

Quantification Blues

Andrea Saltelli

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2016 Edition of the

LIPHE4 Summer School

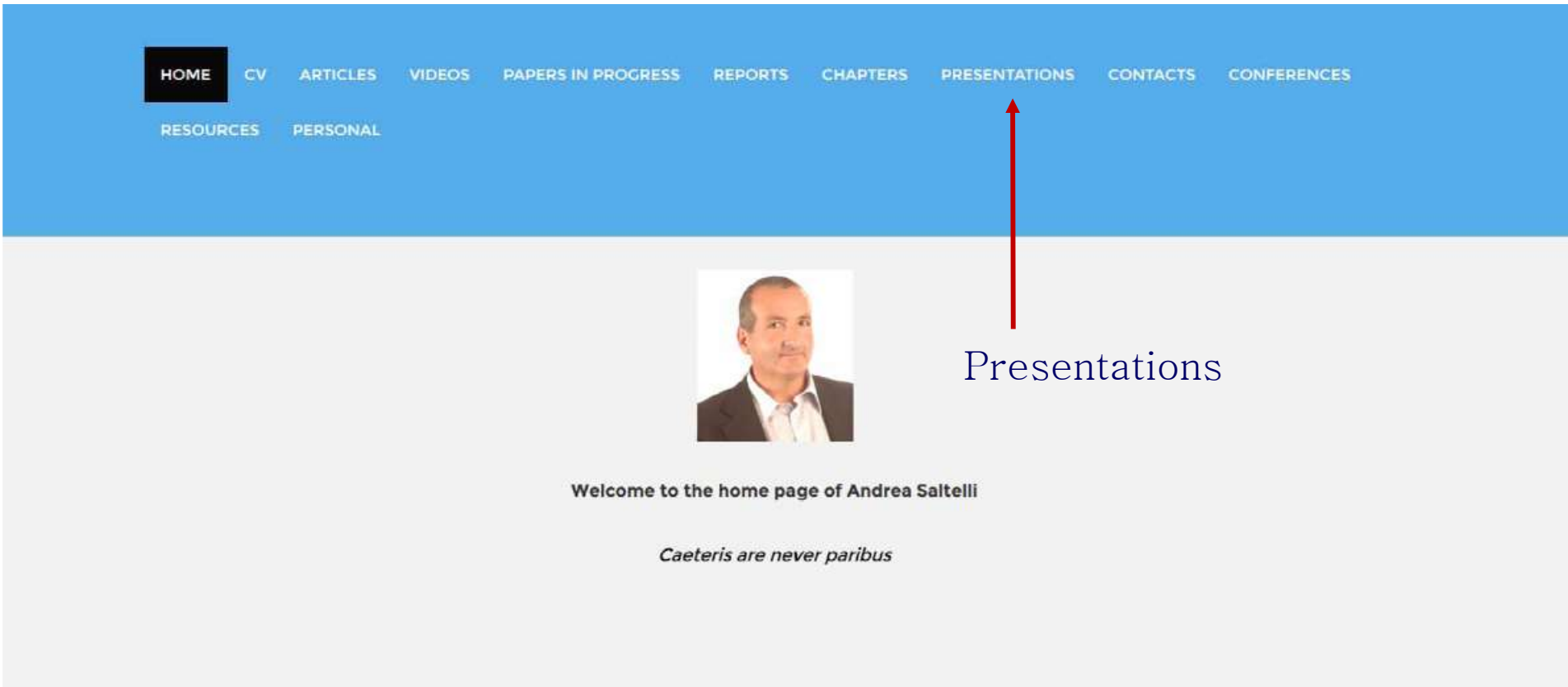
The Nexus between Food, Energy, Water and Land-use:
Quantitative Storytelling with MUSIASSEM

11–15 July 2016, ICTA–UAB, Bellaterra, Barcelona, Spain



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Where to find this presentation

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sensitivity analysis,
sensitivity auditing,
science for policy,
impact assessment, ...

Problems

Science: is there a crisis?

Why Quantify? Quantification and trust

Evidence based policy and its opposite

Evidence as hypocognition & Socially constructed ignorance

Evidence as the currency of the lobbies

Economics and its cyclic crises of relevance
(the mathiness discussion)

Remedies

Post-normal science

NUSAP

Sensitivity analysis

Sensitivity auditing

Quantitative story telling & Responsible quantification

Is there a crisis?





THE RIGHTFUL PLACE OF SCIENCE: **SCIENCE ON THE VERGE**

CONTRIBUTORS

Alice Benessia	Jerome R. Ravetz
Silvio Funtowicz	Andrea Saltelli
Mario Giampietro	Roger Strand
Ângela Guimarães Pereira	Jeroen P. van der Sluijs

http://www.andreasaltelli.eu/file/repository/Saltelli_Verge_Barcelona_June.pdf



**The
Economist**

OCTOBER 19TH - 26TH 2013

economist.com

Washington's lawyer surplus
How to do a nuclear deal with Iran
Investment tips from Nobel economists
Junk bonds are back
The meaning of Sachin Tendulkar

HOW SCIENCE GOES WRONG.

99

Einsteinium

Unreliable research

Trouble at the lab

Scientists like to think of science as self-correcting. To an alarming degree, it is not

Oct 19th 2013 | From the print edition



22K



Jason Ford

The crisis has ethical, epistemological, methodological and even metaphysical dimensions;

Note for the MuSIASEM class: this crisis is relevant as MuSIASEM in among the suggested solutions (e.g. to the irrelevance of economics)



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Identified points of friction:

- paradigm of evidence-based policy
- use of science to produce implausibly precise numbers and reassuring techno-scientific imaginaries
- use of science to ‘compel’ decision by the sheer strength of ‘facts’



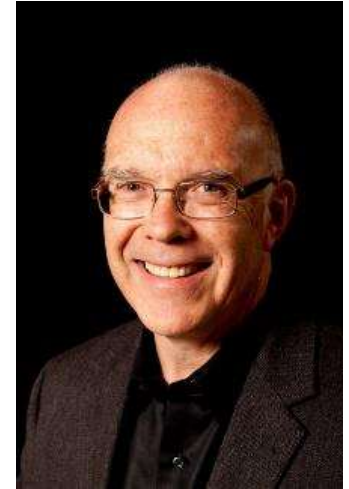
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- Generation of new data/ publications at an unprecedented rate.
- Compelling evidence that the majority of these discoveries will not stand the test of time.
- Causes: failure to adhere to good scientific practice & the desperation to publish or perish.
- ...



