Ethics of Quantification

Andrea Saltelli

Course Theory of Science and Ethics (MNF990),
September 10, 2025

Andrea Saltelli

HOME ABOUT ME PUBLICATIONS NEWS & VIDEOS RESOURCES

Latest papers

Models and the common good

A short analysis of norms and counter-norms in modelling, discussing how models may misuse their epistemic authority for reasons of occasion, opportunity and interest.

Outline:
Narratives and counter-narratives,
State of exception,
Seeking Cinderella,
Reformation

Ranking the Rankers

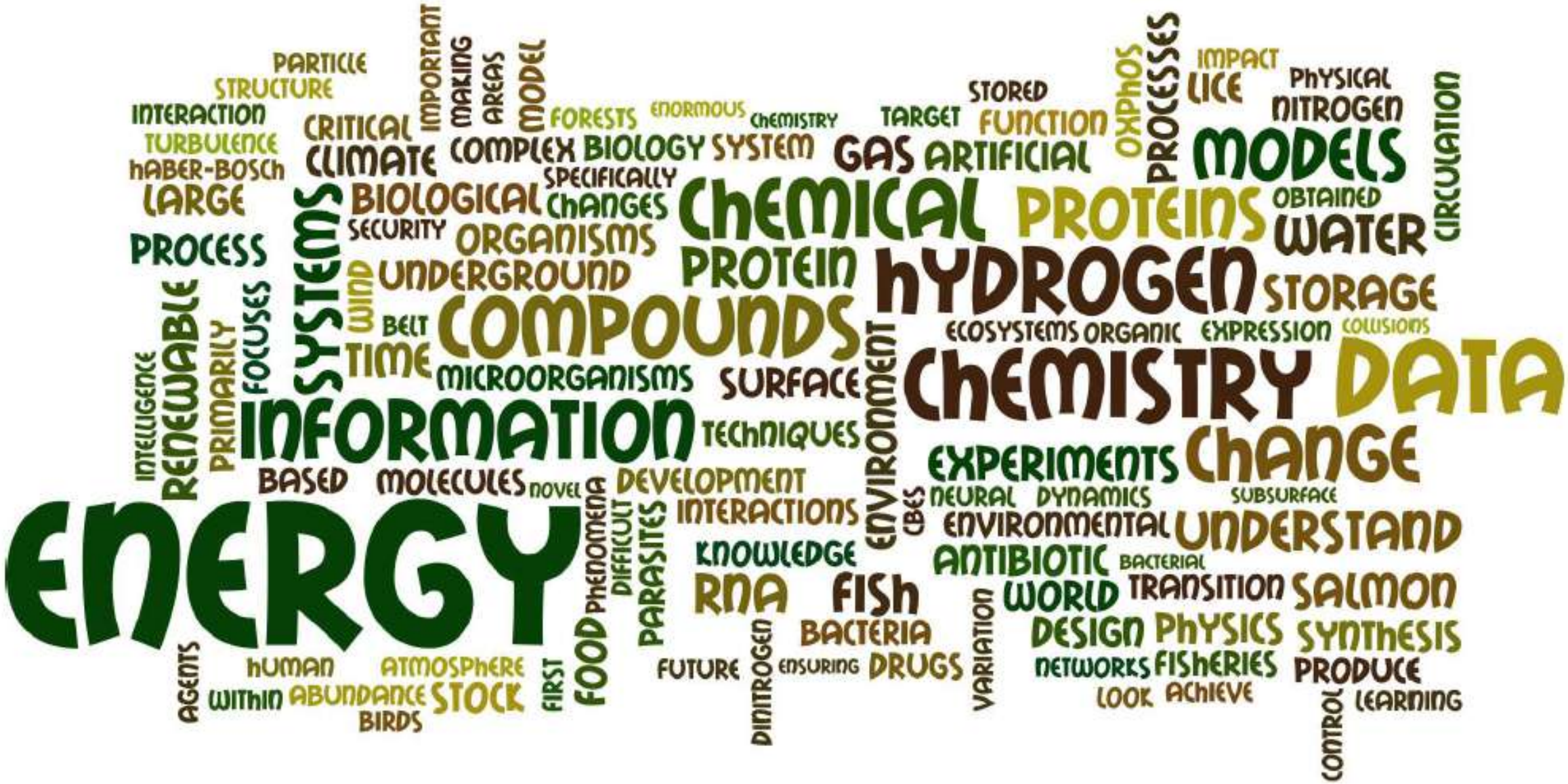
Ranking the Rankers? We investigate using global sensitivity analysis the properties of the science-wide author databases' standardised citation indicators produced since 2015 by a team of researchers led by John P. A. Ioannidis.

Digital twins

We reflect on the development of digital twins of

Where to find this talk:

www.andreasaltelli.eu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ENORMOUS
CHEMISTRY
ECOSYSTEMS
ORGANIC
EXPRESSION
COLLISIONS
HUMAN
ATMOSPHERE
WITHIN
ABUNDANCE
STOCK
BIRDS
AGENTS
FIRST

Outline

Fantastic numbers
Stern controversy
Crosby
Sociology of quantification
Porter, trust, Luhmann, Ravetz
Goodhart, Ravetz
O'Neil, Coded bias
Zuboff, Social Dilemma
Supiot
Economists
Muller's Tyranny of metrics
Statactivism
Modelling Manifesto
Beck, Majone
Salais, Desrosières
Thévenot
Scoones, Stirling
Fishing Expeditions, Forking Paths
Digital Twins of the Earth

… our world is structured by numbers, visible and invisible, where truth is conveyed and reality constructed

Numbers are seductive, performative, confer to their masters' epistemic power and legitimacy

Governing the modern state, or even contesting it, without numbers is impossible

Numbers are the prevalent means to express value in our societies … Access & production of numbers reflect and reinforce power imbalances

Source: Saltelli, A., Andreoni, A., Drechsler W., Ghosh, J., Kattel, R., Kvangraven, I. H., Rafols, I., Reinert, E. S., Stirling, A. and Xu, T. (2021). Why ethics of quantification is needed now. UCL Institute for Innovation and Public Purpose, Working Paper Series (IIPP WP 2021/05) https://www.ucl.ac.uk/bartlett/public-purpose/publications/2021/jan/why-ethics-quantification-needed-now.

IIPP UCL Institute for Innovation and Public Purpose

WORKING PAPER
WP 2021/05

Numbers capture our attention; they illuminate the part of reality which is being numerified, and fatally push those parts into the background which come without the clothing of …

… numbers are so deeply entrenched in our existence that we barely reflect on them critically them anymore — too close to us, they have become part of the very lens through which we attend to and comprehend the world.

Source: Saltelli, A., Andreoni, A., Drechsler W., Ghosh, J., Kattel, R., Kvangraven, I. H., Rafols, I., Reinert, E. S., Stirling, A. and Xu, T. (2021). Why ethics of quantification is needed now. UCL Institute for Innovation and Public Purpose, Working Paper Series (IIPP WP 2021/05) https://www.ucl.ac.uk/bartlett/public-purpose/publications/2021/jan/why-ethics-quantification-needed-now.

IIPP UCL Institute for Innovation and Public Purpose

WORKING PAPER
WP 2021/05

Do we live immersed in fantastic numbers?

OPINION

PETER COY

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

Sept. 17, 2021

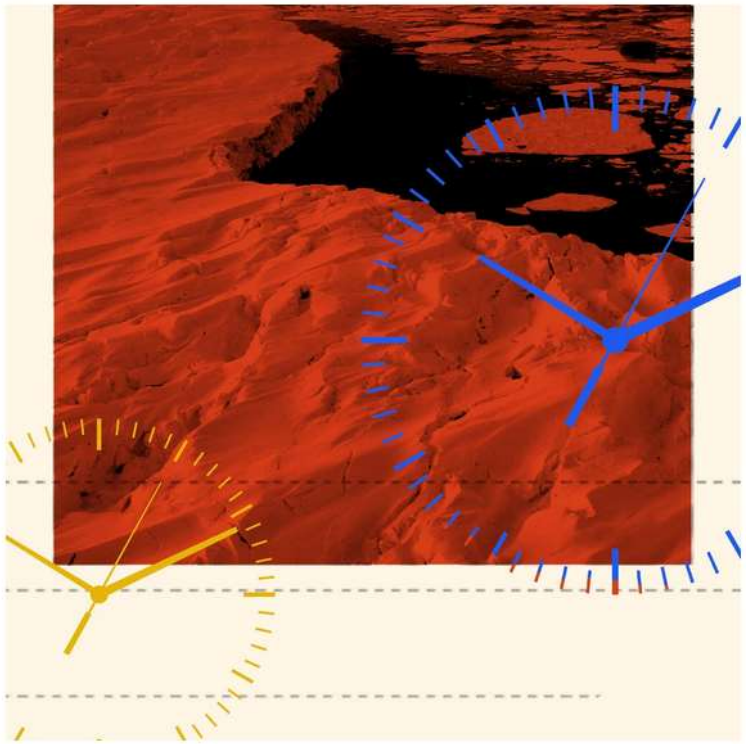


Illustration by Arsh Raziuddin, The New York Times

“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

nature climate change

Article

https://doi.org/10.1038/s41558-023-01680-x

Social cost of carbon estimates have increased over time

Richard S. J. Tol

Received: 3 August 2022

Accepted: 23 April 2023

Published online: 15 May 2023

Check for updates

Mathematical models predicting the damage in dollars from hurricanes and draughts up to the year 2300

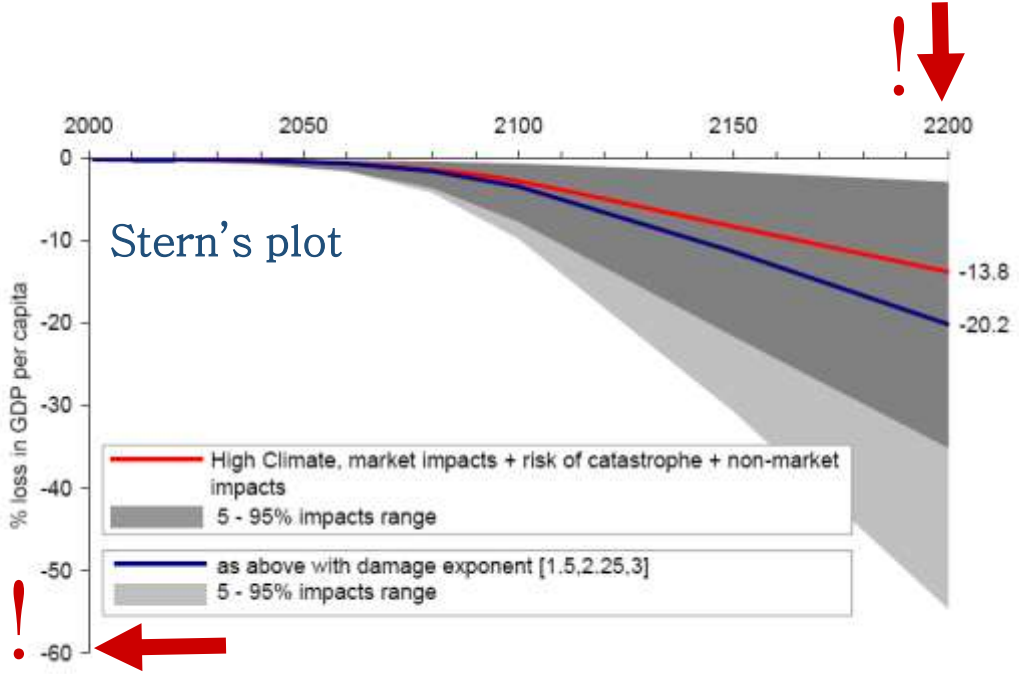
RESOURCES for the FUTURE

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

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

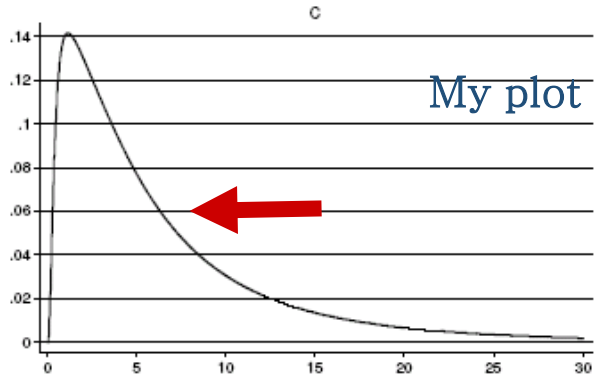
Global Environmental Change

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

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

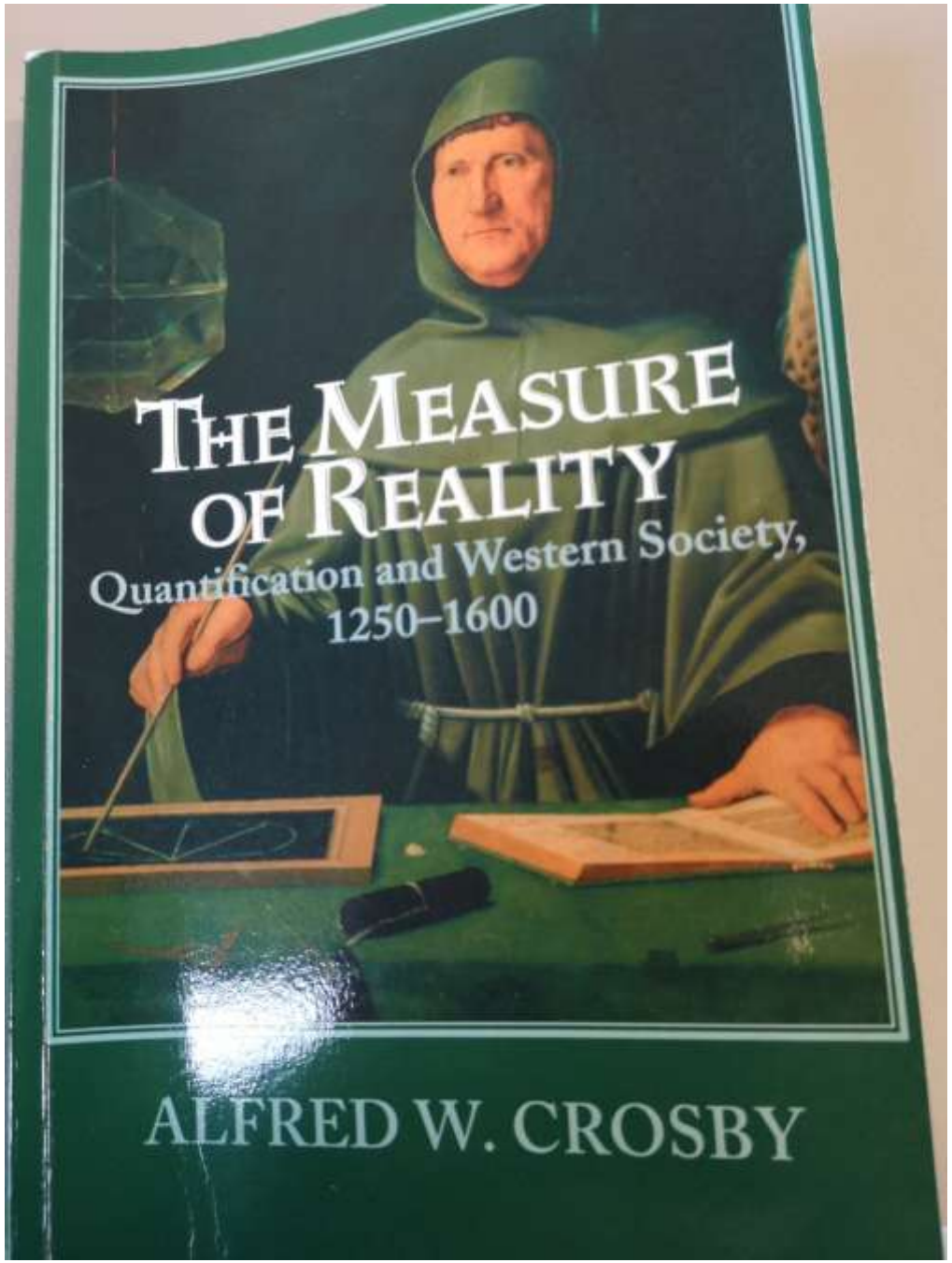
Andrea Saltelli *, Beatrice D'Hombres

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

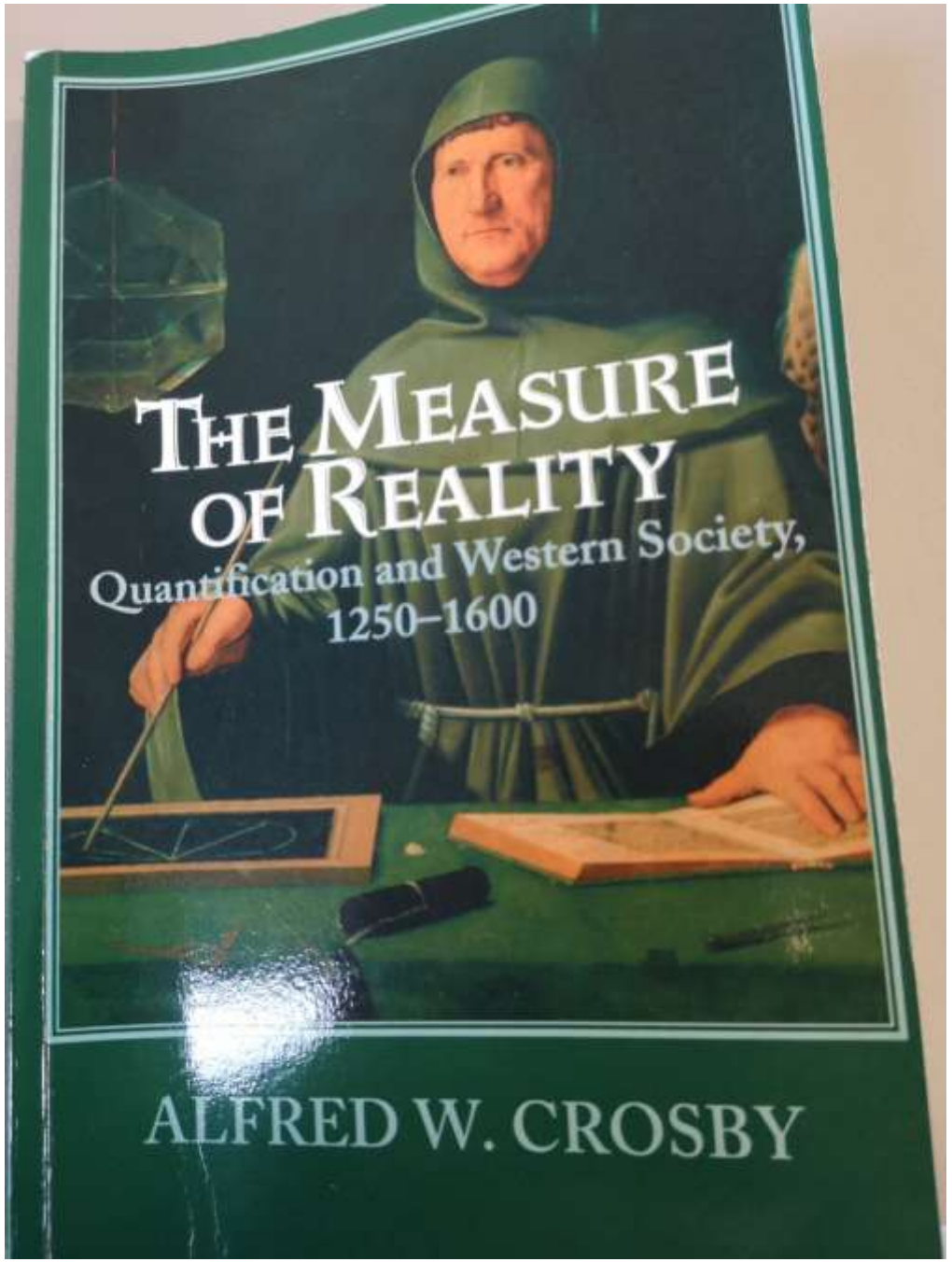


% loss in GDP per capita

How did we get there?



Were quantification and visualization the engine inside the engine of western success and domination?



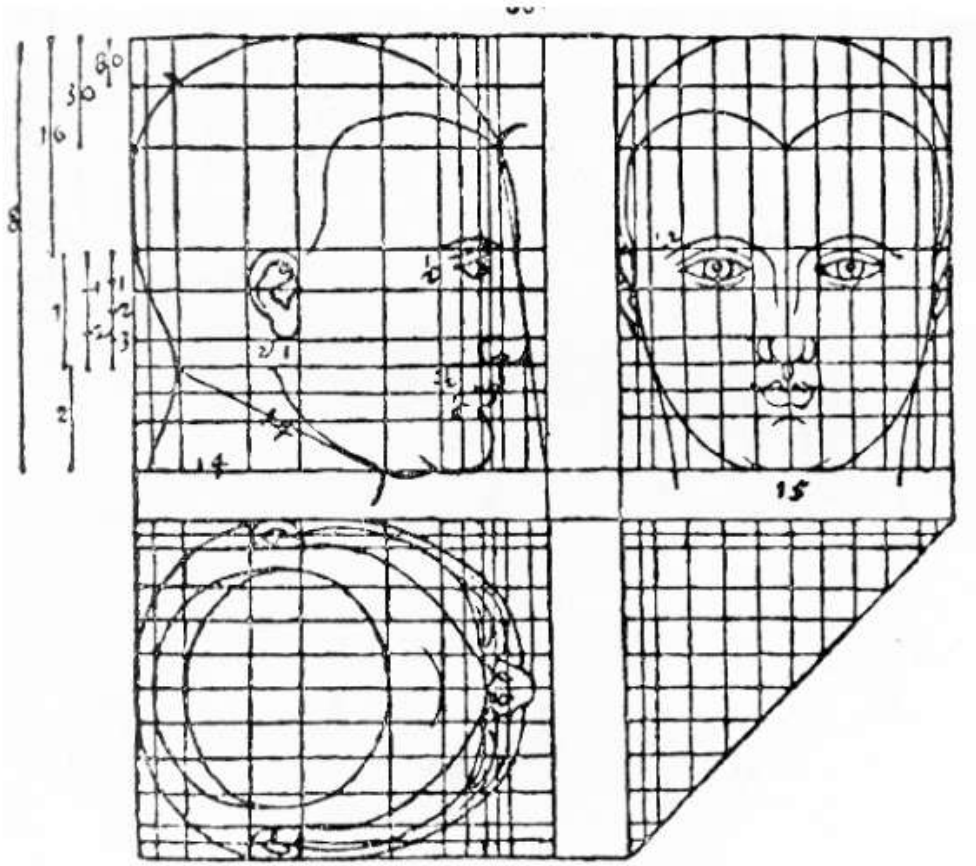
Quantification and visualization of space and time gave rise in the XIV century to a true revolution, in music, painting, accounting, cartography, astronomy …

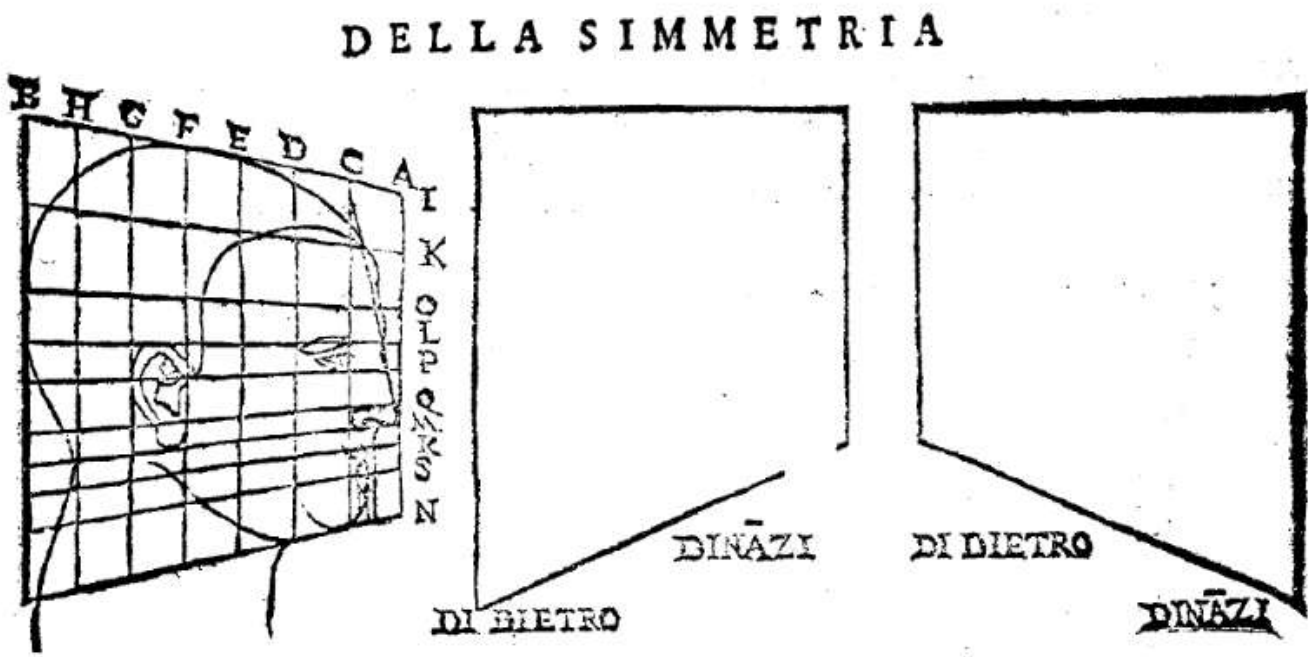
Pieter Bruegel the Elder, Temperance, 1560

Measuring: military technology, accounting, perspective, polyphonic music, the windmill, the watch …

The Annunciation, Carlo Crivelli (1435, 1495)

Draftsman Drawing a Reclining Nude
Albrecht Dürer (1471-1528)





From “De Varietate figurarum”
Albrecht Dürer (1471-1528)

Many voices of alarm as to misuse of quantification

With numbers both visible and invisible…

Blurring lines:

"what qualities are specific to rankings, or indicators, or models, or algorithms?"

Elizabeth Popp Berman

E. Popp Berman and D. Hirschman, The Sociology of Quantification: Where Are We Now?, Contemp. Sociol., vol. in press, 2017.

