

# Science's crisis: facts and ethical implications

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Course NANO 310, August 19, 2020





## Futures

Volume 91, August 2017, Pages 5-11



# What is science's crisis really about?

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



## Futures

Volume 104, December 2018, Pages 85-90



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

Andrea, Saltelli 



Silvio Funtowicz

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




Brow

 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  
ECONOMIC  
JOURNAL



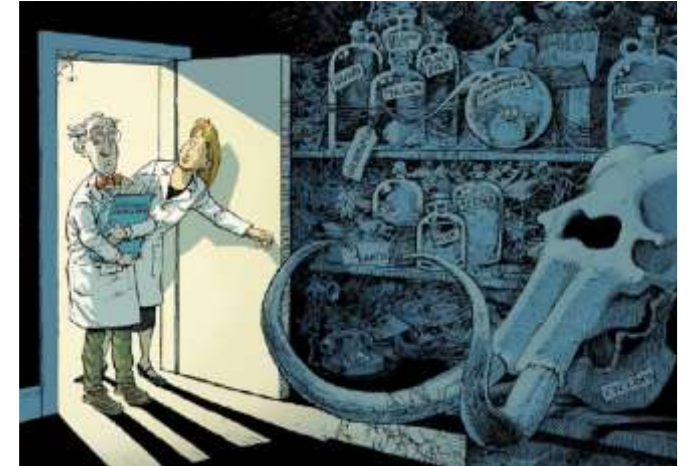
*The Economic Journal*, 127 (October), F236–F265. Doi: 10.1111/eoj.12461 © 2017 Royal Economic Society. Published by John Wiley & Sons, 9600 Garsington Road, Oxford OX4 2DQ, UK and 350 Main Street, Malden, MA 02148, USA.

THE POWER OF BIAS IN ECONOMICS RESEARCH\*

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

October 27, 2017

The crisis is methodological,  
epistemological, ethical and  
metaphysical



COMMENT • 20 MARCH 2019

## Scientists rise up against statistical significance

Valentin Amrhein, Sander Greenland, Blake McShane and more than 800 signatories call for an end to hyped claims and the dismissal of possibly crucial effects.

Valentin Amrhein , Sander Greenland & Blake McShane



**nature**

International journal of science



Statistical wars on  
significance?

See the discussion on the blog  
of Andrew Gelman

<https://statmodeling.stat.columbia.edu/>



# Powerful drivers: the crisis will be worse before it can be better

Downloaded from <http://rsos.royalsocietypublishing.org/> on September 23, 2016

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

Research



**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>

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 Roache (more: [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

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## *Incentive*

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“Researchers rewarded for increased number of publications.”

### *Intended effect*

---

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

### *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

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

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## *Incentive*

---

“Researchers rewarded for increased number of citations.”

*Intended effect*

---

Reward quality work that influences others.

*Actual effect*

Extended reference lists to inflate citations; reviewers request citation of their work through peer review

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

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## *Incentive*

---

“Researchers rewarded for increased grant funding.”

### *Intended effect*

---

“Ensure that research programs are funded, promote growth, generate overhead.”

### *Actual effect*

---

Increased time writing proposals and less time gathering and thinking about data.  
Overselling positive results and downplay of negative results.

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

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# *Incentive*

---

Increase PhD student productivity

*Actual effect*

*Intended effect*

---

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.

Higher school ranking and more prestige of program.



---

*Incentive*

---

“Teachers rewarded for increased student test scores.”

“Departments rewarded for increasing U.S. News ranking.”

*Intended effect*

---

“Improve teacher effectiveness.”

“Stronger departments.”

