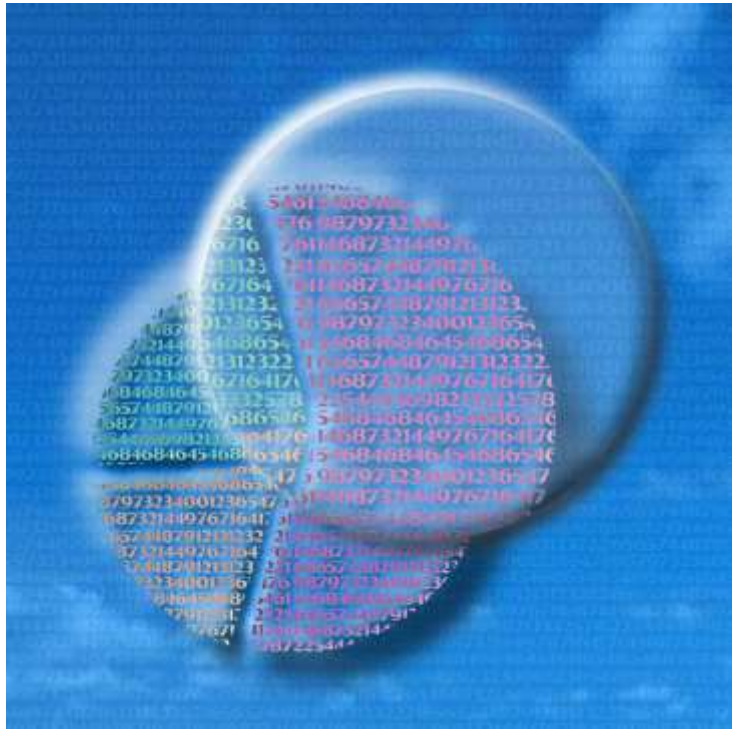

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UNIVERSITAS BERGENSIS

Models: a state of exception

Andrea Saltelli

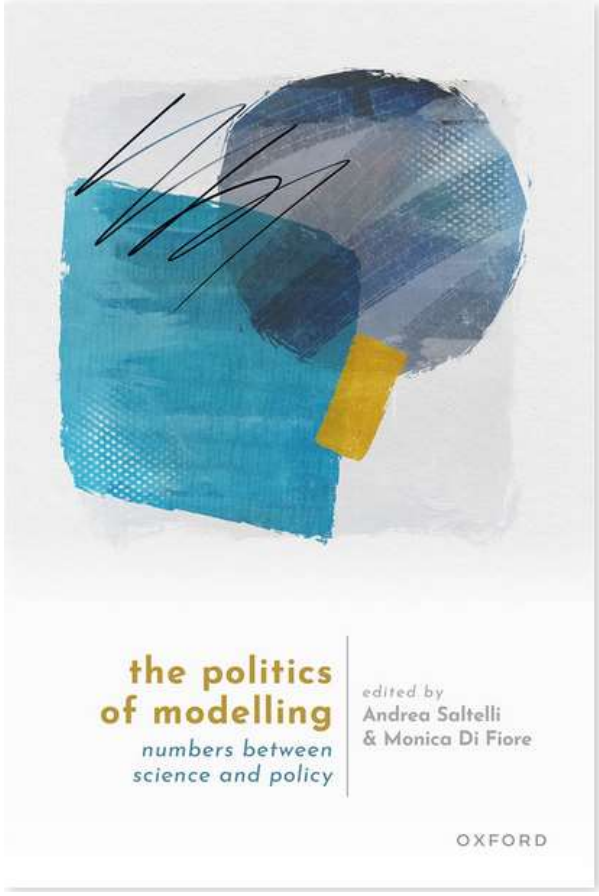
School on Mathematical Modeling and Governance
October 30 – November 3, 2023
São Paulo, Brazil
ICTP-SAIFR/IFT-UNESP

Where to find this talk: www.andreasaltelli.eu

Andrea Saltelli

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

Mastodon Toots by
@AndreaSaltelli

AndreaSaltelli
2023/8/28 11:24
August 26 Podcast (16m) - interview for ABC NET RADIO, AUS: Assumptions and consequences: the politics of modelling, Guests: Ehsan Nabavi and Andrea Saltelli, Producer - Chris Bullock.

abc.net.au/listen/programs/sun

View on mstdn.social

Summary

Models live in a state of exception. Their versatility, the variety of methods, the impossibility of their falsification and their epistemic authority permit mathematical models to escape, better than other instances of quantification, the lenses of sociology and other humanistic disciplines. This endows models with a pretence of neutrality that perpetuates the asymmetry between developers and users. Models are thus underexplored and overinterpreted. While retaining a firm grip on policy, they reinforce entrenched cultures of transforming political issues into technical ones.

To combat this state of exception one should start discussing the reproducibility of models, foster complexity of interpretation rather than complexity of construction, and encourage forms of activism following the French statactivists, aimed to achieve a reciprocal domestication between models and society. To breach the solitude of modellers, more actors should engage in practices such as assumption hunting / modelling of the modelling process / sensitivity analysis and auditing.

Do we live immersed in fantastic numbers?

