Máster Universitario en Administración y Dirección de Empresas

Full Time MBA

Quantitative methods for decision making

Professor Andrea Saltelli

upf. BARCELONA SCHOOL OF MANAGEMENT

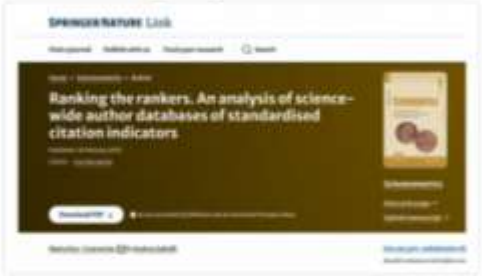
Crunching numbers for sustainability

upf. BARCELONA SCHOOL OF MANAGEMENT

Andrea Saltelli

HOME ABOUT ME PUBLICATIONS NEWS & VIDEOS RESOURCES ← Where to find this talk

Latest papers



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 the Earth, which we associate with a reductionist view of nature as a machine. We contest the utility of digital twins for addressing climate change issues and discuss societal risks associated with the concept, including the twins' potential to reinforce economicism and governance by numbers, emphasizing concerns about democratic accountability...

In this set of slides:

1 Introduction

2 The multiverse of composite indicators

3 Deconstructing

4 (Multi-criteria análisis)

1.

Introduction

A bit of history and some definitions

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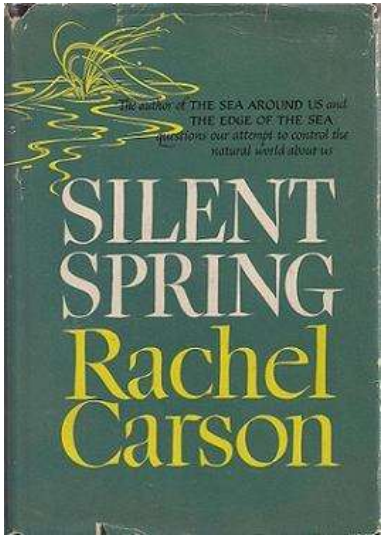
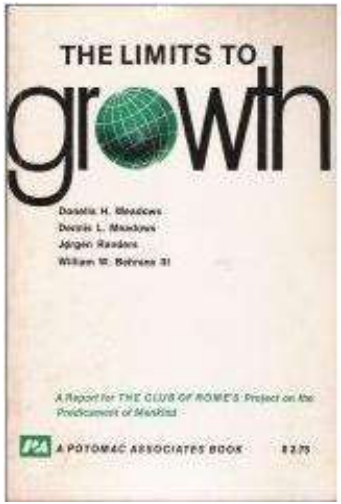
What is sustainability?



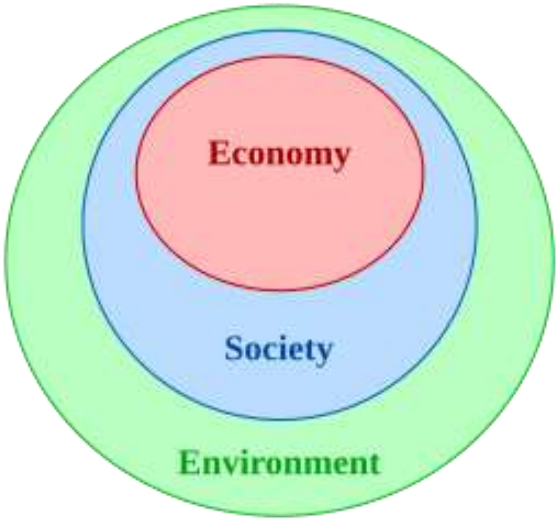
Rachel Carson, 1962



Donella Meadows et al., report for the Club of Rome, 1972

Report for the United Nations by Gro Harlem Brundtland, 1987

What is sustainability?



Images: Wikipedia Commons

A discussion started in the 70's

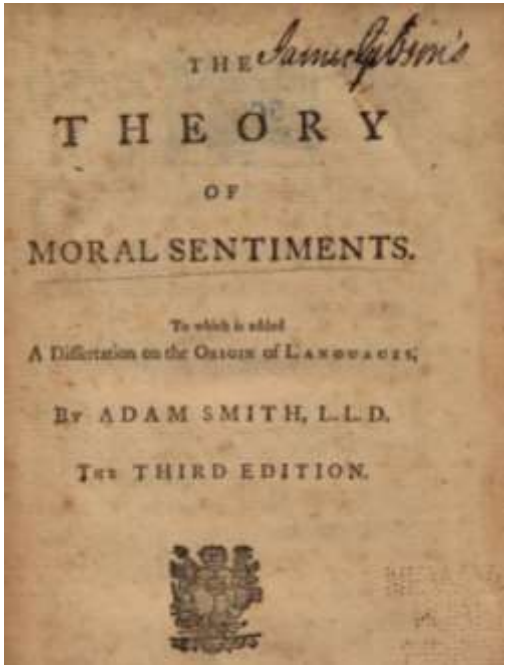
An economist appeals to Adam Smith to conclude that the rational answer to the survival of posterity ("Who cares?") deserves instead a different answer

What has posterity ever done for me?

By Robert L. Heilbroner

An essay on depriving the living to insure the survival of the unborn

The New York Times
Published: January 19, 1975



THE *Samuel Johnson's*

THEORY

OF

MORAL SENTIMENTS.

To which is added

A Dissertation on the Origin of Languages.

By ADAM SMITH, L.L.D.

The THIRD EDITION.

Bruntland report (1987): "Meeting the needs of the present without compromising the ability of future generations to meet their own needs"

Precautionary Principle

Rio Declaration, 1992
United Nations Conference on Environment and Development (UNCED)

Opening way to

Kyoto Protocol (1997)

Paris Agreement (2015)

Katowice Rulebook (COP24, 2018); The Glasgow Climate Pact (COP26, 2021); The Sharm el-Sheikh Implementation Plan (COP27, 2022), Dubai (COP28, 2023) …

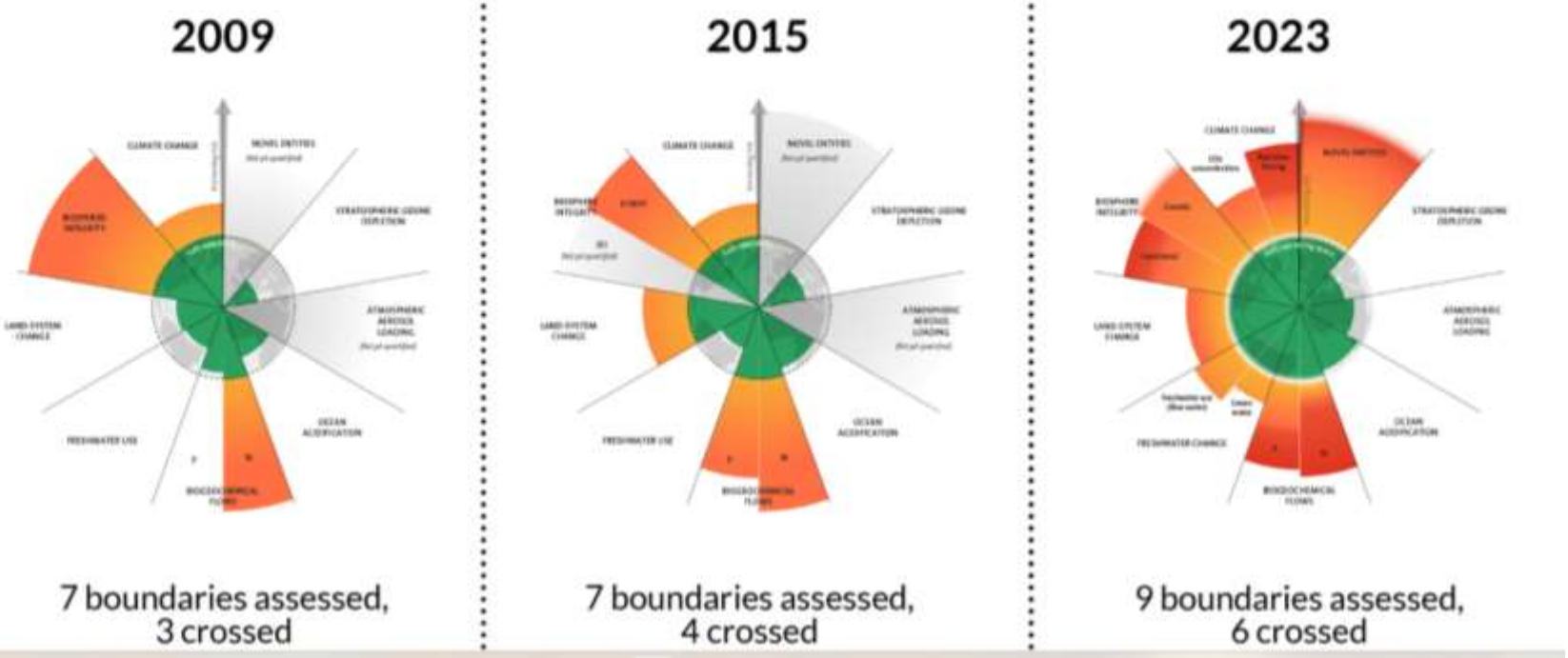
2023 Global Stocktaking: not on track
https://unfccc.int/topics/global-stocktake

