

# The politics of modelling, numbers between science and policy

Andrea Saltelli

European University Institute (Fiesole, IT)

Interdisciplinary Research Clusters, Virtual, July 04, 13:30 – 15:00



## 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

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## 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](http://abc.net.au/listen/programs/sun)

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Do we live immersed in  
fantastic numbers?

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

Sept. 17, 2021

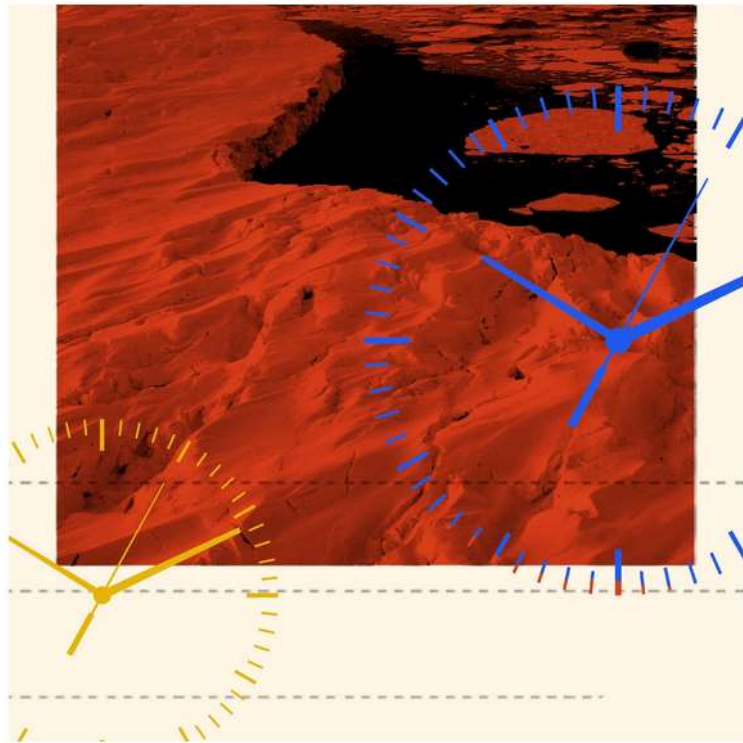


Illustration by Arsh Raziuddin, The New York Times

“social cost of carbon:

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

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

**The New York Times**


# 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

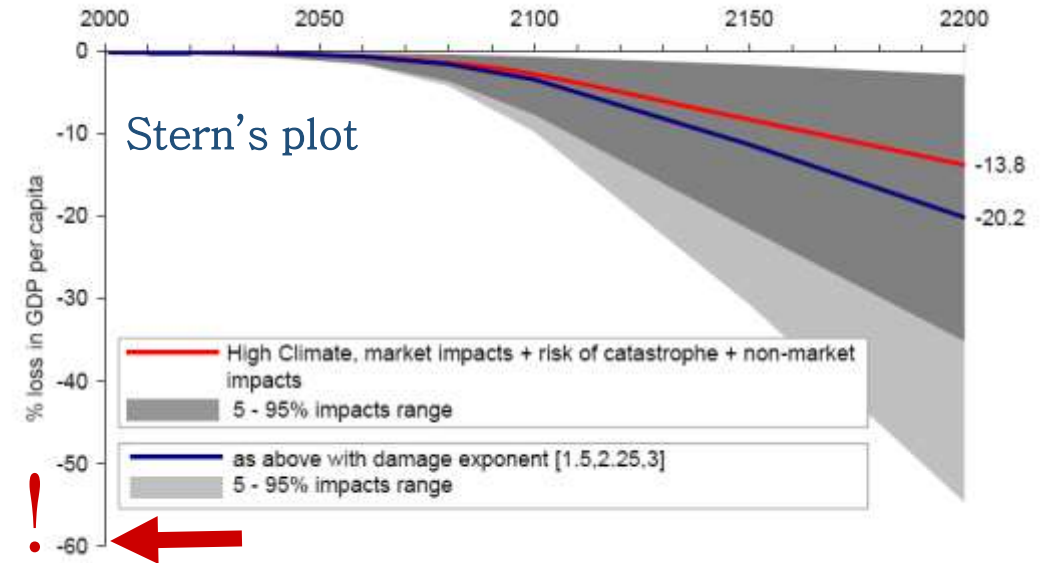
Mathematical models predicting the damage in dollars from hurricanes and draughts up to the year 2300

## 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



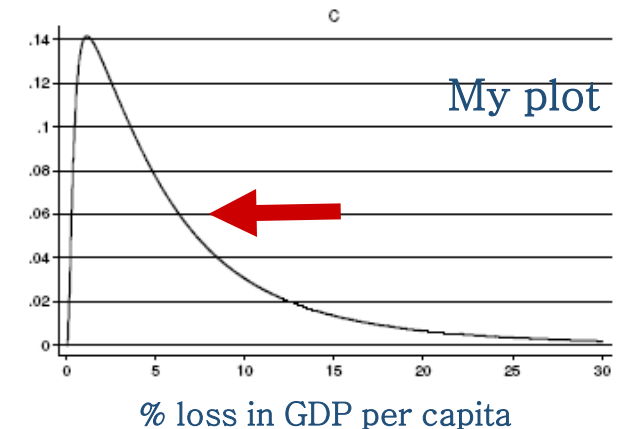
Global Environmental Change 20 (2010) 298–302



Contents lists available at ScienceDirect

Global Environmental Change

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



# The Politics of Modelling

Numbers Between Science and Policy

Foreword

Mathematical modelling as a critical cultural enterprise

*Wendy Nelson Espeland*<sup>1</sup>



*Wendy Nelson Espeland*

Preface

The sciences of modelling through

*Daniel Sarewitz*



*Daniel Sarewitz*



# The Politics of Modelling

## PART I. MEETING MODELS

1. Introduction  
*Monica Di Fiore and Andrea Saltelli*
2. Pay no attention to the model behind the curtain  
*Philip B. Stark*



*Monica Di Fiore*



*Philip Stark*



# The Politics of Modelling

## PART II. THE RULES

3. Mind the framings: Match purpose and context  
*Monica Di Fiore, Marta Kuc-Czarnecka, Samuele Lo Piano, Arnald Puy, and Andrea Saltelli*
4. Mind the hubris: Complexity can misfire  
*Arnald Puy and Andrea Saltelli*
5. Mind the assumptions: Quantify uncertainty and assess sensitivity  
*Emanuele Borgonovo*
6. Mind the consequences: Quantification in economic and public policy  
*Wolfgang Drechsler and Lukas Fuchs*
7. Mind the unknowns: Exploring the politics of ignorance in mathematical models  
*Andy Stirling*

*Arnald Puy*



*Emanuele Borgonovo*



*Andy Stirling*



*Wolfgang Drechsler*



# The Politics of Modelling

## PART III. THE RULES IN PRACTICE

8. Sensitivity auditing: A practical checklist for auditing decision-relevant models  
*Samuele Lo Piano, Razi Sheikholeslami, Arnald Puy, and Andrea Saltelli*
  9. Mathematical modelling: Lessons from composite indicators  
*Marta Kuc-Czarnecka and Andrea Saltelli*
  10. Mathematical modelling, rule-making, and the COVID-19 pandemic  
*Ting Xu*
  11. In the twilight of probability: COVID-19 and the dilemma of the decision maker  
*Paolo Vineis and Luca Savarino*
  12. Models as metaphors  
*Jerry R. Ravetz*
- Epilogue: Those special models: A political economy of mathematical modelling  
*Andrea Saltelli and Monica Di Fiore*

Samuele  
Lo Piano



Marta Kuc-  
Czarnecka



Paolo Vineis



Ting Xu

2

## Pay no attention to the model behind the curtain

*Philip B. Stark*



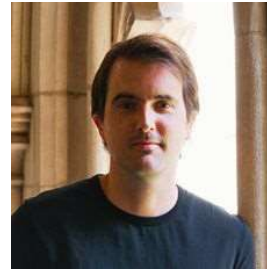
*Philip Stark*

4

## Mind the hubris

Complexity can misfire

*Arnald Puy and Andrea Saltelli*



*Arnald Puy*

8

## Sensitivity auditing

A practical checklist for auditing decision-relevant models

*Samuele Lo Piano, Razi Sheikholeslami, Arnald Puy, and Andrea Saltelli*



*Samuele Lo Piano*



*Razi Sheikholeslami*

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Mind the unknowns

← Exploring the politics of ignorance in mathematical models

Andy Stirling



Ting Xu

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← Mathematical modelling, rule-making, and the COVID-19 pandemic

Ting Xu

## Epilogue: Those special models

A political economy of mathematical modelling

*Andrea Saltelli and Monica Di Fiore*

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BOOKS ET AL. | MODELING


## The responsibility turn

Lessons from the COVID-19 pandemic inspire a guide to recognizing the politics of modeling

[EHSAN NABAVI](#) AND [SAMAN RAZAVI](#) [Authors Info & Affiliations](#)

SCIENCE • 16 Nov 2023 • Vol 382, Issue 6672 • p. 775 • DOI:10.1126/science.adl3473

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BOOKS ET AL.

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## The Politics Behind Overinterpreted and Underexplored Models: A Review of Andrea Saltelli and Monica Di Fiore (eds.), *The Politics of Modelling - Numbers between Science and Policy*

Oxford, UK: Oxford University Press, 2023

Book Review | Published: 17 February 2024

Volume 62, pages 141–144, (2024) Cite this article



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1. Campbell, P. J. (14 March 2024). "Reviews: Saltelli, Andrea, and Monica Di Fiore (eds.), *The Politics of Modelling: Numbers Between Science and Policy*, Oxford University Press". *Mathematics Magazine*. **97** (2). Taylor & Francis: 234–235. doi:10.1080/0025570X.2024.2313390. ISSN 0025-570X.
2. Elsawah, S. (2024). "A Review of Andrea Saltelli and Monica Di Fiore (eds.), *The Politics of Modelling - Numbers between Science and Policy*". *Environmental Modelling and Software*. doi:10.1016/j.envsoft.2024.106023.
3. Nabavi, E., Razavi, S. (17 November 2023). "The responsibility turn *The Politics of Modelling: Numbers Between Science and Policy* Andrea Saltelli and Monica Di Fiore, Eds. Oxford University Press, 2023. 272 pp". *Science* (New York, N.Y.). **382** (6672): 775. doi:10.1126/science.adl3473. ISSN 1095-9203.
4. Melsen, L. A. (17 February 2024). "*The Politics Behind Overinterpreted and Underexplored Models: A Review of Andrea Saltelli and Monica Di Fiore (eds.), The Politics of Modelling - Numbers between Science and Policy*". *Minerva*. doi:10.1007/s11024-024-09524-4. ISSN 1573-1871.