Numbers, visible and invisible…

ANNUAL REVIEWS

Publications A-Z Journal Information

Home / A-Z Publications / Annual Review of Sociology / Volume 45, 2019 / Article

ANNUAL REVIEW OF SOCIOLOGY Volume 45, 2019

Review Article | Open Access

What's New with Numbers? Sociological Approaches to the Study of Quantification

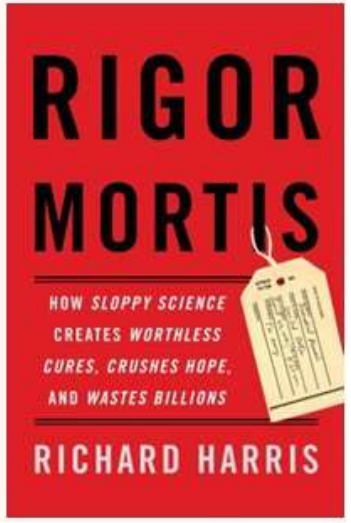
Andrea Mennicken[1], and Wendy Nelson Espeland[2]

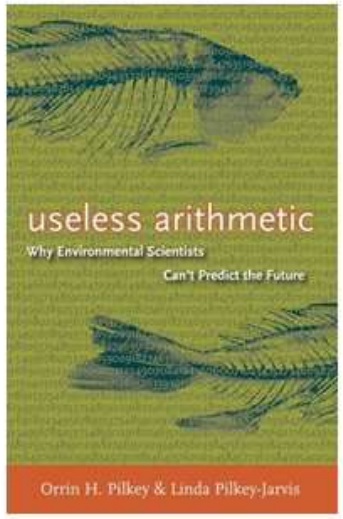
View Affiliations

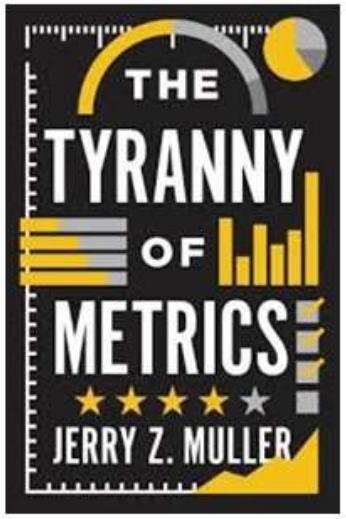
Vol. 45:223-245 (Volume publication date July 2019) | https://doi.org/10.1146/annurev-soc-073117-041343

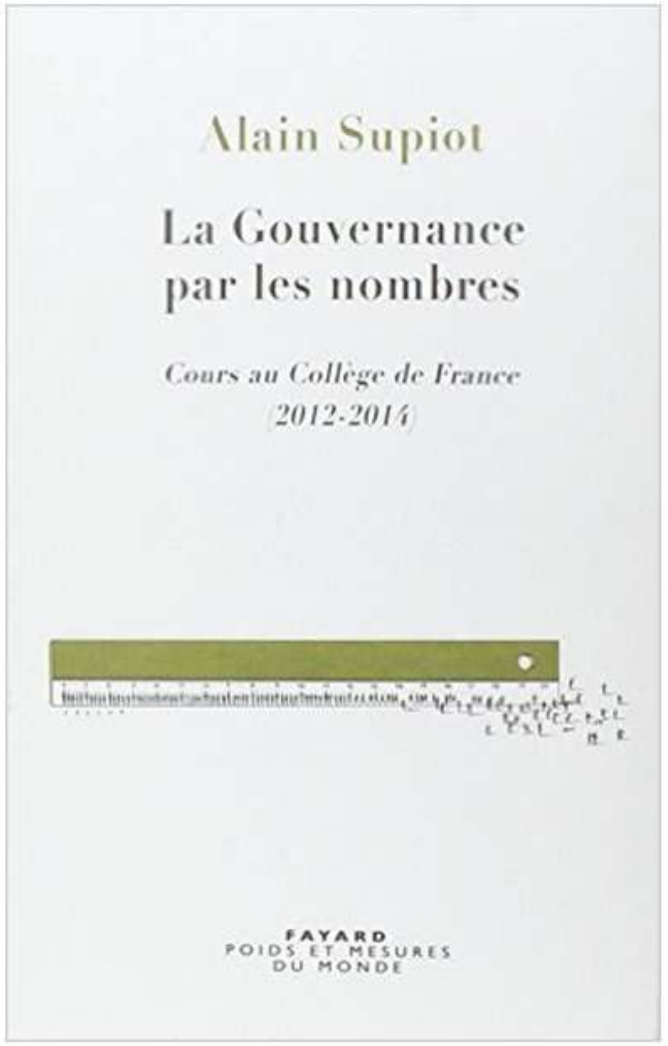
First published as a Review in Advance on May 13, 2019

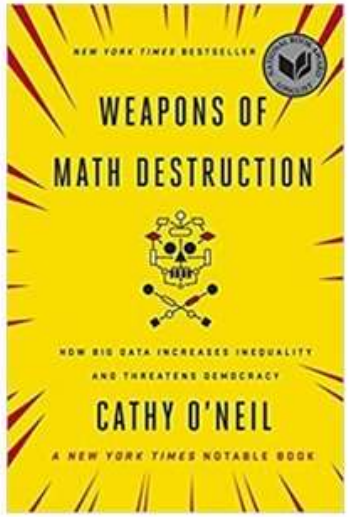
Algorithms, models, metrics, statistics…

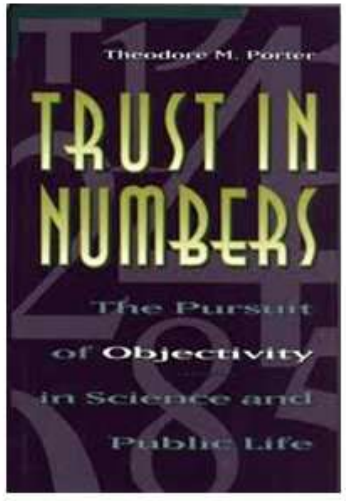




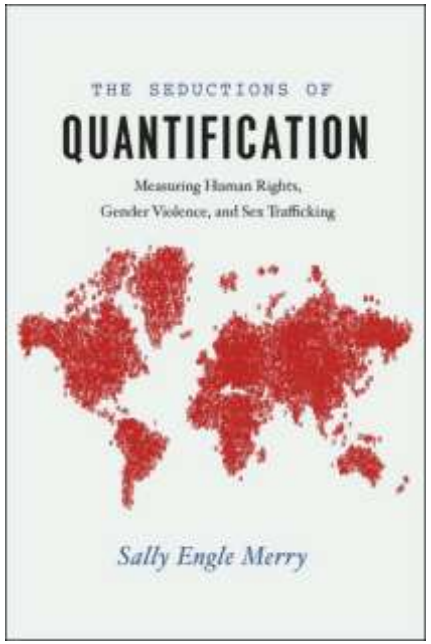


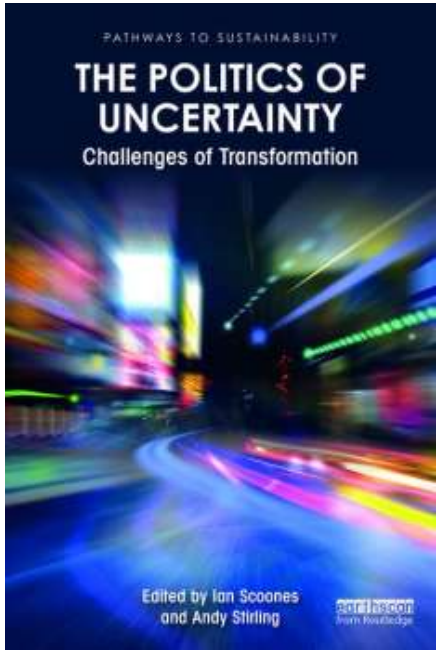


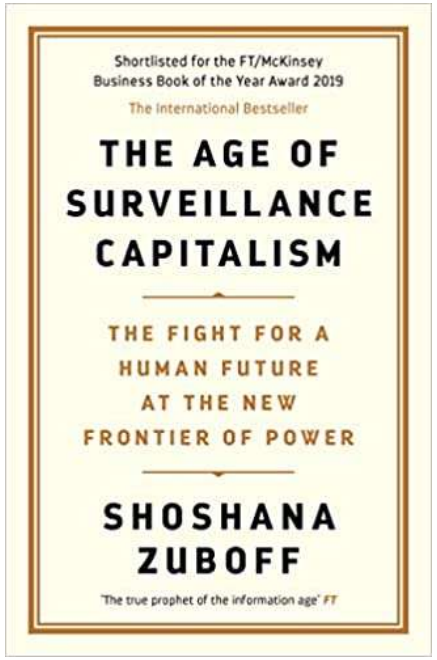


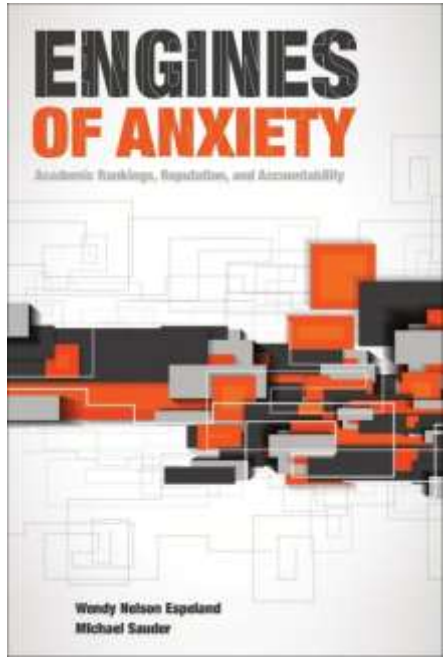


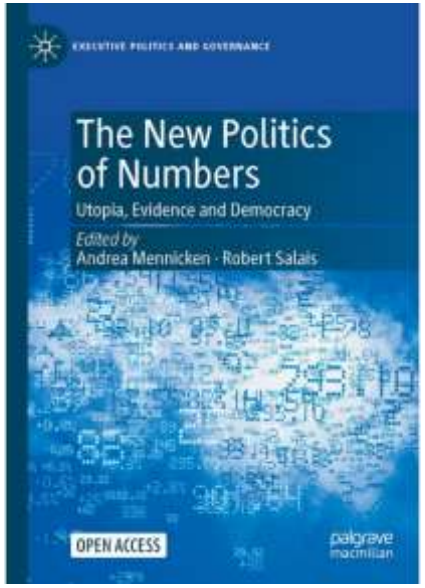
Algorithms, models, metrics, statistics…

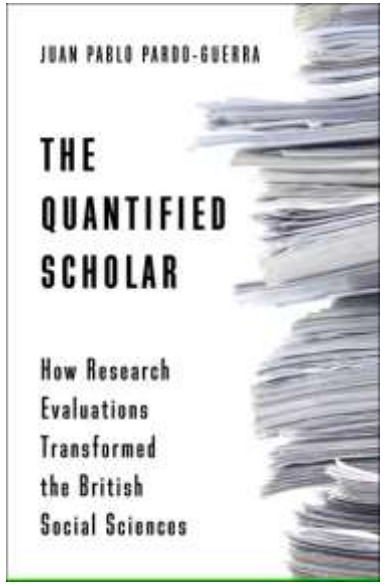


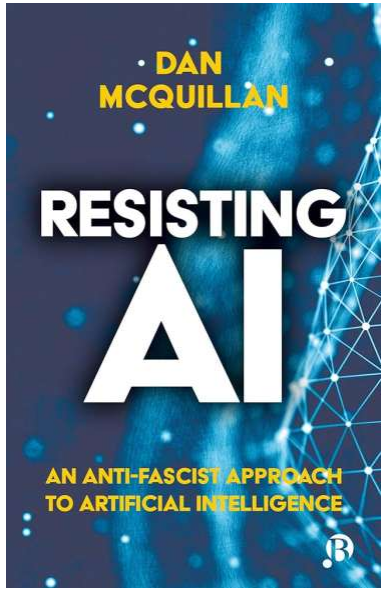






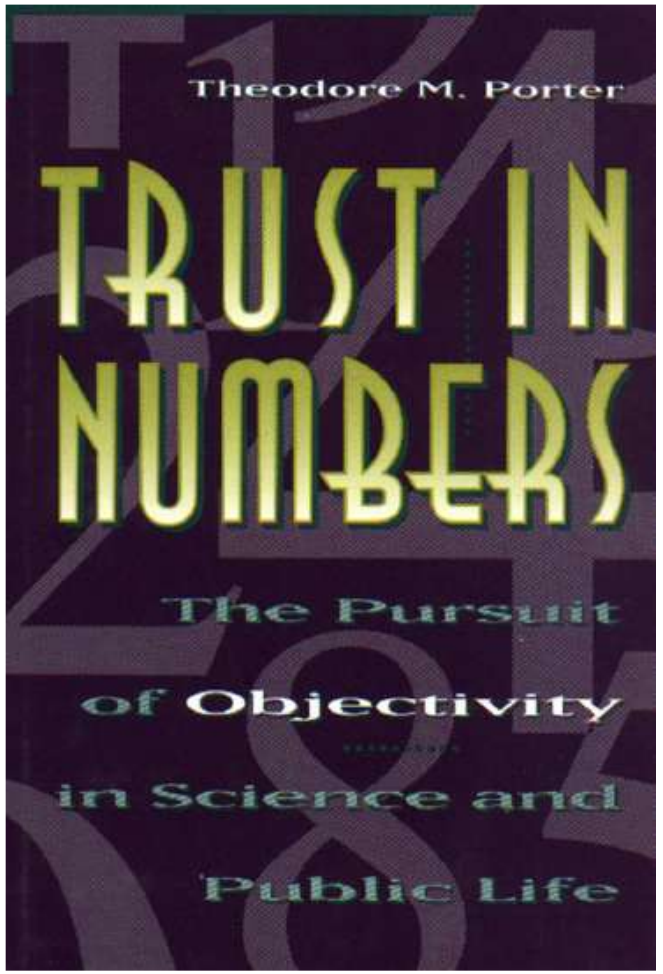






Numbers and trust

Theodor
M. Porter



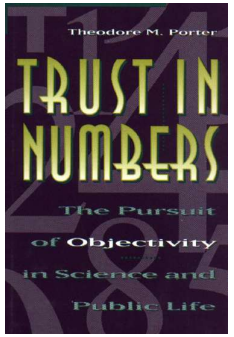
Theodore M. Porter, Trust in Numbers,
The Pursuit of Objectivity in Science and Public Life, Princeton 1995

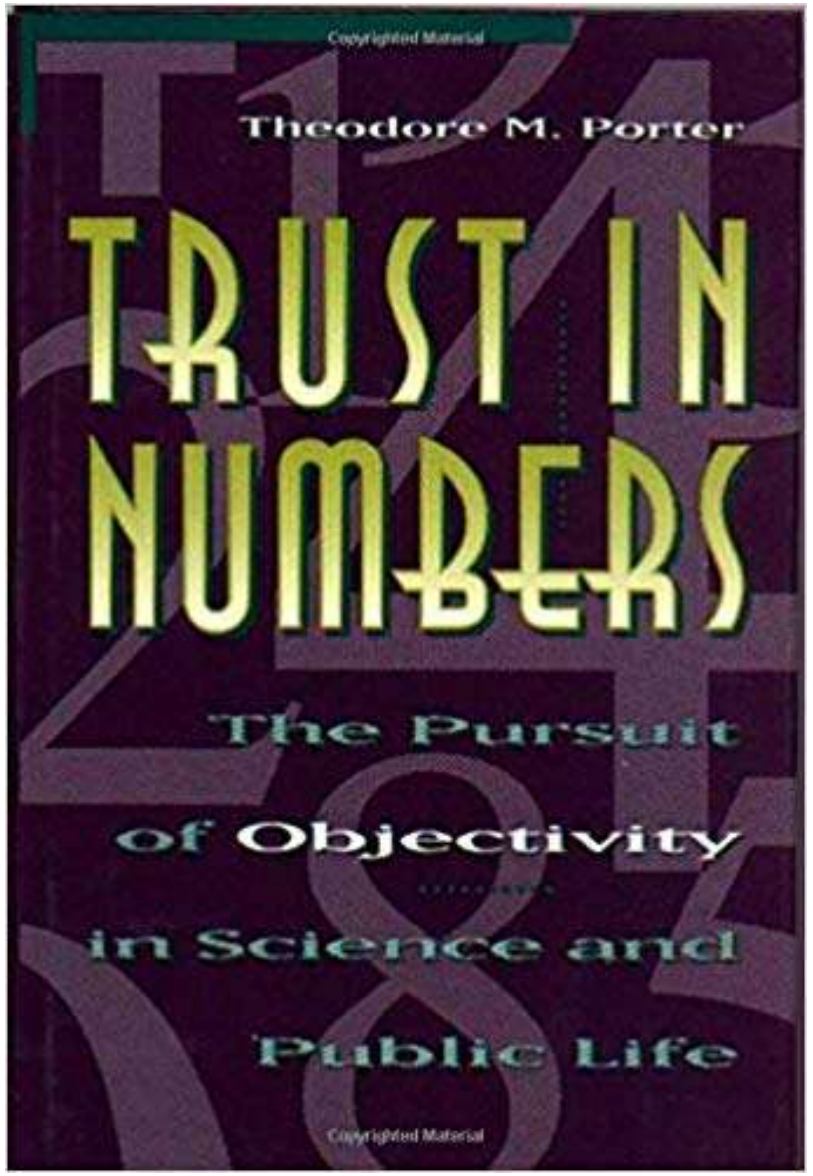
Porter's story: Quantification needs judgment which in turn needs trust …without trust quantification becomes mechanical, a system, and 'systems can be played'.

The appeal of numbers is especially compelling to bureaucratic officials who lack the mandate of a popular election, or divine right, p. 8

...

A decision made by the numbers (or by explicit rules of some other sort) has at least the appearance of being fair and impersonal, p. 8





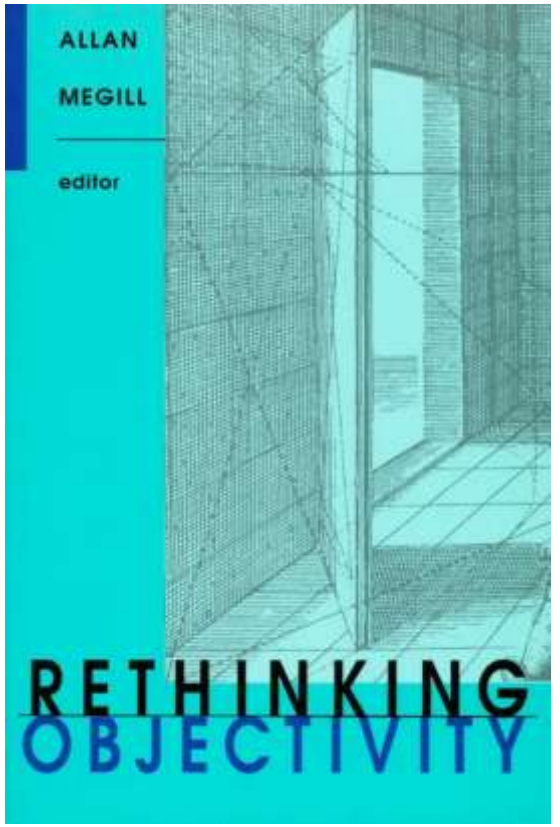
Numbers are not neutral but their purported neutrality is a large part of their appeal: being performative without appearing to be so

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

Objectivity as Standardization: The Rhetoric of Impersonality in Measurement, Statistics, and Cost-Benefit Analysis

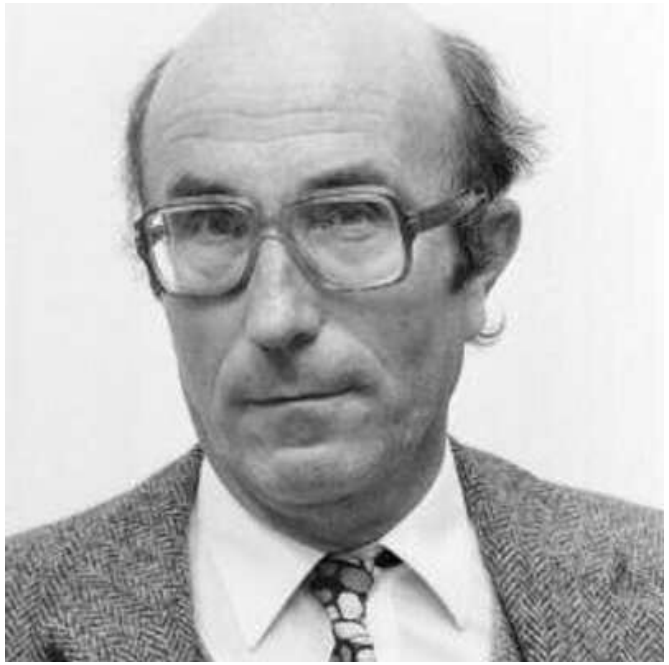
THEODORE M. PORTER

1. Quantification makes knowledge impersonal, hence objective.



‘System trust’, is social system theory:

“The reduction of complexity [made possible by generalized media of communication as money, power and truth] **assumes trust** on the part of those who are expecting such reduction and of those who are supposed to accept it once it is accomplished”



Niklas Luhmann

N. Luhmann, Trust and Power. Polity Press, 2017.

‘the essential fiduciary status’ of science= Trust in science is necessary for the general society to continue to support it, materially and with recruits. And mutual trust within science is necessary for its systems of quality assurance to function

Jerome R. Ravetz

For Ravetz (1971, pp. 295–296), when the goals of a task are complex, sophisticated, or subtle, then crude systems of measurements can be played exactly by those persons possessing the skills to execute the tasks properly, who thus manage to achieve their own goals to the detriment of those assigned.

Ravetz, J.R., 1971, Scientific Knowledge and Its Social Problems, 1996 Edition, Transaction Publishers. See examples in Muller, J.Z., 2018, The Tyranny of Metrics, Princeton.

Charles Goodhart

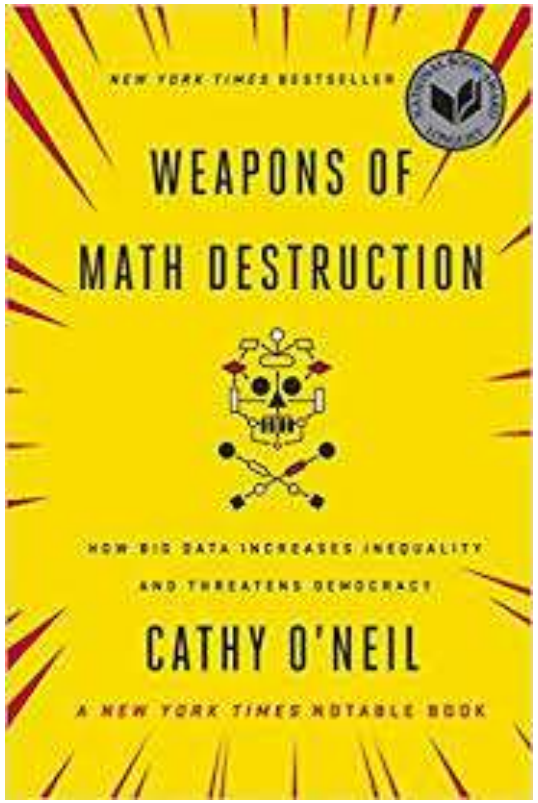
p. 44 “Any … measures necessarily involve a loss of information … [and distorts behavior]” (Porter, 1995)

This is what we normally call Goodhart’s law, from Charles Goodhart. "When a measure becomes a target, it ceases to be a good measure."

Also known as Campbell's law (1976);
https://en.wikipedia.org/wiki/Goodhart%27s_law

Alarm for Weapons of Math Destruction

Cathy O'Neil

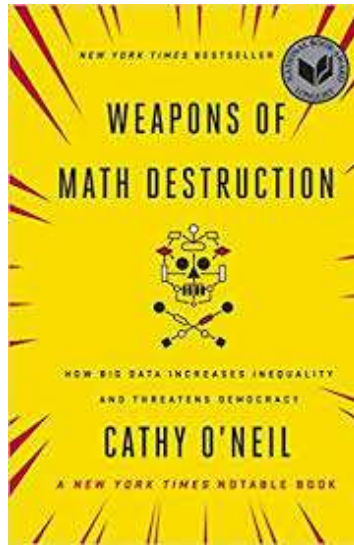


O'Neil, C. (2016). Weapons of math destruction : how big data increases inequality and threatens democracy. Random House Publishing Group.

Opacity (also because of trade secrecy) of algorithms used to decide on recruiting, carriers (including of researchers), prison sentencing, paroling, custody of minors, political campaigns…

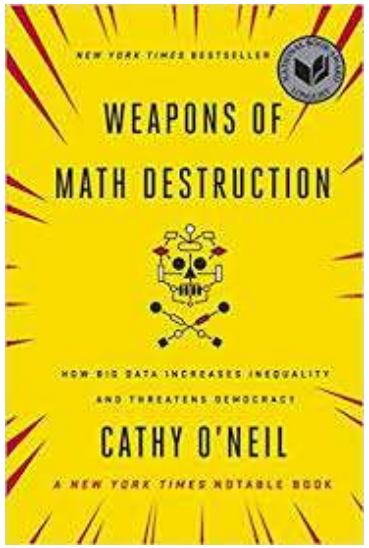
O'Neil, C. (2016). Weapons of math destruction : how big data increases inequality and threatens democracy. Random House Publishing Group.

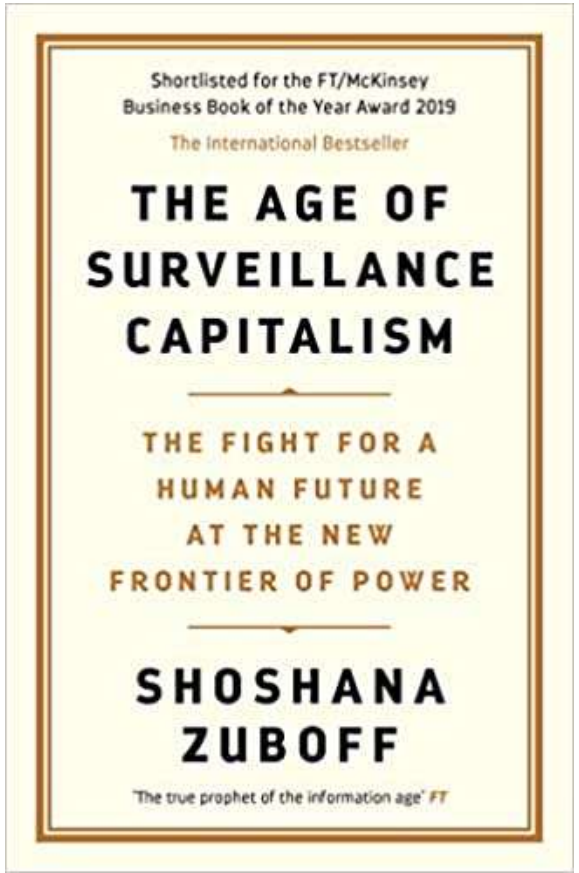
Brauneis, R., & Goodman, E. P. (2018). Algorithmic Transparency for the Smart City. Yale Journal of Law & Technology, 20, 103–176. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3012499



Opacity coupled with opportunity for scale and damage and with non-appealability make them an instrument of oppression & inequality

Cathy O'Neil Google talk https://www.youtube.com/watch?v=TQHs8SA1qpk

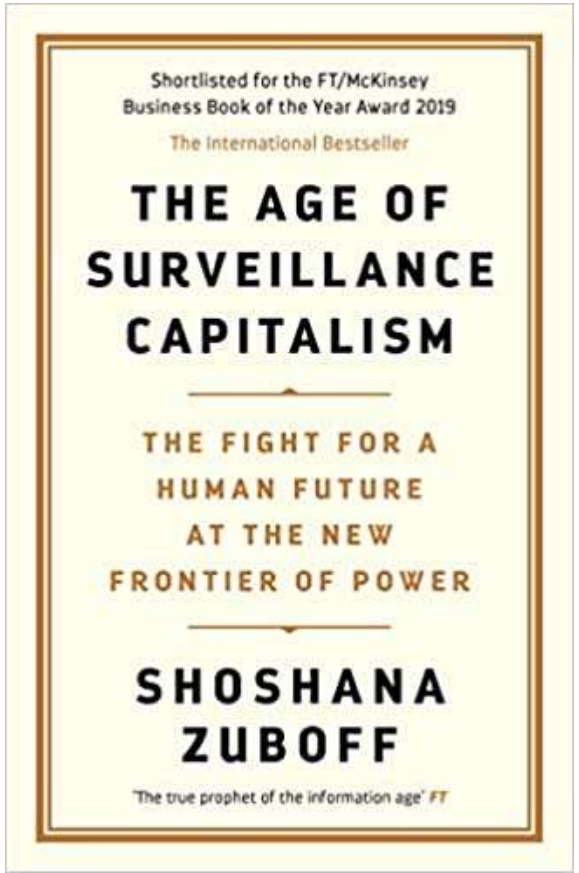




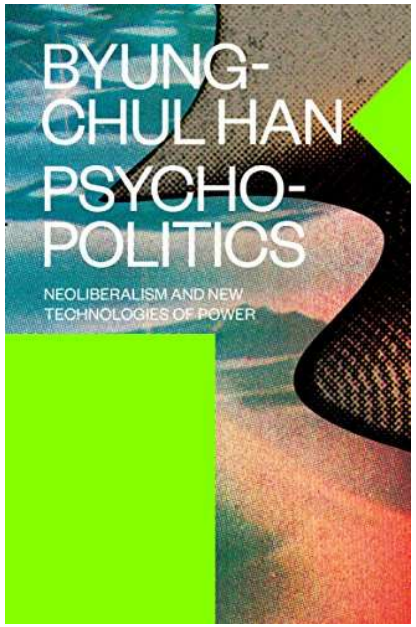
A project of domination of consumers and voters is made possible by artificial intelligence, big data & cognitive psychology

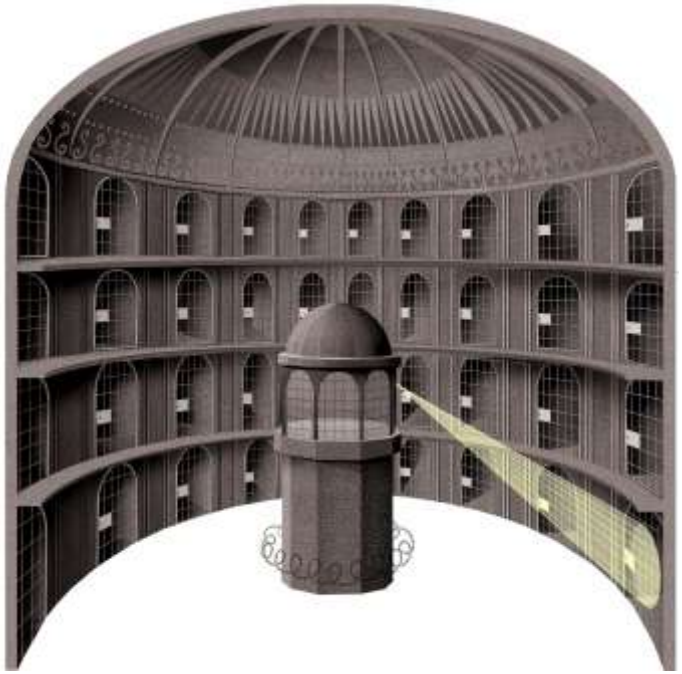
Inequality, power asymmetries and the world of surveillance capitalism

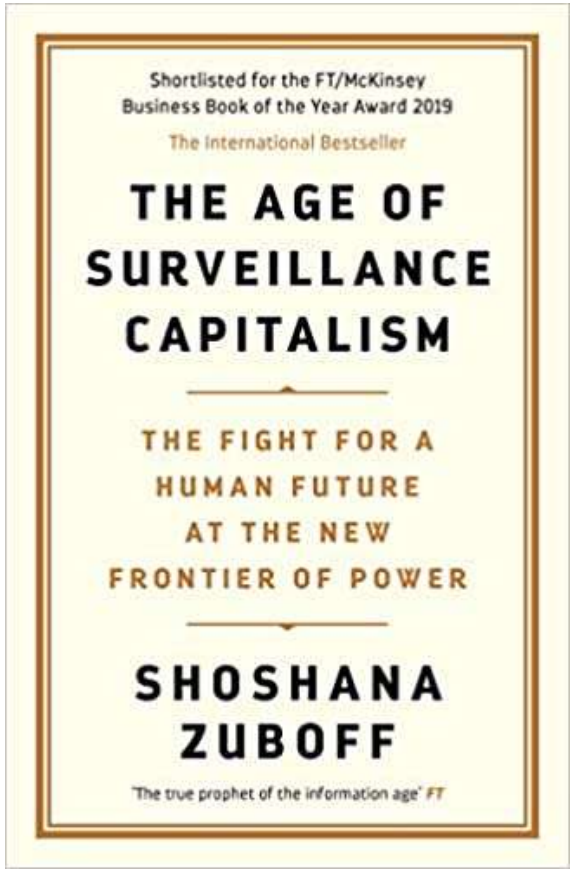
… and the surveillance is voluntarily accepted



Byung Chul Han 'virtual panopticon'







Chapters 11 & 12

Instrumentarian power

Chapter 10

Néorationalism d' importation

La trollisation de l'espace public

AI empowered with cognitive psychology

A project of domination?

