

# Statistics on the Verge

Andrea Saltelli

Centre for the Study of the Sciences and the Humanities,  
University of Bergen, and Open Evidence Research, Open  
University of Catalonia

Lecture for the Bergen Students Association,  
September 11, 2018,  
Det Akademiske Kvarter, Bergen



# Where to find this talk: [www.andreasaltelli.eu](http://www.andreasaltelli.eu)



The screenshot shows the homepage of the website [www.andreasaltelli.eu](http://www.andreasaltelli.eu). The browser's address bar displays the URL. The website features a teal header with the name "Andrea Saltelli" and a navigation menu with links: HOME, ABOUT ME, PUBLICATIONS, NEWS & VIDEOS, and RESOURCES. A red arrow points from the "RESOURCES" link to a dropdown menu that contains "PRESENTATIONS" and "OTHER RESOURCES". The main content area has a background image of terraced rice fields with the text "CAETERIS ARE NEVER PARIBUS". On the right, there is a "Tweets" section by @AndreaSalte, featuring a tweet from andrea saltelli (@AndreaSaltelli) about a science credibility crisis, accompanied by a photo of a microscope.

www.andreasaltelli.eu

Andrea Saltelli

HOME ABOUT ME PUBLICATIONS NEWS & VIDEOS RESOURCES

PRESENTATIONS  
OTHER RESOURCES

Tweets by @AndreaSalte

andrea saltelli  
@AndreaSaltelli

Thoughts on Ioannidis' latest article:  
[onlinelibrary.wiley.com/doi/10.1111/ec...](https://onlinelibrary.wiley.com/doi/10.1111/ec...)  
[theconversation.com/sciences-credi...](https://theconversation.com/sciences-credi...) via  
@TC\_Africa

Science's credibility crisis: why it will g...  
We are observing two new phenomena...  
[theconversation.com](https://theconversation.com)

4h





# 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



ELSEVIER

Contents lists available at [ScienceDirect](http://www.sciencedirect.com)

Futures

journal homepage: [www.elsevier.com/locate/futures](http://www.elsevier.com/locate/futures)

## What is science's crisis really about?

Andrea Saltelli<sup>a,b,\*</sup>, Silvio Funtowicz<sup>a</sup>

<sup>a</sup> Centre for the Study of the Sciences and the Humanities (SVT), University of Bergen, Norway

<sup>b</sup> Institute of Environmental Science and Technology (ICTA), Universitat Autònoma de Barcelona, Spain



ELSEVIER

Contents lists available at [ScienceDirect](http://www.sciencedirect.com)

Futures

journal homepage: [www.elsevier.com/locate/futures](http://www.elsevier.com/locate/futures)

## Why science's crisis should not become a political battling ground

Andrea Saltelli

Centre for the Study of the Sciences and the Humanities – University of Bergen, Norway; Open Evidence Research, Universitat Oberta de Catalunya (UOC), Barcelona, Spain

# Questions

In the text announcing the lecture

- Is statistics bad, or are we infinitely bad at statistics?
- Statistics form the basis for much of our knowledge of society, but can you really rely on statistics?

# Crisis in statistics?

Statistics is experiencing a quality control crisis

- The reproducibility crisis is partly blamed on the statistical test (primarily the p-test) used to gain ‘confidence’ in the identification of an effect
- The p-test is in fact generally misinterpreted

This video gives a crash course in false positive and false negative in 1:35

**The Economist**

### 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*

<https://www.economist.com/graphic-detail/2013/10/21/unlikely-results>



ROYAL SOCIETY  
OPEN SCIENCE

[rsos.royalsocietypublishing.org](http://rsos.royalsocietypublishing.org)

Review



**Cite this article:** Colquhoun D. 2014 An investigation of the false discovery rate and the misinterpretation of  $p$ -values. *R. Soc. open sci.* **1**: 140216.

<http://dx.doi.org/10.1098/rsos.140216>

# An investigation of the false discovery rate and the misinterpretation of $p$ -values

---

David Colquhoun

---

Department of Neuroscience, Physiology and Pharmacology, University College  
London, Gower Street, London WC1 6BT, UK

**P-hacking** (fishing for favourable p-values) and  
**HARKing** (formulating the research **H**ypothesis  
After the **R**esults are **K**nown);  
Desire to achieve a sought for – or simply  
publishable – result leads to fiddling with the data  
points, the modelling assumptions, or the research  
hypotheses themselves

Leamer, E. E. Tantalus on the Road to Asymptopia. J. Econ. Perspect. 24, 31–46 (2010).

Kerr, N. L. HARKing: Hypothesizing After the Results are Known. Personal. Soc. Psychol. Rev. 2, 196–217 (1998).

A. Gelman and E. Loken, “The garden of forking paths: Why multiple comparisons can be a problem, even when there is no ‘fishing expedition’ or ‘p-hacking’ and the research hypothesis was posited ahead of time,” 2013.



Effect or no  
effect?



**nature**  
International journal of science



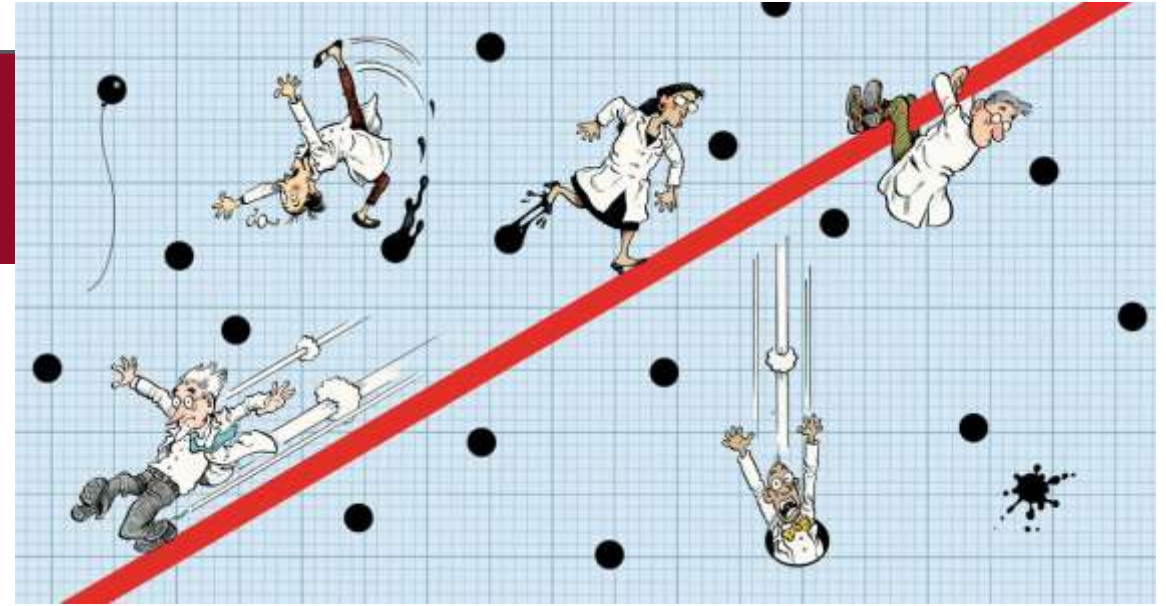


**nature**  
International journal of science

**COMMENT** • 28 NOVEMBER 2017

# Five ways to fix statistics

*As debate rumbles on about how and how much poor statistics is to blame for poor reproducibility, Nature asked influential statisticians to recommend one change to improve science. The common theme? The problem is not our maths, but ourselves.*



---

Jeff Leek , Blakeley B. McShane, Andrew Gelman , David Colquhoun , Michèle B. Nuijten  & Steven N. Goodman 



—  
CORRESPONDENCE • 16 JANUARY 2018

**nature**  
International journal of science

# Fixing statistics is more than a technical issue

[Andrea Saltelli](#) ✉ & [Philip Stark](#)

<https://www.nature.com/articles/d41586-018-00647-9>

—  
CORRESPONDENCE • 16 JANUARY 2018

**nature**  
International journal of science

# Integrity must underpin quality of statistics

[Jerome Ravetz](#) ✉

<https://www.nature.com/articles/d41586-018-00648-8>

The great paradox of science is that passionate practitioners must carefully produce dispassionate facts (J. Ravetz *Scientific Knowledge and its Social Problems* Oxford Univ. Press; 1971). Meticulous technical and normative judgement, as well as morals and morale, are necessary to navigate the forking paths of the statistical garden (Saltelli and Stark, 2018)

All users of statistical techniques, as well as those in other mathematical fields such as modelling and algorithms, need an effective societal commitment to the maintenance of quality and integrity in their work. If imposed alone, technical or administrative solutions will only breed manipulation and evasion (Ravetz, 2018)

# Blaming statistics?

“dodgy statistics”

“statistical sausage factory”



van Gilder Cooke, S. (2016) The unscientific method. New Scientist, 16 April.



# Statistics reacts

The discipline of statistics has been going through a phase of critique and self-criticism, due to mounting evidence of poor statistical practice of which misuse and abuse of the P-test is the most visible sign



AMERICAN STATISTICAL ASSOCIATION  
Promoting the Practice and Profession of Statistics®

732 North Washington Street, Alexandria, VA 22314 • (703) 684-1221 • Toll Free: (888) 231-3473 • [www.amstat.org](http://www.amstat.org) • [www.twitter.com/AmstatNews](https://twitter.com/AmstatNews)

## 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

# + twenty-one ‘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.

See also Christie Aschwanden at <http://fivethirtyeight.com/features/not-even-scientists-can-easily-explain-p-values/>

# Crisis in science?

There have recently been alarms as to the scientific quality arrangement is several disciplines. The most visible symptom of this possible dysfunction is the so-called reproducibility crisis

The  
Economist

OCTOBER 19TH-25TH 2013

[Economist.com](http://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

On the radar:  
October 2013





# Why Most Published Research Findings Are False

John P. A. Ioannidis

2005



John P. A.  
Ioannides

J. P. A. Ioannidis, Why Most Published Research Findings Are False, PLoS Medicine, August 2005, 2(8), 696–701.



Failed replications, entire subfields going bad,  
fraudulent peer reviews, predatory publishers,  
perverse metrics, statistics on trial ...

... misleading science advice, institutions on  
denial, a new breed of science wars


The crisis is methodological, epistemological,  
ethical and metaphysical

 OPEN ACCESS

ESSAY

June 21, 2017

Why Most Clinical Research Is Not Useful

John P. A. Ioannidis 

Published: June 21, 2016 • <https://doi.org/10.1371/journal.pmed.1002049>

THE POWER OF BIAS IN ECONOMICS RESEARCH\*

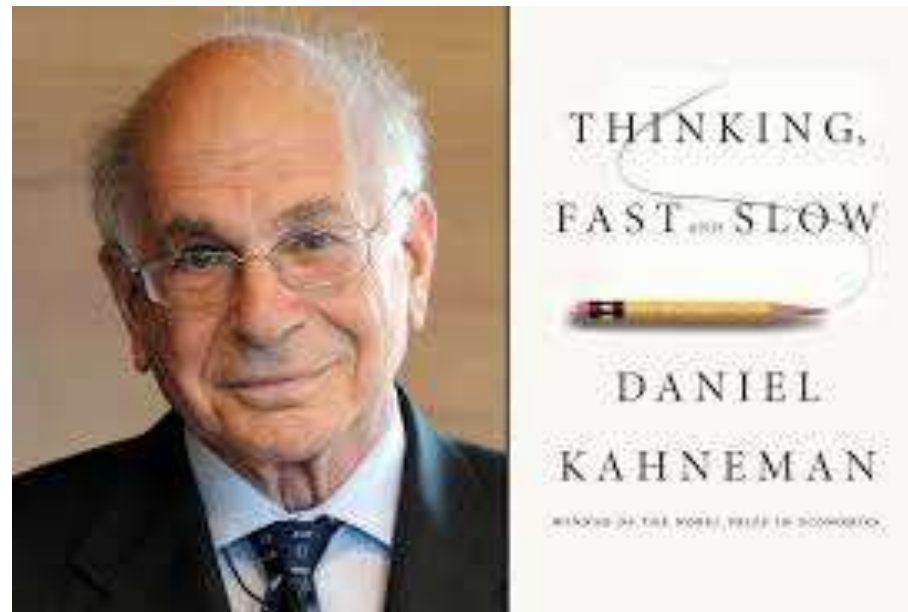
*John P. A. Ioannidis, T. D. Stanley and Hristos Doucouliagos*

October 27, 2017

Rather than isolated instances  
of corruption now entire fields  
of research are found diseased



Reconstruction of a Train Wreck: How Priming Research Went off the Rails



“[...]questions have been raised about the robustness of priming results ... your **field** is now the poster child for doubts about the integrity of psychological research...”