Agenda 21

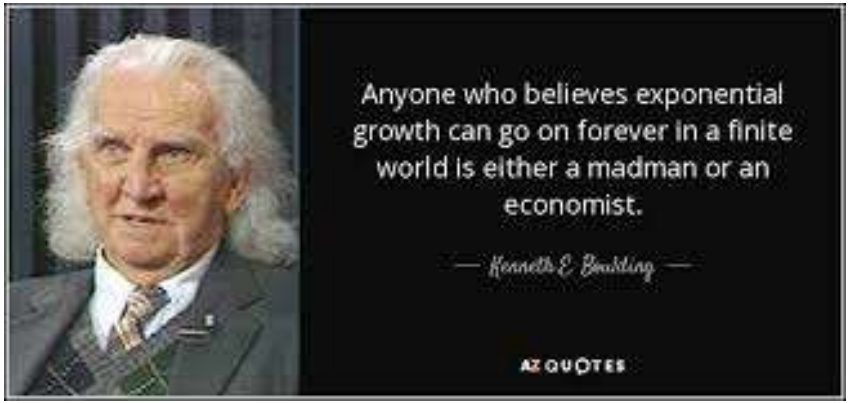
(Johan Rockström, 2009)

Planetary boundaries

Ecological Limits, e.g. Earth Overshoot Day ➔ this lecture



Can innovation substitute for resources? (debate around the theses of Georgescu Roegen), with economists Daly, Solow and Stiglitz, 1997 ➔ third lecture



When one material is exhausted a new one will be put to use

Robert Solow

Mind the limits from the second law of thermodynamics

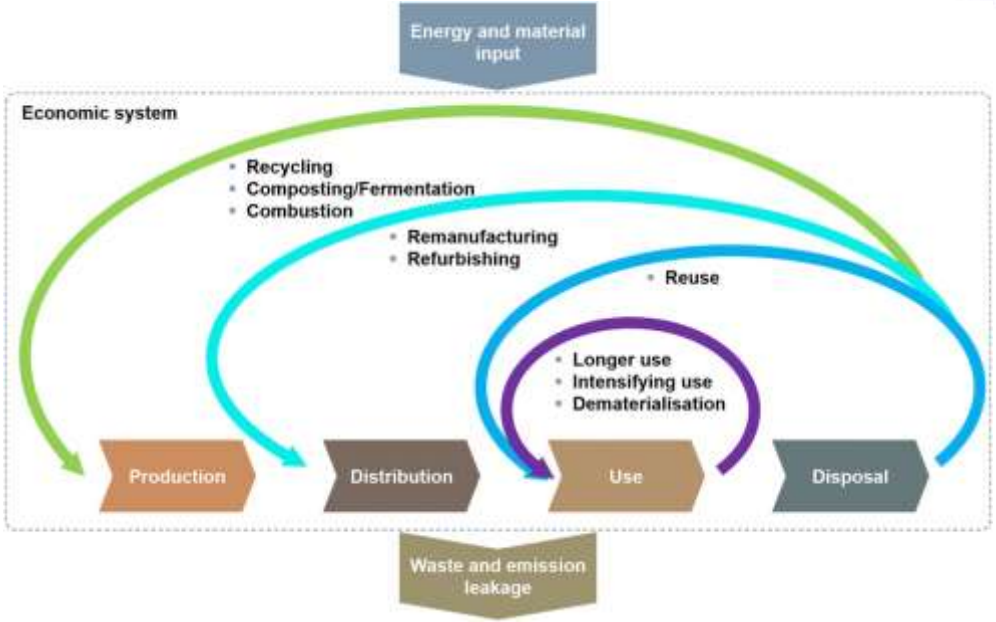
Nicholas Georgescu-Roegen

The most modern of kitchen does not work without food

Herman Daly

Circular Economy

Source: Geissdoerfer, Martin, Marina P. P. Pieroni, Daniela C. A. Pigosso, and Khaled Soufani. 2020. 'Circular Business Models: A Review'. Journal of Cleaner Production 277 (December):123741. https://doi.org/10.1016/j.jclepro.2020.123741.



… but how much?

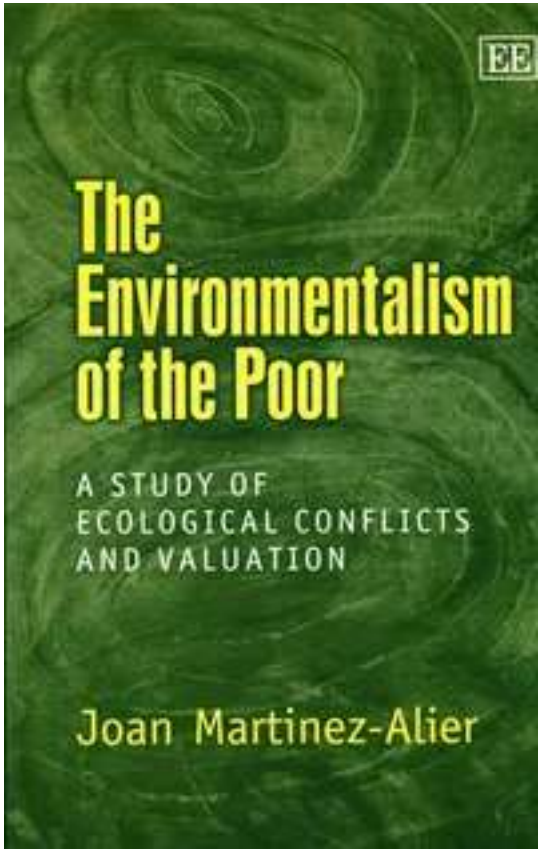
Source: Haas, Willi, Fridolin Krausmann, Dominik Wiedenhofer, and Markus Heinz. 2015. 'How Circular Is the Global Economy?: An Assessment of Material Flows, Waste Production, and Recycling in the European Union and the World in 2005'. Journal of Industrial Ecology 19 (5): 765–77. https://doi.org/10.1111/jiec.12244.

44% of processed materials go to energy / no recycling

Socioeconomic stocks still growing

➔ The degree of circularity ~ 6%; Could go to an ideal 36% if all biomass recycled, which is a far-off target

Environmental Justice



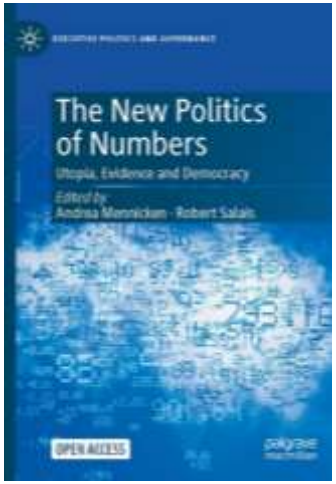
2002

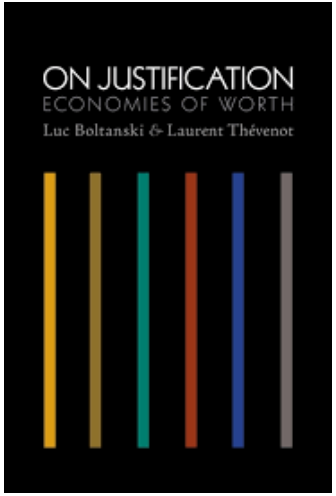
For equity and survival of communities against economic and corporate interests

Against externalization of environmental costs to the poor

Miguel Morales Madrigal

Commodification of Sustainability and Greenwashing





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

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)

Financialization of the environment or corporate social responsibility?

CSRD Corporate Sustainability Reporting Directive

SFDR Sustainable Finance Disclosure Regulation

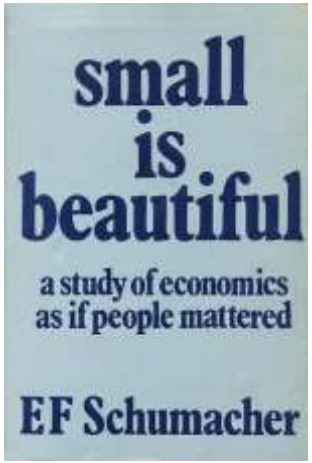
TNFD task force on nature related financial disclosures

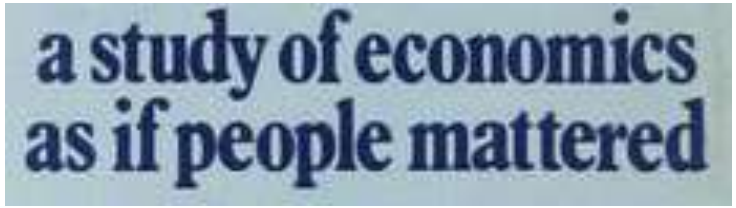
Carroll AB. The Pyramid of Corporate Social Responsibility: Toward the moral management of organizational stakeholders. 1991; Business Horizons, **34**(4), July-August:39–48. Source: https://www.financialeducatorscouncil.org/corporate-social-responsibility-definition-and-history/

Sustainable Development Goals (SDGs) after Agenda 203 established in 2015

The global indicator framework includes 231 unique indicators; 248 in total as thirteen indicators repeat under two or three different targets, source: https://unstats.un.org/

Degrowth, Post-Growth galaxy





Buddhist economics ←

↓

Bhutan Gross National Happiness Index

"The concept of nine domains is central to GNH and its metrics. The nine domains are: psychological wellbeing, community vitality, time use, ecological diversity, cultural resilience, good governance, education, health and living standards"

Gross National Happiness represents the holistic potential of our mind and body: Dasho Karma Ura

GNH represents the holistic potential of our mind and body, and its path towards a deeper peace, calmness and happiness.