OPINION

PETER COY

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

Sept. 17, 2021

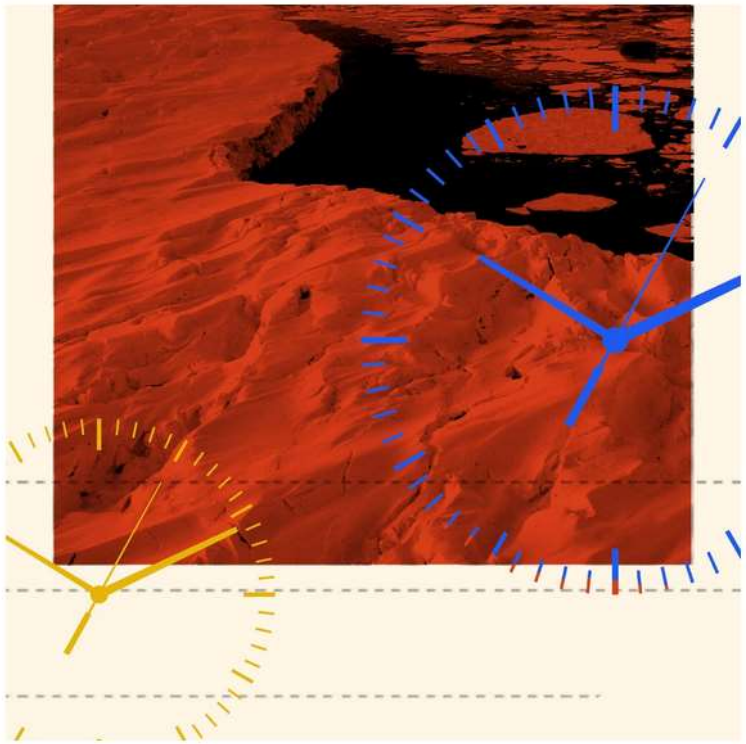


Illustration by Arsh Raziuddin, The New York Times

“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

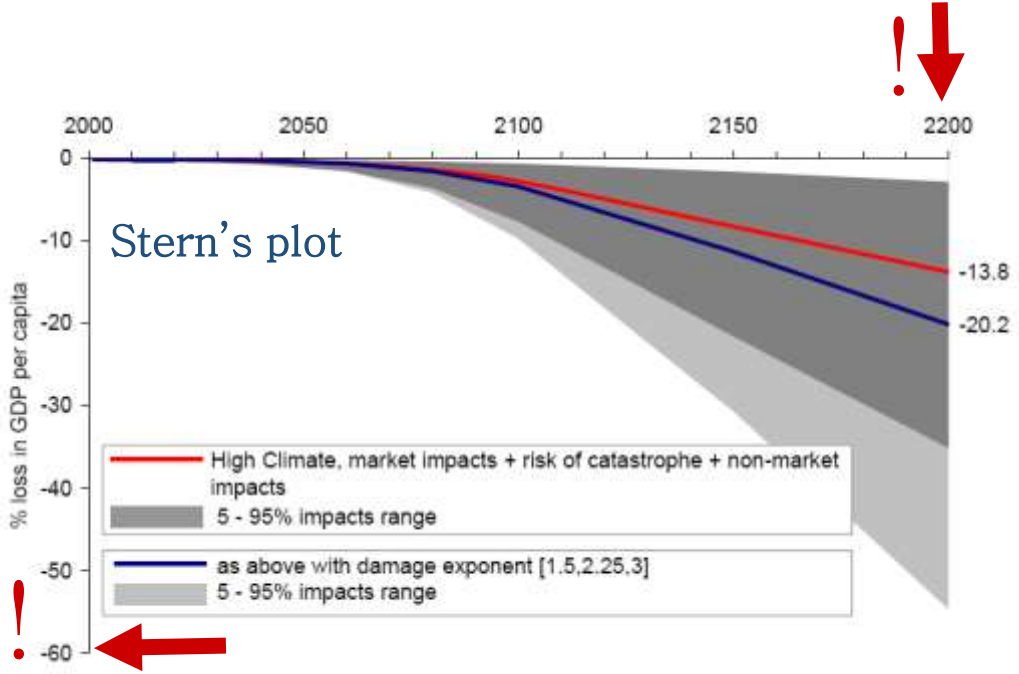
RESOURCES for the FUTURE

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

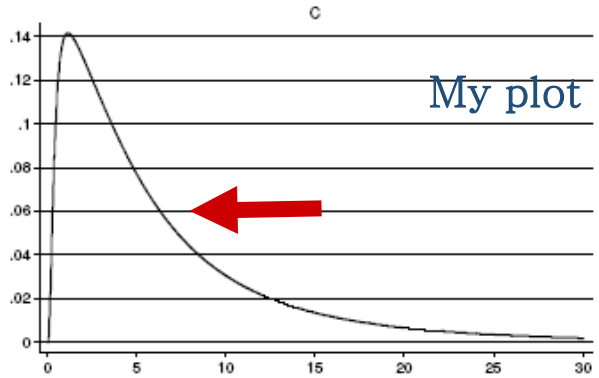
Global Environmental Change

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

Why models live in a state of exception

Unparalleled palette of methods / epistemic authority / invisible models

Models dispose of a unique repertoire of methods.

Are endowed with unparallel epistemic authority that originates from mathematics, the highest ranked among scientific disciplines (Davies & Hersh, 1986), considered by the fathers of the scientific revolution the language of God himself, up to the point that reconnecting it to human experience is up today an unfinished project (Lakoff & Núñez, 2001).

Lack of agreed standards. Modelling as craft.

Why models live in a state of exception

Mathematical models escape sociology of quantification

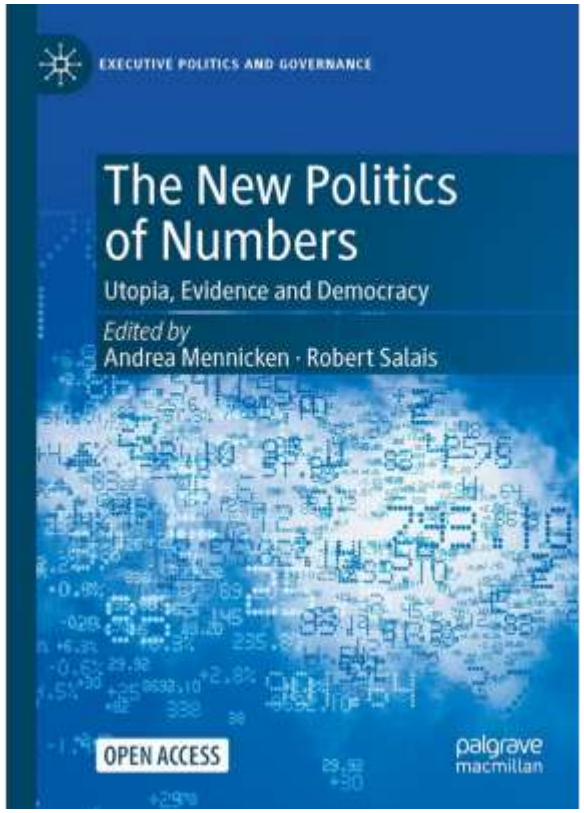
Statistics has a much deeper connection to sociology, and to sociology of quantification in particular (Desrosières, 1998; Mennicken & Espeland, 2019; Mennicken & Salais, 2022) than mathematical modelling. Sociology of quantification is more concerned with statistical indicators than it is with modelling, be it that impact assessment tools such as cost benefit analysis are a classic theme in this discipline (Porter, 1995) and that the field is not entirely deserted (Morgan & Morrison, 1999).

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

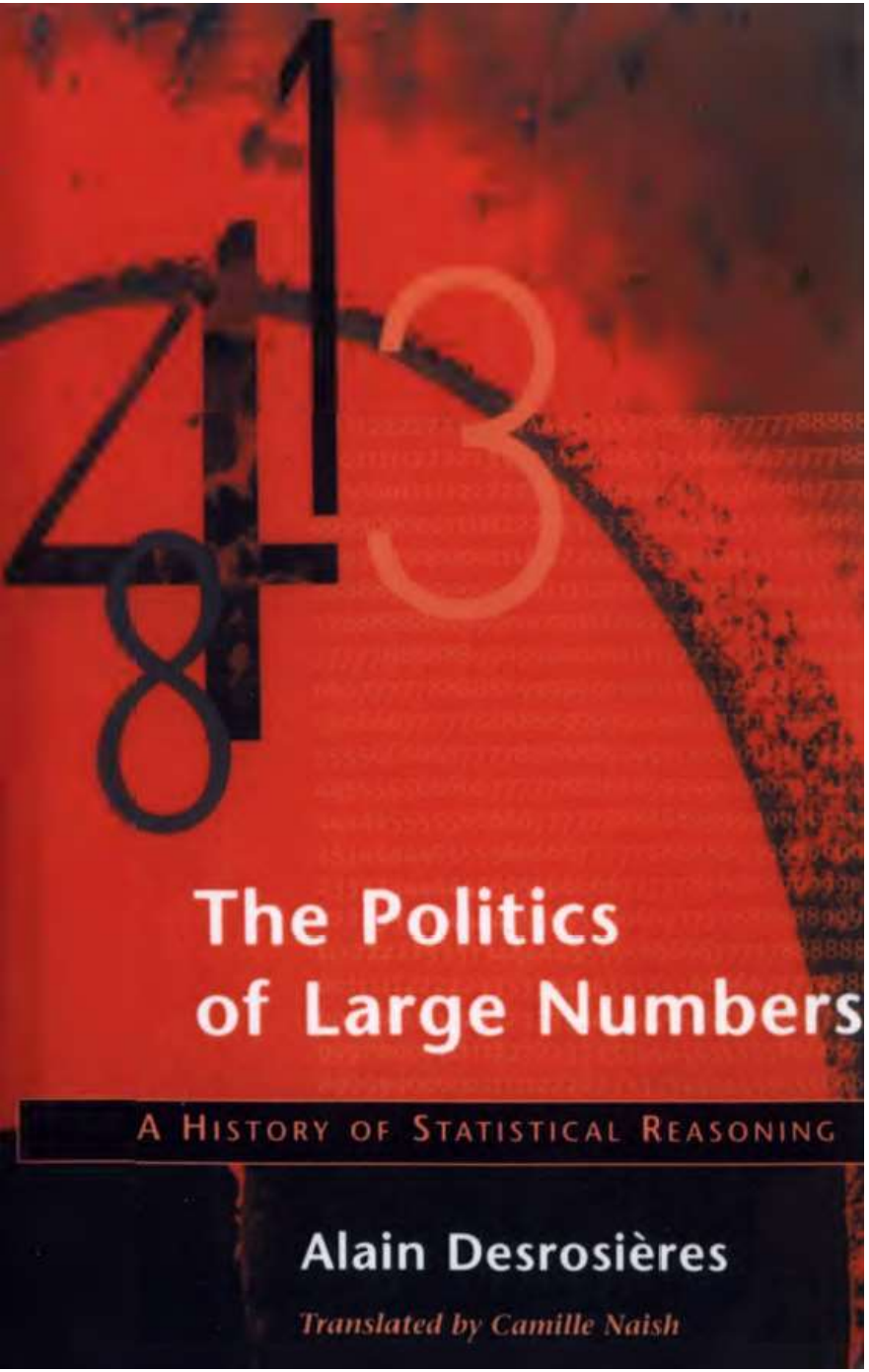
Technical Quality

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.