*The Politics of Modelling, Numbers Between Science and Policy*

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# Occasion for the book: 2020 manifesto

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## 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.**

By [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](#)

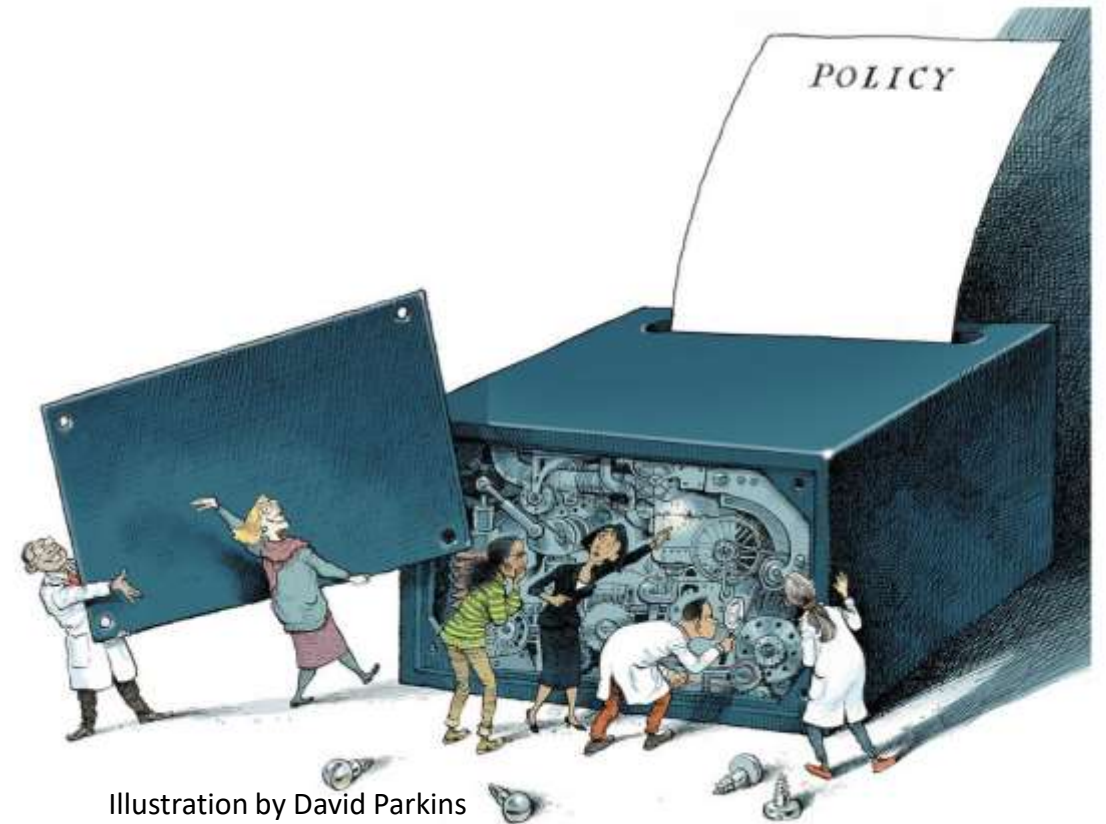
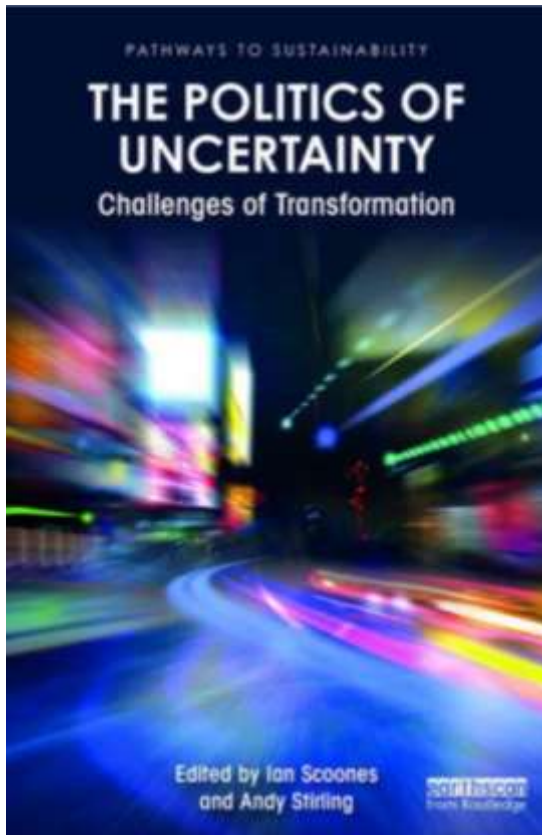
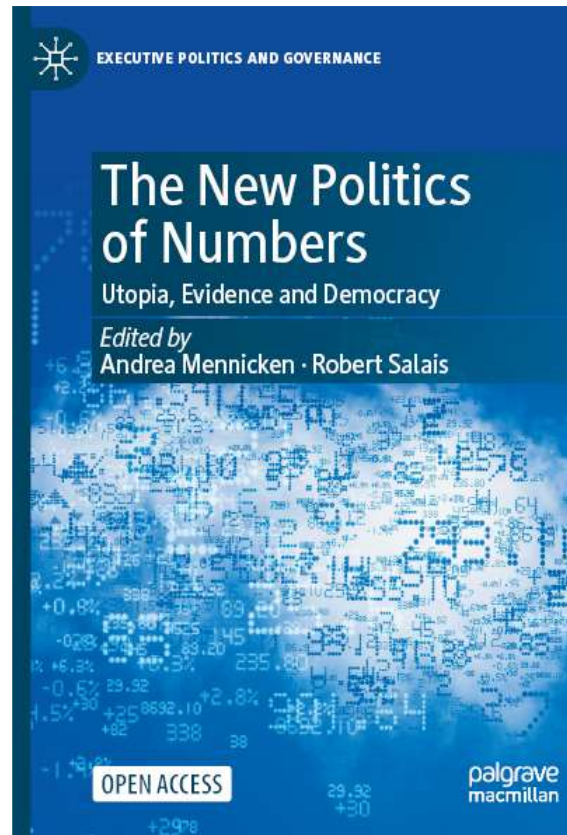


Illustration by David Parkins



2020

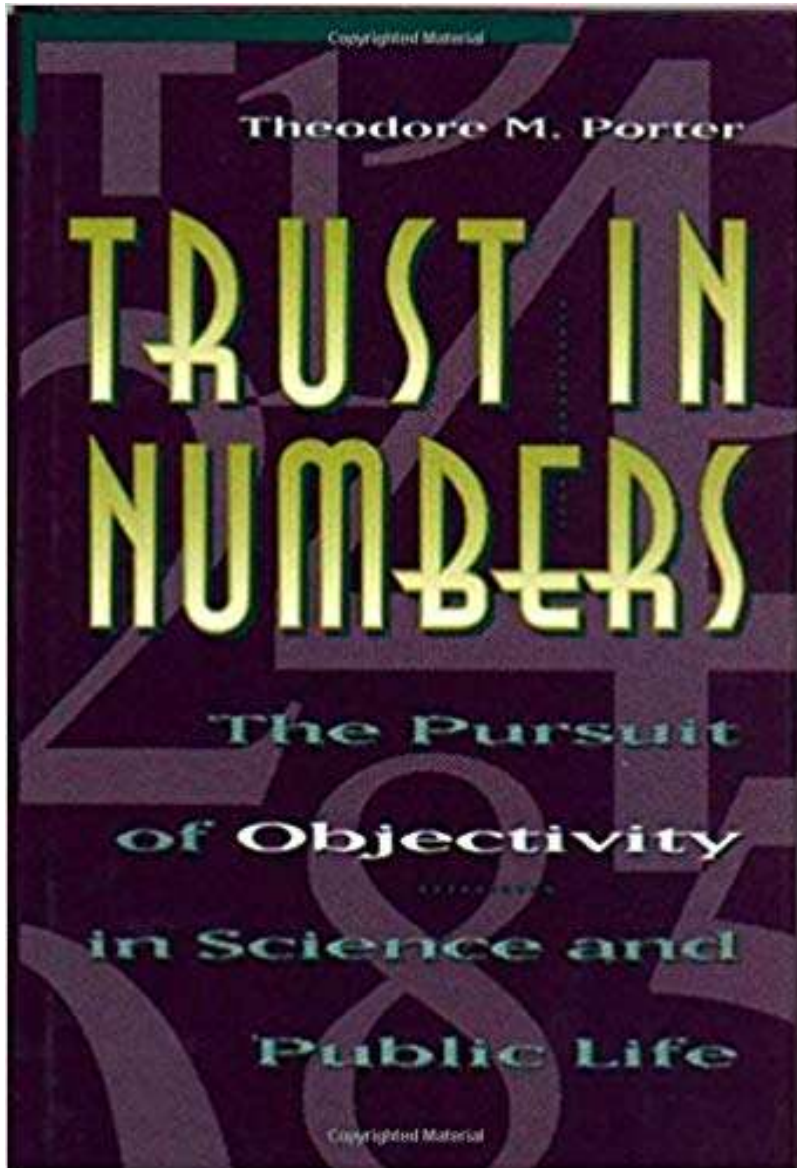


2022



2023

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



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

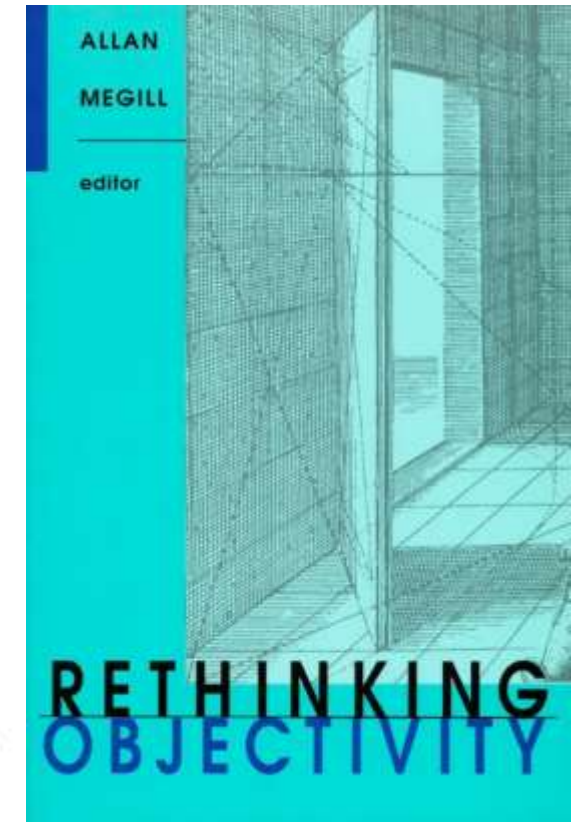
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Objectivity as Standardization:  
The Rhetoric of Impersonality in  
Measurement, Statistics,  
and Cost-Benefit Analysis