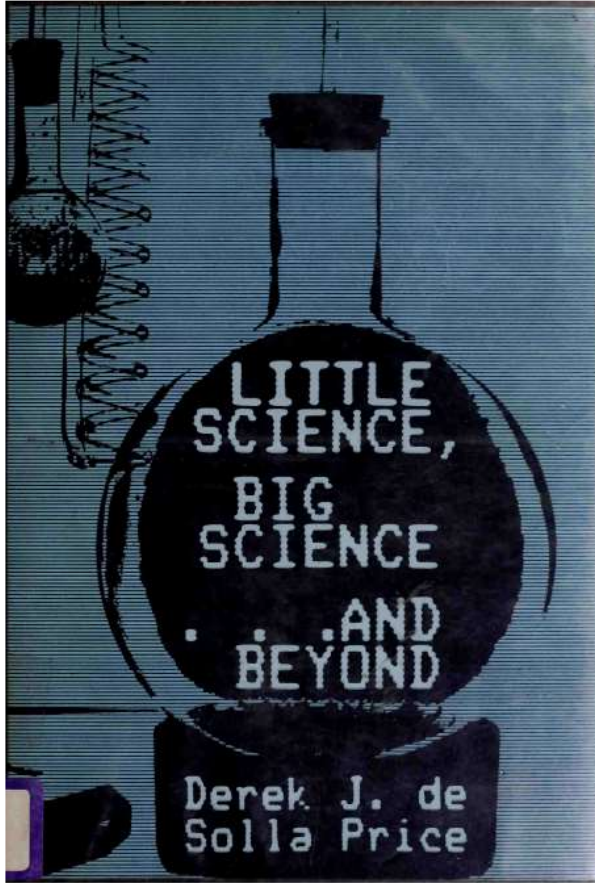
*Actual effect*

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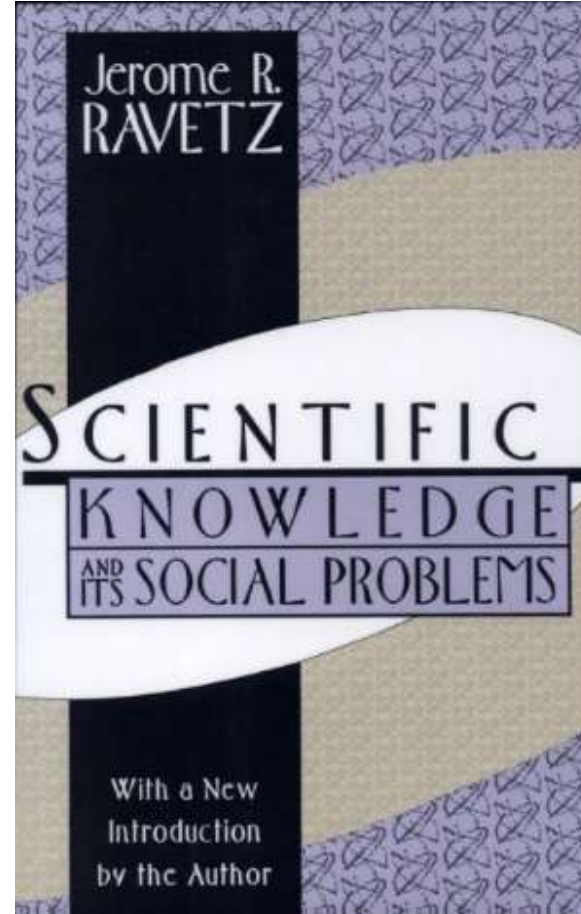
“Teaching to the tests; emphasis on short-term learning.”

Extensive efforts to reverse engineer, game, and cheat rankings.

# The crisis was predicted



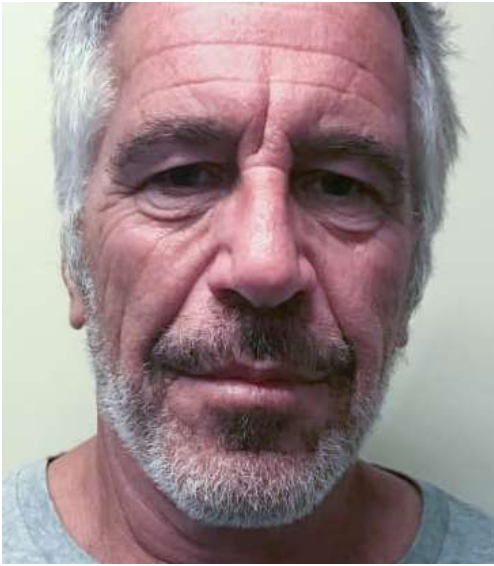
Derek J. de  
Solla Price



Jerome R.  
Ravetz

de Solla Price, D.J., 1963, Little science big science, Columbia University Press;  
Ravetz, J., 1971, Scientific Knowledge and its Social Problems, Oxford University Press.

