

Sensitivity Auditing

Andrea Saltelli

Sensitivity Analysis Summer School, Parma, June 2024



The Politics of Modelling


Numbers Between Science and Policy

Andrea Saltelli and Monica Di Fiore

“*The Politics of Modelling: Numbers between Science and Policy* is a breath of fresh air and a much-needed cautionary view of the ever-increasing dependence on mathematical modelling in ever-widening directions. The five aspects of modelling that should be 'minded' are a sensitive summary of factors that should be considered when evaluating any mathematical model.”


ORRIN H. PILKEY, PROFESSOR, DUKE UNIVERSITY'S NICHOLAS SCHOOL OF THE ENVIRONMENT, CO-AUTHOR, WITH LINDA PILKEY-JARVIS, OF *USELESS ARITHMETIC: WHY ENVIRONMENTAL SCIENTISTS CAN'T PREDICT THE FUTURE*, COLUMBIA UNIVERSITY PRESS, WASHINGTON, DC, 2009

Where to find this talk: www.andreasaltelli.eu



HOME ABOUT ME PUBLICATIONS NEWS & VIDEOS RESOURCES

August 25 2023: The politics of modelling is out!



Praise for the volume

"A long awaited examination of the role —and obligation —of modeling."


Nassim Nicholas Taleb, Distinguished Professor of Risk Engineering, NYU Tandon School of Engineering. Author, of the 5 -volume series Incerto.

"A breath of fresh air and a much needed cautionary view of the ever-widening dependence on mathematical modeling."

Orrin H. Pilkey, Professor at Duke University's Nicholas School of the Environment, co-author with Linda Pilkey-Jarvis of Useless Arithmetic: Why Environmental Scientists Can't Predict the Future, Columbia University Press 2009.

"The methods by which power insinuates itself into models, and facilitates their portability and

Mastodon Toots by @AndreaSaltelli




2024/2/16 16:38

Are you interested in sensitivity analysis? Here a short story of it.

Open access, online in draft form:

scimedirect.com/science/arti

Andrea



View on mstdn.social

Do we live immersed in
fantastic numbers?

‘The Most Important Number You’ve Never Heard Of’

Sept. 17, 2021

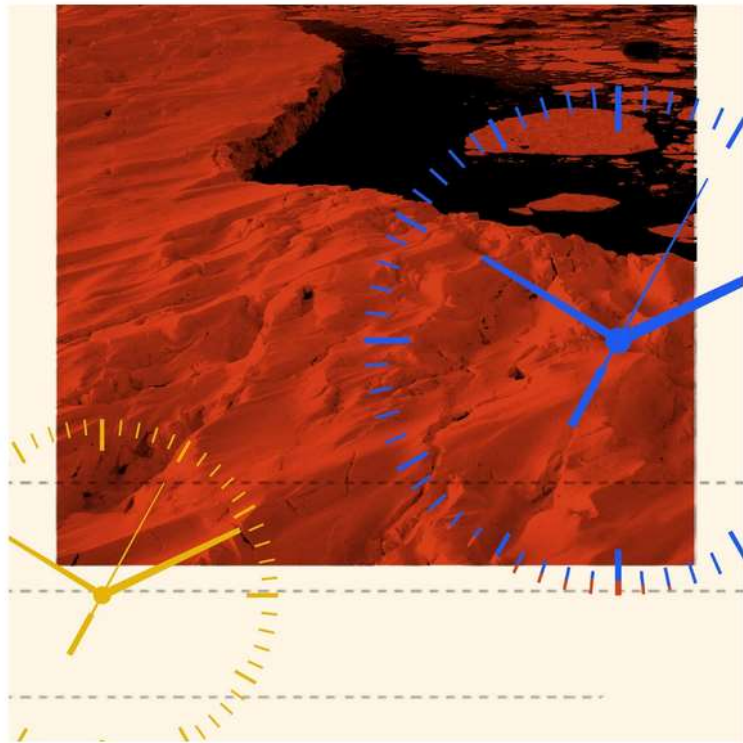


Illustration by Arsh Raziuddin, The New York Times

“social cost of carbon:

= \$56 a ton on average at a 3 percent discount rate

= \$171 a ton on average at a 2 percent discount rate”

The New York Times



The Social Cost of Carbon: Advances in Long-Term Probabilistic Projections of Population, GDP, Emissions, and Discount Rates

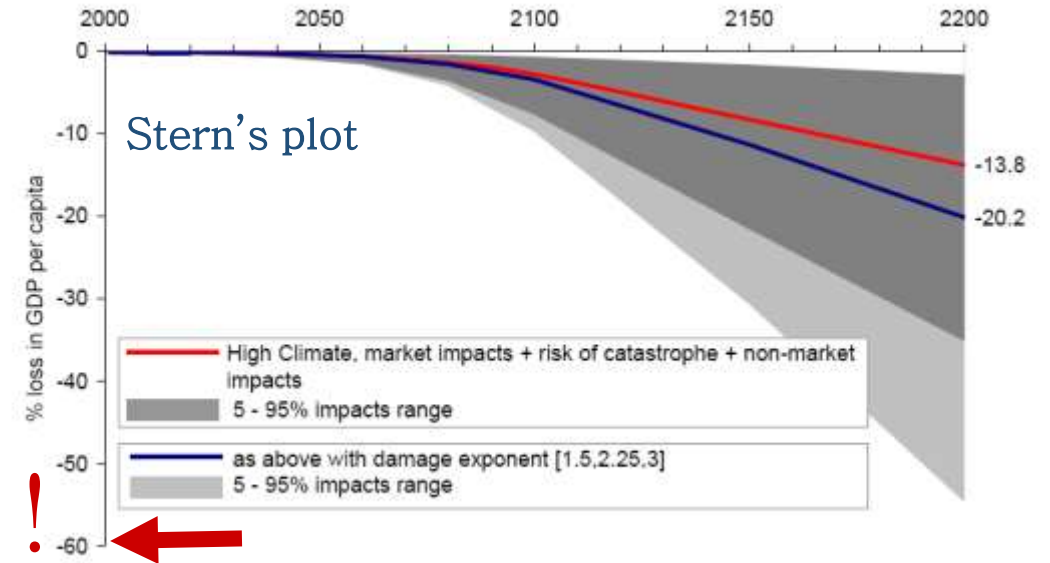
Kevin Rennert, Brian C. Prest, William A. Pizer, Richard G. Newell, David Anthoff,
Cora Kingdon, Lisa Rennels, Roger Cooke, Adrian E. Raftery, Hana Ševčíková,
and Frank Errickson

Working Paper 21-28
October 2021

Averaged till year 2300

Feeds into policy design

The Stern–Nordhaus controversy;
a reverse engineering the model:
→ uncertainty is too large to take
decisions → both Stern and
Nordhaus are wrong



Global Environmental Change 20 (2010) 298–302



Contents lists available at ScienceDirect

Global Environmental Change

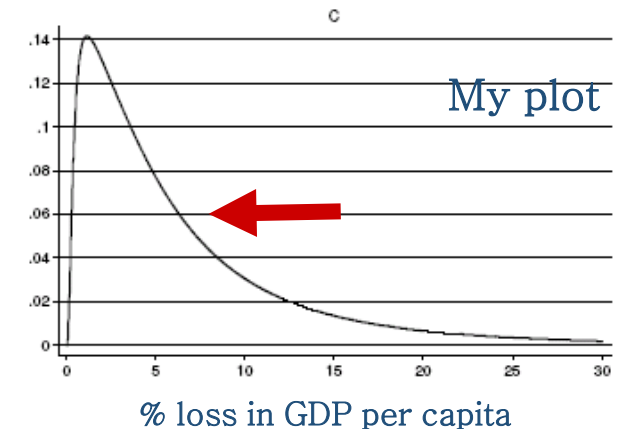
journal homepage: www.elsevier.com/locate/gloenvcha



Sensitivity analysis didn't help. A practitioner's critique of the Stern review

Andrea Saltelli*, Beatrice D'Hombres

Joint Research Centre, Institute for the Protection and Security of the Citizen, Ispra, Italy



Sensitivity Auditing for
mathematical modelling?

What do I make of your latinorum? Sensitivity auditing of mathematical modelling

Saltelli, A., Guimarães Pereira, Â., Van der Sluijs, J.P. and Funtowicz, S.



EC impact assessment guidelines: sensitivity analysis & auditing



Better Regulation
TOOLBOX

November 2021

European Commission. November 2021. “Better Regulation: Guidelines and Toolbox.”

https://ec.europa.eu/info/law/law-making-process/planning-and-proposing-law/better-regulation-why-and-how/better-regulation-guidelines-and-toolbox_en

Sensitivity auditing in the EC Guidelines (p. 563)

“Sensitivity auditing is a wider consideration of the effect of all types of uncertainty, including structural assumptions embedded in the model, and subjective decisions taken in the framing of the problem.”



Better Regulation
TOOLBOX

November 2021

Sensitivity auditing in the EC Guidelines (p. 563)

“In general, sensitivity auditing stresses the idea of clearly communicating the extent to which particular models can be used to support policy decisions and their results can be trusted, taking into account as much as possible all forms of potential uncertainty, ...”



Better Regulation
TOOLBOX

November 2021

Sensitivity auditing in the EC Guidelines (p. 563)

“... and to anticipate criticism by third parties. In particular, one should avoid giving the impression of false confidence by ‘quantification at all costs’.”



Better Regulation
TOOLBOX

November 2021

Sensitivity auditing in the EC Guidelines (p. 563)

“In some cases there is simply not enough data, or the process is too complex, to give a meaningful quantitative prediction.”



Better Regulation
TOOLBOX

November 2021

The rules of sensitivity auditing

1. Check against rhetorical use of mathematical modelling;
2. Adopt an “assumption hunting” attitude; focus on unearthing possibly implicit assumptions;
3. Check if uncertainty been instrumentally inflated or deflated.

4. Find sensitive assumptions before these find you; do your SA before publishing;
5. Aim for transparency; Show all the data;
6. Do the right sums, not just the sums right;
7. Perform a proper global sensitivity analysis.

From sensitivity auditing (2013) to the Manifesto (2022)

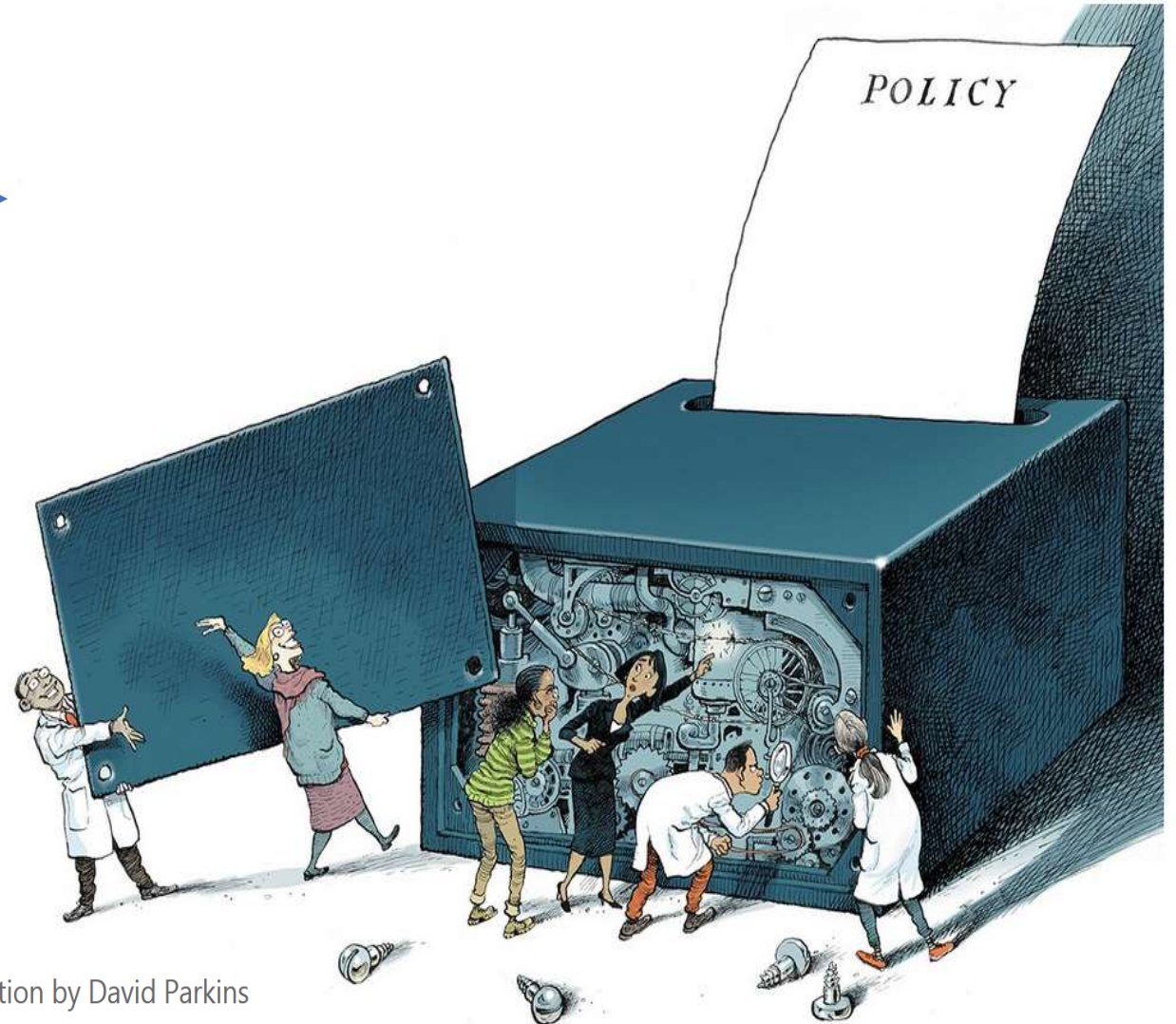
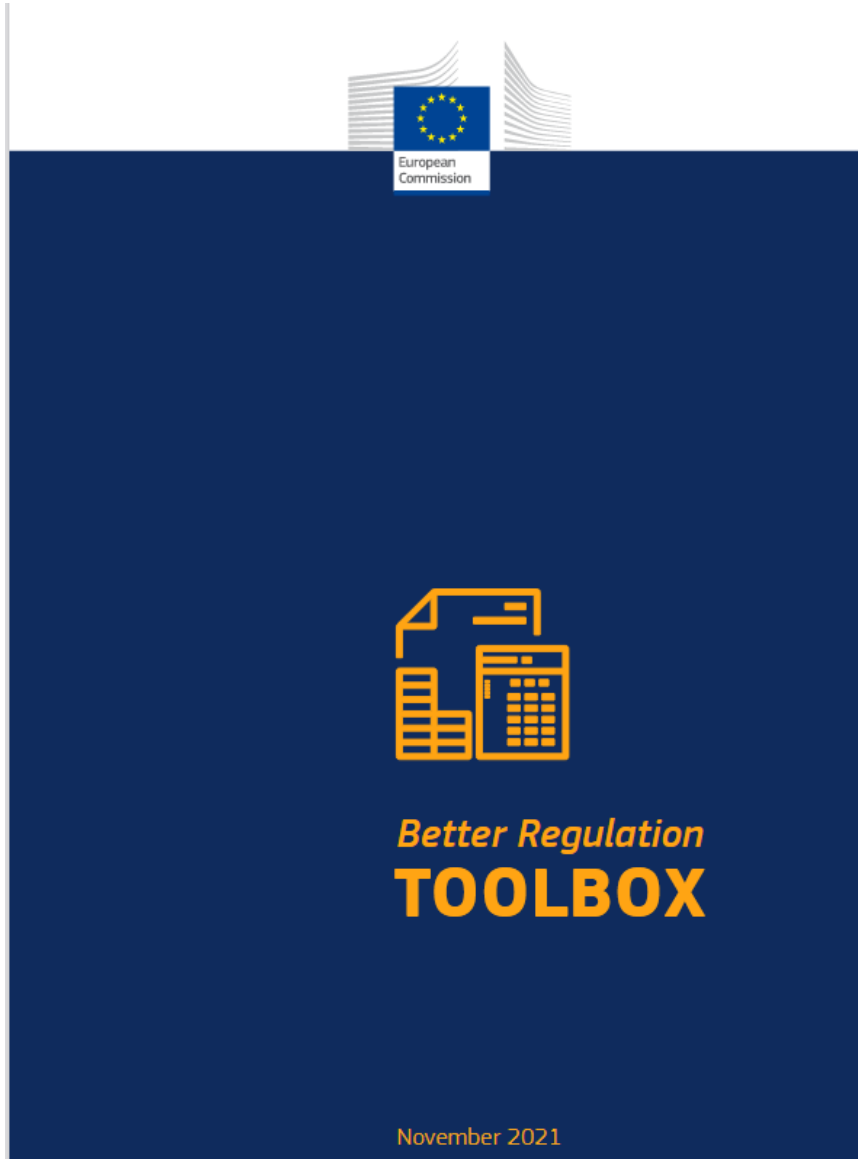


Illustration by David Parkins

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.

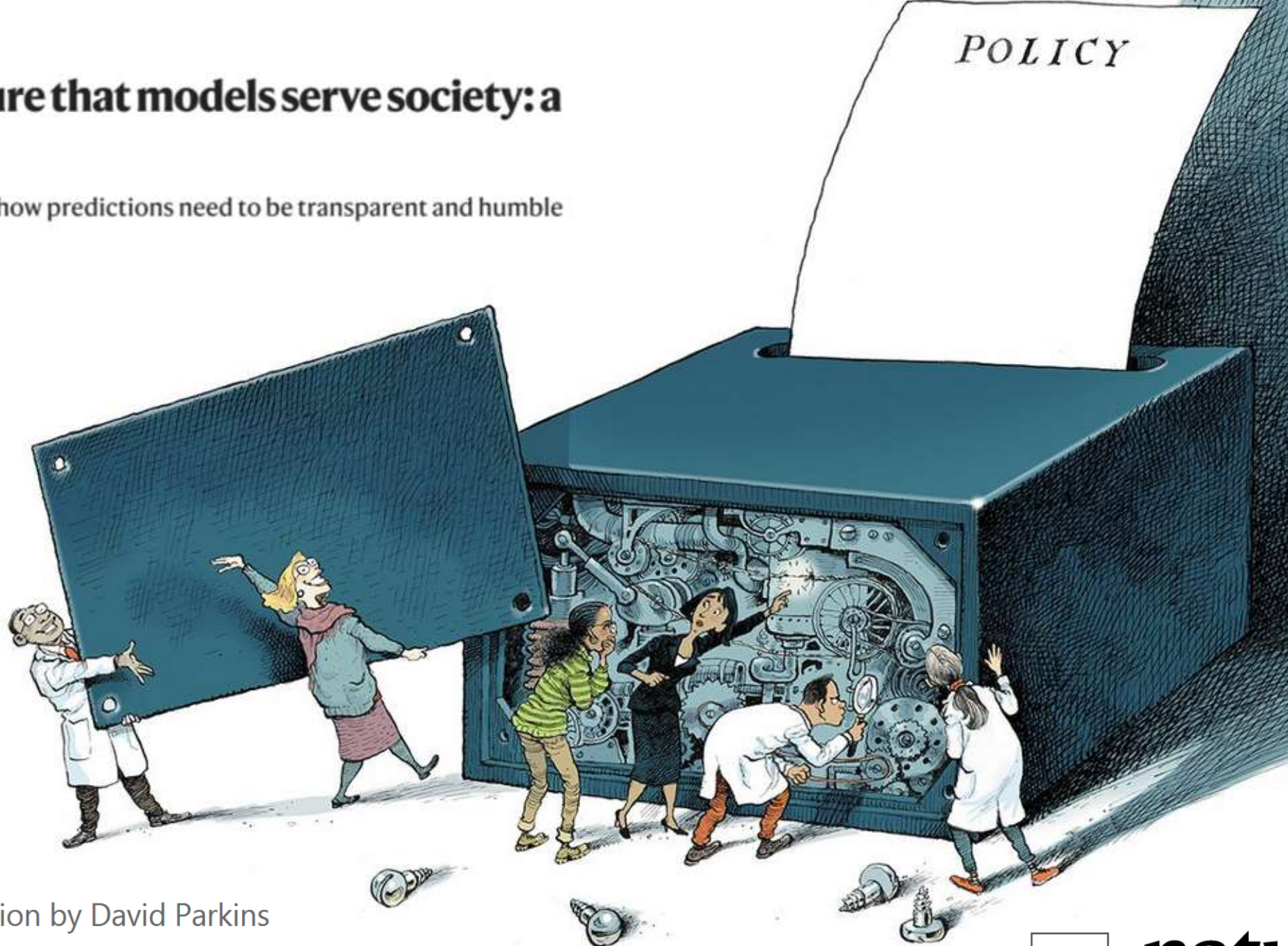


Illustration by David Parkins



nature



nature

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

3 modellers Lo Piano, Puy, Saltelli

2 experts models and society Pielke, van der Sluijs

3 statisticians Mayo, Stark, Portaluri

2 statactivistes Bruno, Didier

2 economists Kay, Raynert

1 epidemiologist Vineis

2 sociologists of quantification

Espeland, Porter

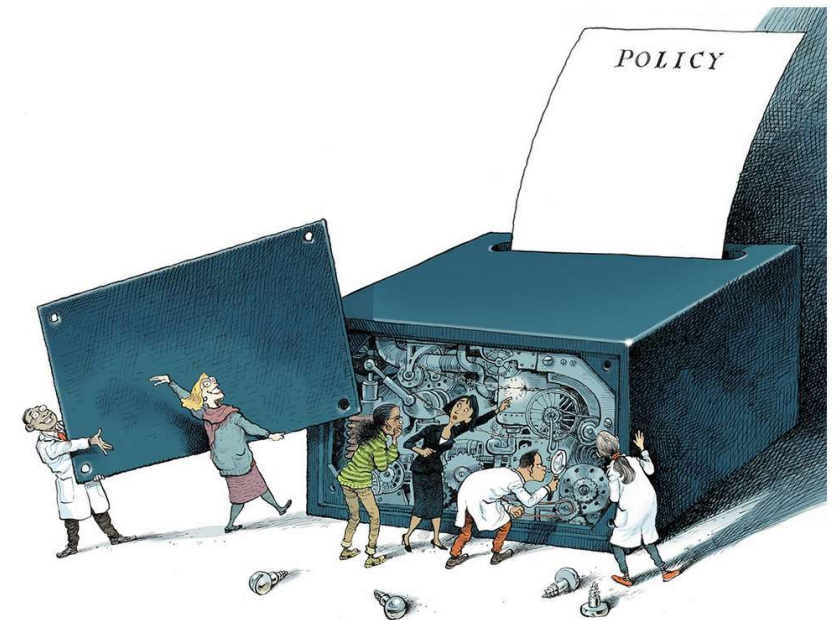
3 STS scholars Bammer, Sarewitz, Stirling

1 philosopher Ravetz

1 historian Charters

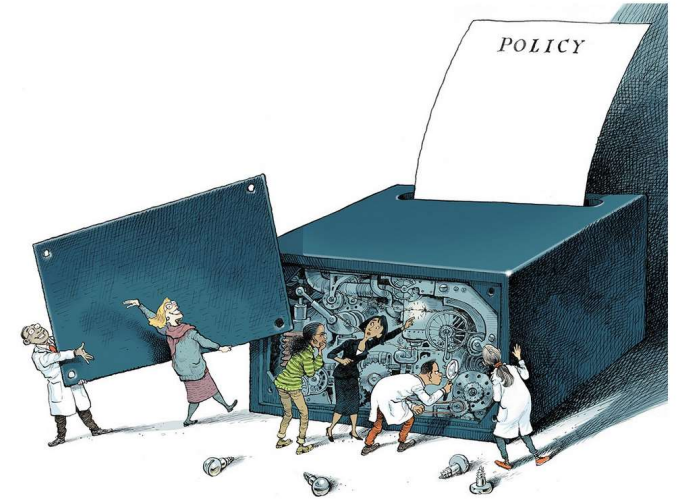
1 political scientists Di Fiore

1 expert RRI - Open Science Rafols



COVID has put mathematical models in the limelight

➔ Power & controversy



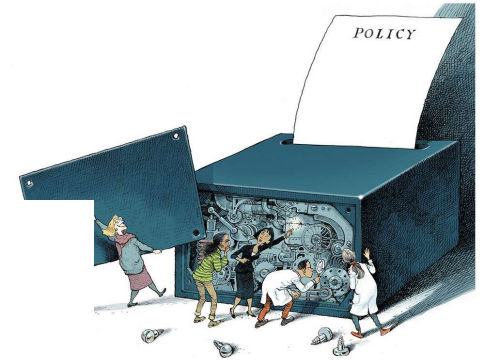
Power

The New York Times

Behind the Virus Report That Jarred the U.S. and the U.K. to Action

It wasn't so much the numbers themselves, frightening though they were, as who reported them: Imperial College London.