Source: https://www.indiatoday.in/happiness-quest/story/gross-national-happiness-represents-the-holistic-potential-of-our-mind-and-body-dasho-karma-ura-1859259-2021-09-30

Degrowth, Post-Growth galaxy

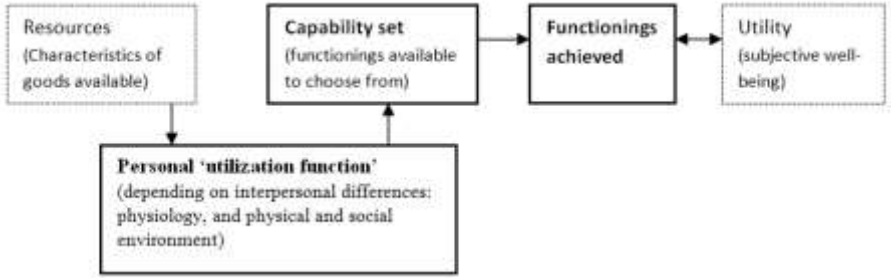
Amartya Sen's Capability Approach

Sen, A. (1990). Justice: Means versus Freedoms. Philosophy & Public Affairs, 19(2), 111–121

Human lives are battered and diminished in all kinds of different ways and the first task… is to acknowledge that deprivations of very different kinds have to be accommodated within a general overarching framework.

Nobel Laureate Amartya Sen

OPHI Oxford Poverty & Human Development Initiative



Source: https://iep.utm.edu/sen-cap/

OPHI Oxford Poverty & Human Development Initiative

Amartya Sen, with Mahbub ul Haq, conceived the Human Development Index

Human Development Reports

Created in 1990 by the United Nations Development Programme (UNDP)

Amartya Sen

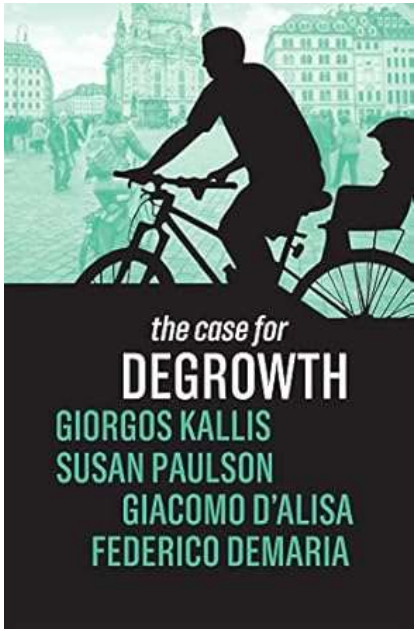
Mahbub ul Haq
(1934 –1998)

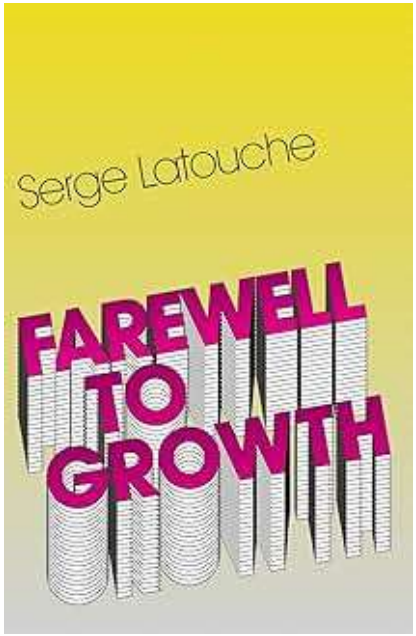
Health
➔life expectancy at birth

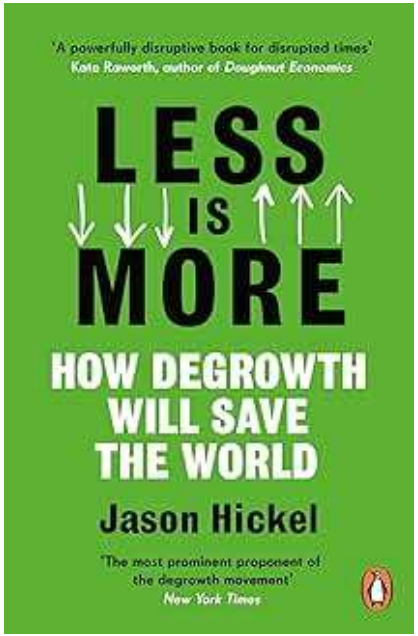
Education
➔Mean years of schooling received by people aged 25 and older
➔Expected years of schooling for a child entering school

Standard of Living
➔Gross National Income (GNI) per capita, adjusted for purchasing power parity (PPP)

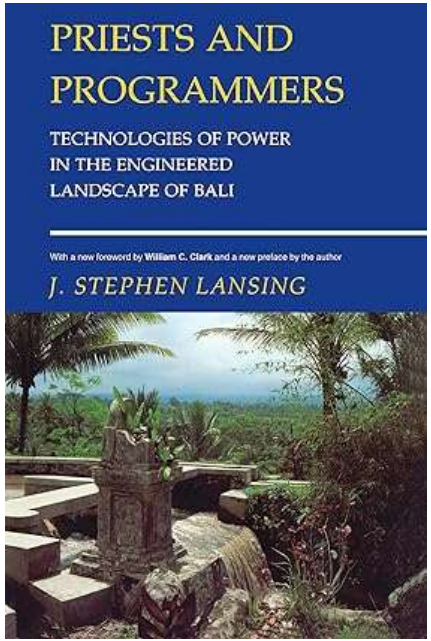
Degrowth, Post-Growth galaxy:
Giorgos Kallis' **Limits as a Positive Concept**, Serge Latouche's ***Décroissance Heureuse***, Jason Hickel's **Post-Capitalism**







Subak: Balinese water temple system active for over 1,000 years (since about 10th century); ➔both religious and administrative centres; ➔coordinated water sharing and irrigation agricultural cycles; ➔Balinese Hindu cosmology & practical hydrology; ➔Indonesian government & the World Bank revert to subak after failed attempt to modernize



Post normal science: sustainability as a political and ethical problem to be tackled participatorily; a critique of nature 'valuation'

ELSEVIER

Ecological Economics
Volume 10, Issue 3, August 1994, Pages 197-207

The worth of a songbird: ecological economics as a post-normal science

Silvio O. Funtowicz [a], Jerome R. Ravetz [b]

2.

The multiverse of composite indicators

There is now a composite indicator for everything, from the quality of urban life to the freedom of the press passing by the ranking of institutes of higher education. These statistical indicators built aggregating different variables are an excellent vehicle for drawing attention to a particular issue, but should be constructed and / or used with care

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Composite indicators: What are they?

Blame – by Ron Tandberg | Image Source: theage.com.au

Eight factors further disaggregated into 44 sub-factors

1.1 Government powers are effectively limited by the legislature
1.2 Government powers are effectively limited by the judiciary
1.3 Government powers are effectively limited by independent auditing and review
1.4 Government officials are sanctioned for misconduct
1.5 Government powers are subject to non-governmental checks
1.6 Transition of power is subject to the law

One of the eight factors with its 6 sub factors …
https://worldjusticeproject.org/sites/default/files/documents/WJP-ROLI-2019-Single%20Page%20View-Reduced_0.pdf

Where indicators come from: from images to numbers

Ambrogio Lorenzetti (c. 1290 – 1348), Allegory: Effects of good and bad government, Palazzo Pubblico di Siena, (detail: Safety)

Ambrogio Lorenzetti (c. 1290 – 1348), Allegory: Effects of good and bad government, Palazzo Pubblico di Siena, Effects of **good** government in the city

Ambrogio Lorenzetti (c. 1290 – 1348), Allegory: Effects of good and bad government, Palazzo Pubblico di Siena, Effects of the **good** government in the countryside

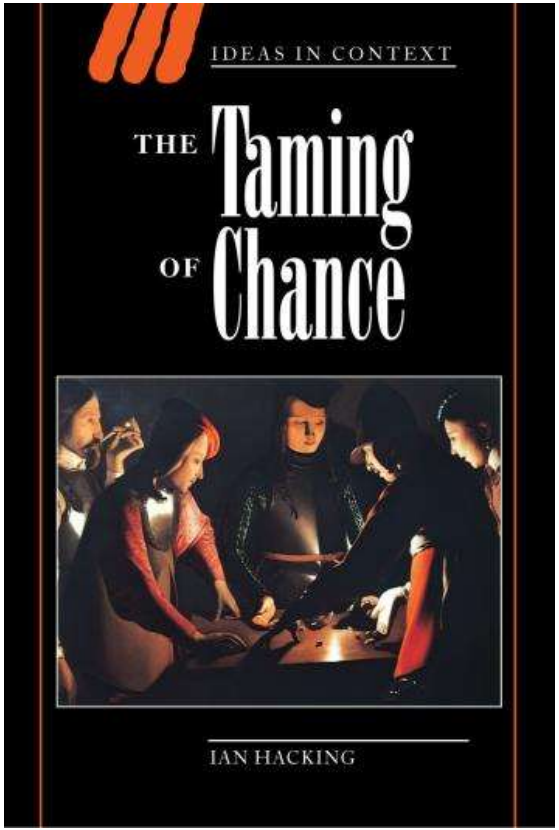
Ambrogio Lorenzetti (c. 1290 – 1348), Allegory: Effects of good and bad government, Palazzo Pubblico di Siena, Effects of the **bad** government in the countryside

“[…] Lorenzetti is modern because he invites the spectator of his frescoes, […] to assess governments not so much on the political principles and values […] than on the practical consequences of their decisions.

