

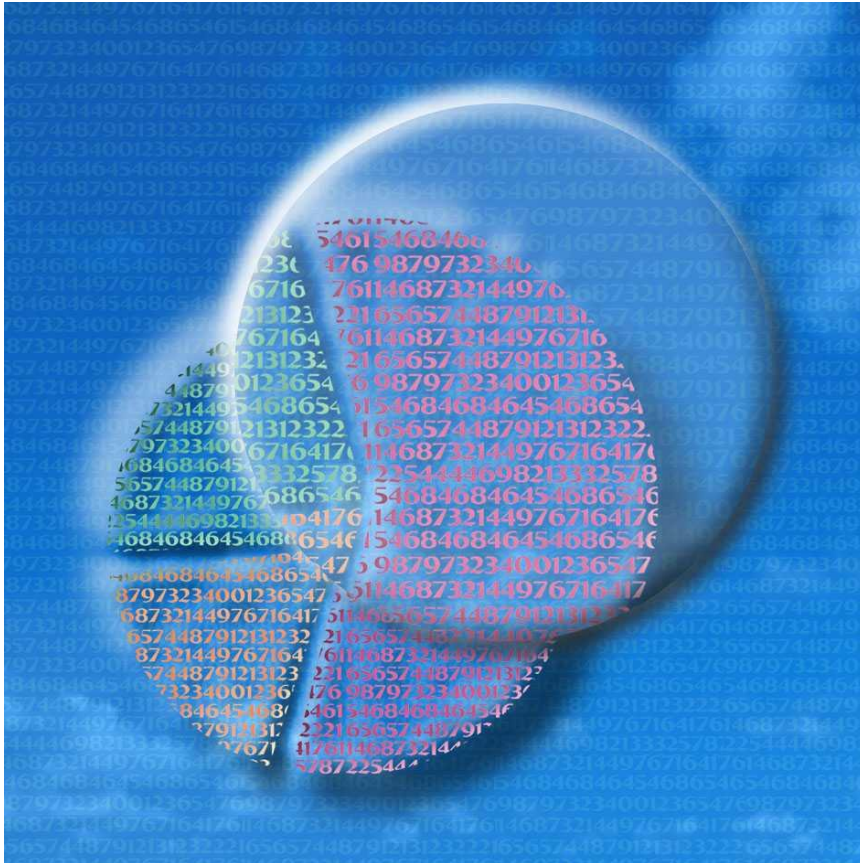
# Science on the Verge

Senter for vitenskapsteori (SVT),  
University of Bergen, May 23 2016.

Andrea Saltelli

European Centre for Governance in Complexity,  
Universities of Bergen (NO) and Autnoma of Barcelona (ES)

[andrea.saltelli@uib.no](mailto:andrea.saltelli@uib.no)



www.andreasaltelli.eu

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RESOURCES PERSONAL NEWS SCIENCE ON THE VERGE A PLEDGE



Welcome to the home page of Andrea Saltelli

*Caeteris are never paribus*

Where to find this presentation



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



## The Rightful Place of Science: Science on the Verge

Paperback – 20 Feb 2016

by [Andrea Saltelli](#) (Author), [Alice Benessia](#) (Author), & 7 more

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[http://www.amazon.com/Rightful-Place-Science-Verge/dp/0692596380/ref=sr\\_1\\_1?s=books&ie=UTF8&qid=1456255907&sr=1-1&keywords=saltelli](http://www.amazon.com/Rightful-Place-Science-Verge/dp/0692596380/ref=sr_1_1?s=books&ie=UTF8&qid=1456255907&sr=1-1&keywords=saltelli)

<http://www.andreasaltelli.eu/science-on-the-verge>

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

Root causes of the crisis, from history and philosophy of science scholarship to present-day historical critique of commodified science;

The crisis of science *qua science* impacts science as used for policy.



THE RIGHTFUL  
PLACE OF SCIENCE:

# SCIENCE ON THE VERGE

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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’



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

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# Is there a crisis?





# New Scientist

WEEKLY April 16 - 22, 2016

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

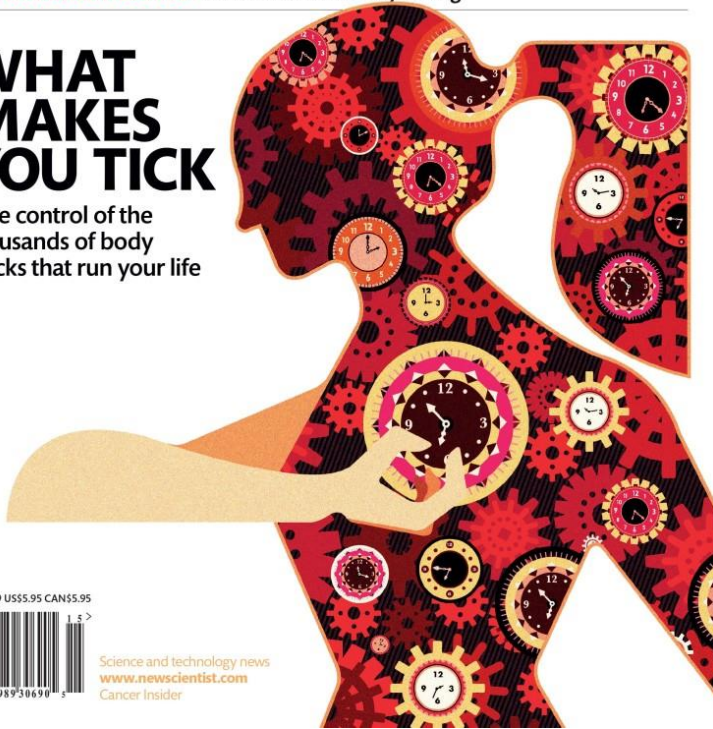
**SINS OF THE FATHER**  
How you inherit your dad's bad habits

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

**IMPROBABLE RESULTS** Is most of science really wrong?

## WHAT MAKES YOU TICK

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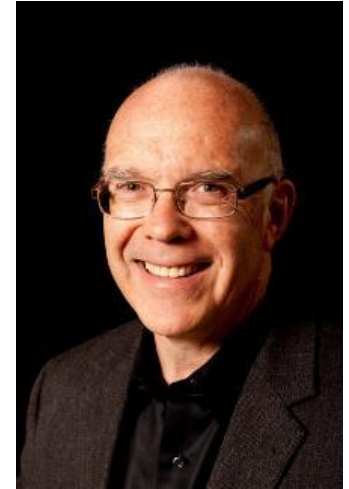
Science and technology news  
[www.newscientist.com](http://www.newscientist.com)  
Cancer Insider

# Crisis? What Crisis?



- 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.
- This is a multifaceted, multistakeholder problem.
- No single party is solely responsible, and no single solution will suffice.