Landler, Mark, and Stephen Castle. 2020. Behind the Virus Report That Jarred the U.S. and the U.K. to Action – The New York Times.



Conflicts, when questions of urgency, stakes, values and uncertainty collide

Rush Limbaugh

“Wild-Ass Covid numbers
... The minute I hear
anybody start talking about
models and modeling, I
blanch”



Rhodes, Tim, and Kari Lancaster. 2020. “Mathematical Models as Public Troubles in COVID-19 Infection Control: Following the Numbers”, *Health Sociology Review* 1–18. doi: 10.1080/14461242.2020.1764376

Mind the assumptions

Assess uncertainty and sensitivity

Mind the hubris

Complexity can be the enemy of relevance

Mind the framing

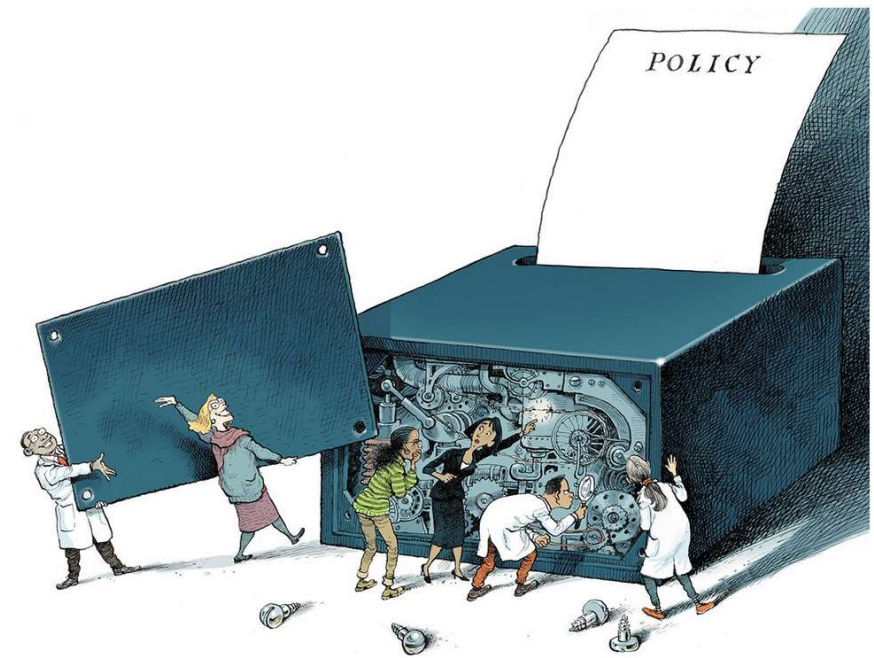
Match purpose and context

Mind the consequences

Quantification can backfire.

Mind the unknowns

Acknowledge ignorance



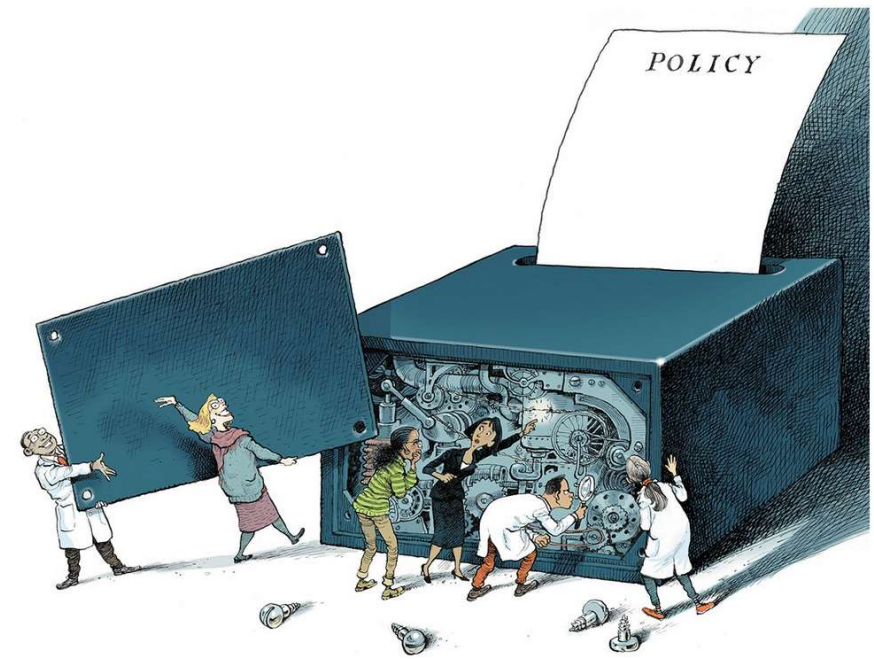
Mind the assumptions

Assess uncertainty and sensitivity



... models require input values for which there is no reliable information...

...global uncertainty and sensitivity analyses are often not done. Anyone turning to a model for insight should demand them ...

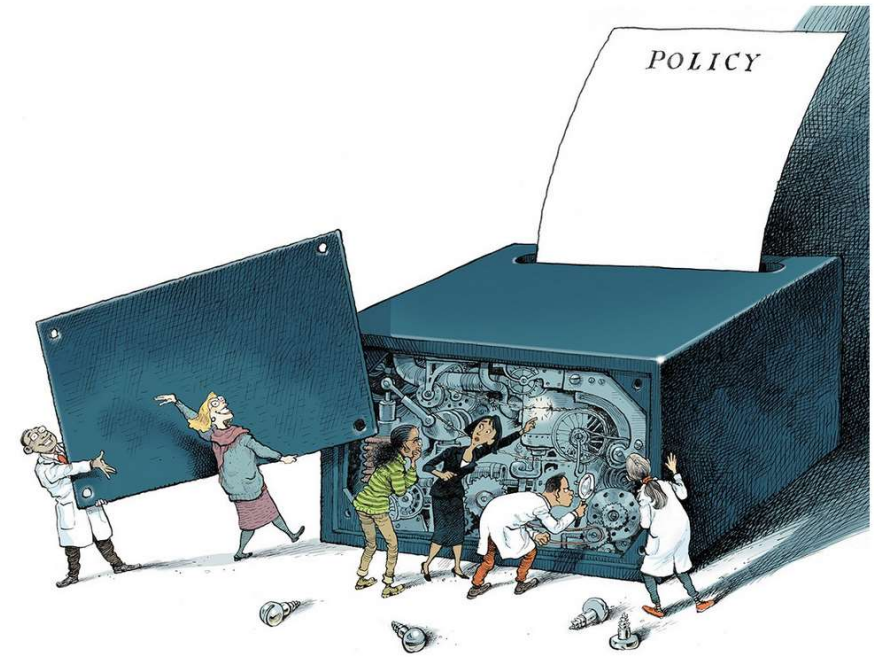


Mind the assumptions

Assess uncertainty and sensitivity



... this may lead to interesting discoveries ...



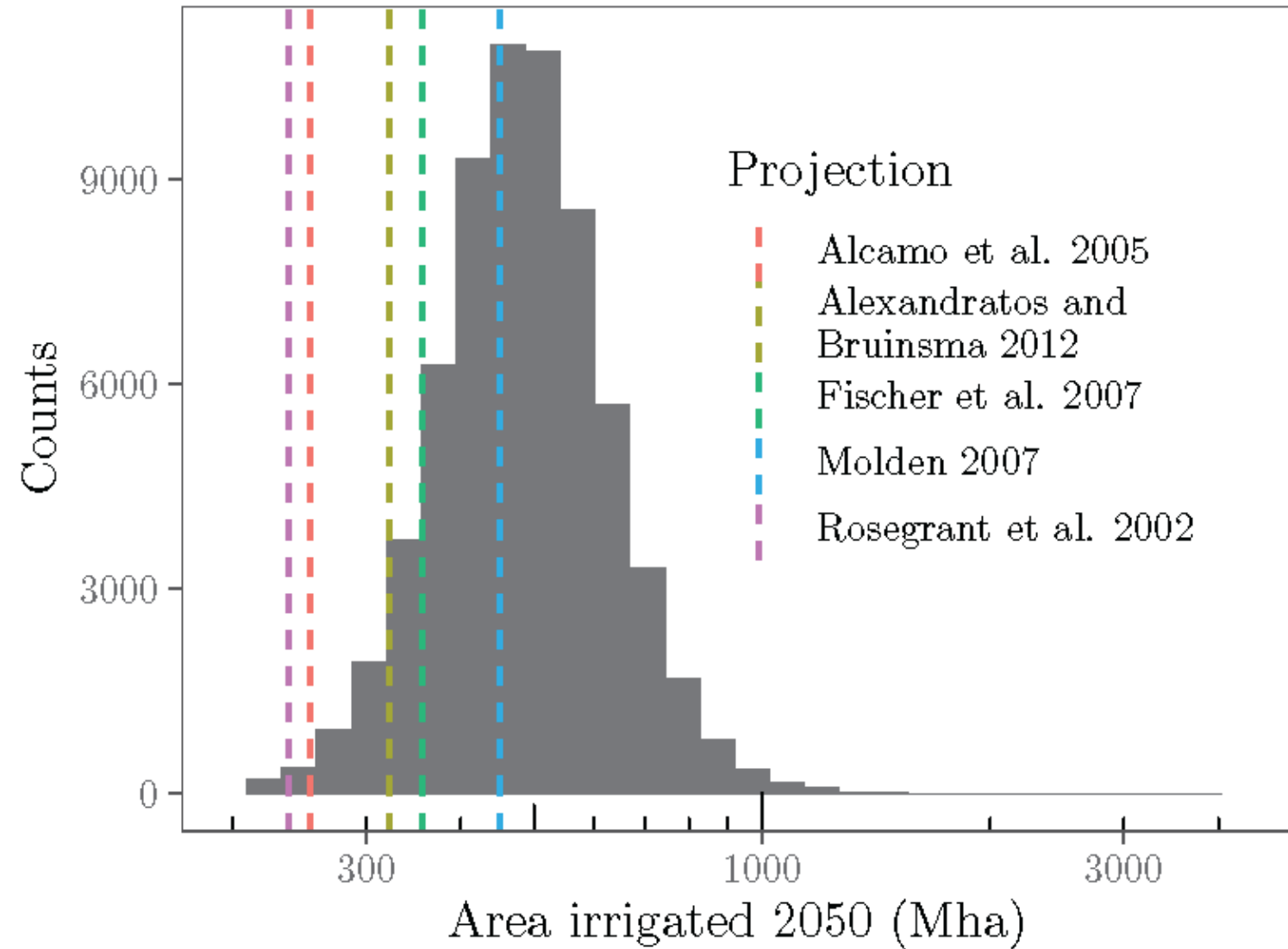
Current Models Underestimate Future Irrigated Areas

Geophysical Research Letters

A. Puy✉, S. Lo Piano, A. Saltelli

First published: 17 April 2020

An uncertainty analysis (grey histogram) reveals that the range of possible outcomes is larger and less conservative than official estimates (dashed lines)



Results confirmed by more recent work (June 2022)


nature communications

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[nature](#) > [nature communications](#) > [comment](#) > article

Comment | [Open Access](#) | [Published: 08 June 2022](#)

The delusive accuracy of global irrigation water withdrawal estimates

[Arnald Puy](#) , [Razi Sheikholeslami](#), [Hoshin V. Gupta](#), [Jim W. Hall](#), [Bruce Lankford](#), [Samuele Lo Piano](#), [Jonas Meier](#), [Florian Pappenberger](#), [Amilcare Porporato](#), [Giulia Vico](#) & [Andrea Saltelli](#)

[Nature Communications](#) **13**, Article number: 3183 (2022) | [Cite this article](#)

[Metrics](#)

Models ask as input information which we don't have – The case of WEBTAG

John Kay

J. A. Kay, “Knowing when we don't know,” 2012,
https://www.ifs.org.uk/docs/john_kay_feb2012.pdf



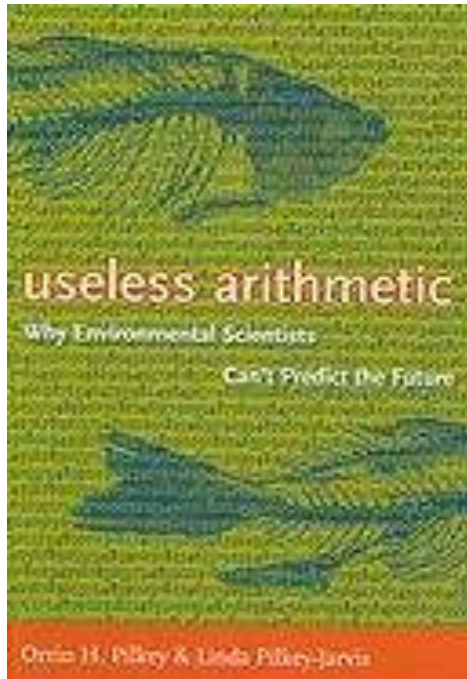
WebTAG: Annual Percentage Change in Car Occupancy (% pa) up to 2036

Journey Purpose	Weekday					Weekend	All Week
	7am-10am	10am-4pm	4pm-7pm	7pm-7am	Weekday Average		
Work	-0.48	-0.4	-0.62	-0.5	-0.44	-0.48	-0.45
Non - Work (commuting and other)	-0.67	-0.65	-0.53	-0.47	-0.59	-0.52	-0.56



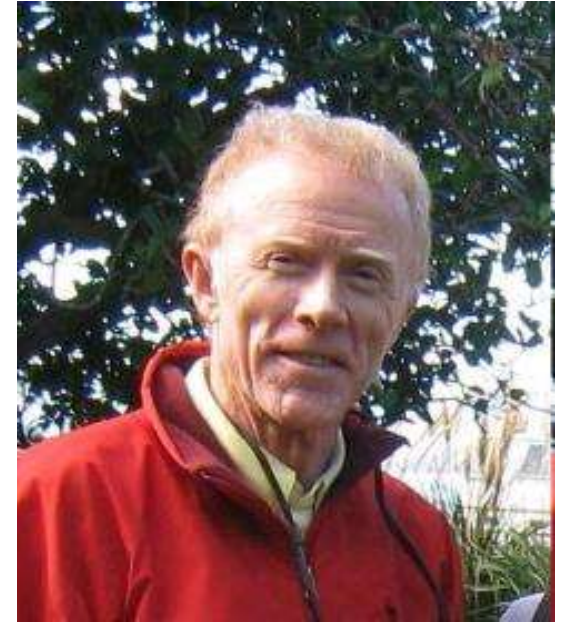
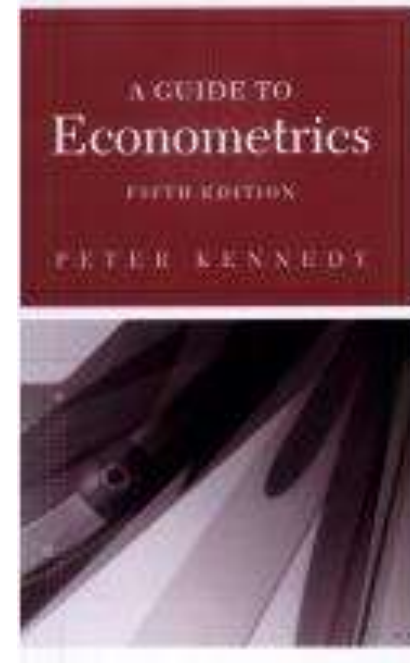
Orrin H. Pilkey

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



Peter Kennedy, A Guide to Econometrics.

One of the ten commandments of applied econometrics according to Peter Kennedy:



Peter Kennedy

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

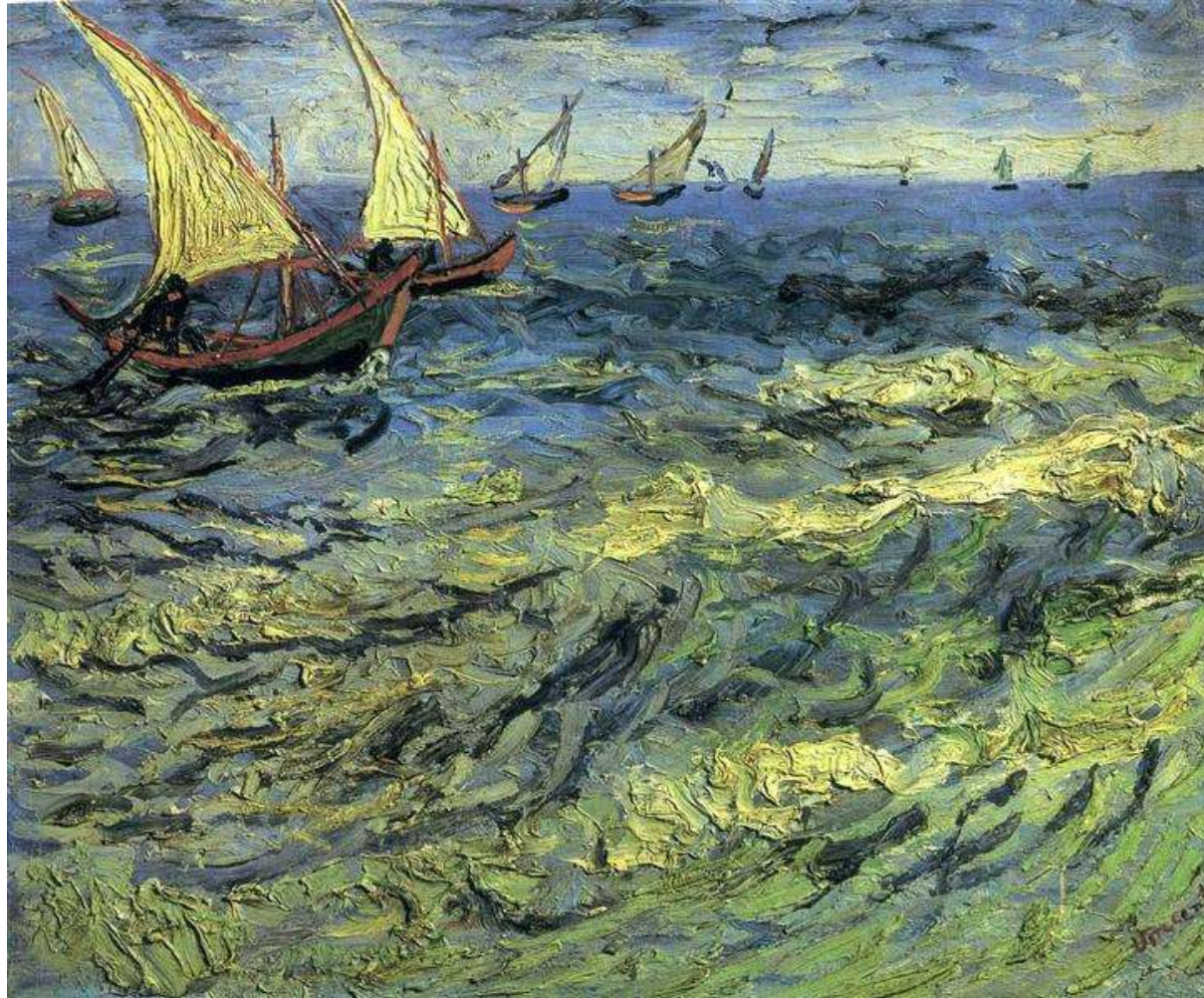


“One reason these methods [global sensitivity analysis] are rarely used is their honesty seems destructive;”

“or, to put it another way, a fanatical commitment to fanciful formal models is often needed to create the appearance of progress”

Tantalus on the Road to Asymptopia, Edward E. Leamer, 2010 *Journal of Economic Perspectives*, **24**, (2), 31–46.