<https://replicationindex.wordpress.com/2017/02/02/reconstruction-of-a-train-wreck-how-priming-research-went-of-the-rails/comment-page-1/>



# An existential crisis?

Most observers have noted that the crisis has technical as well as ethical and behavioural elements which interact with one another – e.g. the ‘publish or perish’ obsession has an impact on selection bias – the tendency to favour positive over negative results

Bad science reproduces  
better than the good sort

ROYAL SOCIETY  
OPEN SCIENCE

[rsos.royalsocietypublishing.org](http://rsos.royalsocietypublishing.org)



**Cite this article:** Smaldino PE, McElreath R.  
2016 The natural selection of bad science.  
*R. Soc. open sci.* **3**:160384.  
<http://dx.doi.org/10.1098/rsos.160384>

Received: 1 June 2016

Accepted: 17 August 2016

# The natural selection of bad science


---

Paul E. Smaldino<sup>1</sup> and Richard McElreath<sup>2</sup>

---

<sup>1</sup>Cognitive and Information Sciences, University of California, Merced, CA 95343, USA

<sup>2</sup>Department of Human Behavior, Ecology, and Culture, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

 PES, 0000-0002-7133-5620; RME, 0000-0002-0387-5377

Poor research design and data analysis encourage false-positive findings. Such poor methods persist despite perennial calls for improvement, suggesting that they result from something more than just misunderstanding. The persistence of poor methods results partly from incentives that favour them, leading to the natural selection of bad science. This dynamic requires no conscious strategizing—no deliberate cheating nor loafing—by scientists, only that publication is a principal factor for

As in the real world, successful labs produce more 'progeny,' such that their methods are more often copied and their students are more likely to start labs of their own. Selection for high output leads to poorer methods and increasingly high false discovery rates.

Improving the quality of research requires change at the institutional level.

Smaldino PE, McElreath R., 2016 The natural selection of bad science. R. Soc. open sci. 3: 160384. <http://dx.doi.org/10.1098/rsos.160384>

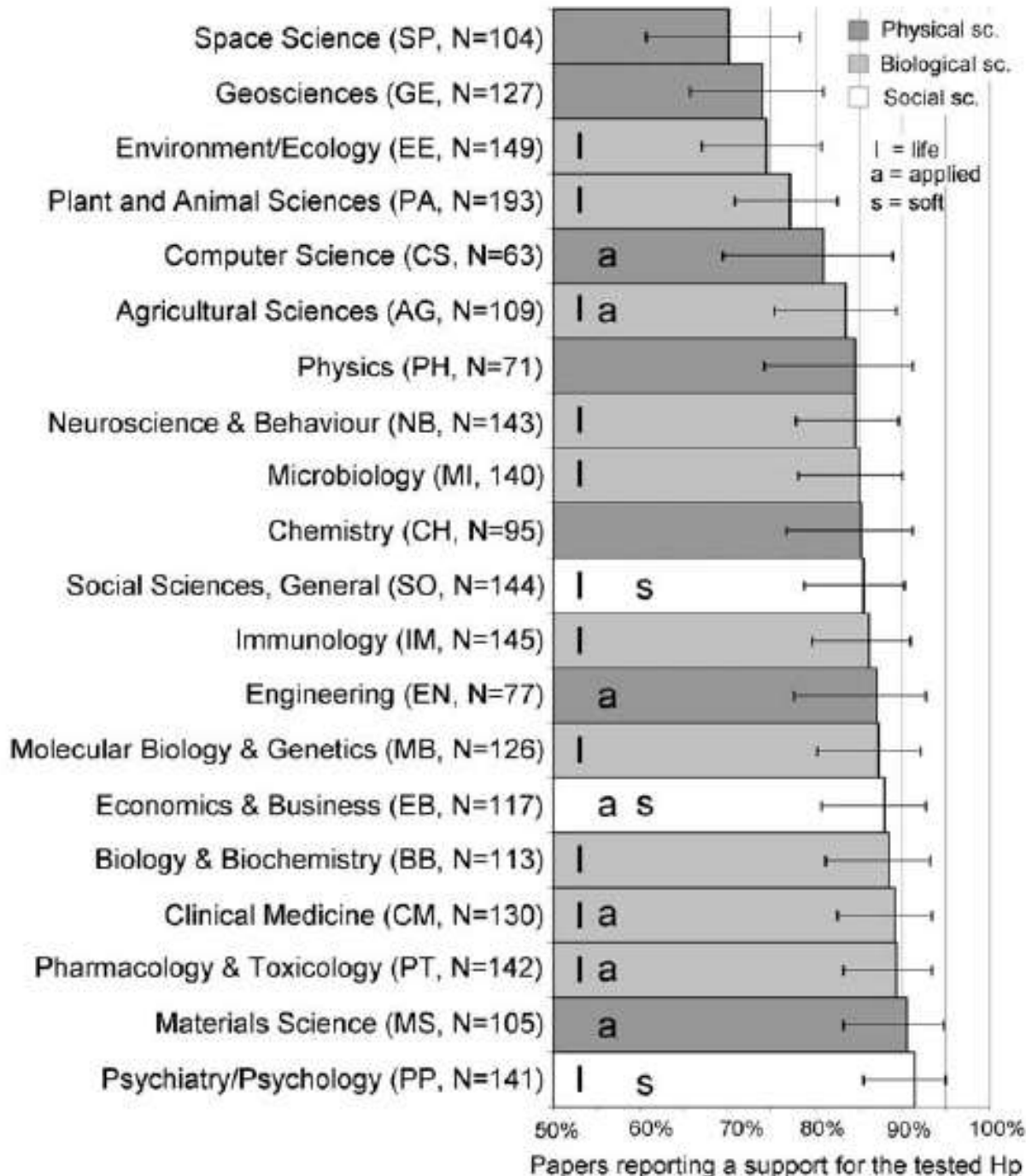
Not all disciplines  
the same



# “Positive” Results Increase Down the Hierarchy of the Sciences

Daniele Fanelli\*

INNOGEN and ISSI-Institute for the Study of Science, Technology & Innovation, The University of Edinburgh, Edinburgh, United Kingdom



“odds of reporting a positive result ~5 times higher among papers in the disciplines of Psychology and Psychiatry and Economics and Business than Space Science”

April 7, 2010

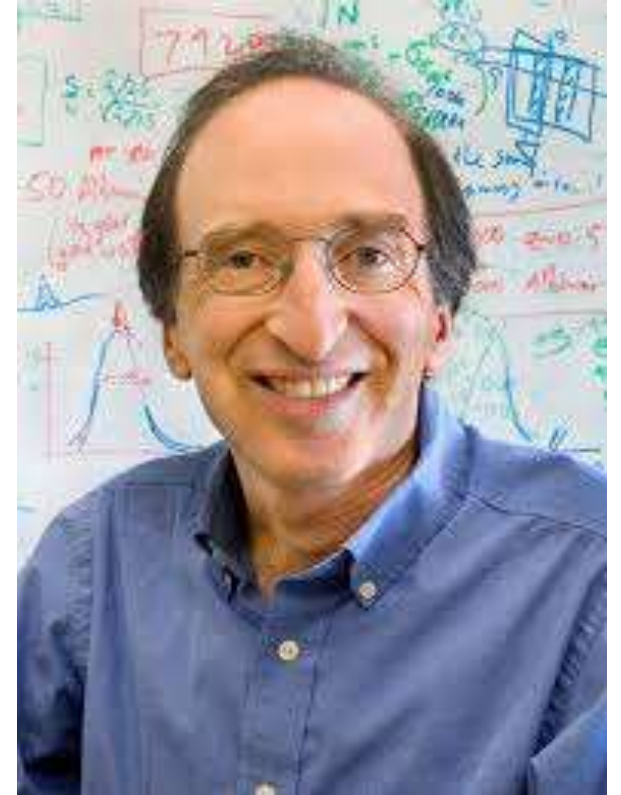
# Physics as a model:

Following several high-profile errors, the particle physics community now invests great effort into intensive checking and re-checking of data prior to publication. By filtering results through independent working groups, physicists are encouraged to criticise.

R. Horton, “Offline: What is medicine’s 5 sigma?,” **Lancet**, vol. 385, p. 1380, 2015.

Saul Perlmutter, an astrophysicist at the University of California, Berkeley.

“Science is an ongoing race between our inventing ways to fool ourselves, and our inventing ways to avoid fooling ourselves.



Saul Perlmutter

R. Nuzzo, “How scientists fool themselves – and how they can stop,”  
Nature, vol. 526, no. 7572, pp. 182–185, Oct. 2015.

# What is science, or who is a scientist?



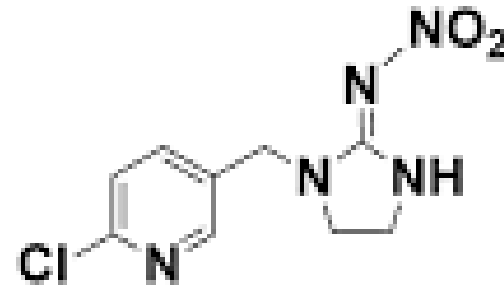
Mark Edwards,  
Aleksandr Kogan

Paolo Macchiarini,  
Rick Mishkin





Shoddy science, entrepreneurial science, reckless science, and dirty science (Ravetz, 1971)



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



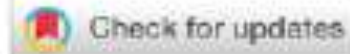
Back to statistics: has it  
become a ritual (the cargo  
cult hypothesis)?

## Surrogate Science

*The Idol of a Universal Method for Scientific Inference*

Gerd Gigerenzer, Julian N. Marewski,

First Published September 2, 2014 | Research Article |



<https://doi.org/10.1177/0149206314547522>

Advances in Methods and Practices in Psychological Science **apsp**

## Statistical Rituals: The Replication Delusion and How We Got There

Gerd Gigerenzer,

First Published June 14, 2018 | Research Article |



<https://doi.org/10.1177/2515245918771329>

IN PRACTICE

## Cargo-cult statistics and scientific crisis

---

ROYAL  
STATISTICAL  
SOCIETY  
DATA · EVIDENCE · DECISIONS

ASA  
AMERICAN STATISTICAL  
ASSOCIATION

significance

The mechanical, ritualistic application of statistics is contributing to a crisis in science. Education, software and peer review have encouraged poor practice – and it is time for statisticians to fight back. By **Philip B. Stark** and **Andrea Saltelli**

Is it that statistics is  
difficult, like baseball,  
or knitting?