THEODORE M. PORTER

*1. Quantification makes knowledge impersonal,  
hence objective.*



# Numbers, visible and invisible...



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**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<sup>1</sup>, and Wendy Nelson Espeland<sup>2</sup>

[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

Blurring lines:

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



Elizabeth  
Popp Berman

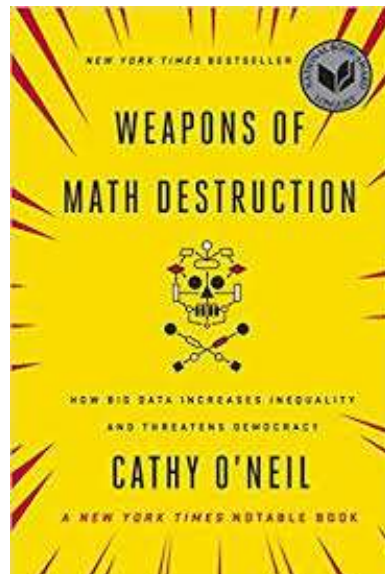
E. Popp Berman and D. Hirschman, *The Sociology of Quantification*: Where Are We Now?, *Contemp. Sociol.*, vol. in press, 2017.

# Powered by algorithms, governance by (visible and invisible) numbers contributes to a loss of democratic agency (a-democracy)

2015  
(jurist)



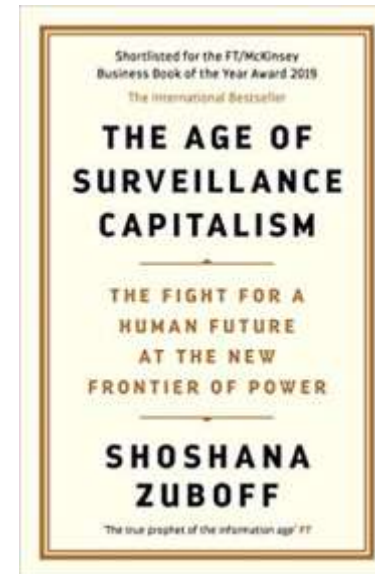
2016  
(data scientist)



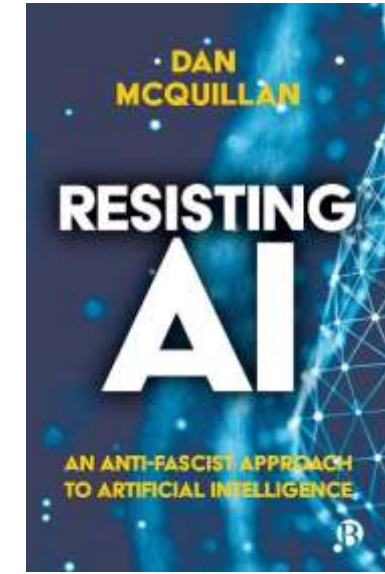
2017  
(philosopher)



2019  
(economist)



2022  
(physicist/sociologist)



# From loss of political agency to identity politics

## The Clash Of Civilizations Is The Politics Of The End of History

Reflections by the philosopher Slavoj Žižek on universality and "workless places."

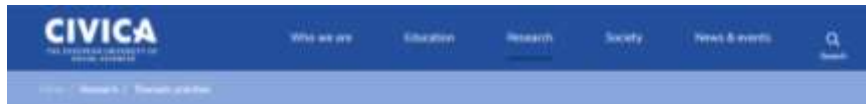
ESSAY GEOPOLITICS & GLOBALIZATION

BY NATHAN GARDELS

MAY 3, 2024



“The only remaining legitimate source of conflicts are cultural (ethnic, religious) tensions → rise of ‘irrational’ populism result from the disappearance of the proper political dimension” (Slavoj Žižek)



### Thematic priorities

As CIVICA, we strive to find solutions to complex societal challenges around four thematic priorities. We chose these topics because they reflect both pressing contemporary issues and our joint expertise.

Visit the pages to learn more about the specific research topics, seminars, events, and the thematic groups from the alliance that are working on each of the CIVICA priorities.



Data-Driven Technologies for the Social Sciences



Democracy in the 21st Century



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Societies in Transition, Crises of Earth



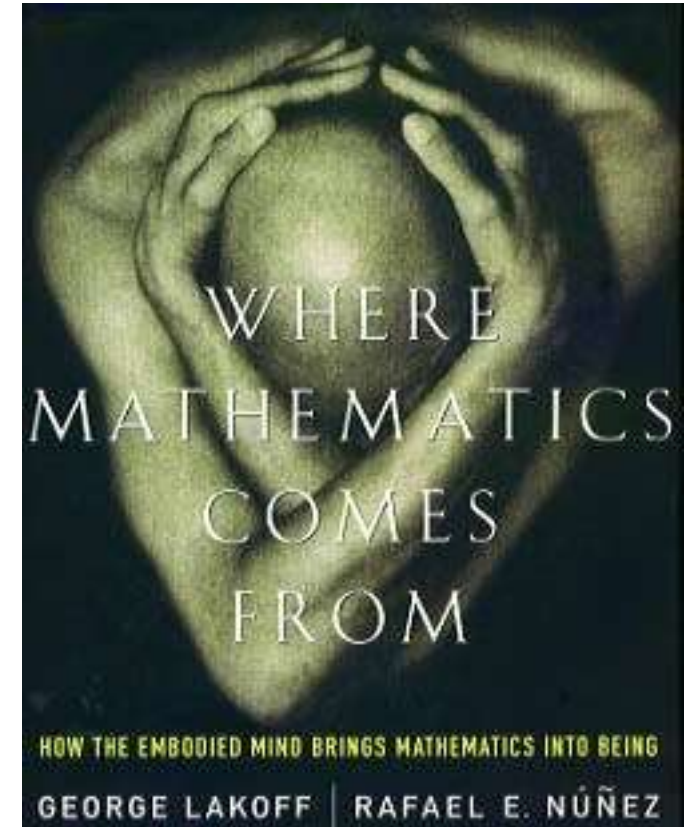
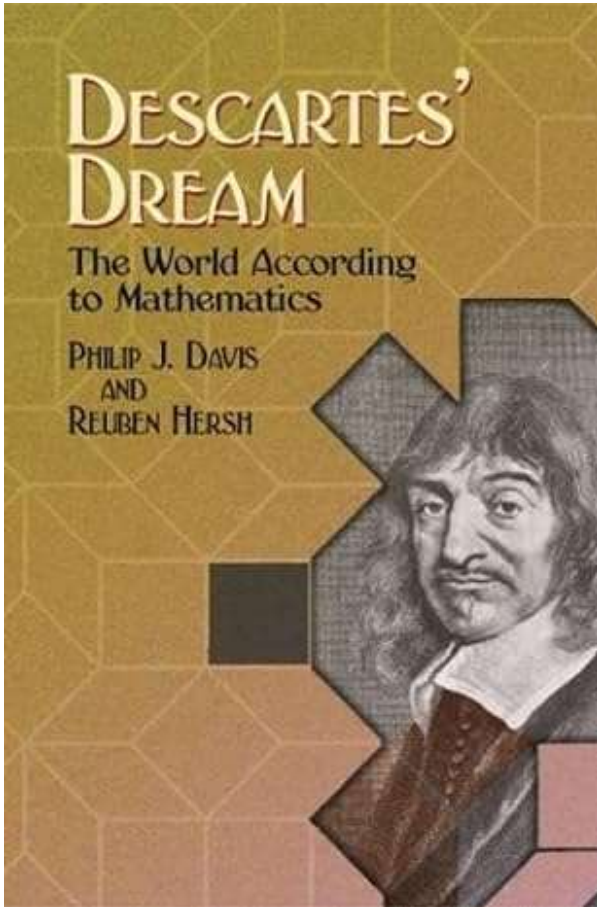
Relevant to EUI clusters

<https://www.noemamag.com/the-clash-of-civilizations-is-the-politics-of-the-end-of-history/>