Why is all this important? Fishing expeditions and forking paths ...





Jorge Luis Borges
(1899–1986)



Taking different
narratives within the
same novel like Ts'ui Pên



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*

Andrew Gelman[†] and Eric Loken[‡]

14 Nov 2013

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*

Andrew Gelman[†] and Eric Loken[‡]

14 Nov 2013

Why this matters? 

PNAS

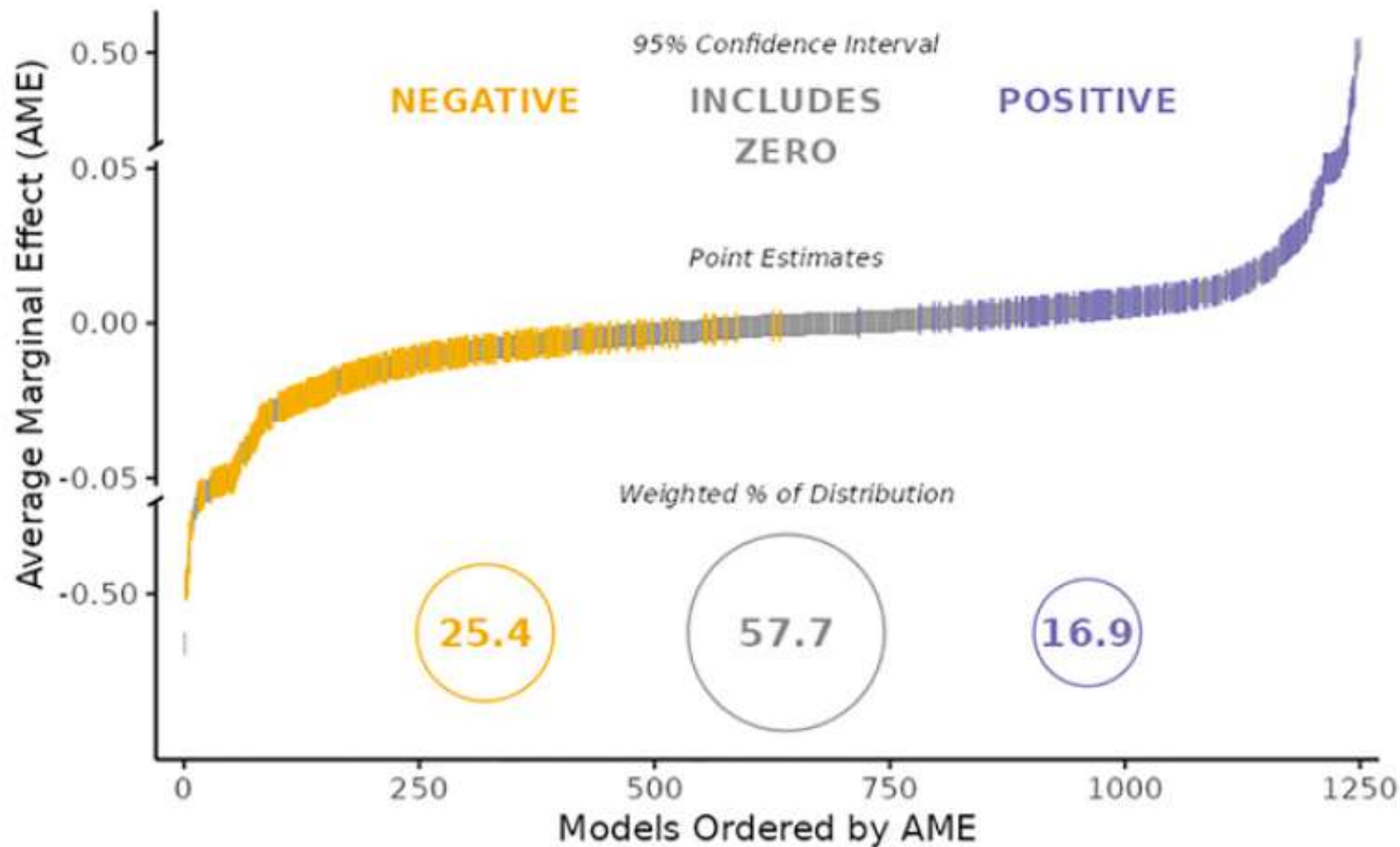
RESEARCH ARTICLE

SOCIAL SCIENCES

 OPEN

Observing many researchers using the same data and hypothesis reveals a hidden universe of uncertainty

Edited by Douglas Massey, Princeton University, Princeton, NJ; received March 6, 2022; accepted August 22, 2022



“Will different researchers [73 teams] converge on similar findings when analyzing the same data?”

“...teams’ results varied greatly, ranging from large negative to large positive effects”

(Breznau et al. 2022)

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Mind the hubris

Complexity can be the enemy of relevance

Mind the framing

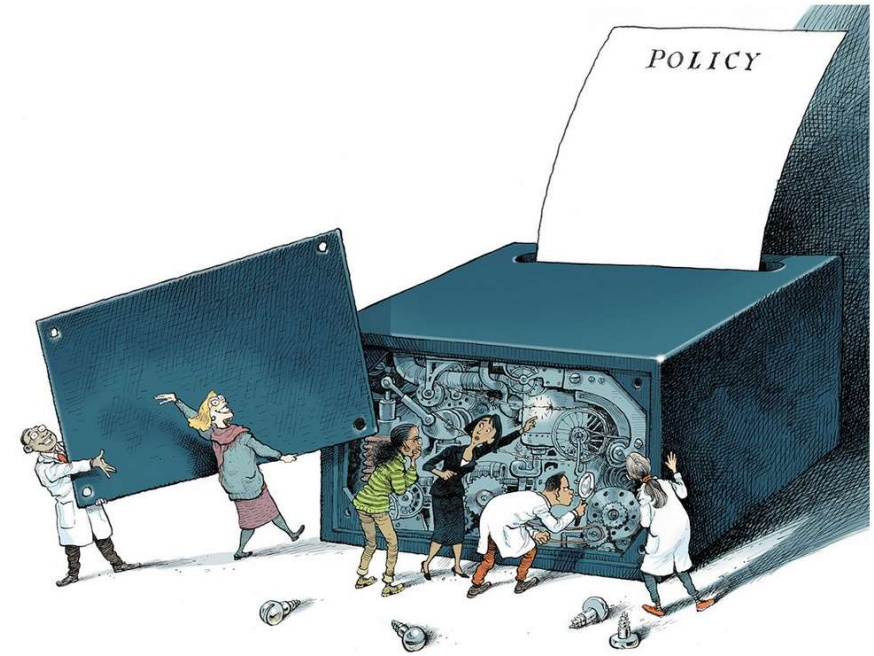
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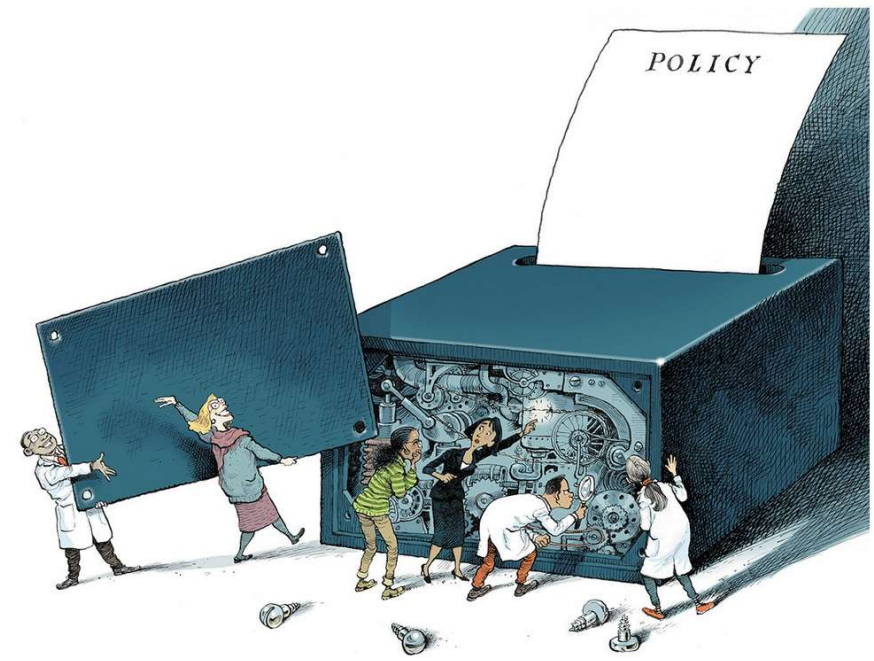
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Mind the hubris

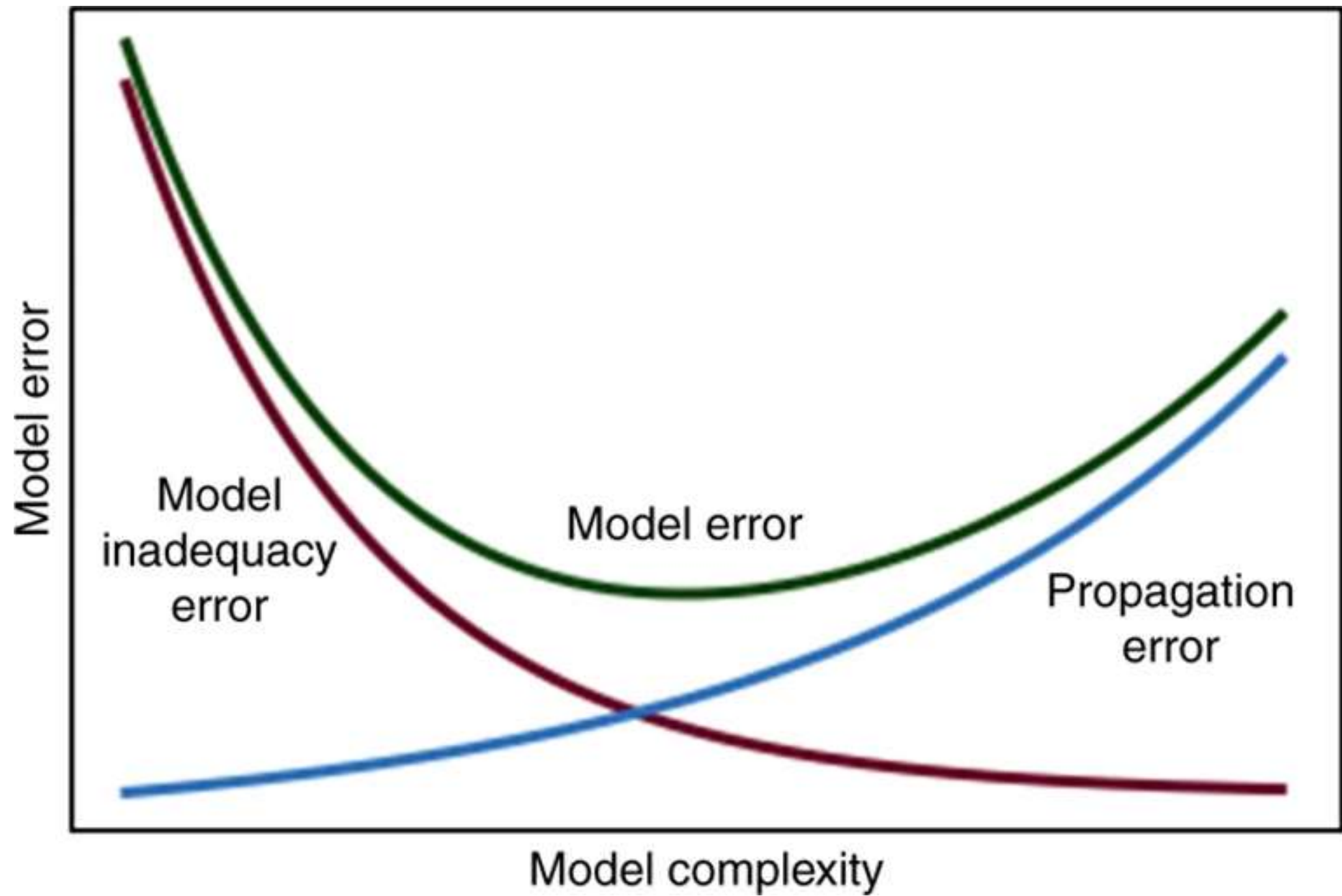
Complexity can be the enemy of relevance

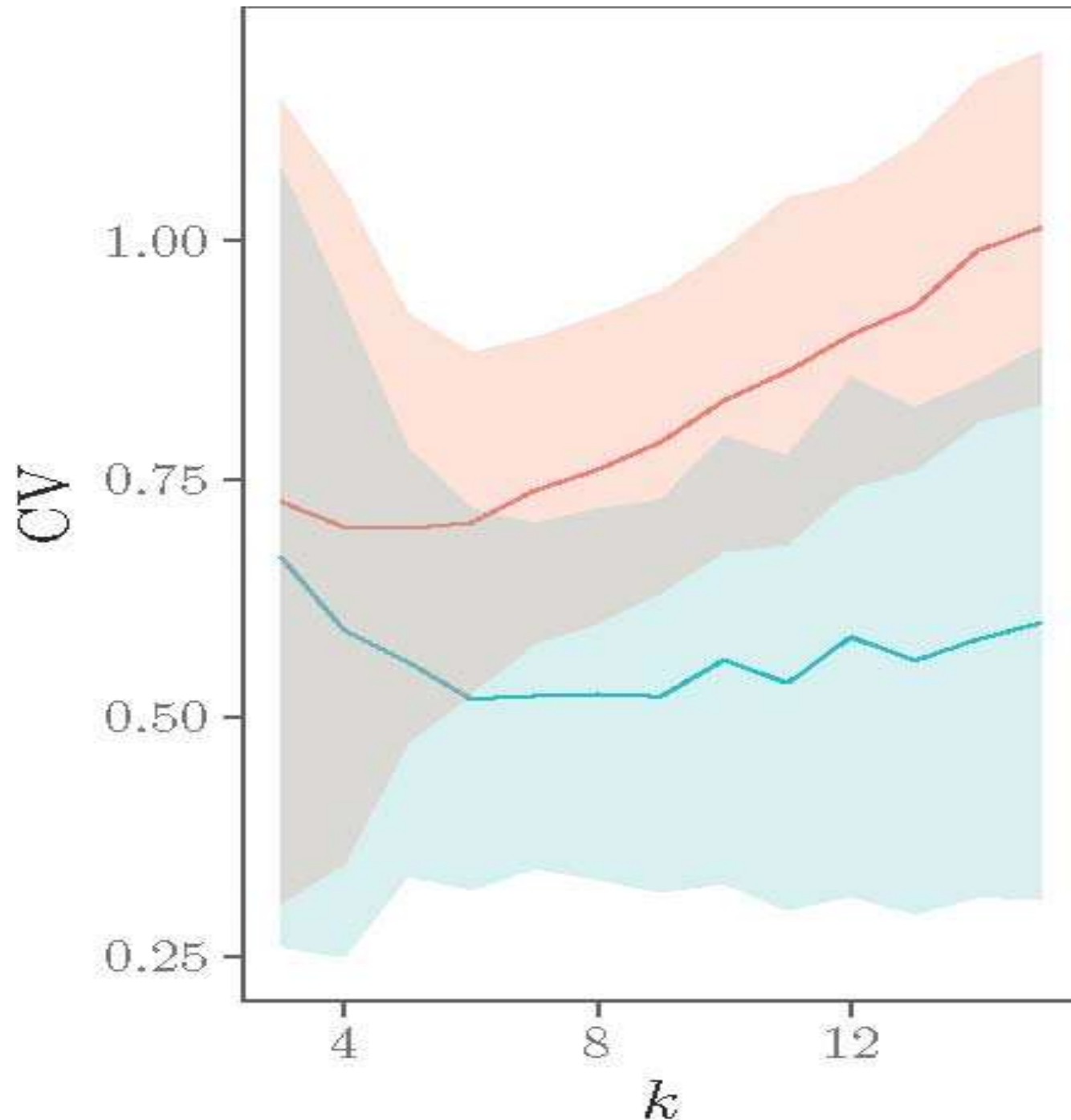


... many are seduced by the idea of adding complexity in an attempt to capture reality more accurately, but...

SUPPLEMENTARY INFORMATION

1. Additional information and references >260 references





O'Neil conjecture

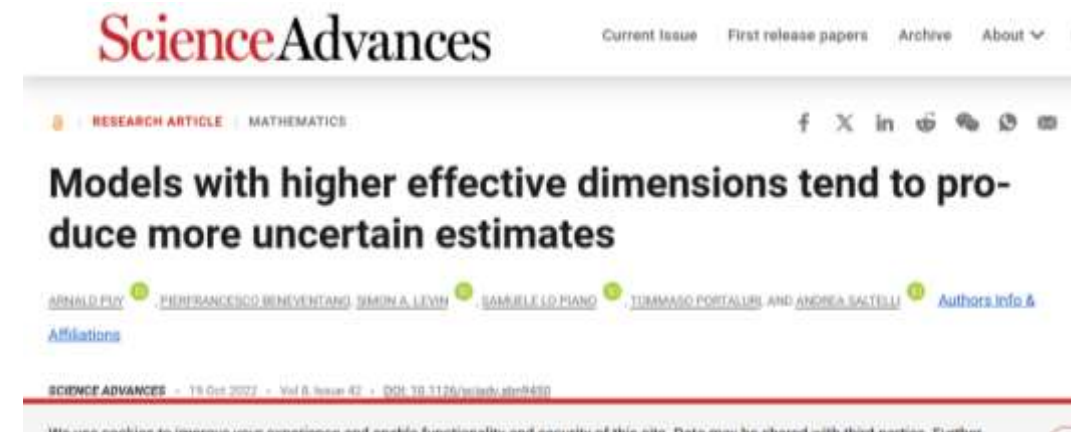
CV=coeff. of variation=
STD/mean

k model dimensionality

Interactions

- Up to the k -th order
- Up to the n -th order

with $n \leq k$



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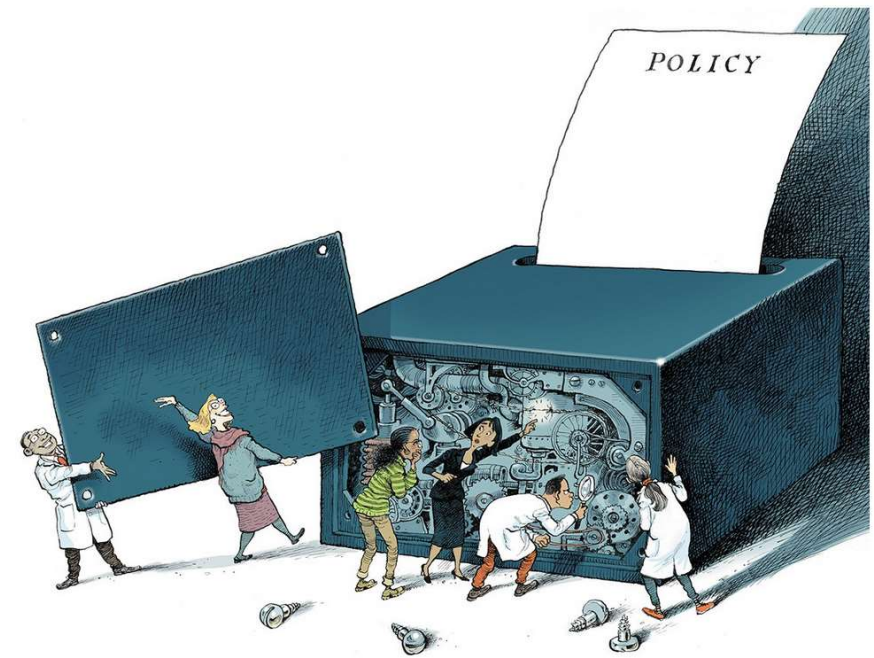
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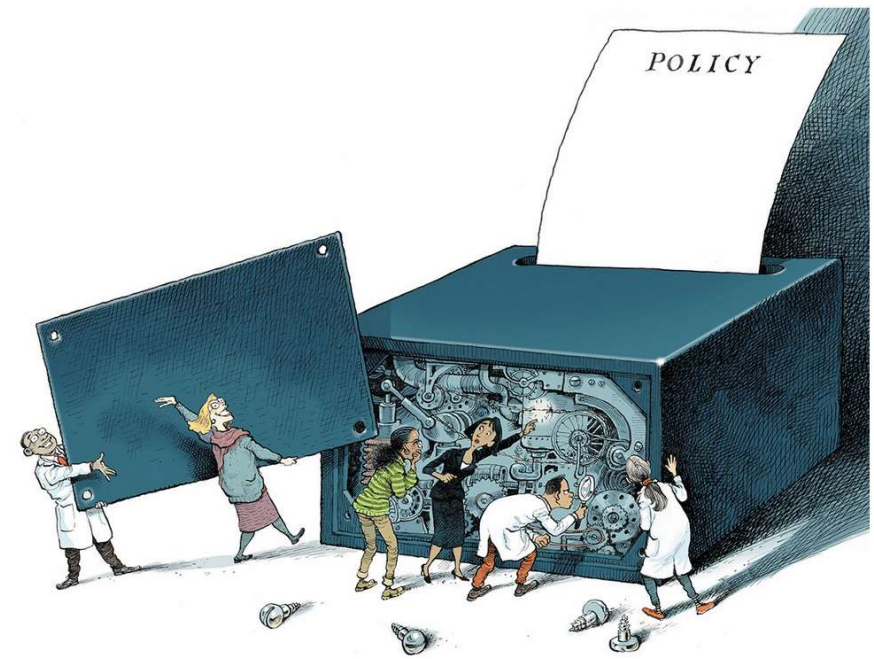
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… models will reflect the interests, disciplinary orientations and biases of the developers…