C. Glenn Begley



John P. A. Ioannides

Begley, C. G., and Ioannidis, J. P., 2015, Reproducibility in Science. Improving the Standard for Basic and Preclinical Research, *Circulation Research*, 116, 116–126, doi: 10.1161/CIRCRESAHA.114.303819

New Scientist

WEEKLY April 16 - 22, 2016

FLY ME TO THE STARS
The tiny spaceship bound
for Alpha Centauri

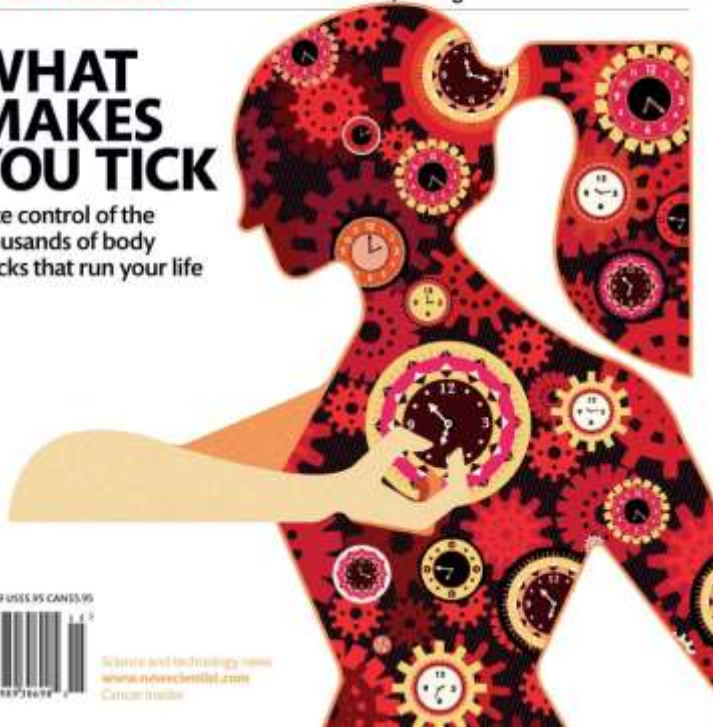
SINS OF THE FATHER
How you inherit your
dad's bad habits

LIFE IN THE CLOUDS
High-flying microbes are
controlling the weather

IMPROBABLE RESULTS Is most of science really wrong?

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Science and technology news
www.newscientist.com
Cancer inside



The crisis is registered by New Scientist;
Editorial “Crisis? What Crisis?”

[Home](#) | [Letters](#)

Published 22 June 2016

A new community for science

From Andrea Saltelli, Jerome R. Ravetz and Silvio Funtowicz

We would like to complement your analysis of a crisis in science relating to studies that can't be replicated (16 April, p 5 and p 38). One of us, Jerome Ravetz, predicted in 1971 in his book *Scientific Knowledge and its Social Problems* that the system of internal quality control of science would not easily withstand the evolution toward big science.

Quality in science depends on the existence of a community of scholars linked by norms and standards, and willing to stand by these. The historian Philip Mirowski in *Science-Mart* (2011), fills in the blanks of Ravetz's analysis with details of how science's internal quality control system stalled when “market” replaced “community” as a unifying principle, driven by firms funding research.

<https://www.newscientist.com/letter/mg23030791-600-7-a-new-community-for-science/>



The crisis has deep significance, since the contract between science and power is a basis of modernity. Science offers legitimacy to power via its guarantee of “truth”. If trust collapses within the research sector, how can public trust be maintained for the many policy-relevant functions of science?

Reform will depend on the emergence of a new “polity” of science including citizen scientists who take responsibility for rooting out corruption of all sorts, scientist-citizens working primarily in the policy arena and concerned journalists and teachers. Issues of ethics and quality, previously largely restricted to coffee-time grumbles, now attract public debates and activist campaigns.

Bergen, Norway; Barcelona, Spain; and Oxford, UK

Magazine issue 3079 published 25 June 2016



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Does the crisis impact
science for policy &
science's advice?

“Belinda Phipps, who took over at the Science Council last year, accused the sector of complacency and said the public trusted scientists only because they did not understand their work.”

Whipple, T., The Times, February 22, 2016

THE  TIMES

Science

News | Opinion | Business | Money | Sport | Life | Arts | Puzzles | Papers | Irish news

Welcome to your preview of The Times

Scientists ‘should take ethics oath like doctors’



Tom Whipple Science Editor

Published at 12:01AM, February 22 2016

Scientists need their own version of the Hippocratic oath and a regulation system similar to doctors to avoid a big scandal, the head of their standards body has said.

Studies suggest that a significant proportion of scientific papers are not repeatable

Monty Rakusen/Corbis

 Post a comment

“What struck me, coming into this sector is just how unregulated it is compared to the medical profession,” Ms Phipps said. “Think what damage a scientist could do if he or she behaved badly or fraudulently. The potential damage is enormous, yet there is almost no regulation.”

Whipple, T., The Times, February 22, 2016

THE  TIMES

Science

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Monty Rakusen/Corbis

 Post a comment

Ignoring the connection
between science's crisis and
science advice?

The OECD report on Science
Advice 2015; not a single
mention of science's crisis.

<http://www.oecd-ilibrary.org/docserver/download/5js33l1jcpwb.pdf?expires=1442656356&id=id&accname=guest&checksum=AF1467AD25F8BE6516083077CCEE31A>

OECD publishing



Please cite this paper as:

OECD (2015), "Scientific Advice for Policy Making: The Role and Responsibility of Expert Bodies and Individual Scientists", *OECD Science, Technology and Industry Policy Papers*, No. 21, OECD Publishing, Paris.
<http://dx.doi.org/10.1787/5js33l1jcpwb-en>

OECD Science, Technology and Industry
Policy Papers No. 21

Scientific Advice for Policy Making

THE ROLE AND RESPONSIBILITY OF EXPERT
BODIES AND INDIVIDUAL SCIENTISTS

OECD

Those aspect of science most used in policy (mathematical and statistical modelling) are also those more problematic. See e.g. the p-value saga...



**AMERICAN STATISTICAL ASSOCIATION RELEASES STATEMENT ON
STATISTICAL SIGNIFICANCE AND P-VALUES**

*Provides Principles to Improve the Conduct and Interpretation of Quantitative
Science*

March 7, 2016

Saltelli, A., Funtowicz, S., 2014, 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.

<http://issues.org/30-2/andrea/>

Wasserstein, R.L. and Lazar, N.A., 2016. 'The ASA's statement on p-values: context, process, and purpose', *The American Statistician*, DOI:10.1080/00031305.2016.1154108.

Why quantify?

The myth of scientific quantification via risk or cost benefit analyses, including of the impact of new technologies, has been at the hearth of the critique of the ecological moment (e.g. Schumacher, 1973; Winner, 1986; Funtowicz and Ravetz, 1994)

E. F. Schumacher, 1973, *Small Is Beautiful. Economics as if People Mattered*, Penguin Perennial,

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.