NYT running the story of one worker working difficult hours

The New York Times

Working Anything but 9 to 5

Scheduling Technology Leaves Low-Income Parents With Hours of Chaos

By **JODI KANTOR**, Photographs by **SAM HODGSON**

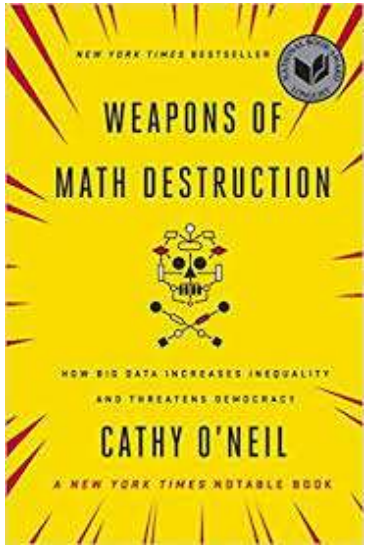
AUGUST 13, 2014

https://www.nytimes.com/interactive/2014/08/13/us/starbucks-workers-scheduling-hours.html

“managers’ pay is contingent upon the efficiency of their staff measured by revenue for employee hour” p. 126

“I consider scheduling software one of the more appalling WMD [Weapon of Math Destruction]” p. 128

O’Neil, C. (2016). Weapons of math destruction : how big data increases inequality and threatens democracy. Random House Publishing Group.



The New York Review of Books

The Boss Will See You Now

Zephyr Teachout

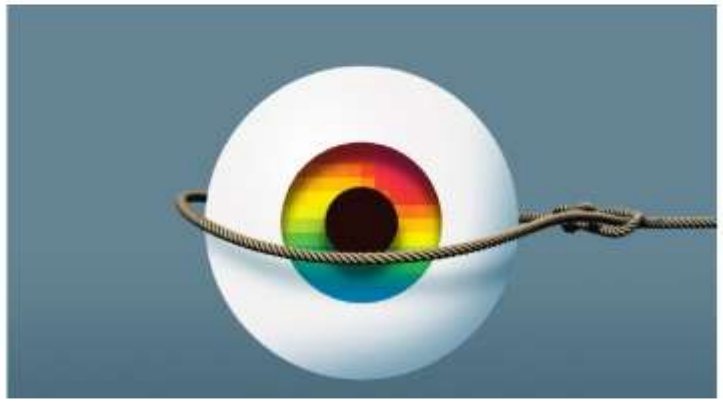
We are experiencing a major turning point in the surveillance of workers, driven by wearable tech, artificial intelligence, and Covid.

The New York Review of Books

The Coming Tech Autocracy

Sue Halpern
November 7, 2024 Issue

A functional government, committed to safeguarding its citizens, might be keen to create a regulatory agency for AI or pass comprehensive legislation, but we in the United States do not have such a government.



Working Anything but 9 to 5

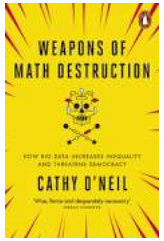
Scheduling Technology Leaves Low-Income Parents With Hours of Chaos

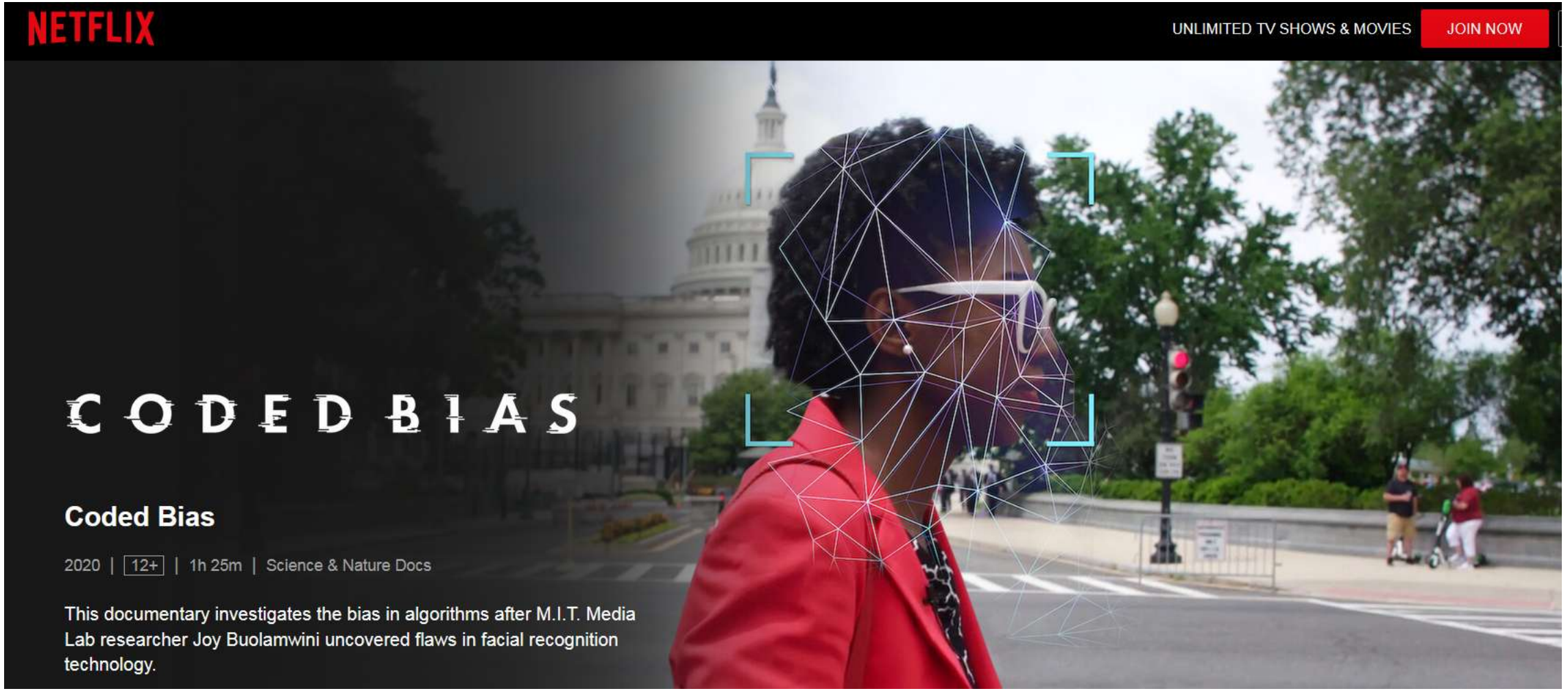
SAN DIEGO —

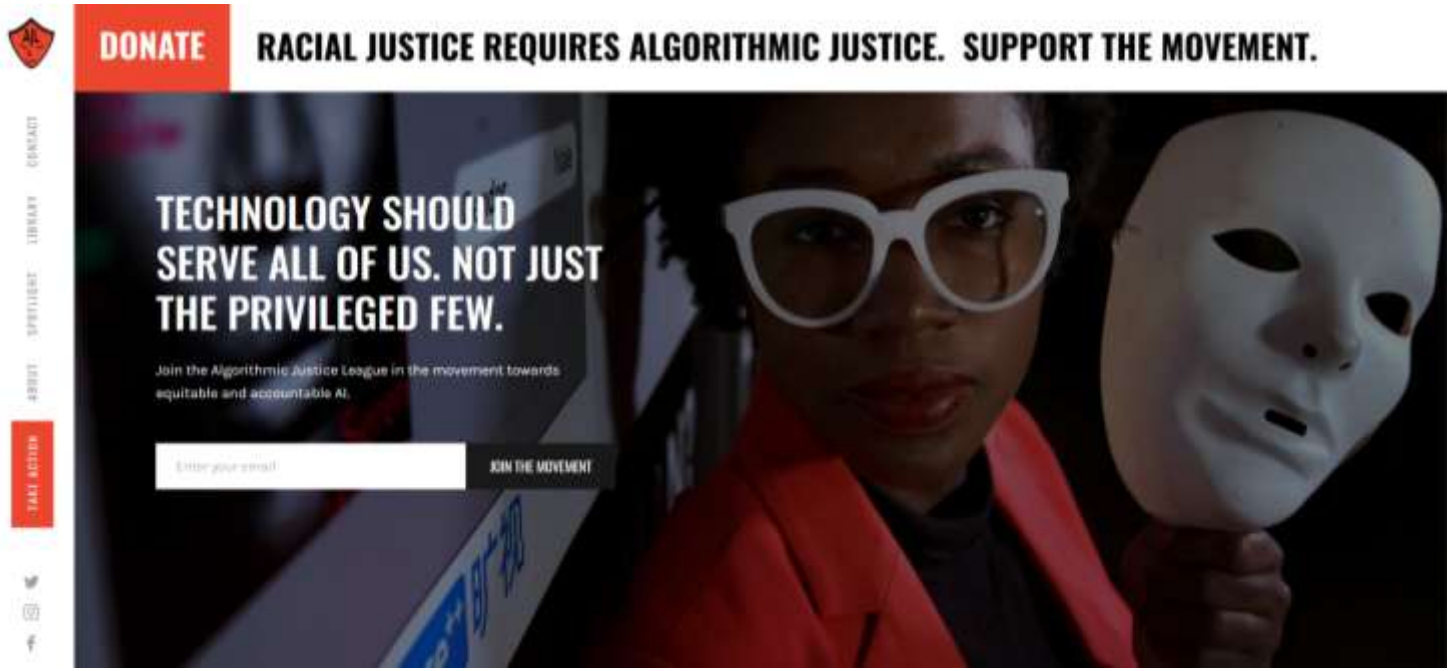
Some reading

The New York Review
of Books

Some watching


WEAPONS OF
MATH DESTRUCTION
CATHY O'NEIL


NETFLIX
UNLIMITED TV SHOWS & MOVIES
JOIN NOW
CODED BIAS
Coded Bias
2020 | 12+ | 1h 25m | Science & Nature Docs
This documentary investigates the bias in algorithms after M.I.T. Media Lab researcher Joy Buolamwini uncovered flaws in facial recognition technology.



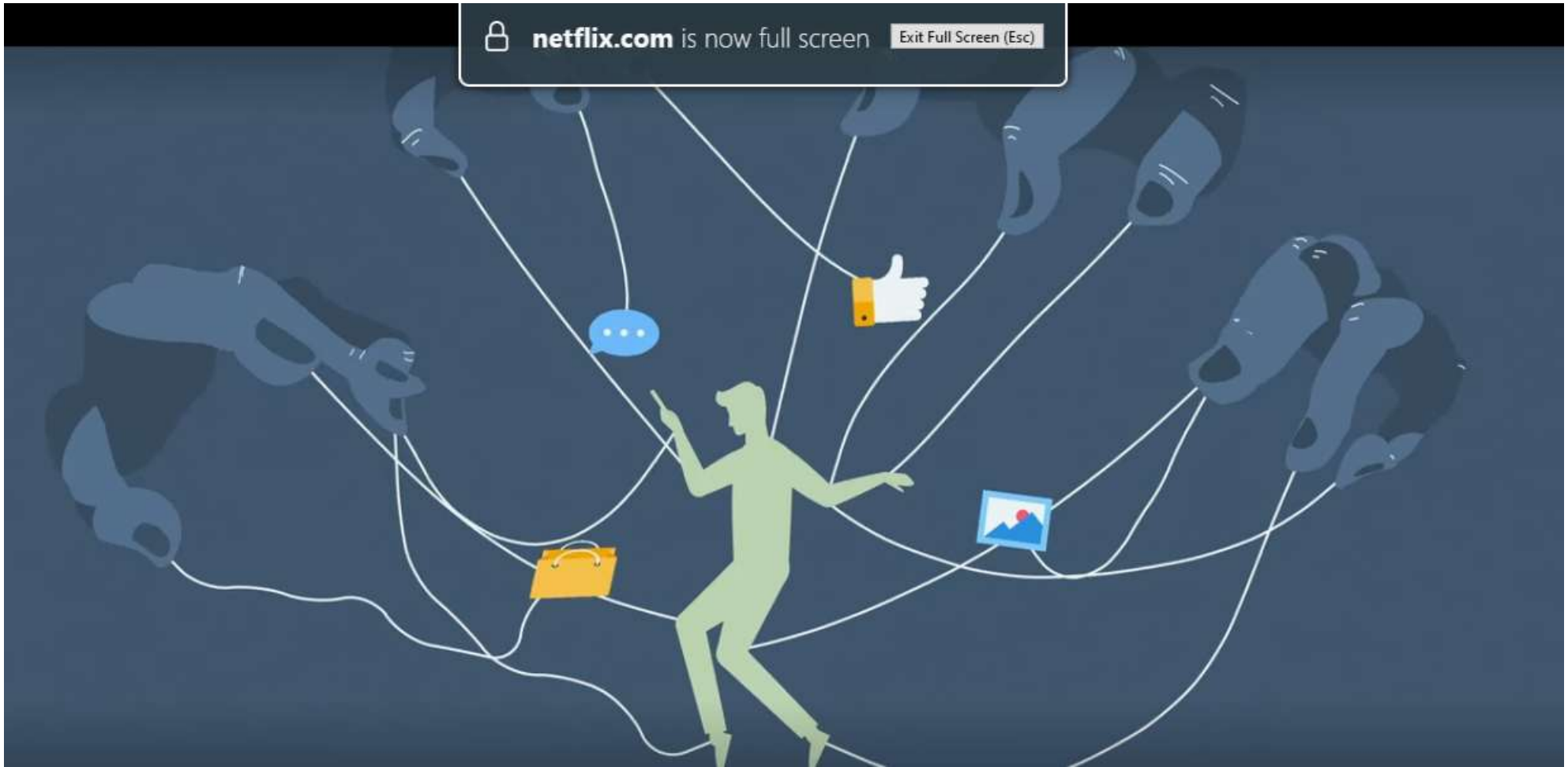
Algorithmic Justice League

https://www.ajl.org/

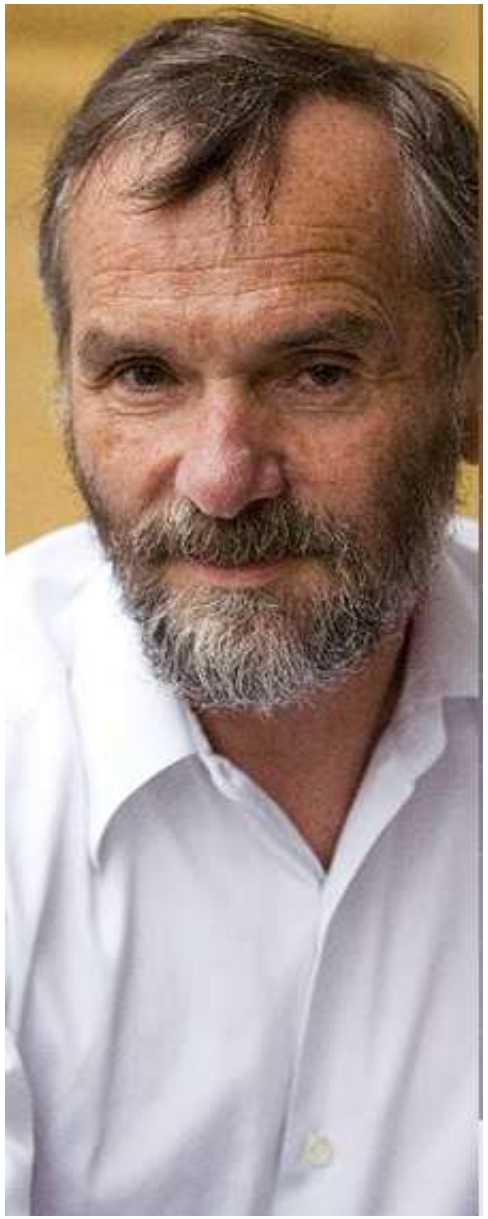
The New York Times
Bloomberg Business
Forbes
TIME
FORTUNE
TED
WIRED
The Telegraph

A useful illustration of strategies of capture, starring O'Neil, Zuboff, Lanier, and GAFA technologists…

… such as Tristan Harris, former design ethicist at Google, explaining from inside how social media pursue addiction to maximize profit and manipulates people's behaviour



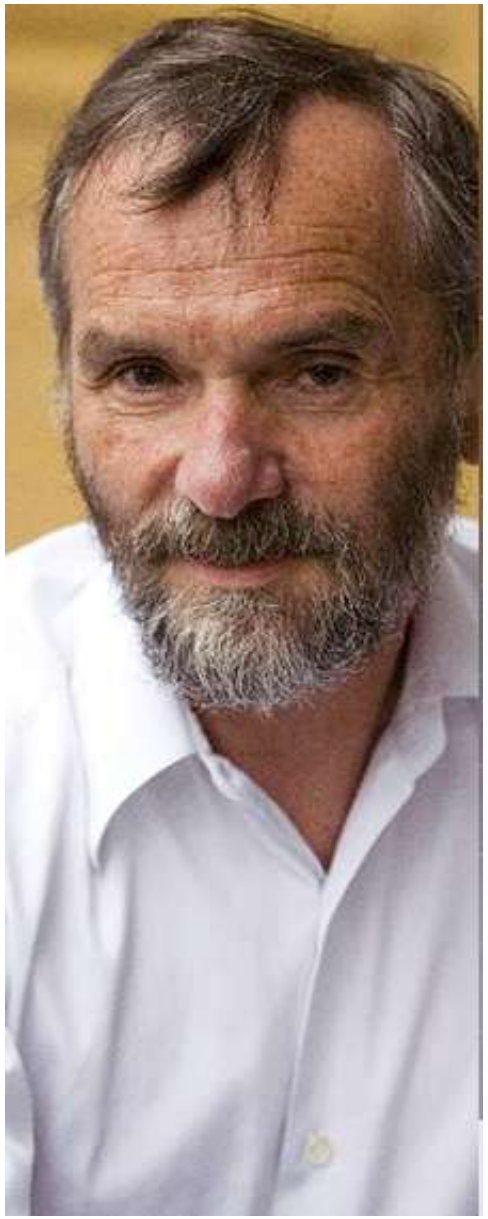
Alain Supiot



An indictment of the Total Market and the normative uses of economic quantification

https://www.college-de-france.fr/site/en-alain-supiot/Governance-by-Numbers-Introduction.htm

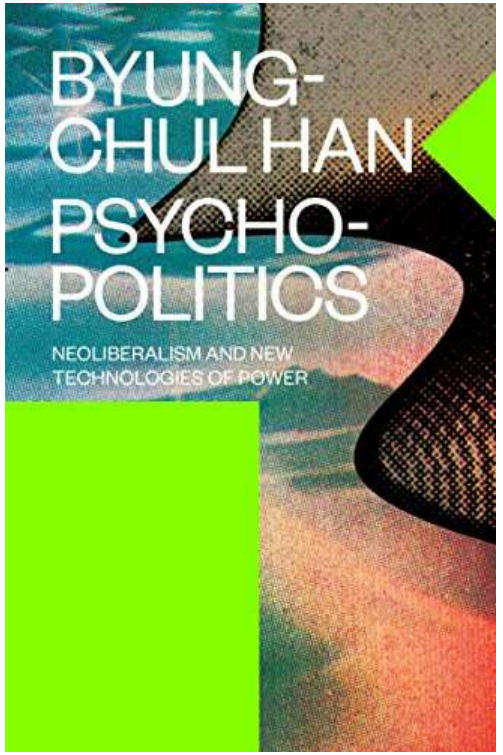
Alain Supiot

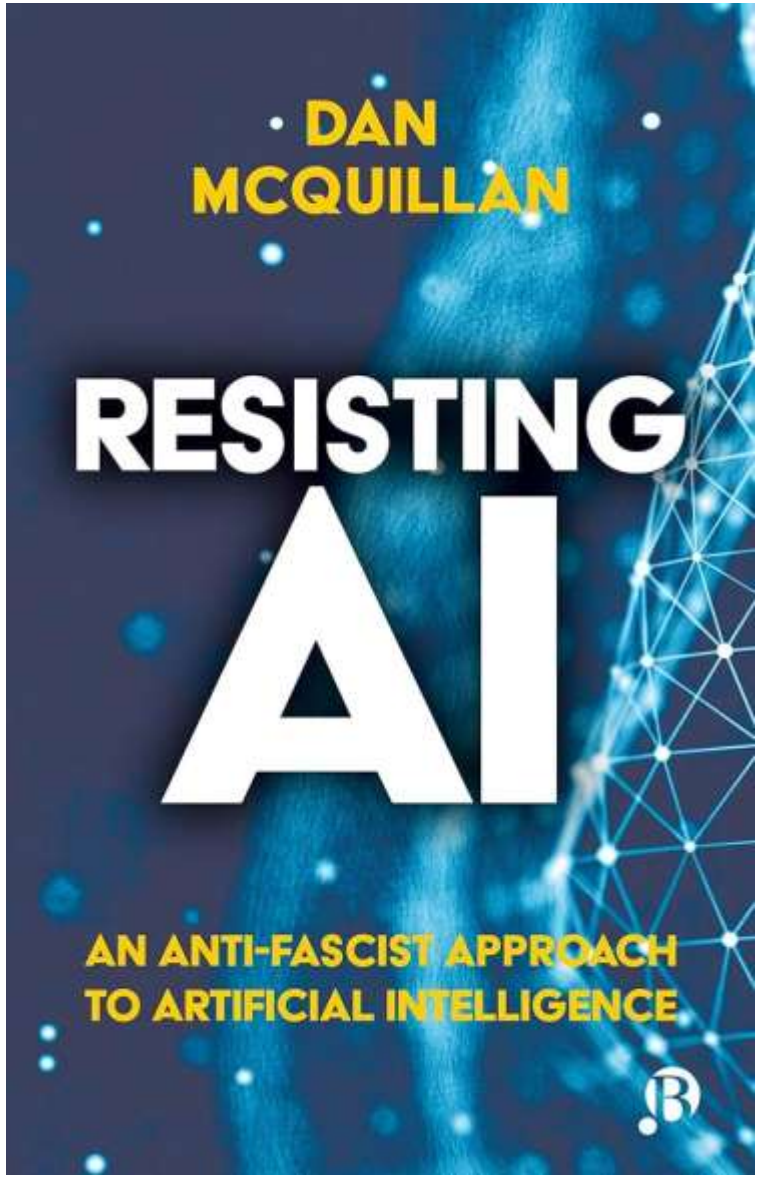


…we have entered the era of the cybernetic imaginary, which revives the West's age-old dream of grounding social harmony in calculations.

Same diagnosis about the neoliberal ‘exploitation of freedom’ from Byung Chul Han

Slave of ourselves





Resisting AI contrasts optimistic visions about AI's … AI may best be seen as a continuation and reinforcement of bureaucratic forms of discrimination and violence, ultimately fostering authoritarian outcomes

AI's promise of objective calculability is antithetical to an egalitarian and just society

… Based on opaque algorithms – various actors can discriminate against categories of people in accessing jobs, loans, medical care, and other benefits

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.

E. S. Reinert, “Full circle: economics from scholasticism through innovation and back into mathematical scholasticism,” *J. Econ. Stud.*, vol. 27, no. 4/5, pp. 364–376, Aug. 2000.

P. Romer, “Mathiness in the Theory of Economic Growth,” *Am. Econ. Rev.*, vol. 105, no. 5, pp. 89–93, May 2015.

Mirowski, Philip. 2013. Never Let a Serious Crisis Go to Waste: How Neoliberalism Survived the Financial Meltdown. Verso.