Ethical issues?  
Tainted donations



Jeffrey Epstein  
& paedophilia



Sackler family  
& opioids



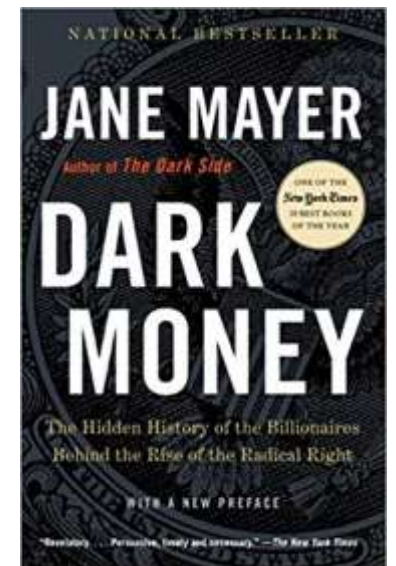
Koch brothers  
& climate

## How Rich Donors Like Epstein (and Others) Undermine Science

ADAM ROGERS

SCIENCE 09.15.2019 07:00 AM

WIRED



Ethical issues?

Reviewer-coerced citation





NEWS • 06 FEBRUARY 2020

## Highly cited researcher banned from journal board for citation abuse

Investigation finds that biophysicist Kuo-Chen Chou repeatedly suggested dozens of citations be added to papers.

Richard Van Noorden



NEWS • 14 AUGUST 2020

# Signs of 'citation hacking' flagged in scientific papers

An algorithm developed to spot abnormal patterns of citations aims to find scientists who have manipulated reference lists.

Richard Van Noorden

Ethical issues?  
Seducing salaries

# *U.S. Accuses Harvard Scientist of Concealing Chinese Funding*



Prosecutors say Charles M. Lieber, the chair of Harvard's chemistry department, lied about contacts with a Chinese state-run initiative that seeks to draw foreign-educated talent.



By **Ellen Barry**

Jan. 28, 2020

“one of Harvard’s scientific luminaries was in handcuffs, ... false statement to federal authorities about his financial relationship with the Chinese ... Thousand Talents program”

\$50,000 monthly salary, \$150,000 in annual in living expenses and more than \$1.5 million for a second laboratory in Wuhan

Predatory publishers (the Achilles heel of the APC model)

Predatory open access publishers

<https://beallslist.net>

Beall was threatened by Omics International with a \$1billion lawsuit



Jeffrey Beall,  
librarian,  
University  
of Colorado,  
Denver



Dear Andrea Saltelli,  
I hope everything is going well.