The paintings on the effects of good and bad governance show them were to look, what are the signs, or, in contemporary language, the indicators, to monitor in that respect.”

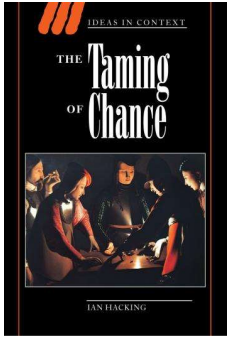
P.-M. Boulanger, www.statistics.gov.hk/wsc/STS023-P3-S.pdf

How numbers flooded the modern world



Ian Hacking, 1990, The taming of chance, Cambridge University Press.

‘Probability’ won an epistemological war between the eighteen and the nineteen century.



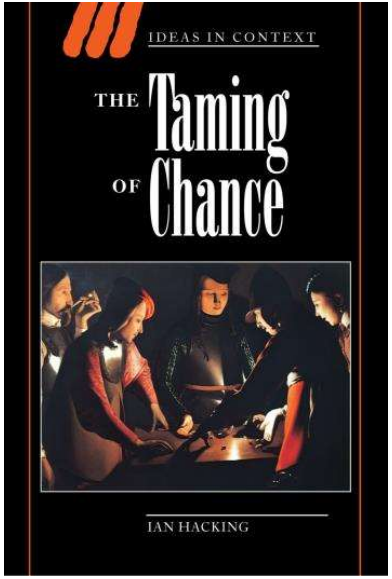
‘Probability’ became king in adjudicating the credibility of evidence.

We look at facts mostly through the lenses of statistics – before the enlightenment chance was equated with superstition

Leibnitz, ‘philosophical godfather of Prussian official statistics’ advising Prince Frederik of Prussia 1700

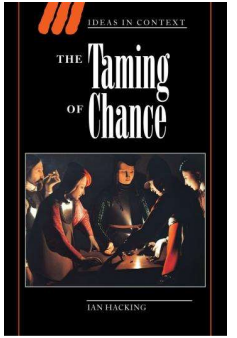
Leibnitz’s first proposal for a statistical office

Gottfried Wilhelm Leibniz (1646-1716)



Statistics ⟷ nation state ⟷ Modernity?

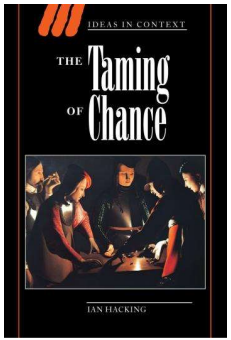
The victory of probability is metaphysical (quantum mechanics), epistemological (statistics as a way of knowing things), logical (statistical inference methods) and ethical (no decision taken without statistical evidence), leading to the 'imperialism of probability'…



Statistics ⟷ nation state ⟷ Modernity

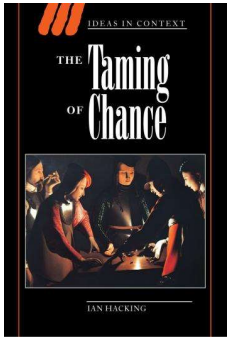
56 categories to ‘measure the power of a state’, the first scoreboard;

- number of marriageable girls,
- able bodied capable to carry arms,
- diseases,
- child mortality,
- …
- number of Jews



Gottfried Wilhelm Leibniz (1646-1716)

➔ only in 1853 the first international congress of official statisticians, in Belgium, organized by Adolphe Quetelet

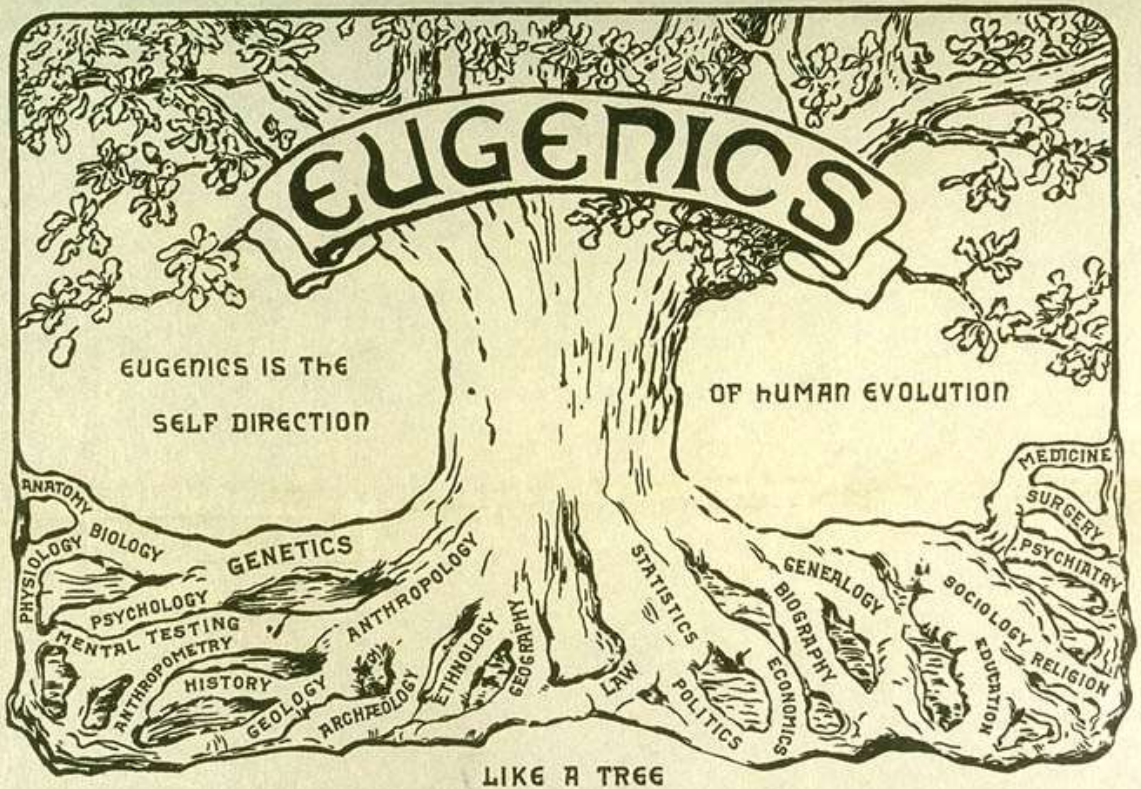


- number of Jews

Already in 1745 Jews are being treated as a separate category and counted in Prussian statistics (statistics and antisemitism is one of the chapters in the book)

Statistics has a story in eugenics (Pearson, Galton)

Gottfried Wilhelm Leibniz (1646-1716)

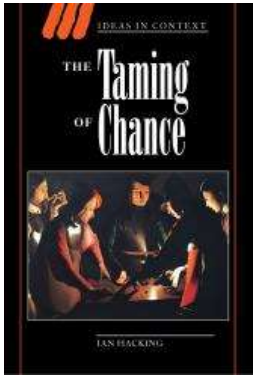


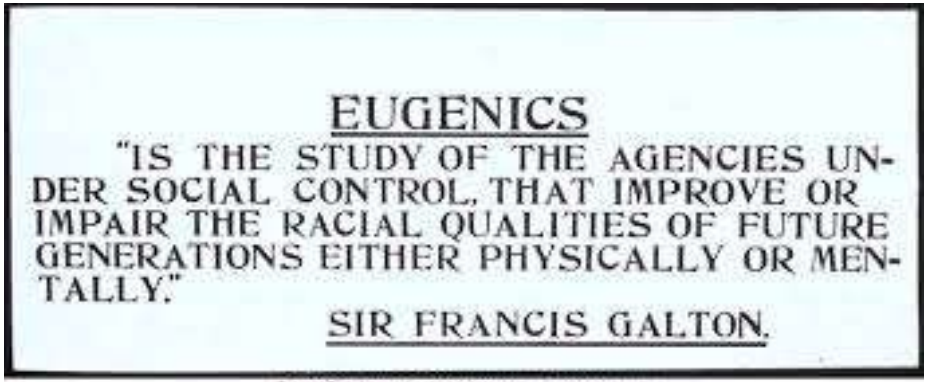
LIKE A TREE
EUGENICS DRAWS ITS MATERIALS FROM MANY SOURCES AND ORGANIZES
THEM INTO AN HARMONIOUS ENTITY.