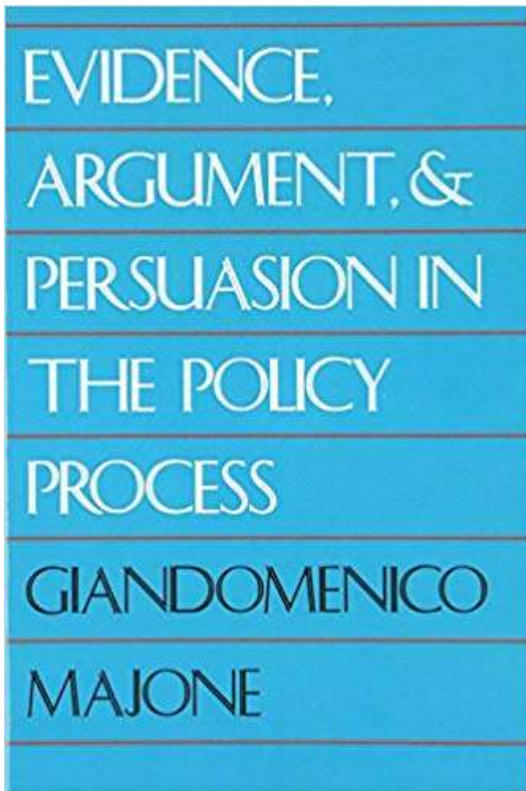
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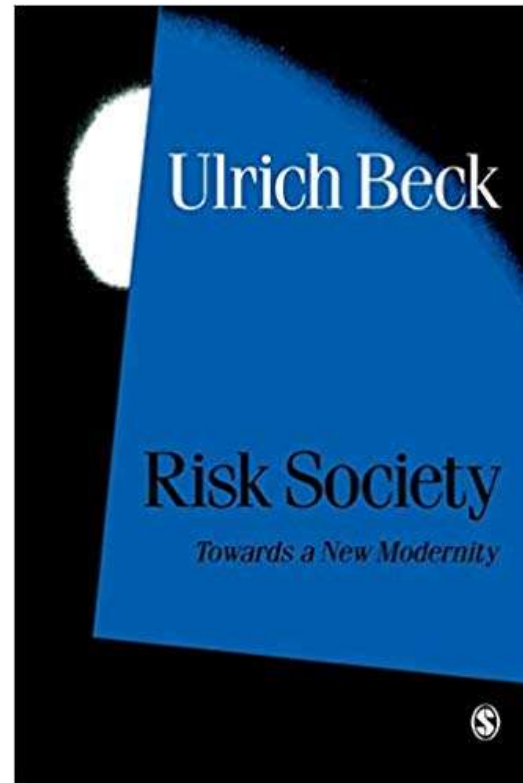
From Ulrich Beck to Giandomenico Majone: the technique is never neutral



Ulrich Beck
(1944 –2015)



1989



1992 (1986)



Environmental Science & Policy

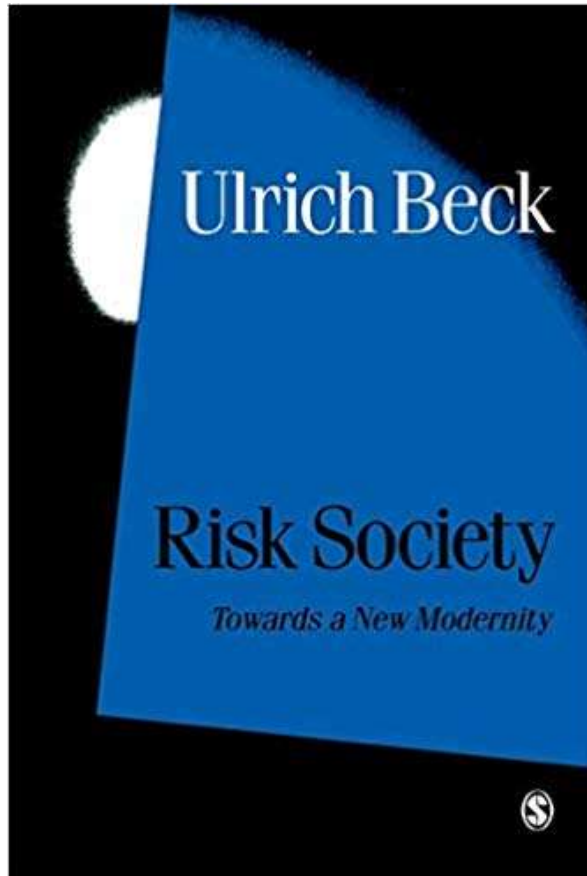
Volume 106, April 2020, Pages 87-98



The technique is never neutral. How
methodological choices condition the
generation of narratives for sustainability

Andrea Saltelli ^{a, b} ✉, Lorenzo Benini ^c, Silvio Funtowicz ^a, Mario Giampietro ^{d, e}, Matthias Kaiser ^a,
Erik Reinert ^{a, f}, Jeroen P. van der Sluijs ^{a, g, h}

“It is not uncommon for political programs to be decided in advance simply by the choice of what expert representatives are included in the circle of advisers.”



1992 (1986)



Ulrich Beck
(1944 –2015)

The technique is never neutral. How methodological choices condition the generation of narratives for sustainability



Environmental Science & Policy
Volume 106, April 2020, Pages 87–98



Andrea Saltelli ^{a, b}  , Lorenzo Benini ^c, Silvio Funtowicz ^a, Mario Giampietro ^{d, e}, Matthias Kaiser ^a, Erik Reinert ^{a, f}, Jeroen P. van der Sluijs ^{a, g, h}

Combine more lenses, including Post-normal science (PNS), Bioeconomics, and Non-Ricardian economics

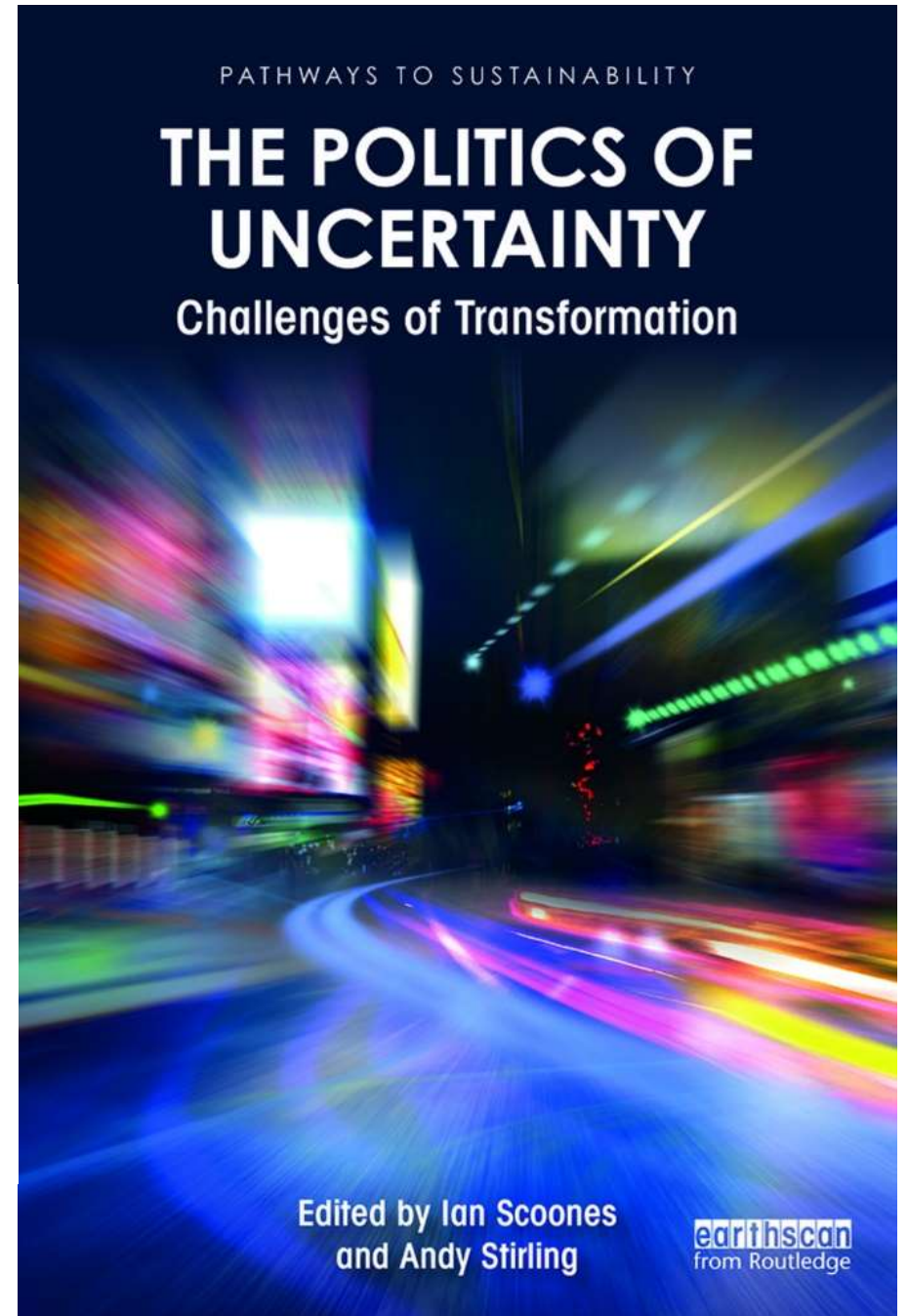
On reductionism

4

THE UNRAVELLING OF TECHNOCRATIC ORTHODOXY?

Contemporary knowledge politics
in technology regulation

Patrick van Zwanenberg



Frames as hypocognition &
Socially constructed ignorance



Steve Rayner

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

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

Denial, Dismissal, Diversion, Displacement



Model based

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

Displacement: “The model we have developed tells us that real progress is being achieved” (The focus is now the model not the problem).

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

Example of displacement: Chesapeake Bay Program (CBP) modelling work

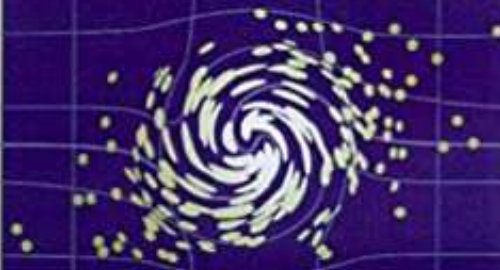
“Bay models are used to track nutrient loads to ensure the cap is not exceeded”

→ The model results – rather than the actual measurements, become the substance of use

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

PREDICTION

Science, Decision Making,



and the Future of Nature

Edited by Daniel Sarewitz,
Roger A. Pielke, Jr., and Radford Byerly

Model GENESIS for beach
erosion



**US Army Corps
of Engineers®**

Manipulated to support coastal-engineering
projects

It neglected the role of extreme event

Sarewitz, D., Pielke, R. A. & Byerly, R. *Prediction: Science, Decision Making, and the Future of Nature* (Island Press, 2000).

Mind the assumptions

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Mind the hubris

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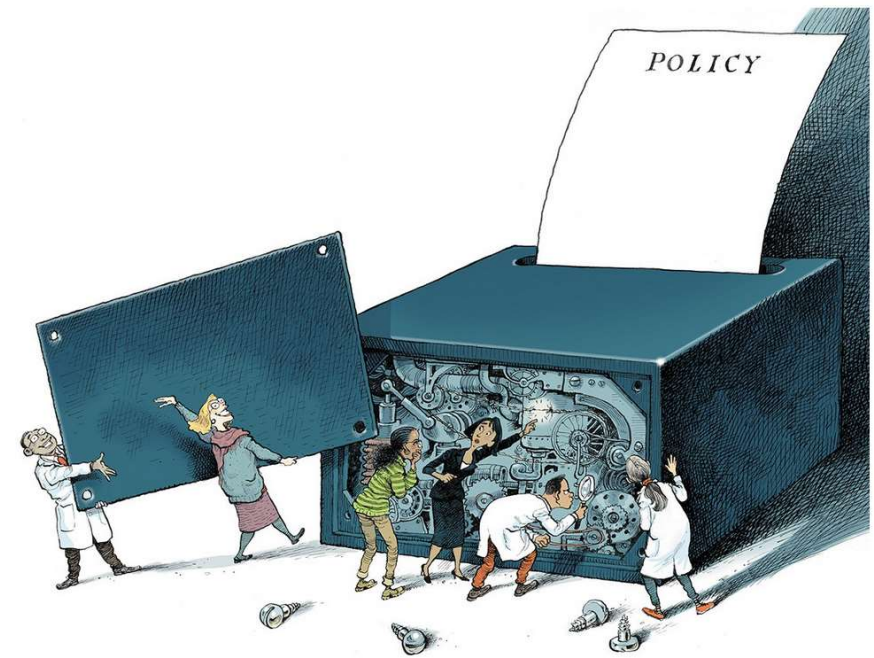


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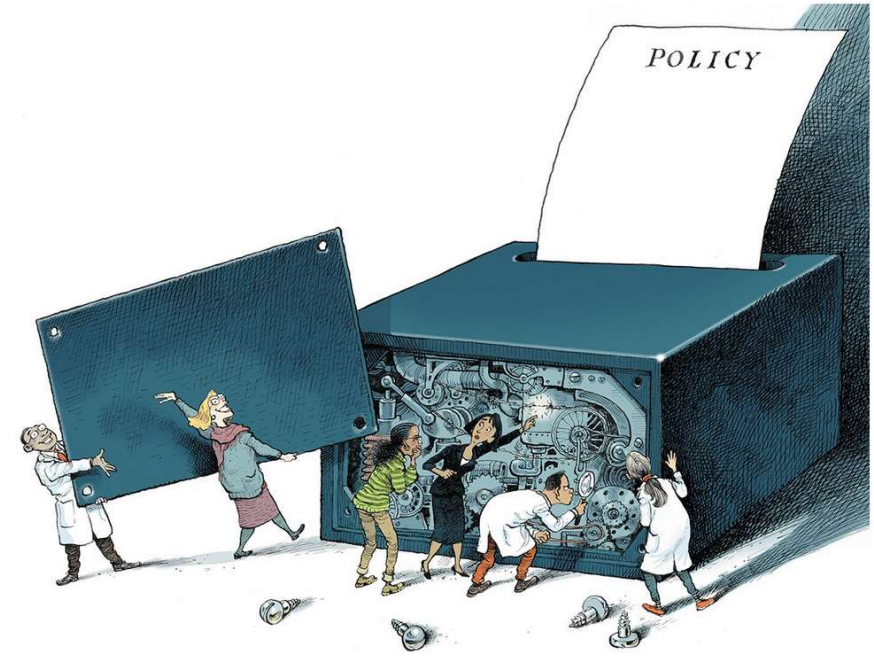
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From the risk of financial products to the management of coastal zones to the models for disaster insurance bad modelling may lead to wrong decisions

SUPPLEMENTARY INFORMATION

1. Additional information and references >260 references

$$\Pr[T_A < 1, T_B < 1] = \Phi_2(\Phi^{-1}(F_A(1)), \Phi^{-1}(F_B(1)), \gamma)$$

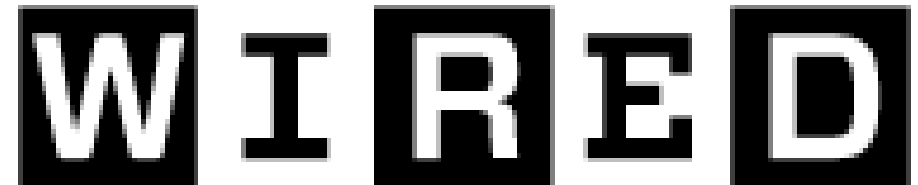
Here's what killed your 401(k) *David X. Li's Gaussian copula function as first published in 2000. Investors exploited it as a quick—and fatally flawed—way to assess risk. A shorter version appears on this month's cover of Wired.*

Here is what killed your 401(k)...

Li's Gaussian copula function ...

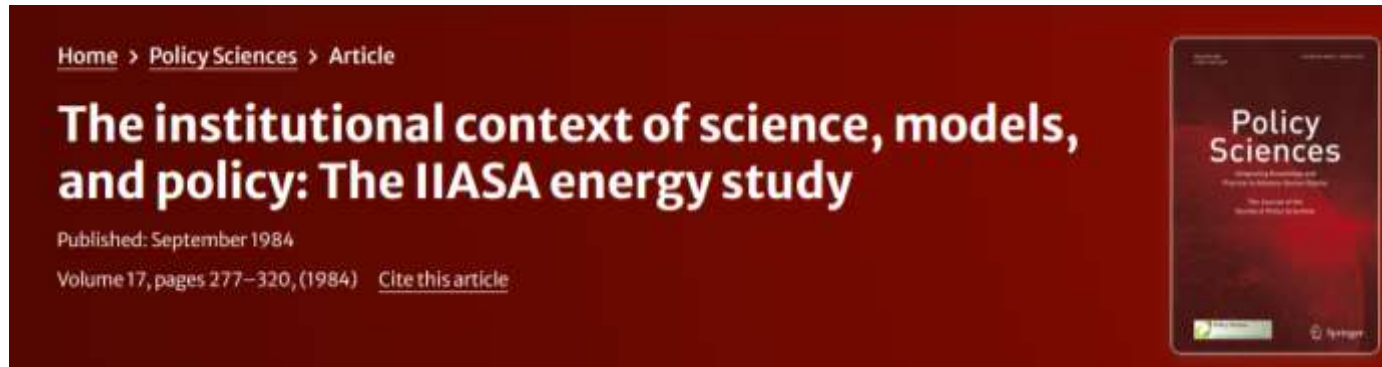
Nassim Nicholas Taleb, hedge fund manager and author of *The Black Swan*, is particularly harsh when it comes to the copula. "People got very excited about the Gaussian copula because of its mathematical elegance, but the thing never worked," he says. "Co-association between securities is not measurable using correlation," because past history can never prepare you for that one day when everything goes south. "Anything that relies on correlation is charlatanism."

Felix Salmon, Wired, February 2009



Source: <https://www.wired.com/2009/02/wp-quant/>

Delusion of scientificity



“models are more symbolic vehicles for gaining authority than objective technical framework” (1984)

Brian Wynne (and others such as William Keepin) debunked in the early 80’s a totally off-the-mark model-based energy future, declared as ‘scientifically prescribed’ by analysts at IIASA ...

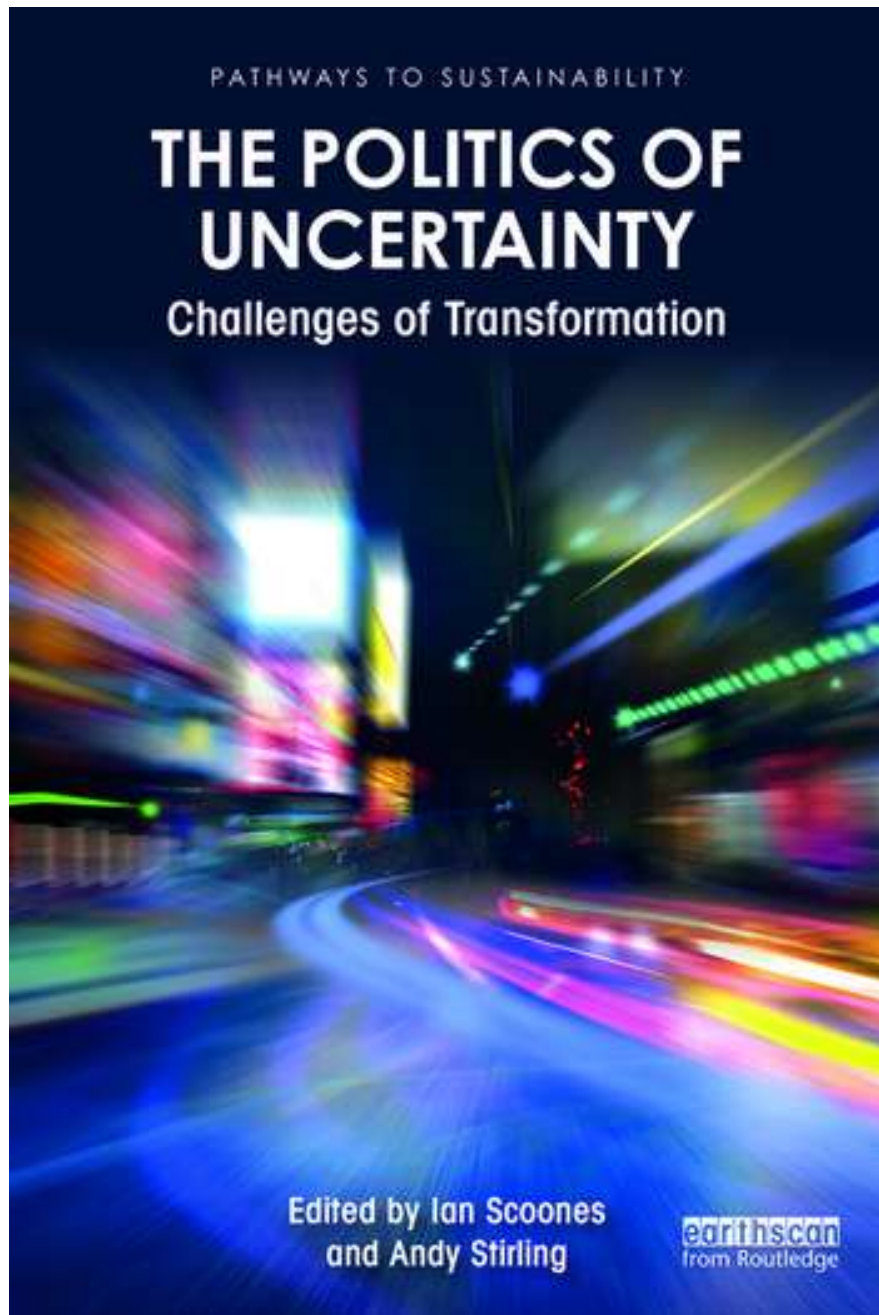
The same way Digital Twins of the planet are ‘scientifically prescribed’ today ...