IIPP UCL Institute for Innovation and Public Purpose

UCL

WORKING PAPER
WP 2021/07

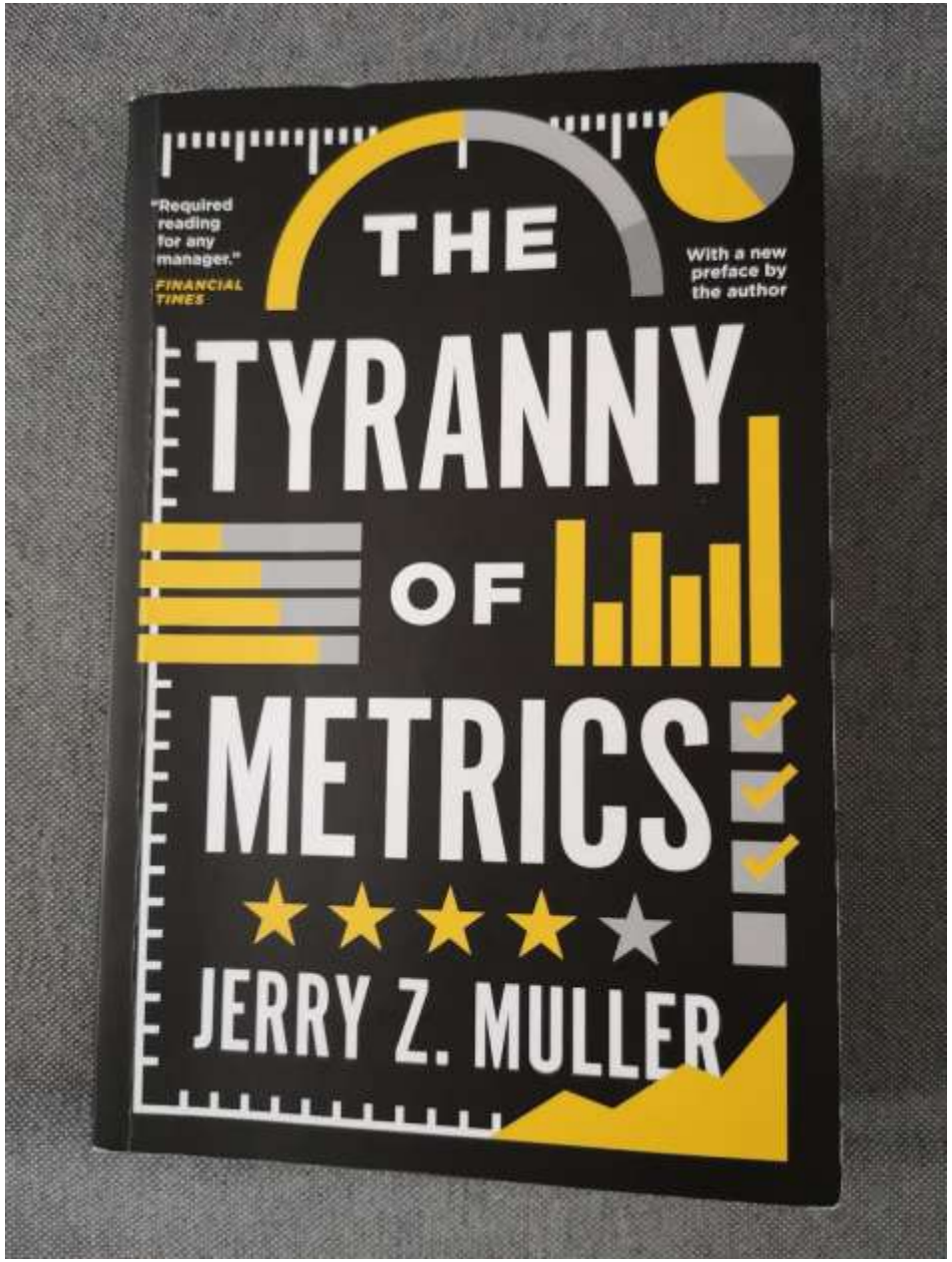
Altered States: Cartesian and Ricardian dreams

Erik S. Reinert
Tallinn University of Technology
UCL Institute for Innovation and Public Purpose

Monica di Fiore
Institute for Cognitive Sciences and Technologies, Consiglio Nazionale delle Ricerche

Andrea Saltelli
Open Evidence Research, Universitat Oberta de Catalunya (UOC)

Jerome R. Ravetz
Institute for Science, Innovation and Society, University of Oxford

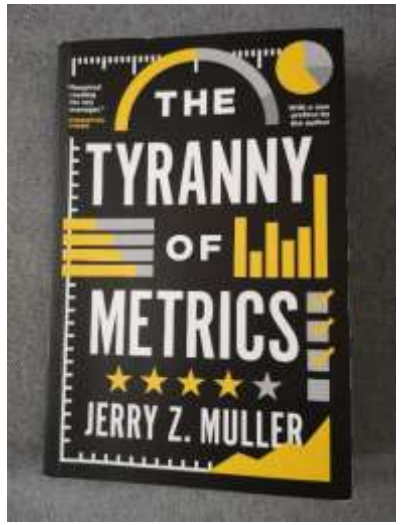


J. Z. Muller, The tyranny of metrics. Princeton University Press , 2018.

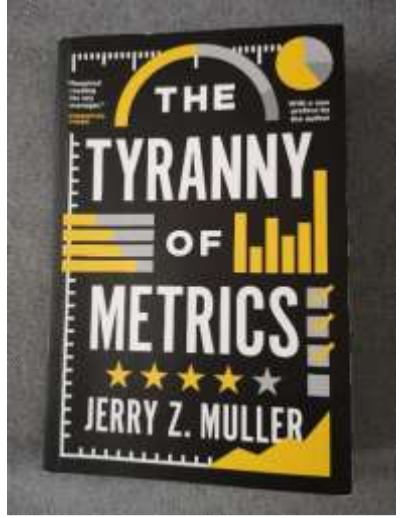
Metric fixation, or the irresistible pressure to measure performance

Gaming of metrics (recall Goodhart law)

A wealth of case studies from education to war to medicine to foreign aid..



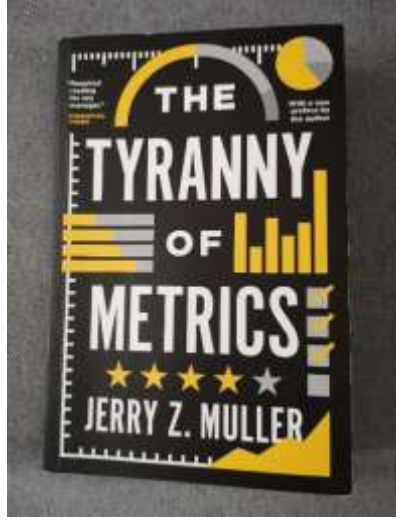
Unintended consequences



- Goal displacement
- Short termism
- Diminishing utility
- Rule cascade
- Discouraging risk taking
- Discouraging innovation
- Rewarding luck
- Discouraging cooperation and common purpose
- Degrading work
- Time waste
- Loss of productivity

A concluding remark of Muller

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

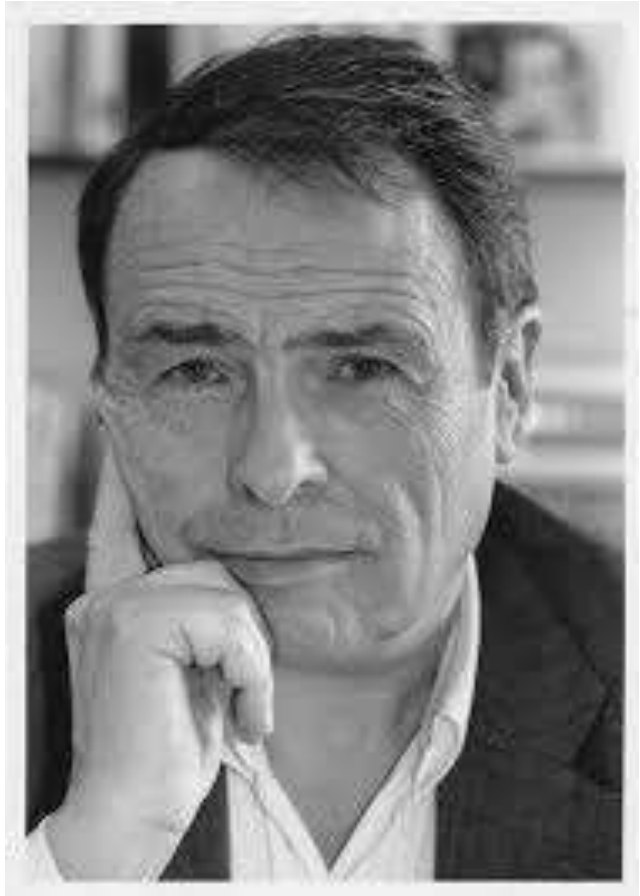


Do we need a movement of resistance?

I. Bruno, E. Didier, and J. Prévieux, Stat-activisme. Comment lutter avec des nombres. Paris: Zones, La Découverte, 2014

How to be a "statactiviste"?

1. Deconstruct existing metrics, including using irony (Pierre Bourdieu, *Les héritiers*).



La sociologie, ça doit être rigolo

(Sociology must be fun)

How to be a "statactiviste"?

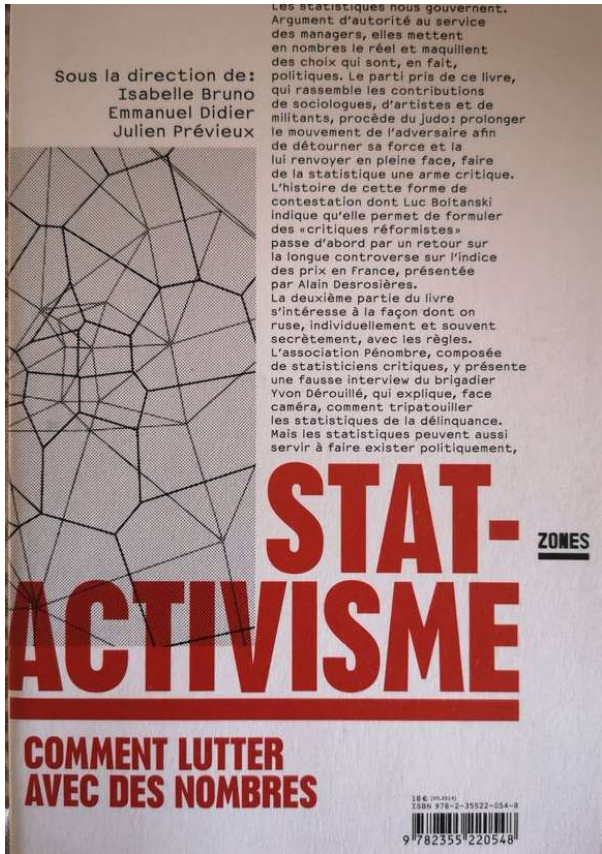
2. Gaming metrics (statistical judo) – use Goodhart's law to your advantage – or make the ruse public.

- Police statistics in NY

How to be a "statactiviste"?

3. Bring to the surface what is hidden / unsaid/ excluded – new social classes, marginalization, minorities:

- ‘Creative class’ or ‘precarious intellectuals’?



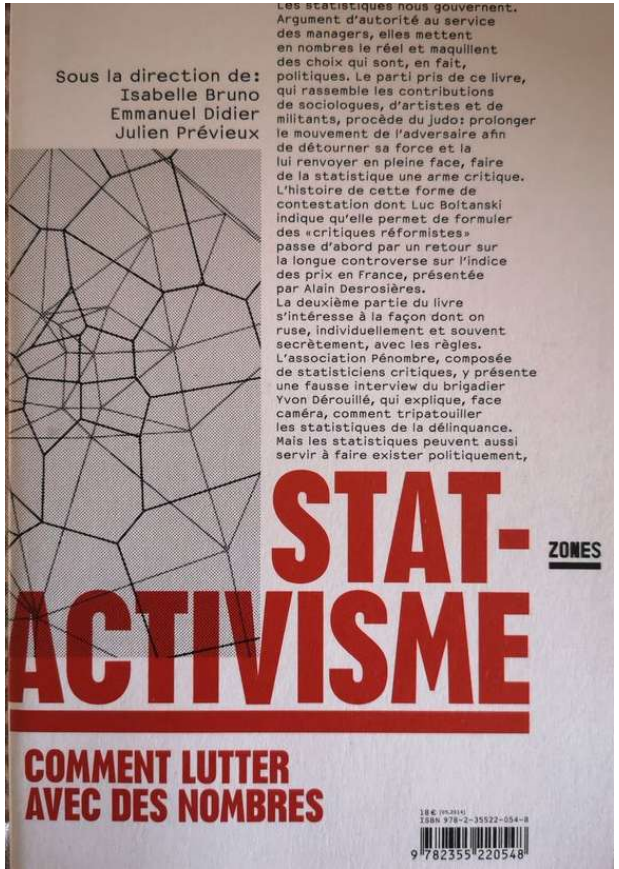
How to be a "statactiviste"?

4. Measure something different.

- Suicides at France Telecom;
- BIP 40, a new French measure of poverty/inequality

Important:

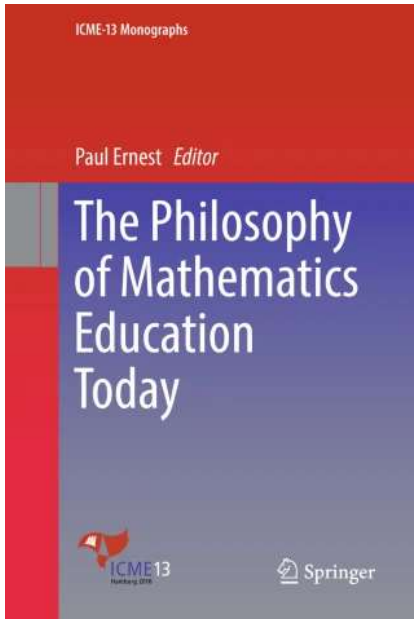
"Quantification should not be abandoned to the advantage of exalting qualities, singularities, and the incommensurable. Such an abandon would be a tactical error"



The Ethics of Mathematics: Is Mathematics Harmful?

Paul Ernest

© Springer International Publishing AG, part of Springer Nature 2018
P. Ernest (ed.), *The Philosophy of Mathematics Education Today*,
ICME-13 Monographs, https://doi.org/10.1007/978-3-319-77760-3_12



Mathematics – styles of thinking that can be damaging when applied beyond mathematics to social and human issues

Condorcet's dream

Applications in society can be deleterious to our humanity unless very carefully monitored and checked

Algorithms

Impact of learning mathematics on learners' thinking and life chances

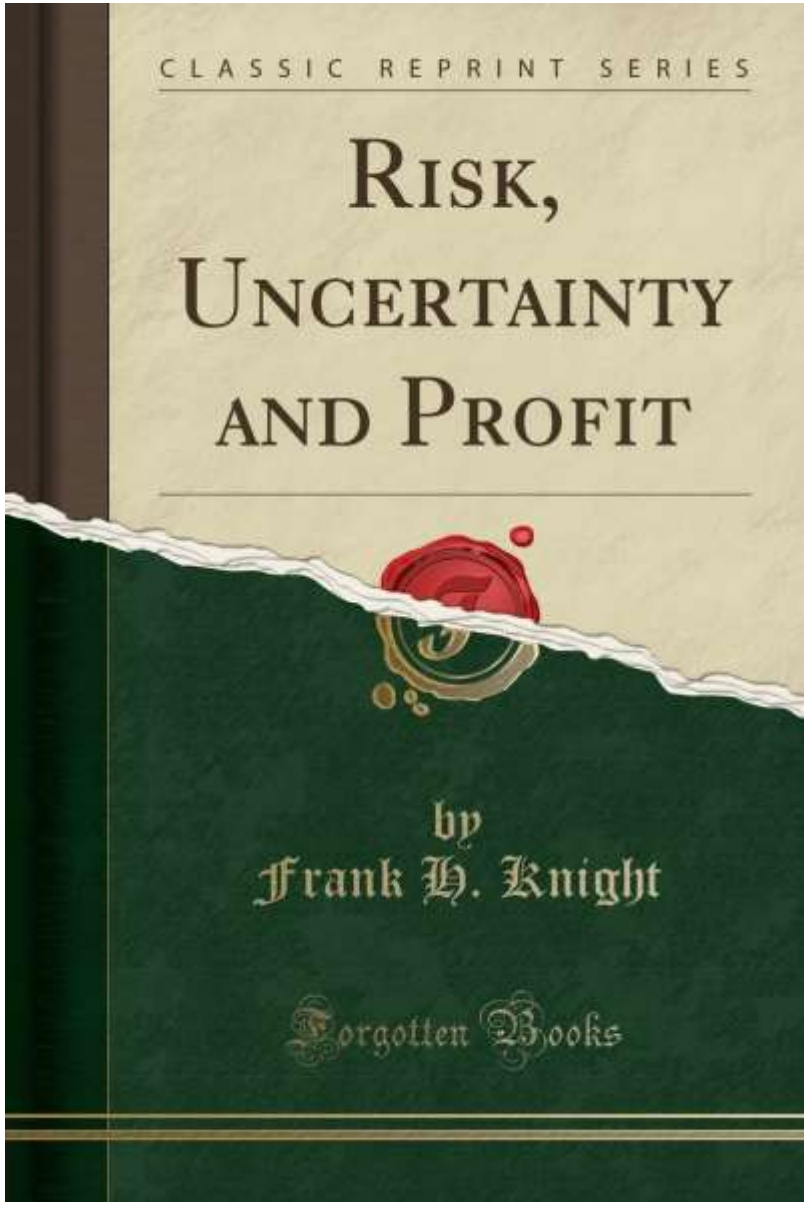
Regimenting, stigmatizing

upf. BARCELONA SCHOOL OF MANAGEMENT

Frank Knight (1921) distinguished risk from uncertainty

Risk = know outcomes & probabilities; roulette game

Uncertainty = unsure about the probabilities; starting a business



Frank H. Knight
1885-1972

But the story has many more twists

The debate between Leonard Savage and Frank Ramsey on one side and John Maynard Keynes and Frank Knight on the other: **a fundamental disagreements in decision theory**

Savage and Ramsey: pioneers of subjective probability theory for rational decision making – Keynes and Knight: sceptical that all uncertainties could be quantified probabilistically due to uncertainty & ambiguities

Leonard Jimmie Savage (1917–1971)

Frank Ramsey (1903–1930)

But the story has many more twists … Suggested reading

Savage's agents are rational and indifferent to ambiguity. Keynes and Knight suggested that known risks are preferred over unknown ones ➔ today behavioural economics

Savage and Ramsey "won" but see "info-gap theory" and "robust decision-making" (both involving better exploration and sensitivity analysis)

Frank H. Knight
1885-1972

John Maynard Keynes
1883-1946

upf. BARCELONA SCHOOL OF MANAGEMENT

Mathematical and statistical models

nature communications

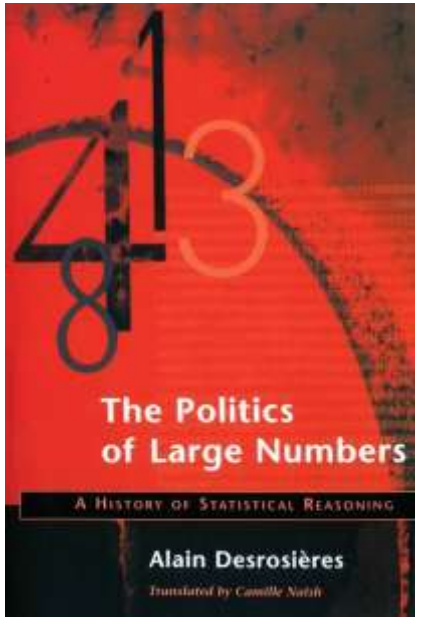
Comment | Open Access | Published: 27 August 2019

A short comment on statistical versus mathematical modelling

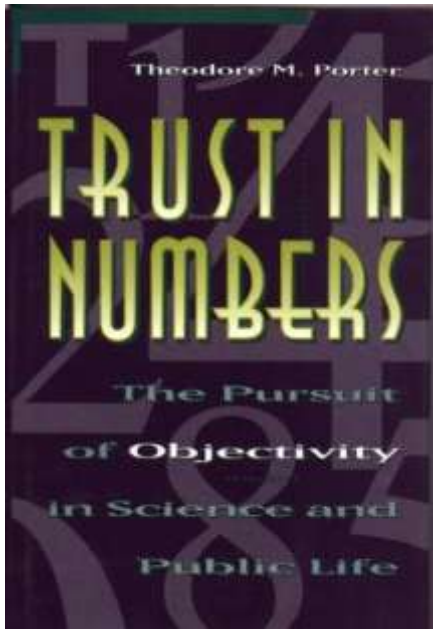
Andrea Saltelli ✉

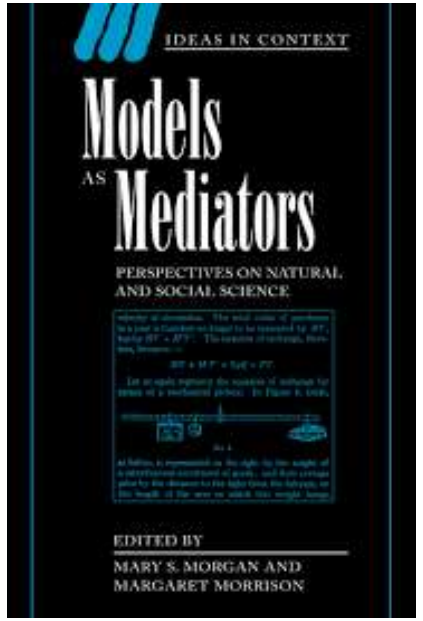
Nature Communications **10**, Article number: 3870 (2019) | Cite this article

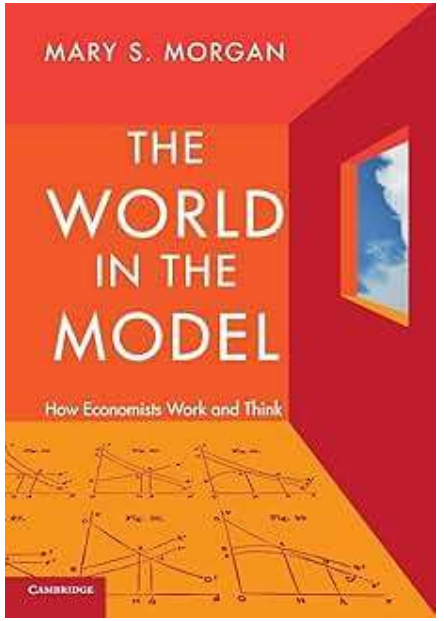
Mathematical models escape sociology of quantification



Statistics has a much deeper connection to sociology, and to sociology of quantification in particular (Desrosières, 1998; Mennicken & Espeland, 2019; Mennicken & Salais, 2022) than mathematical modelling. Sociology of quantification treats impact assessment tools such as cost benefit analysis (Porter, 1995). Less on modelling, see exceptions: (Morgan, 2012, Morgan & Morrison, 1999).







COMMENT · 24 JUNE 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.

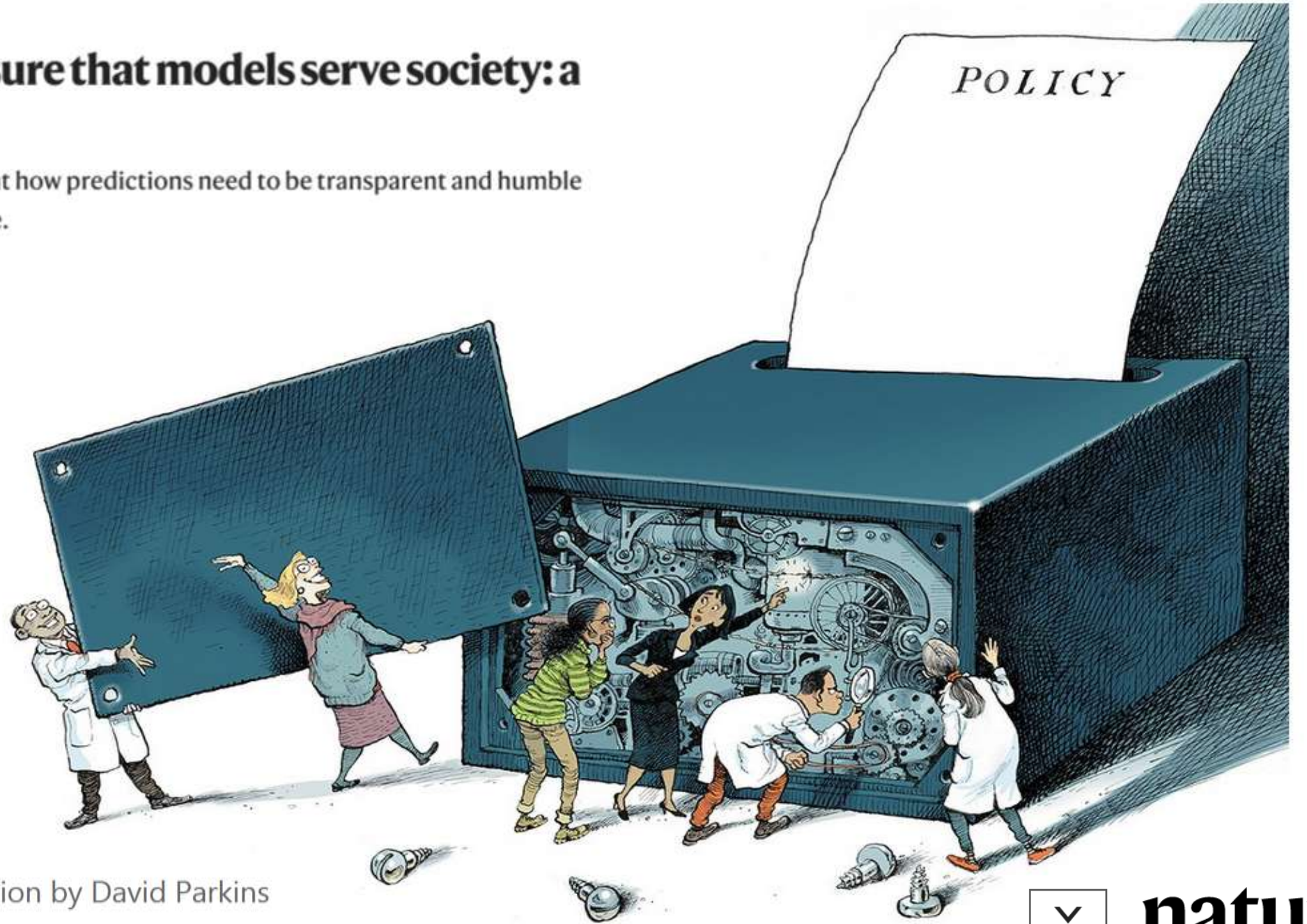
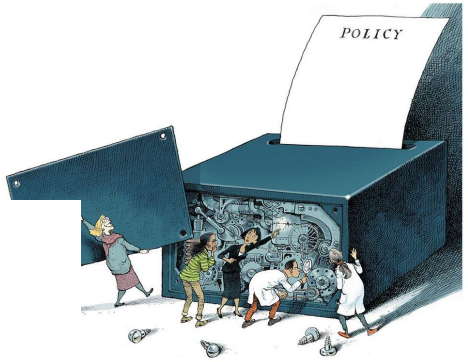


Illustration by David Parkins

nature

Power

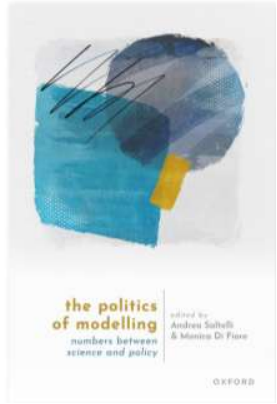


The New York Times

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.

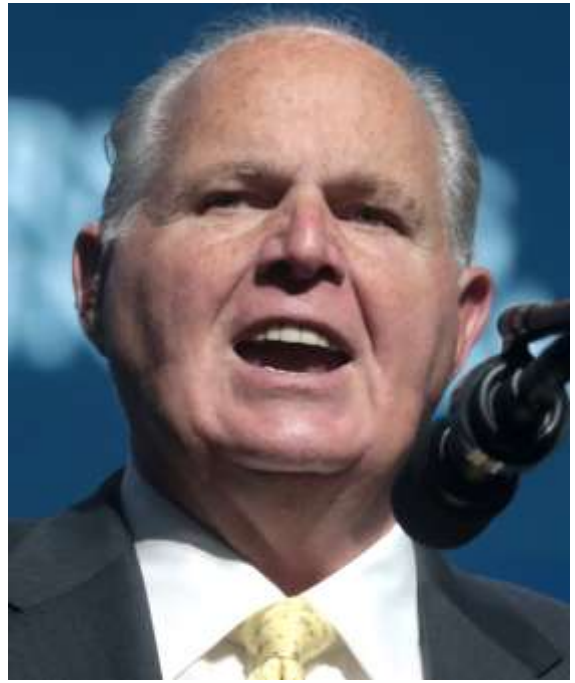
Landler, Mark, and Stephen Castle. 2020. Behind the Virus Report That Jarred the U.S. and the U.K. to Action - The New York Times.