Some sins of statistics …

Third lecture

Francis Galton and Karl Pearson (the one of chi-squared) and their laboratory of biometrics … distinguishing army officers from private soldiers from criminals convicted of murder from non-violent felons from Jews …





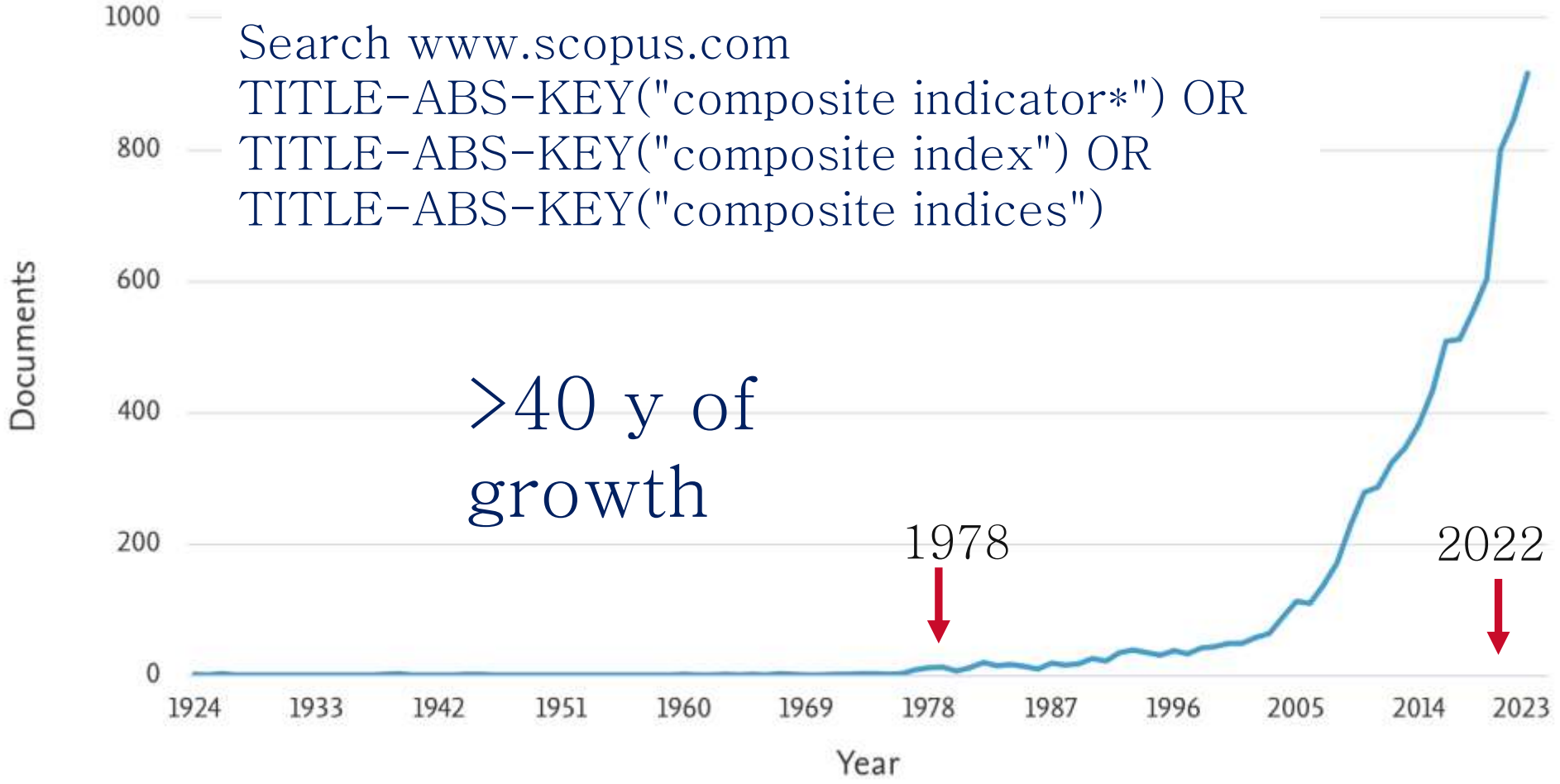
Recognizing
'the Jewish type'

Coming closer to our times, the story of the first R&D Statistics ever. Benoît Godin (2010) tells us what these researchers thought: Measuring the numbers of sons and daughters of scientists will tell us whether a society degenerates toward stupidity.

Mind the spirit of the times: at beginning XX century everyone was eugenicist: Theodore Roosevelt, Winston Churchill, John Maynard Keynes, Bernad Shaw ….

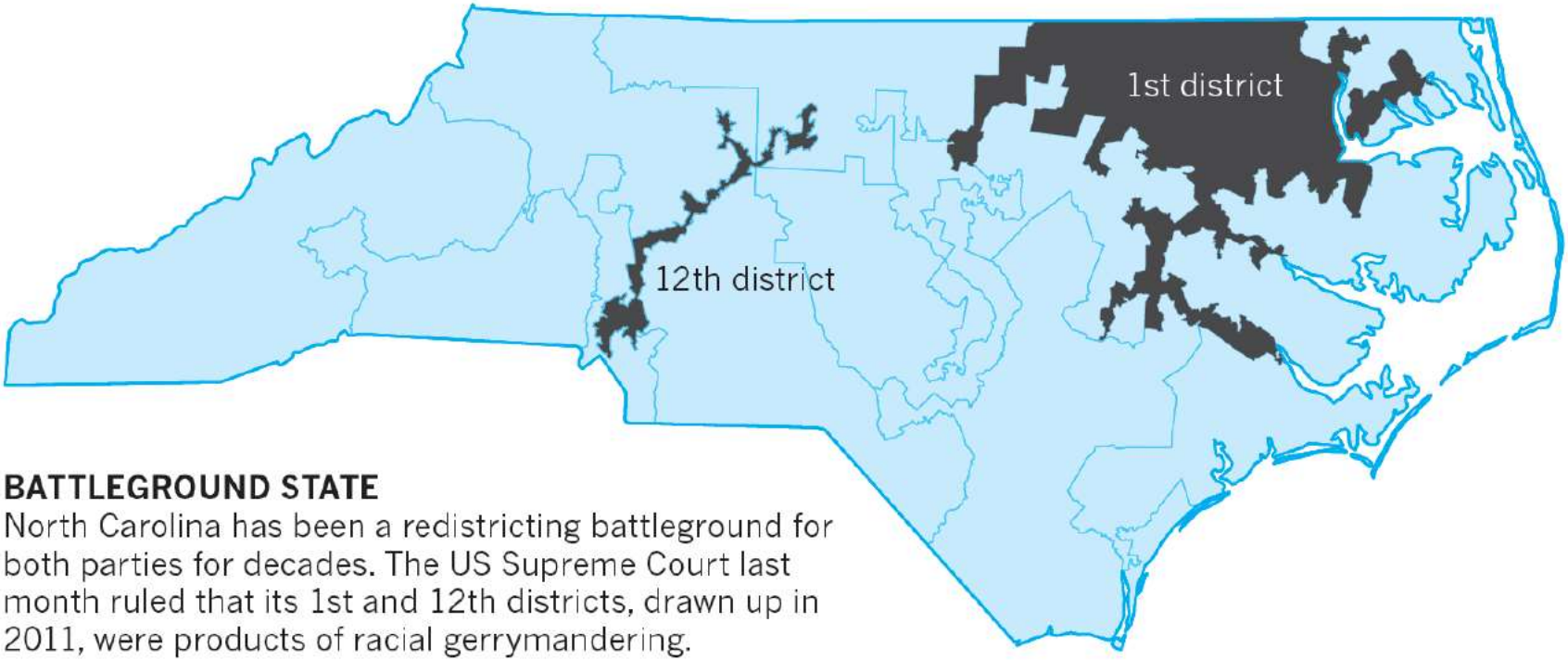
Godin, B., From Science to Innovation, INRS, Montreal, Canada, Communication presented to the Government-University-Industry Research Roundtable (GUIRR) US National Academy of Sciences, Washington, May 21, 2010.

Ubiquity of composite indicators


Search www.scopus.com
TITLE-ABS-KEY("composite indicator*") OR
TITLE-ABS-KEY("composite index") OR
TITLE-ABS-KEY("composite indices")
>40 y of growth
1978
2022
Documents
Year
1000
800
600
400
200
0
1924
1933
1942
1951
1960
1969
1978
1987
1996
2005
2014
2023

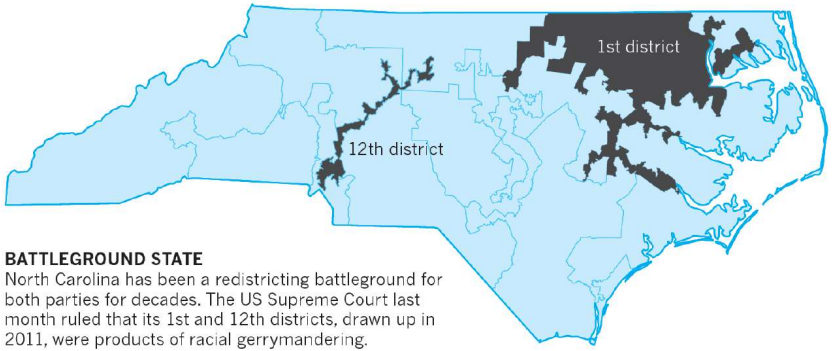
Useful composite indicators

Making the case for gerrymandering?



BATTLEGROUND STATE
North Carolina has been a redistricting battleground for both parties for decades. The US Supreme Court last month ruled that its 1st and 12th districts, drawn up in 2011, were products of racial gerrymandering.

Nature June 2017 article on the mathematics of ‘nailing’ gerrymandering



BATTLEGROUND STATE
North Carolina has been a redistricting battleground for both parties for decades. The US Supreme Court last month ruled that its 1st and 12th districts, drawn up in 2011, were products of racial gerrymandering.