Funtowicz, S.O. and Ravetz, J.R. (1994). The worth of a songbird: Ecological economics as a post-normal science. *Ecological Economics* 10(3), 197–207.

[...] quality is much more difficult to 'handle' than quantity, just as the exercise of judgment is a higher function than the ability to count and calculate. Quantitative differences can be more easily grasped and certainly more easily defined than qualitative differences: their concreteness is beguiling and gives them the appearance of scientific precision, even when this precision has been purchased by the suppression of vital differences of quality.



Ernst Friedrich
"Fritz"
Schumacher

E. F. Schumacher, 1973, *Small Is Beautiful. Economics as if People Mattered*, Penguin Perennial,

Techniques (such as cost benefit analysis, CBA) are never neutral; according to Winner (1986) ecologists should not fall into the trap of CBA and risk analyses

(Chapter ON NOT HITTING THE TAR-BABY)



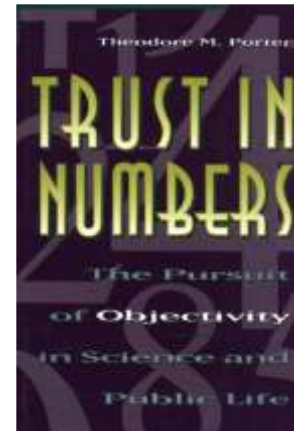
Langdon Winner

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.

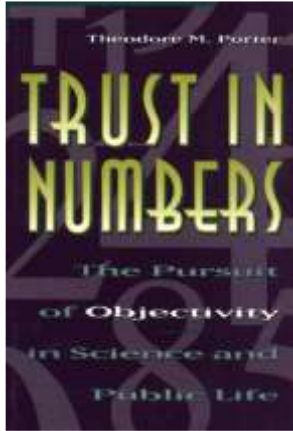
p. 8: “The appeal of numbers is especially compelling to bureaucratic officials who lack the mandate of a popular election, or divine right. Arbitrariness and bias are the most usual grounds upon which such officials are criticized. A decision made by the numbers (or by explicit rules of some other sort) has at least the appearance of being fair and impersonal.”



Theodor M. Porter

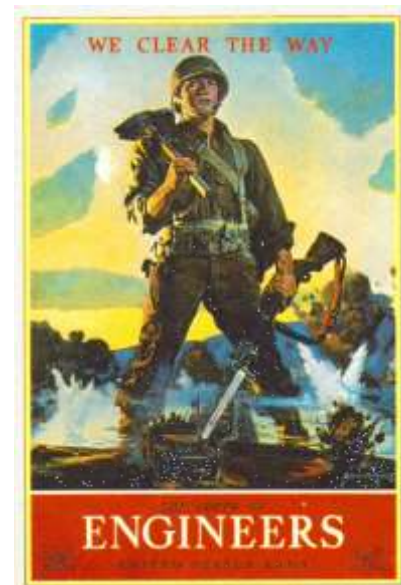
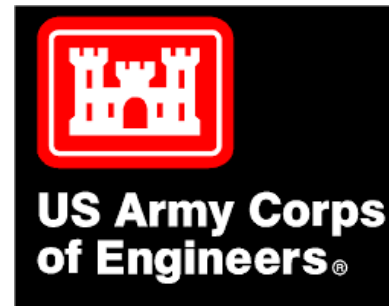


Theodore M. Porter, Trust in Numbers, The Pursuit of Objectivity in Science and Public Life, Princeton 1995

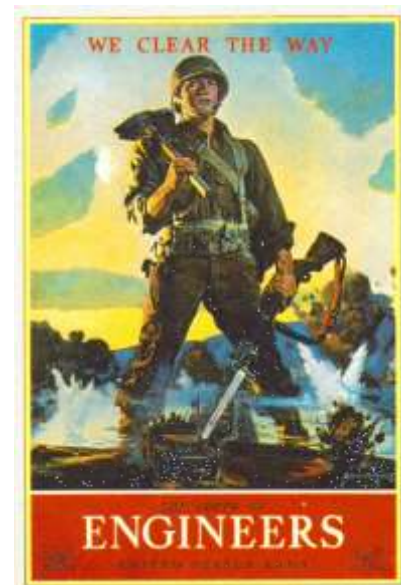


p. 8: “Scientific objectivity thus provides an answer to a moral demand for impartiality and fairness. Quantification is a way of making decisions without seeming to decide. Objectivity lends authority to officials who have very little of their own.”

Trust, authority and styles of quantification: two different stories



Porter's story: Quantification needs judgment which in turn needs trust ...without trust quantification becomes mechanical, a system, and 'systems can be played'.





Discussion points



- Do I see a relationship between trust and quantification?
- Are we (my team, my organization) more like the ‘corps des ingénieurs des ponts et chaussées’ or the US Army corps of Engineers?
- Are we (my team, my organization) into evidence based policy or policy based evidence? Build cases for one and the other.

Evidence based
policy or its
opposite?

PETRUCHIO: I say it is the moon.

KATHERINE: I know it is the moon.

PETRUCHIO: Nay, then you lie. It is the blessèd sun.

KATHERINE: Then God be blessed, it is the blessèd sun.

But sun it is not, when you say it is not,

And the moon changes even as your mind.

...

(Shakespeare, the Taming of the Shrew, Act IV)



The expression ‘Policy based evidence’ has entered the public discourse.

Warring parties accuse one another of the sin.

“Greenpeace [...] wants is policy based evidence making not evidence based policy making” (Sanderson, 2015) ...

Wilkes, G., 2015, Free Lunch: Policy-based evidence-making, Financial Times, July 3.

Sanderson, A.B., 3 Feb 2015, Breitbart, see <http://www.breitbart.com/london/2015/02/03/academic-attacks-greenpeace-for-ignoring-the-evidence-on-gm-crops/>; the politician is UKIP Energy Spokesman Roger Helmer MEP.

“This need [for evidence] has been reified in the UK and elsewhere, as routines of 'evidence-based policy'-making have been hardwired into the business of Government.

[...]such approaches are fundamentally flawed [because] Government [...] seeks to capture and control the knowledge producing processes to the point where this type of 'research' might best be described as 'policy-based evidence'.”

Boden, R. and Epstein D., 2006, Managing the Research Imagination? Globalisation and Research in Higher Education. *Globalisation, Societies and Education*, 223–236.