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"



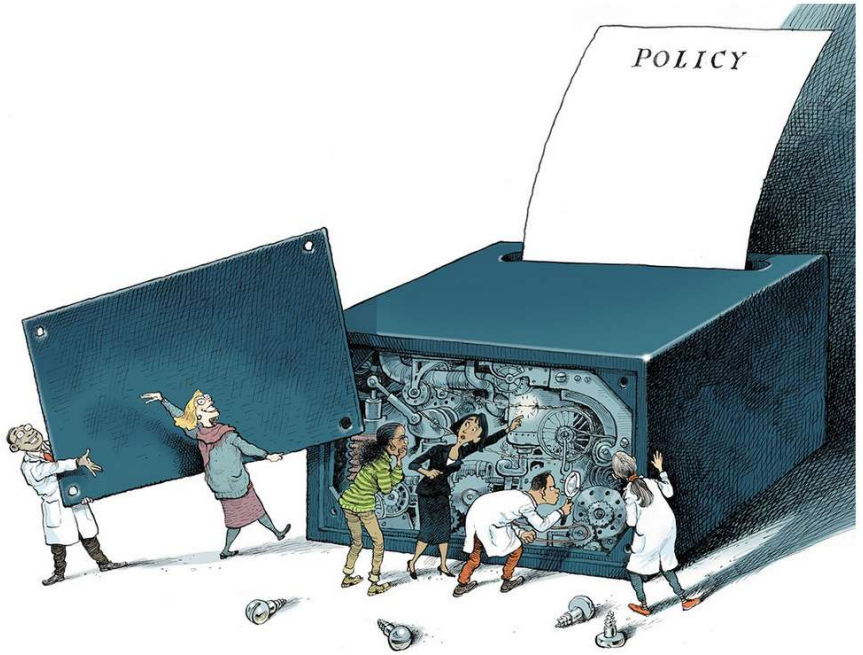
Rhodes, Tim, and Kari Lancaster. 2020. "**Mathematical Models as Public Troubles in COVID-19 Infection Control: Following the Numbers**", Health Sociology Review 1-18. doi: 10.1080/14461242.2020.1764376

Mind the assumptions

Assess uncertainty and sensitivity

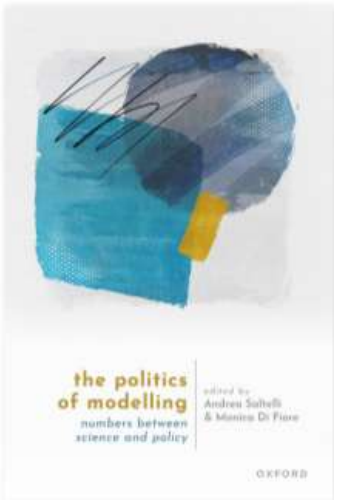
Mind the hubris

Complexity can be the enemy of relevance



Mind the framing

Match purpose and context



Mind the consequences

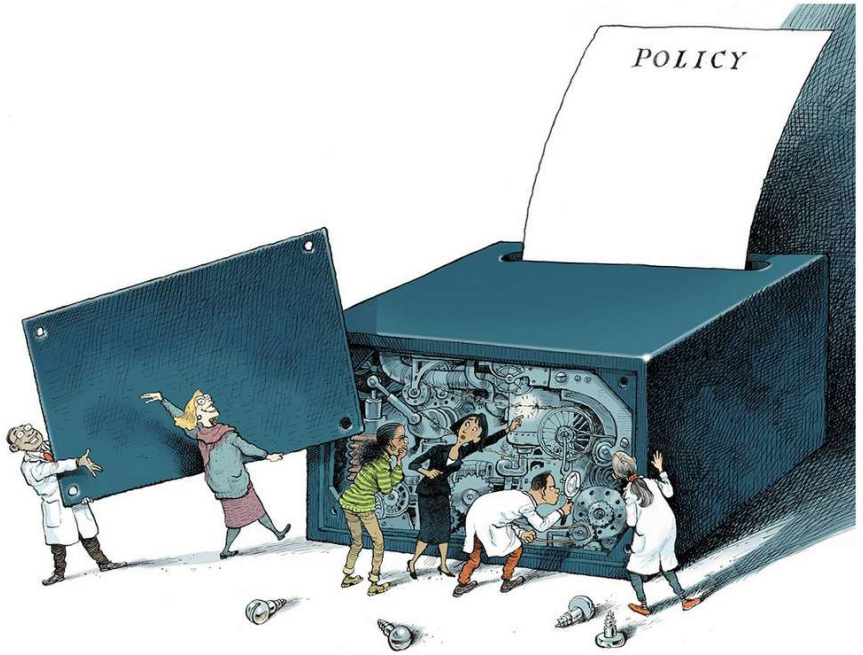
Quantification can backfire

Mind the unknowns

Acknowledge ignorance

Mind the assumptions

Assess uncertainty and sensitivity

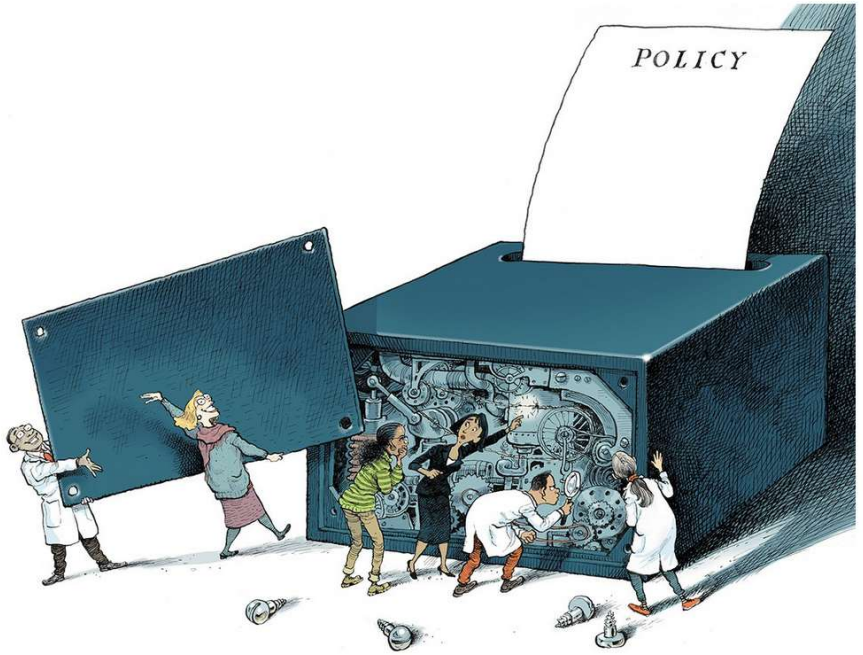


… models require input values for which there is no reliable information…

…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

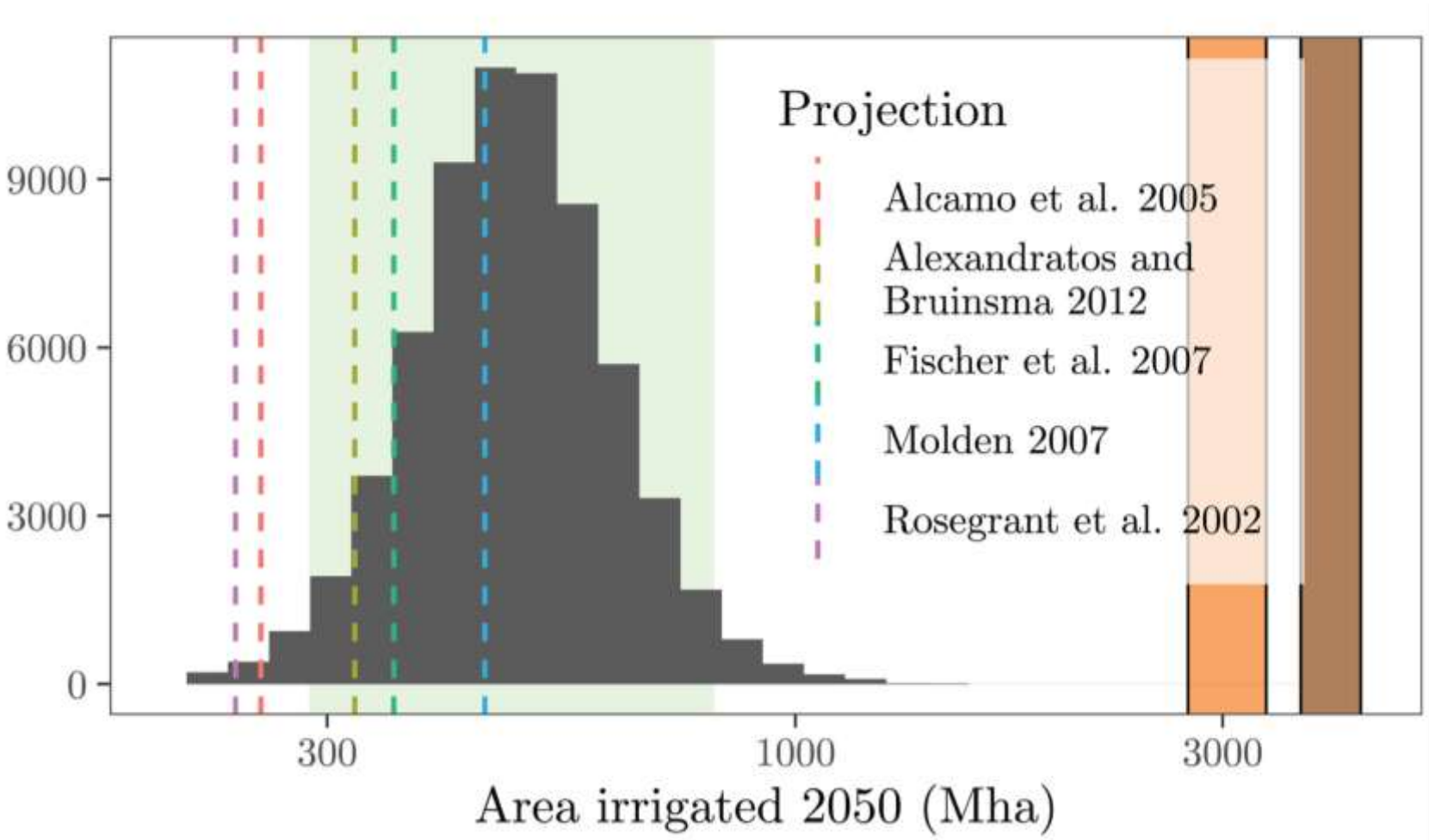


… this may lead to interesting discoveries …

Geophysical Research Letters

Current Models Underestimate Future Irrigated Areas

A. Puy ✉, S. Lo Piano, A. Saltelli First published: 17 April 2020 https://doi.org/10.1029/2020GL087360 |

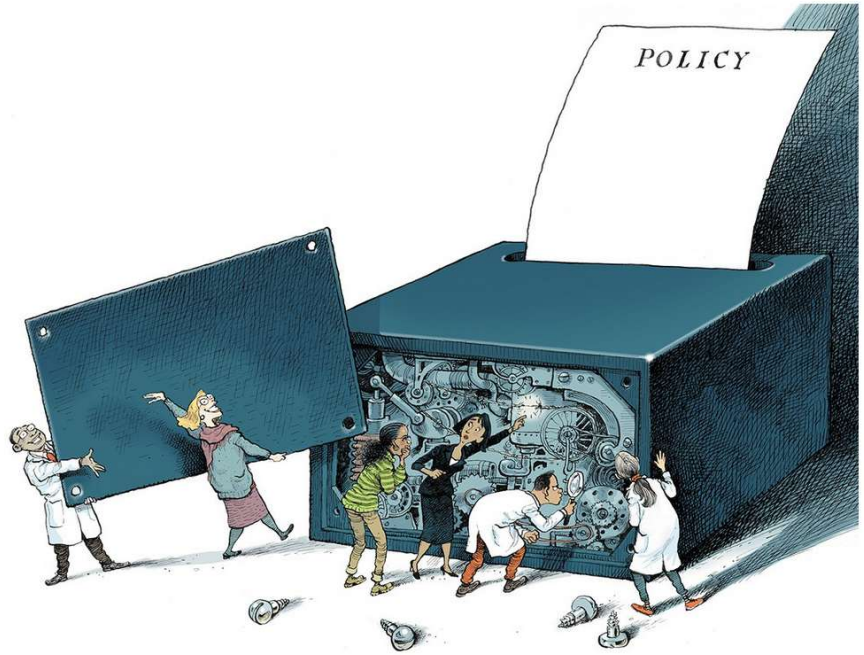


Mind the assumptions

Assess uncertainty and sensitivity

Mind the hubris

Complexity can be the enemy of relevance



Mind the framing

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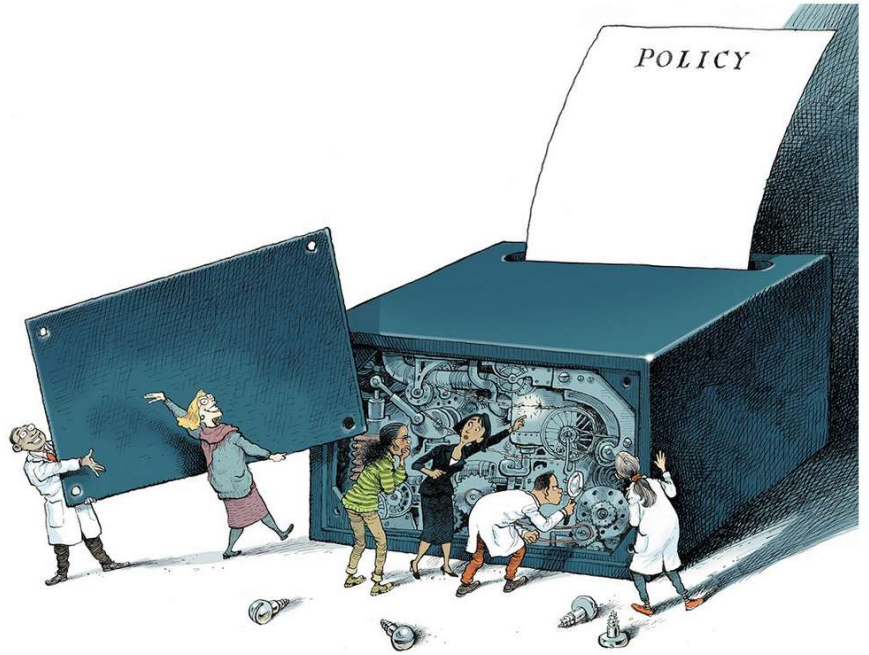
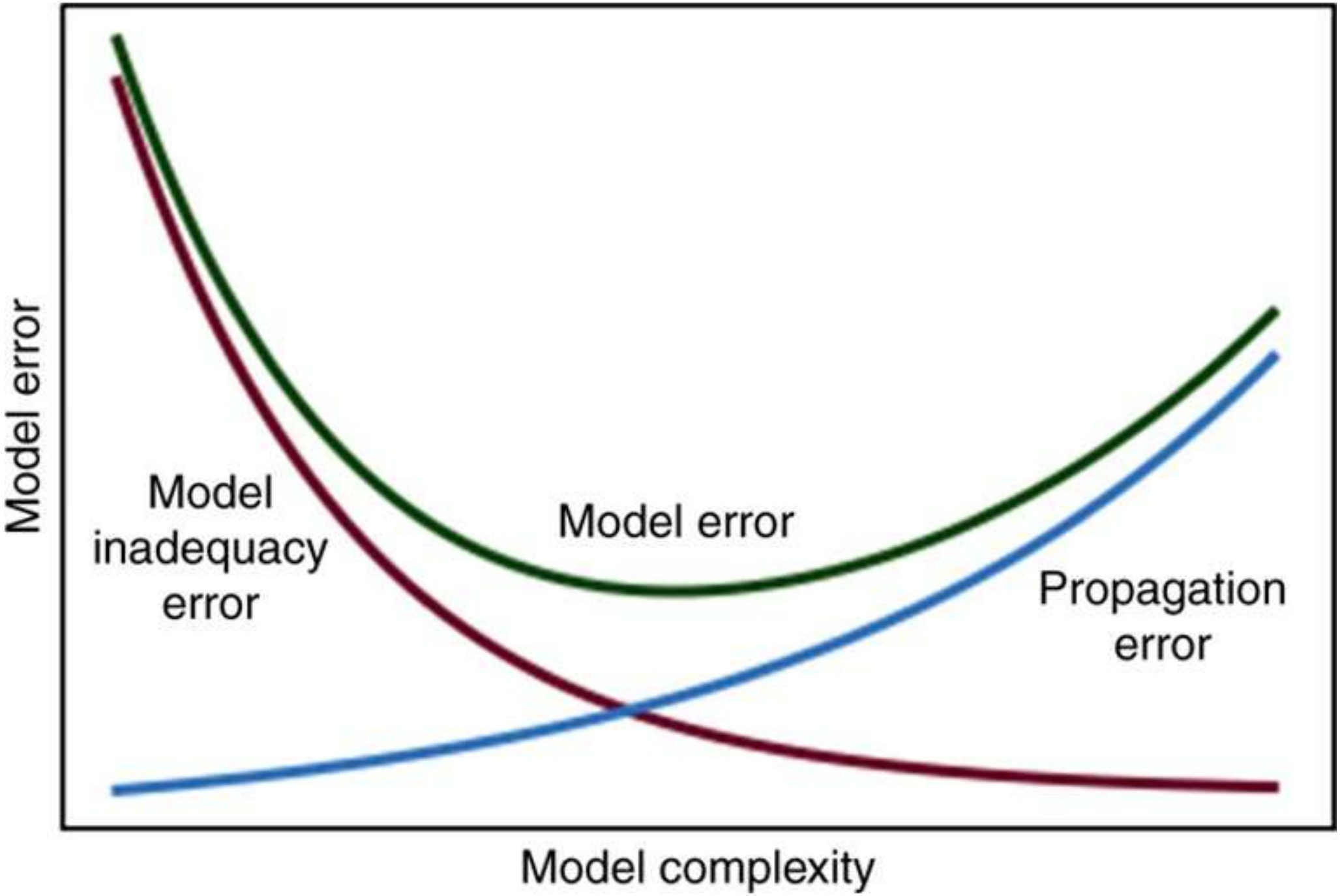
Complexity can be the enemy of relevance



… 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

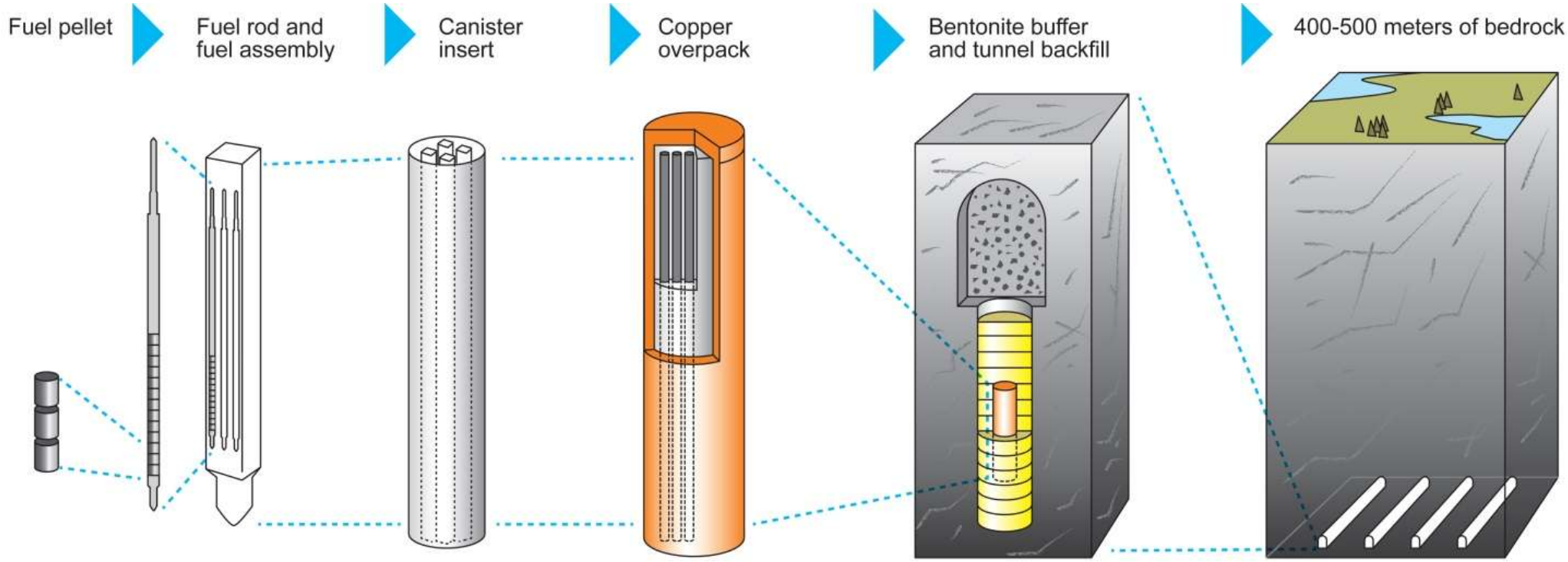

Model error
Model inadequacy error
Model error
Propagation error
Model complexity

Science Advances

RESEARCH ARTICLE | MATHEMATICS

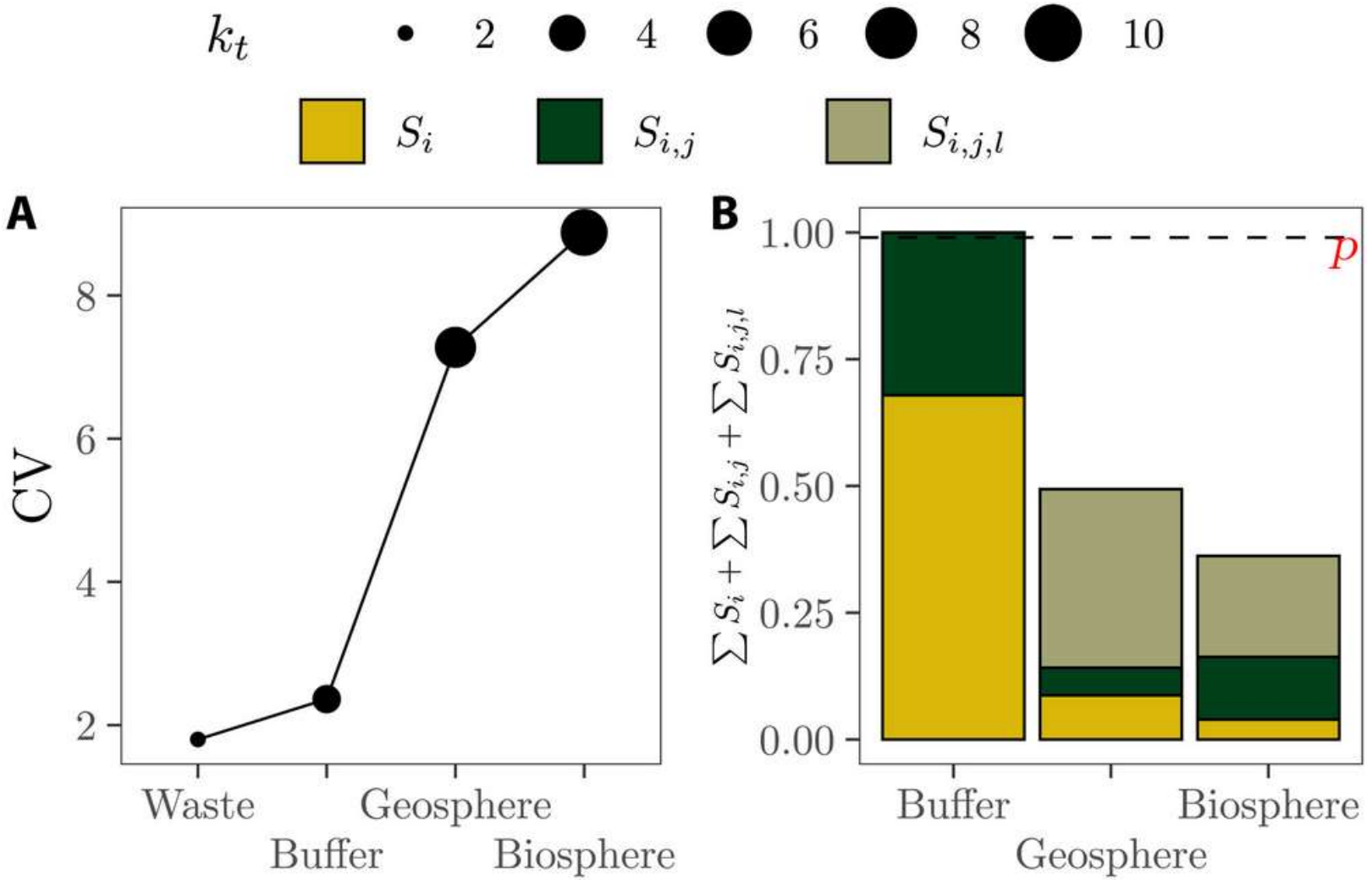
Models with higher effective dimensions tend to produce more uncertain estimates

ARNALD PUY, PIERFRANCESCO BENEVENTANO, SIMON A. LEVIN, SAMUELE LO PIANO, TOMMASO PORTALURI, AND ANDREA SALTELLI Authors Info & Affiliations

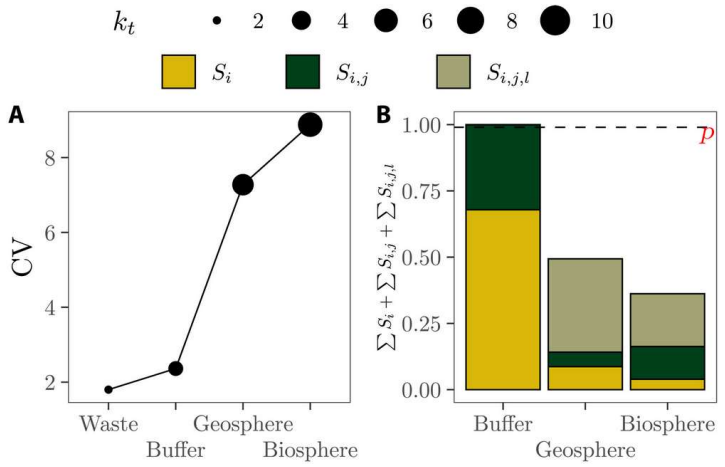


A typical nuclear waste disposal concept: the waste is separated from humans by a series of barriers

Source: World Nuclear Organization, https://world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-waste/storage-and-disposal-of-radioactive-waste.aspx



Propagating uncertainty across the barriers increases variability **(CV=std/mean)**, effective dimension **(k_t)** and the importance of interactions **(S_{ij}, S_{ijk})**



ScienceAdvances

Current Issue | First release papers | Archive | About

HOME > SCIENCE ADVANCES > VOL. 8, NO. 42 > MODELS WITH HIGHER EFFECTIVE DIMENSIONS TEND TO PRODUCE MORE UNCERTAIN ESTIMATES