We cordial  
As you be  
If you have  
Hoping

  
GAVIN PUBLISHERS

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 Food & Nutrition Jou

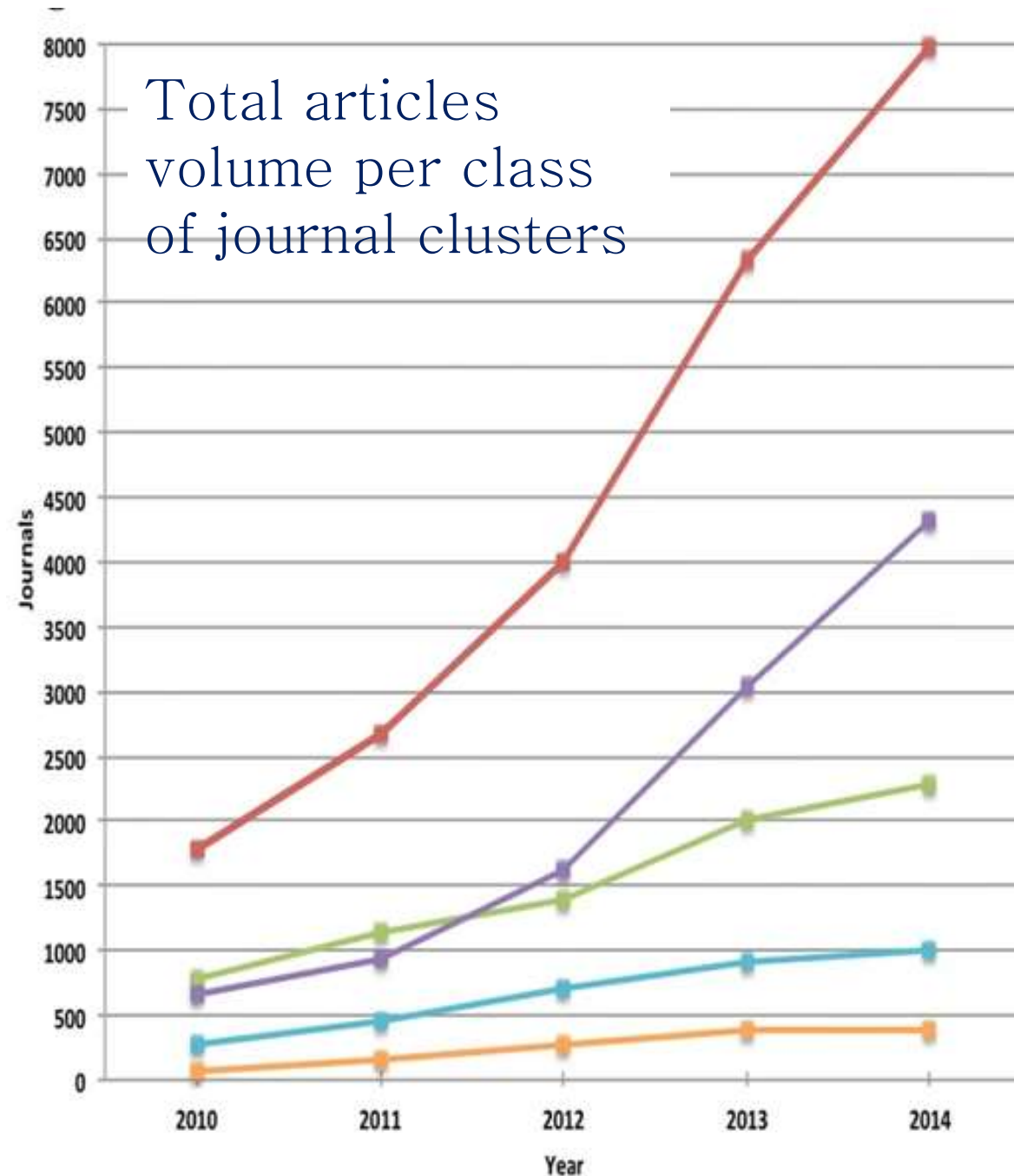
About the Journal

Journal Impact Factor 1.2\*

Is on Beall's list ←

- \*Genamics – JournalSeek
- \*Academic Keys
- \*ResearchBib - Academic Research Index
- \*Free Medical Journals - Geneva Foundation for Medical Education and Research
- \*International Innovative Journal Impact Factor (IIJIF)
- \*Al-Azhar University
- \*Open J-Gate
- \* Directory of Journals indexing

C. Shen and B.-C. Björk, “‘Predatory’ open access: a longitudinal study of article volumes and market characteristics,” BMC Med., vol. 13, no. 1, p. 230, Dec. 2015.



## Opinion

Peer review and scientific publishing

Thu 13 Sep 2018

# Scientific publishing is a rip-off. We fund the research – it should be free

*George Monbiot*



## Those who take on the global industry that traps research behind paywalls are heroes, not thieves







I. Graber-Stiehl, "Science's pirate queen," *Verge*, Feb-2018.



Kazakhstani scientist  
Alexandra Elbakyan



The long read

## Is the staggeringly profitable business of scientific publishing bad for science?

Elsevier profits 2010 = £724m on £2bn revenue: a 36% margin – higher than Apple, Google, or Amazon

Stephen Buranyi, The Guardian, 27 Jun 2017.

