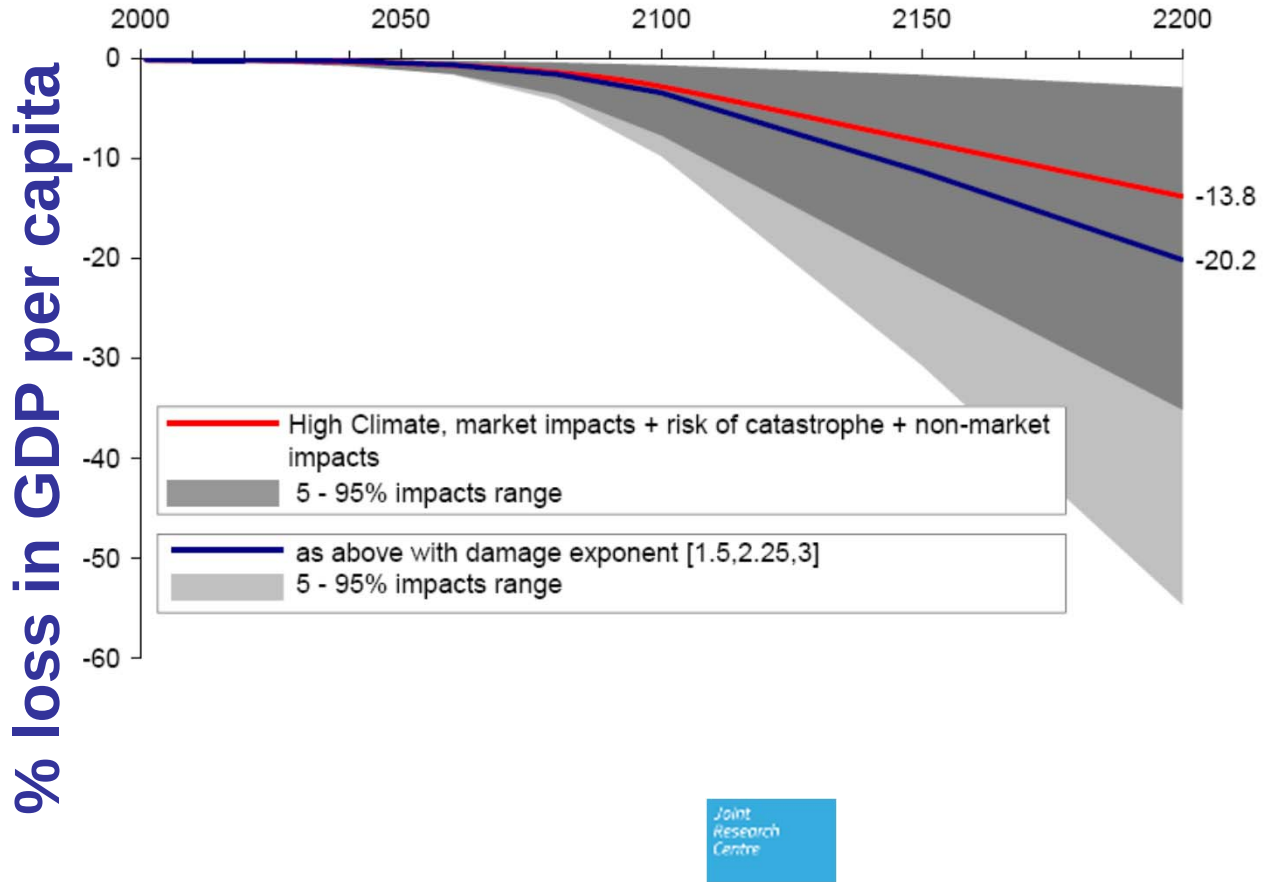


… but foremost Stern says:

changing assumptions → important effect

when instead he should admit that:

changing assumptions → all changes a lot



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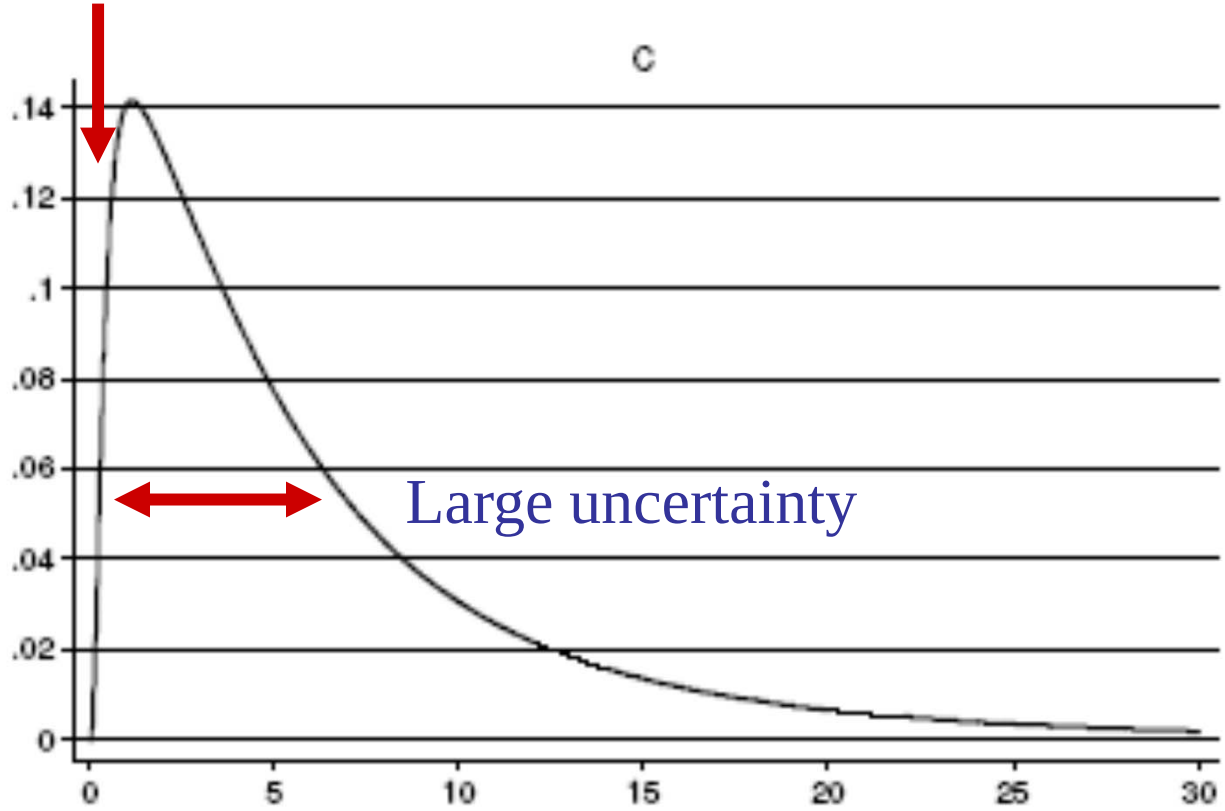
How was it done? A reverse engineering of the analysis

Missing points

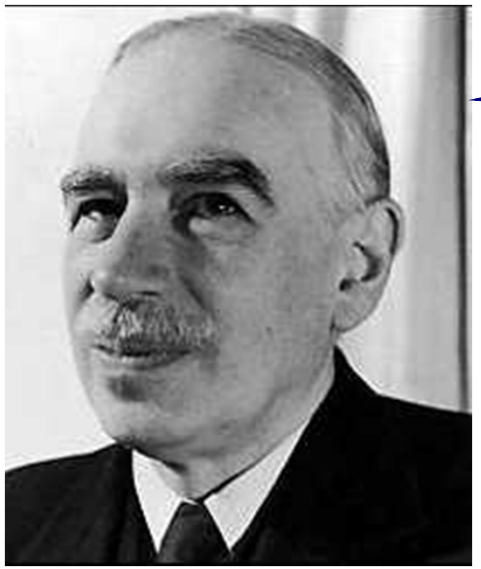


% loss in GDP per capita

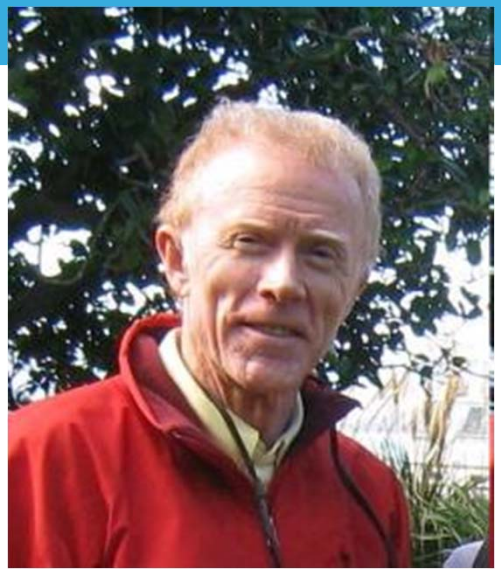
RULE FOUR : find sensitivities before sensitivities find you;

Same criticism applies to Nordhaus – both authors frame the debate around numbers which are …