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



C. Glenn Begley



John P. A. Ioannides



The  
Economist

OCTOBER 19TH - 27TH 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

 Timekeeper

 Like

22K

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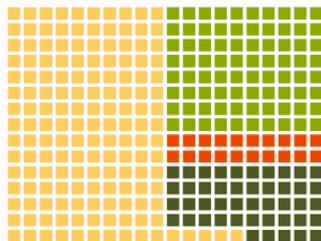
## Unlikely results

How a small proportion of false positives can prove very misleading

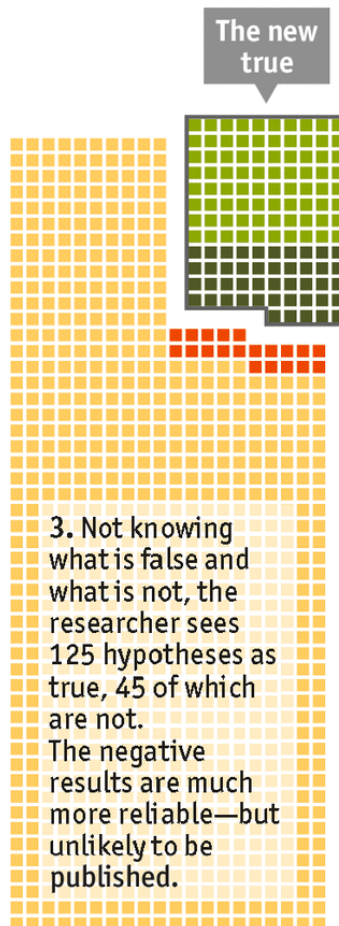
False True False negatives False positives



1. Of hypotheses interesting enough to test, perhaps one in ten will be true. So imagine tests on 1,000 hypotheses, 100 of which are true.



2. The tests have a false positive rate of 5%. That means they produce 45 false positives (5% of 900). They have a power of 0.8, so they confirm only 80 of the true hypotheses, producing 20 false negatives.



3. Not knowing what is false and what is not, the researcher sees 125 hypotheses as true, 45 of which are not. The negative results are much more reliable—but unlikely to be published.

Source: *The Economist*

Ioannidis J P A

2005 Why Most  
Published Research Findings  
Are False PLoS Medicine  
2(8) 696–701, a source of  
The Economist's piece.

The  
Economist

“A career structure which lays great stress on publishing copious papers exacerbates all these problems”, Brian Nosek, quoted by The Economist.

The  
Economist





“There is no cost to getting things wrong. The cost is not getting them published”, Brian Nosek again



A landmark effort to reproduce the findings of 100 recent papers in psychology failed in more than half the cases – and the effects were smaller than claimed in the original studies (Brian Nosek's work).

Baker, M., 2015, Over half of psychology studies fail reproducibility test. Largest replication study to date casts doubt on many published positive results, *Nature*, 27 August 2015.

OSC, Open Science Collaboration, 2015, Estimating the reproducibility of psychological science, *SCIENCE*, 349(6251) aac4716. DOI: 10.1126/science.aac4716

Yong, E., Nobel laureate challenges psychologists to clean up their act, *Nature*, News, 03 October 2012.

... and a couter study saying that Nosek's team got it wrong.

Gilbert, D. T., King, G., Pettigrew, S. & Wilson, T. D. *Science* 351, 1037 (2016).



Brian Nosek  
Professor,  
Department of  
Psychology  
University of Virginia



Solutions from within:

Four international conferences on science integrity between 2007 and 2015.

San Francisco declaration, (2012), as of May 2016 signed by 12,700 individuals, and 591 organizations.

“Do not use journal-based metrics, such as Journal Impact Factor, as a surrogate measure of the quality of individual research articles to assess an individual scientist’s contributions, or in hiring, promotion, or funding decisions.”

Declaration: <http://am.ascb.org/dora/>, drafted by publishers, with separate recommendations for institutions, publishers, organizations that supply metrics and researchers.

Lancet, Editorial, 2015, Rewarding true inquiry and diligence in research, 385, p. 2121.

Wilsdon, J., 2015, We need a measured approach to metrics, Nature, 523, 129.

See also The Metric Tide Report in the UK (REF)

Solutions from within:

- Ioannides (2014): a checklist of remedies



John P. A. Ioannides

“[...] adoption of large-scale collaborative research; replication culture; registration; sharing; reproducibility practices; better statistical methods; [...] and improvement in study design standards, peer review, [...] training of the scientific workforce”

## Summary Points

- Currently, many published research findings are false or exaggerated, and an estimated 85% of research resources are wasted.