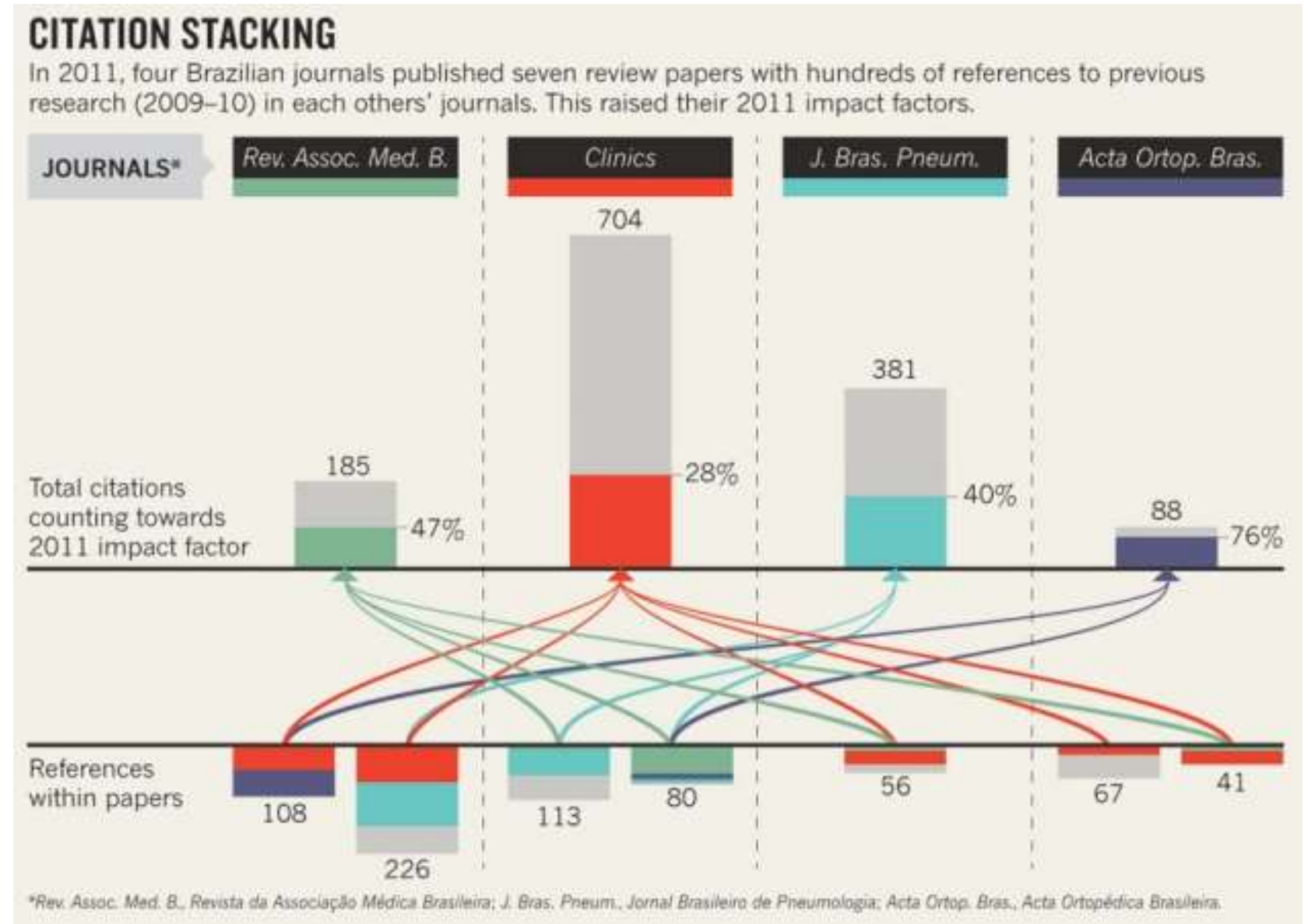




A 2005 Deutsche Bank report referred to it as a “bizarre” “triple-pay” system, in which “the state funds most research, pays the salaries of most of those checking the quality of research, and then buys most of the published product”

Stephen Buranyi, The Guardian, 27 Jun 2017.