A fast breeder reactor in the Netherlands, today an amusement park

See a summary here





3

SHARING RISKS OR PROLIFERATING UNCERTAINTIES?

Insurance, disaster and development

Leigh Johnson

Model-based parametric insurance led to dramatic consequences for developing countries experiencing draughts

Open access: <https://www.taylorfrancis.com/books/politics-uncertainty-ian-scoones-andy-stirling/e/10.4324/9781003023845>

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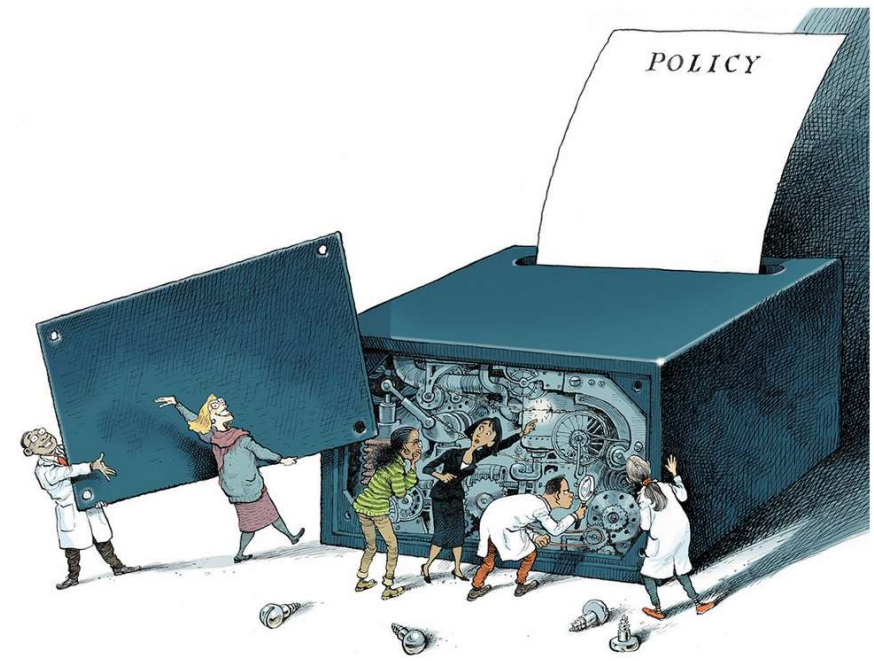
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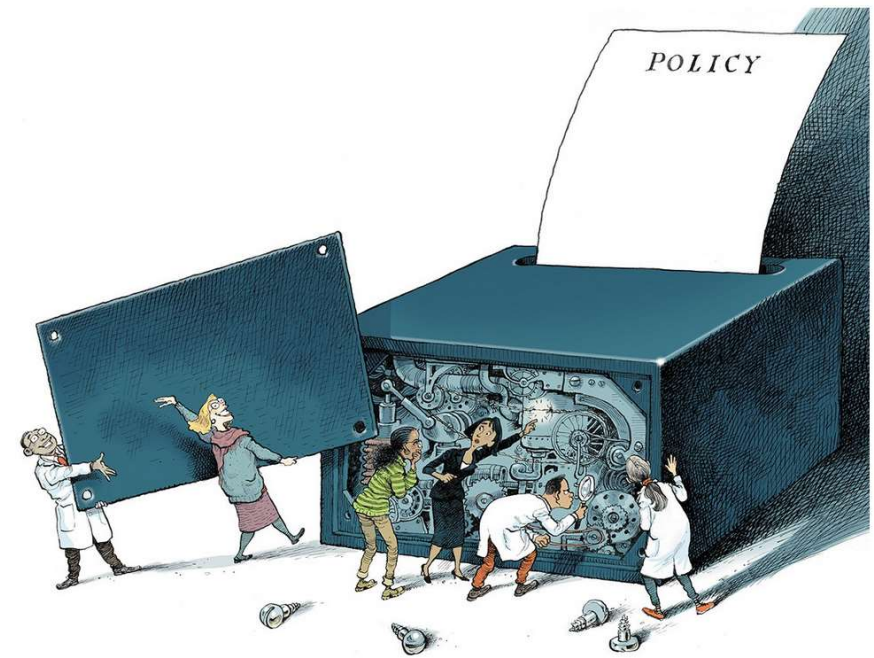
Acknowledge ignorance



Mind the unknowns

Acknowledge ignorance

“there is no
number-answer to
your question”

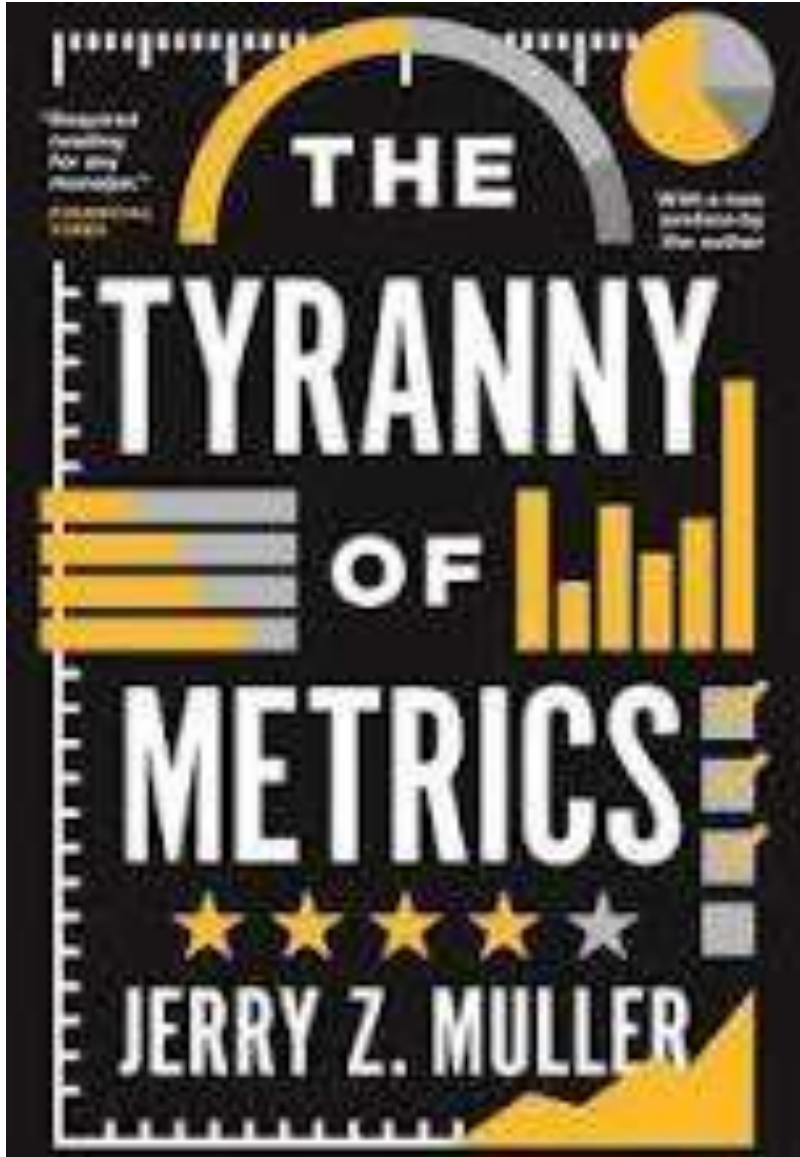


SUPPLEMENTARY INFORMATION

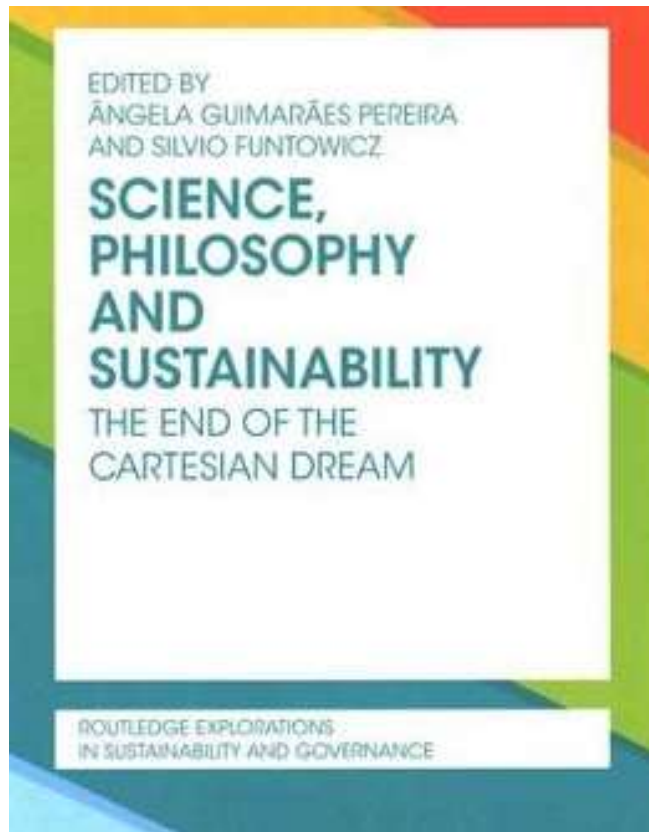
1. Additional information and references

>260 references

Anthony Fauci



“keep in mind at every step that the best use of metrics **may** be not to use it at all”



Jerome R. Ravetz

Ravetz, J, R, 2015, Descartes and the rediscovery of **ignorance**, in Guimarães Pereira, Â, and Funtowicz, S, Eds, 2015, The end of the Cartesian dream, Routledge.

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



Futures

Volume 91, August 2017, Pages 62-71



Original research article

What is wrong with evidence based policy, and how can it be improved?

Andrea Saltelli^{a, b, c}  , Mario Giampietro^{a, c, d}

Responsible use of quantitative information; try via negativa (N. Taleb); instead of proving policy options try to falsify them



Futures

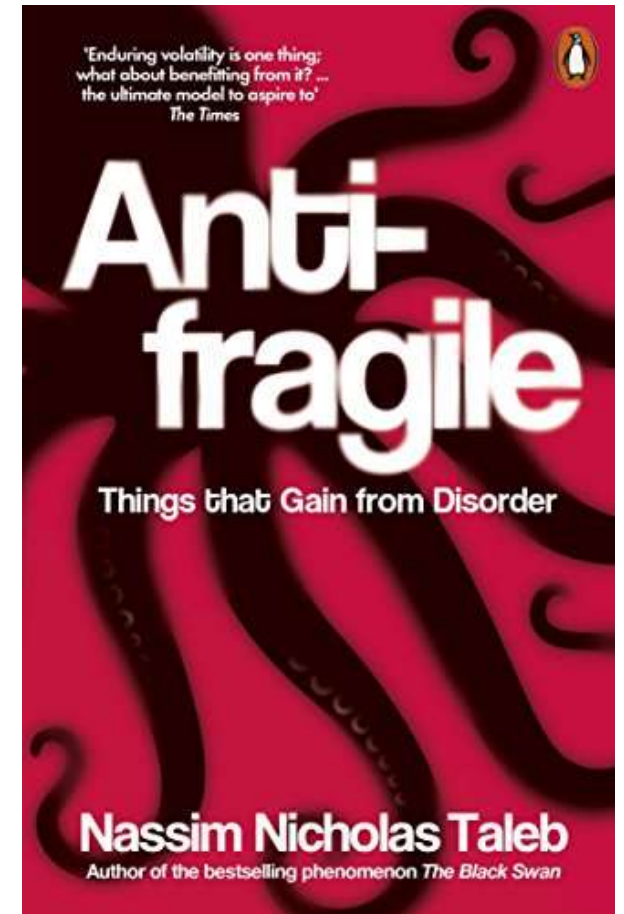
Volume 91, August 2017, Pages 62-71



Original research article

What is wrong with evidence based policy, and how can it be improved?

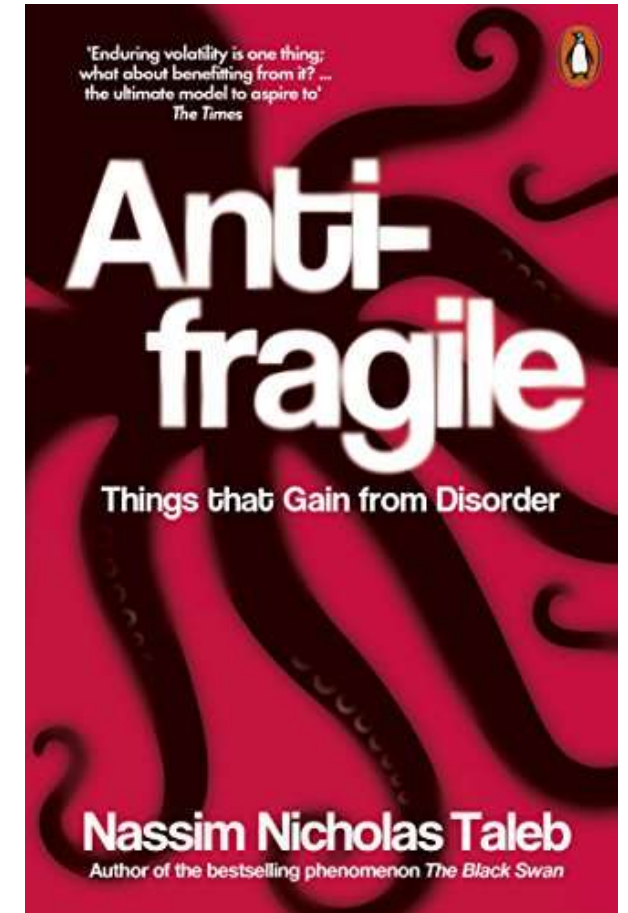
Andrea Saltelli ^{a, b, c}  , Mario Giampietro ^{a, c, d}



“...we know what is wrong with more clarity than what is right, and that knowledge grows by subtraction

... easier to know that something is wrong than to find the fix ...

Actions that remove are more robust than those that add because addition may have unseen, complicated feedback loops”



Falsification of the available options based on:

- Feasibility (compatibility with external constraints),
- Viability (compatibility with internal constraints), and
- Desirability (compatibility with normative values adopted in the given society)



Futures
Volume 91, August 2017, Pages 62-71



Original research article

What is wrong with evidence based policy, and how can it be improved?

Andrea Saltelli ^{a, b, c} , Mario Giampietro ^{a, c, d}

➔ Responsible modelling; reciprocal domestication between models and society





COMMENTARY

Open Access



What did COVID-19 really teach us about science, evidence and society?

Andrea Saltelli Joachim P. Sturmberg, Daniel Sarewitz, John P. A. Ioannidis

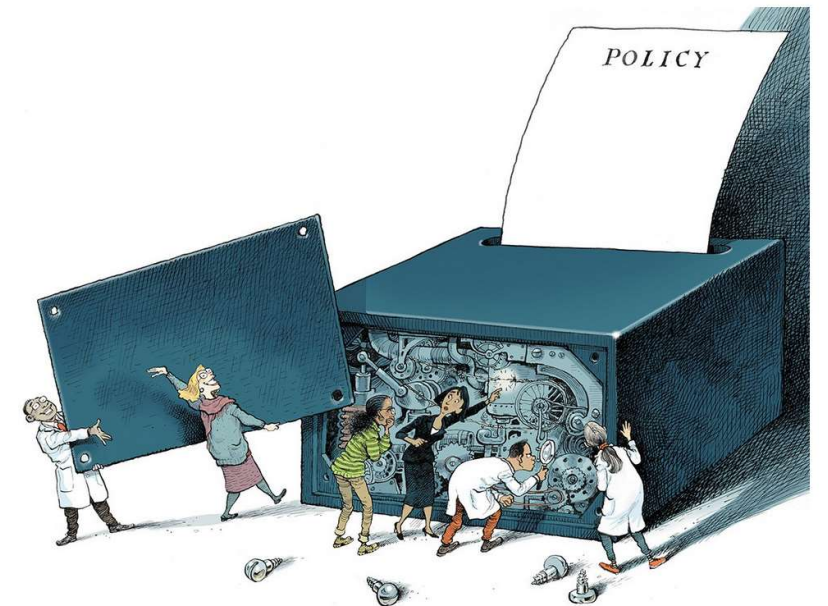
First published: 06 June 2023 | <https://doi.org/10.1111/jep.13876>

“COVID–19 policies allocated sacrifice, privation and suffering across all walks of society [but] radically different responses from nation to nation—from draconian lockdowns, to relatively permissive and flexible pandemic regimes—made obvious to all that the value of **scientific evidence** was to support what was politically desirable and possible in different contexts

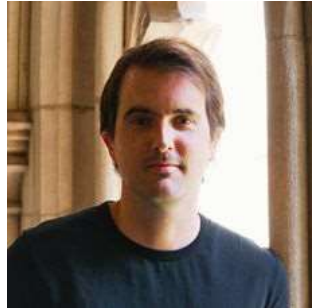
Mostly provided by models

“Modellers must not be permitted to project more certainty than their models deserve;

and politicians must not be allowed to offload accountability to models of their choosing”



Impact assessment culture
in the European Union
Time for something new?



Mostly based on

Environmental Science and Policy 142 (2023) 99–111



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Impact assessment culture in the European Union. Time for something new?

Andrea Saltelli^{a,b,*}, Marta Kuc-Czarnecka^c, Samuele Lo Piano^d, Máté János Lőrincz^d,
Magdalena Olczyk^c, Arnald Puy^e, Erik Reinert^{f,g}, Stefán Thor Smith^d,
Jeroen P. van der Sluijs^{b,h}

Better regulation: guidelines and toolbox

General principles


The better regulation guidelines set out the principles that the European Commission follows when preparing new initiatives and proposals and when managing and evaluating existing legislation.

The guidelines apply to each phase of the law-making cycle.



3 NOVEMBER 2021


Better regulation guidelines
English (663.75 KB - PDF)

Download 



20 JULY 2023

Better regulation toolbox
English (6.45 MB - PDF)

Download 



614 pages of tools

https://commission.europa.eu/law/law-making-process/planning-and-proposing-law/better-regulation/better-regulation-guidelines-and-toolbox_en

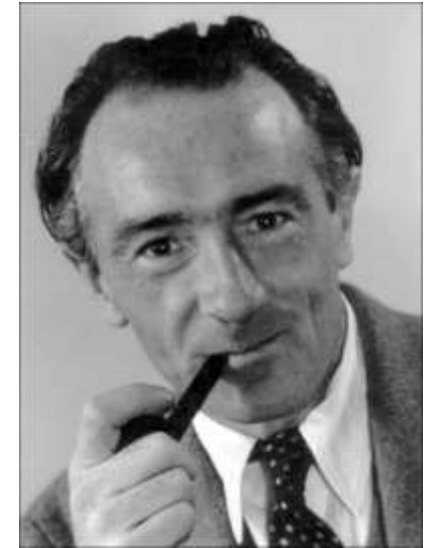
Evidence based medicine came first!