Evidence as hypocognition
& Socially constructed
ignorance

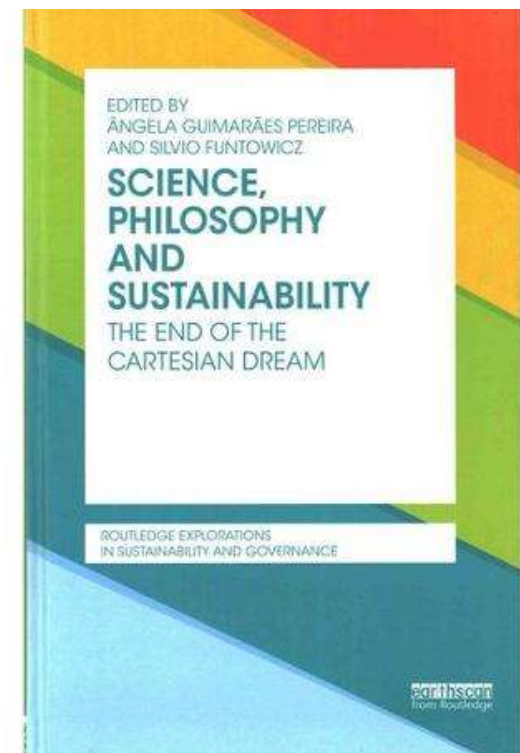
For Rayner (2012) “Sense-making is possible only through processes of exclusion. Storytelling is possible only because of the mass of detail that we leave out. Knowledge is possible only through the systematic ‘social construction of ignorance’ (Ravetz, 1986)”

Rayner, S., 2012, Uncomfortable knowledge: the social construction of ignorance in science and environmental policy discourses, *Economy and Society*, 41:1, 107–125.

Rayner's (2012) strategies societies may use to deal with “uncomfortable knowledge”.

- Denial: “There isn’t a problem”
- Dismissal: “It’s a minor problem”
- Diversion: “Yes I am working on it” (In fact I am working on something that is only apparently related to the problem)
- Displacement: “Yes and the model we have developed tells us that real progress is being achieved” (The focus is now the model not the problem).

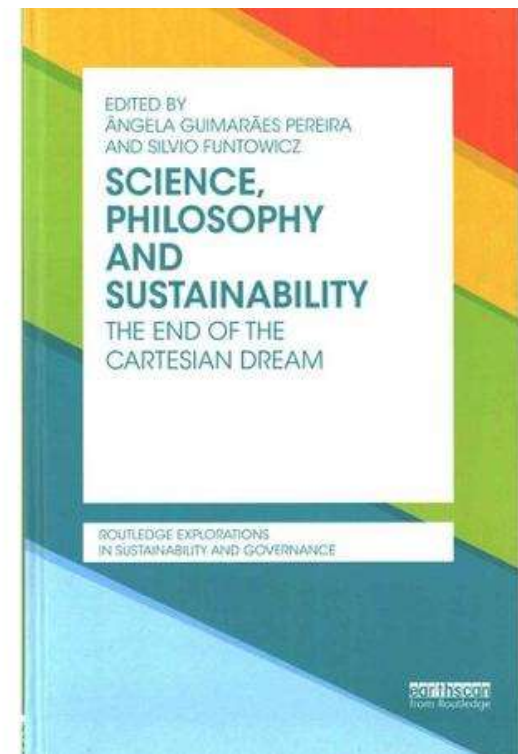
- A plea for a rediscovery of ignorance
 - especially ignorance generated by science itself;



Ravetz, J., R., 2015, Descartes and the rediscovery of ignorance, in Guimarães Pereira, Â., and Funtowicz, S., Eds., 2015, The end of the Cartesian dream, Routledge's series: Explorations in Sustainability and Governance.

Ravetz, J., R., 1987, Usable Knowledge, Usable Ignorance, Incomplete Science with Policy Implications, Knowledge: Creation, Diffusion, Utilization, 9(1), 87–116.

- Dichotomy between knowledge and ignorance as problematic as that between facts and value;
- Ignorance useful: work can be done on its boundaries (finding where these can be penetrated, spotting signals of troubles ahead).



Ravetz, J., R., 2015, Descartes and the rediscovery of ignorance, in Guimarães Pereira, Â., and Funtowicz, S., Eds., 2015, The end of the Cartesian dream, Routledge's series: Explorations in Sustainability and Governance.

Ravetz, J., R., 1987, Usable Knowledge, Usable Ignorance, Incomplete Science with Policy Implications, Knowledge: Creation, Diffusion, Utilization, 9(1), 87–116.

“Uncomfortable knowledge” can be used as a gauge of an institution’s health.

The larger the “uncomfortable knowledge” an institution needs to maintain, the closer it is to its ancient régime stage (Funtowicz and Ravetz, 1994).