“[US] ranked 55th of 158 nations — last among Western democracies — in a 2017 index of voting fairness (Electoral Integrity Project)”

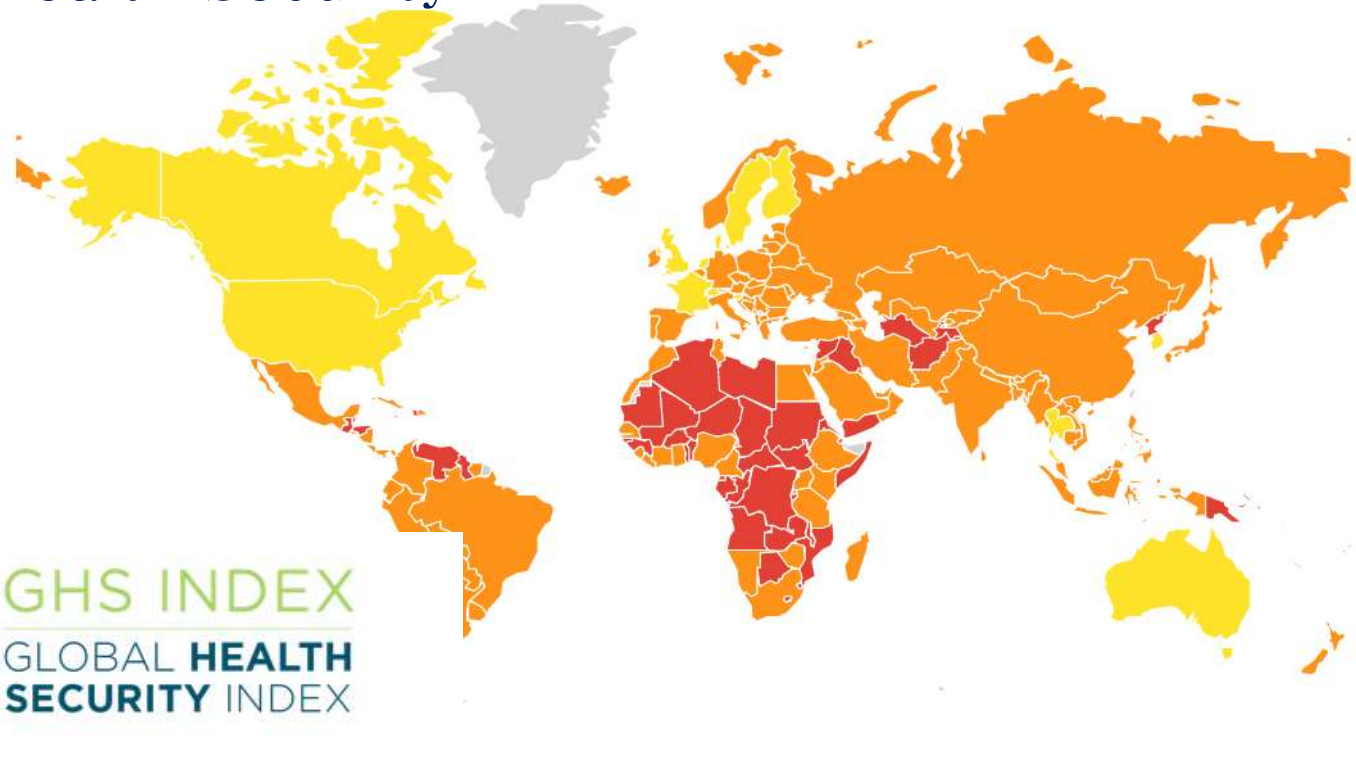
Carrie Arnold, 2017, The mathematicians who want to save democracy, 200, NATURE, VOL 546, 8 JUNE 2017.

At times wrong

The Global Health Security Index, released 2019 to "spur measurable changes in national health security" in light of "high-consequence and globally catastrophic biological events"

Cameron, E.E. et al., Global Health Security Index. Building Collective Action and Accountability. Nuclear Threat Initiative & Johns Hopkins Center for Health Security (October 2019). Available at https://www.ghsindex.org/#l-section--map.

US and UK rank 1 and 2 respectively in Global Health Security



M. Kaiser, A. T.-Y. Chen, and P. Gluckman, "Should policy makers trust composite indices? A commentary on the pitfalls of inappropriate indices for policy formation," arXiv.org, vol. 2008.13637, Aug. 2020.

How can a country ranked last in quality of health care, with a raging opioid pandemic, be rated first in ‘preparedness’?

See also:

https://www.nybooks.com/articles/2020/10/22/best-health-care/

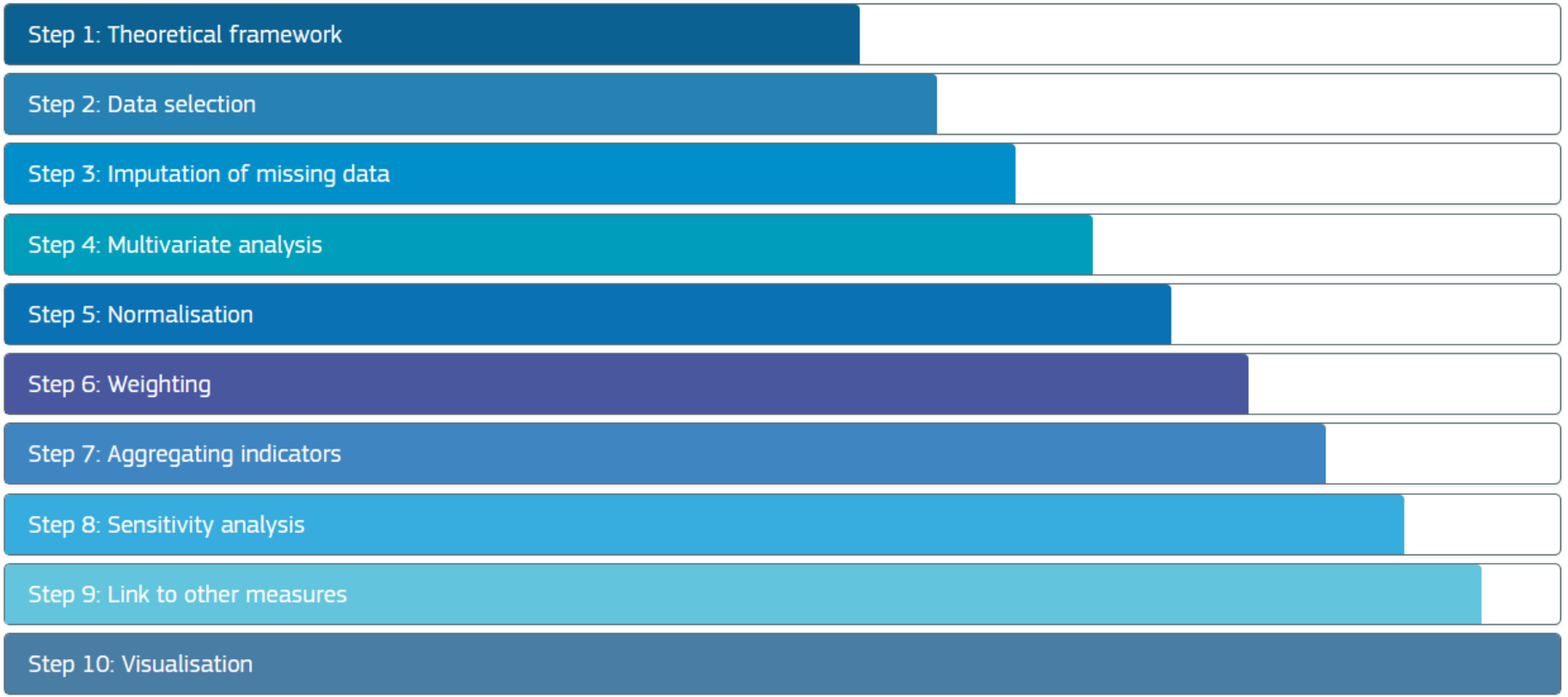
https://www.commonwealthfund.org/publications/newsletter-article/us-ranks-last-among-seven-countries-health-system-performance

‘Hot’ topic these days …

Quality of composite indicators


Handbook
on Constructing
Composite
Indicators
METHODOLOGY
AND USER GUIDE

Ten steps



Source: https://composite-indicators.jrc.ec.europa.eu/?q=10-step-guide

Specific elements of quality for composite indicators

OECD JRC

RELEVANCE

In the context of composite indicators, relevance has to be evaluated considering the degree to which it meet current and potential needs of the users

[…] ensure that the right range of domains is covered in a balanced way

ACCURACY

The credibility of data products refers to confidence that users place in … the image of the data producer, i.e., the brand image …

[crucial] that the data are perceived to be produced professionally and that practices are transparent

(for example, data are not manipulated, nor their release timed in response to political pressure)

COHERENCE

… ensure coherence over time and across countries … Coherence across countries implies that from country to country the data are based on common concepts, definitions, classifications and methodology, or that any differences can be justified

Is a theory for composite indicators possible?

Elements for a comprehensive assessment of public indicators

Paul-Marie Boulanger

2014

Editor: Andrea Saltelli

Paul-Marie Boulanger

Paul-Marie Boulanger, 2014, Elements for a comprehensive assessment of public indicators, Report EUR 26921 EN. http://publications.jrc.ec.europa.eu/repository/bitstream/JRC92162/lbna26921enn.pdf

CI as boundary objects, between analysis and advocacy, as:

- semiotic objects
- instruments of social discovery
- instruments of democratization of expertise

Paul-Marie Boulanger, 2014, Elements for a comprehensive assessment of public indicators, Report EUR 26921 EN.
http://publications.jrc.ec.europa.eu/repository/bitstream/JRC92162/lbna26921enn.pdf

A triadic conception of the sign as structure connecting three elements:

- the sign properly said (S);
- an object (O) and
- an “interpretant”(I)

Charles Sanders Peirce,
the father of semiotics
1839-1914

“This monkey possess a sophisticated repertory of vocal signs for signaling the presence of a predator”

African vervet monkey
(Cercopithecus aethiops)

It can distinguish

- a terrestrial stalking one such as a leopard,
- an aerial raptor such as an eagle or
- a ground predator such as a snake

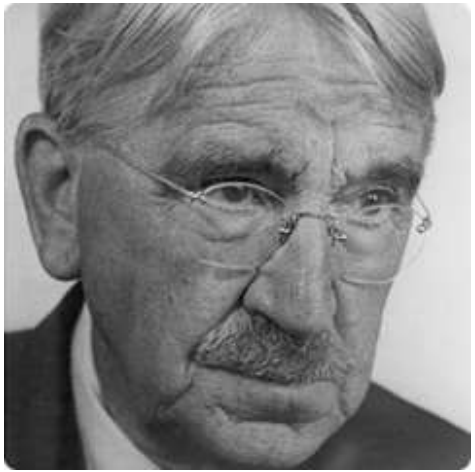
African vervet monkey (Cercopithecus aethiops)

Sign ⟷ Cry

Object ⟷ Predator

Interpretant ⟷ Behaviour

Composite indicators as instrumental to the creation of a new public, through a process of social discovery (J. Dewey)



John Dewey
1859-1952

Dewey, J., 1938. The Public and its Problems, Read Book Ltd. Edition, 2013.