“applied statistics is hard. Doing a statistical analysis is like playing basketball, or knitting a sweater. You can get better with practice”



Andrew Gelman

<https://andrewgelman.com/2016/03/11/statistics-is-like-basketball-or-knitting/>



“20% of the faculty teaching statistics in psychology, 39% of the professors and lecturers, and 66% of the students” don’t understand what the P-test is about

Gigerenzer, G., 2018, Statistical Rituals: The Replication Delusion and How We Got There, *Advances in Methods and Practices in Psychological Science*, 1–21

# The statistical garden of the forking paths

Jorge Luis Borges



Andrew Gelman



[http://www.stat.columbia.edu/~gelman/research/unpublished/p\\_hacking.pdf](http://www.stat.columbia.edu/~gelman/research/unpublished/p_hacking.pdf)

How badly are taught?

Kuhn said that the “educational initiation that prepares and licenses the student for professional practice... is both rigorous and rigid”

and “It is a narrow and rigid education [in physics/science], probably more so than any other except perhaps in orthodox theology”



Thomas Kuhn, *The structure of scientific revolution*, 192, Chapters I and XIII

and “the member of a mature scientific community is, like the typical character of Orwell’s 1984, the victim of a history rewritten by the powers that be.”

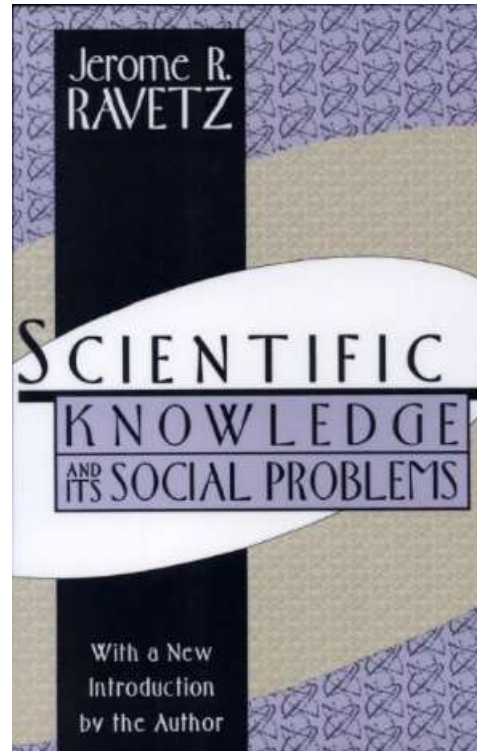


Thomas Kuhn, The structure of scientific revolution, 192, Chapter XIII



Thus disciplinary advancements are presented in textbooks as the “perception of the obvious” made by one-eyed men in the kingdom of the blinds (Ravetz, 1971).

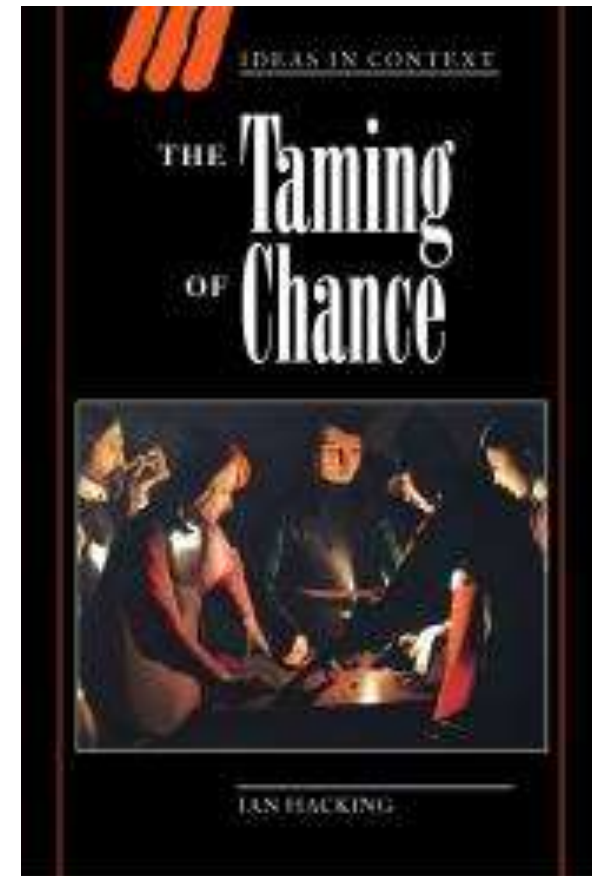
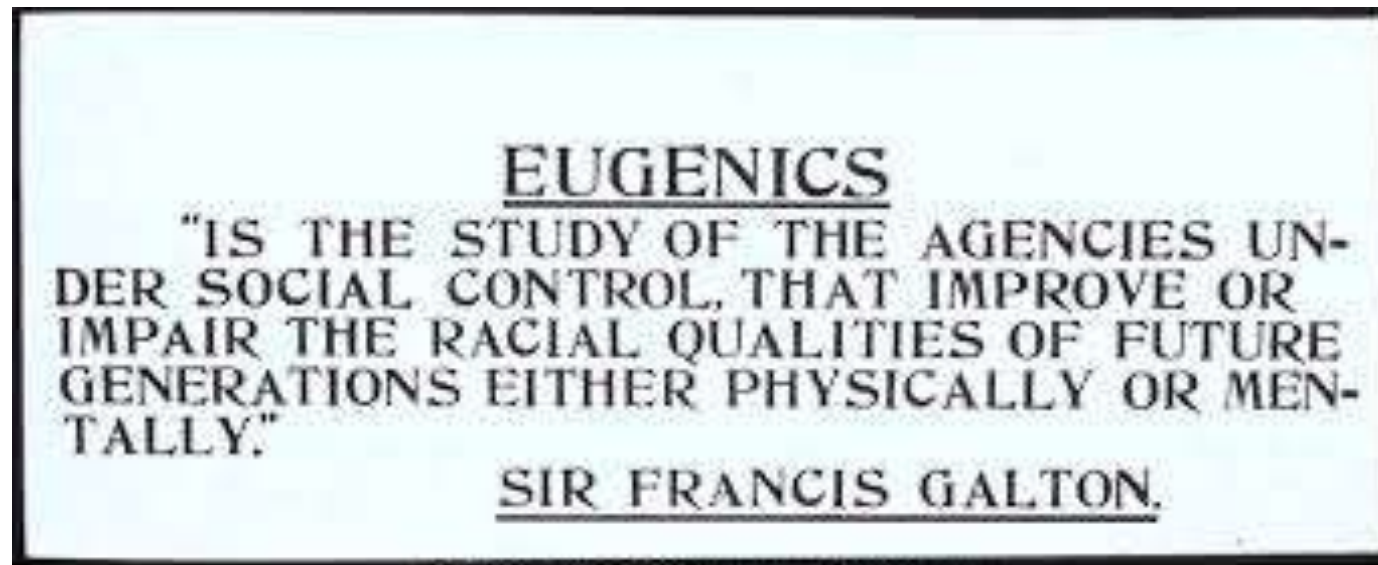
Ravetz, J., 1971, Scientific Knowledge and its Social Problems, Oxford University Press.



Jerome R.  
Ravetz

Statisticians may ignore the role of statistics in Eugenics; chemists what is phlogiston; geologists the hostile reception of Wegener's theory of continental drift (1915) ...

Francis Galton and Karl Pearson (the one of chi-squared); laboratory of biometrics; distinguishing army officers from private soldiers from criminals convicted of murder from non-violent felons from Jews ...



## How bad are we taught statistics?

- The myth of efficiency in university departments
- Recipes instead of judgment, facilitated by low expectations
- All this ‘friendly’ software ...

# Hence? What to do?

In the age of post truth, conspiracy theories, big data and algorithms there is no lack of occasion for taking side with critical spirit, upholding good scientific practice without hubris, trusting science with circumspection.



IN PRACTICE

Young statistician,  
you shall live in  
adventurous times



The so-called "crisis in science" presents challenges for statisticians starting out in their career. But there are strategies for survival, says **Andrea Saltelli**

IN PRACTICE

## Cargo-cult statistics and scientific crisis

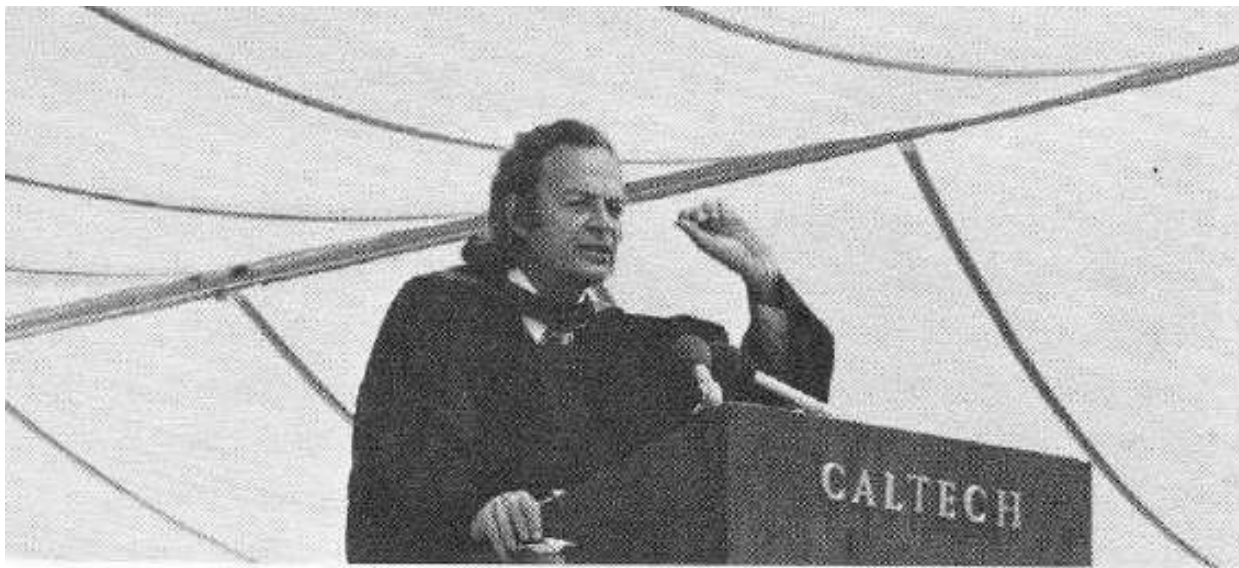
---

ROYAL  
STATISTICAL  
SOCIETY  
DATA · EVIDENCE · DECISIONS

ASA  
AMERICAN STATISTICAL  
ASSOCIATION

significance

A lesson from a  
recent past



# Cargo Cult Science

by RICHARD P. FEYNMAN

**Some remarks on science, pseudoscience,  
and learning how to not fool yourself.  
Caltech's 1974 commencement address.**



“[...] there is one feature I notice that is generally missing in cargo cult science. That is the idea that we all hope you have learned in studying science in school [...] .





It's a kind of scientific integrity, a principle of scientific thought that corresponds to a kind of utter honesty—a kind of leaning over backwards. [...] Details that could throw doubt on your interpretation must be given, if you know them. [...] give all of the information to help others to judge the value of your contribution.”



# The End



@andreasaltelli

From science crisis to  
science wars?

# A new breed of science wars, predicted in 2016



January 27, 2017

## To tackle the post-truth world, science must reform itself

Andrea Saltelli, *University of Bergen* and Silvio Oscar Funtowicz, *University of Bergen*

Scientists must bear some responsibility for the post-truth era and the current crisis in democracy.