Alain Desrosières: “Making things that hold”

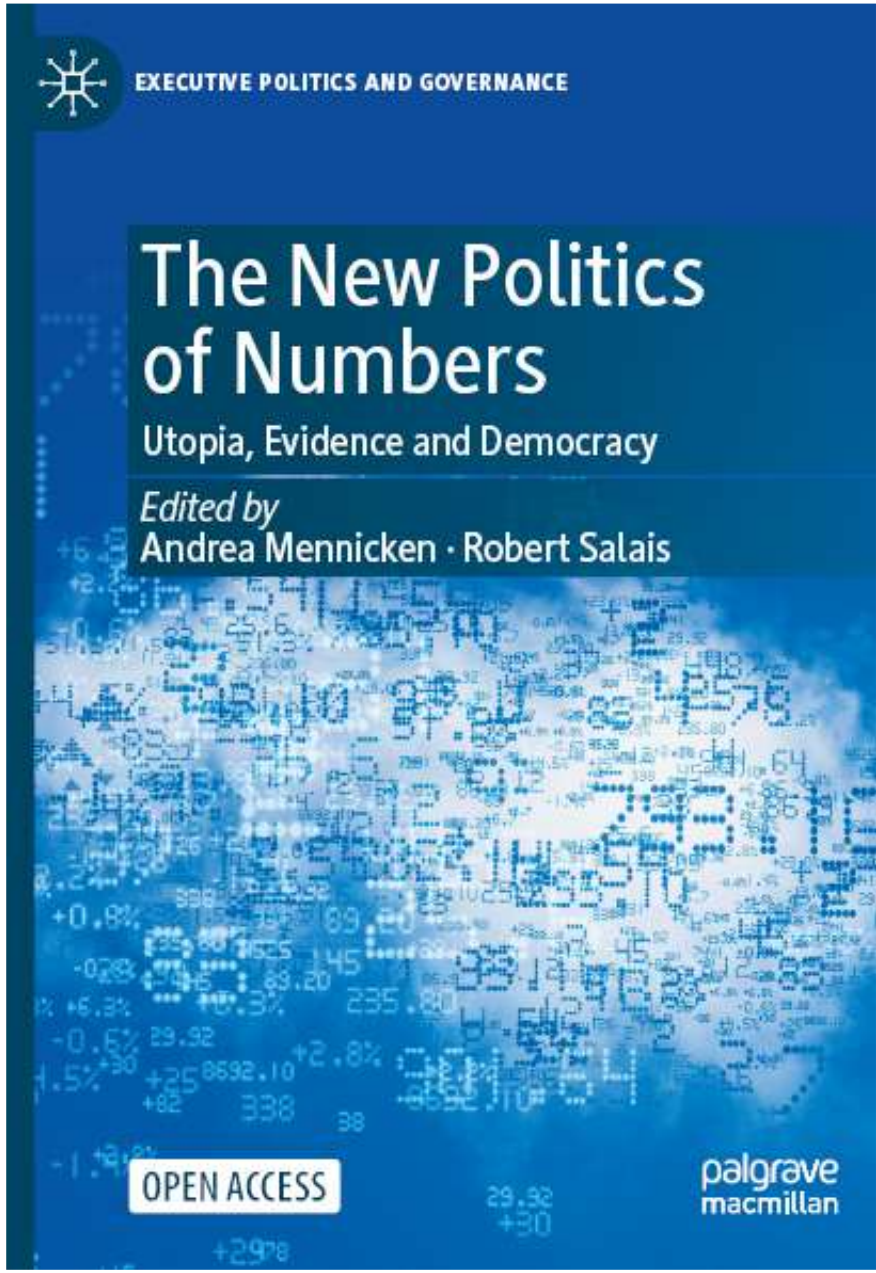
The construction of statistical concepts and categories that can serve for action

BUT

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

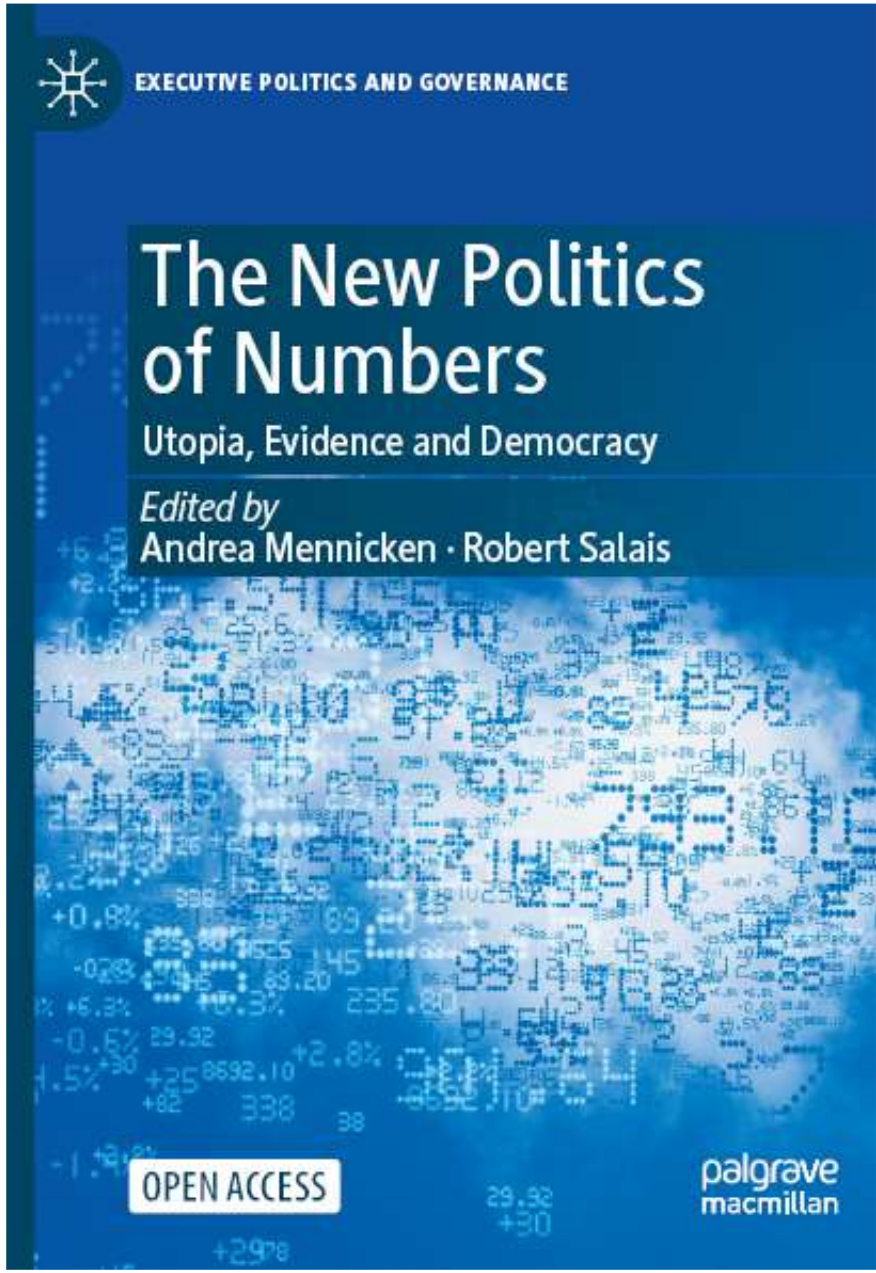
Governance driven quantification is based on pretended objectivity (neutrality), reductionism and justificationism that contribute to a loss of democratic agency (a-democracy)

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



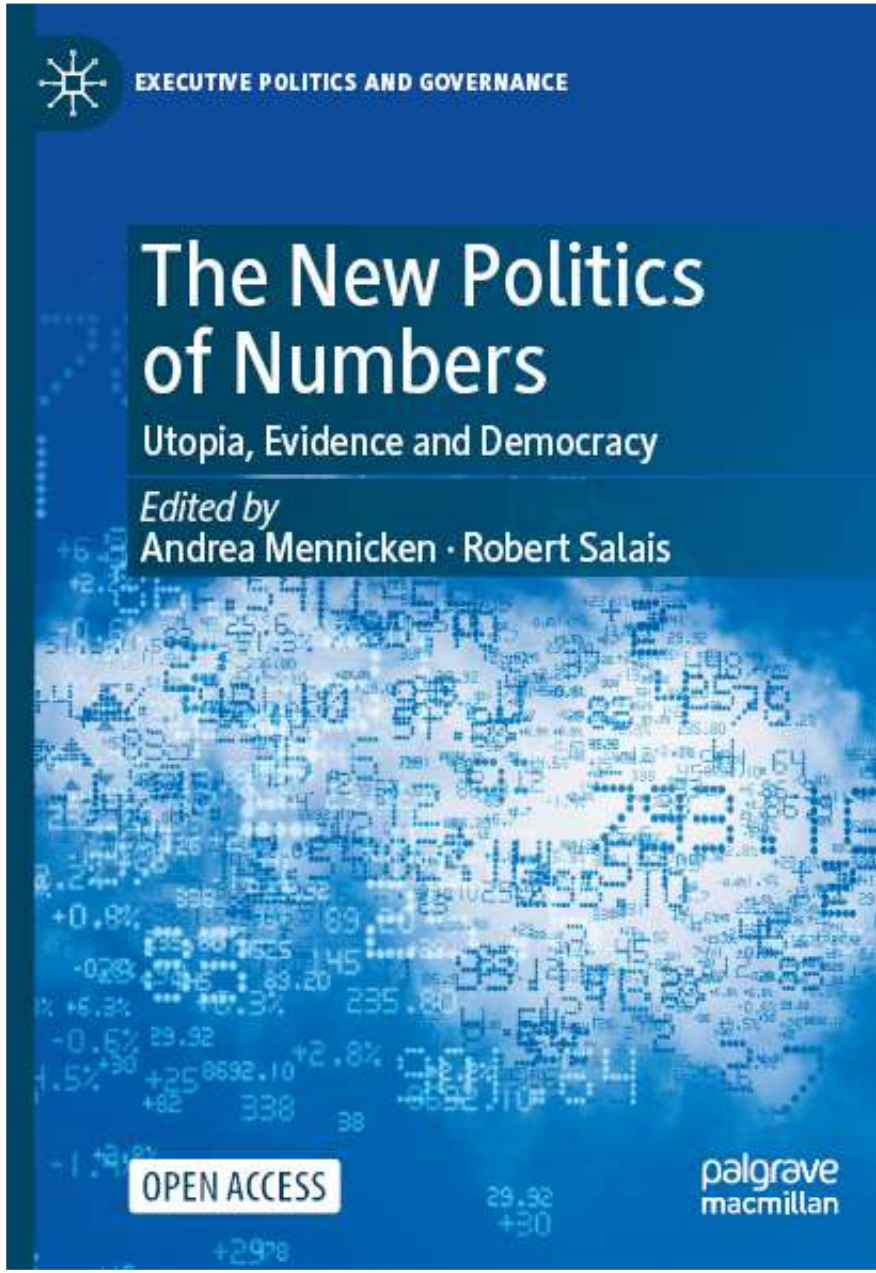
Contesting unjust/unfair governance arrangement is impossible without producing alternative constructions of evidence – that requires muscles not easily available to the lay citizen