John P. A. Ioannides

Ioannidis, J. P. (2014). How to Make More Published Research True. PLoS medicine, 11(10), e1001747

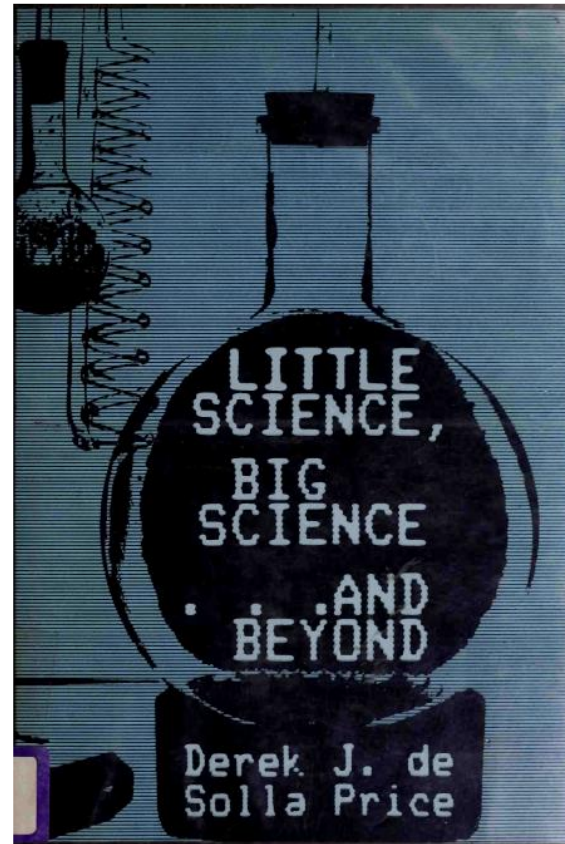
For Lancet (2015) an estimated US\$200 billion were wasted in the US in 2010.

Lancet, Editorial, 2015, Rewarding true inquiry and diligence in research, 385, p. 2121.

## Different readings of the crisis :

- Poor training, statistical design, hubris of data mining, perverse incentives, counterproductive metrics (e.g. Ioannidis; San Francisco Declaration, ...)
- Science victim of its own success, exponential growth, senility by exponential growth & hyper-specialization (de Solla Price)
- Science as another victim of the neoliberal ideology (e.g. Mirowski)
- Science as a social enterprise whose quality control apparatus suffers under the mutated conditions of technoscience (Ravetz, Lyotard)

There were rare anticipations of this crisis. In 1963 Derek J. de Solla Price prophesized that Science would reach saturation (and in the worst case senility) under its own weight, victim of its own success and exponential growth (pp 1-32).



Derek J. de Solla Price

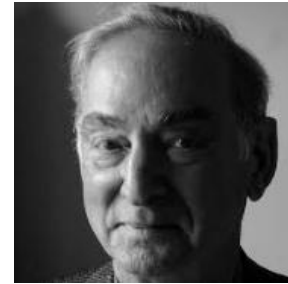


Science/knowledge degenerates when it becomes a commodity for Ravetz (1971), Lyotard (1979) and Mirowski (2011).

Ravetz, J., 1971, *Scientific Knowledge and its Social Problems*, Oxford University Press, p. 22.

Lyotard, J.-F. 1979. *La Condition postmoderne. Rapport sur le savoir*, Paris : Minuit, Chapter 10.

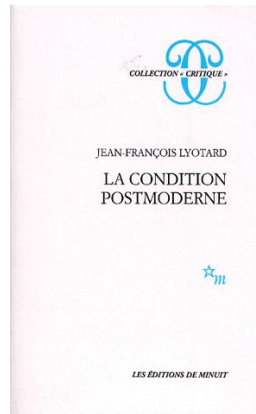
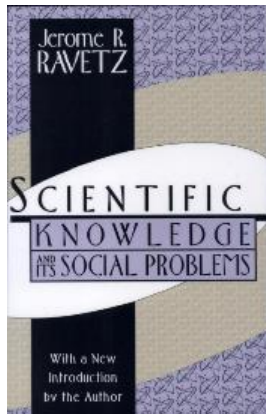
Mirowski, P. 2011. *Science-Mart: Privatizing American Science*, Harvard University Press.



Jerome R.  
Ravetz



Jean-François  
Lyotard

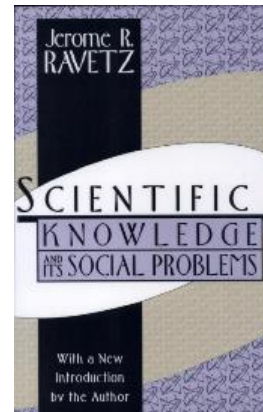


Philip Mirowski

p.22: About the industrialization of science and the weakening of its quality control mechanism:

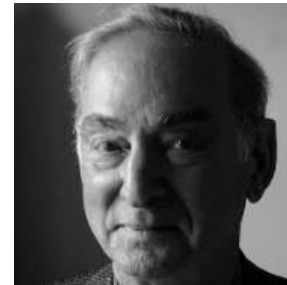
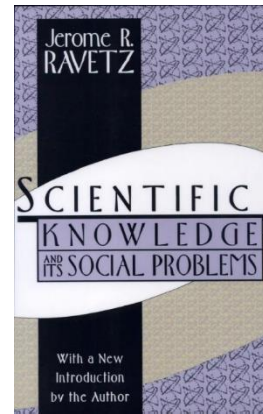
“The problem of quality control in science is [...] at the centre of the social problems of the industrialized science [...]. If it fails to resolve this problem [...] then the immediate consequences for morale and recruitment will be serious; and those for the survival of science itself, grave”

Ravetz, J., 1971, *Scientific Knowledge and its Social Problems*, Oxford University Press, p.22.



Jerome R.  
Ravetz

p. 22–23: “Two separate factors are necessary for the achievement of worthwhile scientific results: a community of scholars with a shared knowledge of the standards of quality appropriate for their work and a shared commitment to enforce those standards by the informal sanctions the community possesses; and individuals whose personal integrity sets standards at least as high as those required by their community…”



Jerome R.  
Ravetz

Ravetz, J., 1971, *Scientific Knowledge and its Social Problems*, Oxford University Press, p.22.