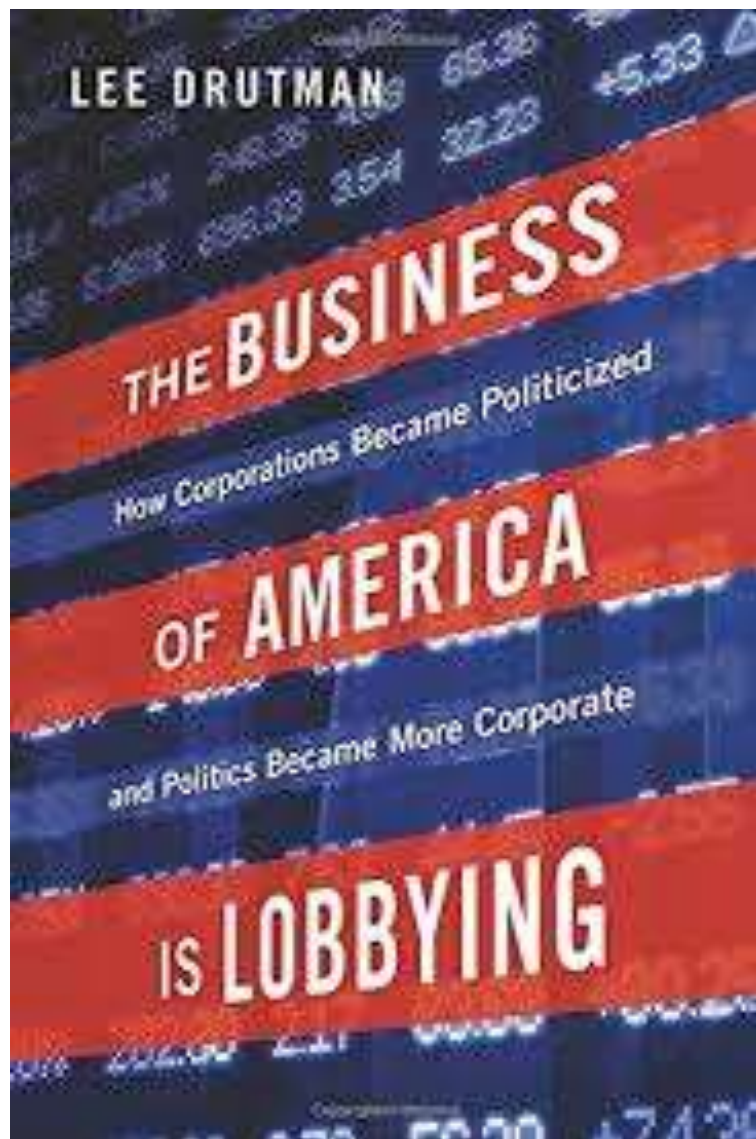


Discussion points

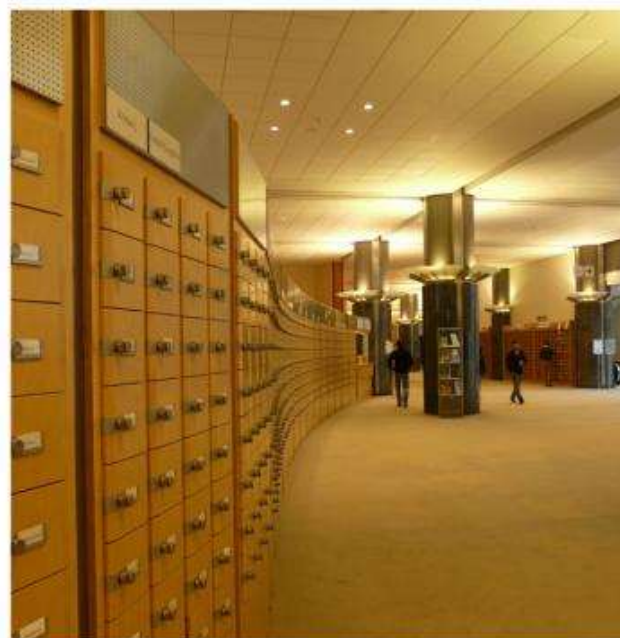


- Can I recall an example of a framing which did not sound right to me?

Evidence as the
currency of
lobbies



Lee Drutman



Sylvain Laurens

Some quick read:

<http://www.nybooks.com/articles/2016/04/07/how-lobbyists-win-in-washington/>

<http://www.contretemps.eu/lectures/lire-extrait-courtiers-capitalisme-sylvain-laurens/>

général. Or, il existe une différence fondamentale entre avancer l'idée qu'un système démocratique serait simplement perverti par des lobbys et émettre l'hypothèse que l'existence de ces lobbys est consubstantielle d'un mode de gouvernement technocratique dans lequel la légitimité conférée à des élus par le suffrage universel ne pèse presque rien au regard d'autres critères. Ce

Sylvain Laurens, 2015, Les Courtiers du capitalisme, Milieux d'affaires et bureaucrates à Bruxelles, Marseille, Éditions Agone.



Economics and its cyclic crises of relevance

Today: the ‘Mathiness’ discussion: blogs of Paul Romer, Judith Curry and Erik Reinert’s ‘scholasticism’ paper.

See <https://paulromer.net/mathiness/>

<https://judithcurry.com/2015/08/12/the-adversarial-method-versus-feynman-integrity-2/>

http://www.andreasaltelli.eu/file/repository/Full_Circle_scholasticism_2.pdf



Paul Romer



Judith Curry



Erik Reinert

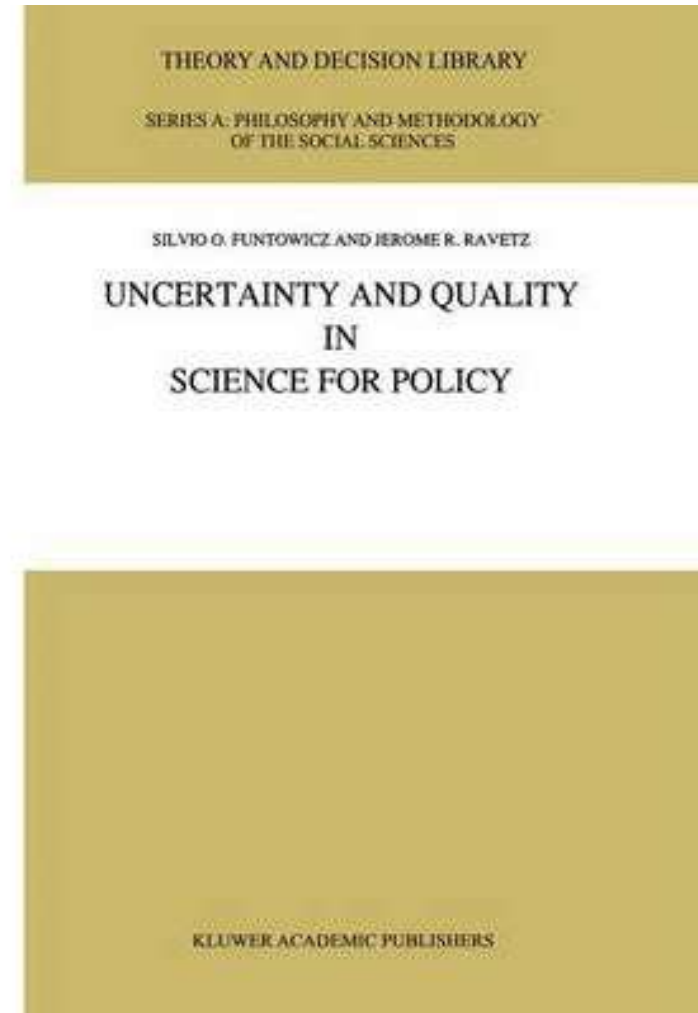
Post-normal science and NUSAP

What is Pseudo-science?