… precisely wrong

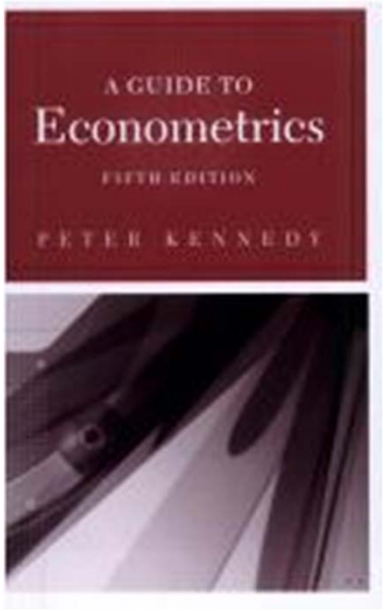


RULE FOUR : find sensitivities before sensitivities find you;

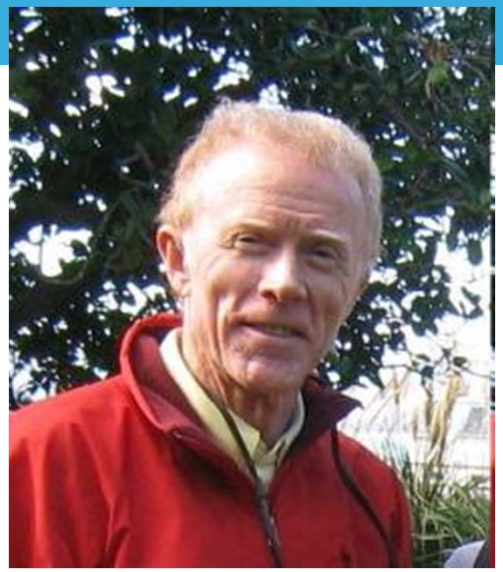


Peter Kennedy, A Guide to Econometrics. Anticipating criticism by applying sensitivity analysis. This is one of the ten commandments of applied econometrics according to Peter Kennedy:

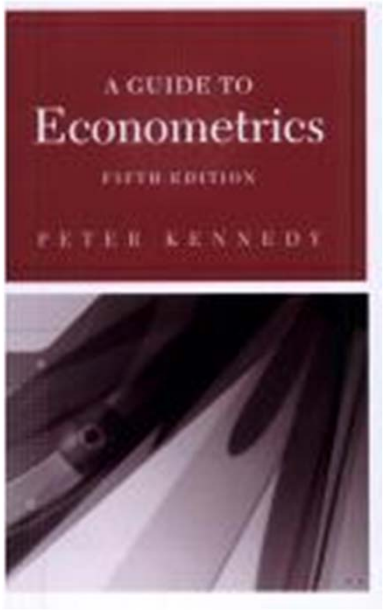
<<Thou shall confess in the presence of sensitivity.
Corollary: Thou shall anticipate criticism >>



RULE FOUR : find sensitivities before sensitivities find you;



<<When reporting a sensitivity analysis, researchers should explain fully their specification search so that the readers can judge for themselves how the results may have been affected. This is basically an `honesty is the best policy' approach, […]'.>>



RULE FIVE: aim for transparency

European Commission

Doubts raised over Europe's green energy plan

'Host of questions' from advisers

Economic model lacks transparency

By Pilita Clark in London

The credibility of a European energy review has been cast into doubt by specialist advisers who say plans to cut carbon emissions up to 2050 are based on an economic model owned by a single Greek university that cannot be independently scrutinised.

The energy experts have "raised a host of questions" on how the European Commission's use of a non-transparent model could affect the review, according to a leaked report by advisers chosen by Brussels to comment on the "Energy Roadmap 2050" proposals.

The economic model, known as Primes, is owned by the National Technical University of Athens and is designed to show how the use of different mixes of energy sources affect the wider economy.

The European Commission has used it for many years to help guide the bloc's energy policies. But industry critics complain that its assumptions are impossible to question because the model is privately owned. One trade group, Business Europe, has called for the Commission to use other, more transparent models.

The forthcoming reform of the energy road map, which will increase the share of renewable energy, from wind and less nuclear power to meet Europe's green targets, has heightened concern about the model's transparency, the expert advisory group report shows. One of the group's three meetings was "devoted largely" to how the Commission was using the Primes model to produce different energy scenarios for the road map.

"There was considerable debate about the role of fossil fuel price assumptions in the Primes model," said the report by the group, which is chaired by Dieter Helm, an Oxford university economics professor, and includes bodies such as the International Energy Agency.

There were also questions on "the costs of different technologies" and "the assumption of perfect foresight by companies but not by individuals".

The group's key concern was "about the transparency of the Primes work, and in particular the properties rights in the algorithms and detailed internal workings of the model", says the report, which is marked "final draft".

"The model remains the private property of the National Technical University of Athens," it says.

"The consequence is that independent parties cannot replicate the results. This is a substantial matter for the Commission, but members of the group pointed out that it does have obvious consequences for the credibility of the road map."

The advisory group recommends that the Primes model be made publicly available "so that its results can be replicated by interested parties".

Pantelis Capros, an economist from the National Technical University of Athens who built the Primes model, told the Financial Times he agreed that transparency was important and would not mind if some of the model's workings were made public, "but not the code itself – not the software".