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

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Studies suggest that a significant proportion of scientific papers are not repeatable  
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/5js3311jcpwb.pdf?expires=1442656356&id=id&accname=guest&checksum=AF1467AD25FF8BE6516083077CCEE31A>

OECDpublishing



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/10.1787/5js3311jcpwb-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 vulnerable to abuse

IN FOCUS NEWS

REPRODUCIBILITY

# Statisticians issue warning on *P* values

*Statement aims to halt missteps in the quest for certainty.*

“Misuse of the *P* value — a common test for judging the strength of scientific evidence — is contributing to the number of research findings that cannot be reproduced”



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

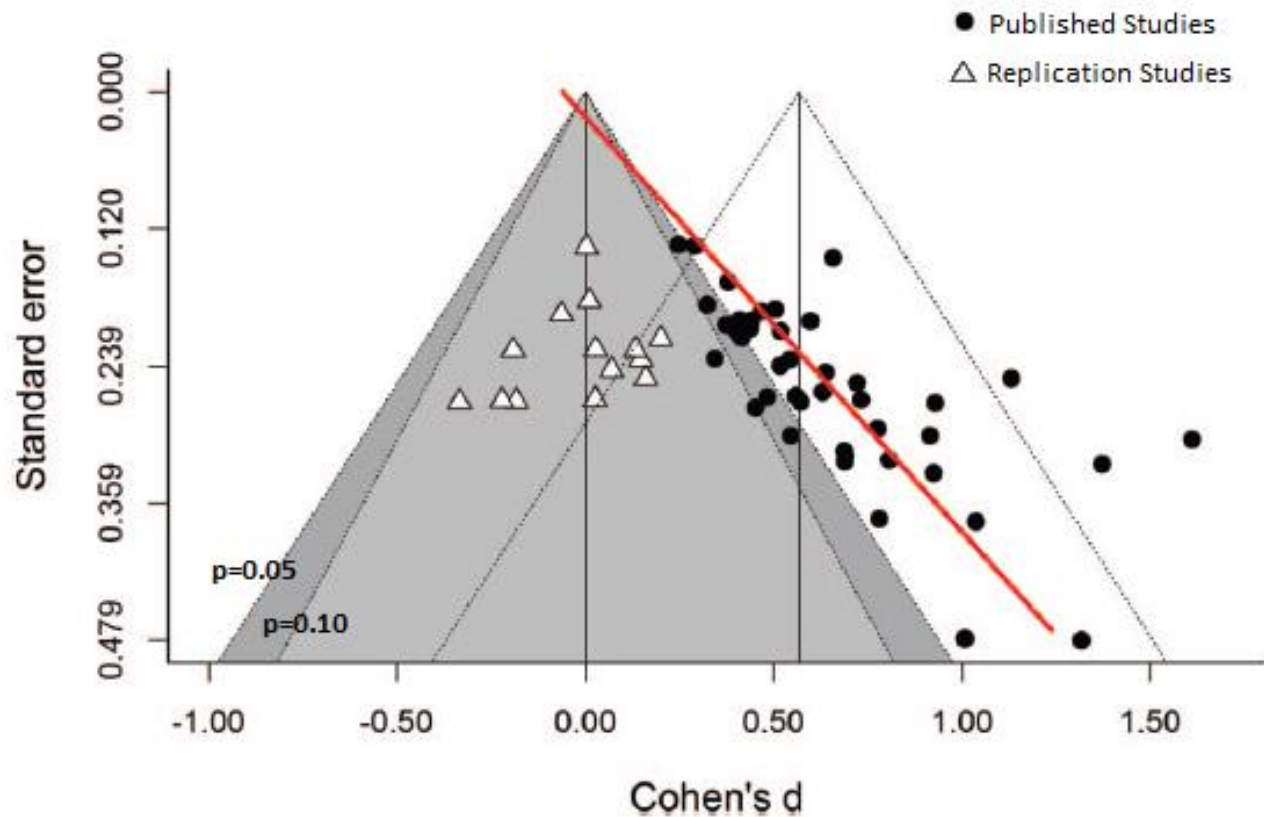
*Provides Principles to Improve the Conduct and Interpretation of Quantitative  
Science*

March 7, 2016

… and twenty ‘dissenting’ commentaries

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.

# “P-hacking’s smoking gun”



Shanks et al. (2015) JEP:General

J Exp Psychol Gen. 2015 Oct 26. “Romance, Risk, and Replication: Can Consumer Choices and Risk-Taking Be Primed by Mating Motives?”, Shanks DR, Vadillo MA, Riedel B, Clymo A, Govind S, Hickin N, Tamman AJ, Puhlmann LM.: <http://www.ncbi.nlm.nih.gov/pubmed/26501730>



New Scientists talks of “dodgy statistics” and “statistical sausage factory”

# New Scientist

WEEKLY April 16 - 22, 2016

**IMPROBABLE RESULTS** Is most of science really wrong?

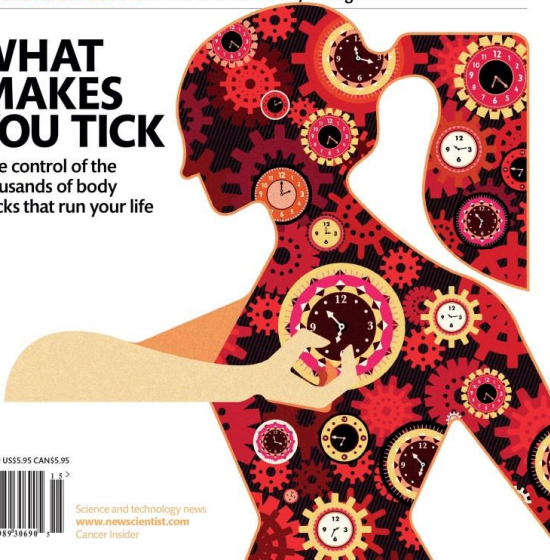
## WHAT MAKES YOU TICK

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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



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Science and technology news  
[www.newscientist.com](http://www.newscientist.com)  
Cancer Insider

FEATURE 13 April 2016

## Why so much science research is flawed – and what to do about it

Dodgy results are fuelling flawed policy decisions and undermining medical advances. They could even make us lose faith in science. **New Scientist** investigates



An alarming amount of research is flawed  
Brett Ryder

## Solution? Methods

- NUSAP, is a notational system for the management and communication of uncertainty in science for policy

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



NUSAP's five categories for characterizing any quantitative statement: Numeral, Unit, Spread, Assessment and Pedigree.