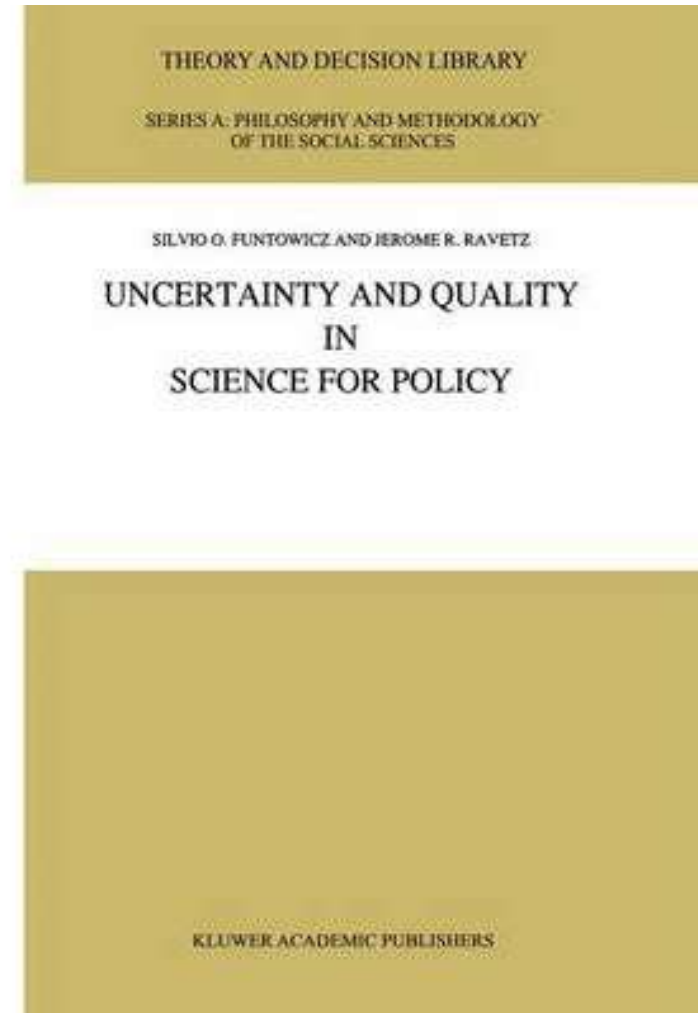
STS scholars Silvio
Funtowicz & Jerome R.
Ravetz's

(STS=studies of science
and technology)

Funtowicz, S. O. and Ravetz, J. R., 1990.
Uncertainty and quality in science for policy.
Dordrecht: Kluwer.



- NUSAP, is a notational system for the management and communication of uncertainty in science for policy
- NUSAP's five categories: Numeral, Unit, Spread, Assessment and Pedigree.



Funtowicz, S. O. and Ravetz, J. R., 1990.
Uncertainty and quality in science for policy.
Dordrecht: Kluwer.

Childhood obesity: The challenge of policy development in areas of post-normal science

***Speaker:** Sir Peter Gluckman (Chief Science Advisor to the Prime Minister, Co-Chair of the WHO Commission on Ending Childhood Obesity)*

Post Normal Science's model of Extended Participation: (1) across disciplines – acknowledging that different disciplines see through different lenses, and (2) across communities of both experts and stakeholders;



From ‘speaking truth to power’ towards ‘working deliberately within imperfections’;

Science is but one among a plurality of relevant knowledges;

Facts become ‘extended facts’.

Funtowicz, S. O. & Ravetz, J. R. 1993. Science for the post-normal age. *Futures*, 25(7), 739–755.

Gluckman, P., 2014, Policy: The art of science advice to government, *Nature*, 507, 163–165.

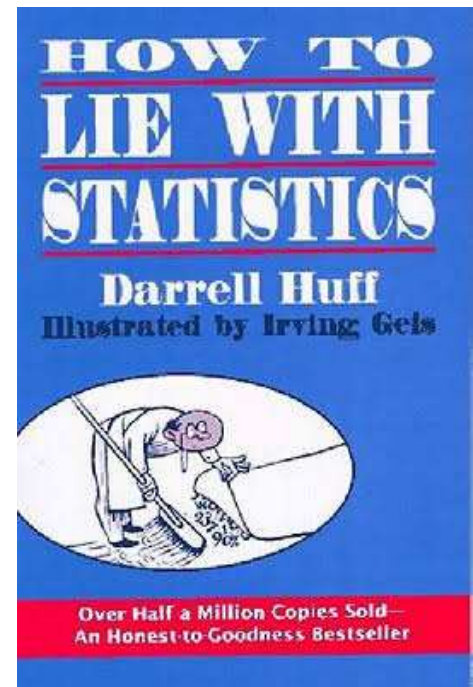
Sensitivity Analysis

Sensitivity analysis secrets

- What is the question? Confirmation or falsification?
- Sensitivity analysis is not “run” on a model but on a model once applied to a case.
- Sensitivity analysis should not be used to hide assumptions.
- If SA shows that a question cannot be answered by the model find another question/model which can be treated meaningfully (the workhorse argument).

Will any sensitivity analysis do the job?

Can I lie with sensitivity analysis as I can lie with statistics?



Saltelli, A., Annoni P., 2010, How to avoid a perfunctory sensitivity analysis, *Environmental Modeling and Software*, **25**, 1508–1517.

Most of sensitivity analyses
(apparently 96 over 100 in 2014)
leave unexplored a very large fraction
– if not the almost totality – of the
input factors space.

Saltelli, A., Annoni P., 2010, How to avoid a perfunctory sensitivity analysis, *Environmental Modeling and Software*, **25**, 1508–1517.

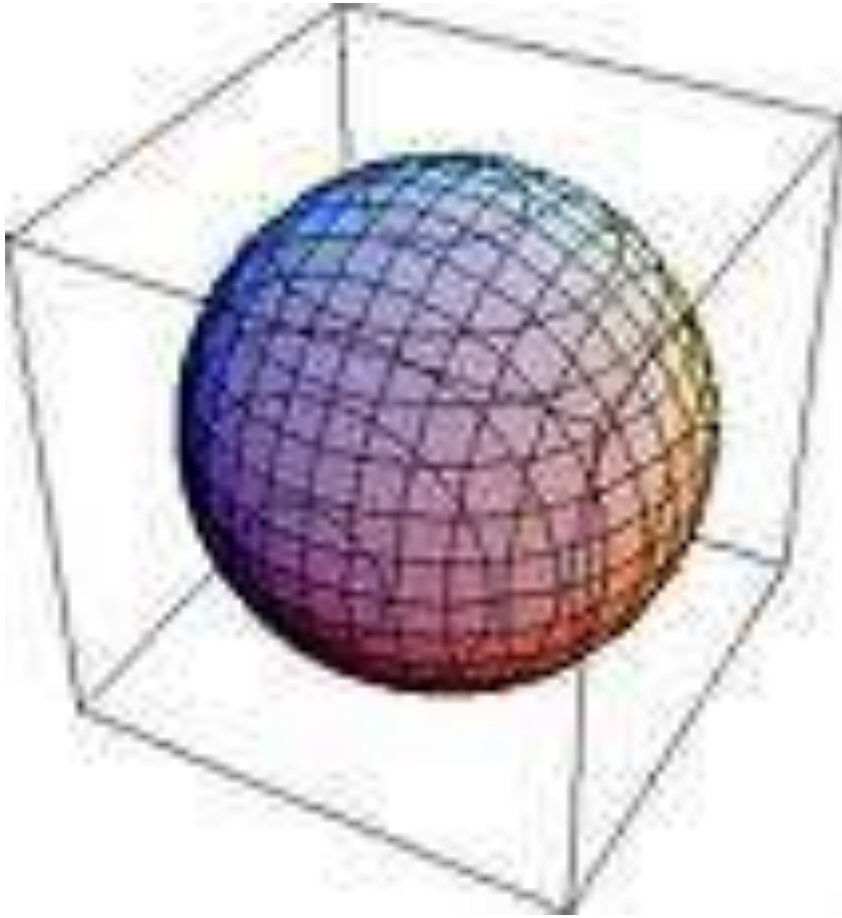
Ferretti, F., Saltelli A., Tarantola, S., 2016, Trends in Sensitivity Analysis practice in the last decade, *Science of the Total Environment*, special issue on Human and biota exposure, <http://dx.doi.org/10.1016/j.scitotenv.2016.02.133>

For a 10 factors model a SA done by moving one factor at a time leaves unexplored 99.75% of the input space.