A spokeswoman for the energy commissioner, Günther Oettinger, said she could not comment on an unpublished document. The final version of the advisory group's report would be released with the energy road map next month.

Prof Capros has been an energy consultant for many years and has held positions on bodies ranging from Greece's energy regulator to the country's Public Power Corporation.

'Independent parties cannot replicate the results because the model is private property'

A mining plant in Germany: the credibility of plans to cut EU emissions has been called into question by experts

Joint Research Centre

RULE FIVE: aim for transparency

"Experts have "raised a host of questions" about how the European Commission's use of a non-transparent model could affect the energy review, according to a leaked report by energy specialists chosen by Brussels to advise on the forthcoming "Energy Roadmap to 2050"
FT November 6, 2011

RULE FIVE: aim for transparency

"The credibility of a European energy review has been cast into doubt by experts who point out that long-term plans to cut carbon emissions are based on an economic model owned by a single Greek university that cannot be independently scrutinised."

Part IX

Office of Management and Budget

Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies; Notice; Republication

The OMB about transparency

http://www.whitehouse.gov/omb/inforeg/

Joint Research Centre

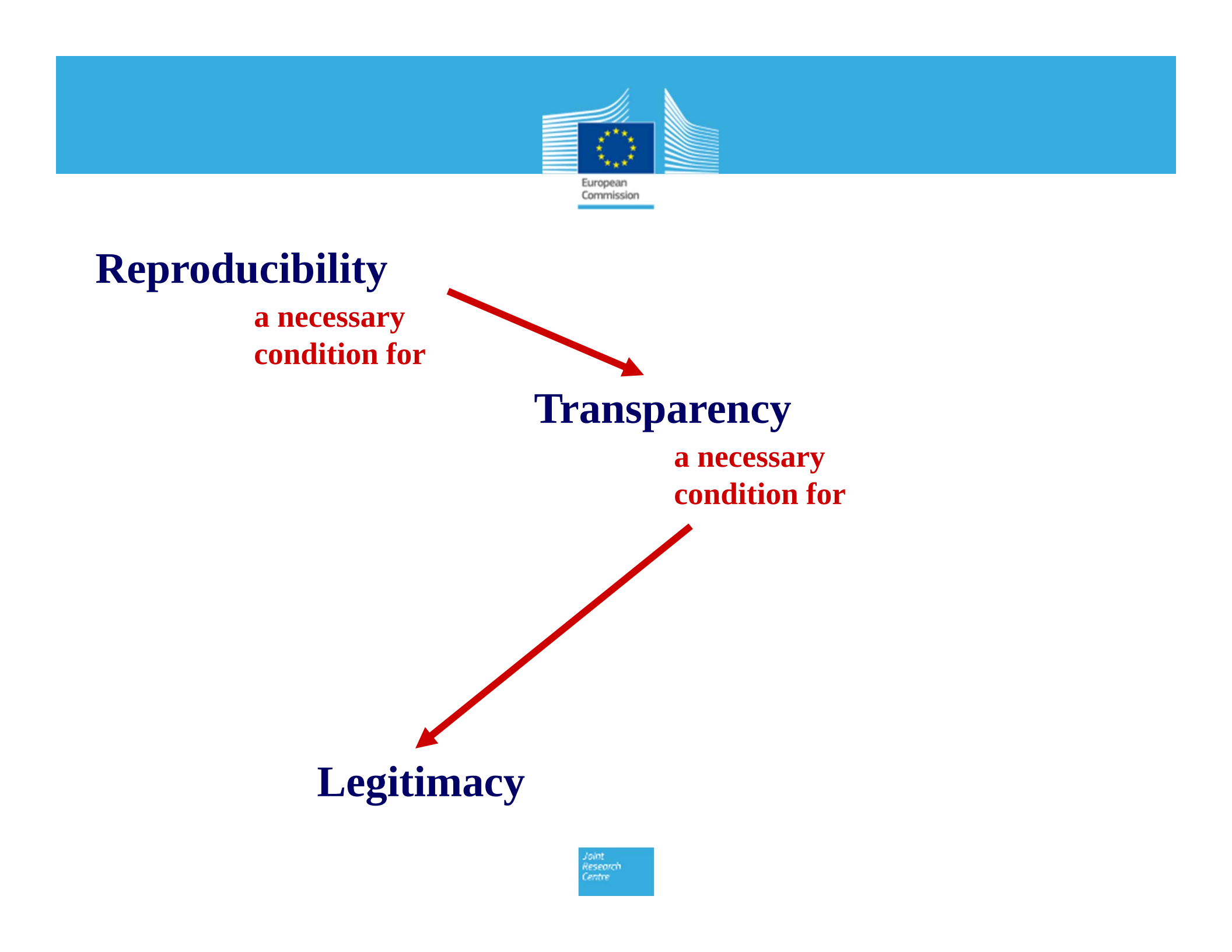
RULE FIVE: aim for transparency

[models should be made available to a third party so that it can] use the same data, computer model or statistical methods to replicate the analytic results reported in the original study.