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



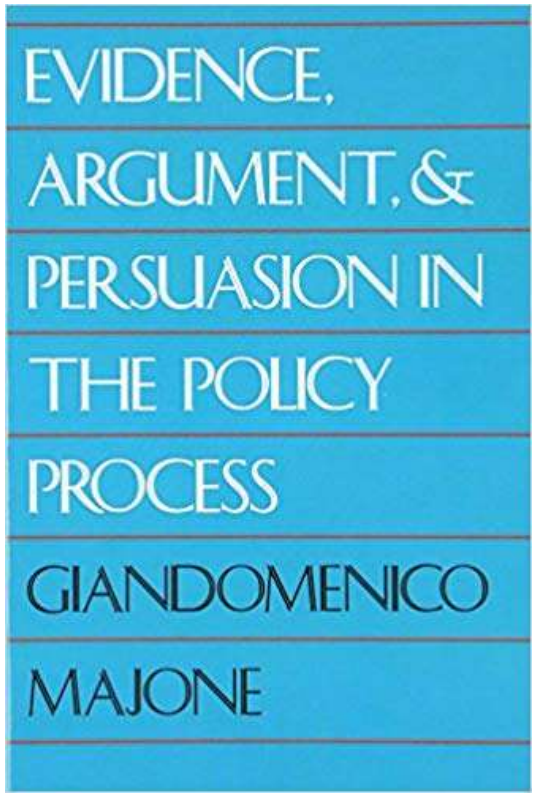
Evidence based policy	Statistics (creating things that hold together for the solution of practical problems)
Policy based evidence	Governance driven quantification (a reversal of the statistical pyramid)

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

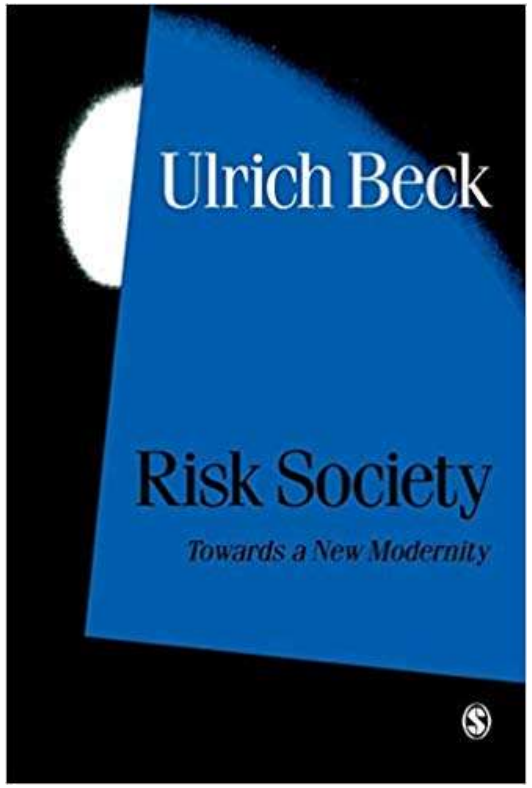


From Ulrich Beck to Giandomenico Majone: the technique is never neutral

Ulrich Beck
(1944 –2015)



1989



1992 (1986)

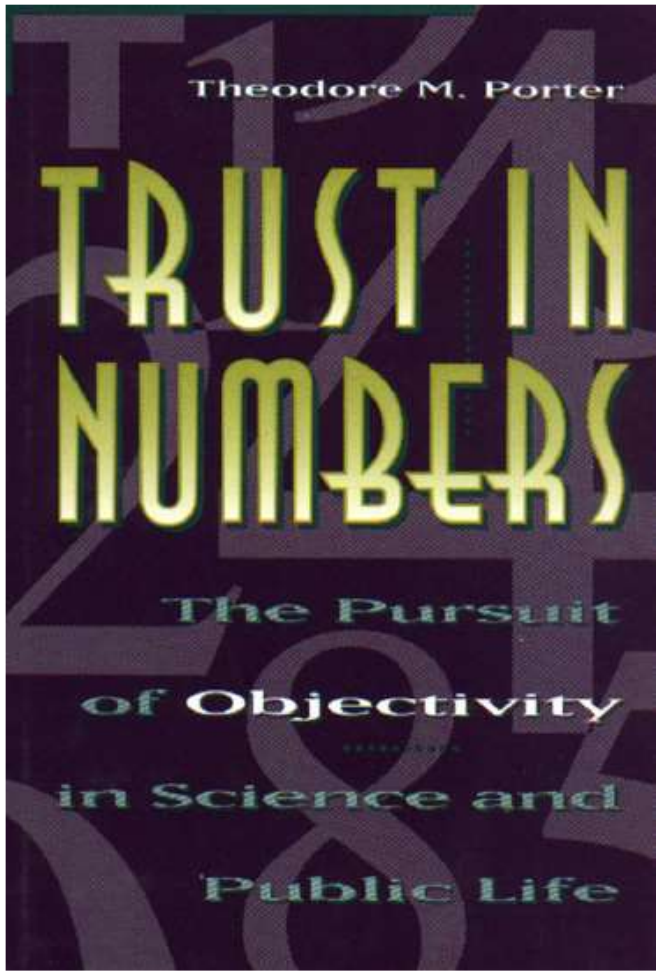
ELSEVIER

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]

Theodor
M. Porter



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

Why models live in a state of exception

Models cannot be falsified

Models do not meet classic (Popperian) criteria of scientificity. Oreskes (2000) has observed that model-based predictions tend to be treated like logical inferences in a classic hypothetic-deductive model.

The relation between models and data is often more symbiotic than adversarial. In climate studies this relation has been defined as ‘incestuous’, exactly to make the point that in modelling studies using data to prove a model wrong may not be straightforward (Edwards, 1999).

Why models live in a state of exception

Models as the most effective mediators between theory and reality

Due to their independence from both theory and the world, models are understood as “mediators”, instruments that act and describe things in ways that advance understanding thanks to the tacit craftsmanship of scientists (Morgan & Morrison 1999). They are even regarded as metaphors that help us understand how we see the world: they express “in an indirect form our presuppositions about the problem and its possible solutions”, and can thus assist in an extended community of peers to deliberate about social or ecological problems (Ravetz 2023).

Consequences descending from state of exception

Gross asymmetry developers/ users

Models operate in a context of asymmetry of knowledge between developers and users (Jakeman *et al.*, 2006)). One can contest this claim referring to ‘black boxes’ used in other families of quantification, typically algorithms or statistics. We contend that this asymmetry is especially of concern for large mathematical models (Puy et al., 2022).

Consequences descending from state of exception

Ritual use

Models lend themselves to ritual use. An important analogy between statistical and mathematical modelling is in the ‘ritual’ use of methods. Existence of rituals in statistics has been discussed extensively by Gigerenzer (Gigerenzer, 2018; Gigerenzer & Marewski, 2015).

An anecdote by Kenneth Arrow. During the Second World War he was a weather officer in the US Army Air Corps working on the production of month-ahead weather forecasts, and this is how he tells the story (Szenberg, 1992):

> *The statisticians among us subjected these forecasts to verification and they differed in no way from chance. The forecasters themselves were convinced and requested that the forecasts be discontinued. The reply read approximately like this: “The commanding general is well aware that the forecasts are no good. However, he needs them for planning purposes”.*

See also Niklas Luhmann ‘deparadoxification’ (Moeller, 2006); ‘We follow the science’ during COVID-19

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.