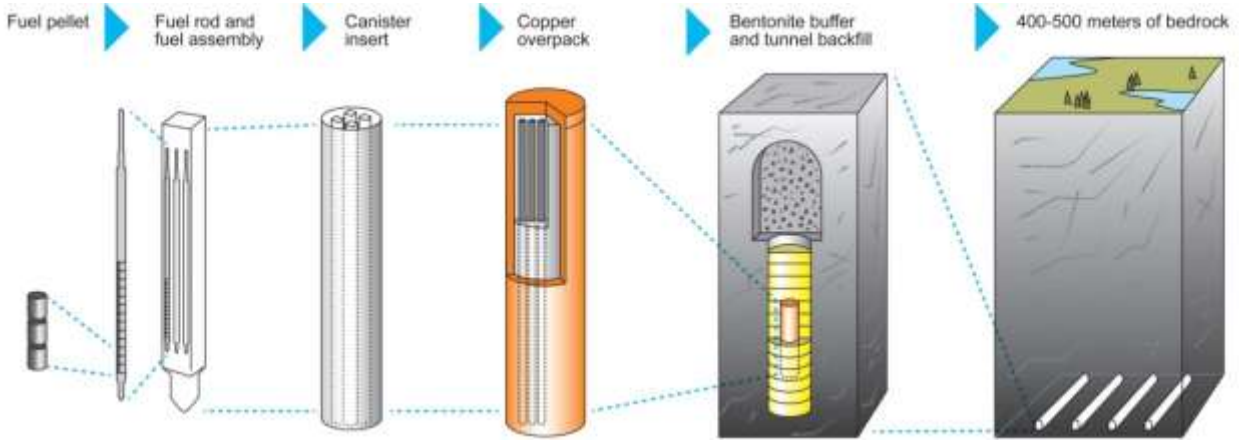
RESEARCH ARTICLE | MATHEMATICS

Models with higher effective dimensions tend to produce more uncertain estimates

ARNALD PUY, PIERFRANCESCO BENEVENTANO, SIMON A. LEVIN, SAMUELE LO PIANO, TOMMASO PORTALURI, AND ANDREA SALTELLI Authors Info & Affiliations

The regulation should not set limits on doses to humans in the biosphere, as done e.g. in the US, since these are impossible to predict with any certainty

A more realistic and defensible safety standard could be set as a maximum level of radioactivity leaving the buffer

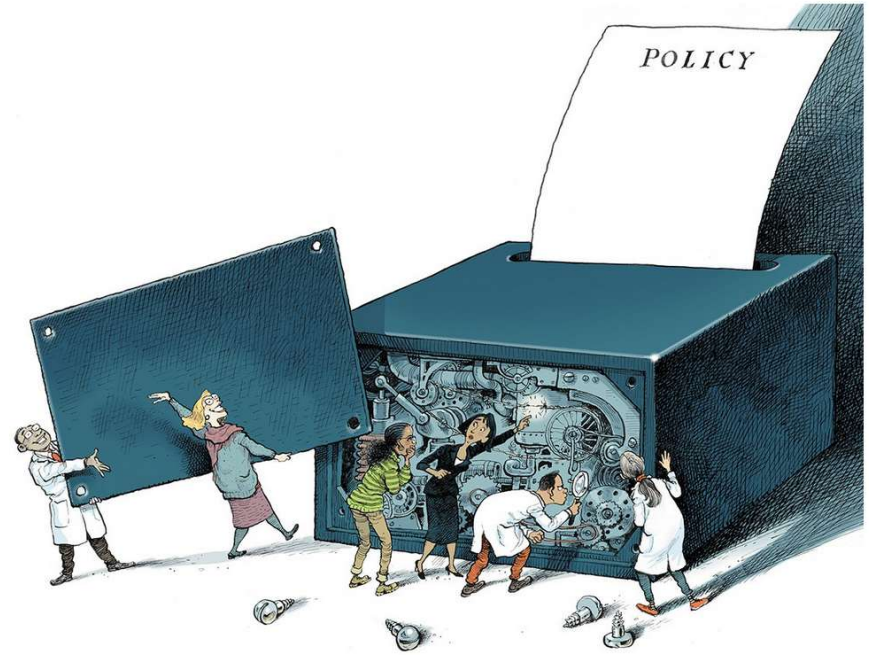


Mind the assumptions

Assess uncertainty and sensitivity

Mind the hubris

Complexity can be the enemy of relevance



Mind the framing

Match purpose and context

Mind the consequences

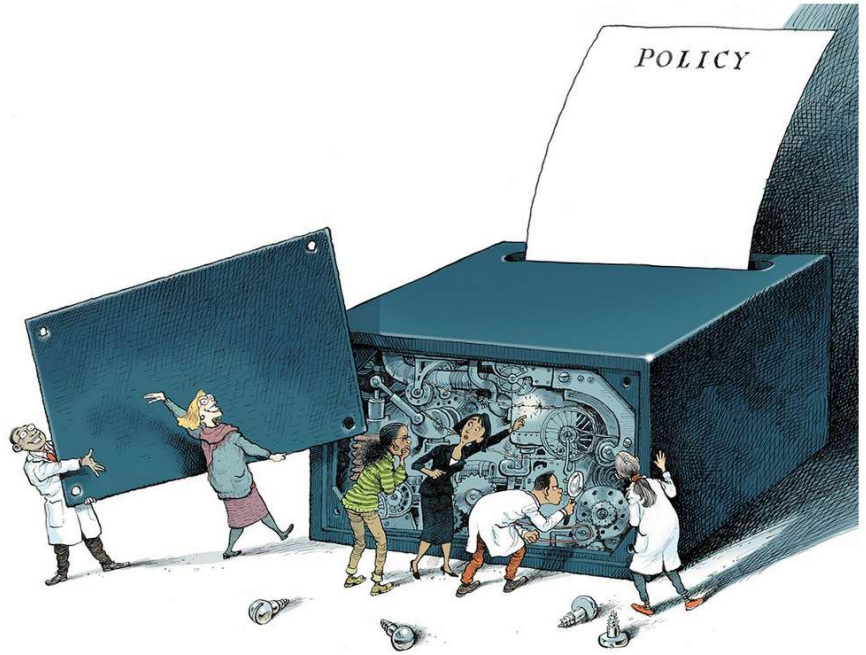
Quantification can backfire

Mind the unknowns

Acknowledge ignorance

Mind the framing

Match purpose and context



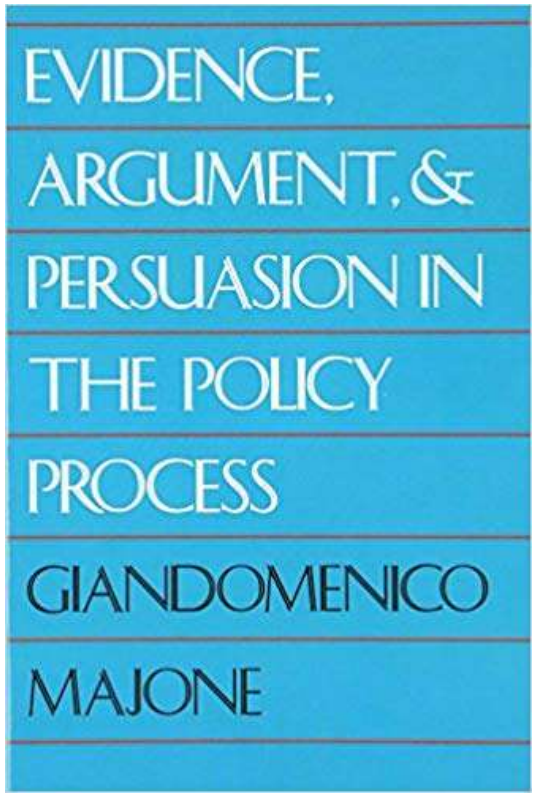
… models will reflect the interests, disciplinary orientations and biases of the developers…

SUPPLEMENTARY INFORMATION

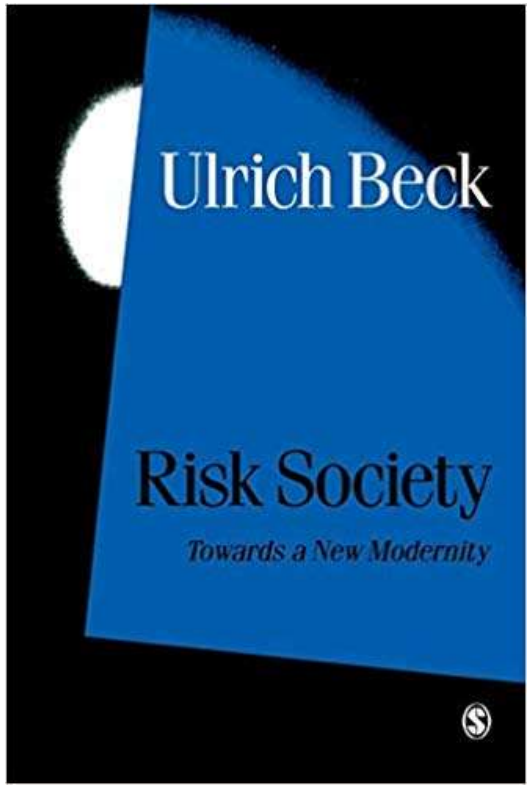
1. Additional information and references >260 references

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

Ulrich Beck
(1944 –2015)



1989



1992 (1986)

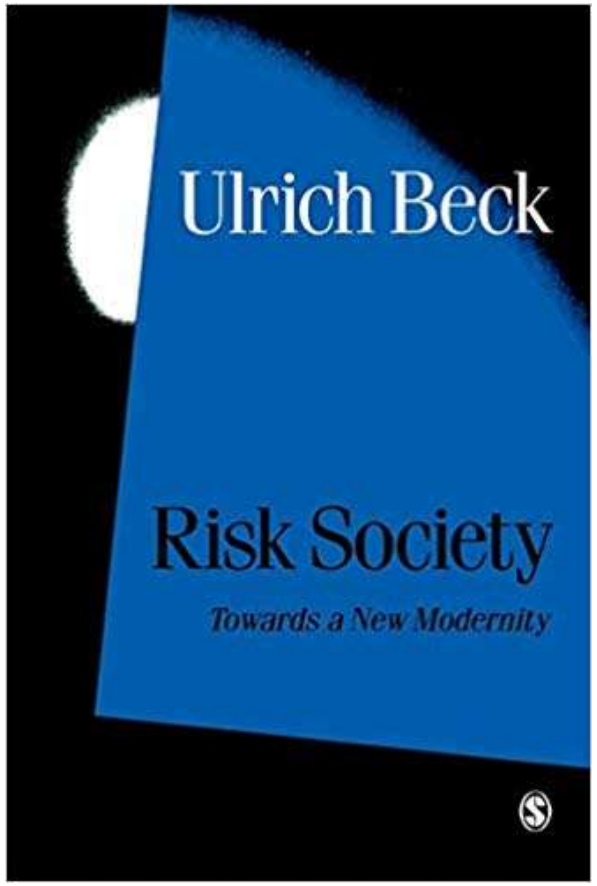
ELSEVIER

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)

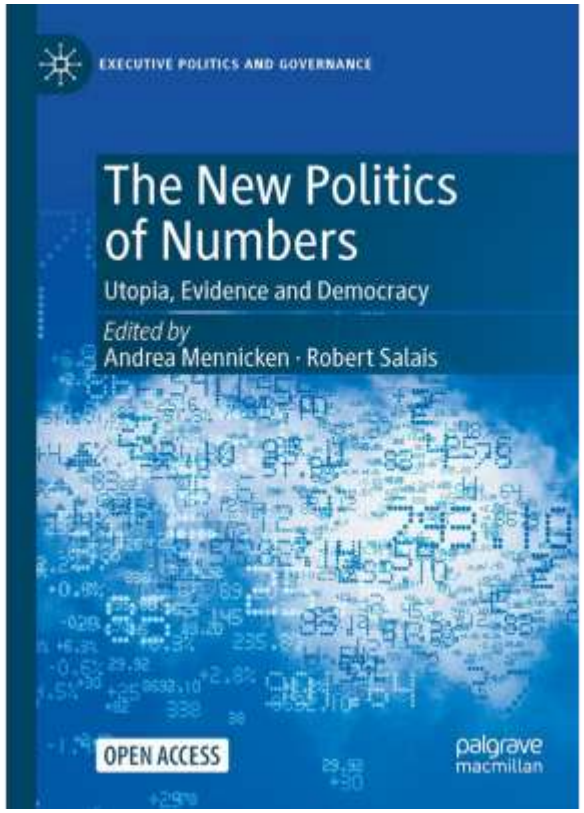
Ulrich Beck
(1944 –2015)

Since the technique is never neutral a technical proof of quality is illusory without a parallel investigation of normative quality

Technical Quality

Normative quality

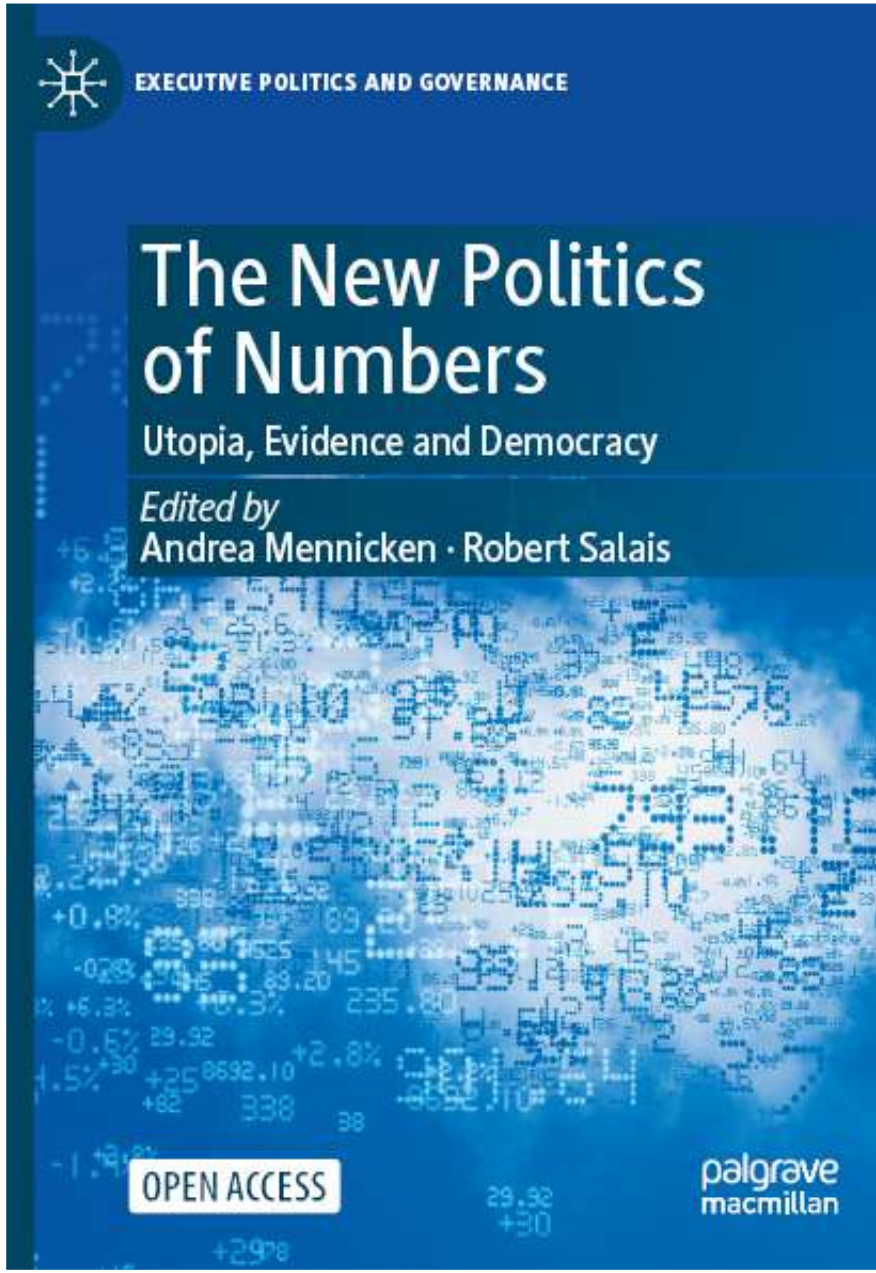
How the numbers of neoliberalism (New Public Management) constitute a regime of a-democracy; the example of indicators of employment

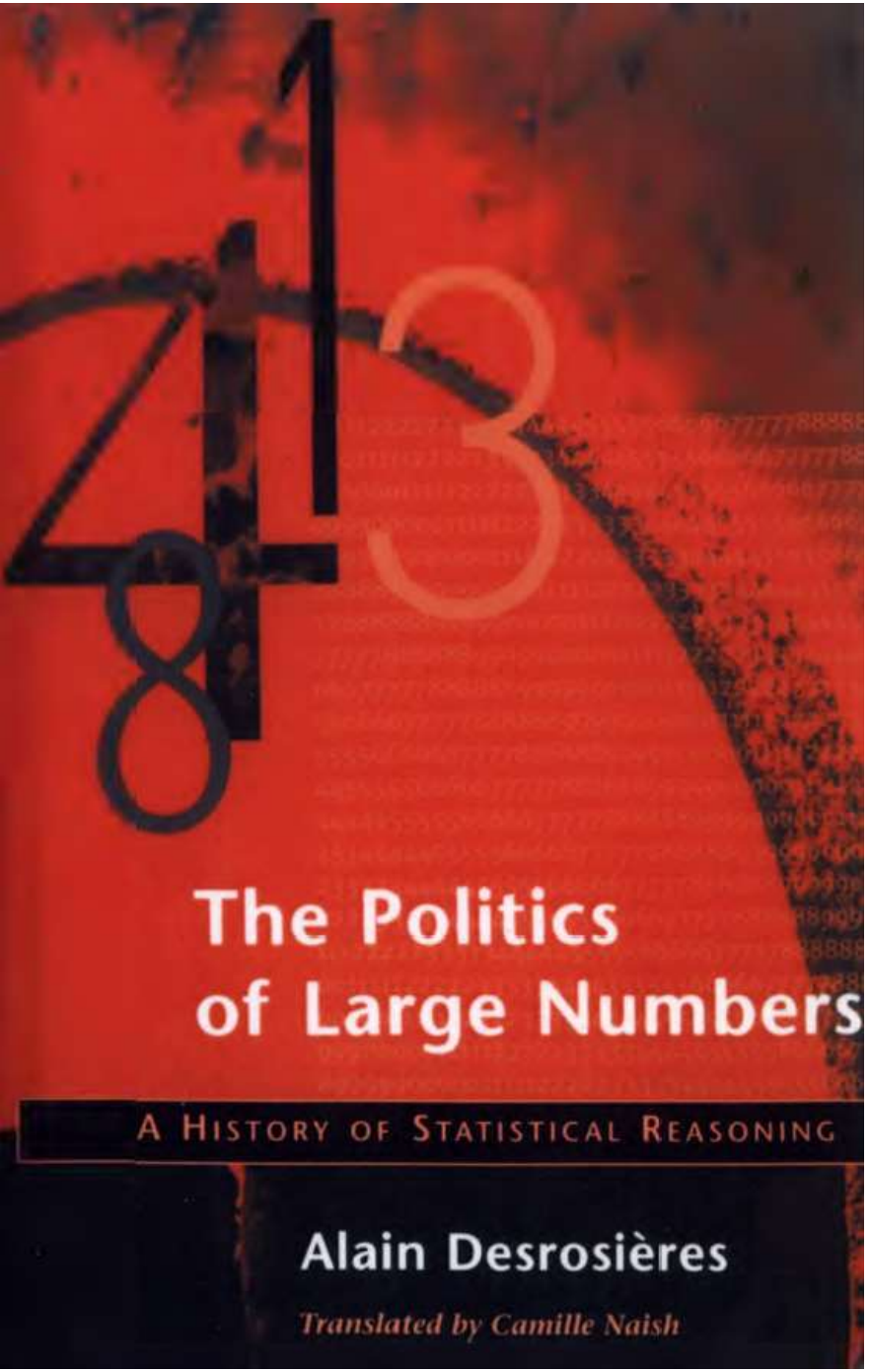


Salais, R. (2022). "La donnée n'est pas un donné": Statistics, Quantification and Democratic Choice. In *The New Politics of Numbers: Utopia, Evidence and Democracy*, Andrea Mennicken and Robert Salais, Palgrave Macmillan, pp. 379–415.

Evidence based policy	Statistics (creating things that hold together for the solution of practical problems)
Policy based evidence	Governance driven quantification (a reversal of the statistical pyramid)

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





Alain Desrosières: “Making things that hold”

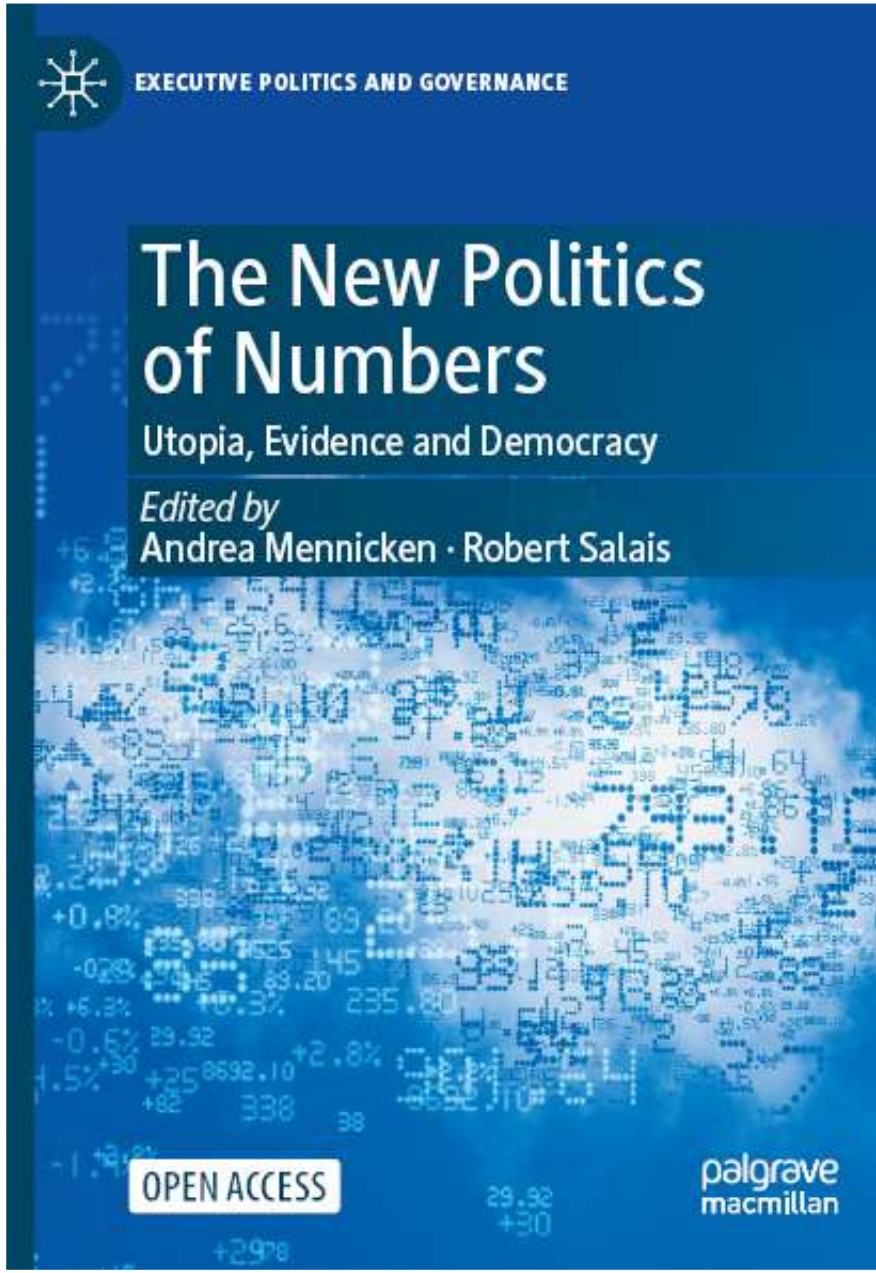
The construction of statistical concepts and categories that can serve for action

BUT

“It is because the moment of objectification can be made autonomous that the moment of action can be based on firmly established objects”

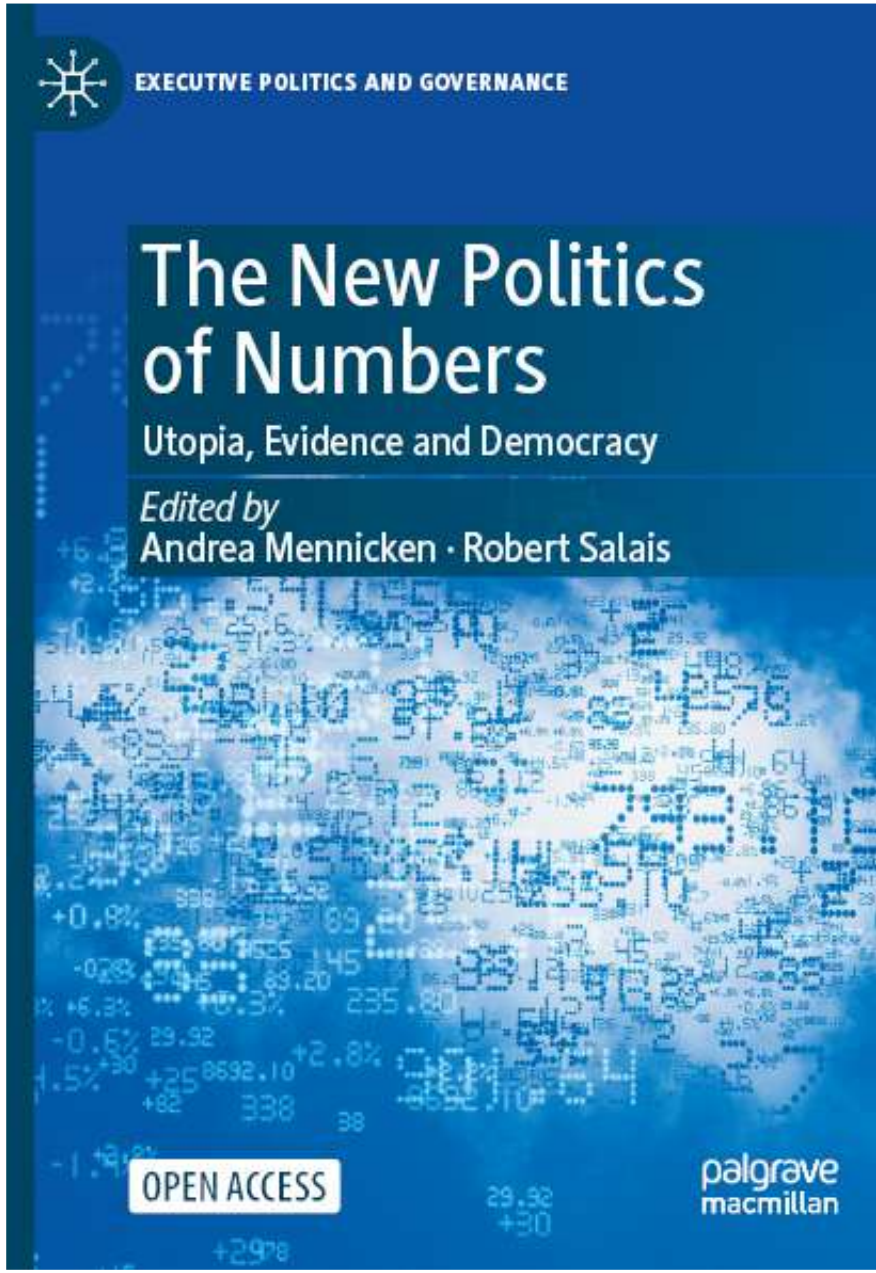
Governance driven quantification is based on pretended objectivity (neutrality), reductionism and justificationism that contribute to a loss of democratic agency (a-democracy)

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

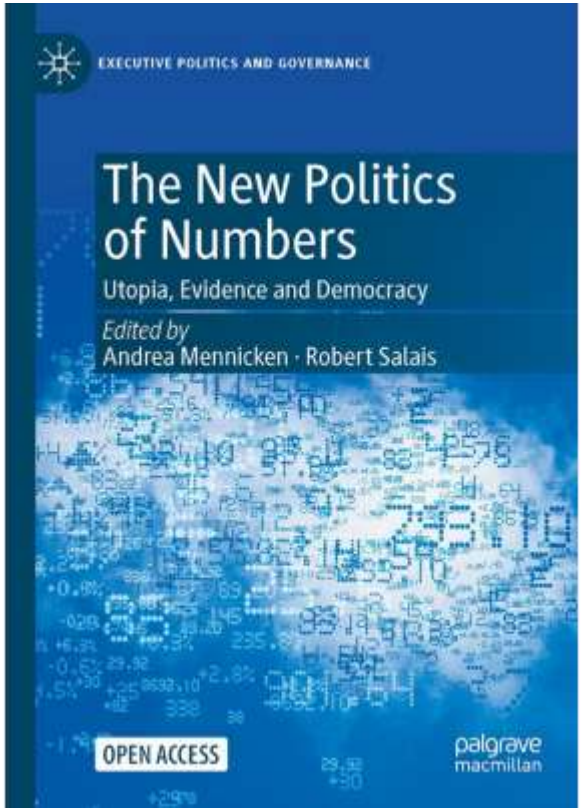


Contesting unjust/unfair governance arrangement is impossible without producing alternative constructions of evidence – that requires muscles not easily available to the lay citizen

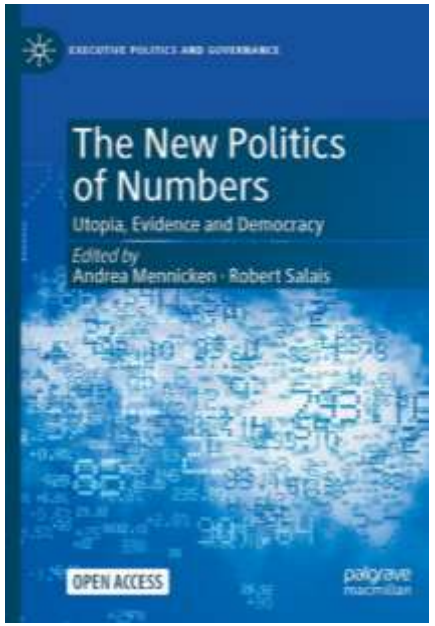
CHAPTER 12, “La donnée n’est pas un donné”: Statistics, Quantification and Democratic Choice, *Robert Salais*

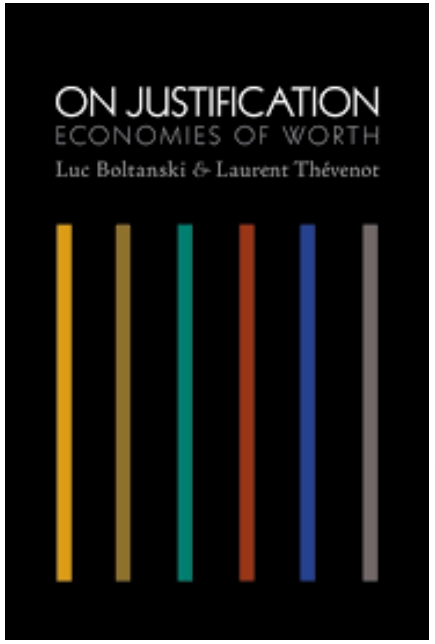


Normative quality … yes but which norms?