November 16, 2016

## Science wars in the age of Donald Trump

Andrea Saltelli, *University of Bergen* and Silvio Oscar Funtowicz, *University of Bergen*

Is the election of Donald Trump going to reignite a futile war between science and anti-science?

# What the present science war looks like:

## **Opinion: Is science really facing a reproducibility crisis, and do we need it to?**

Daniele Fanelli

PNAS March 12, 2018. 201708272; published ahead of print March 12, 2018. <https://doi.org/10.1073/pnas.1708272114>



“The new “science is in crisis” narrative is not only empirically unsupported, but also quite obviously counterproductive. Instead of inspiring younger generations to do more and better science, it might foster in them cynicism and indifference. Instead of inviting greater respect for and investment in research, it risks discrediting the value of evidence and feeding antiscientific agendas.”

# What the present science war looks like:

## **Crisis or self-correction: Rethinking media narratives about the well-being of science**

Kathleen Hall Jamieson

PNAS March 13, 2018. 115 (11) 2620-2627; published ahead of print March 12, 2018. <https://doi.org/10.1073/pnas.1708276114>



“Because those whose work is prominently cited to certify that science is broken [Ioannidis, Oransky, Begley, and Nosek among them] are spearheading efforts to solve identified problems, their work is evidence of the resilience of science”



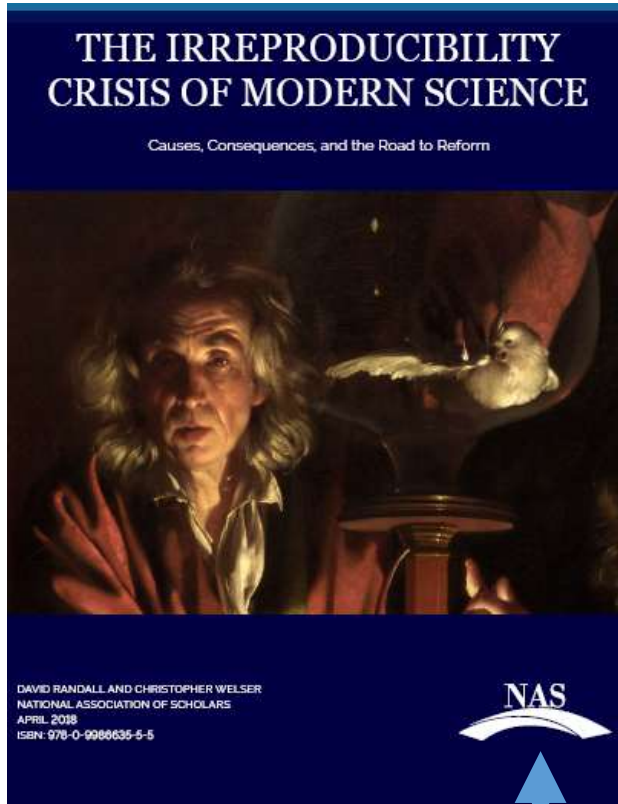
“Even well-intentioned academics, perceiving an attack on science, may be tempted to take an unproductive, hand-waving defensive position: ‘We have no problem with reproducibility’, ‘everything is fine’, ‘science is making progress’.”



John P. A.  
Ioannides

J. P. A. Ioannidis, “All science should inform policy and regulation,” PLOS Med., vol. 15, no. 5, p. e1002576, May 2018.

On the other side: (conservatives, corporations)



Crisis? Yes, due to progressives' assault on higher education with ideologies such as “neo-Marxism, radical feminism, historicism, post-colonialism, deconstructionism, post-modernism, liberation theology”

National Association of Scholars

# THE IRREPRODUCIBILITY CRISIS OF MODERN SCIENCE

Causes, Consequences, and the Road to Reform



DAVID RANDALL AND CHRISTOPHER WELSER  
NATIONAL ASSOCIATION OF SCHOLARS  
APRIL 2018  
ISBN: 978-0-9986635-5-5



“Congress should pass an expanded Secret Science Reform Act to prevent government agencies from making regulations based on irreproducible research ...”

**THE GLOBAL WARMING  
POLICY FOUNDATION**

Director: Dr Benny Peiser



Common Sense on  
Climate Change

Date: 27/10/16 | Global Warming Policy Foundation

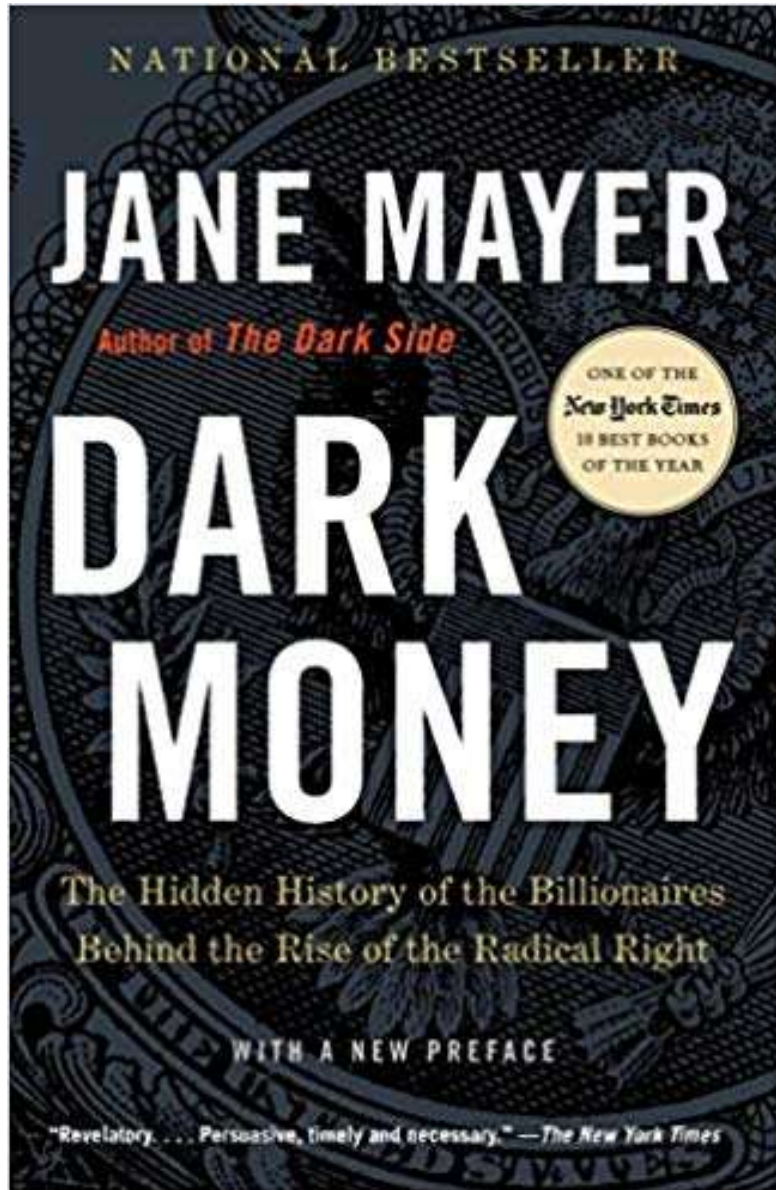
# PEER REVIEW

## Why skepticism is essential

Donna Laframboise

“If half of published, peer-reviewed papers ‘may simply be untrue’, half of the papers cited by the IPCC may also be untrue...”





Chapter 8, The  
fossils, on Koch  
brothers against  
climate



# Gaming the crisis, also in Europe

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>



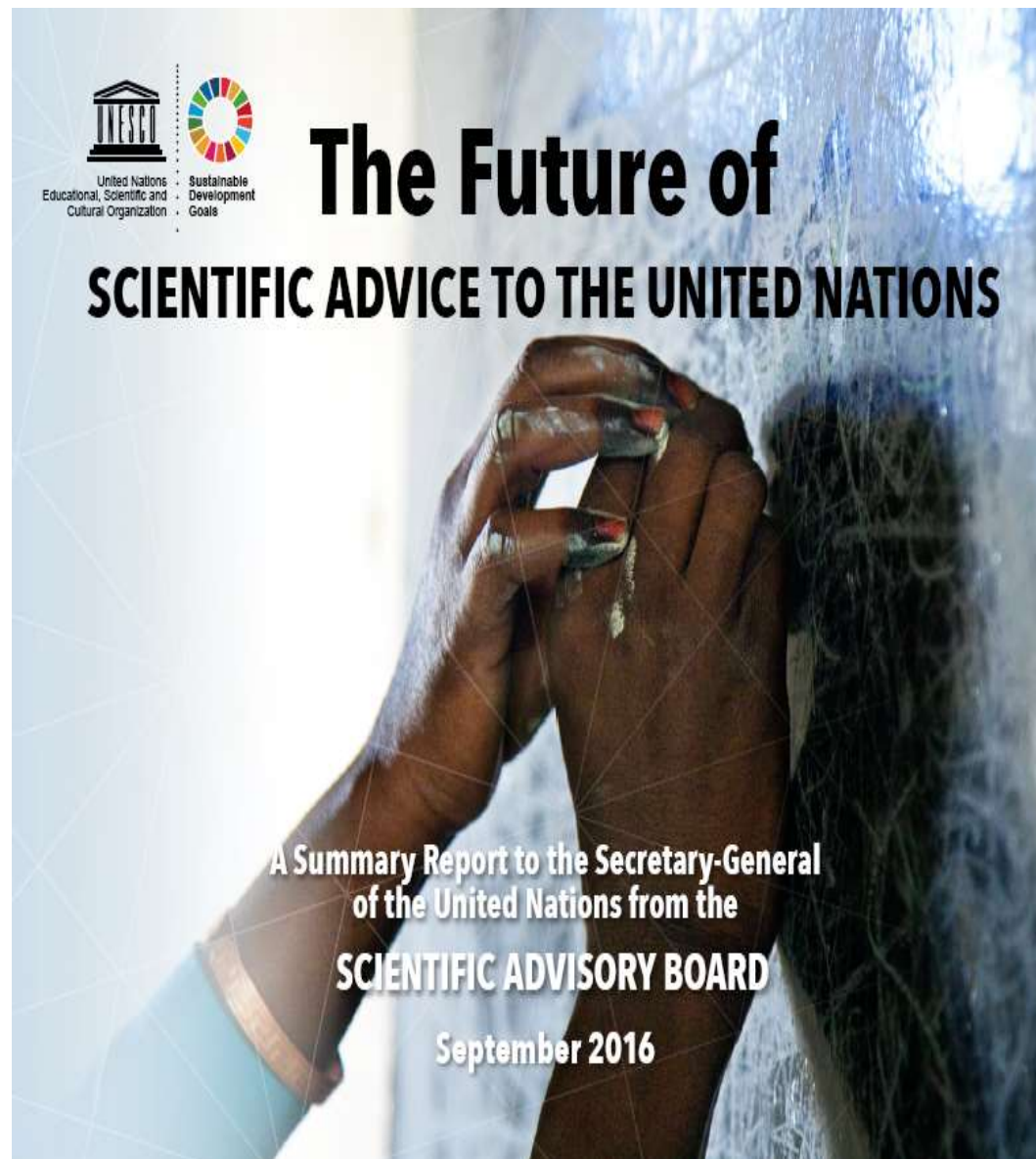
OECD Science, Technology and Industry  
Policy Papers No. 21