[…] The more important benefit of transparency is that the public will be able to assess how much an agency's analytic result hinges on the specific analytic choices made by the agency.

Friday, February 22, 2002
Graphic - Federal Register, Part IX
Office of Management and Budget
Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies; Notice; Republication
http://www.whitehouse.gov/omb/inforeg/

This was 2002


European Commission
Reproducibility
a necessary condition for
Transparency
a necessary condition for
Legitimacy
Joint Research Centre

House Republicans Aim To Limit Power Of Environmental Protection Agency

This is 2014

The Huffington Post | by Robin Wilkey (/robin-wilkey)

Posted: 02/07/2014 6:18 pm EST | Updated: 02/08/2014 10:59 am EST

The bill, dubbed the Secret Science Reform Act would force the EPA to publicly release its research on a topic before issuing a policy recommendation, and require that the research be "reproducible." Supporters claim the bill will increase transparency in public policy, while opponents have accused the bill's authors of trying to “keep the EPA from doing its job.”

AUTHENTICATED
U.S. GOVERNMENT
INFORMATION
GPO

I

113TH CONGRESS
2D SESSION

H. R. 4012

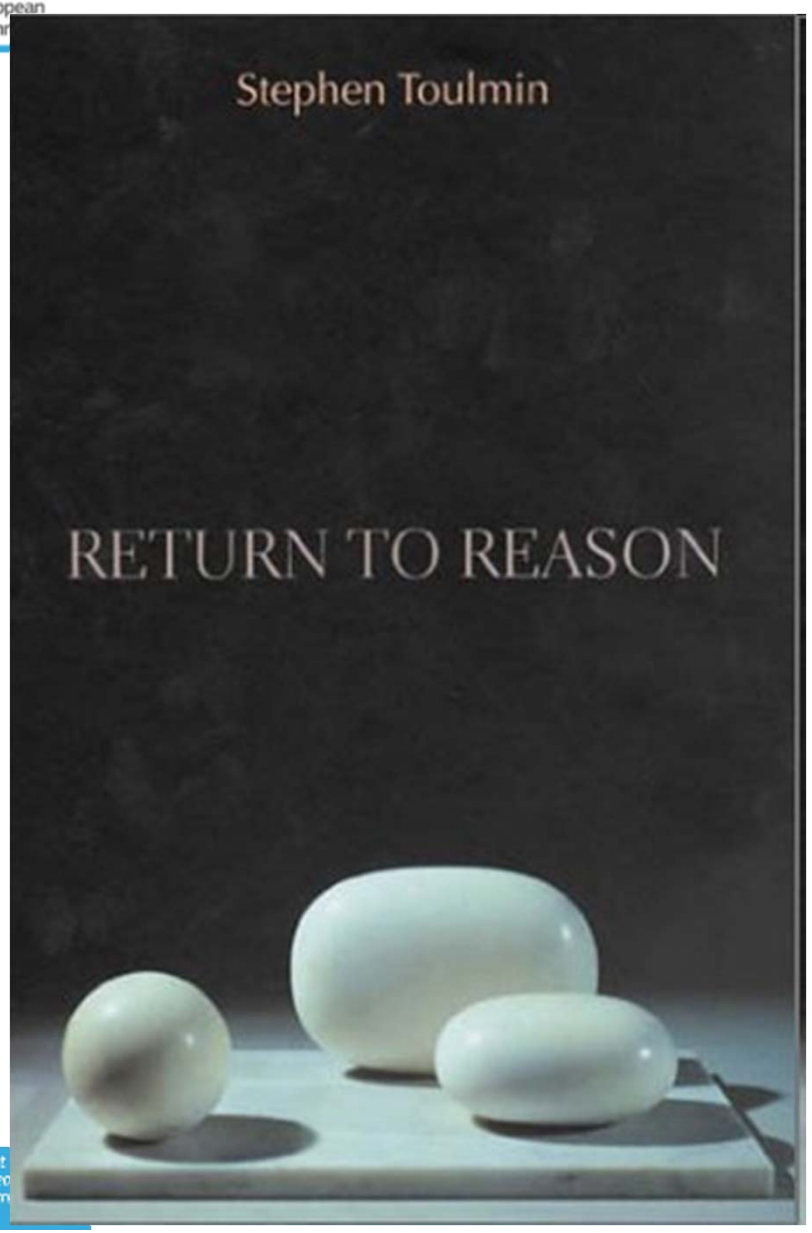
To prohibit the Environmental Protection Agency from proposing, finalizing, or disseminating regulations or assessments based upon science that is not transparent or reproducible.