Saltelli, A., Annoni P., 2010, How to avoid a perfunctory sensitivity analysis, *Environmental Modeling and Software*, **25**, 1508–1517.

Ferretti, F., Saltelli A., Tarantola, S., 2016, Trends in Sensitivity Analysis practice in the last decade, *Science of the Total Environment*, special issue on Human and biota exposure, <http://dx.doi.org/10.1016/j.scitotenv.2016.02.133>

Moving one factor at a time in 3 dimensions
all points remain in the sphere while.



Volume sphere /
volume cube =?

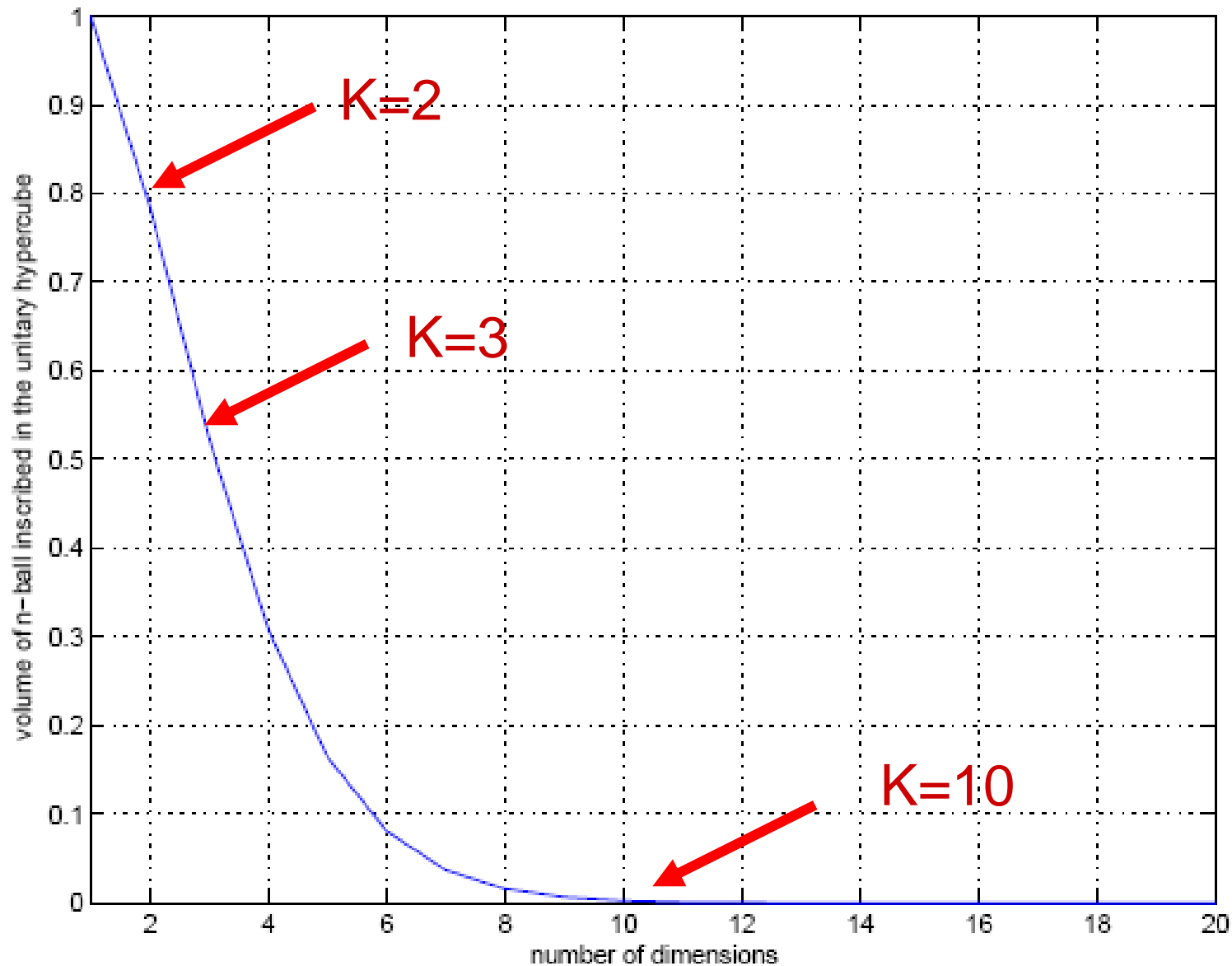
~ 1/2

OAT in 10 dimensions

Volume hypersphere / volume
ten dimensional hypercube ~ 0.0025



OAT in k dimensions



Sensitivity Auditing

Sensitivity auditing

- Originates from uncertainty & sensitivity analysis
- Addresses model-based evidence used for policy

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.
<http://issues.org/30-2/andrea/>

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 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