## Scientific Advice for Policy Making

THE ROLE AND RESPONSIBILITY OF EXPERT  
BODIES AND INDIVIDUAL SCIENTISTS

OECD

2015

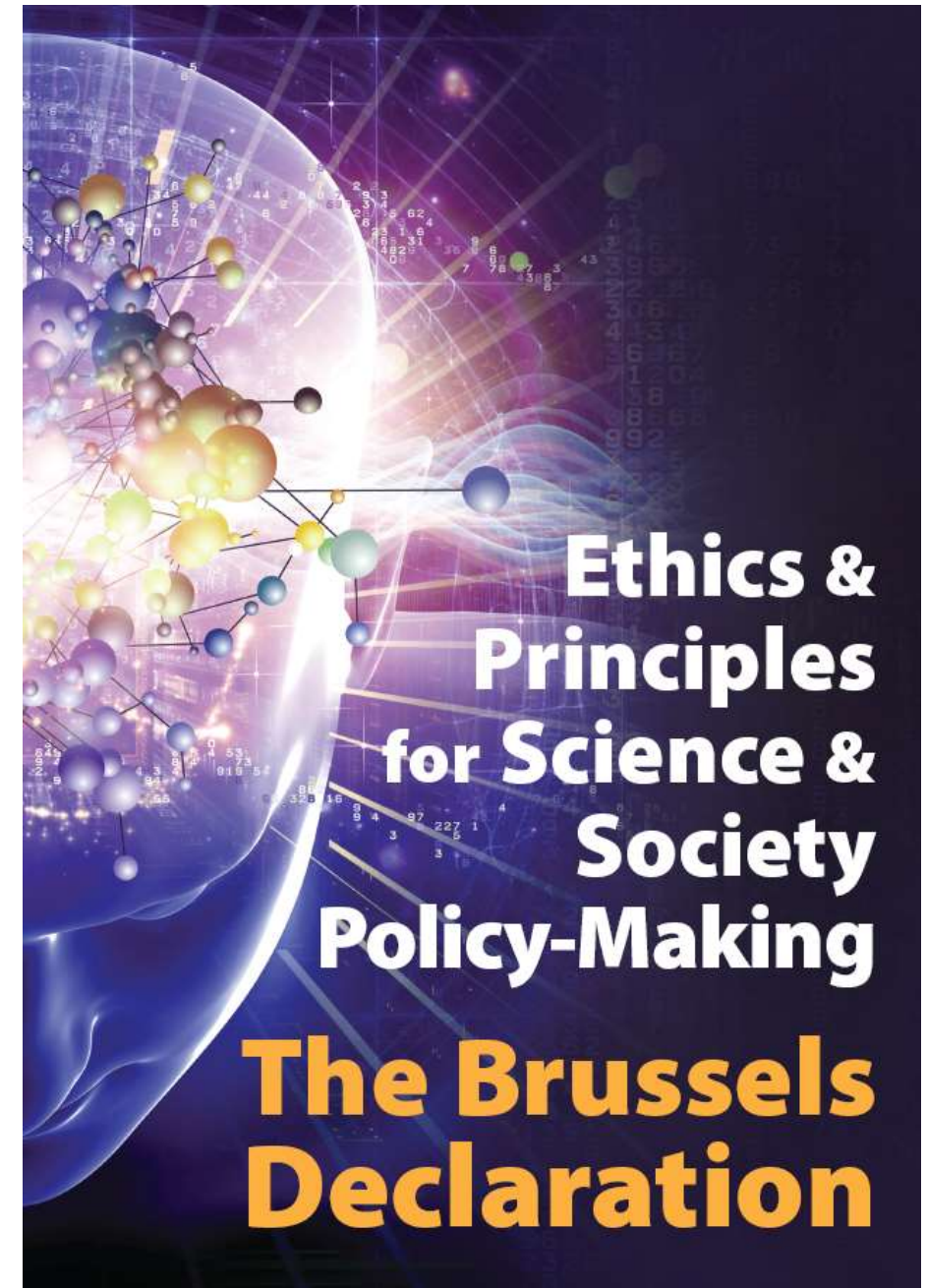


2016

Adopted Feb. 2017 at AAAS  
symposium, 5y gestation

Hundreds of experts involved

- No crisis
- No effect of crisis on  
evidence based policy



... extensive involvement of tobacco and alcohol industry actors... the Declaration offers potential to serve as a vehicle for advancing the vested interests of corporate sectors in public policymaking and appears to have been regarded in this way by a range of organisations related to the alcohol industry

J. McCambridge, M. Daube, and M. McKee, “Brussels Declaration: a vehicle for the advancement of tobacco and alcohol industry interests at the science/policy interface?,” Tob. Control, p. tobaccocontrol-2018-054264, Jun. 2018.

L. Bero, “Ten tips for spotting industry involvement in science policy.,” Tob. Control, p. tobaccocontrol-2018-054386, Jun. 2018.

A left-right divide in the reading of the  
present predicaments is unhelpful and  
dangerous

The same for a too complacent attitude of  
science institutions toward corporate interests

Ewen Callaway, 2018, CRISPR plants now subject to tough GM laws in European Union, Top court's ruling threatens research on gene-edited crops in the bloc, Nature,  
doi: 10.1038/d41586-018-05814-6, <https://www.nature.com/articles/d41586-018-05814-6>



Alternative reading of the crisis: structural contradictions have emerged in modern science

Addressing them should be the focus of our attention

J.R. Ravetz, Postnormal Science and the maturing of the structural contradictions of modern European science, *Futures*, 43(2), (2011), pp. 142–148.

# Does history repeats itself?

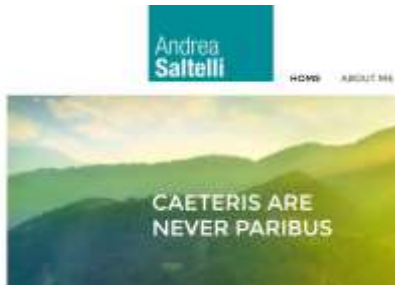
(Love canal, Flint...)



Lois Gibbs



Marc Edwards



[http://www.andreasaltelli.eu/file/repository/LOVE\\_CANAL.pdf](http://www.andreasaltelli.eu/file/repository/LOVE_CANAL.pdf)

[https://en.wikipedia.org/wiki/Flint\\_water\\_crisis](https://en.wikipedia.org/wiki/Flint_water_crisis); <http://flintwaterstudy.org/>;

<http://www.nytimes.com/2016/08/21/magazine/flints-water-crisis-and-the-troublemaker-scientist.html>

# Different cultures, different reactions



Yoshiki Sasai 1962 – 2014

<http://www.nature.com/news/stem-cell-pioneer-blamed-media-bashing-in-suicide-note-1.15715>

# Different cultures, different reactions



Aaron Swartz, 1986 – 2013

<https://www.rollingstone.com/culture/news/the-brilliant-life-and-tragic-death-of-aaron-swartz-20130215>

ARTICLE IN PRESS

Futures xxx (xxxx) xxx–xxx



Contents lists available at [ScienceDirect](#)

Futures

journal homepage: [www.elsevier.com/locate/futures](http://www.elsevier.com/locate/futures)



## Why science's crisis should not become a political battling ground

Andrea Saltelli

*Centre for the Study of the Sciences and the Humanities – University of Bergen, Norway; Open Evidence Research, Universitat Oberta de Catalunya (UOC), Barcelona, Spain*



Science' reproducibility crisis: a political and industrial battleground

**Conservatives and corporate interests:** weaken regulations

**Their opponents:** deny the existence of a crisis

This right-left divide unhelpful and dangerous

Structural contradictions have matured in modern science

Time we address them

# Where to?

- Reformation
- Collapse
- Techno-split

Reformation?

Science exhibits pathologies /  
corruptions comparable to the  
traffic in indulgencies which  
enraged Luther ~1517



Silvio Funtowicz

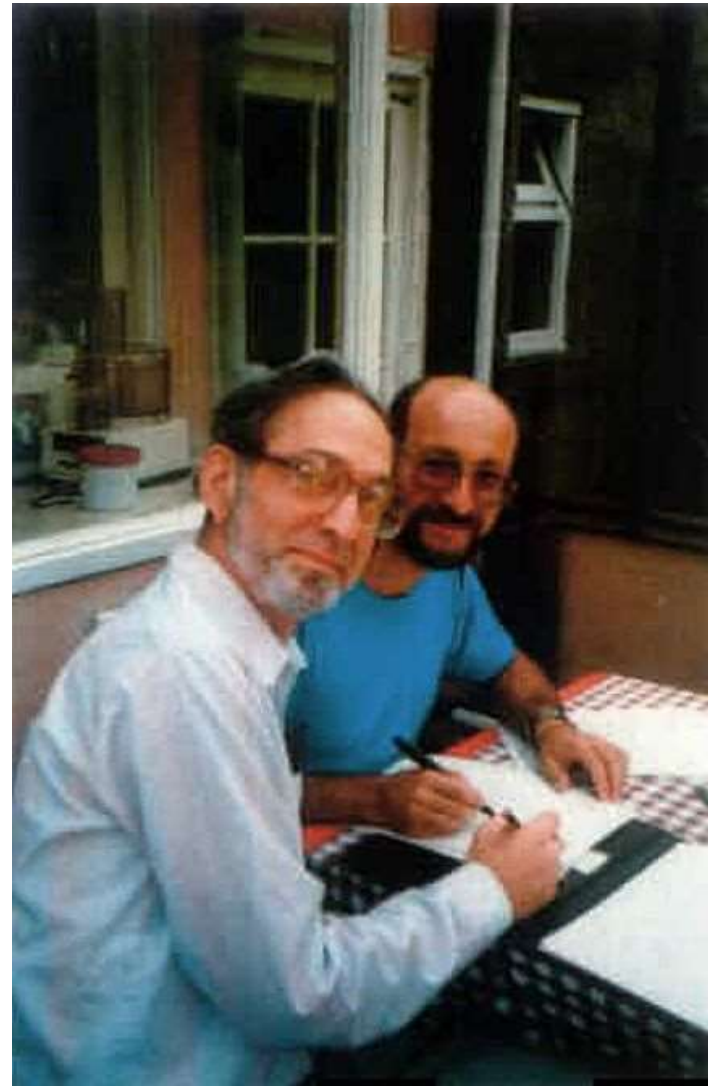
The internet the new press?

Reformation from combination of  
corruption, indignation and  
revolutionary technology

Is the same possible for  
science?



Silvio Funtowicz



Funtowicz and Ravetz, Sheffield ~1988



Collapse?