# Why models live in a state of exception

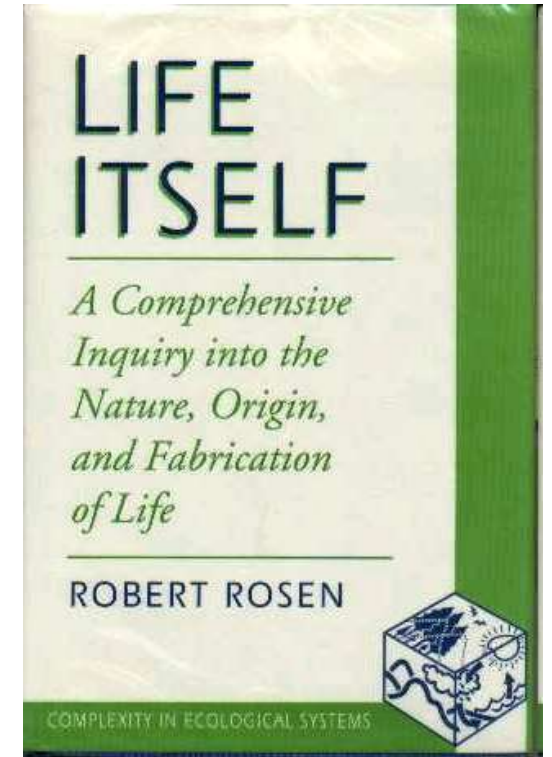
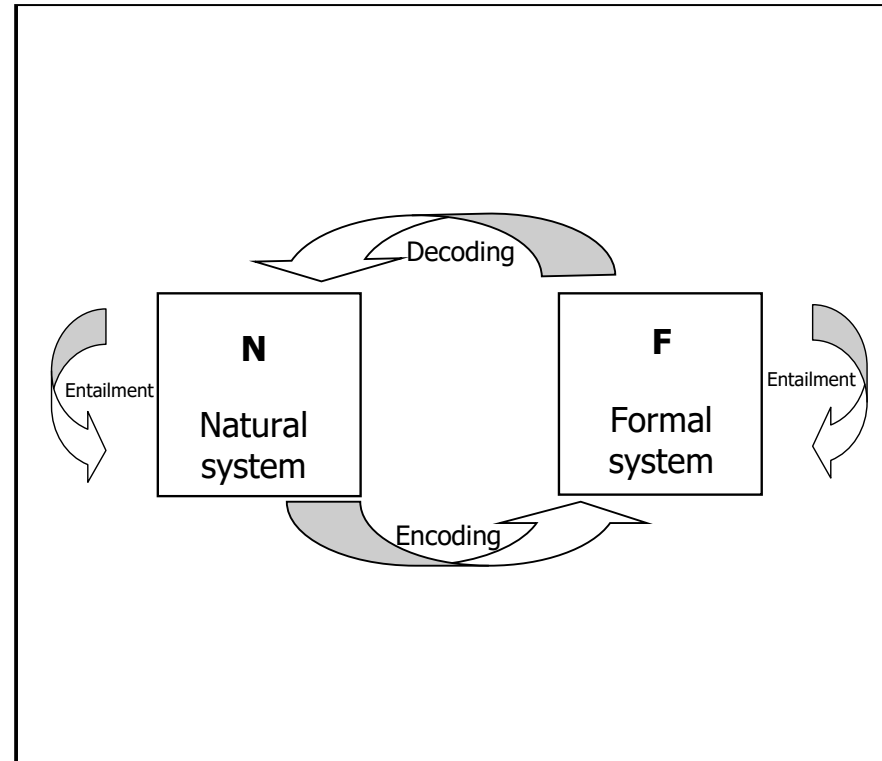
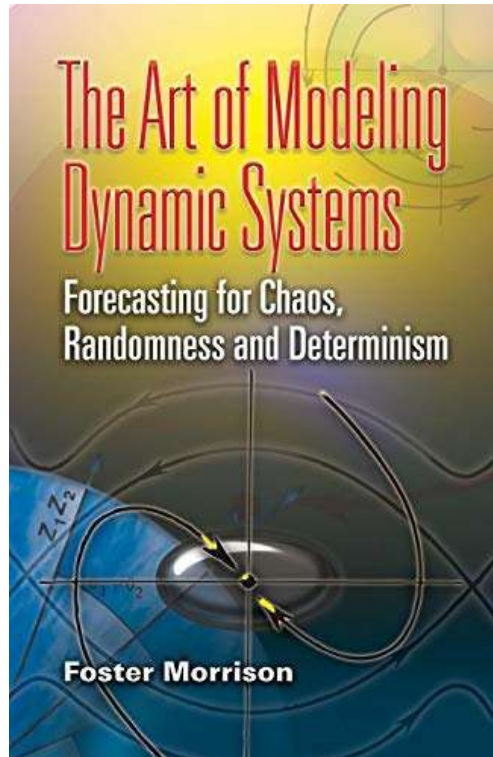
## Unparalleled palette of methods / epistemic authority

Models dispose of a unique **repertoire of methods**. Are endowed with unparalleled **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).



# Why models live in a state of exception

**Lack of agreed standards. Modelling as art/craft (Rosen).**



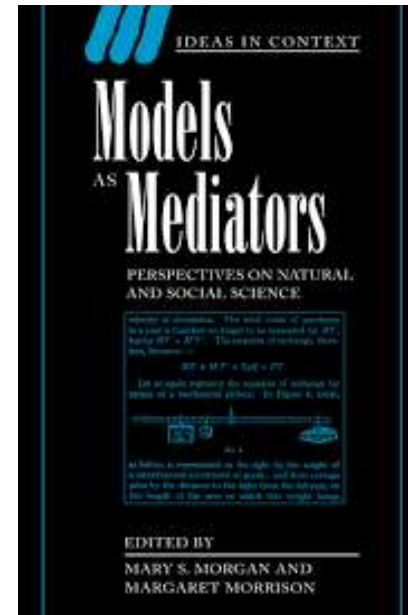
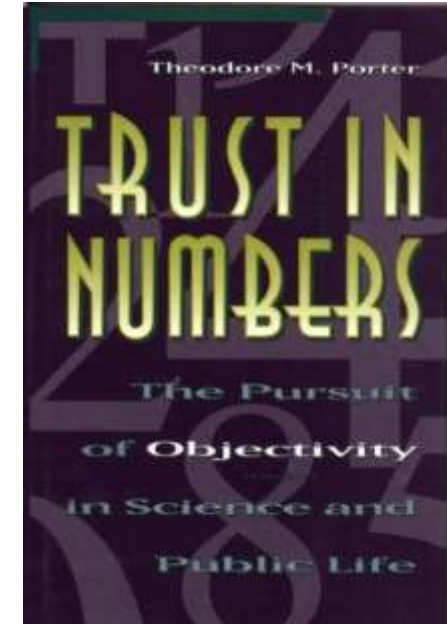
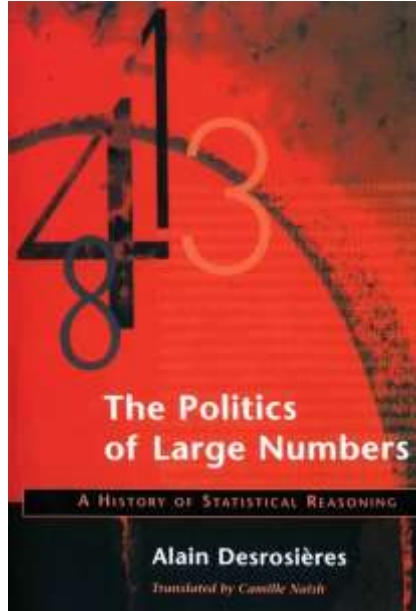
Louie, A.H. 2010. “Robert Rosen’s Anticipatory Systems.” *Foresight* 12 (3): 18–29.

Padilla, J. J., Diallo, S. Y., Lynch, C. J., & Gore, R. (2018). Observations on the practice and profession of modeling and simulation: A survey approach. *SIMULATION*, 94(6), 493–506.

# 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 treats impact assessment tools such as cost benefit analysis (Porter, 1995). Little on modelling, see an exception in (Morgan & Morrison, 1999).



# Why models live in a state of exception

**Mathematical models escape sociology of quantification**

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](#)

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**Model have a better pretense to neutrality than other instances of quantification**

A technical proof of quality is illusory without a parallel investigation of normative quality; the example of indicators of employment

Technical Quality

Normative quality

Justice: Means versus Freedoms

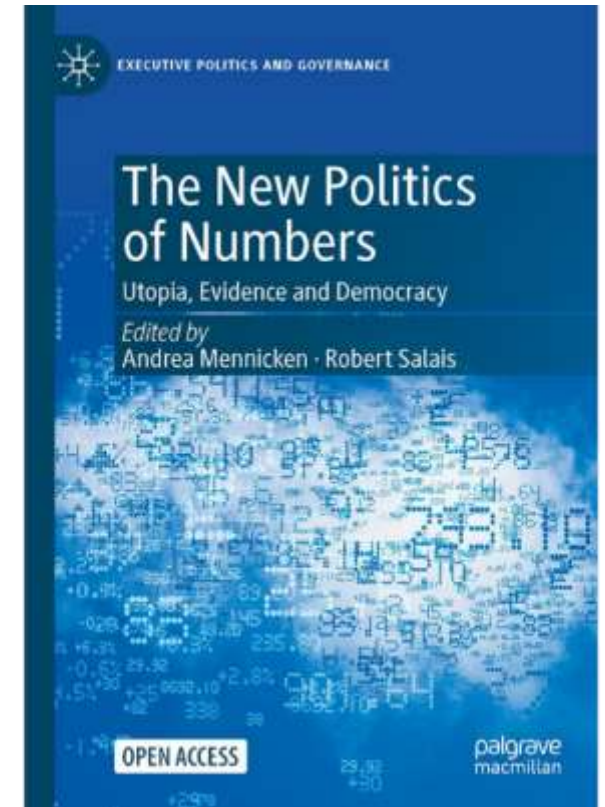
Author(s): Amartya Sen

Source: *Philosophy & Public Affairs*, Vol. 19, No. 2 (Spring, 1990), pp. 111-121

Published by: [Wiley](#)

Stable URL: <http://www.jstor.org/stable/2265406>

Accessed: 28/10/2014 14:48



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.

# Why models live in a state of exception

## **Mathematical models are extremely malleable**

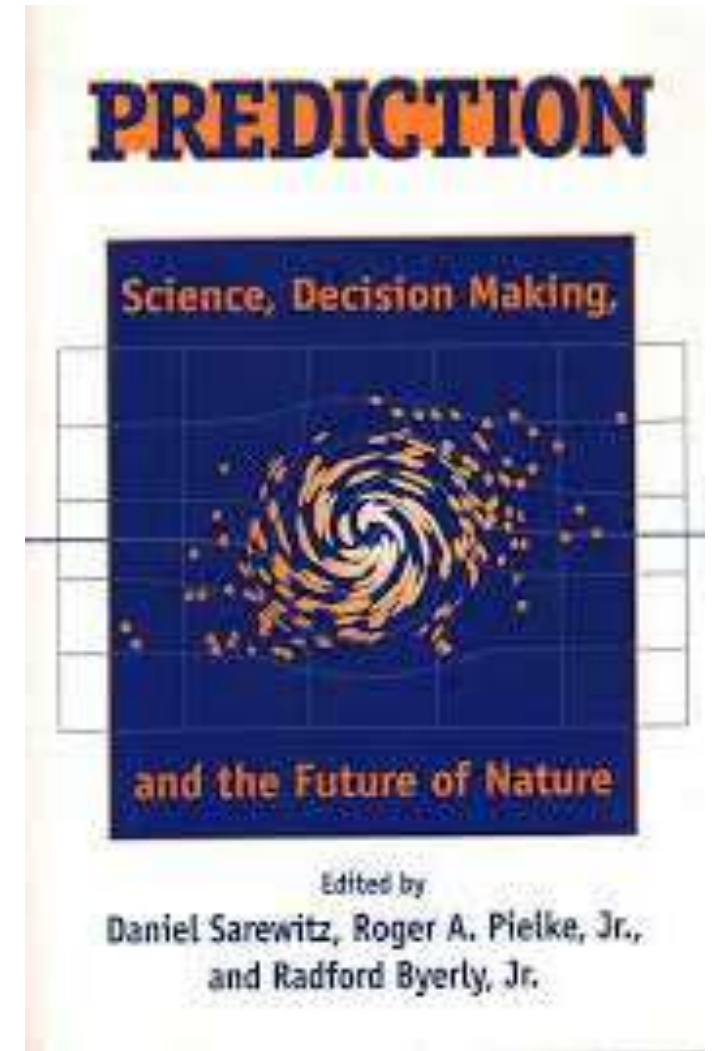
Models lend themselves very naturally to evidence based policy. In statistics you have to reverse the statistical pyramid to achieve the same result – this goes much faster with models