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



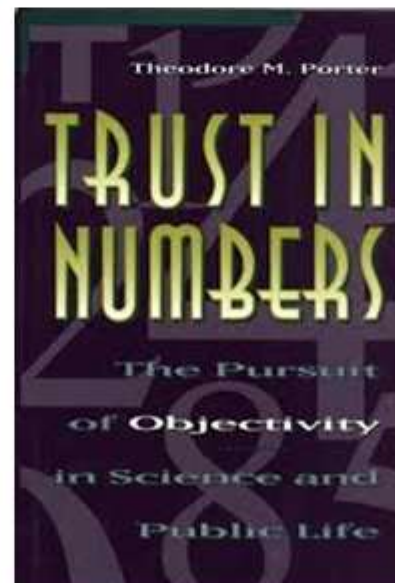
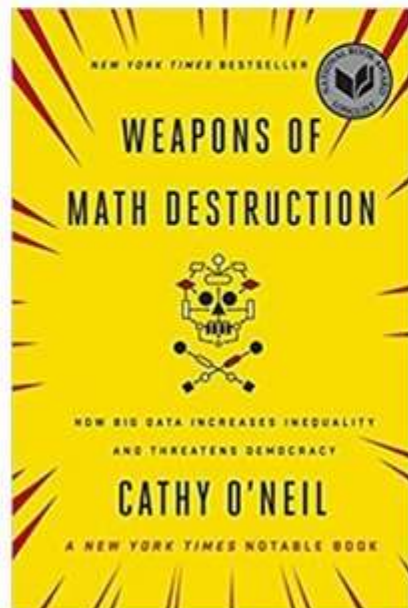
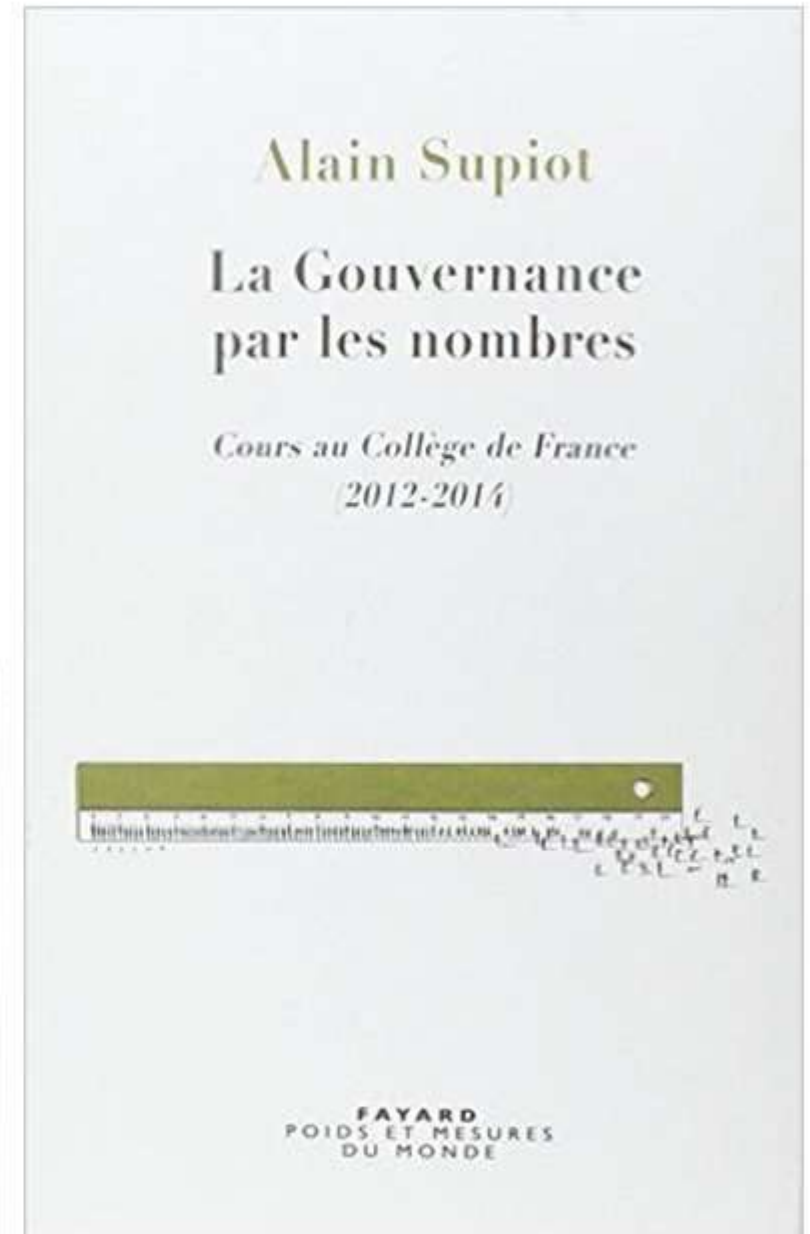
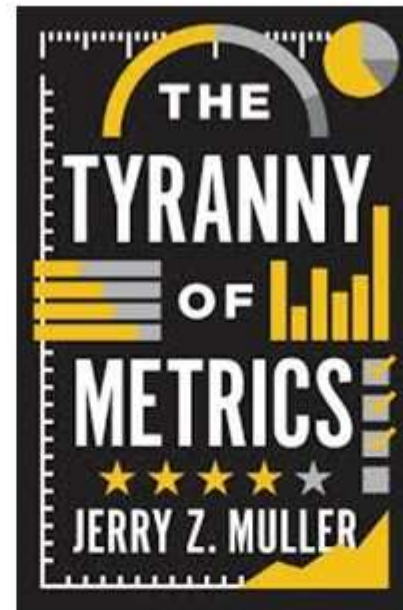
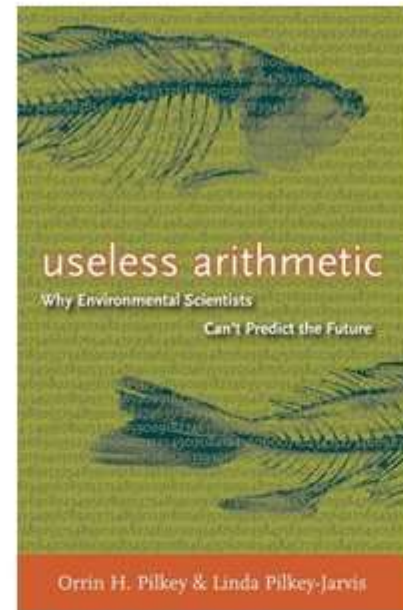
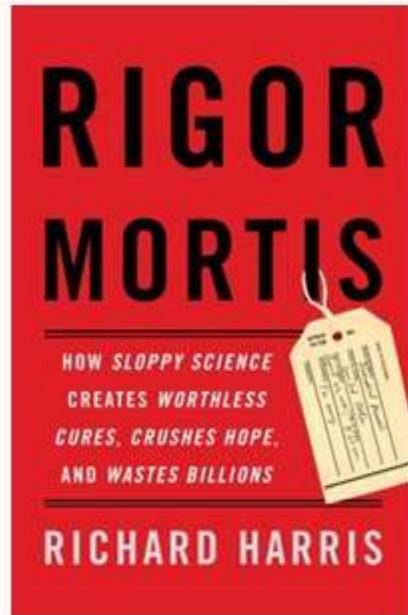
Richard Van Noorden, 2017, Brazilian citation scheme outed. Thomson Reuters suspends journals from its rankings for 'citation stacking'. Nature, 27 August 2013