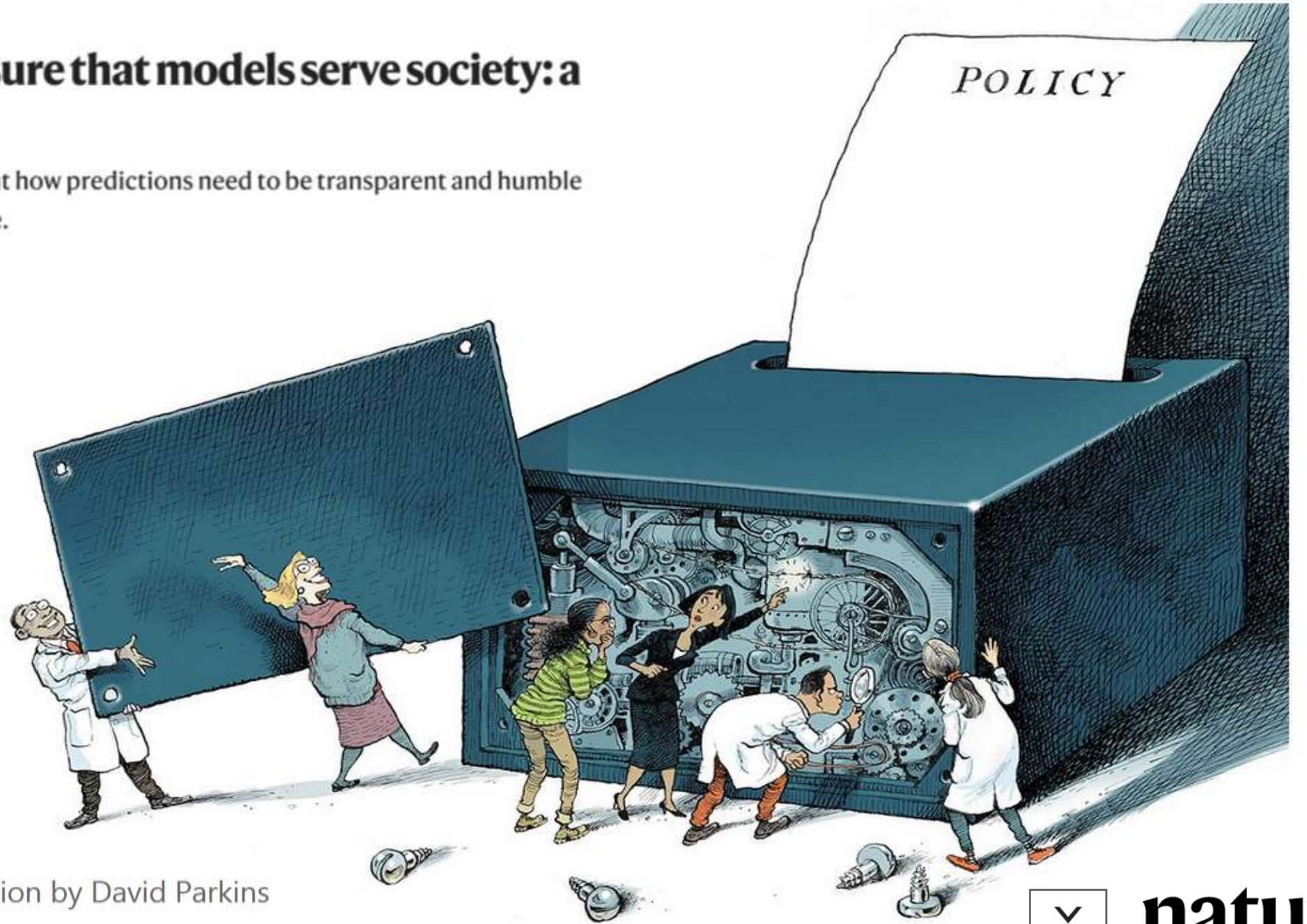


Illustration by David Parkins

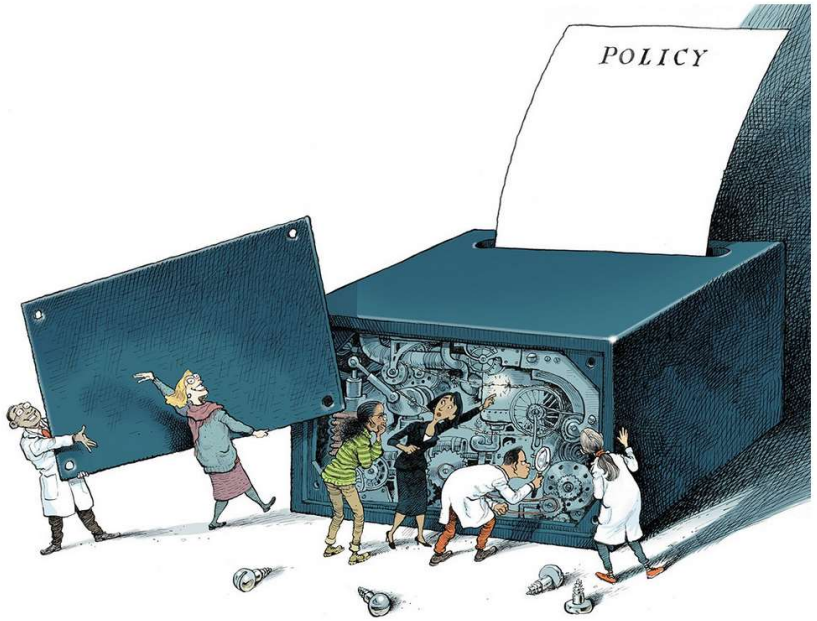
nature

nature

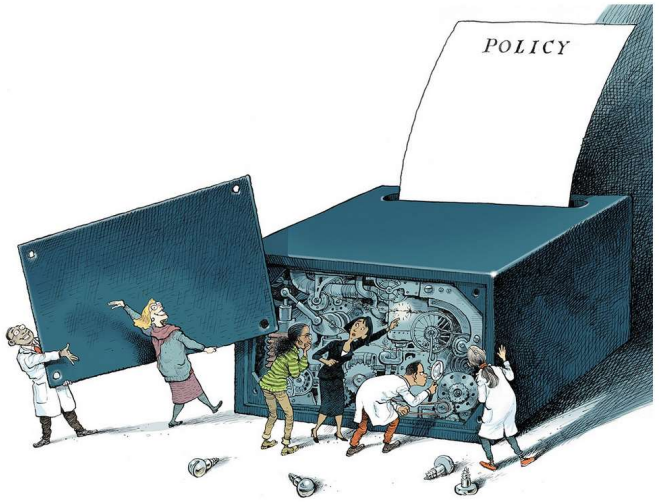
Andrea Saltelli, Gabriele Bammer, Isabelle Bruno, Erica Charters, Monica Di Fiore, Emmanuel Didier, Wendy Nelson Espeland, John Kay, Samuele Lo Piano, Deborah Mayo, Roger Pielke Jr, Tommaso Portaluri, Theodore M. Porter, Arnald Puy, Ismael Rafols, Jerome R. Ravetz, Erik Reinert, Daniel Sarewitz, Philip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

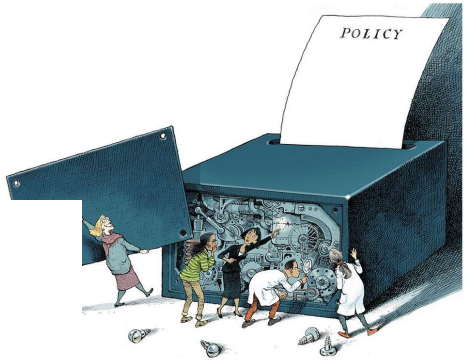


COVID has put mathematical models in the limelight



➔ Power & controversy

Power



The New York Times

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

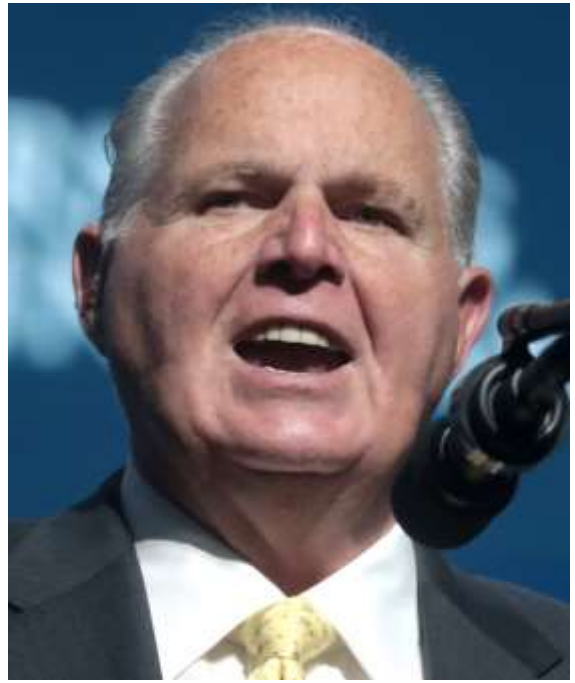
It wasn't so much the numbers themselves, frightening though they were, as who reported them: Imperial College London.