Jeroen van der Sluijs

[www.nusap.net](http://www.nusap.net)

<https://en.wikipedia.org/wiki/NUSAP>

van der Sluijs, J., Craye, M., Funtowicz, S., Kloprogge, P., Ravetz, J., and Risbey, J. (2005) Combining Quantitative and Qualitative Measures of Uncertainty in Model based Environmental Assessment: the NUSAP System, Risk Analysis, 25 (2). p. 481-492. see also <http://www.nusap.net/>

## Solutions? Methods

- Sensitivity auditing: testing the entire inferential chain

In the **EC impact assessment guidelines**; JRC teaches it twice a year since 2009. Last course April 28–29 this year.

See slides at <http://www.andreasaltelli.eu/presentations>

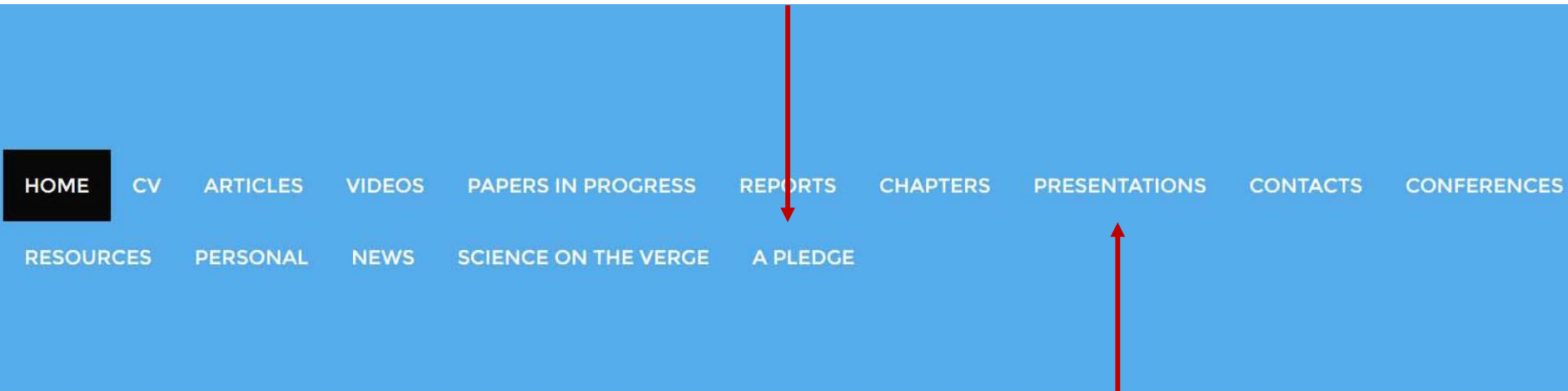
Saltelli, A., Funtowicz, S., 2014, When all models are wrong: More stringent quality criteria are needed for models used at the science–policy interface, *Issues in Science and Technology*, Winter 2014, 79–85.

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

Workshop organized by the JRC June 2015: ‘Significant Digits: Responsible Use of Quantitative Information’ in June 2015, see a video recording <https://ec.europa.eu/jrc/en/event/workshop/new-narratives-innovation>.

# Solutions? Methods? Next? Quantitative story telling, responsible quantification, ethics of quantification (Utrecht, November 2016)

...



**Welcome to the home page of Andrea Saltelli**

*Caeteris are never paribus*



John Kay, Financial Times

Watch the videos from the workshop  
'Significant digits. Responsible Use of  
Quantitative Information', Brussels,  
11,9–10 June 2015.

<https://ec.europa.eu/jrc/en/event/conference/use-quantitative-information>



Philip Stark,  
University of Berkeley



My experience of the crisis in the quality of quantifications:  
perfunctory sensitivity analyses, fantastically precise digits...



The image shows a screenshot of the Nature journal website. At the top, the "nature" logo is displayed in white on a dark red background, with the tagline "International weekly journal of science" below it. A navigation bar contains links for Home, News & Comment, Research, Careers & Jobs, Current Issue, Archive, Audio & Video, and For Authors. Below this, a breadcrumb trail shows the path: Archive > Volume 532 > Issue 7598 > Correspondence > Article. The main content area features the text "ARTICLE PREVIEW" and a link to "view full access options". The article is categorized as "NATURE | CORRESPONDENCE" and includes share and print icons. The title of the article is "Modelling: Climate costing is politics not science" by Andrea Saltelli. Publication details include "Nature 532, 177 (14 April 2016)" and the DOI "10.1038/532177a".

**nature** International weekly journal of science

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Archive > Volume 532 > Issue 7598 > Correspondence > Article

ARTICLE PREVIEW

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NATURE | CORRESPONDENCE

Modelling: Climate costing is politics not science

Andrea Saltelli

Nature 532, 177 (14 April 2016) | doi:10.1038/532177a

Published online 13 April 2016

Saltelli, A., Funtowicz, S., Giampietro, M., Sarewitz, D., Stark, P.B., van der Sluijs, J.P., 2016, Climate costing is politics not science, Nature, 14 April, 532, 177.

# Current climate models are grossly misleading

Nicholas Stern calls on scientists, engineers and economists to help policymakers by better modelling the immense risks to future generations, and the potential for action.