Evidence Based Medicine was born when clinical decision making was set to integrate clinical expertise with external evidence (e.g. randomized trials) and patient values and preferences

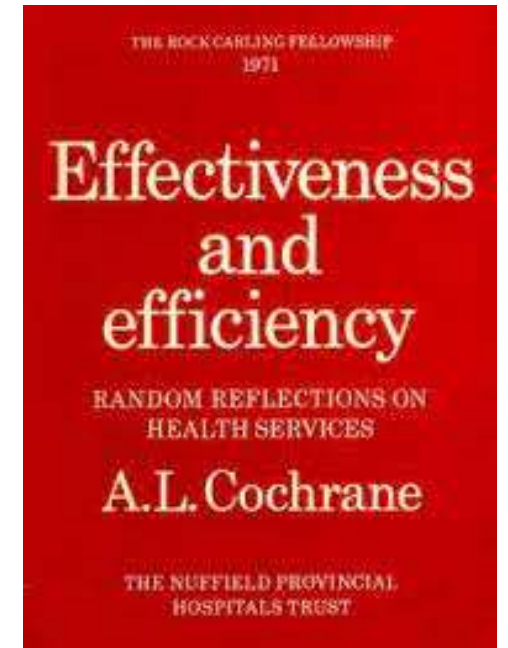


This led to the Cochrane collaboration (now simply Cochrane), involving health professionals, patients and policy makers

Runs major systematic reviews. Maintains a library



Archie Cochrane,
1909 –1988



- “A NEW paradigm for medical practice is emerging. Evidence-based medicine de-emphasizes intuition, unsystematic clinical experience, and ... stresses the examination of evidence from clinical research”

This Issue

Article

November 4, 1992

Evidence-Based Medicine

A New Approach to Teaching the Practice of Medicine

Gordon Guyatt, MD, MSc; John Cairns, MD; David Churchill, MD, MSc; Deborah Cook, MD, MSc; Brian Haynes, MD, MSc, PhD; Jack Hirsh, MD; Jan Irvine, MD, MSc; Mark Levine, MD, MSc; Mitchell Levine, MD, MSc; Jim Nishikawa, MD; David Sackett, MD, MSc; Patrick Brill-Edwards, MD; Hertzell Gerstein, MD, MSc; Jim Gibson, MD; Roman Jaeschke, MD, MSc; Anthony Kerigan, MD, MSc; Alan Neville, MD; Akbar Panju, MD; Allan Detsky, MD, PhD; Murray Enkin, MD; Pamela Frid, MD; Martha Gerrity, MD; Andreas Laupacis, MD, MSc; Valerie Lawrence, MD; Joel Menard, MD; Virginia Moyer, MD; Cynthia Mulrow, MD; Paul Links, MD, MSc; Andrew Oxman, MD, MSc; Jack Sinclair, MD; Peter Tugwell, MD, MSc

» Author Affiliations

JAMA. 1992;268(17):2420-2425. doi:10.1001/jama.1992.03490170092032





JAMA. 1992;

JAMA®
The Journal of the
American Medical
Association

SERIES: DAVID SACKETT – A YEAR LATER | VOLUME 73, P82-86, MAY 2016

 Download Full Issue

Evidence-based medicine has been hijacked: a report to David Sackett

John P.A. Ioannidis  

Published: February 28, 2016 • DOI: <https://doi.org/10.1016/j.jclinepi.2016.02.012> •  Check for updates



- “Under market pressure, clinical medicine has been transformed to finance-based medicine” (2016)

Early milestones in the development of impact assessment was the National Environmental Policy Act (NEPA) in the United States, enacted in 1969



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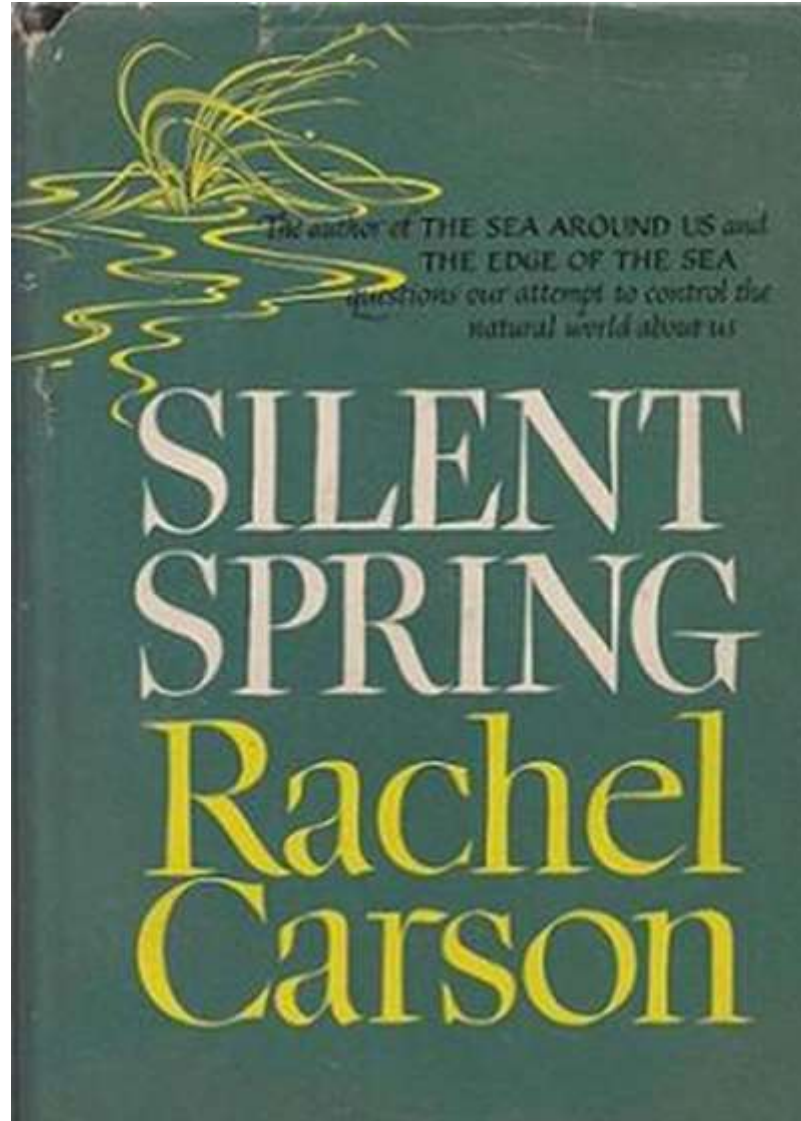
[Log In](#)

[Bills & Resolutions](#) / [S. 1075 \(91st\)](#) / [Text](#)

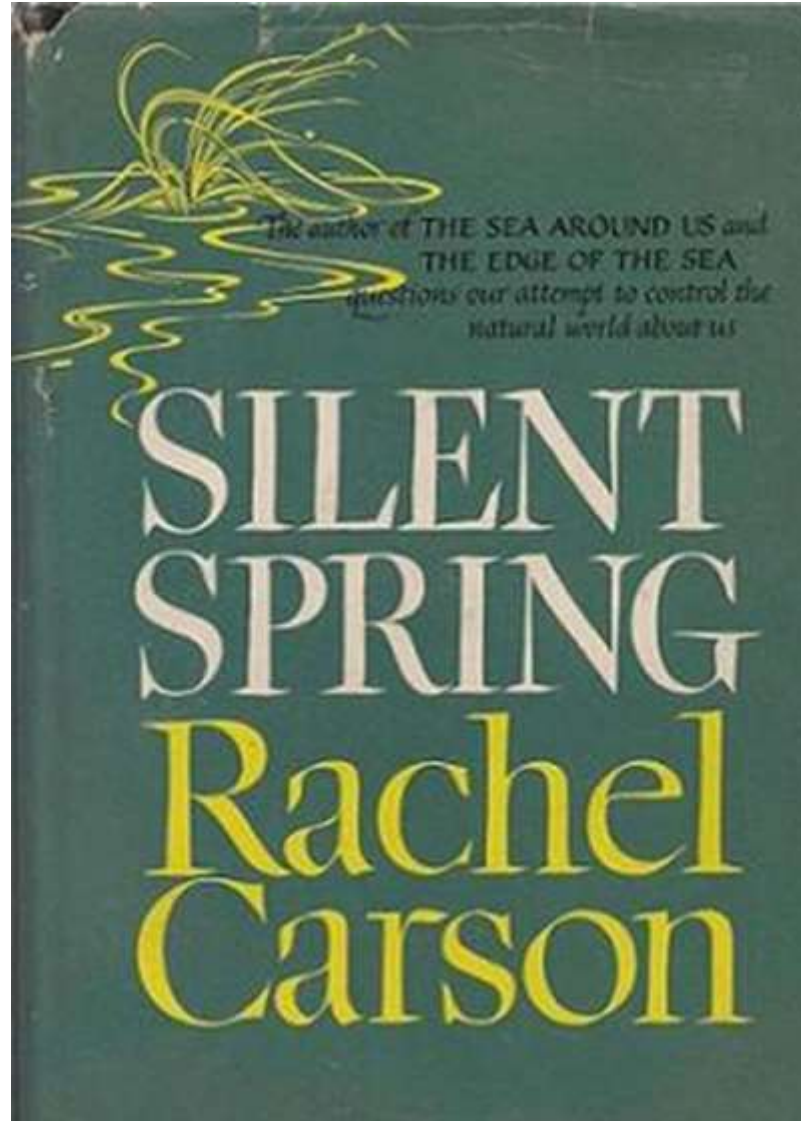
S. 1075 (91st): An Act to establish a national policy for the environment; to authorize studies, surveys, and research relating to ecological systems, natural resources, and the quality of the human environment; and to establish a Board of Environmental Quality Advisers

... NEPA came into being as a result ... of a book (1962)!

The book kickstarted the environmental movement worldwide. Led to the creation of the US Environmental Protection Agency (EPA) ...



... it also led in the US to a ban of DDT, to the Endangered Species Act (1973), to the Clean Air (1970) and Clean Water (1972) acts



A seminar with Naomi Oreskes and others about Carson's book in its 60th anniversary

<https://www.youtube.com/watch?v=jWlXNOXJkns>



Search



Science, lobbies and the environment | seminar on 60th anniversary of Rachel Carson's Silent Spring



Why is this story of evidence based policy (EBP) so important?

- Because it is a key component of the policy cycle and is enshrined in standards and guidelines
- It is a conflicted topic (like evidence based medicine)
- Many say it has become its opposite (policy based evidence), also as part of New Public Management theories and movement
- Some highlight power differentials (industry–regulators–citizens) and see EBP as a vehicle for regulatory capture
- Some take issue with its purported neutrality

What is New Public Management (NPM)?

- Gained traction in the 1980s and 1990s
- Market-oriented reforms, privatization, deregulation
- Origin in public choice theory (James M. Buchanan)
- Neoliberal revolution (UK, both Tories and New Labour)
- US: reinventing Government Movement (1990s); NPM principles applied to federal agencies (Al Gore)
- World Bank and the International Monetary Fund (IMF)

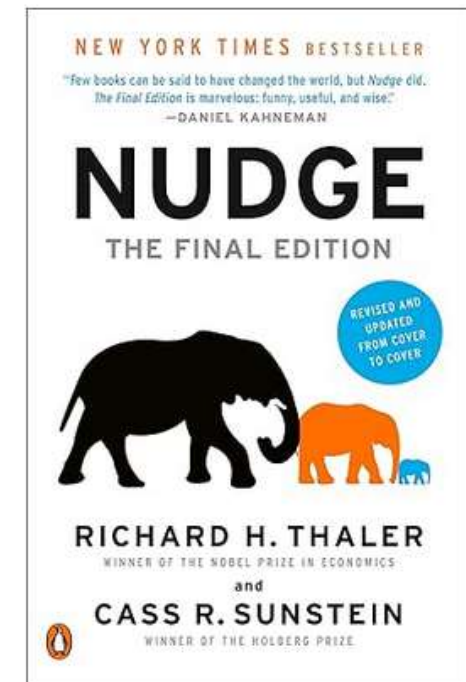
What is public choice theory?

- Rational choice
- Actors maximizing their utility
- Fighting bureaucracy thanks to market incentives (see Thaler and Sunstein's 'nudging')
- Tackles rent seeking and voting behaviour

Timms, A. (2019, June). The Sameness of Cass Sunstein | The New Republic. New Republic. <https://newrepublic.com/article/154236/sameness-cass-sunstein>



Cass Sunstein



The most widely used technique: Cost Benefit Analysis

Pros: Efficiency, simplicity, ease of communication, *prima facie* impersonality

Cons: Dependence of the outcome upon what is included or excluded (what are the externalities?); monetization

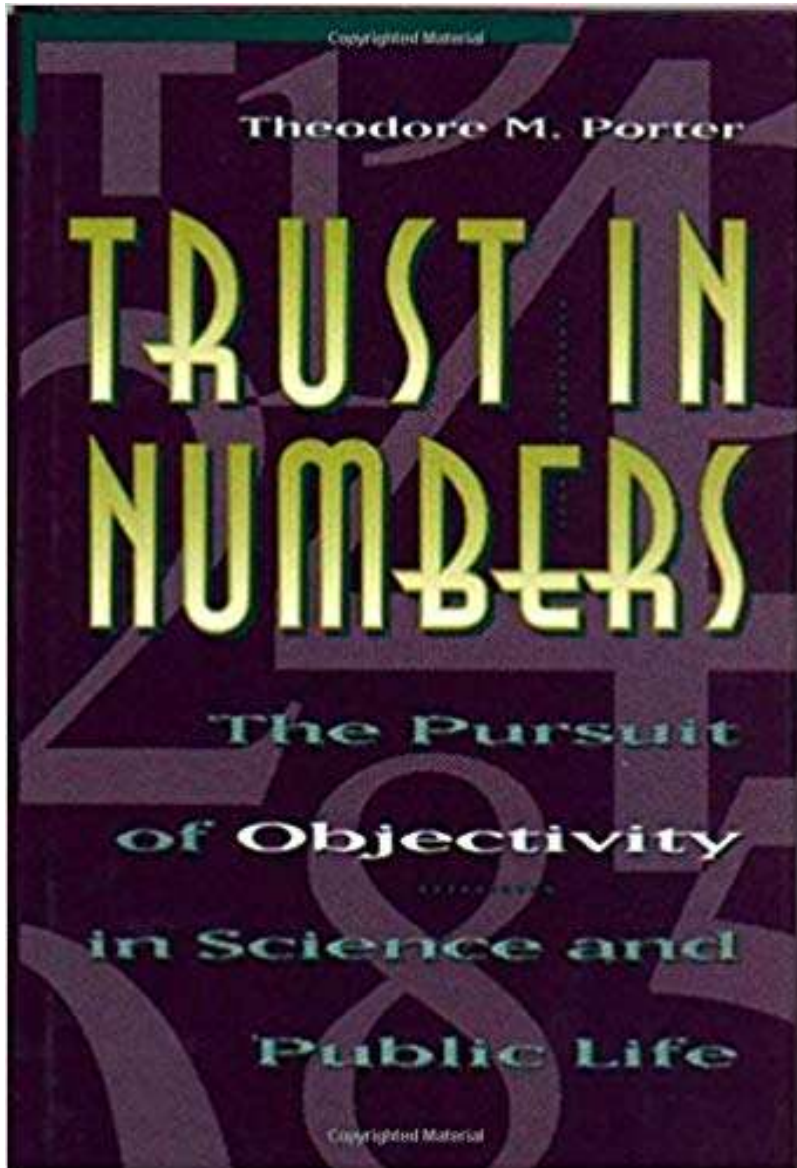
Exercise in class (20m + 10 reporting)

Imagine you work for the health ministry and need to find analytic arguments to judge the desirability and feasibility of policies aimed to reduce smoking habits in the population.



Source: The Simpsons, Smoke on the Daughter

- 1) What policies to consider?
- 2) What other ministries should participate to the discussion?
- 3) What factors should be considered in the analysis?
- 4) What costs should be included? What benefits?
- 5) Indicate whether the selected cost and benefits are amenable to quantification.



History of cost benefit analysis. See Chapter 7: “U.S. Army Engineers and the Rise of Cost–Benefit Analysis”

or this paper:

Porter, T. M. Objectivity as Standardization: The Rhetoric of Impersonality in Measurement, Statistics, and Cost–Benefit Analysis. in Rethinking objectivity (ed. Megill, A.) 197 –237 (Duke University Press, 1994).

<http://ereserve.library.utah.edu/Annual/WRTG/3705/Mathison/objectivity.pdf>

Frames

Most analyses offered as input to policy are framed as cost benefit analysis or risk analyses, but some environmentalists disagree

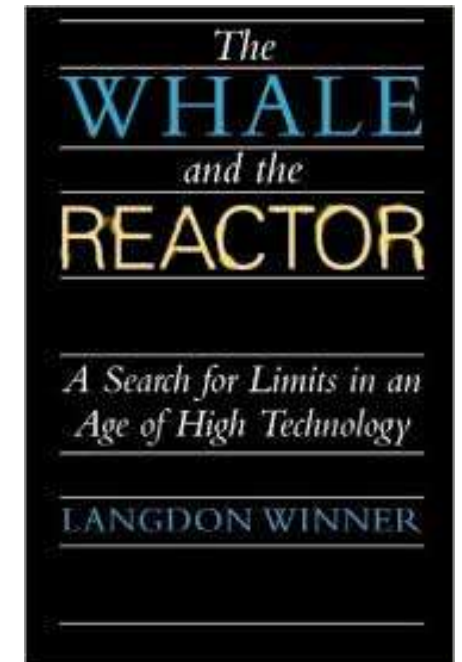


Langdon Winner

8

ON NOT HITTING
THE TAR-BABY

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

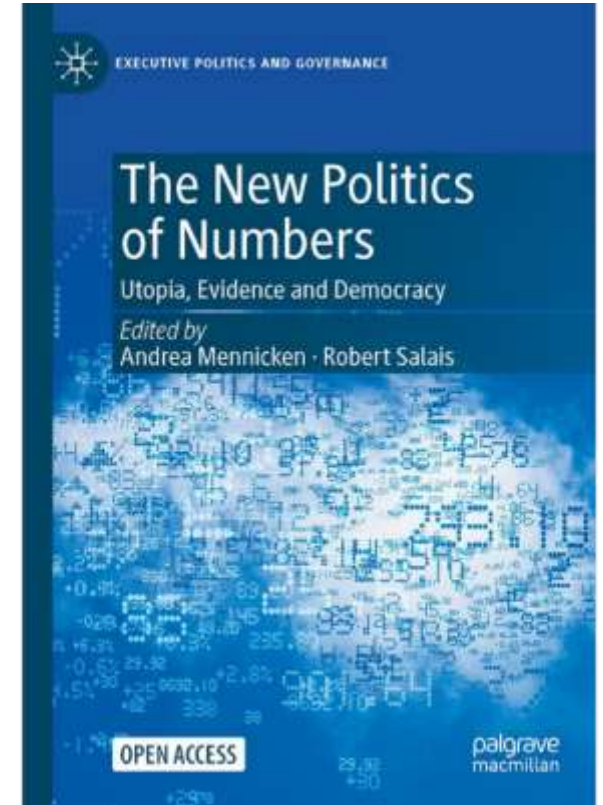


A technical proof of quality is illusory without a parallel investigation of normative quality

Technical Quality

Normative quality

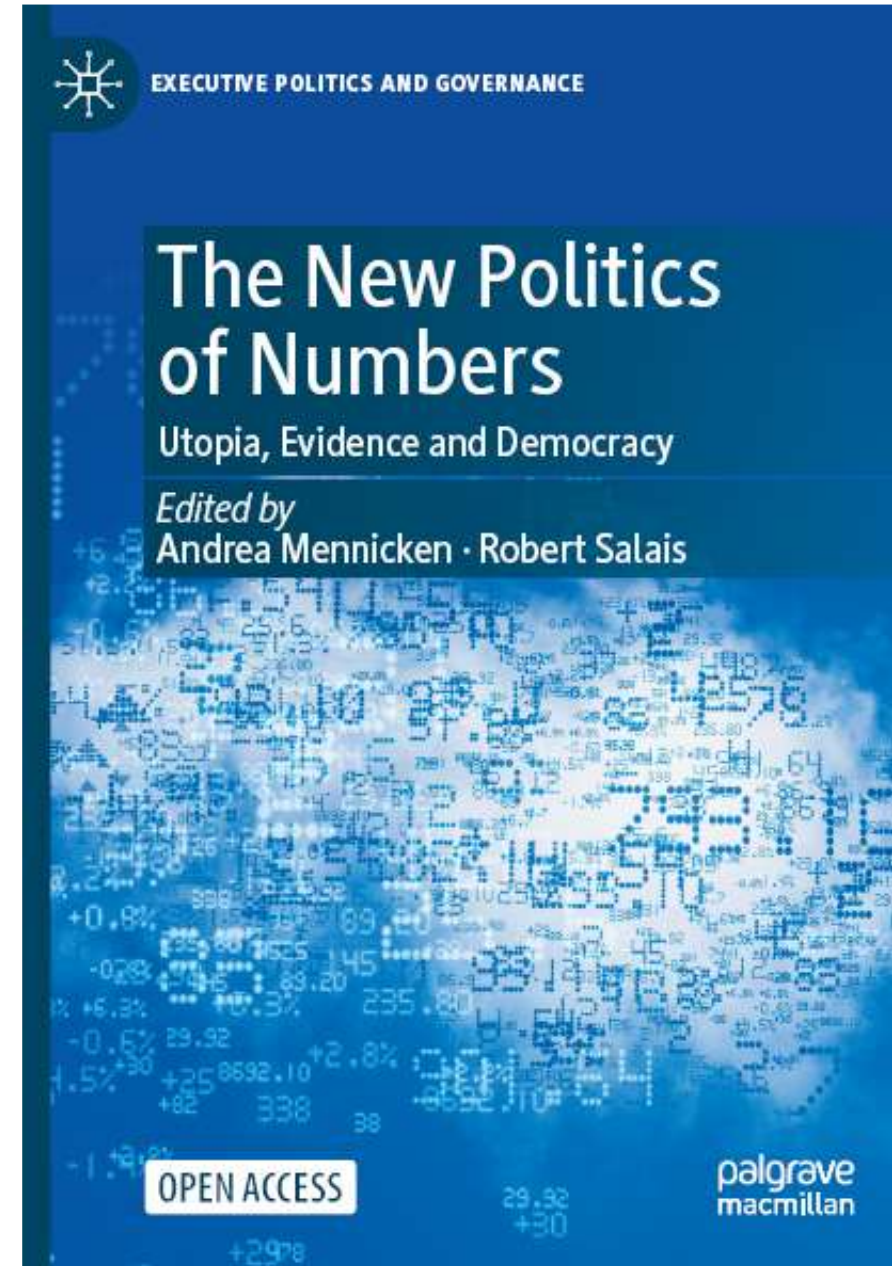
How the numbers of neoliberalism (New Public Management) constitute a regime of a-democracy; the example of indicators of employment