Thévenot, L. (2022). A New Calculable Global World in the Making: Governing Through Transnational Certification Standards. In *The new politics of numbers*, Andrea Mennicken and Robert Salais, Palgrave Macmillan, pp. 197–252.





A New Calculable Global World in the Making: Governing Through Transnational Certification Standards

Laurent Thévenot

critical public debates between conceptions of the **common good**

- collective solidarity social justice
- *Civic* worth
- environmental concern
- *Green* worth
- tradition
- *Domestic* worth

individual consumers' choices between certified **market goods**

market coordination [*market* worth] through certified products & services

- 'Fair-trade'
- 'Organic'
- 'Protected Geographic Indication' (PGI)

Mind the assumptions

Assess uncertainty and sensitivity

Mind the hubris

Complexity can be the enemy of relevance

Mind the framing

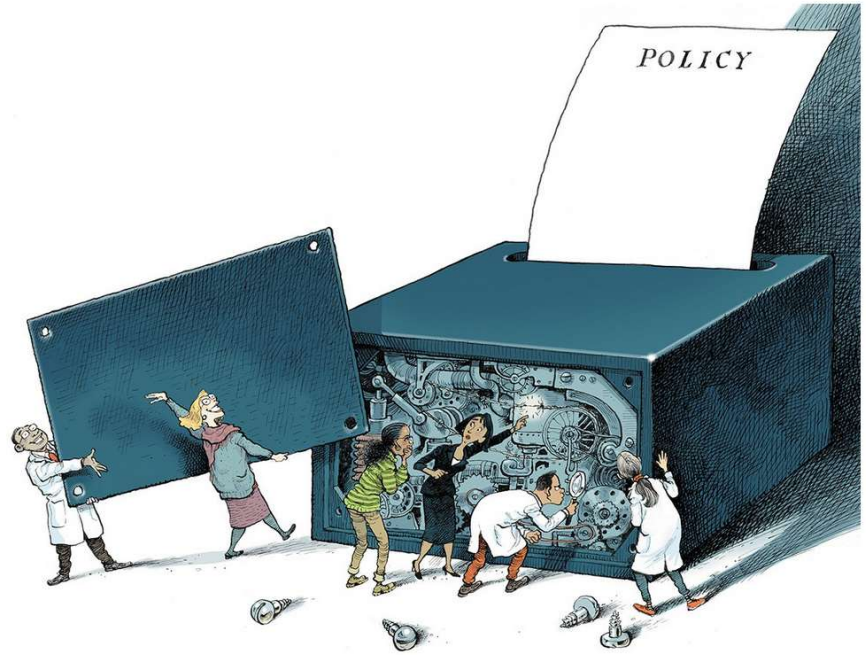
Match purpose and context

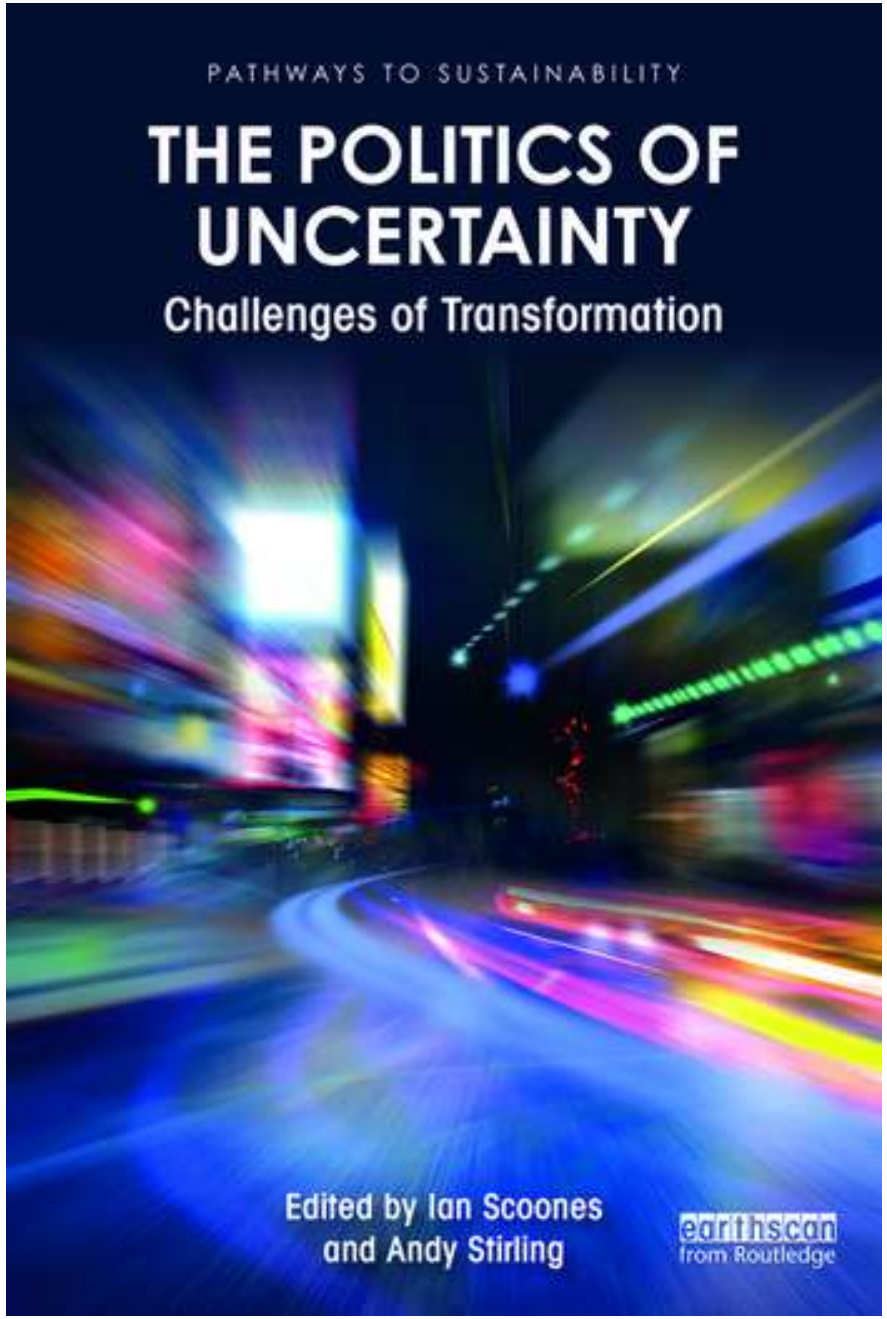
Mind the consequences

Quantification can backfire

Mind the unknowns

Acknowledge ignorance





3

SHARING RISKS OR PROLIFERATING UNCERTAINTIES?

Insurance, disaster and development

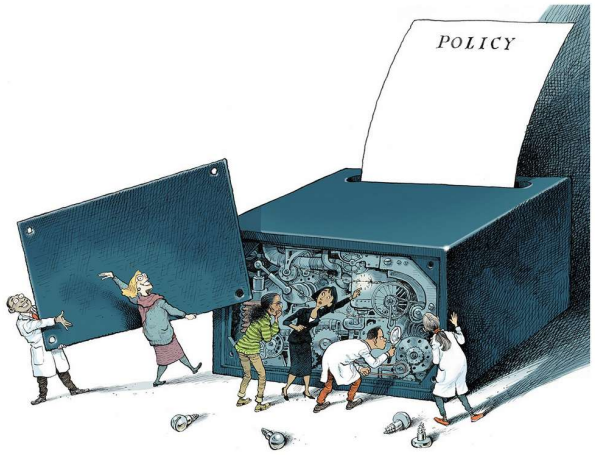
Leigh Johnson

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

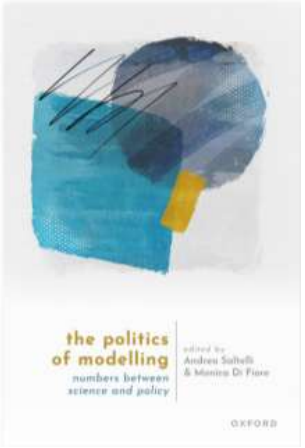
A recipe: ‘falsification’ of the available options based on:

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



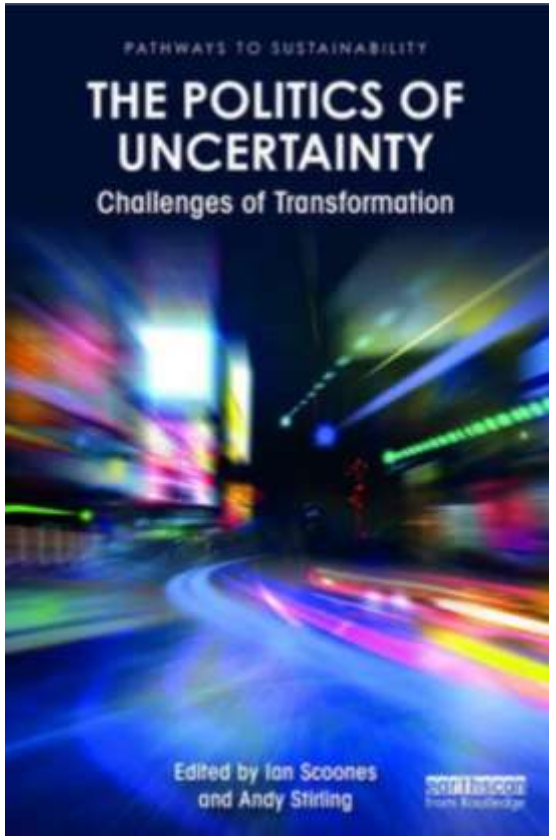
2020

2023

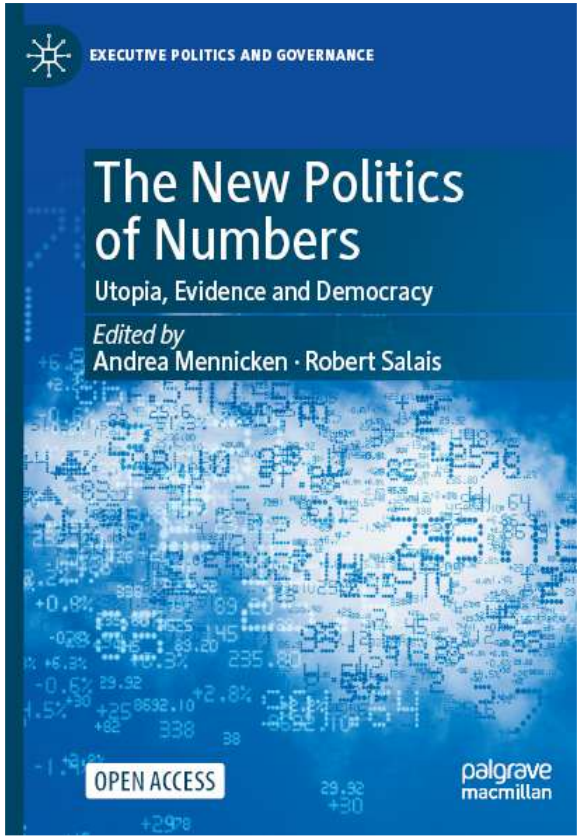


➔ Reciprocal domestication between models and society

2024



2020



2022

2023

Goal: Reveal the policy of (mathematical modelling's) numbers

Article | Open Access | Published: 06 May 2023

What can mathematical modelling contribute to a sociology of quantification?

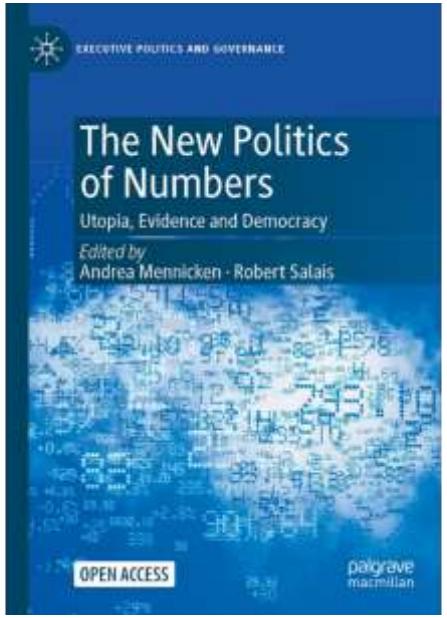
Andrea Saltelli & Arnald Puy

Humanities and Social Sciences Communications **10**, Article number: 213 (2023) | Cite this article

448 Accesses | **4** Altmetric | Metrics

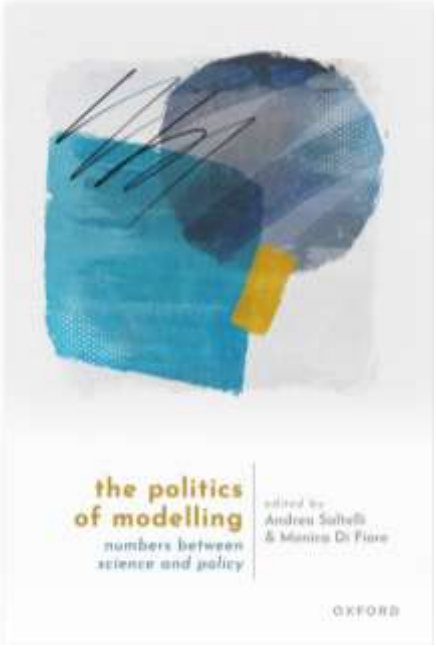
Technical Quality

Normative quality



Sensitivity analysis

Sensitivity auditing

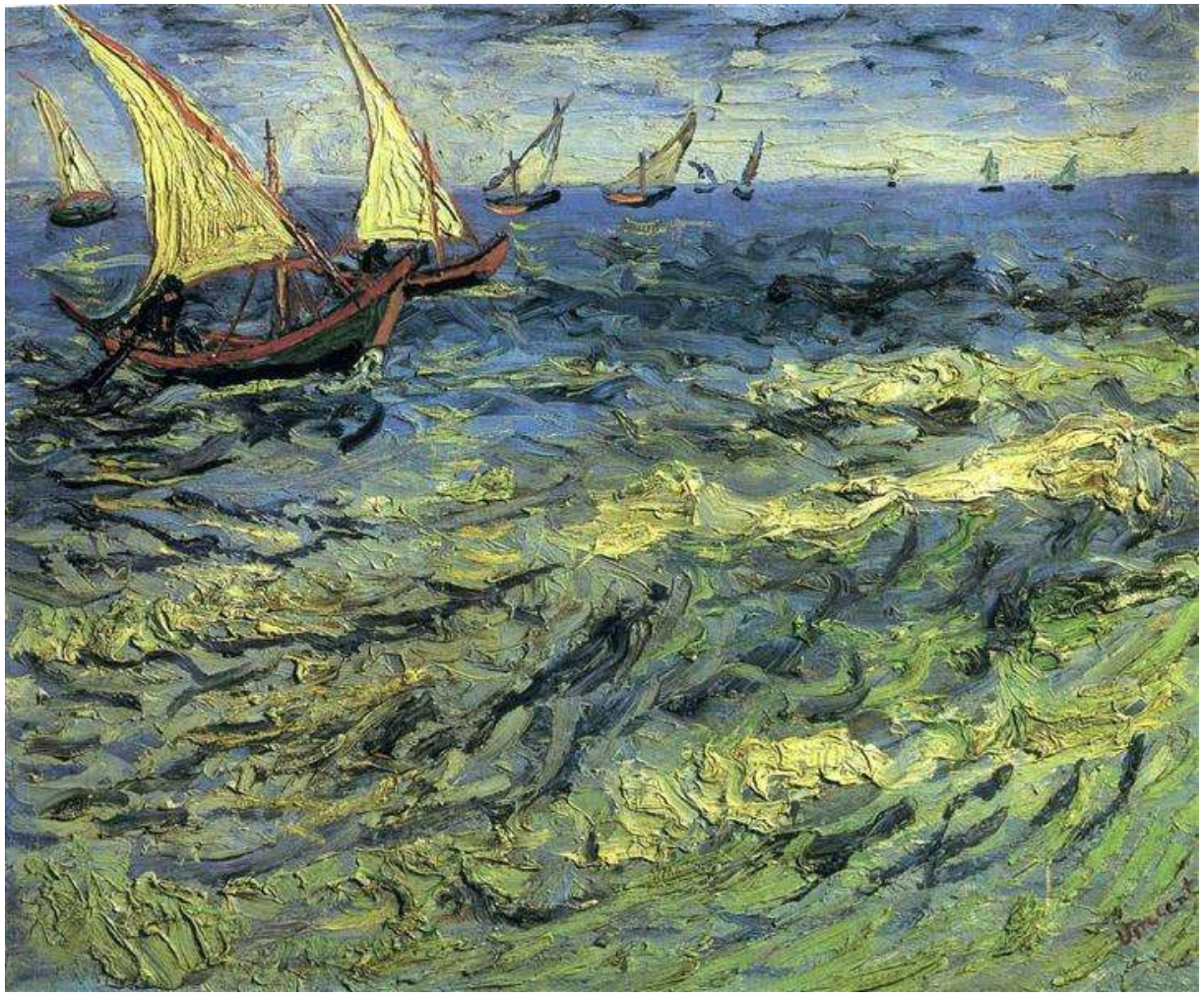


Uncertainty analysis: the study of the uncertainty in model output—see also uncertainty cascade

Sensitivity analysis: the study of the relative importance of different input factors on the model output

Sensitivity auditing : “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” (European Commission, 2021).

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

Many multi-analyst studies ongoing, e.g.:

"Are soccer players with dark skin tone more likely to receive red cards from referees?", Silberzahn et al. 2018

"Is there an impact of compulsory schooling on teenage pregnancy rates?", Huntington-Klein et al. (2021)

Source: BBC https://www.bbc.com/sport/football/68435064

"There are at least twenty multi-analyst experiments brewing"

… some large! 343 authors of Menkveld et al. (2024)"

HUNTINGTON-KLEIN, N., ARENAS, A., BEAM, E., BERTONI, M., BLOEM, J. R., BURLI, P., CHEN, N., GRIECO, P., EKPE, G., PUGATCH, T. et al. (2021). The influence of hidden researcher decisions in applied microeconomics. Economic Inquiry 59 944–960.
MENKVELD, A. J., (2024). Nonstandard Errors. The Journal of Finance 79 2339–2390. https://doi.org/10.1111/jofi.13337.
SILBERZAHN, R., UHLMANN, E. L., MARTIN, D. P., ANSELMI, P., AUST, F., AWTREY, E., BAHNÍK, Š., BAI, F., BANNARD, C., BONNIER, E. et al. (2018). Many analysts, one data set: Making transparent how variations in analytic choices affect results. Advances in Methods and Practices in Psychological Science 1, 337–356.

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‡

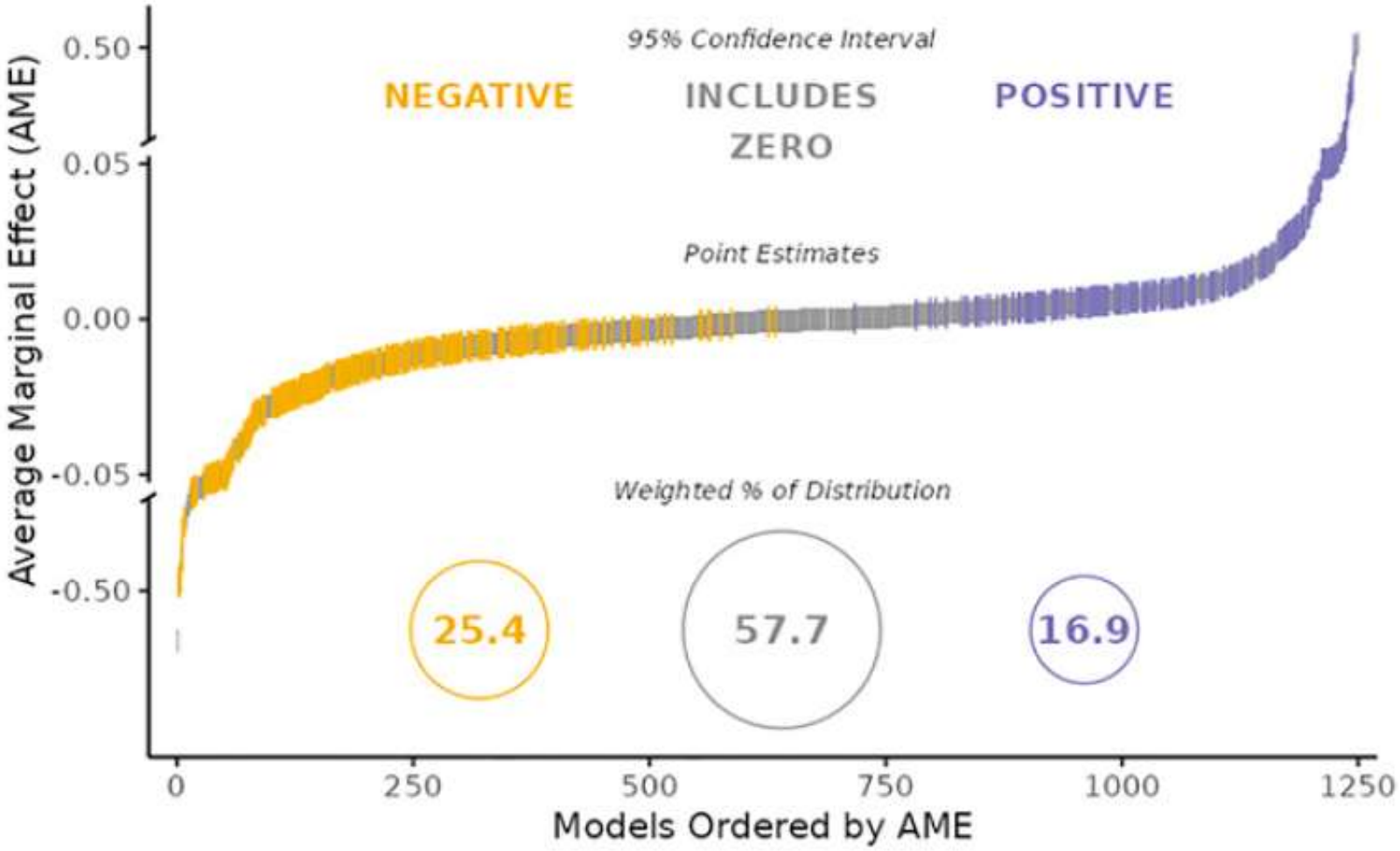
14 Nov 2013

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"
(Massey et al. 2022)

In the original multi-analyst study the normative (political) orientation of the analysts was found **not** to explain the variance

The modelling variables were found to explain at most a few percent of the variance of the results … **where does the variance come from?**