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

# 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).



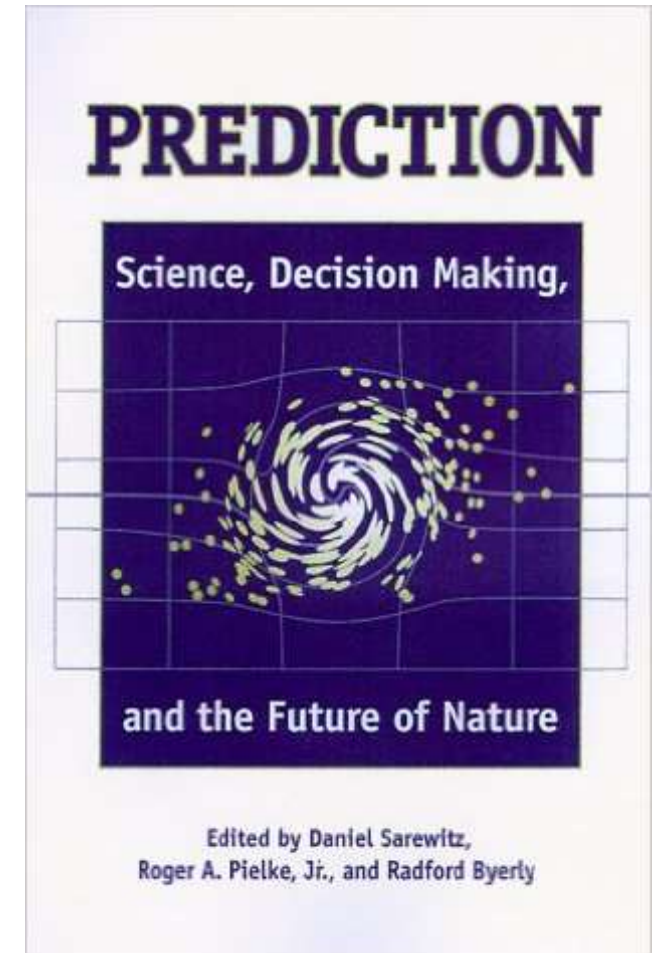
“models are most useful when they are used to challenge existing formulations, rather than to validate or verify them”



Naomi  
Oreskes

N. Oreskes, K. Shrader-Frechette, and K. Belitz, “Verification, Validation, and Confirmation of Numerical Models in the Earth Sciences,” *Science*, 263, no. 5147, 1994.

# Models are not physical laws



Oreskes, N., 2000, Why predict? Historical perspectives on prediction in Earth Science, in Prediction, Science, Decision Making and the future of Nature, Sarewitz et al., Eds., Island Press, Washington DC

“When a model generates a prediction, of what precisely is the prediction a test? The laws? The input data? The conceptualization?

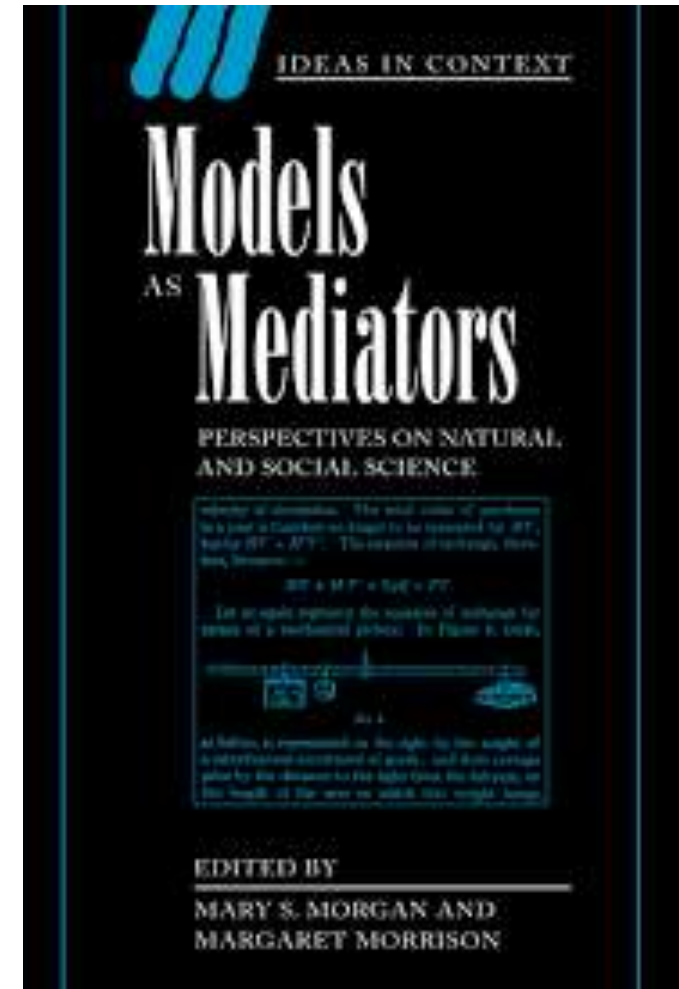
Any part (or several parts) of the model might be in error, and there is no simple way to determine which one it is” (Oreskes, 2000)

→ Duhem–Quine critique

# 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 act as “mediators”, instruments that advance understanding thanks to the tacit craftsmanship of scientists (Morgan & Morrison 1999).



# Why models live in a state of exception

## Models as the most effective mediators between theory and reality

Models are metaphors that 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).



## Extended peer community

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From Wikipedia, the free encyclopedia

The concept of **Extended peer community** belongs to the field of [Sociology of science](#), and in particular the use of science in the solution of social, political or ecological problems. It was first introduced by in the 1990s by [Silvio Funtowicz](#) and [Jerome R. Ravetz](#).<sup>[1]</sup> in the context of what would become [Post-normal science](#). An **Extended peer community** is intended by these authors as a space where both credentialed experts from different disciplines and lay stakeholders can discuss and deliberate.

# 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). There are ‘black boxes’ also in other families of quantification, typically algorithms or statistics. Yet this asymmetry may be larger for mathematical models.



# Consequences descending from state of exception

## Ritual use

An important analogy between statistical and mathematical modelling is in the ‘ritual’ use of methods. Rituals in statistics are described in Gigerenzer (Gigerenzer, 2018; Gigerenzer & Marewski, 2015). For models here an anecdote by Kenneth Arrow: producing one month-ahead weather forecasts

*“... 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); See also politicians’ claim:

‘We follow the science’ during COVID-19



Kenneth Arrow

# Consequences descending from state of exception

## Models and trans-science

Models lend themselves to trans-science (Weinberg, 1972).

- How many people will sit in autonomous cars by 2050
- How will the spread of malaria change if global temperature increases by 1.5°C
- What will be the cost of CO<sub>2</sub> averaged over the next three centuries

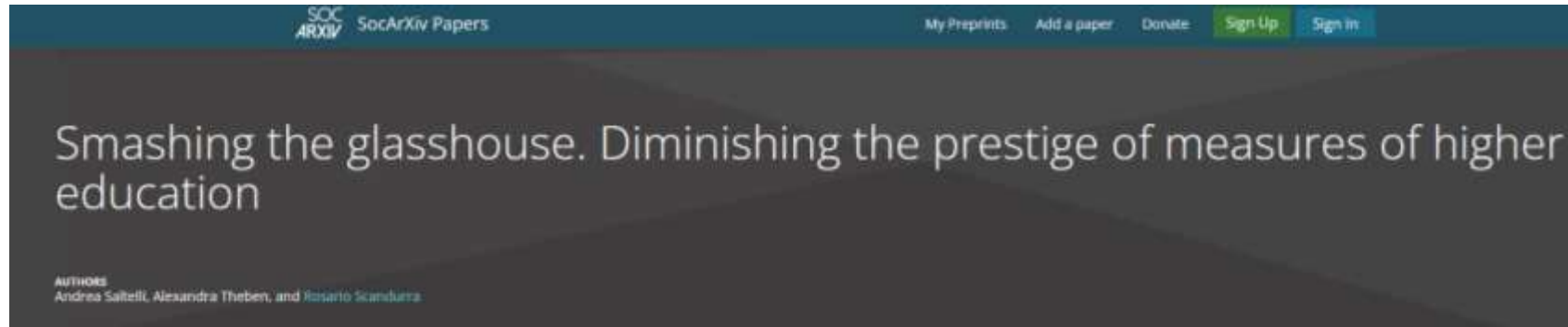
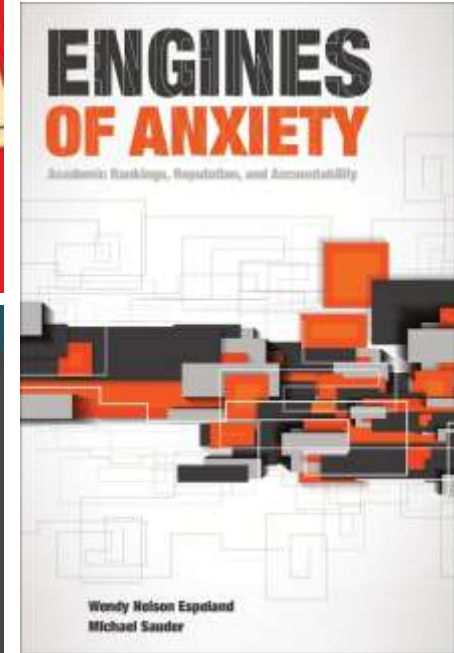
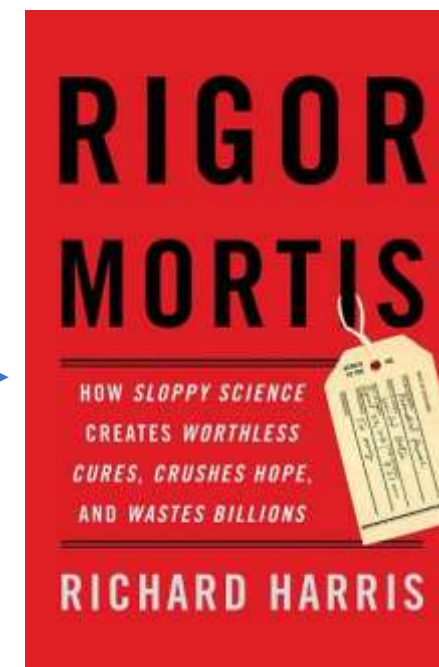
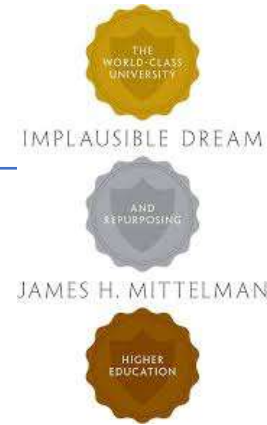