http://beta.congress.gov/bill/113th-congress/house-bill/4012
Accessed May 2014

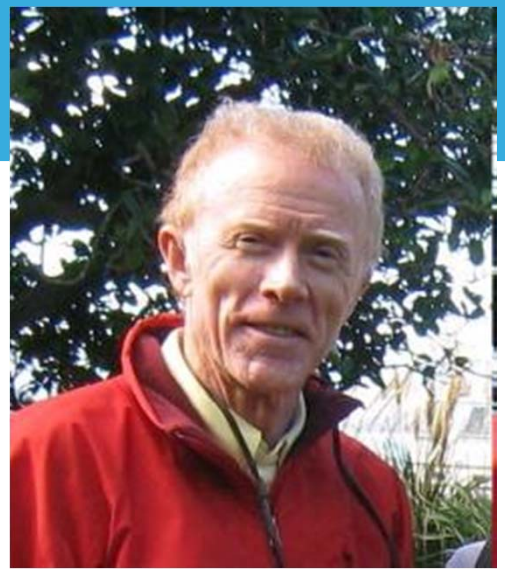
Joint Research Centre

RULE SIX: Do the right sums

Do the sum right
Versus
Do the right sums
(*Stephen Toulmin*)
A plea for reasonableness versus rationality



RULE SIX: Do the right sums



Peter Kennedy's commandment of applied econometrics: 'Thou shall answer the right question', Kennedy 2007

Expertise and responsibility Rule 6

- Experts as stakeholders among many, with their occupational psychoses.
- Example: most analyses offered as input to policy are framed as cost benefit analysis (monetization, the occupational psychosis of economists) or risk analyses.
- Techniques (such as CBA) is never neutral; according to Winner (1986) ecologists should not fall into the trap of CBA.

Langdon Winner

Winner, L., 1986. The Whale and the Reactor: a Search for Limits in an Age of High Technology. The University of Chicago Press, 1989 edition.

Rule 6 and Frames:

- Frames are never neutral. The example of car accident statistics framed with a focus on the driver and not on the car, or the road.

- "the statistics on road accidents [give] details about the driver (age, gender, speed, alcohol or drugs intake, etc.) but none about the vehicle (age, make and model) or about the road where the accident took place. In other words, the institutions put the emphasis on the "agent-act ratio" excluding implicitly the importance of others elements of the drama such as the scene (road and traffic) and the agency (hazardousness of the vehicle)", Boulanger, 2014.

Gusfield, J. (1981). The Culture of Public Problems. Drinking-Driving and the Symbolic Order. Chicago : The University of Chicago Press.

GMO presented as a food scare. The Economist, discussing a GMO labelling scheme in Vermont (US): "Montpelier is America's only McDonald's-free state capital. A fitting place, then, for a law designed to satisfy the unfounded fears of foodies […] genetically modified crops, declared safe by the scientific establishment, but reviled as Frankenfoods by the Subarus-and-sandals set", (The Economist, 2014).

The Economist, Vermont vs science, The little state that could kneecap the biotech industry, May 10th 2014

Questions about GMO deemed relevant by citizens (Marris, 2001)

- Why do we need GMOs? What are the benefits?
- Who will benefit from their use?
- Who decided that they should be developed and how?
- Why were we not better informed about their use in our food, before their arrival on the market?
- Why are we not given an effective choice about whether or not to buy and consume these products?
- Do regulatory authorities have sufficient powers and resources to effectively counter-balance large companies who wish to develop these products?

Marris, C., Wynne, B., Simmons P., and Weldon, S. 2001. Final Report of the PABE research project funded by the Commission of European Communities, Contract number: FAIR CT98-3844 (DG12 - SSMI), December 2001.

Thus, as exemplified by the case of GMO, a risk analysis is performed to demonstrate the safety of a new technology after the technology has been introduced. According to Langdon Winner (1986, p. 138-163) citizens should instead question the broader power, policy and profit implications of that introduction.

Winner, L. Op. cit.

RULE SIX: Do the right sums

Type-three error can be uncovered in stakeholders consultations. Example flood modeling – experts had failed to consider—upstream storage of flood waters—until local stakeholders were brought into the modeling process.

… upstream storage was neglected in the models because of the "use of a pit-filling algorithm that made sure that all water flows downhill"!

RULE SEVEN: Explore diligently the space of the assumptions

Environmental Modelling & Software 25 (2010) 1508–1517

Contents lists available at ScienceDirect

Environmental Modelling & Software

journal homepage: www.elsevier.com/locate/envsoft

How to avoid a perfunctory sensitivity analysis

Andrea Saltelli*, Paola Annoni

Joint Research Center, Institute for the Protection and Security of the Citizen, via E.Fermi, 2749, Ispra VA 21027, Italy

RULE SEVEN: Explore diligently the space of the assumptions

"The uncertainties which are more carefully scrutinised are usually those which are the least relevant" (*lampposting*, Jeroen van der Sluijs).