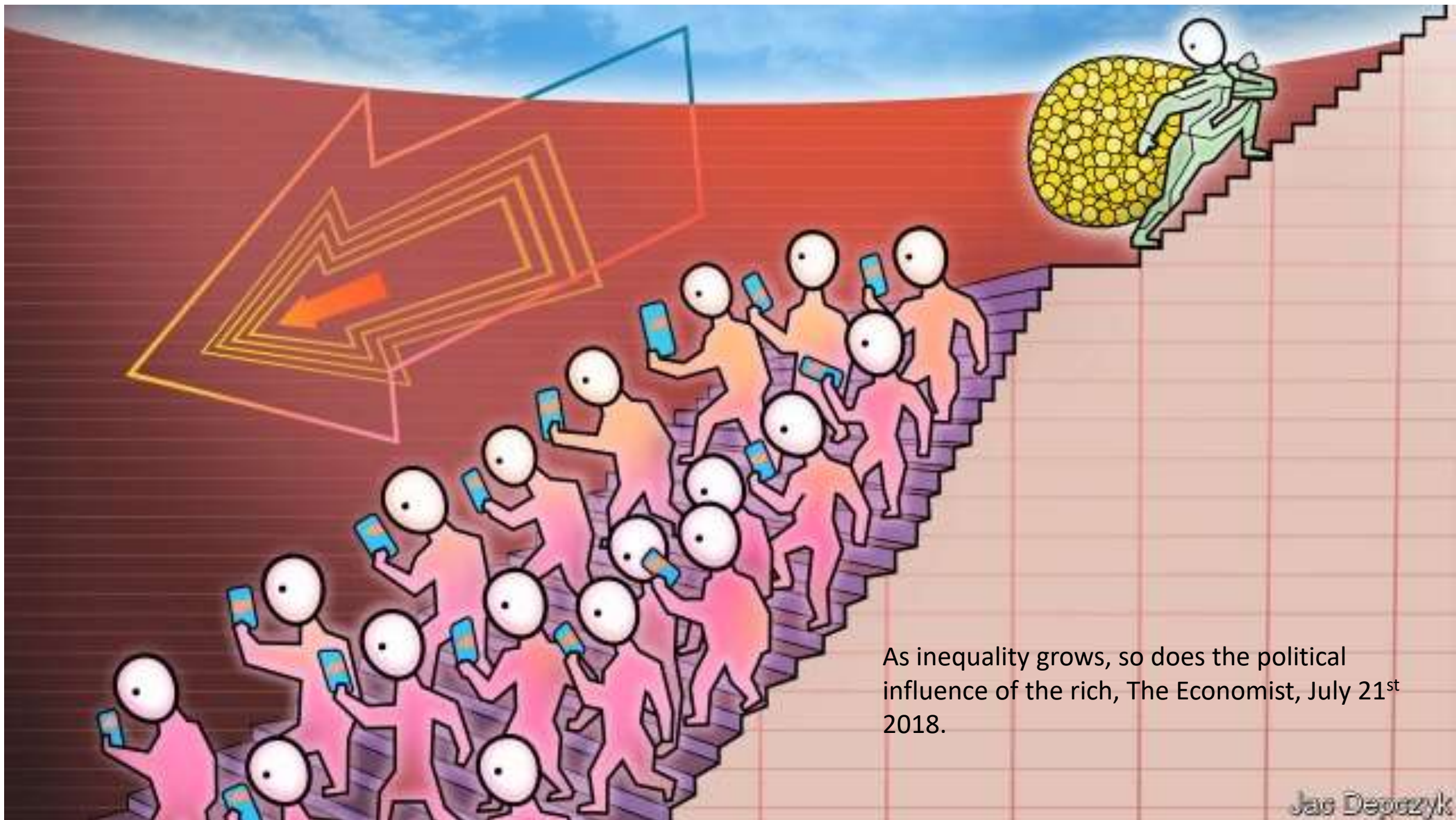
Planetary boundary or reckless science  
(Insectageddon)

Conspiracy theories obfuscate actual  
misdeeds of authorities and corporations

...

# Techno-split (*sensu* Jeremy Lent)





As inequality grows, so does the political influence of the rich, *The Economist*, July 21<sup>st</sup> 2018.

# Techno-split?



John and  
Laura  
Arnold



Brian Nosek, the  
Reproducibility  
Project.



John Ioannidis, Meta-  
research innovation  
centre at Stanford



Ben Goldacre,  
alltrials.net



Gary Taubes, The  
case against sugar

<https://www.wired.com/2017/01/john-arnold-waging-war-on-bad-science/>



The Observer Yuval Noah Harari

## **Yuval Noah Harari extract: 'Humans are a post-truth species'**



In his new book, 21 Lessons for the 21st Century, the bestselling author turns his attention to the problems we face today. Here, he argues that 'fake news' is much older than Facebook

Harari's 3 rules: 1) Pay for your information 2) inform yourself if you care and 3) scientists, please engage more.

1. is a market solution fostering inequality, 2. is the deficit model (again), and 3. on whose side?

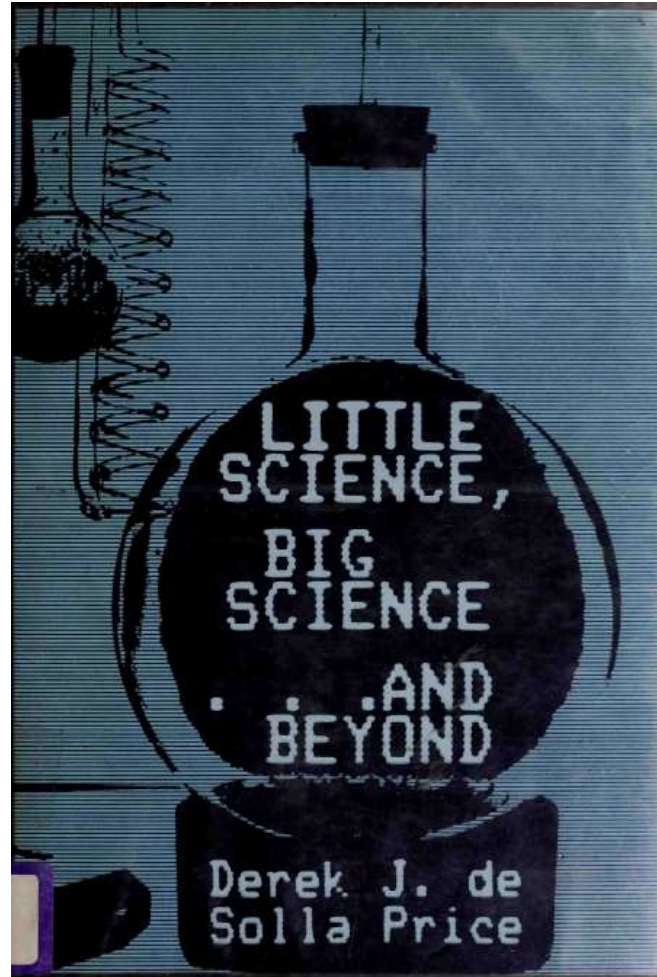


Scholars who saw it coming

...

and how they were vindicated

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

de Solla Price, D.J., 1963, Little science big science, Columbia University Press.

~ 2.2 million  
articles a year  
(2016) over  
~ 30,000 journals

newsblog

*Nature* brings you breaking news from the world of science

NEWS BLOG

## Global scientific output doubles every nine years

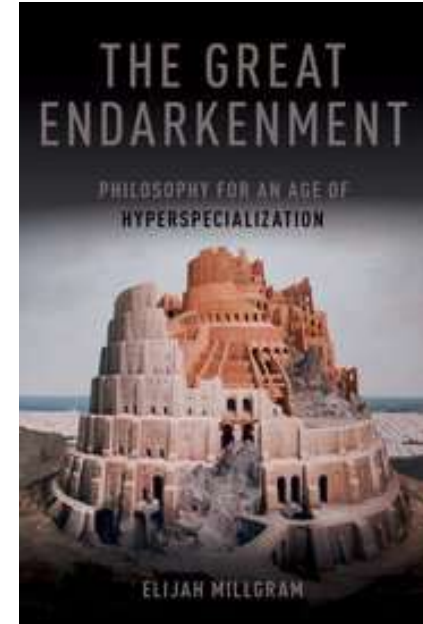
07 May 2014 | 16:46 GMT | Posted by Richard Van  
Noorden | Category: Policy, Publishing

<https://www.aje.com/en/arc/scholarly-publishing-trends-2016/>

<http://blogs.nature.com/news/2014/05/global-scientific-output-doubles-every-nine-years.html>

Derek de Solla Price ↔ Elijah Millgram

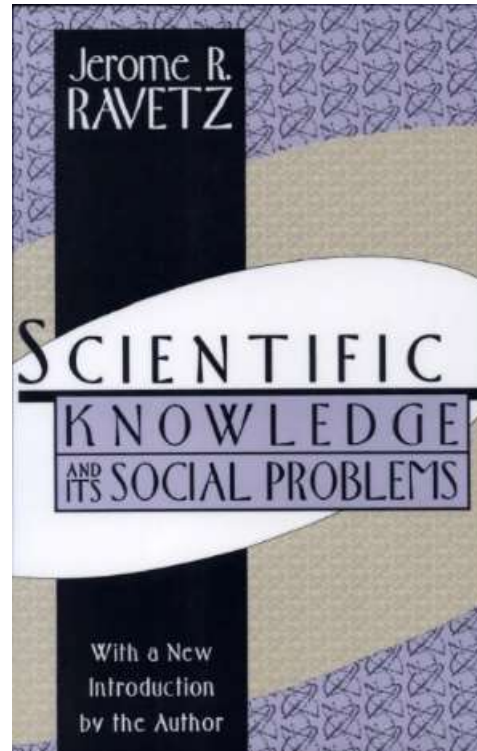
The Great Endarkenment.  
Philosophy for an Age of Hyperspecialization  
By Elijah Millgram



Describes a world in which all knowledge and products are the result of some form of extremely specialized expertise, and in which expertise is itself highly circumscribed, since experts depend in turn on other experts whose knowledge claims and styles of argumentation cannot be exported from one discipline to the next. ➔ “serial hyperspecializers” (p. 26)  
Experts thus become “logical aliens” (p. 32)

p.22: [...] The problem of quality control in science is at the centre of the social problems of the industrialized science of the present period.”

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

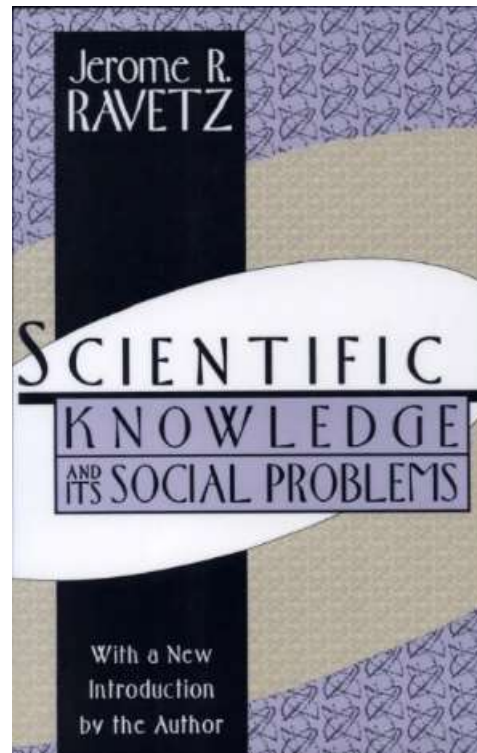


Jerome R.  
Ravetz



“If [science] 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.