Alvin Weinberg



Scope for harm from ‘wrong numbers’  
e.g. in :

- Medical research
- Governance of science
- Higher education
- Finance



Why ethics of quantification  
is needed now



UCL Institute for  
Innovation and  
Public Purpose

WORKING PAPER  
WP 2021/05

Scope for harm from ‘wrong numbers’ e.g.:

- ...
- Numbers from international organizations
  - Food and Agriculture Organization
  - The World Bank
  - OECD (see PISA!) →
  - ...
- ...

erms here

International Journal of Comparative Education and Development / Volume 19 Issue 1 / Do PISA data justify PISA-based education

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## Do PISA data justify PISA-based education policy?

Luisa Araujo, Andrea Saltelli, Sylke V. Schnepf ▾

International Journal of Comparative Education and  
Development

ISSN: 2396-7404

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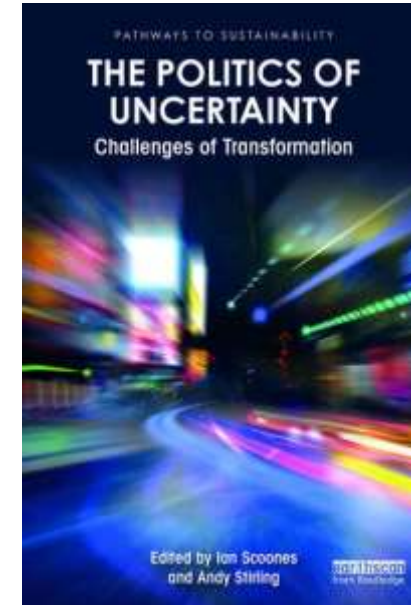
ALTMETRICS



28

‘Trendy’ methods may also harm

- Randomized control trials) may be misused to suggest more general conclusions that may not be valid
- Sophisticated statistical/econometric techniques that can be designed in ways that promote particular policy conclusions reflecting researchers’ biases



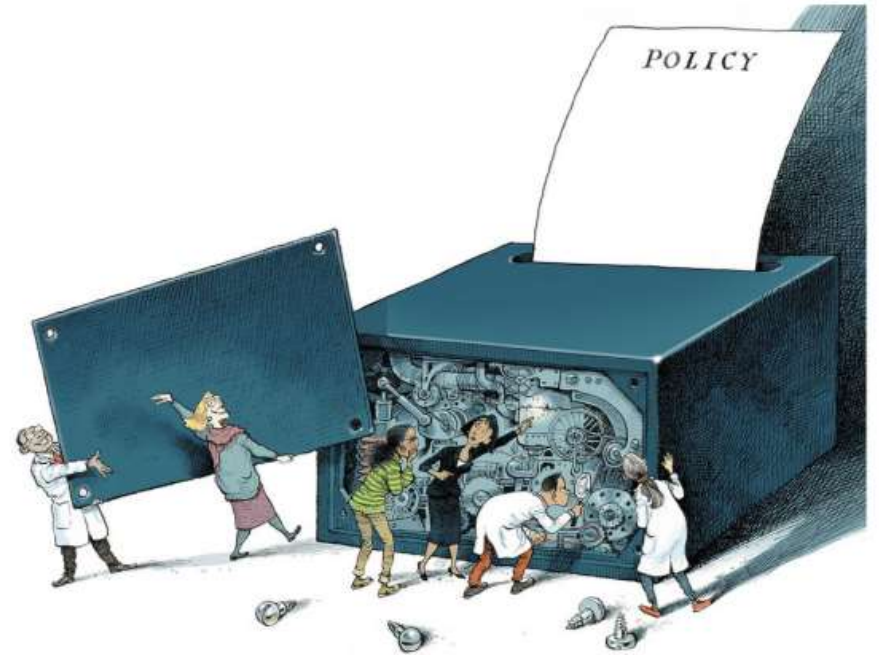
# Mind the assumptions

Assess uncertainty and sensitivity



## Mind the hubris

Complexity can be the enemy of relevance



## Mind the framing

Match purpose and context



More example of good and bad models in the Manifesto, it supplementary material, and in the book

## Mind the consequences

Quantification can backfire.

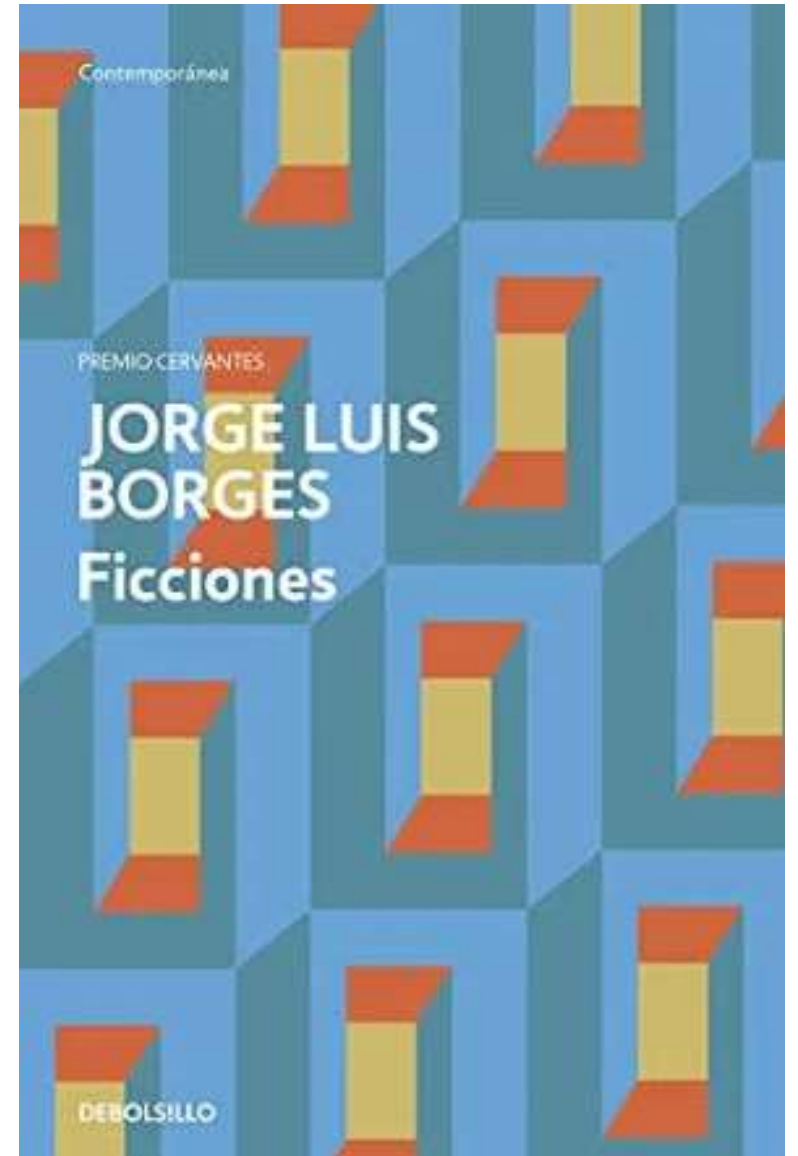
## Mind the unknowns

Acknowledge ignorance

# Consequences descending from state of exception

## One to one map of the empire

Model as Jorge Luis Borges' (1946) one-to-one map of the empire



## A digital twin of Earth for the green transition

For its green transition, the EU plans to fund the development of digital twins of Earth. For these twins to be more than big data atlases, they must create a qualitatively new Earth system simulation and observation capability using a methodological framework responsible for exceptional advances in numerical weather prediction.

Peter Bauer, Bjorn Stevens and Wilco Hazeleger

The European Union (EU) intends to become climate neutral by 2050, and the set of policies designed to bring about this green transition — the European Green Deal — was announced in December 2019 (ref. 1). Accompanied by €1 trillion of planned investment, Green Deal policies aim to help the world's second-largest economy sustainably produce energy, develop carbon-neutral fuels and advance circular products in energy-intensive industrial sectors with zero waste and zero pollution.