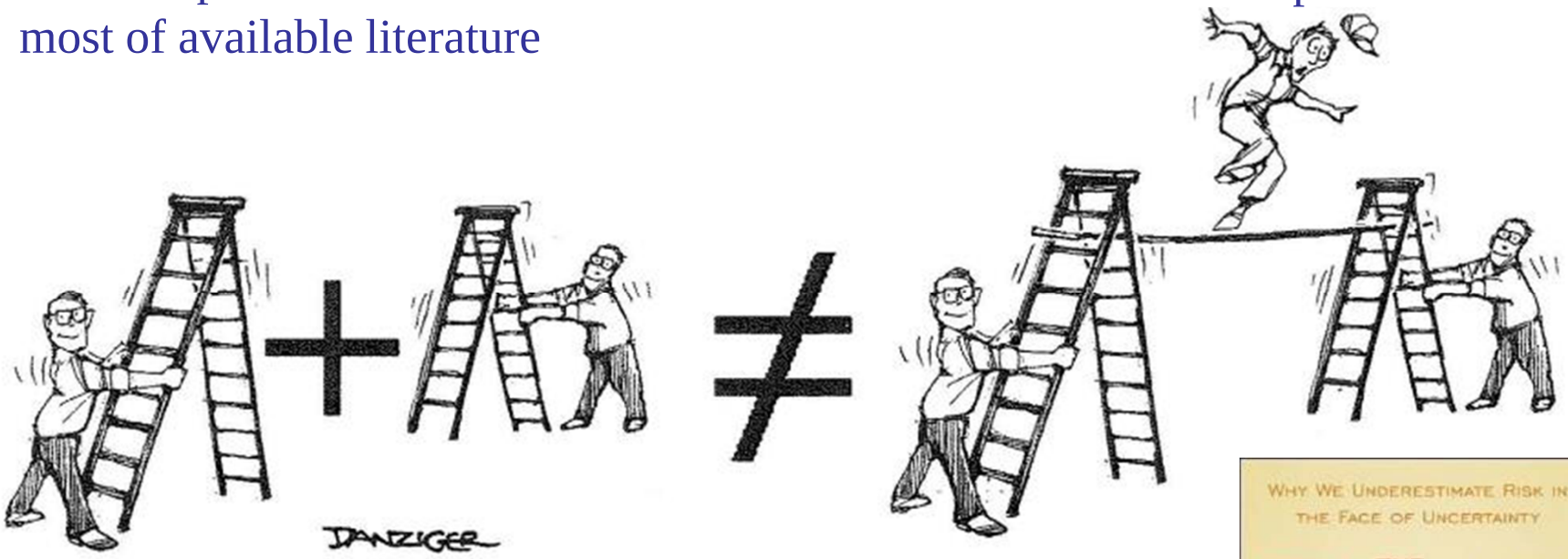
Nassim Nicholas Taleb calls this 'The delusion of uncertainty' .

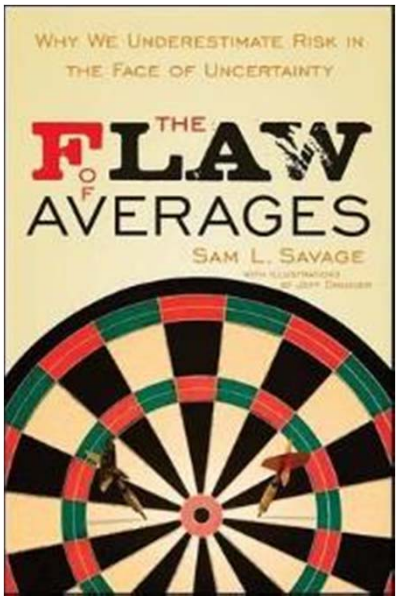
Uncertainty can be instrumentally amplified or downplayed