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

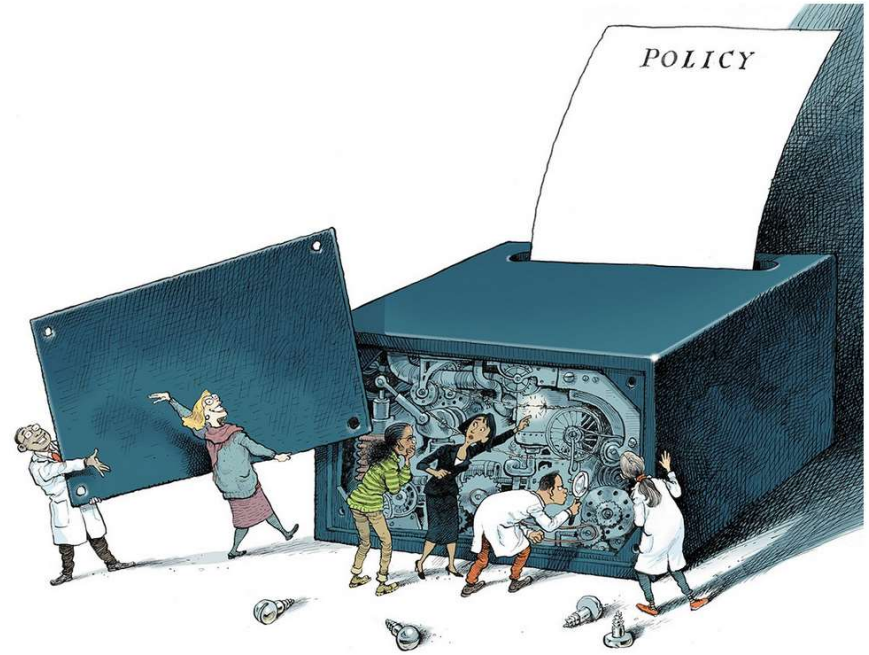
Match purpose and context

Mind the consequences

Quantification can backfire

Mind the unknowns

Acknowledge ignorance



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Journal of Evaluation in Clinical Practice
International Journal of Public Health Policy and Health Services Research

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

During the pandemic crisis of 2020–2023, it is likely that the successes of biomedical science were more than offset by its failures. These failures continue to undermine once-powerful ideals and hopes for science's role in societal betterment. Here, we dissect the underpinnings of these failures and argue that restoring such ideals first requires systemic reform of science itself.

Consequences descending from state of exception

Models and trans-science

Models lend themselves to trans-science. Trans-science refer to scientific practices that appear formulated in the language of science, but that science cannot solve because of sheer complexity or insufficient knowledge (Weinberg, 1972).

Examples of trans-science are not difficult to find:

- How many people will drive autonomous cars by 2050.
- How will the spread of malaria change if global temperature increases by 1.5ºC
- What will be the cost of CO2 averaged over the next three centuries

Model thus risk becoming like Borges' (1946) one-to-one map of the empire described in the short story entitled *Del Rigor en la Ciencia* (On Exactitude in Science).

Consequences descending from state of exception

Have the strongest grip in policy

Models have their own political economy. Like other strategies of quantification, models encourage strategies of economicism, solutionism, reductionism, transforming of the qualitative into quantitative (Stirling, 2023a, 2023b).

For Chalmers and Glasziou (2009) the percentage of non-reproducible studies in the field of clinical medical research could reach 85%. Nobody can provide a similar figure for mathematical modelling.

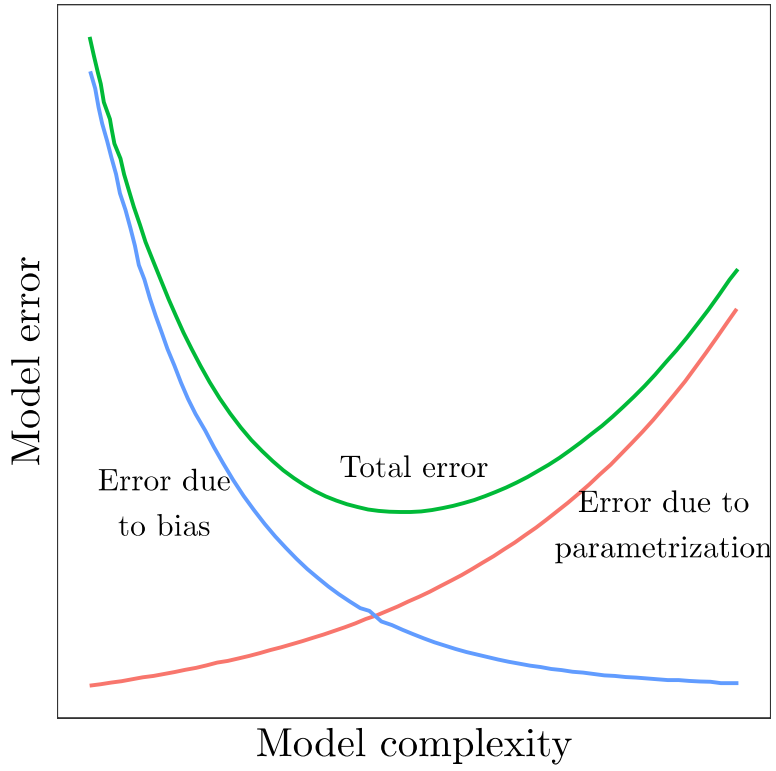
‘Navigating the political’ (adapting their inference to an ongoing policy process becoming thus part of the process itself, as discussed in van Beek *et al.* 2022)

Acting as chameleons [jumping from a context of investigation (what if) to one of prediction, and defending from criticism by reverting to ‘this is just a study model’ , Pfleiderer (2020)].

Consequences descending from state of exception

Models are vulnerable to modelling hubris

The conjecture of O'Neill (1971), see also Turner & Gardner (2015), posits that too simple a model may miss important features of the system, and thus lead to systematic error, while a too complex one – burdened by an excessive number of estimated parameters, may lead to a greater imprecision due the error propagation.



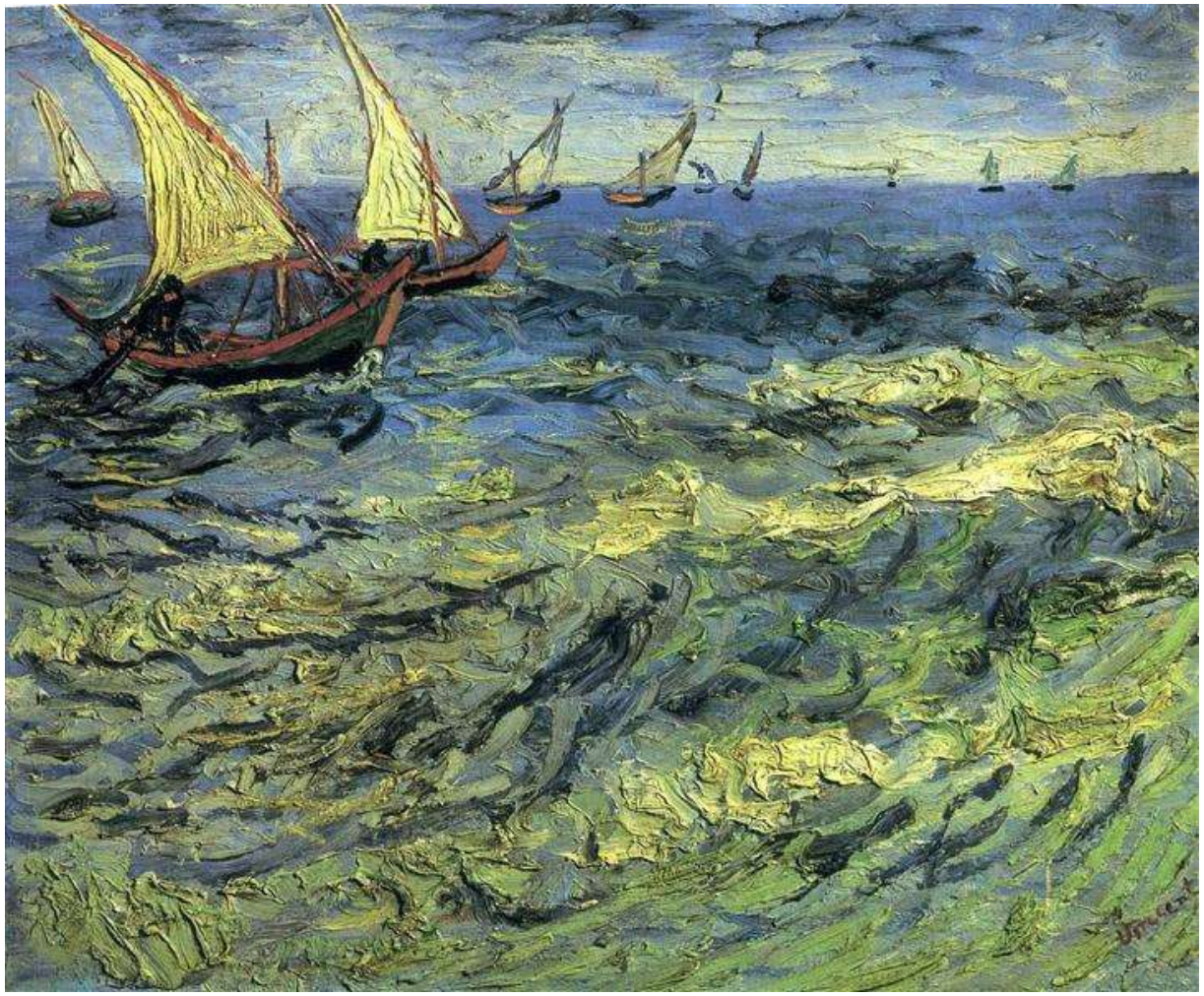
Solutions to resolve the state of exception