A key element of the Green Deal is its dependence on the 'digital transformation' — an openly accessible and interoperable European dataspace as a central hub for informed decision making. The EU identified two landmark actions to support the necessary information systems: GreenData4All<sup>2</sup> and Destination Earth<sup>3</sup>. Whereas GreenData4All will develop the European approach to discover, manage and exploit geospatial information, Destination Earth aims to construct highly accurate models, or 'digital twins', of the Earth to monitor and predict environmental change and human impact in support of sustainable development. Aligned with the new Digital Europe funding programme<sup>4</sup>, Destination Earth is expected to start in 2021, and the first, high-priority digital twins serving extremes prediction and climate change adaptation will



Credit: Map of Layerace / Freepik

## Digital Twins of the Earth - in the EU Destination Earth

[nature](#) > [nature reviews earth & environment](#) > [review articles](#) > [article](#)

Review Article | [Published: 02 May 2023](#)

## Big Data in Earth system science and progress towards a digital twin

[Xin Li](#) , [Min Feng](#) , [Youhua Ran](#), [Yang Su](#), [Feng Liu](#), [Chunlin Huang](#), [Huanfeng Shen](#), [Qing Xiao](#), [Jianbin Su](#), [Shiwei Yuan](#) & [Huadong Guo](#)

[Nature Reviews Earth & Environment](#) **4**, 319–332 (2023) | [Cite this article](#)

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[Submitted on 19 Jun 2023]

### Developing Digital Twins for Earth Systems: Purpose, Requisites, and Benefits

[Yuhan Rao](#), [Rob Redmon](#), [Kirstine Dale](#), [Sue E. Haupt](#), [Aaron Hopkinson](#), [Ann Bostrom](#), [Sid Boukabara](#), [Thomas Geenen](#), [David M. Hall](#), [Benjamin D. Smith](#), [Dev Niyogi](#), [V. Ramaswamy](#), [Eric A. Kihn](#)

The accelerated change in our planet due to human activities has led to grand societal challenges including health crises, intensified extreme weather events, food security, environmental injustice, etc. Digital twin systems combined with emerging technologies such as artificial intelligence and edge computing provide opportunities to support planning and decision-making to address these challenges. Digital twins for Earth systems (DT4ESs) are defined as the digital representation of the complex integrated Earth system including both natural processes and human activities. They have the potential to enable a diverse range of users to explore what-if scenarios across spatial and temporal scales to improve our understanding, prediction, mitigation, and adaptation to grand societal challenges. The 4th NOAA AI Workshop convened around 100 members who are developing or interested in participating in the development of DT4ES to discuss a shared community vision and path forward on fostering a future ecosystem of interoperable DT4ES. This paper summarizes the workshop discussions around DT4ES. We first defined the foundational features of a viable digital twins for Earth system that can be used to guide the development of various use cases of DT4ES. Finally, we made practical recommendations for the community on different aspects of collaboration in order to enable a future ecosystem of interoperable DT4ES, including equity-centered use case development, community-driven investigation of interoperability for DT4ES, trust-oriented co-development, and developing a community of practice.

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

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 -

Today, the future is literally at our fingertips ”

- Margrethe Vestager -

By [Rosie Frost](#) & Angela Symons

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

**YOU CONTROL  
CLIMATE CHANGE.**



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# The more things change, the more they stay the same: promises of bioeconomy and the economy of promises

Special Feature: Editorial | [Open Access](#) | Published: 23 March 2023 | 18, 557–568 (2023)[Download PDF](#)You have full access to this [open access](#) article[Sustainability Science](#)[Aims and scope](#) →[Submit manuscript](#) →[Dennis Eversberg](#) ✉, [Philip Koch](#), [Rosa Lehmann](#), [Andrea Saltelli](#), [Sabaheta Ramcilovic-Suominen](#) & [Zora Kovacic](#)2247 Accesses | 5 Citations | 7 Altmetric | [Metrics](#) | [Cite this article](#)[Use our pre-submission checklist](#) →

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More  
critical  
work



Debunking promises  
of circular  
economy, energy  
transitions, ...

## Models for techno-promises

Economics of Techno-scientific Promises' (ETP)= The promise of 'transformation without transformation'

# Consequences descending from state of exception

## Have the strongest grip in policy

Models have their own political economy - economicism, solutionism, reductionism, transforming of the qualitative into quantitative (Stirling, 2023a, 2023b).

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

‘Navigating the political’ (van Beek *et al.* 2022)

Acting as chameleons, jumping across contexts, Pfeleiderer (2020).



Source: National Geographic

# 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.

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](#)

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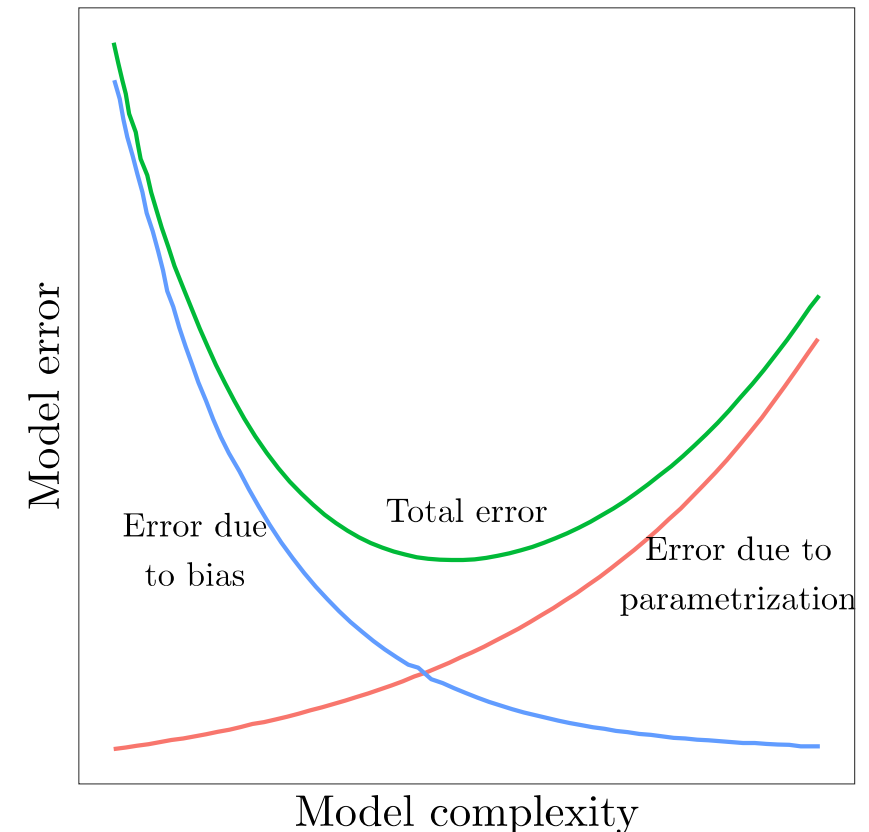
HOME > SCIENCE ADVANCES > VOL. 8, NO. 42 > MODELS WITH HIGHER EFFECTIVE DIMENSIONS TEND TO PRODUCE MORE UNCERTAIN ESTIMATES

 RESEARCH ARTICLE | MATHEMATICS

[f](#) [t](#) [in](#) [d](#) [w](#) [e](#)

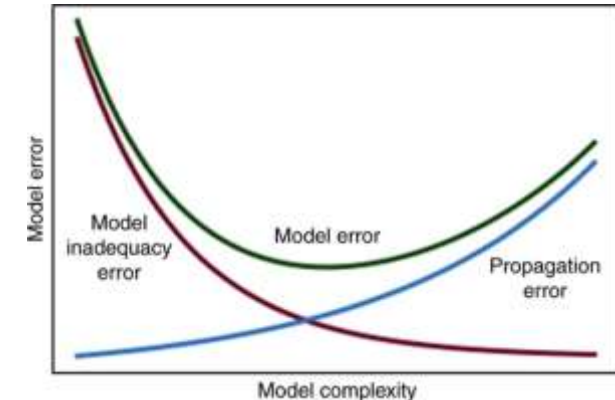
### Models with higher effective dimensions tend to produce more uncertain estimates

ARNALDO PUY , PIERFRANCESCO BENEVENTANO, SIMON A. LEVIN , SAMUELE LO PIANO , TOMMASO PORTALURI, AND ANDREA SALTELLI  [Authors Info &](#)



Solutions to resolve the state of exception  
Modelling of the modelling process  
[ → multiverse analysis (Steege et al 2016) ],  
sensitivity analysis, sensitivity  
auditing for de- and re-construction,  
on the example of statactivism

- retrace what was assumed
- check the level of complexity



➔ 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

## Complexity of interpretation rather than complexity of construction

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).

**Impact of Population Growth:** Complacency concerning this component of man's predicament is unjustified and counterproductive

PAUL R. EHRLICH AND JOHN P. HOLDREN [Authors Info & Affiliations](#)

Science

# 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, 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). From ‘Flattening the curve’ to ... distrust?



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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>



COMMENTARY

Open Access



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

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

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

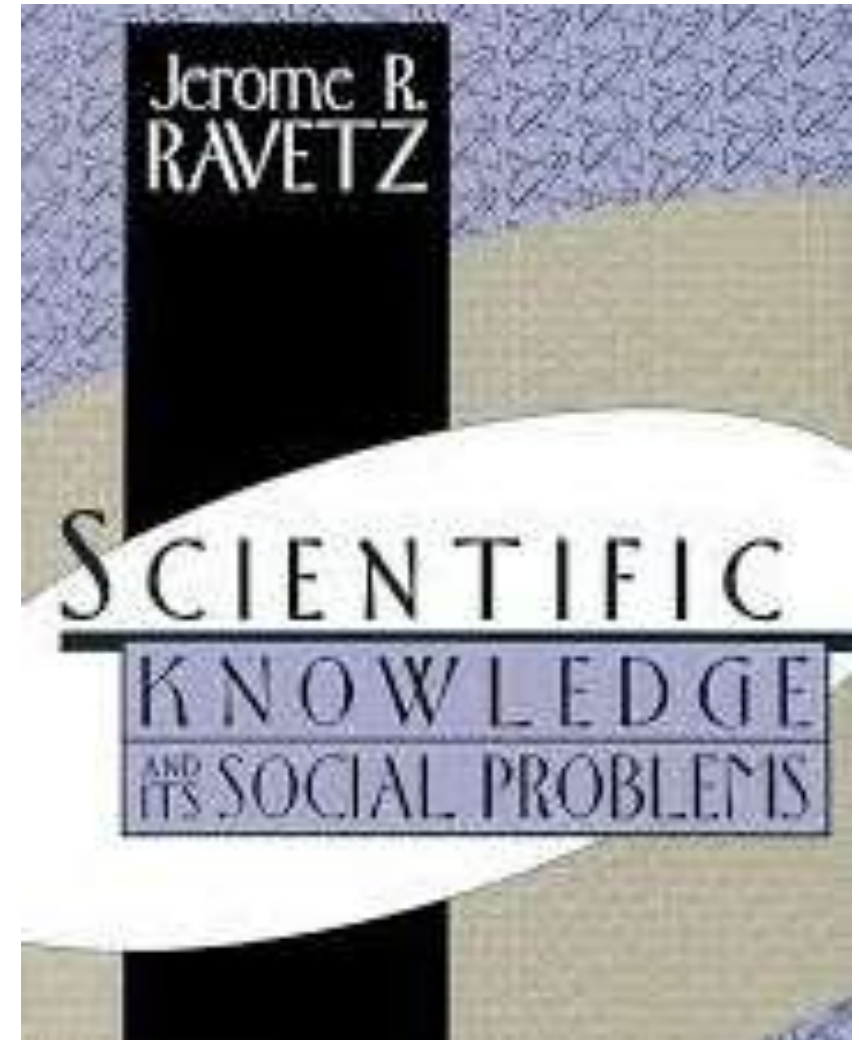
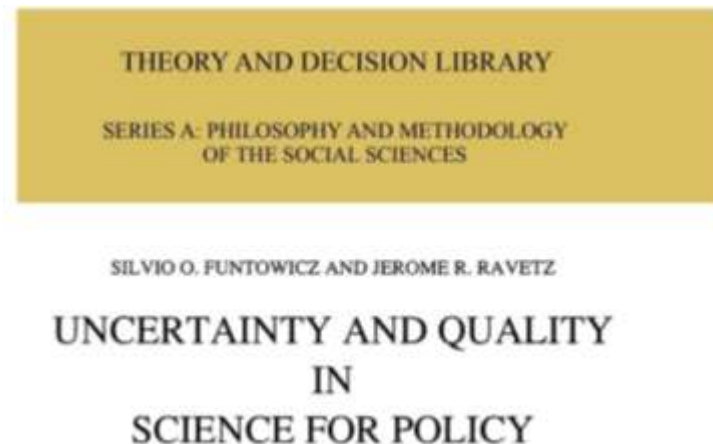
“COVID–19 policies allocated sacrifice, privation and suffering across all walks of society [but] radically different responses from nation to nation—from draconian lockdowns, to relatively permissive and flexible pandemic regimes—made obvious to all that the value of **scientific evidence** was to support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

Mostly provided by models

# 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 at the heart of the scientific method, and *a fortiori* in the use of science for policy.