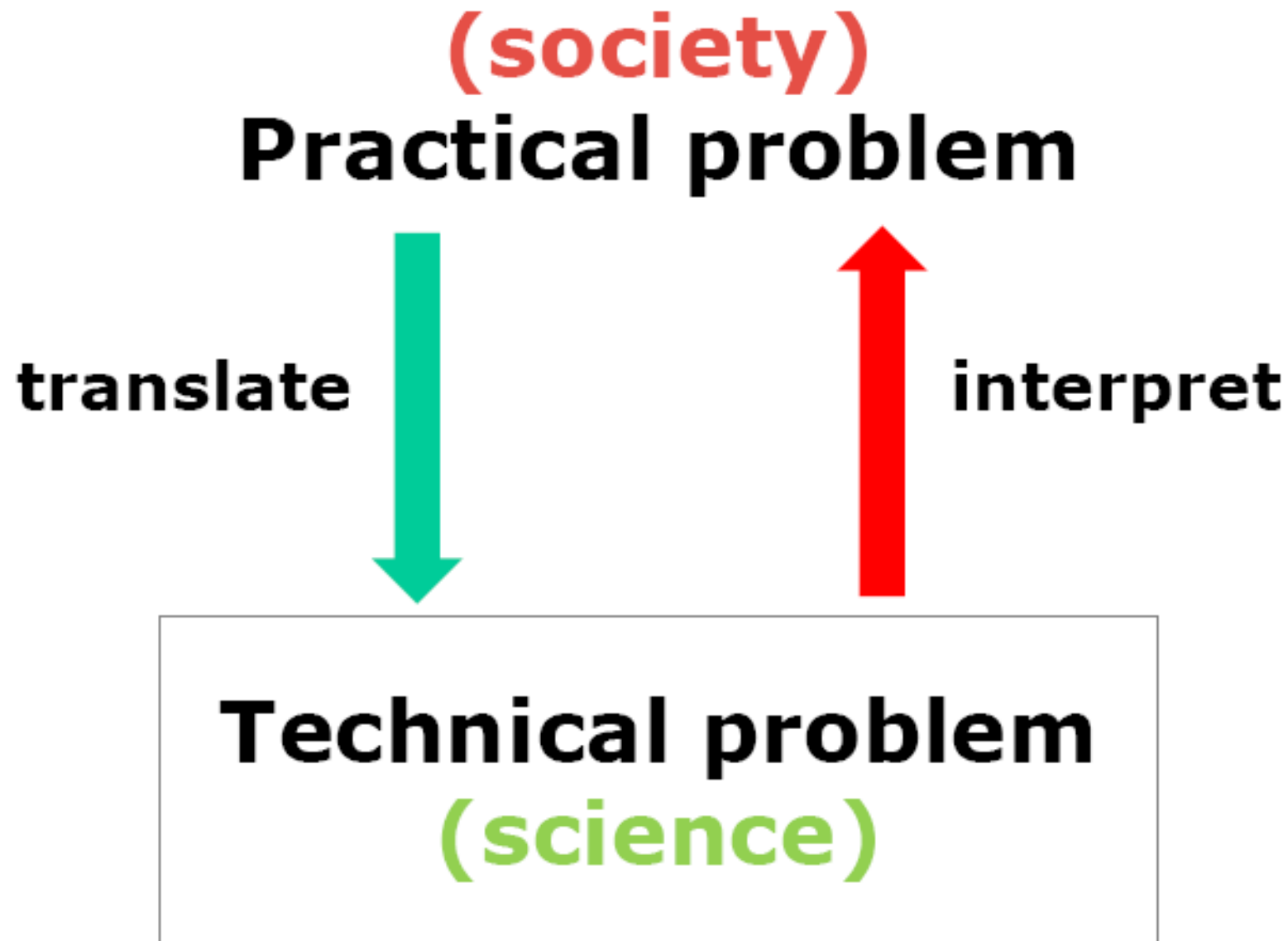


Salais, R. (2022). “La donnée n’est pas un donné”: Statistics, Quantification and Democratic Choice. In *The New Politics of Numbers: Utopia, Evidence and Democracy*, Andrea Mennicken and Robert Salais, Palgrave Macmillan, pp. 379–415.

Contesting unjust/unfair governance arrangement is impossible without producing alternative constructions of evidence – that requires muscles not easily available to the lay citizen

CHAPTER 12, “La donnée n’est pas un donné”: Statistics, Quantification and Democratic Choice, *Robert Salais*

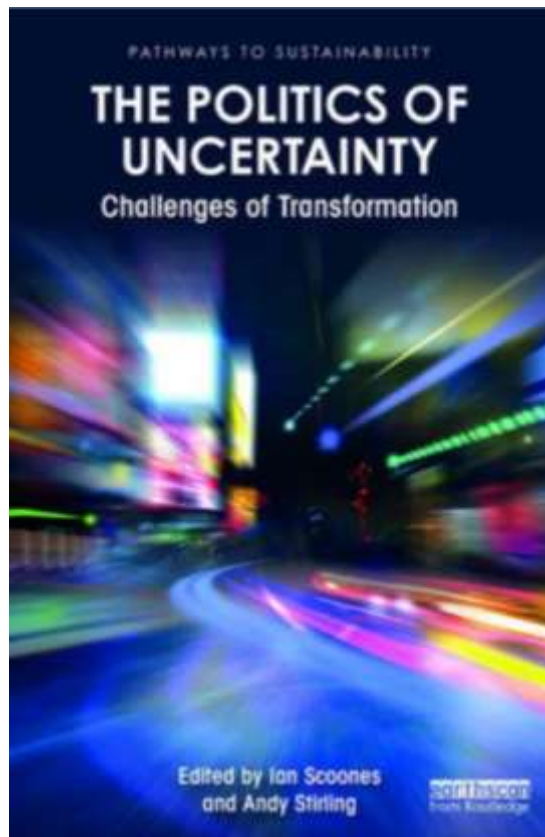




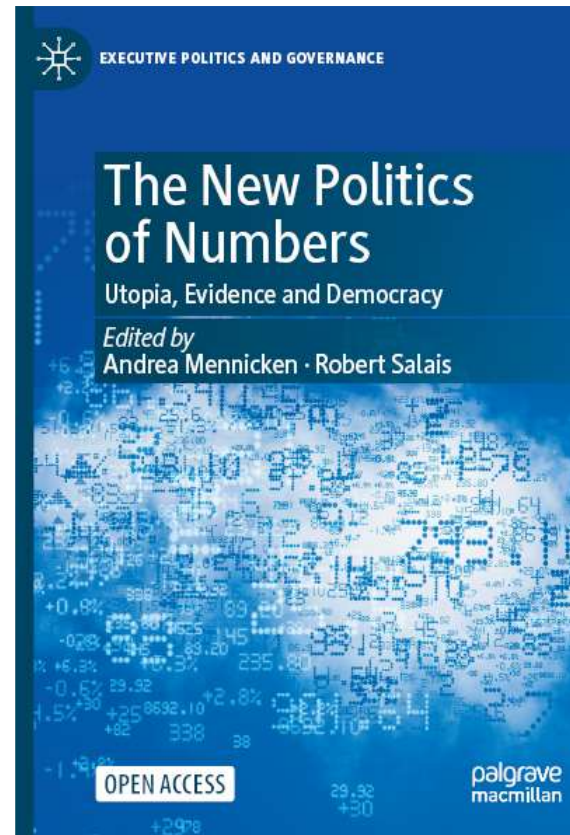
Courtesy of Jeroen
van der Sluijs



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



2020

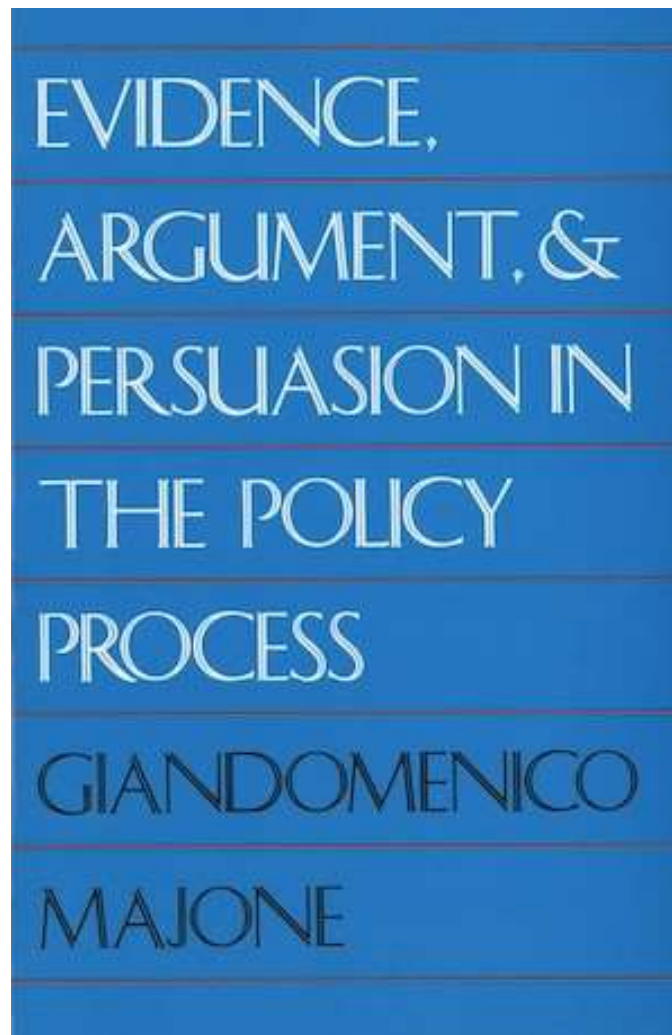


2022



2023

Politics and numbers



Since to say anything of importance in public policy requires value judgment, this artificial separation between values and rational capacity is a threat to all notions of public deliberation and defensible policy choices (p. 8)

Multiple policy evaluation ... would recognize the legitimacy of the different perspectives ... the objective is not to construct a grand model that would combine all the partial perspectives into...a weighted average ...of equity, effectiveness, legality ... (p.9)

EVIDENCE,
ARGUMENT, &
PERSUASION IN
THE POLICY
PROCESS

GIANDOMENICO

MAJONE

The pretended distinction
between facts and value is used
instrumentally

In the policy process fact and
values cannot be separated in
the making of an argument

The impossible separation between facts and values is one of the ‘keys’ of post-normal science

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What is Post-normal Science? A Personal Encounter

[Open access](#) | Published: 10 November 2023

(2023) [Cite this article](#)

[Andrea Saltelli](#) 

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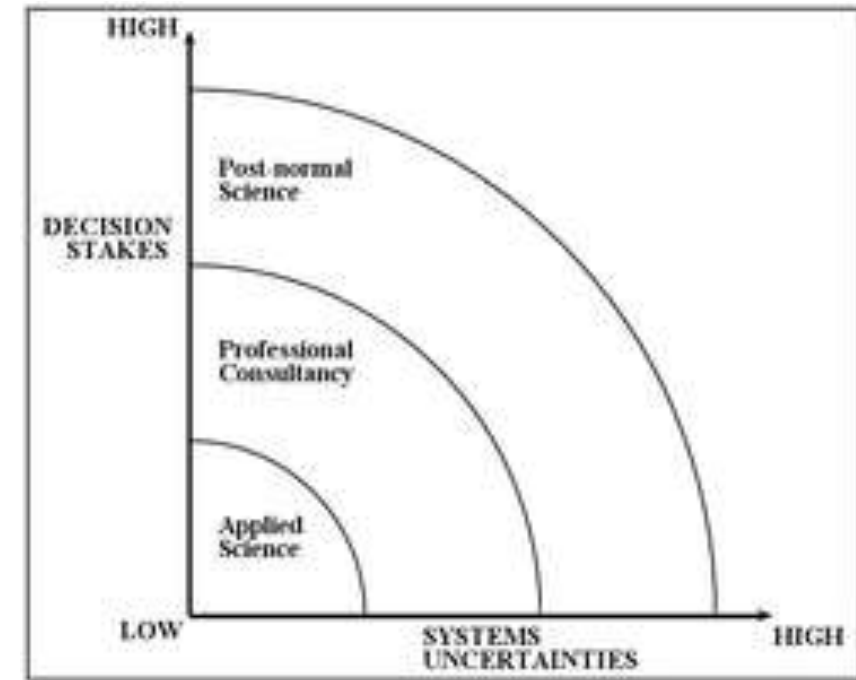
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S. Funtowicz and J. R. Ravetz, ‘Science for the post-normal age’, *Futures*, vol. 25, no. 7, pp. 739–755, Sep. 1993, doi: 10.1016/0016-3287(93)90022-L.

EVIDENCE,
ARGUMENT, &
PERSUASION IN
THE POLICY
PROCESS
GIANDOMENICO
MAJONE

“In any area of public policy the choice of instruments, far from being a technical exercise that can be safely delegated to the experts, reflects as in a microcosm all the political, moral, and cultural dimensions of policy-making”

EVIDENCE,
ARGUMENT, &
PERSUASION IN
THE POLICY
PROCESS

GIANDOMENICO

MAJONE

“[my suggestion is to view a] policy analyst as a producer of arguments, capable of distinguishing between good and bad rhetoric, rather than as a “number cruncher” ...

Power asymmetries in the framing of issues:
those who have the deepest pockets marshal
the best [foremost ‘scientific’] evidence



Futures

Available online 26 October 2021

In Press, Journal Pre-proof ?



Science, the endless frontier of regulatory capture

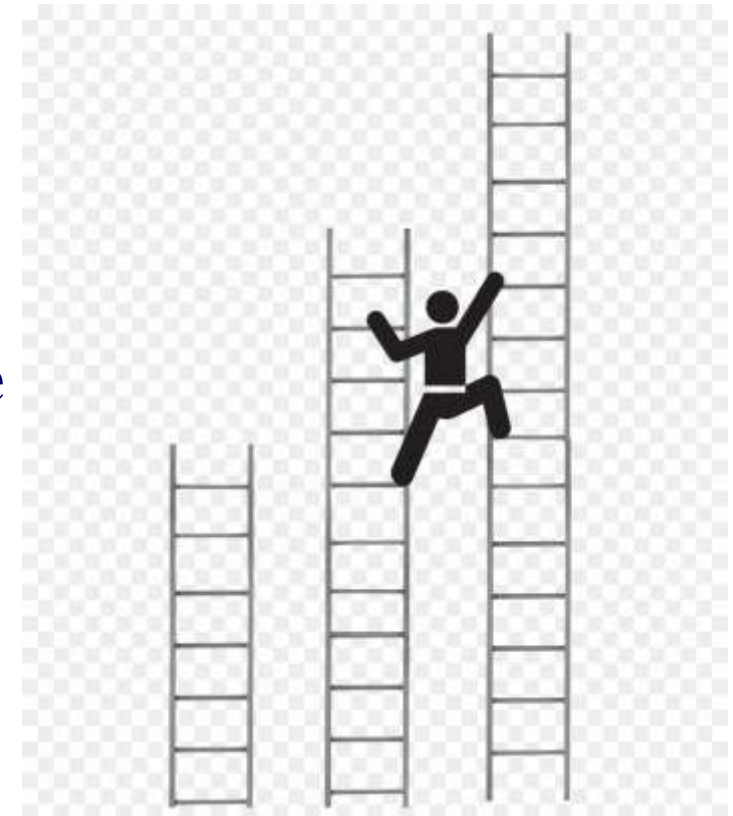
Andrea Saltelli ^a  , Dorothy J. Dankel ^{b, c}, Monica Di Fiore ^d, Nina Holland ^e, Martin Pigeon ^e

An epistemic ladder for regulatory capture

- Epistemic. Invalidating the inference or the methods
- Institutional. Delegitimising and/or ‘colonising’ institutions
- Political. Promoting a worldview where the very idea of regulation is undesirable

Science, the endless frontier of regulatory capture

Andrea Saltelli ^a , Dorothy J. Dankel ^{b, c}, Monica Di Fiore ^d, Nina Holland ^e, Martin Pigeon ^e



Credits: <https://www.subpng.com/>

The present: excessive reliance on a standard neoclassic economic toolbox that neglects alternative perspectives

The new: non-Ricardian economics, bioeconomics and qualitative-quantitative methods from post-normal science (*feminist economics*)



Source: <https://sellhimvs.life>

Environmental Science and Policy 142 (2023) 99–111

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The aim:

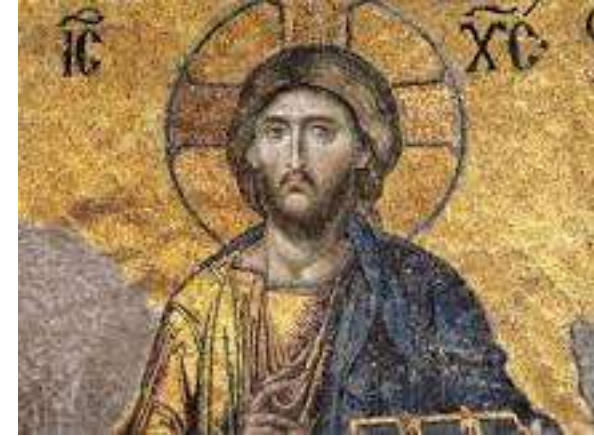
- more inclusive uses of quantitative evidence
- more possible futures explored

Impact assessment culture in the European Union. Time for something new?

Andrea Saltelli^{a,b,*}, Marta Kuc-Czarnecka^c, Samuele Lo Piano^d, Máté János Lőrincz^d,
Magdalena Olczyk^c, Arnald Puy^e, Erik Reinert^{f,g}, Stefán Thor Smith^d,
Jeroen P. van der Sluijs^{b,h}

A technocratic orthodoxy in the EU? Why 'reductionism'?

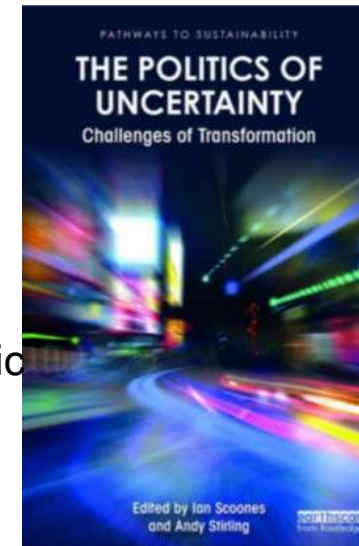
- The single market needs a centralized, standardized risk assessment approach
- EU pro-industry (e.g. biotech) growth agenda
- Fear of opening the road to endless deconstruction of planned policies



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Magdalena Olczyk^c, Arnald Puy^e, Erik Reinert^{f,g}, Stefán Thor Smith^d,
Jeroen P. van der Sluis^{b,h}

See 'The unravelling of technocratic orthodoxy', of P. van Zwanenberg



Terms such as ‘expected utility’, ‘decision theory’, ‘life cycle assessment’, ‘ecosystem services’, ‘externality assessment’, ‘impact analysis’, ‘sound scientific decisions’ and ‘evidence-based policy’ deployed to deliver precise answers

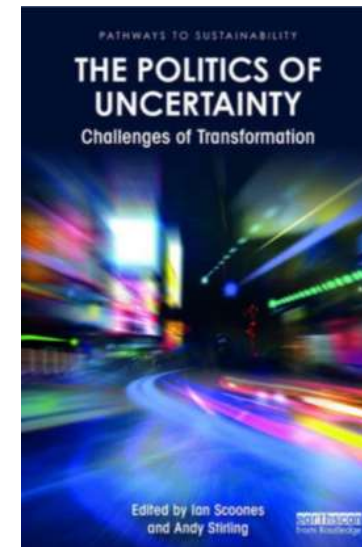
- Is the precision rhetorical?
- Is the aim to prove that a given policy or practice are ‘safe’ or ‘best’



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See ‘Uncertainty and the Politics of Transformation’ of I. Scoones and A. Stirling



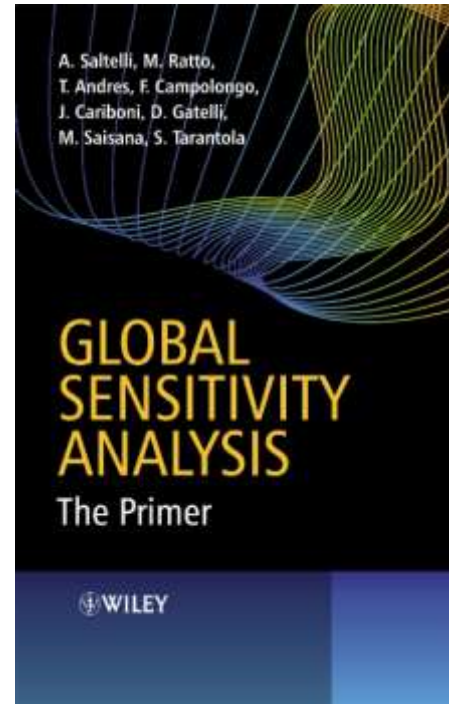
Proposed lenses

- Non-Ricardian economics
- Bioeconomics (in the sense of Nicholas Georgescu-Roegen)
- Approaches originated in the context of post-normal science
 - global uncertainty and sensitivity analysis
 - sensitivity auditing
 - NUSAP
 - quantitative storytelling



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Magdalena Olczyk^c, Arnald Puy^e, Erik Reinert^{f,g}, Stefán Thor Smith^d,
Jeroen P. van der Sluijs^{b,h}



Contrasting invisibilities

Non-Ricardian economics: invisibility of qualities, whereby all hours of work are taken to have the same value

Bioeconomics: invisibility of nature, whereby natural resources are considered as infinite or infinitely substitutable

Post-normal science: invisibility of values, obfuscated by the purported neutrality of quantification



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Erik S. Reinert; Nicholas Georgescu-Roegen; Jerome Ravetz and Silvio Funtowicz

Test cases

- Climate, energy, and Sámi herders
- Climate and Water security
- Biodiversity and pollinator decline
- Lessons learned from COVID-19



COMMENTARY | Open Access |

What did COVID-19 really teach us about science, evidence and society?