25 FEBRUARY 2016 | VOL 530 | NATURE | 407

“The political will to make the necessary decisions depends partly on improving the analysis and estimates of the economics of climate change”



Things to be incorporated in ‘formal modelling’  
[sic]

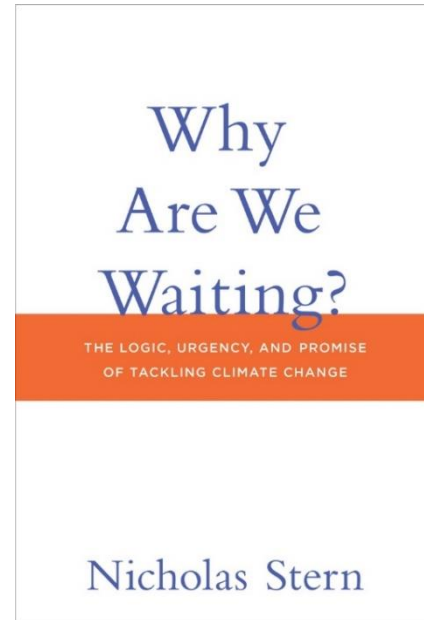
“Damage to social, organizational or  
environmental capital [⋯]

Damage to stock of capitals and land [⋯]

Damage to overall factor productivity [⋯]

Damage to learning and endogenous  
growth”, p. 145

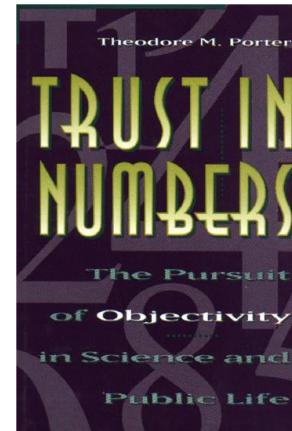
‘formal modelling’ as to produce ‘numbers’?



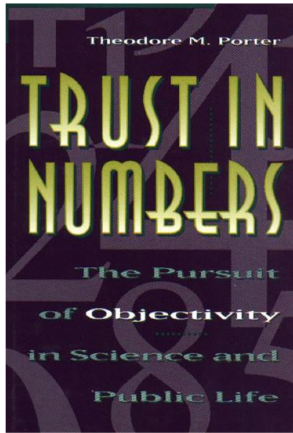
p. 8: “The appeal of numbers is especially compelling to bureaucratic officials who lack the mandate of a popular election, or divine right. Arbitrariness and bias are the most usual grounds upon which such officials are criticized. A decision made by the numbers (or by explicit rules of some other sort)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



Theodor M. Porter

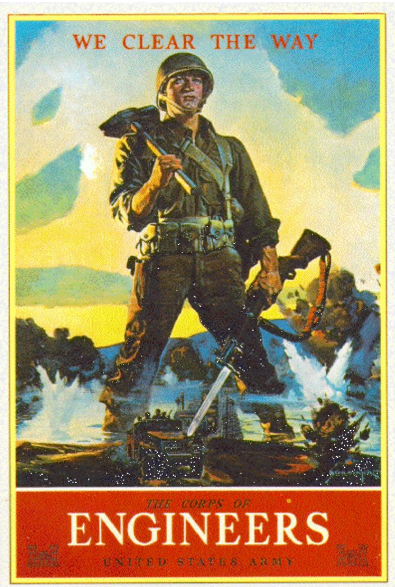
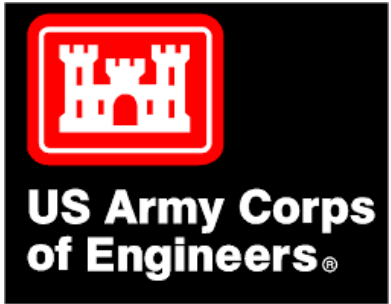


Theodore M. Porter, *Trust in Numbers, The Pursuit of Objectivity in Science and Public Life*, Princeton 1995



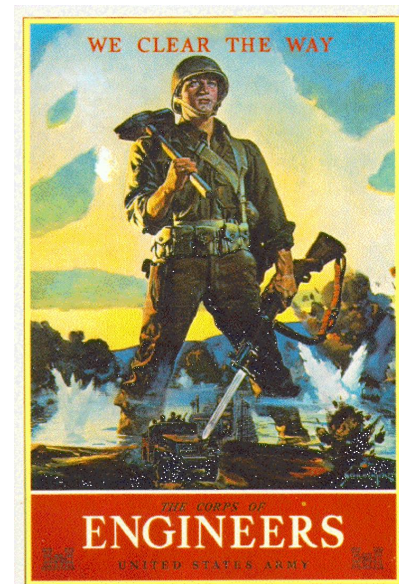
p. 8: “Scientific objectivity thus provides an answer to a moral demand for impartiality and fairness. Quantification is a way of making decisions without seeming to decide. Objectivity lends authority to officials who have very little of their own.”

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'.



Demarcation: facts  
separate from values

On demarcation:

“the incoming commission must find better ways of separating evidence-gathering processes from the ‘political imperative’”, A. Glover, former Chief Science Adviser of President Barroso (Wildson, 2014).



Anne Glover

Wildson, J. 2014. Evidence-based Union? A new alliance for science advice in Europe. In The Guardian. Available at: <http://www.theguardian.com/science/political-science/2014/jun/23/evidence-based-union-a-new-alliance-for-science-advice-in-europe>.

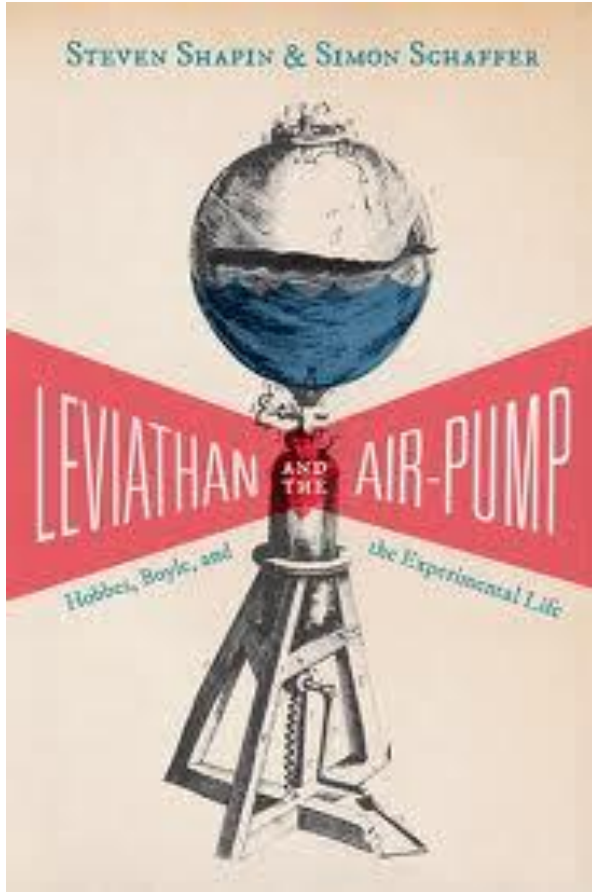
Evidence based policy: separation of facts from values, of scientists from their customers, on demarcation of roles...