# Solutions to resolve the state of exception: adopt more lenses

Environmental Science and Policy 142 (2023) 99–111



Contents lists available at [ScienceDirect](#)

## Environmental Science and Policy

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



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

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

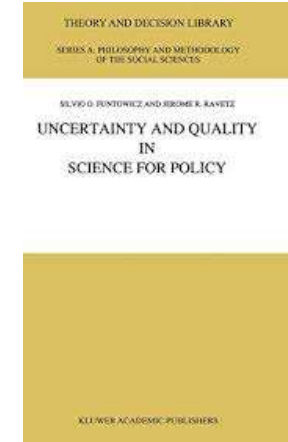
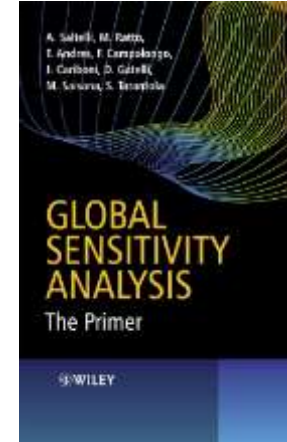
# Proposed lenses

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



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

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



# Contrasting invisibilities

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

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

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



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

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

Nicholas Georgescu-Roegen

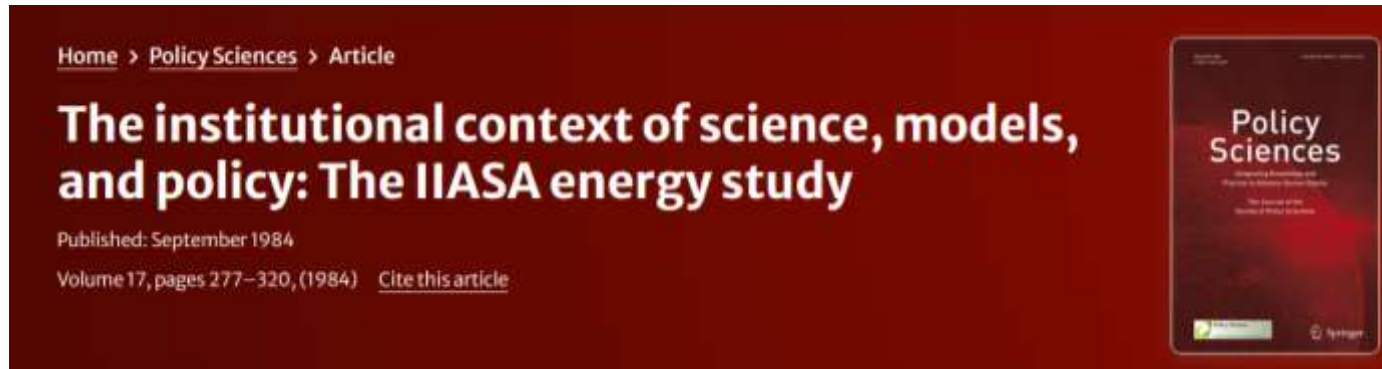


Erik S. Reinert



Jerome Ravetz and Silvio Funtowicz

# Conclusions



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



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

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



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

See a summary here



# END



Summary, extra slides and  
references below



**Abstract:** 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.

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Why is modelling of the global sensitivity analysis 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<sup>†</sup> and Eric Loken<sup>‡</sup>

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<sup>†</sup> and Eric Loken<sup>‡</sup>

14 Nov 2013

Why this matters? 

**PNAS**

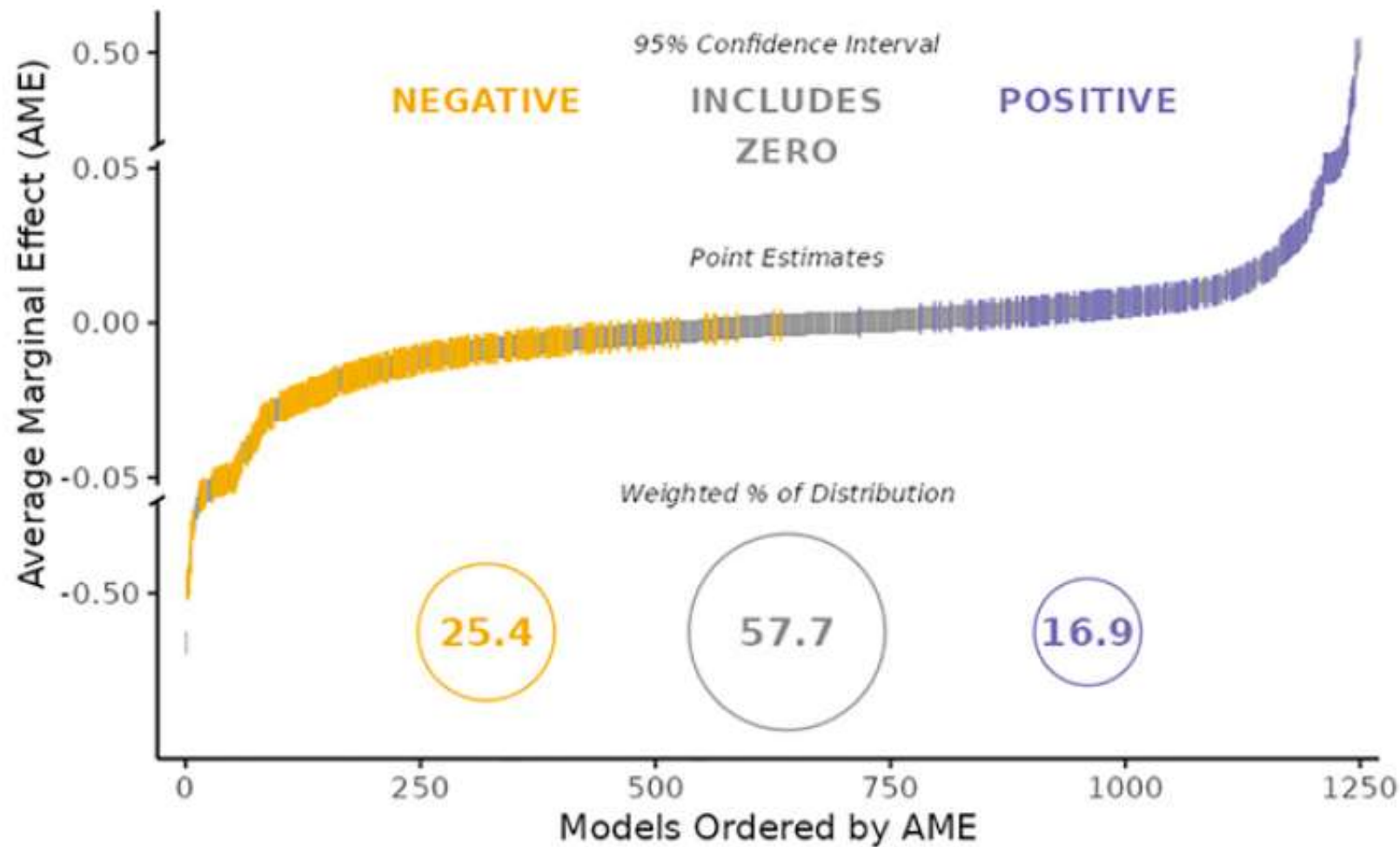
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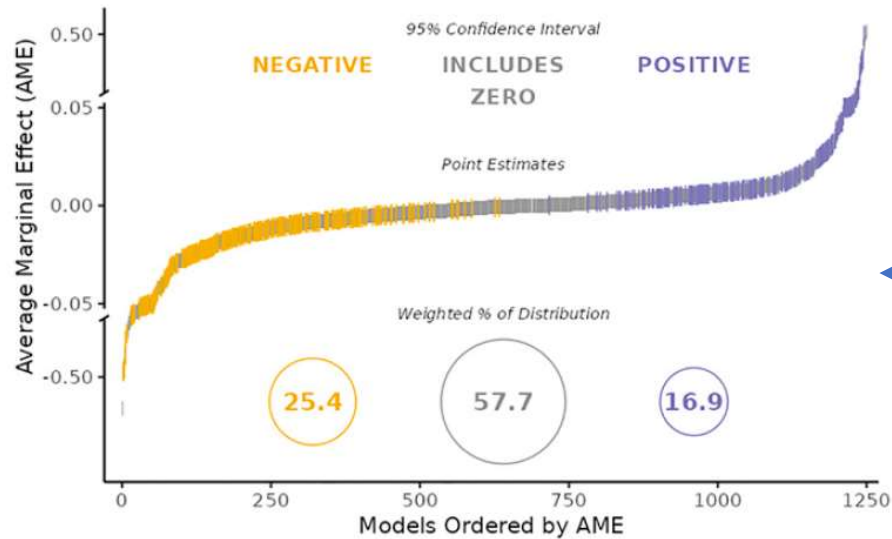
**Observing many researchers using the same data and hypothesis reveals a hidden universe of uncertainty**

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”  
(Bresnau et al. 2022)



Ongoing work:  
reproduce Breznau  
et al.'s results  
using modelling of  
the modelling  
process / global  
sensitivity analysis  
– one team instead  
of 73