Thinking about reproducibility of models

Preregistration of modelling studies is proposed by (Ioannidis, 2022)

See forking paths / fishing expeditions

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‡

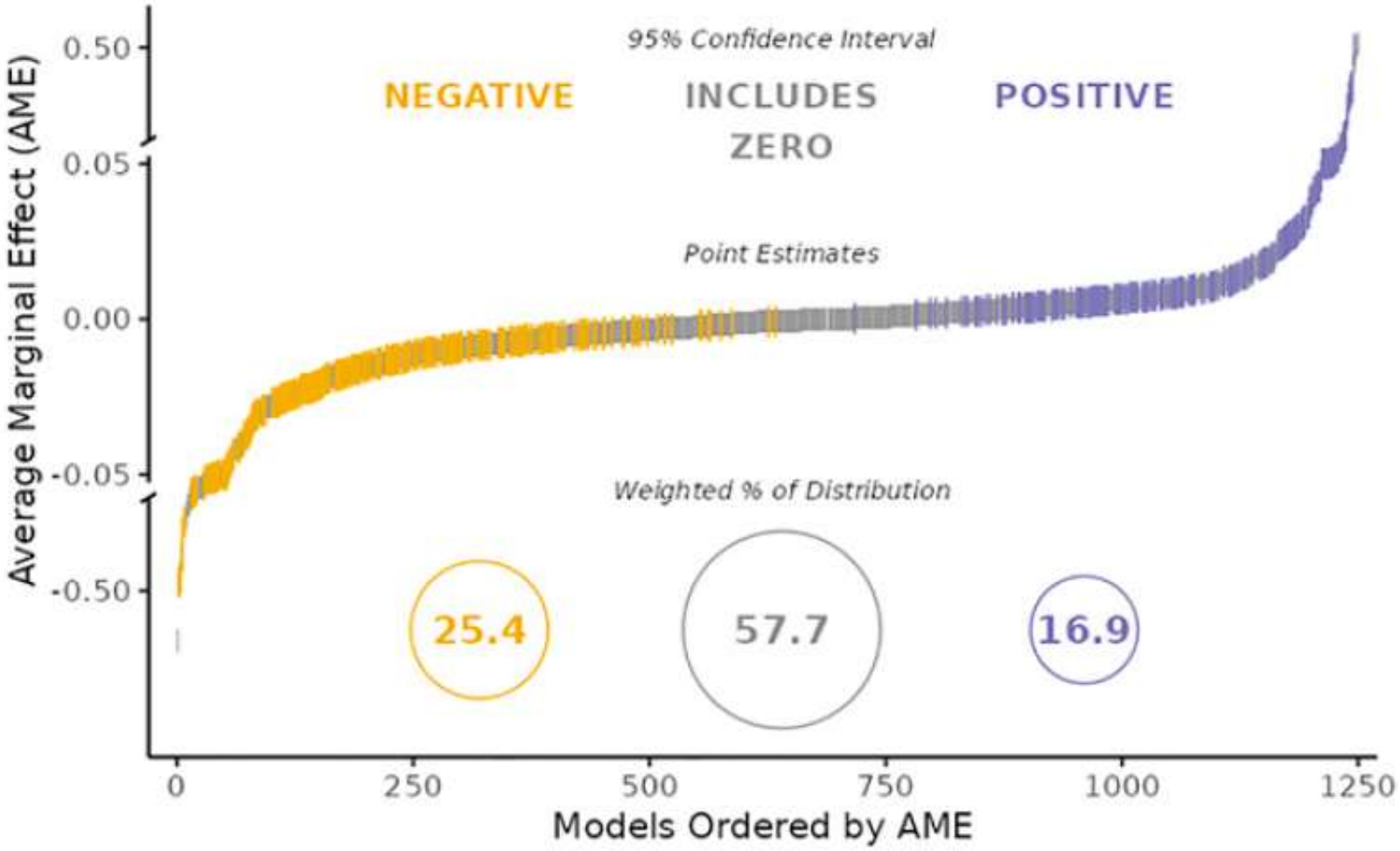
14 Nov 2013

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



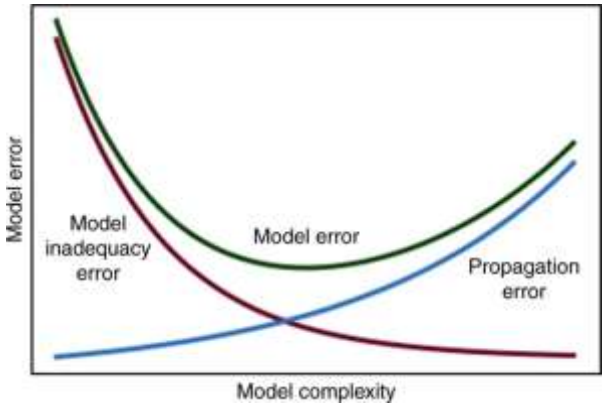
"Will different researchers [73 teams] converge on similar findings when analyzing the same data?

…teams' results varied greatly, ranging from large negative to large positive effects"
(Massey et al. 2022)

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)

…

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

Culture Unbound
Journal of Current Cultural Research

Funny Numbers

By Theodore M. Porter

Solutions to resolve the state of exception

Sensitivity analysis and sensitivity auditing

But the real strength of the models, in my mind at least, were in sensitivity analysis (where one could examine the response of the model to parameters or structures that were not known with precision (i.e., sensitivity analysis), and in the examination of the behavior of the model components relative to that of the real system in question (i.e., validation). By undertaking sensitivity analysis and validation, a great deal can be learned about the real system, including what you do not know. (Hall, 2020)

Article | Open Access | Published: 06 May 2023

What can mathematical modelling contribute to a sociology of quantification?

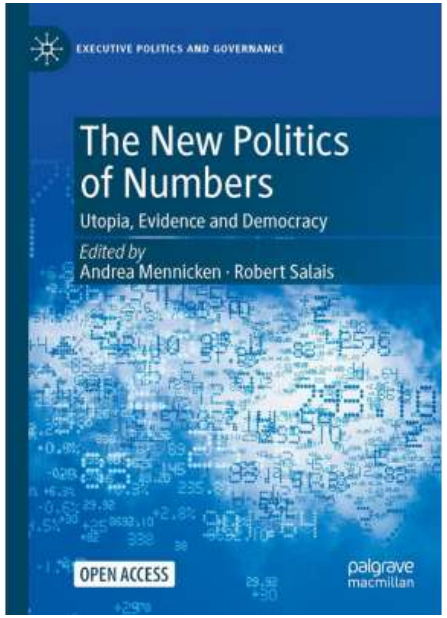
Andrea Saltelli & Arnald Puy

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

448 Accesses | **4** Altmetric | Metrics

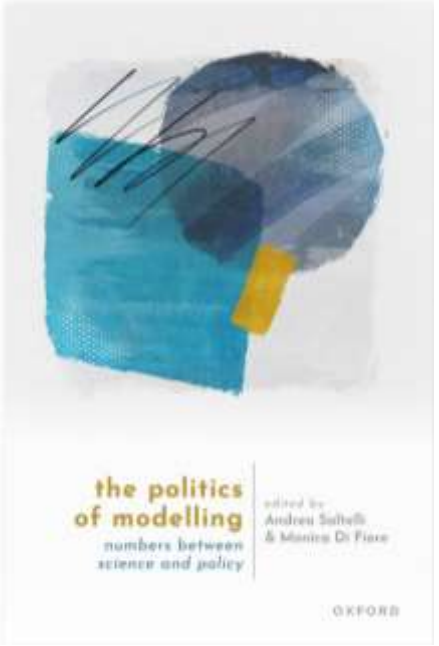
Technical Quality

Normative quality



Sensitivity analysis

Sensitivity auditing



Solutions to resolve the state of exception

Complexity of interpretation rather than complexity of construction

A finite elements model of an engine, a bridge, or of a human hearth, cannot possibly fall in the category of parsimonious. On the other hand, we like to recall when the simplest of models led to an informative and participated debate. Thus was the I=PAT model, whereby the human impact on the environment is driven by population (P), times affluence (A) and technology (T). In the seventies, this model allowed a debate on the limit of growth that continues to the present day (Ehrlich & Holdren, 1971).