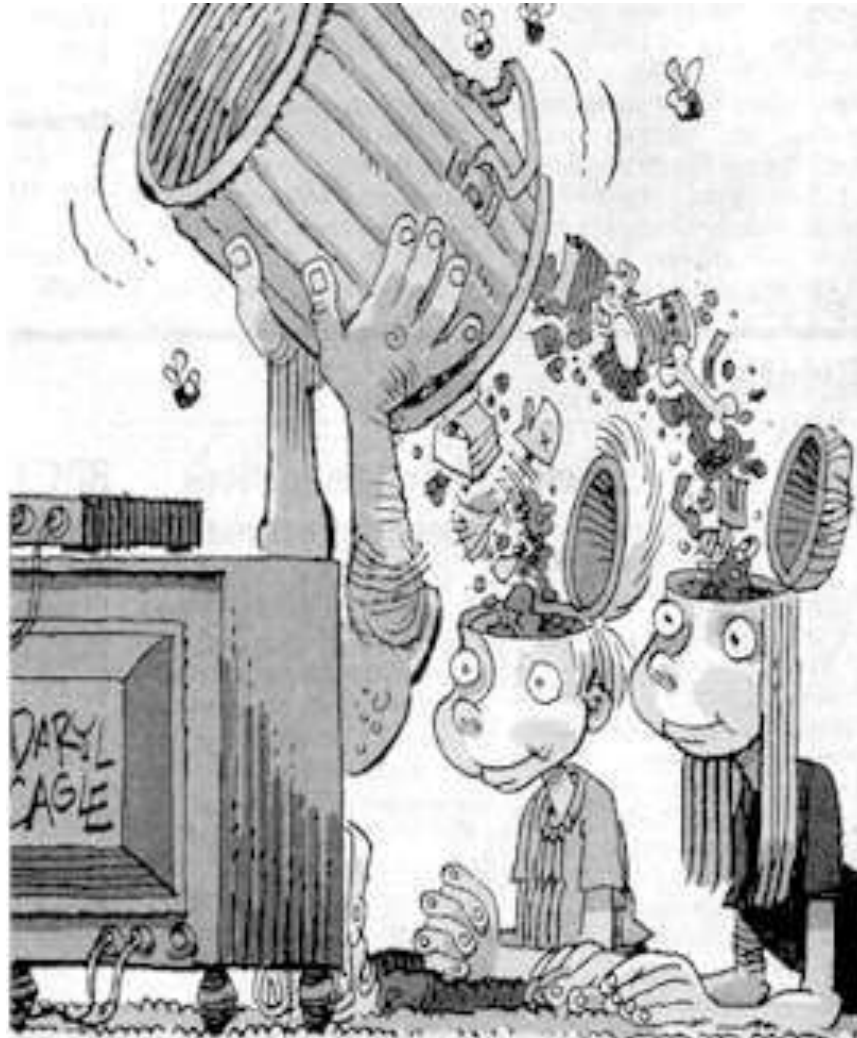


Discussion points



- Can I recall an example of ‘excessive’ or exaggerated quantification (hyper-precision)
- Am I haunted by a hidden assumptions, or by an elephants in the room nobody else sees?

RULE THREE: detect GIGO (Garbage In, Garbage Out)
Science or pseudo-science, artificial inflation/deflation of
uncertainties





Discussion points



- When it comes to quantification does the end justify the means?
- Can I recall an instance where uncertainties have been either amplified or deflated instrumentally?

Quantitative
story-telling
and responsible
quantification

“There is only a perspective seeing, only a perspective “knowing”; and the more affects we allow to speak about one thing, the more eyes, different eyes, we can use to observe one thing, the more complete will our “concept” of this thing, our “objectivity”, be.”

Friedrich Nietzsche, *Genealogy of Morals*, Third Essay

Quantitative story telling paying attention to frames – in order to open them ...

.. To explore a broader set of plausible and relevant stories.

Chapter 2 in THE BOOK



THE RIGHTFUL
PLACE OF SCIENCE:
**SCIENCE ON THE
VERGE**

CONTRIBUTORS

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Silvio Funtowicz	Andrea Saltelli
Mario Giampietro	Roger Strand
Ângela Guimarães Pereira	Jeroen P. van der Sluijs



- Most analyses offered as input to policy are framed as cost benefit analysis (monetization, the occupational psychosis of economists) or risk analyses.



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.

The issue of frames. How do we perceive the world. Socially constructed ignorance.

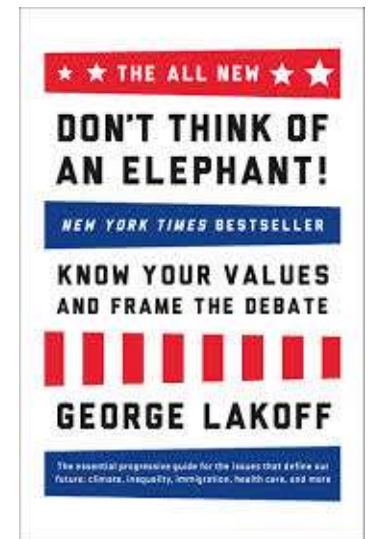
Lakoff, G., 2010, Why it Matters How We Frame the Environment, Environmental Communication: A Journal of Nature and Culture, 4:1, 70-81.

Lakoff, G., 2004-2014, Don't think of an elephant: know your values and frame the debate, Chelsea Green Publishing.

For a summary see http://www.andreasaltelli.eu/file/repository/Hypocognition_Etc.pdf



George Lakoff



Frames

- The expression ‘tax relief’ is apparently innocuous but it suggests that tax is a burden, as opposed to what pays for road, hospitals, education and other infrastructures of modern life (Lakoff, 2004).

Frames

- Published road accident statistics record the conditions of the driver as to alcohol or drug use but not the make and year of the car or its safety features (Gusfield, 1981).

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

Frames; GMO presented as a food scare.

“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 v science, The little state that could kneecap the biotech industry, May 10th 2014

Why Free Markets Make Fools of Us

Cass R. Sunstein

OCTOBER 22, 2015 ISSUE

Phishing for Phools: The Economics of Manipulation and Deception

by George A. Akerlof and Robert J. Shiller

Princeton University Press, 272 pp., \$24.95



The Rolls-Royce Silver Cloud — \$13,995

“At 60 miles an hour the loudest noise in this new Rolls-Royce comes from the electric clock”

An advertisement for Rolls-Royce from the late 1950s

Frames and narratives

For Akerlof and Shiller – against what the ‘invisible hand’ would contend – economic actors have no choice but to exploit frames to ‘phish’ people into practices which benefit the actors not the subject phished. Implication for democracy.



George Akerlof



Robert R. Shiller

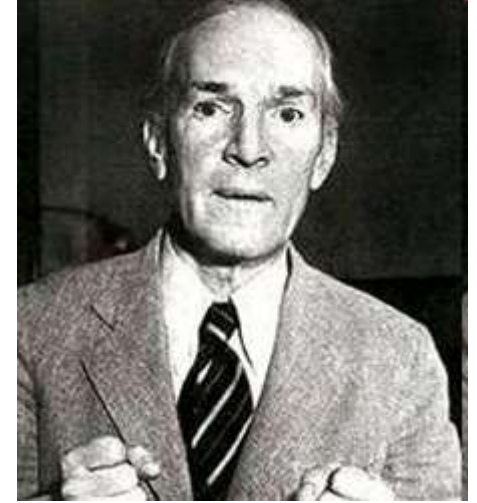
Instead of Evidence-based policy: robust policy.

Test for:

- feasibility (compatibility with processes outside human control);
- viability (compatibility with processes under human control, in relation to both the economic and technical dimensions); and
- desirability (compatibility with a multitude of normative considerations relevant to a plurality of actors).

On the persistence of narratives

“It is difficult to get a man to understand something when his salary depends upon his not understanding it.”



Upton Sinclair



END

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