Give science enough time and truth will emerge ...

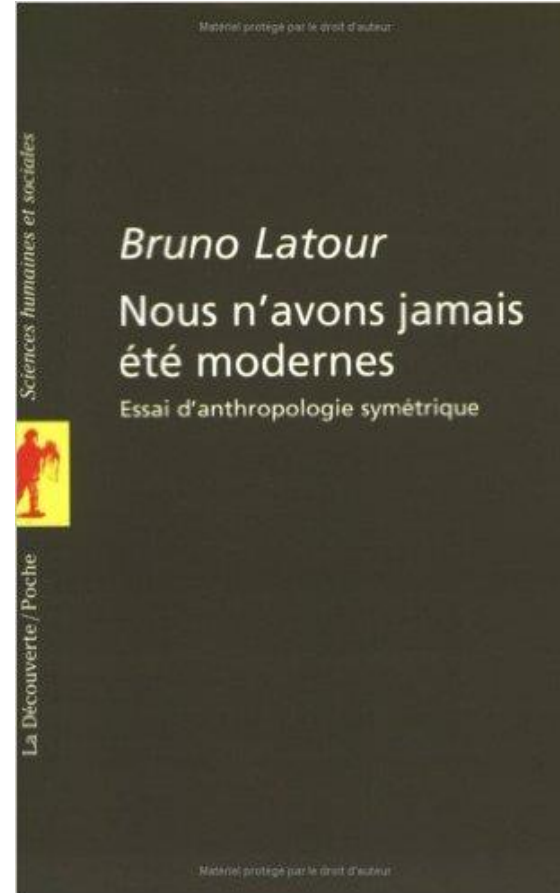




This separation has been said to defines modernity ...



Shapin, S., Schaffer, S., 1985, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*, Princeton, 2011 Edition



Latour, B., 1991, *Nous n'avons jamais été modernes*, Editions La découverte, 1993; *We Have Never Been Modern*. Cambridge, Harvard UP.



## ‘Demarcation model’ of science’s input to policy

- Protecting science from the political interference...
- Preventing possible abuse of science...
- ... and scientific information driven by agendas...
- Prescribes a clear demarcation between the institutions (and individuals) who provide the science, and those where it is used.

Funtowicz, S. 2006. What is Knowledge Assessment? In Guimarães Pereira, Â., Guedes Vaz, S. and Tognetti, S. (eds) Interfaces between Science and Society. Greenleaf Publishers, Sheffield.

Solution?

More recent epistemologies:

‘Post Normal Science’ (Funtowicz and Ravetz, 1993), ‘Co-production of knowledge’ model (Jasanoff, 1996).

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

Jasanoff, S. 1996, *Beyond Epistemology: Relativism and Engagement in the Politics of Science*. *Social Studies of Science*. 26(2) 393–418.



Sheila Jasanoff

# 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.

Van der Sluijs, JP, Petersen, AC, Janssen, PHM, Risbey, JS and Ravetz, JR (2008) 'Exploring the quality of evidence for complex and contested policy decisions', *Environmental Research Letters*, vol 3 024008 (9pp)

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

Where did this separation  
originate?



Francis Bacon  
(1561-1626)

Magnalia Naturae, in the  
New Atlantis (1627),  
*'Wonders of nature, in  
particular with respect to  
human use'*

Demarcation is part of the  
Cartesian dream of man as  
master and possessor of  
nature, of prediction and  
control, of Bacon's wonders  
of science and Condorcet's  
mathematique sociale...



René  
Descartes  
(1596-1650)

Discourse on Method  
(1637)



Nicolas de Caritat,  
marquis de Condorcet  
(1743- 1794)

*'Sketch for a Historical Picture of the  
Progress of the Human Spirit'*



Francis Bacon  
(1561–1626)

Magnalia  
Naturae, in  
the New  
Atlantis  
(1627),  
*‘Wonders of  
nature, in  
particular with  
respect to  
human use’*

The prolongation of life; The restitution of youth in some degree; The retardation of age; The curing of diseases counted incurable; The mitigation of pain; More easy and less loathsome purgings; The increasing of strength and activity; The increasing of ability to suffer torture or pain; The altering of complexions, and fatness and leanness; The altering of statures; The altering of features; The increasing and exalting of the intellectual parts; Versions of bodies into other bodies; Making of new species; Transplanting of one species into another; Instruments of destruction, as of war and poison; Exhilaration of the spirits, and putting them in good disposition; Force of the imagination, either upon another body, or upon the body itself; Acceleration of time in maturations; Acceleration of time in clarifications; Acceleration of putrefaction; Acceleration of decoction; Acceleration of germination; Making rich composts for the earth; Impressions of the air, and raising of tempests; Great alteration; as in induration, emollition, &c; Turning crude and watery substances into oily and unctuous substances; Drawing of new foods out of substances not now in use; Making new threads for apparel ; and new stuffs, such as paper, glass, &c; Natural divinations; Deceptions of the senses; Greater pleasures of the senses; Artificial minerals and cements.





Francis Bacon  
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*Magnalia Naturae, in the  
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[...]

Drawing of new foods out of substances not now in use; Making new threads for apparel; and new stuffs, such as paper, glass, &c; Natural divinations; Deceptions of the senses; Greater pleasures of the senses; Artificial minerals and cements.

We were nourished (and professionally trained) with the principles of the Cartesian dream.

This has deep governance implications due to the centrality of science in the formulation & adjudication of policy.



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

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



# The book's chapters

Dan Sarewitz, **Preface**; Pedro Almodóvar, Jonathan Swift, the floating island of Laputa and a portrayal of XVIII science; what lesson for science's present predicaments.