Solutions to resolve the state of exception

Follow the example of statisticians' Statactivism

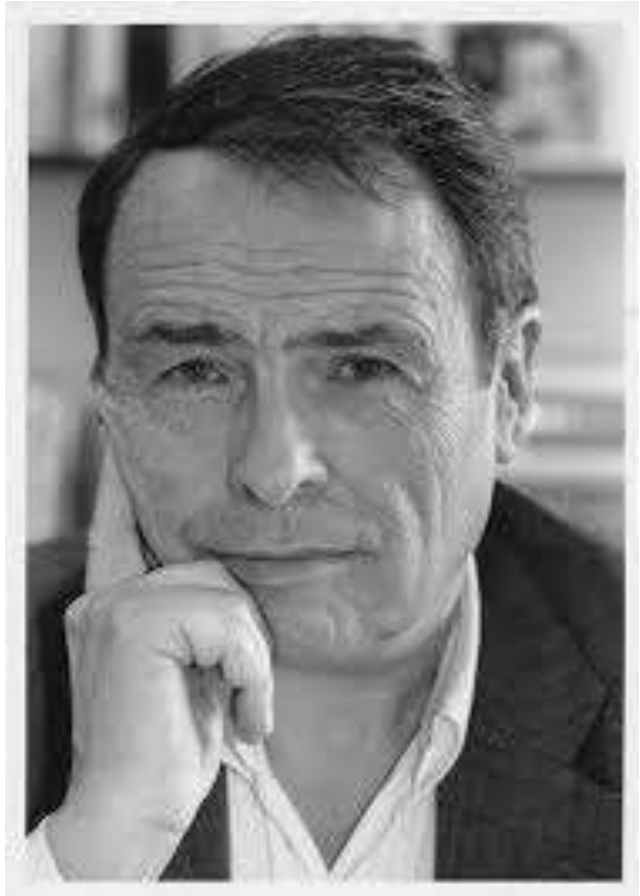
When it comes to the quality of their quantifications, few communities have proven as active as that of statisticians. The movement of French Statactivists (Bruno, Didier, & Prévieux, 2014; Bruno, Didier, & Vitale, 2014), in particular, based on a strong national tradition of sociology of quantification (Bourdieu, 1984; Desrosières, 1998), has proven capable to "fight a number with a number" in domain of policy relevance such as poverty (Concialdi, 2014) and consumer prices indices (Samuel, 2022). One would very much like to imagine modellers taking the viewpoint of those 'measured' into the analysis as advocated by statactivists (Salais, 2022), making the invisible visible (Bruno, Didier, & Prévieux, 2014), or interiorize in full the double nature – technical and normative, of the quality of a quantification (Mennicken & Salais, 2022)

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"

Solutions to resolve the state of exception

Reciprocal domestication between models and society

The COVID pandemic of 2020 has dramatically increased the visibility of mathematical modelling, since models were all the more needed at the moment where epidemiological evidence was scarce. Some models were praised for having made a convincing case for intervention (Landler & Castle, 2020). This was accompanied by a considerable level of controversy, either for the deficiencies of the model, or because of disagreement about the policies (Pielke, 2020; Rhodes & Lancaster, 2020). See also Saltelli *et al.* (2020a, 2020b). Interestingly, not only has mathematical modelling jargon entered the common language with expression such as ‘flattening the curve’, but politicians can be heard discussing mathematical modelling with a considerable level of detail (Seely, 2021). One can only hope that this process continues without leading to a generalized scepticism toward the use of models for policy decision (Saltelli, Sturmberg, et al., 2023).

Solutions to resolve the state of exception

Defog the mathematics of uncertainty

An important issue in mathematical modelling is the management of uncertainty. Uncertainty quantification should be at the heart of the scientific method, and *a fortiori* in the use of science for

It is an old refrain in mathematical modelling, first noted among hydro-geologists, that since models are often over-parametrized, they can be made to conclude everything (Hornberger & Spear, 1981).

Following the intuition of (Funtowicz & Ravetz, 1990b) on the need to 'Defog the mathematics of uncertainty', and more recent analysis of the excess precision associated to impact assessment and risk analysis (Stirling, 2023a) more clarity on how risk numbers are computed is needed.

The non-neutrality of techniques and of models (Saltelli, Benini, et al., 2020; Saltelli, Kuc-Czarnecka, et al., 2023) should be revealed as to allow each party in a conflicted policy issue to make best use of evidence based on numbers.

Conclusions

Do models need rescuing?

The challenges of scepticism. Resistances to change. Modellers in defence of the neutrality of models.

Rayner's 'Displacement'.

How needed is this rescue? Ravetz (1971, 179) prophesized that entire research fields might become diseased, and noted: "*reforming a diseased field, or arresting the incipient decline of a healthy one, is a task of great delicacy. It requires a sense of integrity, and a commitment to good work, among a significant section of the members of the field; and committed leaders with scientific ability and political skill*."

While statistics has been seen to possess the disciplinary arrangements and committed leaders to react to a crisis, mathematical modelling lacks both.

References here

The Politics of Modelling

Numbers Between Science and Policy

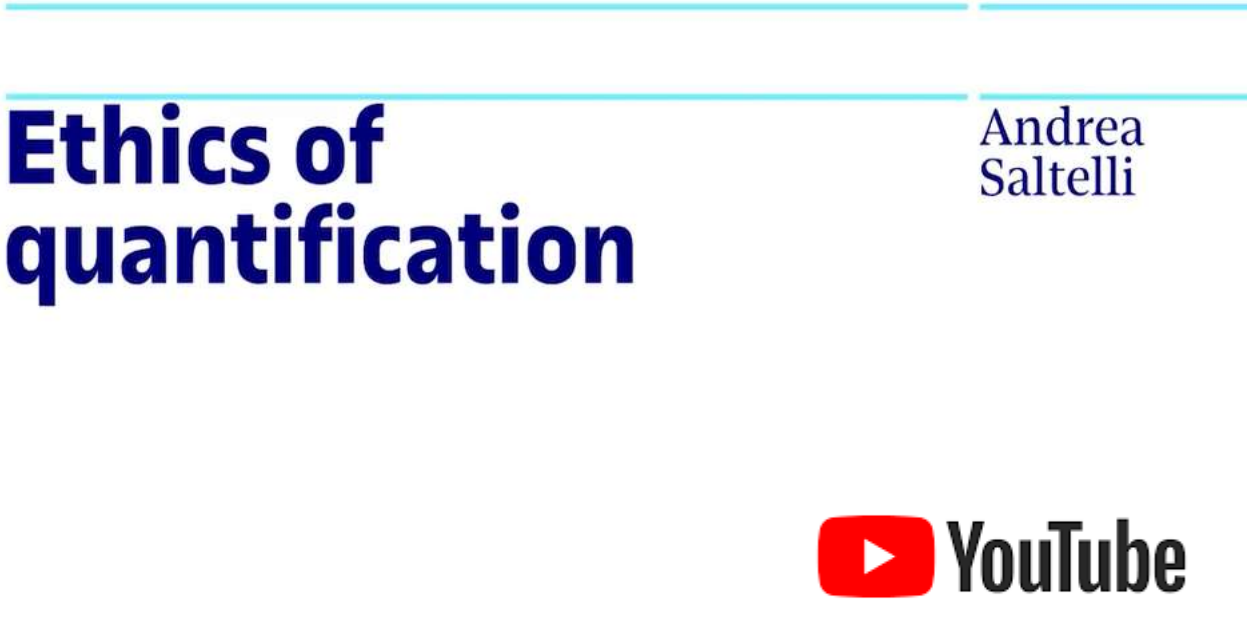
Andrea Saltelli and Monica Di Fiore

> *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

More reading & watching

More in this video recorded by UOC:
https://www.youtube.com/watch?v=eHtJUSxoioI&t=921s



The End

https://mstdn.social/@AndreaSaltelli/