Andrea Saltelli , Joachim P. Sturmberg, Daniel Sarewitz, John P. A. Ioannidis

First published: 06 June 2023 | <https://doi.org/10.1111/jep.13876> | Citations: 2



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Comment | Published: 29 June 2023

Irrigation modelling needs better epistemology

[Arnald Puy](#) , [Michela Massimi](#), [Bruce Lankford](#) & [Andrea Saltelli](#)

[Nature Reviews Earth & Environment](#) **4**, 427–428 (2023) | [Cite this article](#)

337 Accesses | 4 Citations | 8 Altmetric | [Metrics](#)

Robinson, Claire, et al. 2018. “Ensuring a Higher Level of Protection from Pesticides in Europe: The Problems with Current Pesticide Risk Assessment Procedures in the EU –and Proposed Solutions. A White Paper Prepared for the Coalition Citizens for Science in Pesticide Regulation.” <https://doi.org/10.5281/ZENODO.2543743>.



Test cases

- Climate, energy, and Sámi herders ←
- Climate and Water security
- Biodiversity and pollinator decline
- Lessons learned from COVID-19



https://www.researchgate.net/publication/233760548_Eurasian_Arctic_Land_Cover_and_Land_Use_in_a_Changing_Climate/figures?lo=1

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Jeroen P. van der Sluijs^{b,h}

Climate, energy, and Sámi herders

A grid interconnection between Scandinavian countries and Iceland?

Complex web of interests and vulnerabilities

Negative effect of (green) energy production in Scandinavia for the migratory patterns of reindeers, against increased infrastructural burden in Iceland



Norway's Supreme Court has ruled that two western wind farms have illegally encroached on the grazing land of Sámi reindeer herders.



Impact assessment culture in the European Union. Time for something new?

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Magdalena Olczyk^c, Arnald Puy^e, Erik Reinert^{f,g}, Stefán Thor Smith^d,
Jeroen P. van der Sluijs^{b,h}

Climate, energy, and Sámi herders

Loss of habitat, economic predation and legal frameworks “potentially dwarf the putative effects of projected climate change on reindeer pastoralism”

N. J. C. Tyler *et al.*, ‘Saami reindeer pastoralism under climate change: Applying a generalized framework for vulnerability studies to a sub-arctic social-ecological system’, *Global Environmental Change*, vol. 17, no. 2, pp. 191–206, May 2007, doi: 10.1016/j.gloenvcha.2006.06.001.



https://www.researchgate.net/publication/233760548_Eurasian_Arctic_Land_Cover_and_Land_Use_in_a_Changing_Climate/figures?lo=1



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Climate, energy, and Sámi herders

Reductionism in the EU energy policy making: the problem are the emissions and the solution is swapping fossil fuel based with renewable

This ignores causal linkages with social and environmental structures, such as how this interfere with the Sámi herders

https://www.researchgate.net/publication/233760548_Eurasian_Arctic_Land_Cover_and_Land_Use_in_a_Changing_Climate/figures?lo=1



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Impact assessment culture in the European Union. Time for something new?

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Magdalena Olczyk^e, Arnald Puy^e, Erik Reinert^{f,g}, Stefán Thor Smith^d,
Jeroen P. van der Sluijs^{h,i}



Chemicals pollution and biodiversity and ecosystem services: the case of neonicotinoid insecticides and entomofauna collapse (insectageddon)



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<https://www.youtube.com/channel/UC-287XGduchellUy4GouA3Q8>

Late lessons from early warnings:
science, precaution, innovation

Pollinators decline has been a policy
issue for some time now ... see this
2013 report from the European
Environment Agency

Environmental Science and Policy 142 (2023) 99–111

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ISSN 1725-9177



Decline of pollinators

Insects Opinion

Insectageddon: farming is more catastrophic than climate breakdown

George Monbiot



The shocking collapse of insect populations hints at a global ecological meltdown

🐦 @GeorgeMonbiot

Fri 20 Oct 2017 12:11 BST



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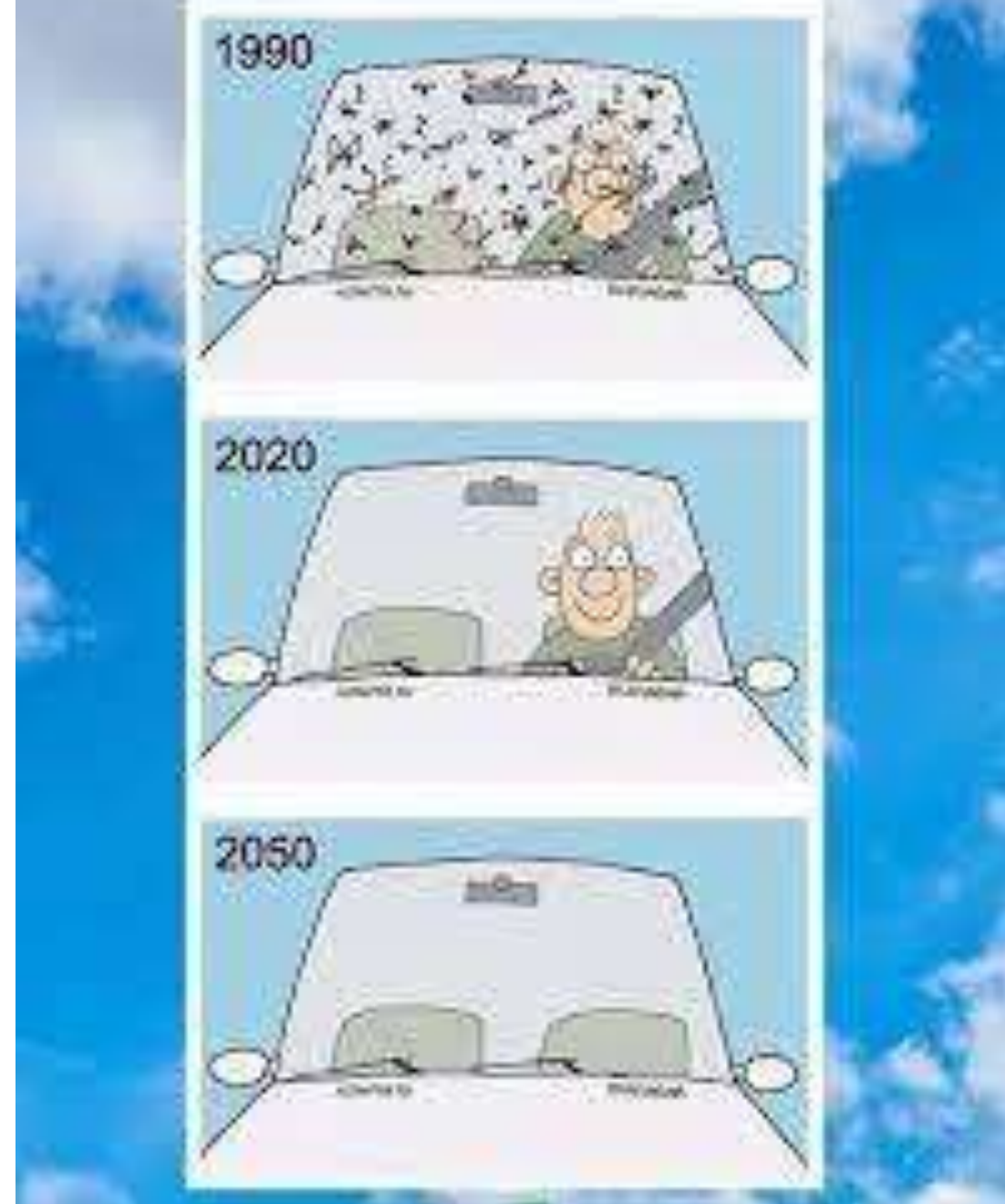
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Windshield effect



While the foraging area of bees may extend over up to 9 km away from the honeybees, and the impact of insecticides implies bioaccumulation and hence long term effects, **the prevailing measuring techniques held valid in regulation fail to detect the toxicity of these insecticides**

See: Van der Sluijs, Jeroen P., Noa Simon-Delso, Dave Goulson, Laura Maxim, Jean-Marc Bonmatin, and Luc P Belzunces. 2013. “Neonicotinoids, Bee Disorders and the Sustainability of Pollinator Services.” *Current Opinion in Environmental Sustainability* 5 (3–4): 293–305.



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A jungle of conflicts of interests, loopholes, and sloppy regulation in the way pesticides are regulated in the EU



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At the level of the narratives, one side insist to a plurality of factors that might explain the decline (including climate change), the other the specific and determinant role of pesticides

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Research Article

Mathematical models: a state of exception

Andrea Saltelli & Arnald Puy & Monica Di Fiore

Received 09 Jan 2024, Accepted 07 May 2024, Published online: 11 Jun 2024

Cite this article: <https://doi.org/10.1080/02692171.2024.2365727>

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Futures

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Essays

Ethics of quantification or quantification of ethics?

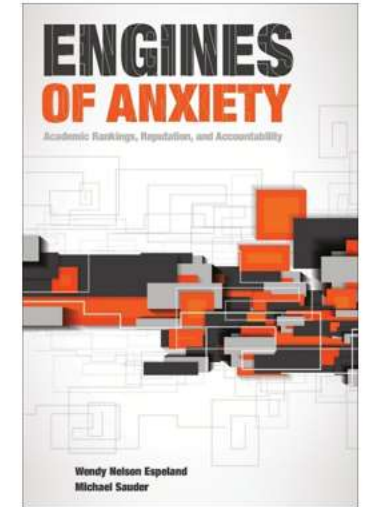
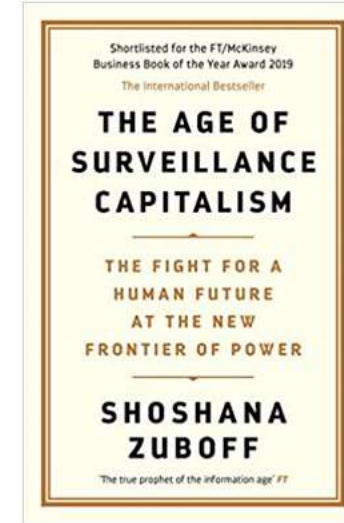
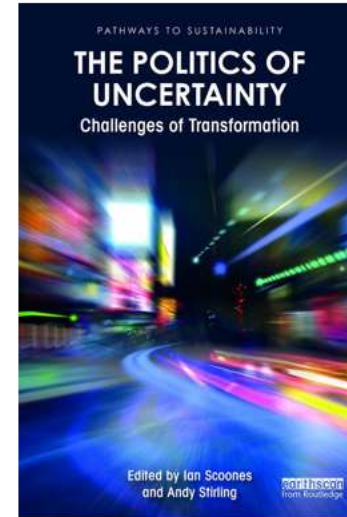
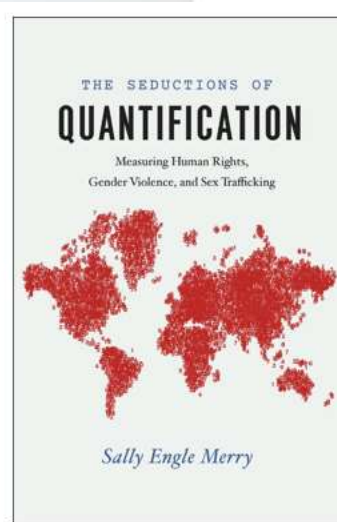
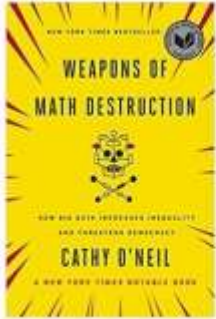
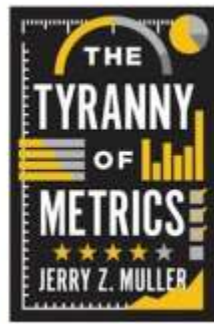
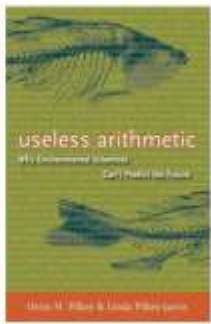
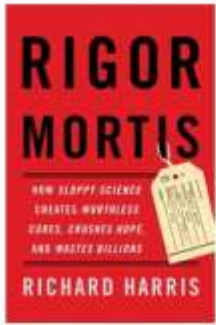
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Sociology of quantification

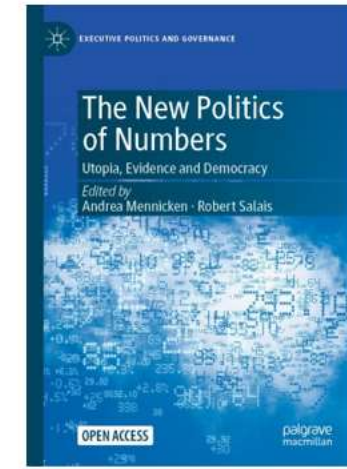
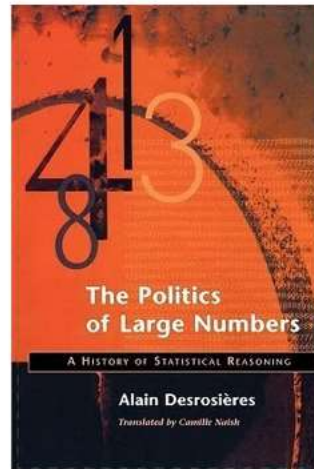
Many voices of
alarm as to misuse
of quantification

And an explosion of works, from
within and without, from many
disciplines

Sociology of quantification:



a flood of disciplinary work ...



... to the effect that quantifying has consequences

Dangers of mathematization of economics



Wolfgang Drechsler



Erik S. Reinert



Paul Romer



Philip Mirowski

W. Drechsler, "On the possibility of quantitative-mathematical social science, chiefly economics," *J. Econ. Stud.*, vol. 27, no. 4/5, pp. 246–259, 2000.

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Erik S. Reinert

Tallinn University of Technology

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Why ethics of quantification is needed now

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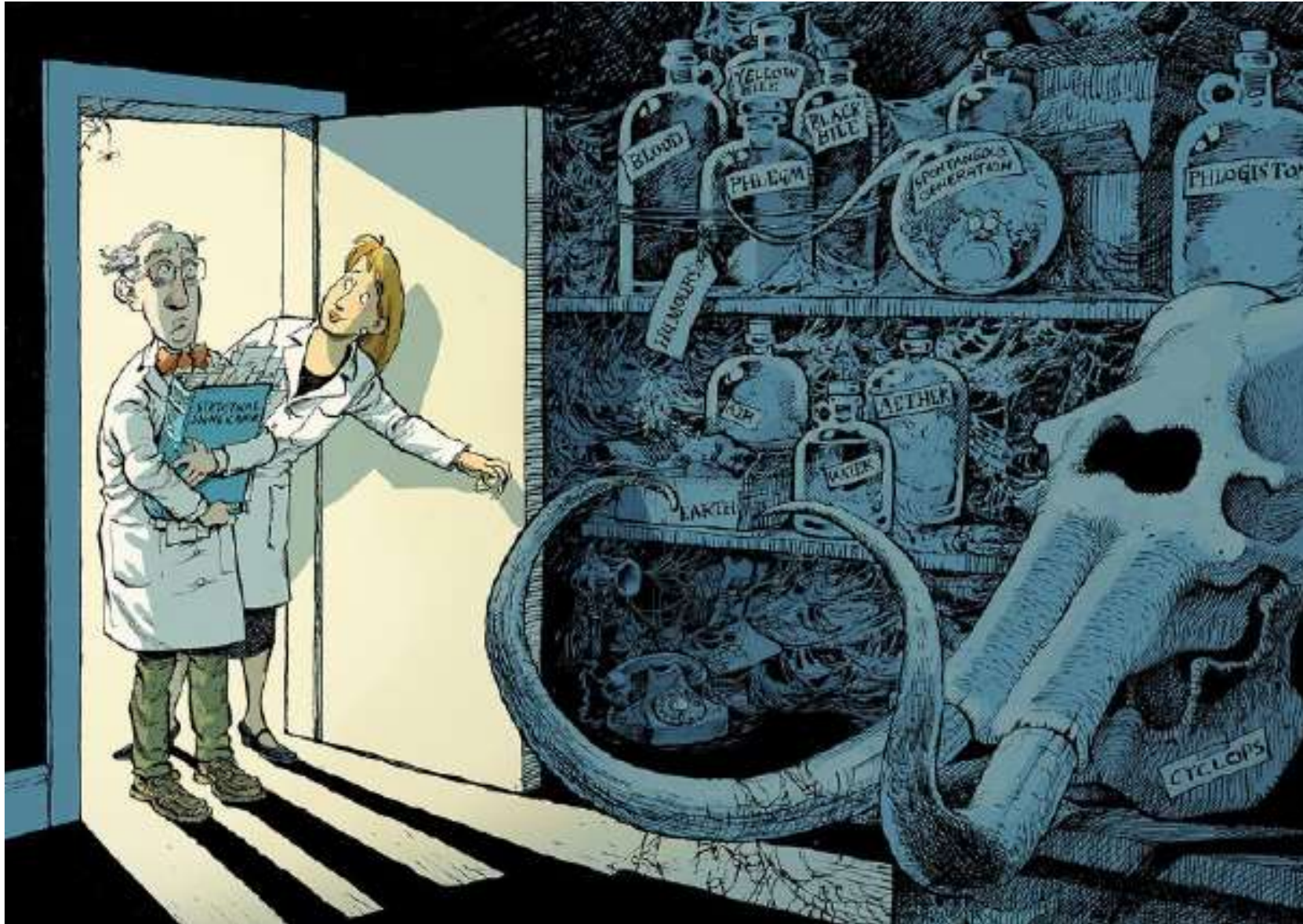
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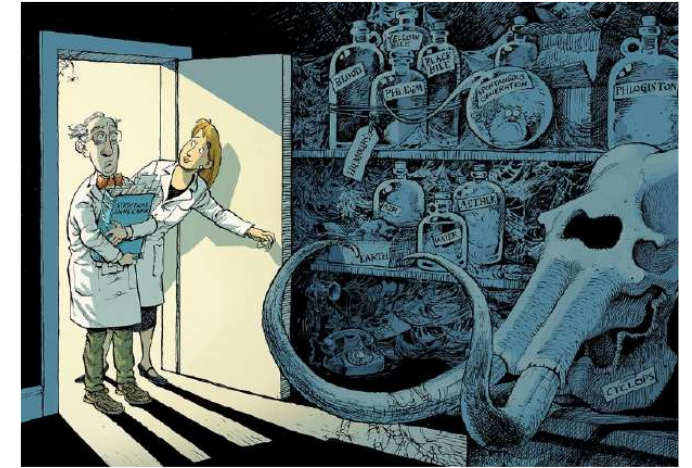
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Throw away
the concept of
statistical
significance?



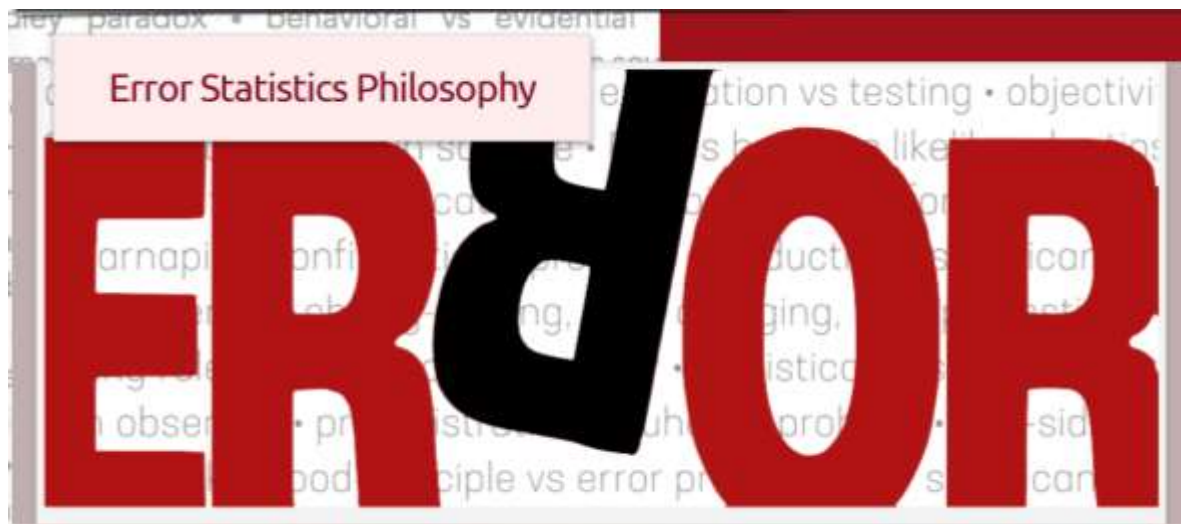
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Scientists rise up against statistical significance

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

See the discussion on the blog of Andrew Gelman <https://statmodeling.stat.columbia.edu/>





A. Saltelli (Guest post): What can we learn from the debate on statistical significance?

Posted on November 22, 2019 by Mayo



Professor Andrea Saltelli
Centre for the Study of the Sciences and the Humanities (SVT), University of Bergen (UIB, Norway),
&
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What can we learn from the debate on statistical significance?

Parent Comments



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Written by Philip B. Stark and Andrea Saltelli on 05 July 2018. Posted in [Science](#)



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wake of the
reproducibility
crisis

Statistical wars?

Unlike statistics, mathematical modelling is not a discipline...



Comment

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Andrea Saltelli 

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