Chapter 1. Andrea Saltelli, Jerome Ravetz, Silvio Funtowicz: **Who will solve the crisis in science?** Is there a crisis? What is being done ‘from within’? Is this sufficient? What are the diagnoses for the crisis’ root causes, and what are the solutions ‘from without’?



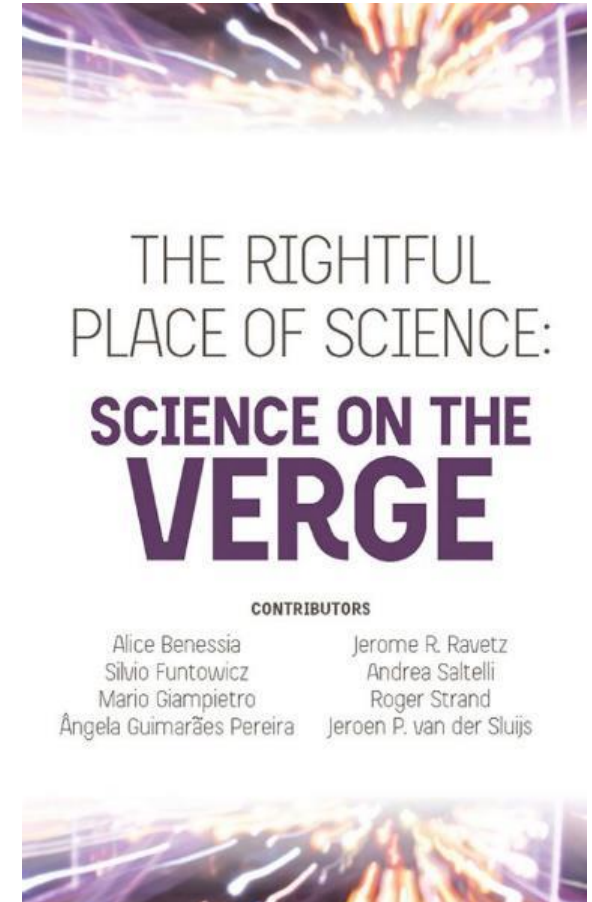
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Chapter 2. Andrea Saltelli, Mario Giampietro: **The fallacy of evidence based policy**: Quantification as hypocognition; socially constructed ignorance & uncomfortable knowledge; ancien régime syndrome; quantitative story telling.





Chapter 3. Alice Benessia, Silvio Funtowicz: **Never late, never lost, never unprepared**; Trajectories of innovation and modes of demarcation of science from society: ‘separation’, ‘hybridization’ and ‘substitution’; what contradictions these trajectories generate.



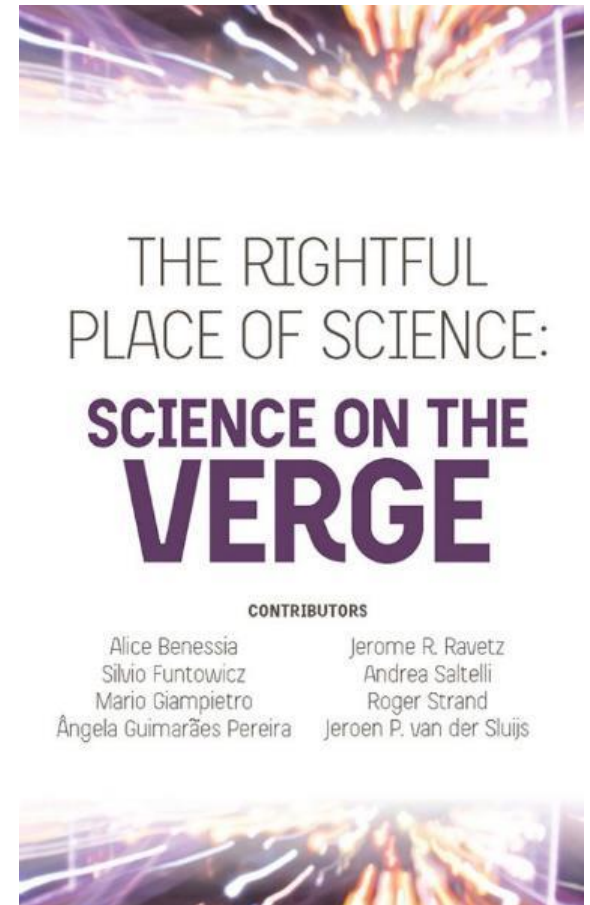
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Chapter 4. Ângela Guimarães Pereira, Andrea Saltelli: **Institutions on the verge**; working at the science policy interface; The special case of the European Commission's in house science service; the Joint Research Centre as a boundary institutions; diagnosis, challenges and perspectives.



Chapter 5. Jeroen van der Sluijs:  
**Numbers running wild**; Uses and abuses of quantification and the loss of ‘craft skills’ with numbers; 7.9% of all species shall become extinct.



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Chapter 6. Roger Strand: **Doubt has been eliminated**; Gro Harlem Brundtland's famous 2007 speech, after the Fourth IPCC report and the Stern review; when science becomes a 'life philosophy'; science as the metaphysics of modernity; the Norwegian Research Ethics Committee for Science and Technology inquiry.



While trust in science as such appears to be still substantially unscathed, the use of science to adjudicate policy disputes is increasingly conflicted;

This entails a crisis in the dual legitimacy system at the heart of modernity: that of science providing the facts and policy taking care of the values.



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"Wow. This penetrating, frightening, provocative and irrefutable view of the debasing of science cuts to—and through—the bone. Every producer, consumer and believer of 'science' should read this book, whether interested in pesticides, GMOs, nuclear power, climate change, psychology or fiscal policy."

*Professor Philip B. Stark, Associate Dean, Division of Mathematical and Physical Sciences, University of California Berkeley*

"An uncomfortable but vital diagnosis of the trouble with science. It describes valuable efforts by scientists to heal themselves, including movements for open access and social responsibility, but is clear about the limits of these endeavours. This book is certainly critical, but it is resolutely constructive."

*Professor Jack Stilgoe, Senior Lecturer, Department of Science and Technology Studies, University College London*



END

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