# Calls for change in the culture of metrics use

- San Francisco Declaration on Research Assessment (DORA)
- The Leiden Manifesto
- The Metric Tide
- Plan S and cOAlition S for open science
- ...

Ethics of  
quantification?

# Algorithms, models, metrics, statistics...







# Futures

Volume 116, February 2020, 102509



Essays

## Ethics of quantification or quantification of ethics?

Andrea Saltelli

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<https://doi.org/10.1016/j.futures.2019.102509>

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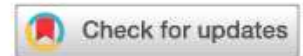
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# From sociology of quantification to ethics of quantification

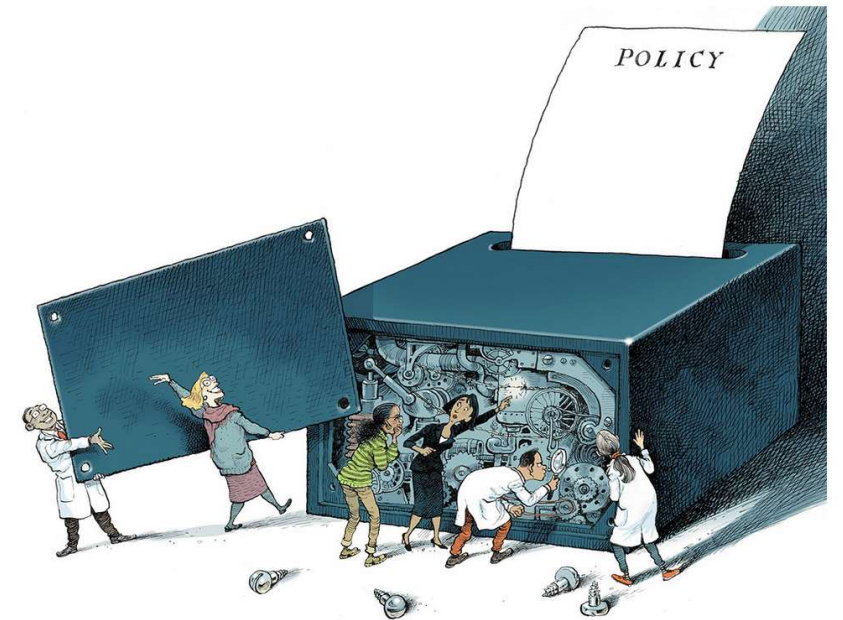
Andrea Saltelli <sup>1</sup>✉ & Monica Di Fiore <sup>2</sup>✉

Online today August 19 2020

# Five ways to ensure that models serve society: a manifesto

Pandemic politics highlight how predictions need to be transparent and humble to invite insight, not blame.