Why are ‘social discoveries’ needed?

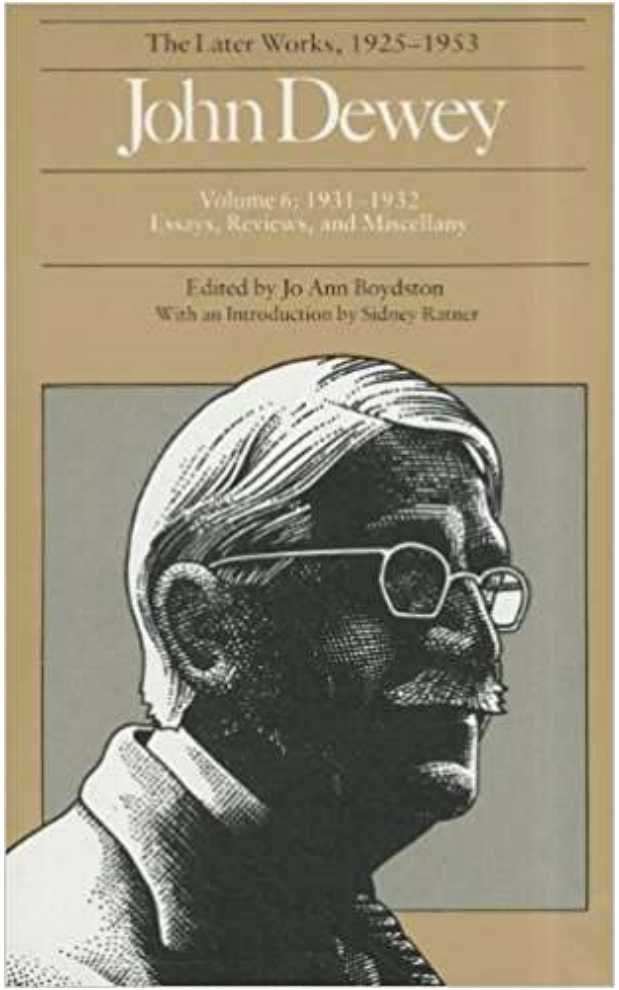
Because there are ‘publics’ affected by transaction taking place somewhere else.

“[…] machine age has so enormously expanded, multiplied, intensified and complicated the scope of the indirect consequences […] that the resultant public cannot identify and distinguish itself”

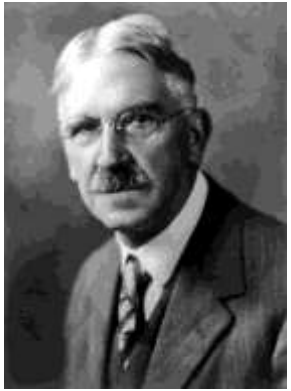
Dewey, J., 1938. The Public and its Problems, Read Book Ltd. Edition, 2013.

Social facts – unlike physical facts, are only meaningful in a context of desired ends

From J. Dewey 'Social Science and Social Control' in John Dewey: The Later Works, 1925-1953: 1931-1932, Vol. 6-ExLibrary,



Controversy Dewey-Lippmann (1920's): can the public express agency?



John Dewey (1859-1952)

Walter Lippmann (1889-1974)

See also controversy between Habermas and Luhmann early 1970's. Today revisited by Philip Mirowski: https://www.academia.edu/42682483/Democracy_Expertise_and_the_Post_Truth_Era_An_Inquiry_into_the_Contemporary_Politics_of_STS

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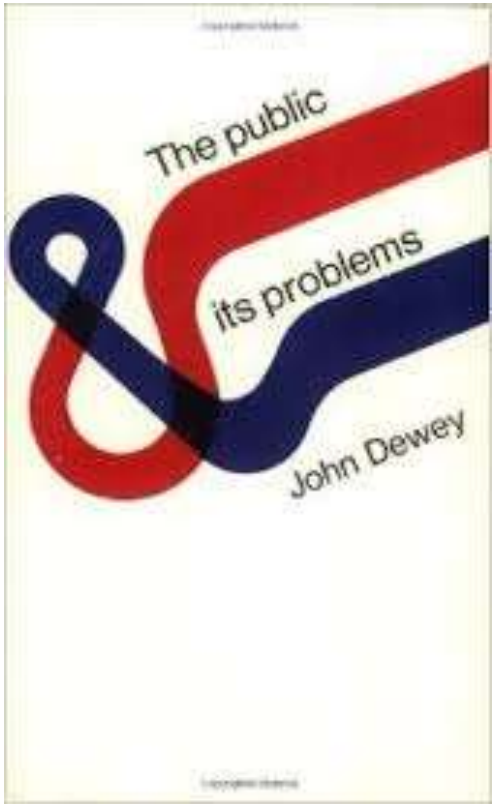
"When writing "The public and its problem" Dewey was taking stance with Walter Lippmann, [who believed that] the citizens had become only spectators of a political game they were not able to play [because] they could not get informed of the relevant facts."

Boulanger, Op. cit.



Building a composite indicator can be seen as a process of social discovery for which a model of extended participation comes natural.
Frames and indicators are co-produced in the process which must be designed as to have a meaningful 'interpretant', or 'end-in-sight'

Paul-Marie Boulanger, 2014, Elements for a comprehensive assessment of public indicators, Report EUR 26921 EN. http://publications.jrc.ec.europa.eu/repository/bitstream/JRC92162/lbna26921enn.pdf

Critique of composite indicators: the Fitoussi-Stiglitz-Sen report

“The role [of statistical indicators] has increased significantly over the last two decades.

This reflects improvements in the level of **education** in the population, increases in the **complexity** of modern economies and the widespread use of **information technology**”

Jean-Paul Fitoussi,
Amartya Sen, Joseph Stiglitz

CMEPSP (2009). Commission on the Measurement of Economic Performance and Social Progress, URL: http://ec.europa.eu/eurostat/documents/118025/118123/Fitoussi+ Commission+ report, last accessed June 2017.

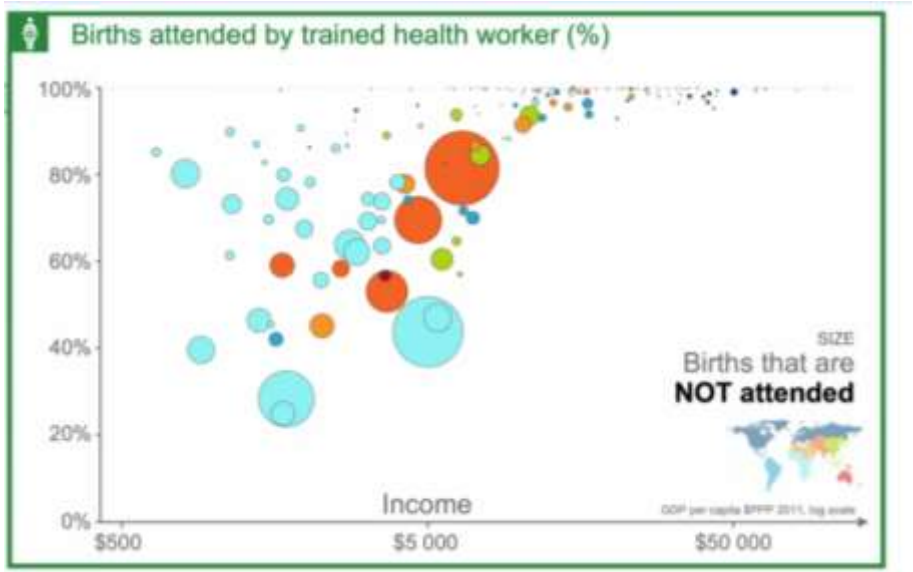
“widespread use of **information technology**”

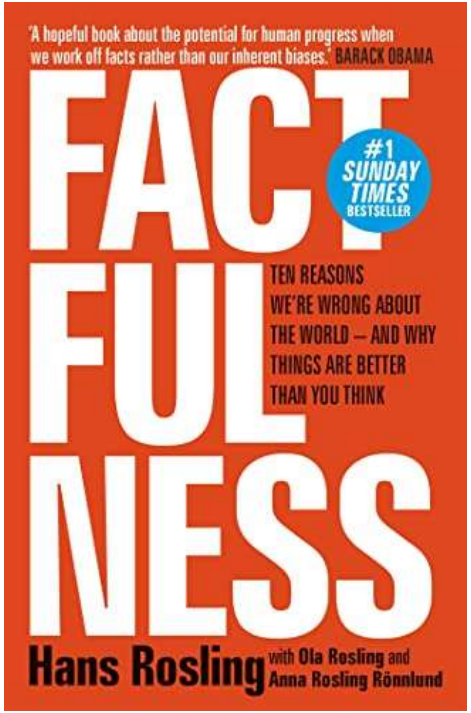
Visit https://joint-research-centre.ec.europa.eu/scientific-activities-z/composite-indicators_en
Resources on composite indicators building

- Composite Indicators and Scoreboards Explorer One-Pager
- Mini-Guide Composite Indicators & Scoreboards Explorer

"widespread use of **information technology**"

Visit Hans Rosling's https://www.gapminder.org/





Hans Rosling
1948-2017

“a general criticism … frequently addressed at composite indicators, i.e. the arbitrary character of the procedures used to weight their various components […]

Jean-Paul Fitoussi,
Amartya Sen, Joseph Stiglitz

[…] an aggregation procedure always means putting relative values on the items that are introduced in the index”

CMEPSP (2009). Commission on the Measurement of Economic Performance and Social Progress, URL: http://ec.europa.eu/eurostat/documents/118025/118123/Fitoussi+ Commission+ report, last accessed June 2017.