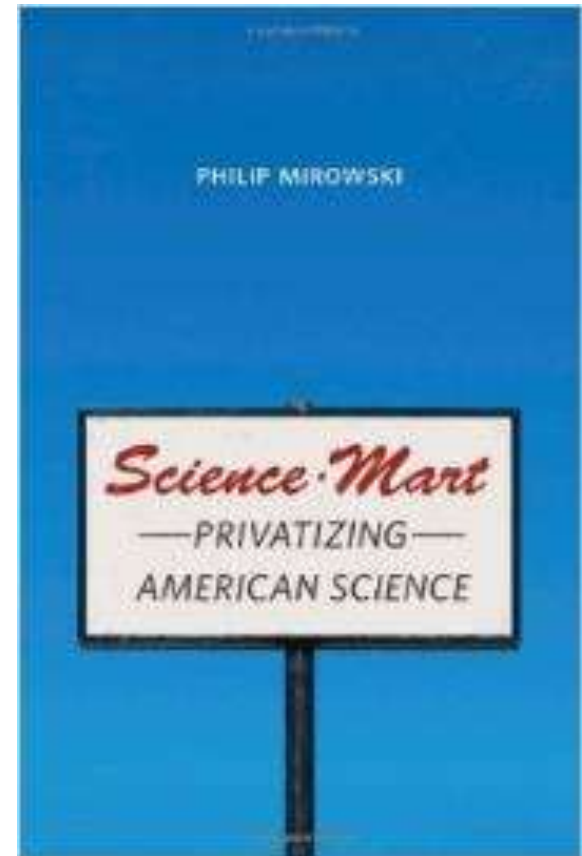
Jerome R.  
Ravetz

... neoliberal ideologies lead to decreasing state funding of science, which becomes privatized ... knowledge as a monetized commodity replaces knowledge as a public good → collapse of quality



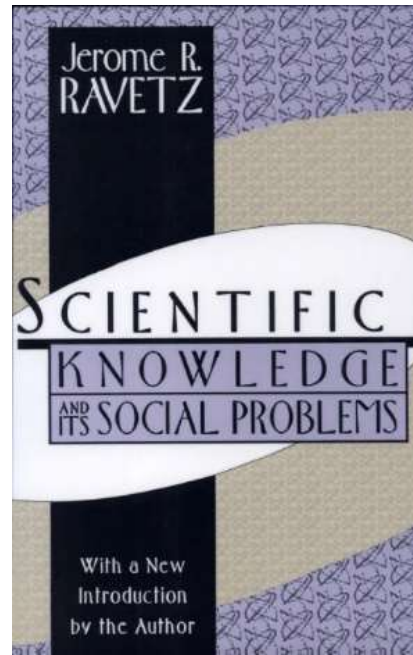
Philip Mirowski

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



p. 179. For it is possible for a field to be diseased [...] reforming a diseased field is a task of great delicacy [...] not even an apparatus of institutional structures can do anything to maintain or restore the health of a field **in the absence of an essential ethical element operating through the interpersonal channel of communication.**

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



Jerome R.  
Ravetz

MBI: Magnitude-based inference:  
persistent bad stats in sports research

MBI false positive rate two to six time  
higher than in NHST (Null hypothesis significance testing)

Christie Aschwanden and Mai Nguyen, How Shoddy Statistics Found A Home In Sports Research, Fivethirtyeight, May 16, 2018, <https://fivethirtyeight.com/features/how-shoddy-statistics-found-a-home-in-sports-research/>

K. L. Sainani, The Problem with 'Magnitude-Based Inference,' Medicine & Science in Sports & Exercise (MSSE), p. 1, Apr. 2018.

Bad science is 'sticky'



Article | Open Access  

## Do rebuttals affect future science?

Jeannette A. Banobi , Trevor A. Branch, Ray Hilborn

First published: 30 March 2011 | <https://doi.org/10.1890/ES10-00142.1> | Cited by: 13

“We examined seven high-profile original articles and their rebuttals, finding that original articles were cited 17 times more than rebuttals, and that annual citation numbers were unaffected by rebuttals”

Bad science in  
bad journals?



**frontiers**

in Human Neuroscience

## **Prestigious Science Journals Struggle to Reach Even Average Reliability**

“...an accumulating body of evidence suggests that methodological quality & reliability of published research works in several fields may be decreasing with increasing journal rank” (20 February, 2018)

Cutting corners effect?

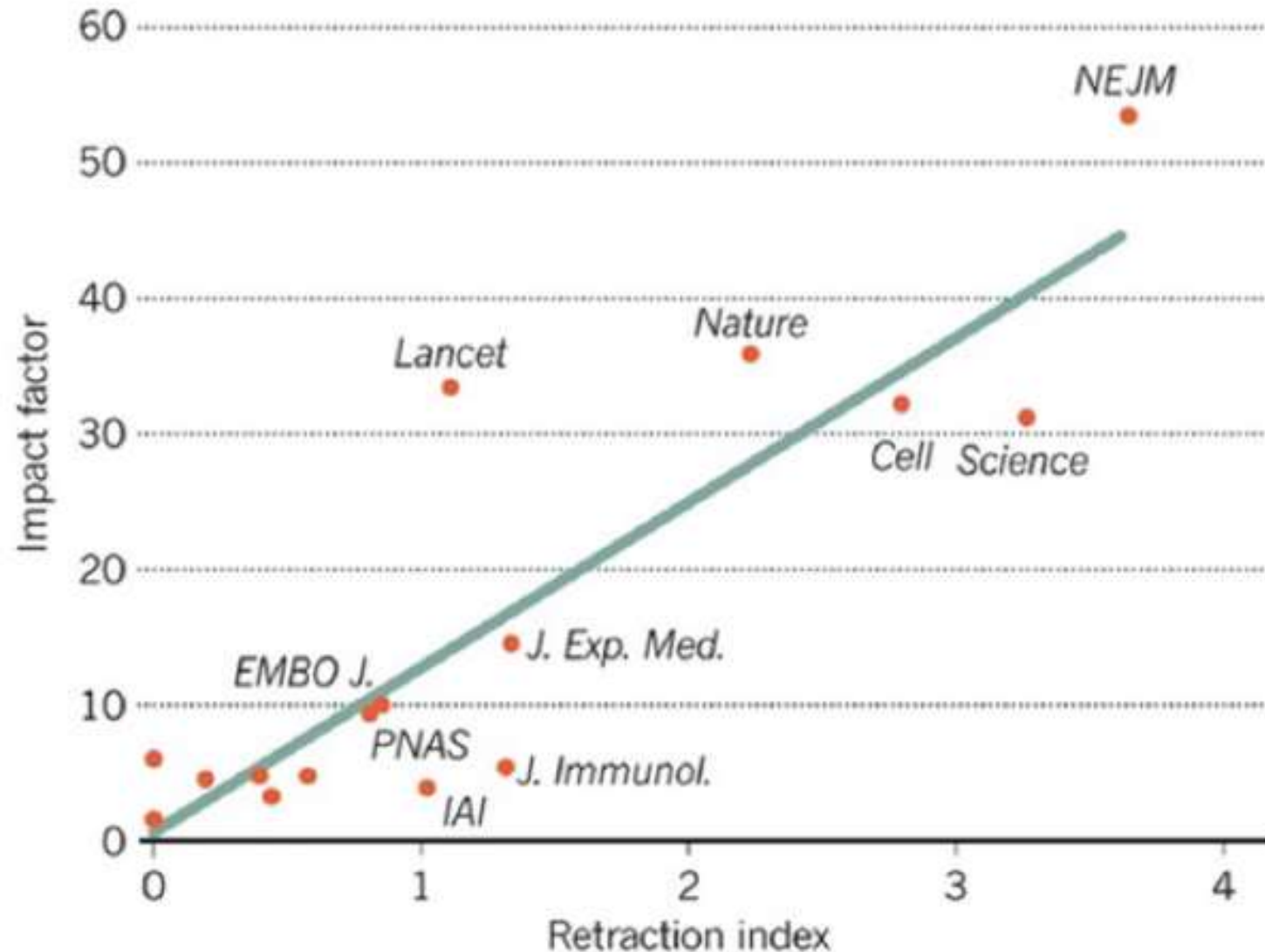


**Björn Brembs\***

Institute of Zoology—Neurogenetics, Universität Regensburg, Regensburg, Germany

## RETRACTION RELATION

Journals with higher impact factors also have a higher rate of retractions.



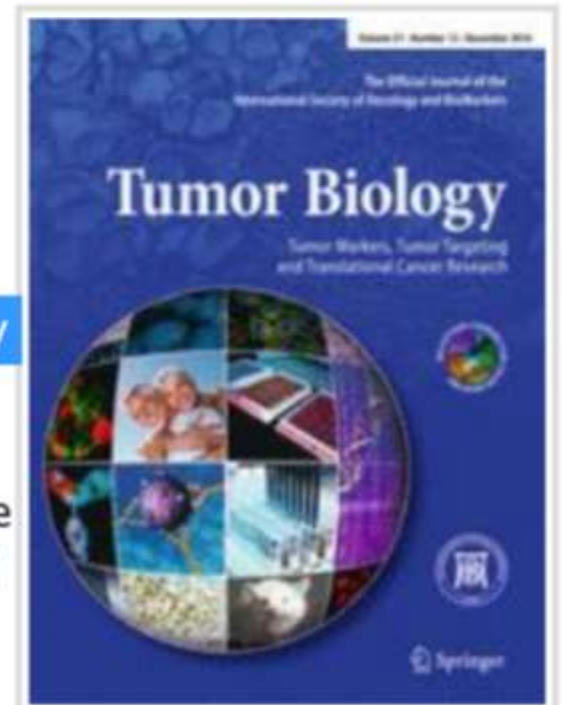
Fang FC, Casadevall A and Morrison R (2011) Retracted science and the retraction index. *Infection and Immunity* 79(10): 3855–3859

### A new record: Major publisher retracting more than 100 studies from cancer journal over fake peer reviews

with 11 comments

Springer is [retracting 107 papers](#) from one journal after discovering they had been accepted with fake peer reviews. Yes, 107.

To submit a fake review, someone (often the author of a paper) either makes up an outside expert to review the paper, or suggests a real researcher — and in both cases, provides a fake email address that comes back to someone who will invariably give the paper a glowing review. In this case, Springer, the publisher of *Tumor Biology* through 2016, told us that an investigation produced “clear evidence” the reviews were submitted under the names of real researchers with faked emails. Some of the authors may have used a third-party editing service, which may have supplied the reviews. The [journal is now published by SAGE](#).





Unintended effects of reforms

# Good intentions going bad

TABLE 1. GROWING PERVERSE INCENTIVES IN ACADEMIA

<i>Incentive</i>	<i>Intended effect</i>	<i>Actual effect</i>
“Researchers rewarded for increased number of publications.”	“Improve research productivity,” provide a means of evaluating performance.	“Avalanche of” substandard, “incremental papers”; poor methods and increase in false discovery rates leading to a “natural selection of bad science” (Smaldino and McElreath, 2016); reduced quality of peer review
“Researchers rewarded for increased number of citations.”	Reward quality work that influences others.	Extended reference lists to inflate citations; reviewers request citation of their work through peer review
“Researchers rewarded for increased grant funding.”	“Ensure that research programs are funded, promote growth, generate overhead.”	Increased time writing proposals and less time gathering and thinking about data. Overselling positive results and downplay of negative results.
Increase PhD student productivity	Higher school ranking and more prestige of program.	Lower standards and create oversupply of PhDs. Postdocs often required for entry-level academic positions, and PhDs hired for work MS students used to do.
Reduced teaching load for research-active faculty	Necessary to pursue additional competitive grants.	Increased demand for untenured, adjunct faculty to teach classes.
“Teachers rewarded for increased student evaluation scores.”	“Improved accountability; ensure customer satisfaction.”	Reduced course work, grade inflation.
“Teachers rewarded for increased student test scores.”	“Improve teacher effectiveness.”	“Teaching to the tests; emphasis on short-term learning.”
“Departments rewarded for increasing U.S. News ranking.”	“Stronger departments.”	Extensive efforts to reverse engineer, game, and cheat rankings.
“Departments rewarded for increasing numbers of BS, MS, and PhD degrees granted.”	“Promote efficiency; stop students from being trapped in degree programs; impress the state legislature.”	“Class sizes increase; entrance requirements” decrease; reduce graduation requirements.
“Departments rewarded for increasing student credit/contact hours (SCH).”	“The university’s teaching mission is fulfilled.”	“SCH-maximization games are played”: duplication of classes, competition for service courses.

Modified from Regehr (pers. comm., 2015) with permission.

Academic Research in the 21st Century: Maintaining Scientific Integrity in a Climate of Perverse Incentives and Hyper-competition, Marc A. Edwards and Siddhartha Roy, ENVIRONMENTAL ENGINEERING SCIENCE, 34(1), 2017

---

## *Incentive*

---

“Researchers rewarded for increased number of publications.”