RULE SEVEN: Explore diligently the space of the assumptions

How coupled ladders are shaken in most of available literature

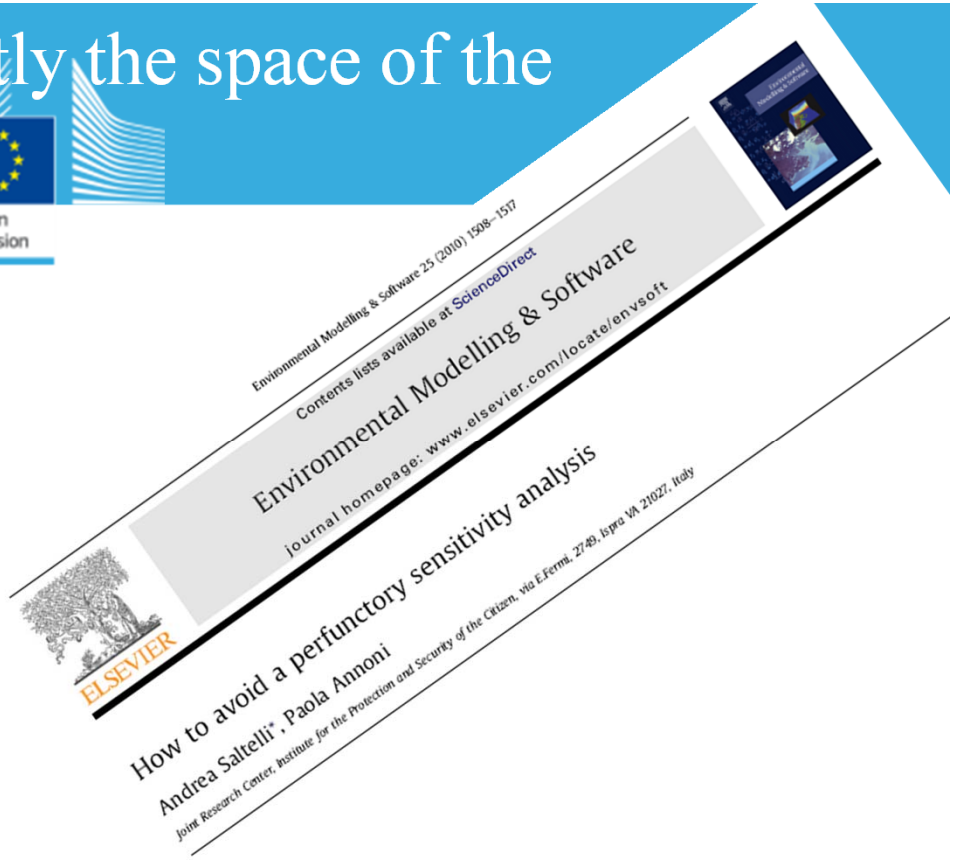
How to shake coupled ladders



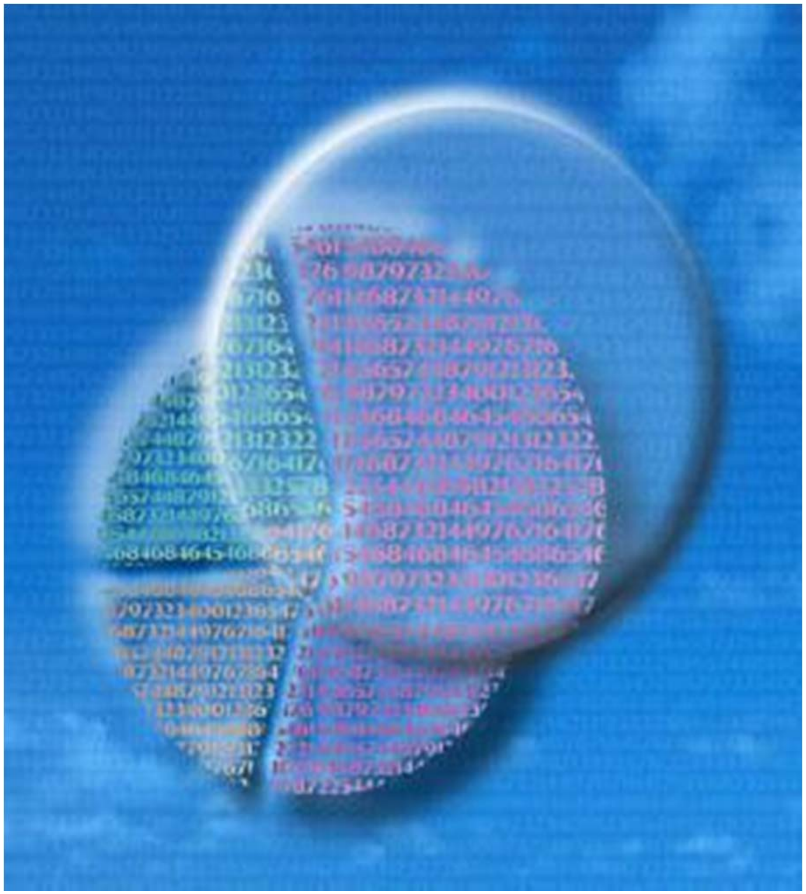


RULE SEVEN: Explore diligently the space of the assumptions

The most popular SA practice seen in the literature is that of 'one-factor-at-a-time' (OAT). This consists of analyzing the effect of varying one model input factor at a time while keeping all other fixed.



While the shortcomings of OAT are known from the statistical literature, its widespread use among modelers raises concern on the quality of the associated sensitivity analyses



END

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