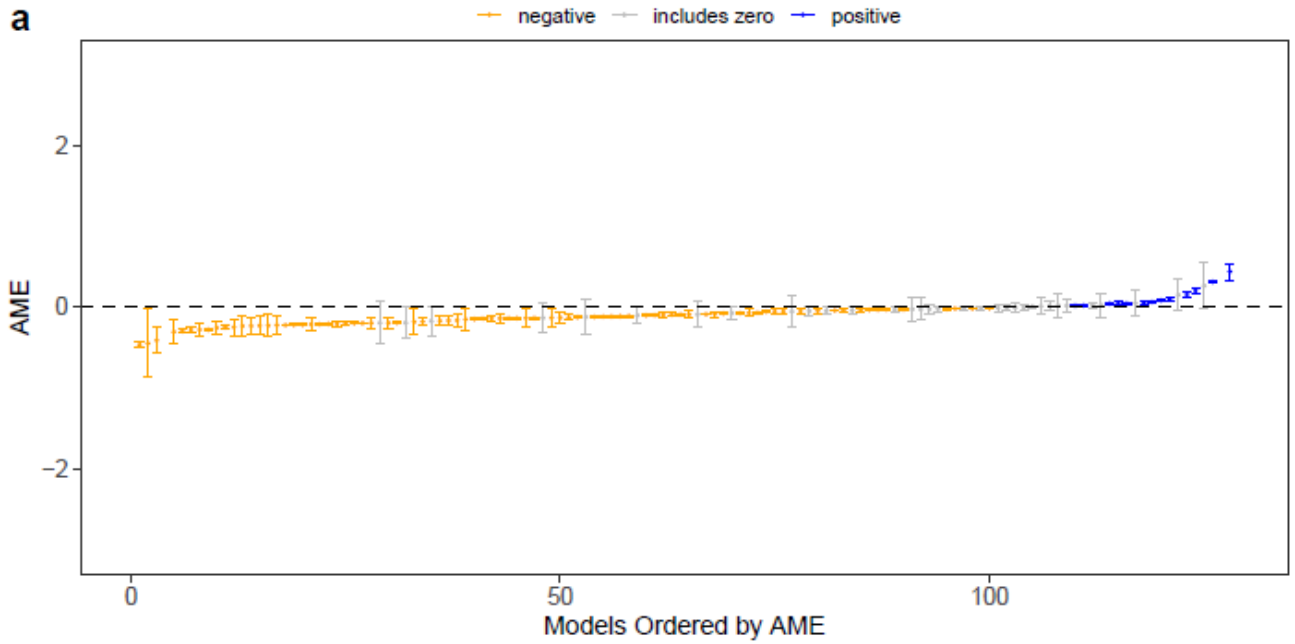
https://www.istockphoto.com/

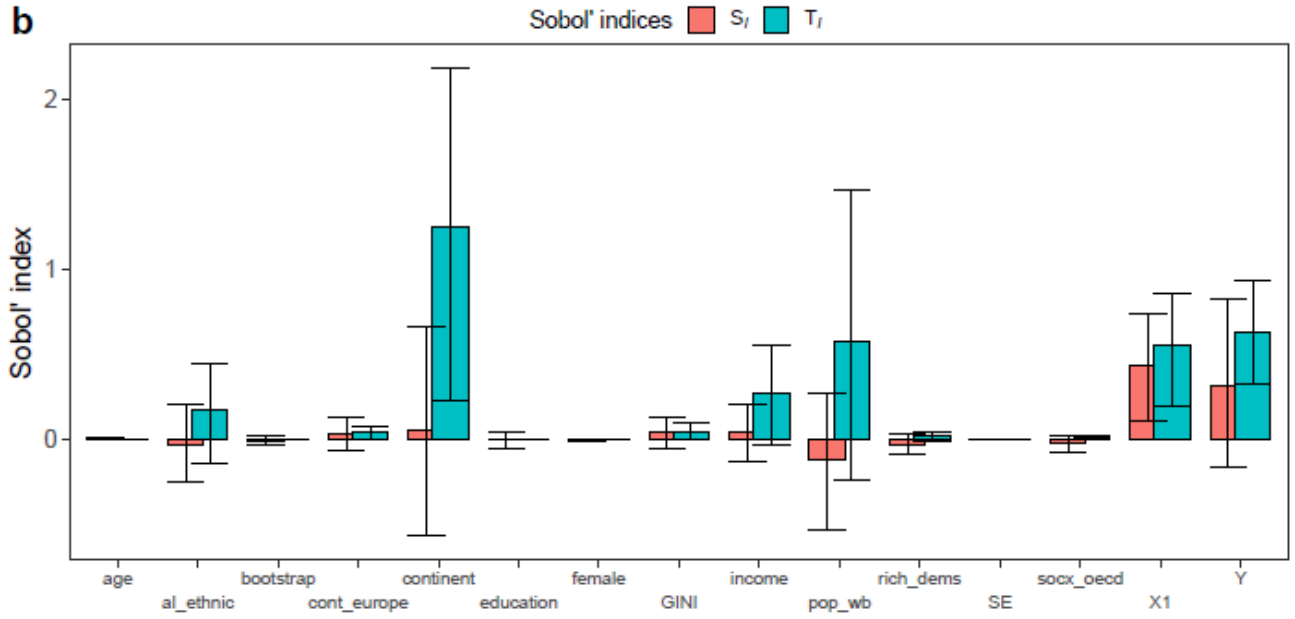
k_i	Variable	Description
1	age	Inclusion or non-inclusion of the covariates age and square age of participants
2	$all - ethnic$	Inclusion or non-inclusion of a covariate that takes into account all ethnic categories
3	$bootstrap$	Inclusion or non-inclusion of the bootstrap procedure
4	$cont - europe$	Inclusion or non-inclusion of continental Europe countries in the analysis
5	$continent$	Inclusion or non-inclusion of different continents in the analysis
6	$education$	Inclusion or non-inclusion of the covariates level of education
7	$female$	Inclusion or non-inclusion of the covariates gender as self-reported by respondents in the survey
8	$GINI$	Inclusion or non-inclusion of the covariates related to the Gini indexes
9	$income$	Inclusion or non-inclusion of the covariate related to the income
10	$pop - wb$	Inclusion or non-inclusion of the covariate related to the information about country-specific numerosity of population
11	$rich - dems$	Inclusion or non-inclusion of rich democracies in the analysis
12	SE	Inclusion or non-inclusion of clustered standard error
13	$socx - oecd$	Inclusion or non-inclusion of the covariate related to social expenditure
14	$X1$	Inclusion or non-inclusion of the covariates related to the migration indexes
15	Y	Choice of policy dependent variable

Table 1. Descriptions of variables included in the analysis.

We simulate different paths using triggers then we do a global sensitivity analysis

https://www.istockphoto.com/





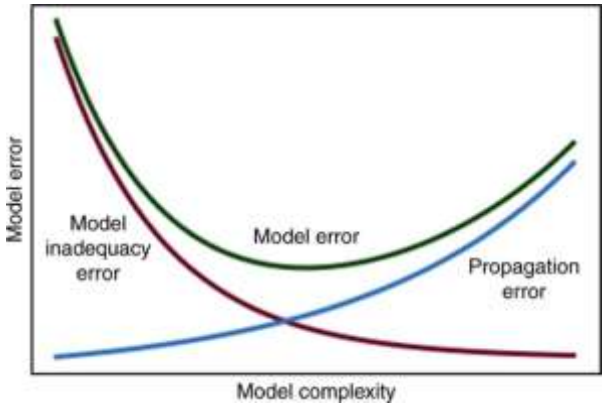
Uncertainty analysis reproduces the results of the multi-analyst experiment

Our sensitivity analysis explains where the missing variance went: **interactions**

Sensitivity analysis and auditing can assist sociology of quantification in activities of de- and re-construction (e.g. for statactivists)

Modelling of the modelling process, to

➔ retrace what was assumed
➔ check the level of complexity
…



…

➔check simultaneously technical and normative quality

Example use SA to ascertain that an algorithm does not make implicit use of protected attributes

PROTECTED ATTRIBUTES:
- Age
- Disability
- National Origin
- Race/color
- Religion
- Sex
- (From the US Equal Opportunity Employment Commission)

Solutions:

➔Avoid “quantifying at all costs” AND expose ‘funny numbers’

Culture Unbound
Journal of Current Cultural Research

Funny Numbers

By Theodore M. Porter

… beyond funny

WIREs CLIMATE CHANGE

RMetS

Royal Geographical Society

Perspective | Open Access

Bring digital twins back to Earth

Andrea Saltelli, Gerd Gigerenzer, Mike Hulme, Konstantinos V. Katsikopoulos, Lieke A. Melsen, Glen P. Peters, Roger Pielke Jr, Simon Robertson … See all authors

First published: 26 August 2024 | https://doi.org/10.1002/wcc.915

Edited by Matthias Heymann, Domain Editor and Maria Carmen Lemos, Editor-in-Chief

Scientists have built a 'digital twin' of Earth to predict the future of climate change

By Rosie Frost & Angela Symons

Published on 11/06/2024 - 16:00 GMT+2 • Updated 16:00

Share this article | Comments

The complex computer model takes into account weather and climate systems as well as our impact on the planet.

DestinE is true game changer in our fight against climate change.

- Margrethe Vestager -

"The launch of the initial Destination Earth (DestinE) is a true game changer in our fight against climate change," says Margrethe Vestager, Executive Vice-President for a Europe Fit for the Digital Age. "It means that we can observe environmental challenges which can help us predict future scenarios - like we have never done before... Today, the future is literally at our fingertips."

Margrethe Vestager

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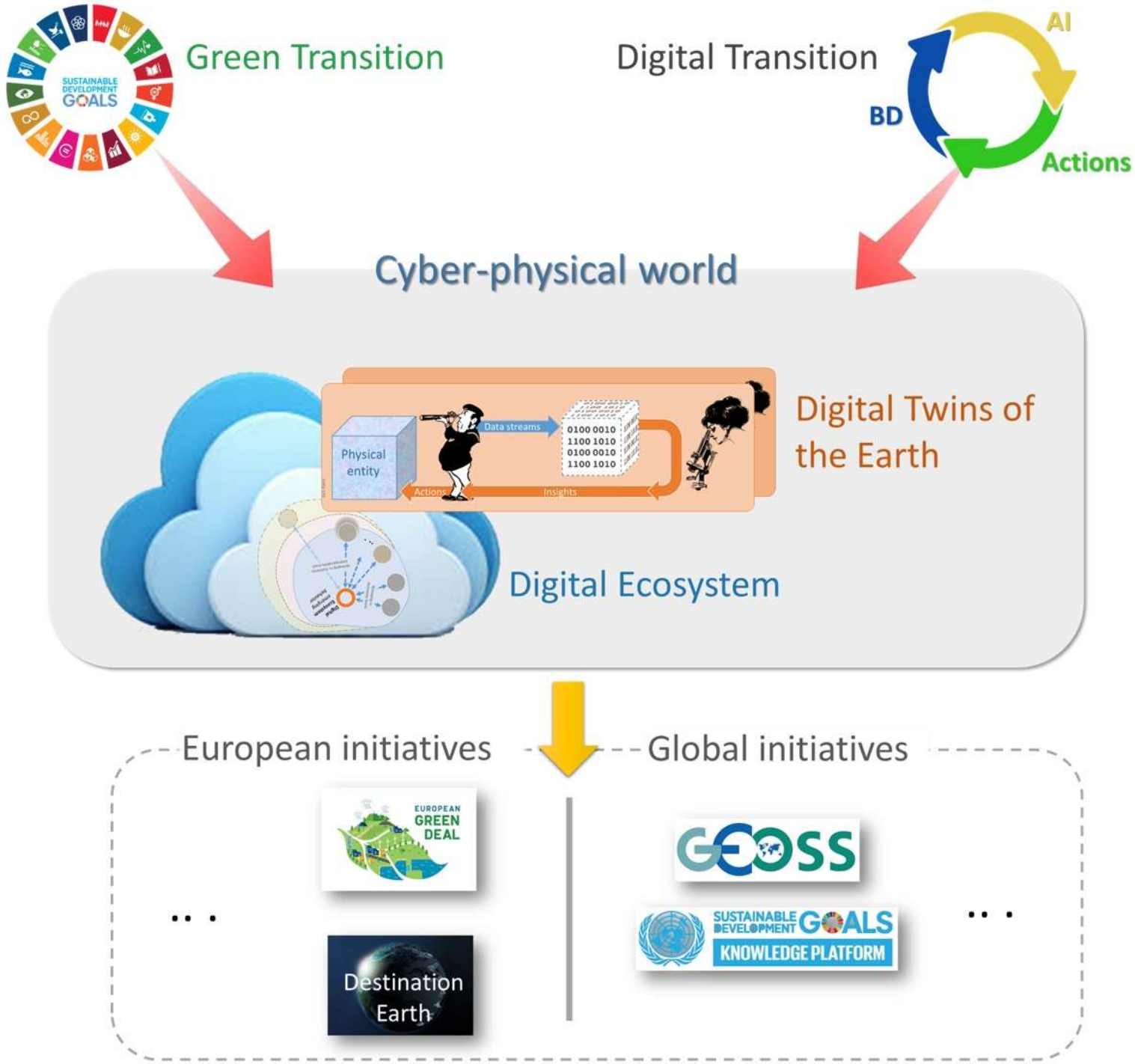
TURN DOWN. SWITCH OFF. RECYCLE. WALK. CHANGE

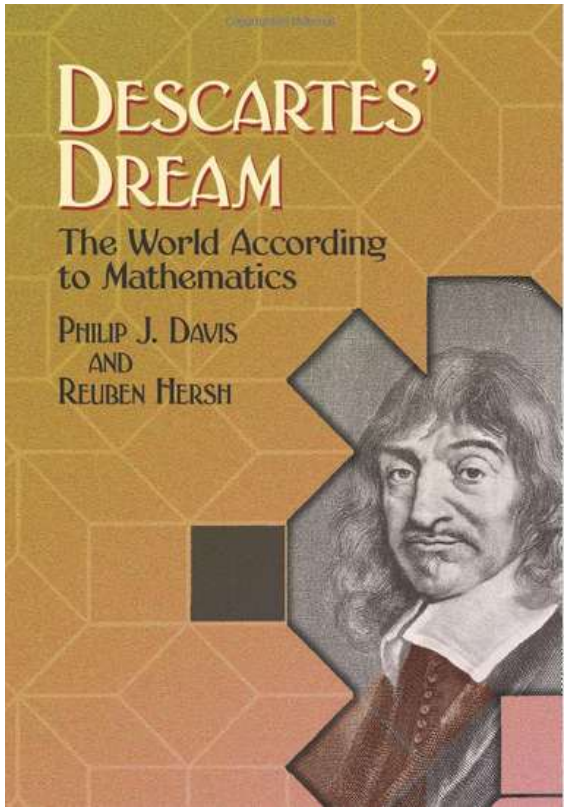
Digital Twins of the Earth

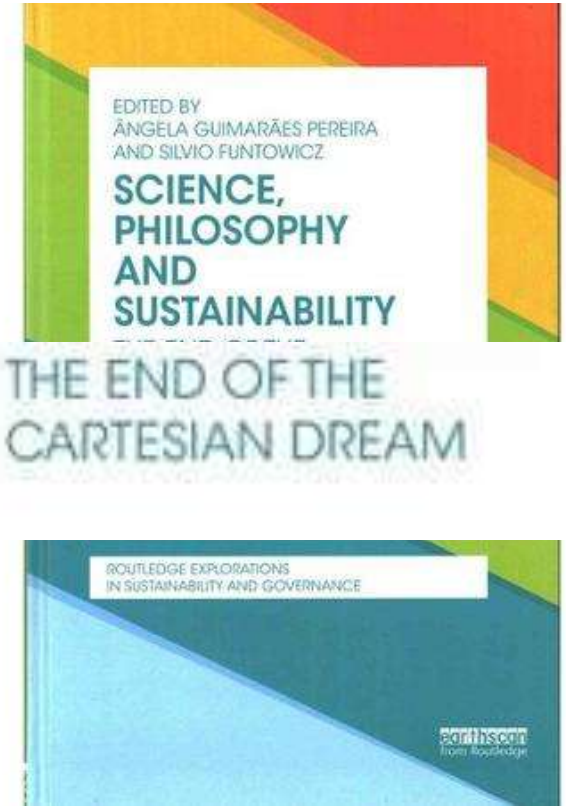
[...] with the advent of the Digital Transformation, the interconnection between the physical and the digital world has become almost complete: economic, industrial, and social relationships have been moved to the "cyber-physical" world …

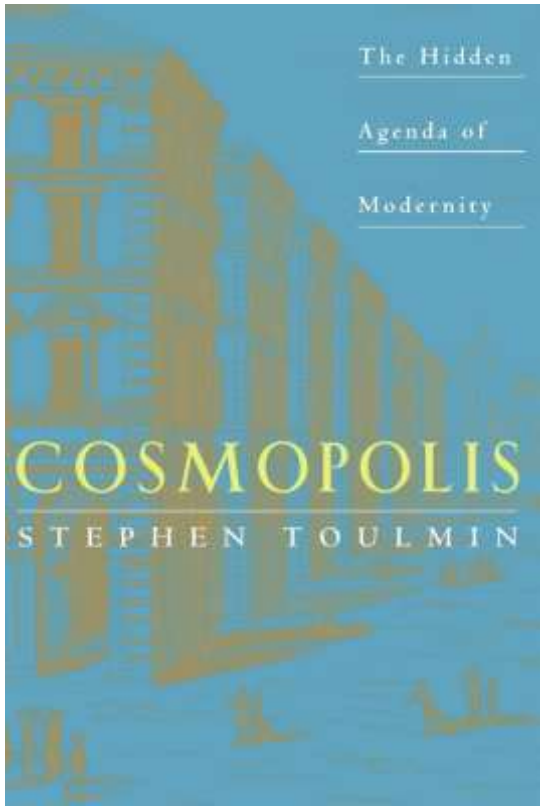
Source: S. Nativi, P. Mazzetti, and M. Craglia, 'Digital Ecosystems for Developing Digital Twins of the Earth: The Destination Earth Case', Remote Sensing, vol. 13, no. 11, Art. no. 11, Jan. 2021, doi: 10.3390/rs13112119



Digital Twins: The planet as a manufact; the ultimate Cartesian Dream



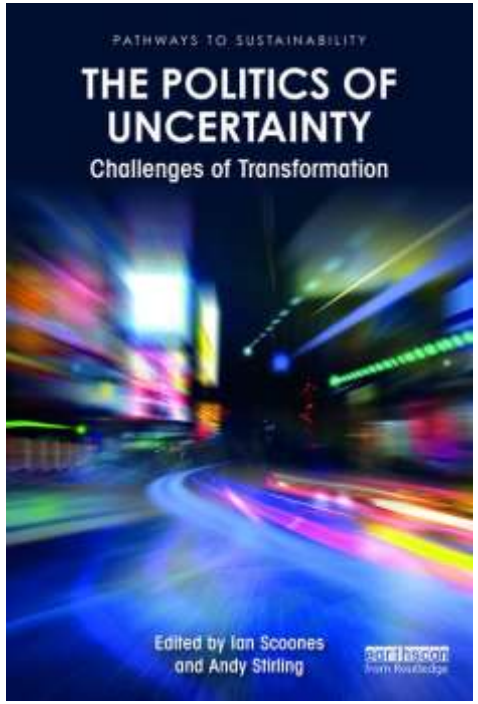




DT's assumes that climate change needs more evidence to promote political agency, and that said evidence can come in the form of DT's

Problems with DestinE

The EC leans toward technology as a conduit to solve policy problems ➔ European institutions are vulnerable to projects oriented to technological solutions and technological optimism



4

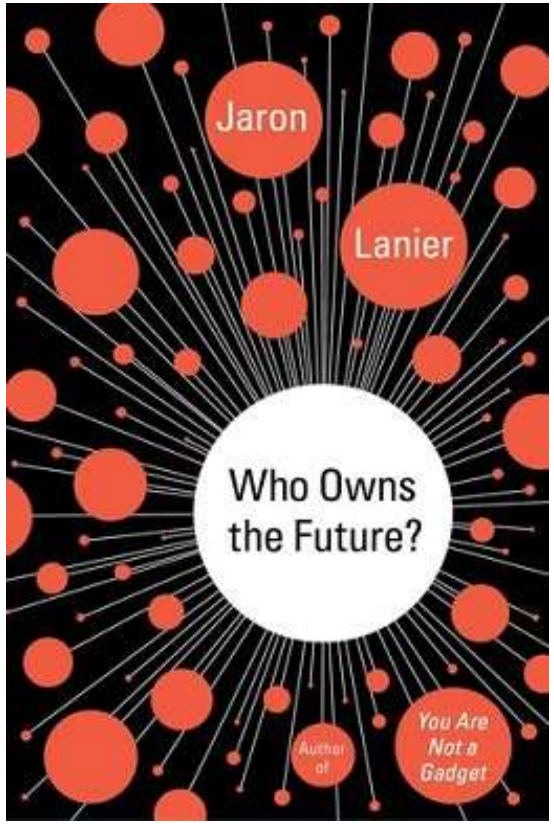
THE UNRAVELLING OF TECHNOCRATIC ORTHODOXY?

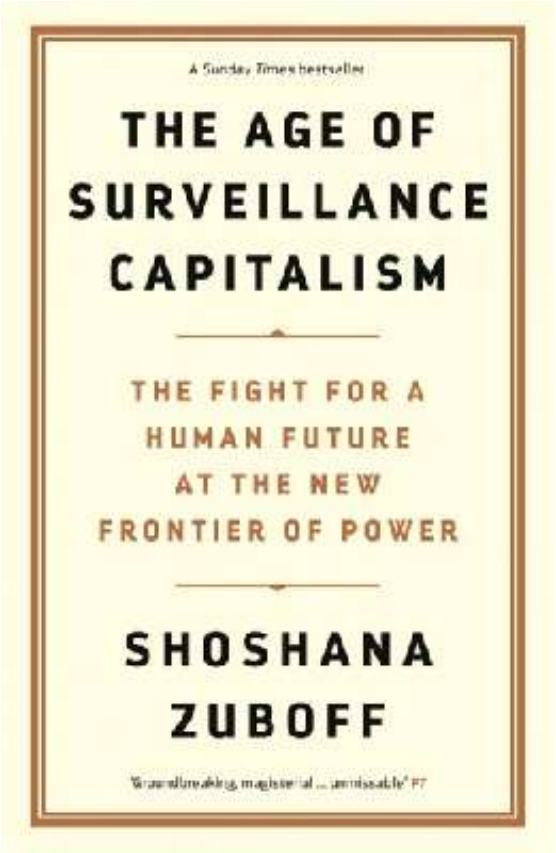
Contemporary knowledge politics in technology regulation

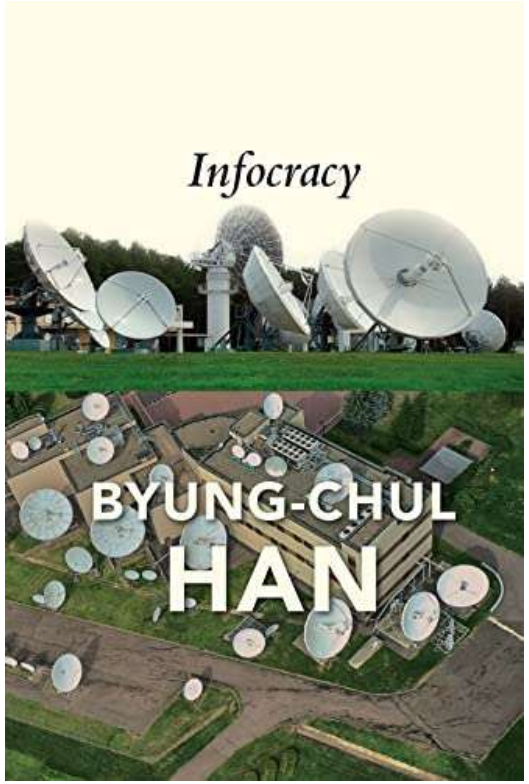
Patrick van Zwanenberg

Problems with DestinE

The epistemic community around DestinE unexposed to the concerns about the digitalization of the real







‘expected utility’, ‘decision theory’, ‘life cycle assessment’, ‘ecosystem services’ ‘sound scientific decisions’ and ‘evidence-based policy’ … profusion of digits, promises of accuracy

ELSEVIER

Research Policy

Available online 21 December 2022, 104709

In Press, Corrected Proof

Discussion

Against misleading technocratic precision in research evaluation and wider policy – A response to Franzoni and Stephan (2023), ‘uncertainty and risk-taking in science’

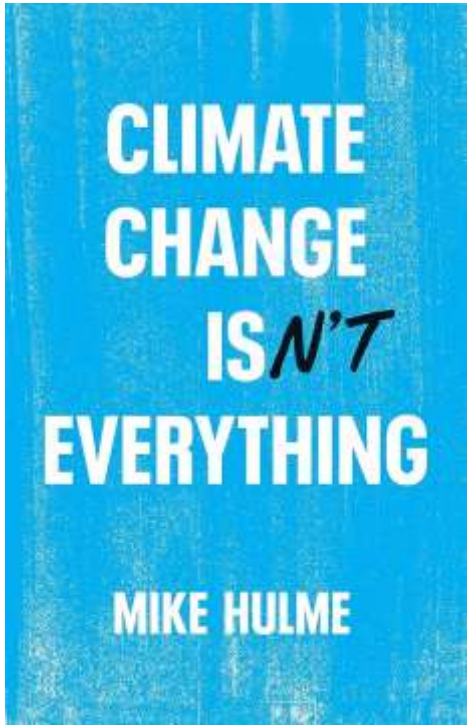
Andy Stirling ✉

Andrew Stirling

Problems with DestinE: A-la-Zuckerberg approach to introducing new technologies: first it is done, then one worries about “How to embed the ethical, legal, and social considerations in the Digital Twin of the Earth and its interface, such as privacy, equity, accessibility …”

Dont't forget 2013 EC's Human Brain Project

"the European Commission awarded ... a staggering 1 billion euro grant ... the people I contacted struggled to name a major contribution that the HBP has made in the past decade" (Yong, 2019)



Climate change cannot be the lens through which to look at the world's problems. The war in Syria is not a result of climate change

Rejecting climatic determinism is not a refutation of climate change but of its instrumental use

“Climate became globalized in new ways, seen as a single universal system that could be simulated with increasing degree of realism and made predictable … knowledge detached from specific cultural meanings… p. 50

The EU Horizon Europe research programme promises to deliver by 2030 “a full replica… a highly accurate digital model of the Earth to monito and predict the interactions between natural phenomena and human activities” p. 130

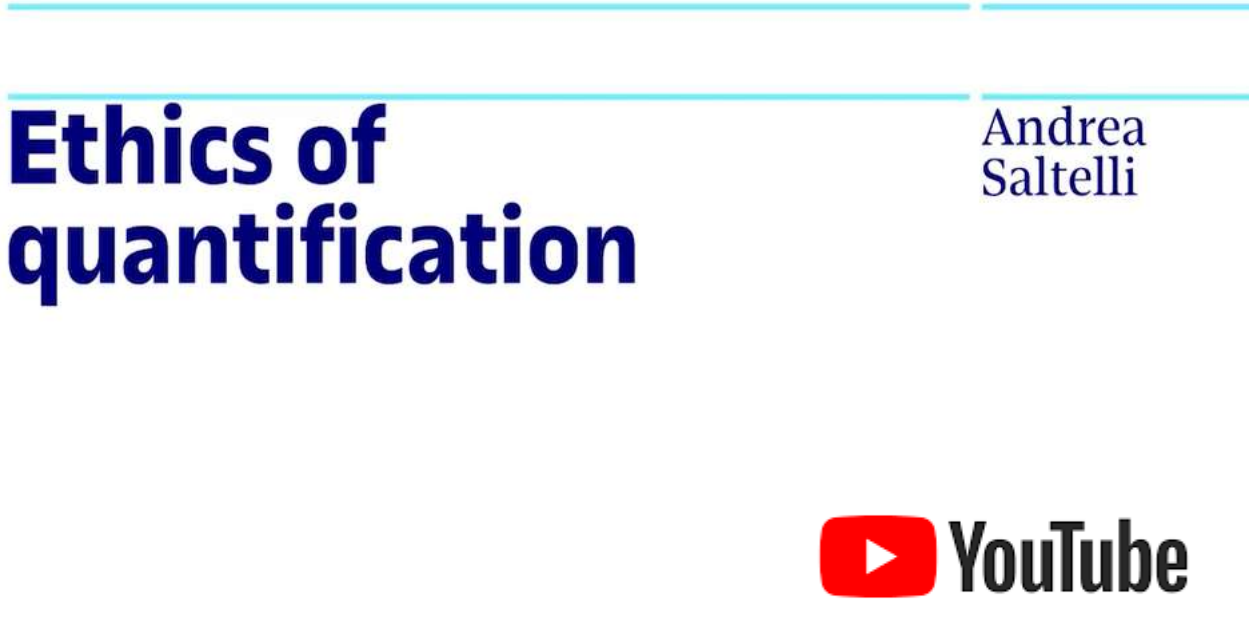
Hulme, Mike. 2023. *Climate Change Isn’t Everything: Liberating Climate Politics from Alarmism*. 1st edition. Medford: Polity.

Ambitious visions to manage the Earth's physical and social complexity – whether using the promise of the EU's Destination Earth, machine learning or artificial intelligence – are chimeras

DT's are marketed as a source of 'climate intelligence' but if it is true that "Financial markets and private companies, are in an "arms race" for climate intelligence" [*], should this race be met with public funds?

[*] L. Harris, "Rise of the Climate Rating Agencies," *The American Prospect*, Apr. 12, 2023. Accessed: Jun. 07, 2023. [Online]. Available: https://prospect.org/api/content/6015e258-d87d-11ed-bd1d-12163087a831/

The End

https://mstdn.social/@AndreaSaltelli/

Video recorded by UOC:
https://www.youtube.com/watch?v=eHtJUSxoioI&t=921s