### *Intended effect*

---

“Improve research productivity,” provide a means of evaluating performance.

Academic Research in the 21st Century: Maintaining Scientific Integrity in a Climate of Perverse Incentives and Hyper-competition, Marc A. Edwards and Siddhartha Roy, ENVIRONMENTAL ENGINEERING SCIENCE, 34(1), 2017

### *Actual effect*

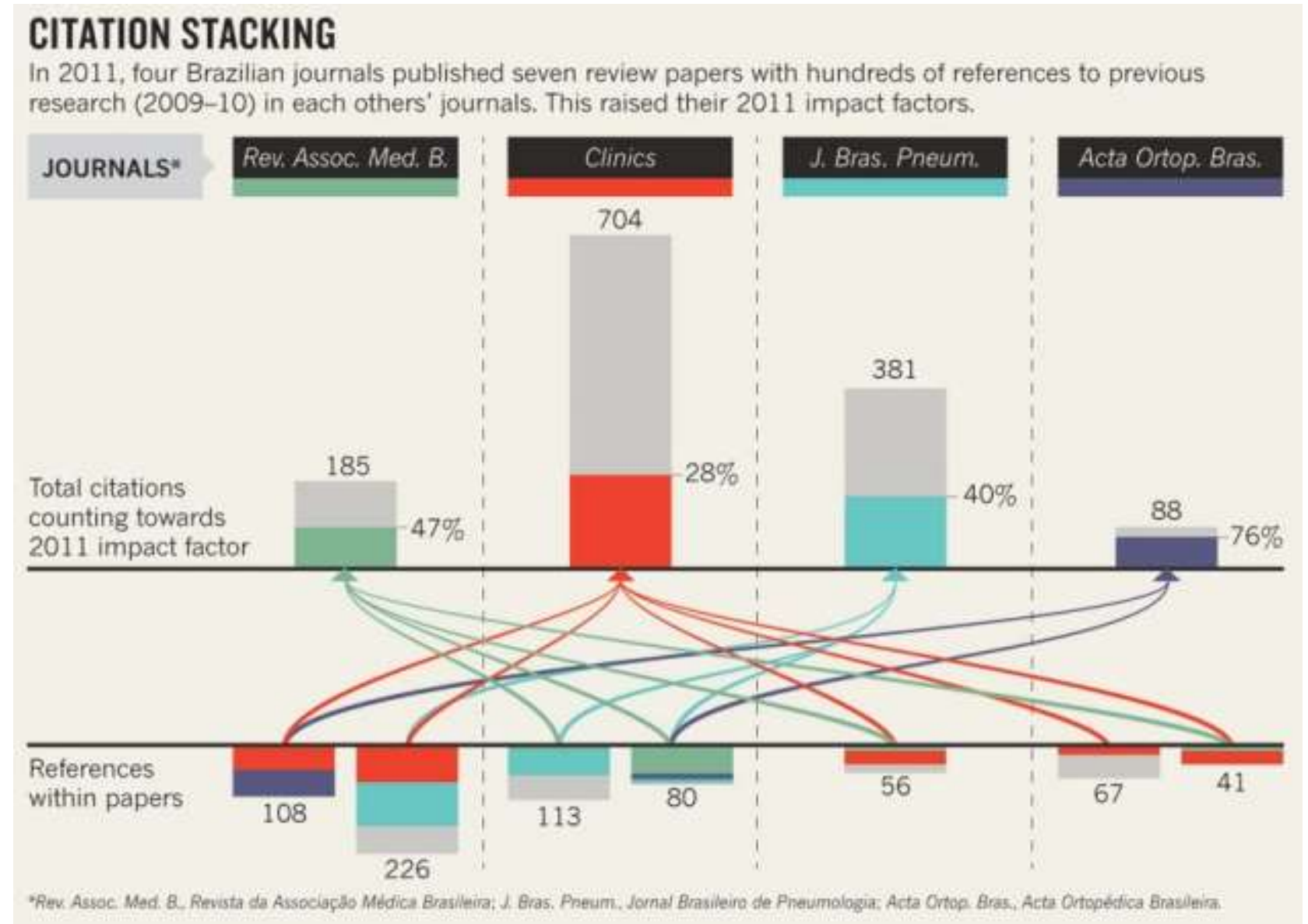
---

“Avalanche of” substandard, “incremental papers”; poor methods and increase in false discovery rates leading to a “natural selection of bad science” (Smaldino and McElreath, 2016); reduced quality of peer review

See also P. Mirowski, “The future(s) of open science,” Soc. Stud. Sci., vol. 48, no. 2, pp. 171–203, Apr. 2018.

Gaming the system

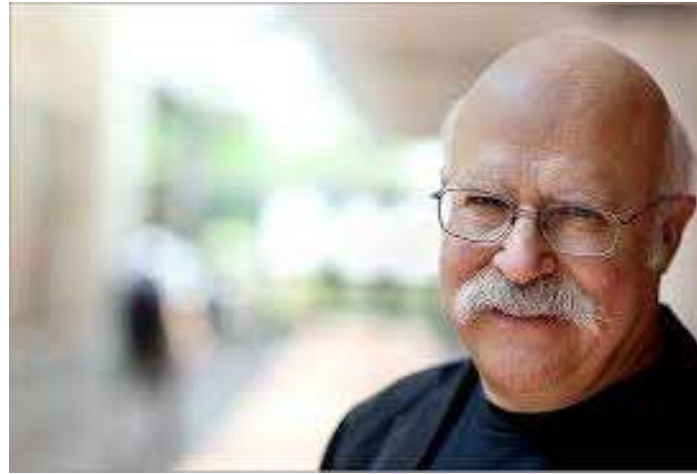
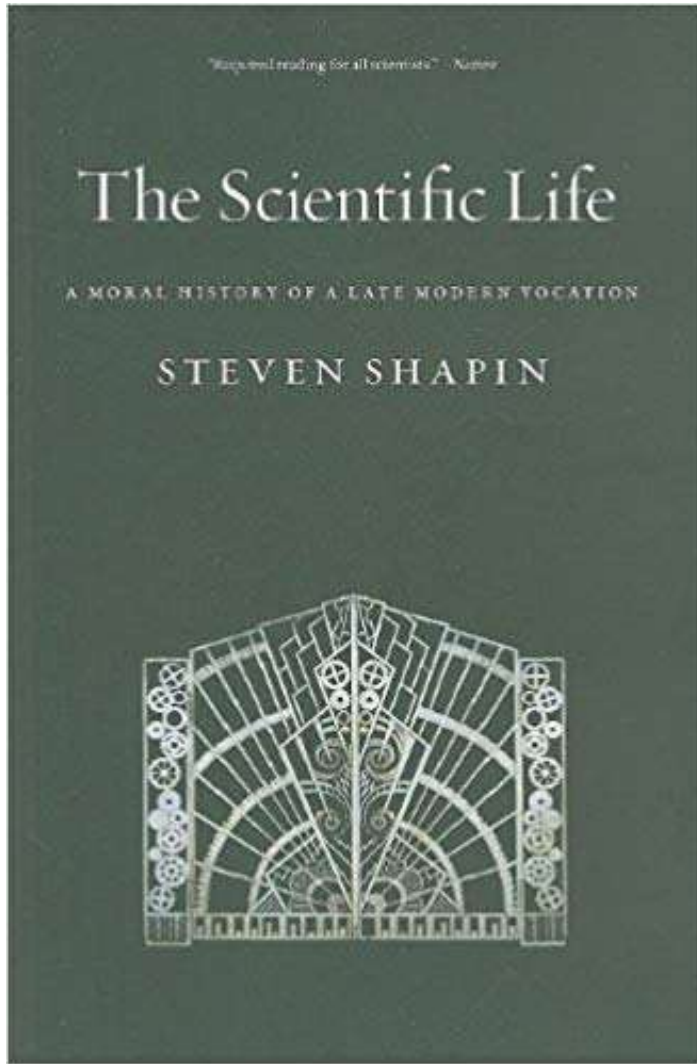
# Use and abuse of metrics: from self-citation to citation cartels to citation stacking



Richard Van Noorden, 2017, Brazilian citation scheme outed. Thomson Reuters suspends journals from its rankings for 'citation stacking'. Nature, 27 August 2013



Lost ethos?



Steven Shapin

Is scientists' civility to each other what holds the venture together?

But someone disagrees: J.R. Ravetz, *Morals and manners in modern science*, *Nature*, 457(5), 662–663.

Renewable sources  
100% of energy in US by  
2050, says Jacobson...

...and sues for \$10-  
million a dissenter



**Los Angeles Times**

A Stanford professor drops his ridiculous defamation lawsuit against his  
scientific critics

<http://www.latimes.com/business/hiltzik/la-fi-hiltzik-jacobson-lawsuit-20180223-story.html>

# World court should rule on climate science to quash sceptics, says Philippe Sands

International Court of Justice ruling would settle the scientific dispute and pave the way for future legal cases on climate change, says high-profile lawyer

Adam Vaughan

 @adamvaughan\_uk

Friday 18 September 2015 10.34 BST



 Shares  Comments


1,805

710



Save for later



 Philippe Sands QC says a court ruling would carry more weight with public opinion than science alone.  
Photograph: Antonio Zazueta Olmos/Antonio Olmos

For Gigerenzer & Marewski statistics has changed the nature all disciplines ...

... Creating a persistent surrogate science based on worshipping P-values

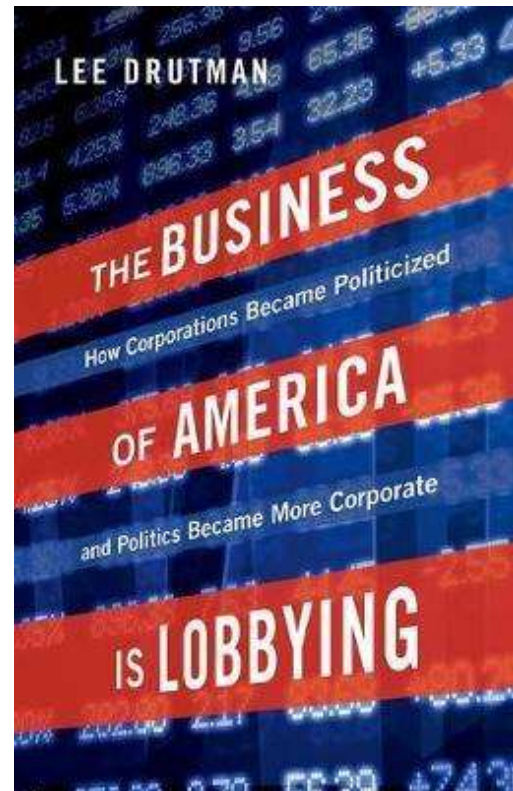


On both sides of the Atlantic scholars note that evidence can be the best currency of lobbies, in a ‘regulation game’ with important power asymmetries.



**LOBBYISTS AND  
BUREAUCRATS IN BRUSSELS**  
CAPITALISM'S BROKERS

Sylvain Laurens



A. Saltelli and M. Giampietro, “What is wrong with evidence based policy, and how can it be improved?,” *Futures*, vol. 91, pp. 62–71, Feb. 2017.

J. P. A. Ioannidis, “Evidence-based medicine has been hijacked: a report to David Sackett,” *J. Clin. Epidemiol.*, vol. 73, pp. 82–86, May 2016.

Owen, B. M., & Braeutigam, R., 1978 *The regulation game, : Strategic Use of the Administrative Process*, Ballinger Press