Andrea Saltelli , Gabriele Bammer, Isabelle Bruno, Erica Charters, Monica Di Fiore, Emmanuel Didier, Wendy Nelson Espeland, John Kay, Samuele Lo Piano, Deborah Mayo, Roger Pielke Jr, Tommaso Portaluri, Theodore M. Porter, Arnald Puy, Ismael Rafols, Jerome R. Ravetz, Erik Reinert, Daniel Sarewitz, Philip B. Stark, Andrew Stirling, Jeroen van der Sluijs & Paolo Vineis



# Five ways to ensure that models serve society: a manifesto

Pandemic politics highlight how predictions need to be transparent and humble to invite insight, not blame.

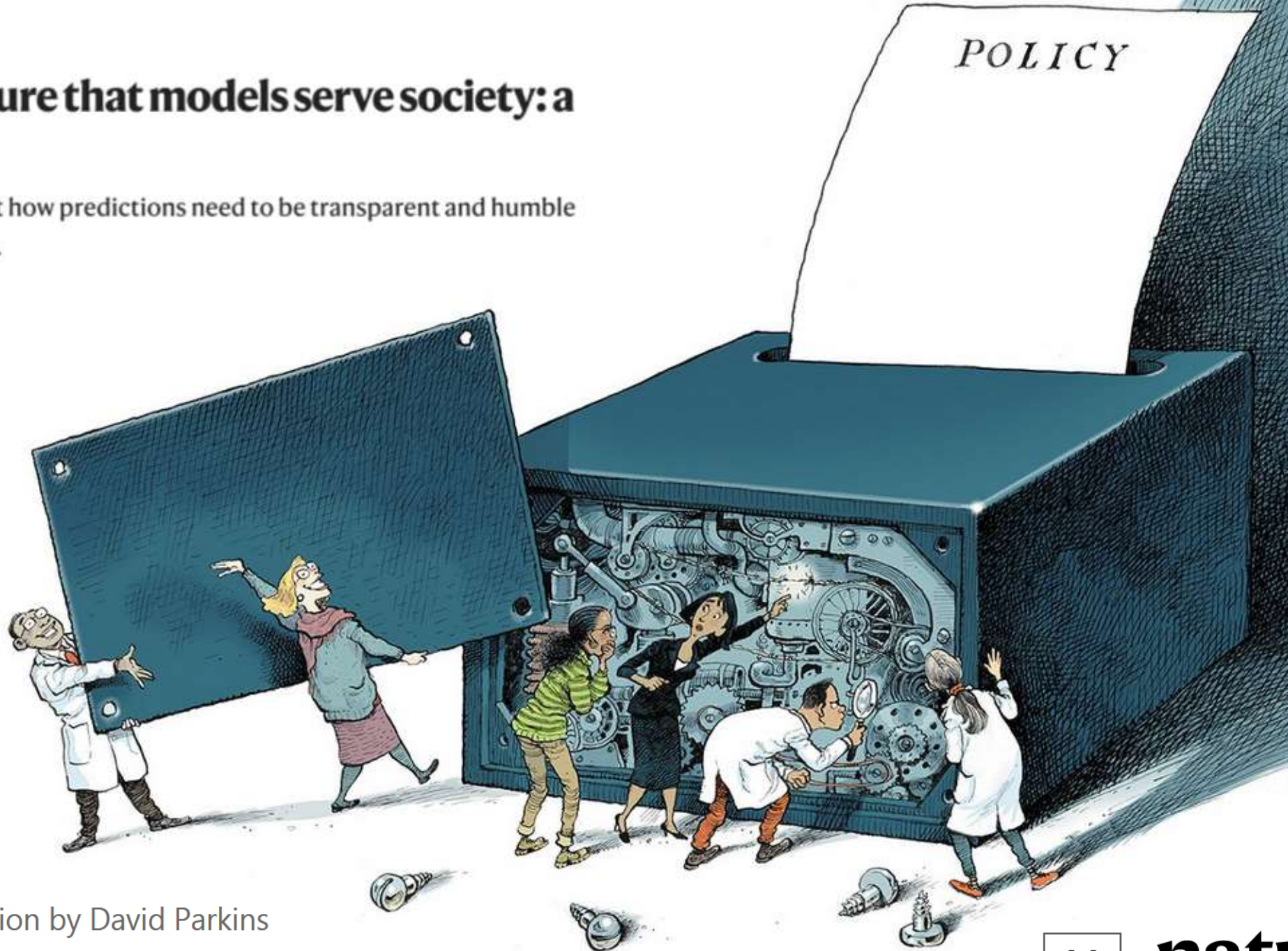


Illustration by David Parkins



**nature**

# The End



@andreasaltelli