"The problem is not that these weighting procedures are hidden, non-transparent or non-replicable – they are often very explicitly presented by the authors of the indices, and this is one of the strengths of this literature.

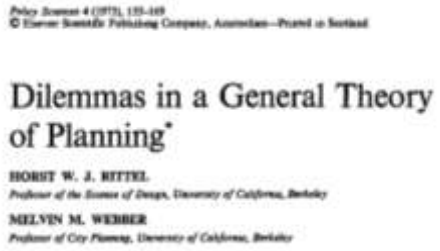
Jean-Paul Fitoussi,
Amartya Sen, Joseph Stiglitz

The problem is rather that their normative implications are seldom made explicit or justified"

CMEPSP (2009). Commission on the Measurement of Economic Performance and Social Progress, URL: http://ec.europa.eu/eurostat/documents/118025/118123/Fitoussi+ Commission+ report, last accessed June 2017.

There are other drivers behind the explosion of CI's

- More hybridization of roles, styles ➔ CI as boundary objects, between analysis and advocacy
- Changing styles of governance ➔ More actors with a voice
- Issues with trust / quality in the scientific enterprise ➔ Do it yourself movements
- More controversy (**wicked issues**) ➔ More communication 'weapons' developed



Dilemmas in a General Theory of Planning*

HORST W. J. RITTEL
Professor of the Science of Design, University of California, Berkeley

MELVIN M. WEBBER
Professor of City Planning, University of California, Berkeley

Statistics/indicators for governance: three models

- A rational-positivist model for the use of indicators and policy (good quality statistics describe reality and underpin good policies)

- A discursive-interpretive model (statistics contribute to a process of framing of and focusing on an issue among the many competing for public's attention)

- A strategic model (statistics is used by parties competing for a given constituency).

Hans Rosling

John Dewey

Niccolò Machiavelli,
Pierre Bourdieu,
Karl Popper,
Michel Foucault …

Boulanger, P-M., Political uses of social indicators: overview and application to sustainable development indicators. International Journal of Sustainable Development, 10 (1,2):14-32, 2007.

Critique of composite indicators: Ravallion

There are types two indices: those built on economic theory / monetary aggregates / shadow prices and all others (=mashup indices)

Martin Ravallion

+ existing measures of e.g. development or poverty (Human Development Index, HDI, the Multidimensional Poverty Index, MPI) are bad at coping with tradeoffs

Martin Ravallion, 2010, Mashup indices of development, Policy Research Working Paper 5432 , The World Bank Development Research Group, http://documents.worldbank.org/curated/en/454791468329342000/pdf/WPS5432.pdf

Martin Ravallion

“To illustrate the distinction, consider two stylized examples of composite indices, both formed from the data on household assets and consumer durables found in the Demographic and Health Surveys (DHS). For index A the variables and their weights are set by the analyst, who has some concept of ―economic welfare‖ in mind, and thinks this is related to certain variables in the DHS, which are aggregated based on the analyst‘s judgments. For index B, the variables and weights are instead based on a regression model calibrated to another survey data set for which a comprehensive measure of consumption (though still containing measurement errors) could be derived. The model is calibrated to common variables in the expenditure survey and the DHS, and the regression model is used to predict wealth in the DHS. A is a mashup index, B is not.”

(M. Ravallion)

Relevance of all this to composite indicators? Common critiques of CI include:

•Composite indicators as 'mashup indices', Ravallion (2010): if only 'arbitrary weights' could be replaced with 'exact' (shadow) prices …

•There can be as many indices of sustainability as there are normative definitions of what we want to sustain, CMEPSP, (2009)…

•All too easy to manipulate!

Ravallion M. (2010). "Mashup Indices of Development". Policy Research Working Paper 5432, The World Bank.

CMEPSP (2009). Commission on the Measurement of Economic Performance and Social Progress, URL: http://www.stiglitz-sen-fitoussi.fr/documents/rapport_anglais.pdf last accessed June 2014.

Human Development Index (HDI): Developed by the United Nations Development Programme (UNDP), the HDI combines indicators of life expectancy, education, and per capita income to assess human development. https://hdr.undp.org/data-center/human-development-index

Environmental Performance Index (EPI): Produced by the Yale Center for Environmental Law and Policy and the Center for International Earth Science Information Network, EPI evaluates environmental performance based on various environmental indicators, including air quality, water resources, and biodiversity. https://epi.yale.edu/

Social Progress Index (SPI): The SPI measures social and environmental performance, covering factors such as basic human needs, foundations of well-being, and opportunity. https://www.socialprogress.org/social-progress-index

Good Country Index: This index evaluates countries based on their contributions to global well-being, including factors related to science and technology, culture, and international peace and security. https://www.goodcountry.org/

Bhutan's Gross National Happiness Index https://ophi.org.uk/gross-national-happiness

… more!

To some observers CI are soft just because a set of pure and hard data corresponding to objective ‘facts’ has been contaminated by subjective weights

Sociologists of science would object that facts are themselves the result of a social process

Whatever the shortcomings of CI (and there are many) the neutrality of data as image of facts needs to be questioned

… but when science is involved, this process has special characteristics

An example where demographic and GDP data are given in the same breath with composite indicators …

THE 1.3m people of Mauritius love to prove famous people wrong. On independence from Britain in 1968, pundits such as a Nobel prize-winning economist, James Meade, and a novelist, V.S. Naipaul, did not give much of a chance to this tiny, isolated Indian Ocean island 1,800km (1,100 miles) off the coast of east Africa. Its people depended on a sugar economy and enjoyed a GDP per person of only $200. Yet the island now boasts a GDP per person of $7,000, and very few of its people live in absolute poverty. It once again ranks first in the latest annual Mo Ibrahim index, which measures governance in Africa. And it bagged 24th spot in the World Bank's global ranking for ease of doing business—the only African country in the top 30, ahead of countries such as Germany and France. How does it pull it off?

Economist October 16, 2008


The Economist

Menu Weekly edition The world in brief Search

Beyond beaches and palm trees

An isolated island continues to reinvent itself and confound the sceptics

Exercise (both CI and sustainability)

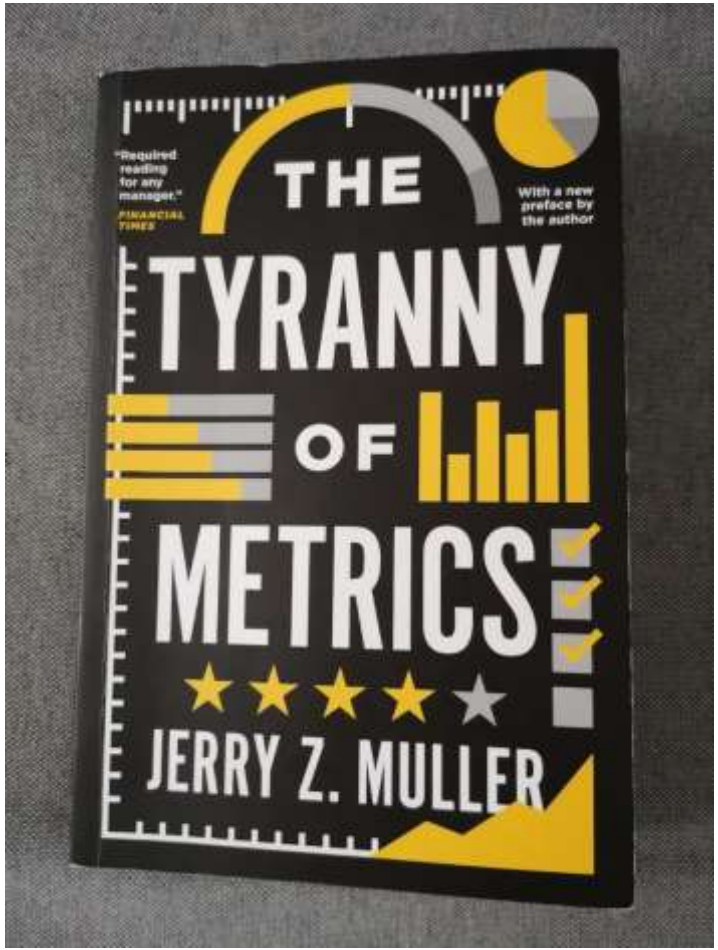
Split in groups of five and answer the question:

If I were to use a CI to decide where (in what country) to grow my children, what dimensions should the index include

The number of dimensions should not be greater than seven

Appoint a rapporteur to relate in class

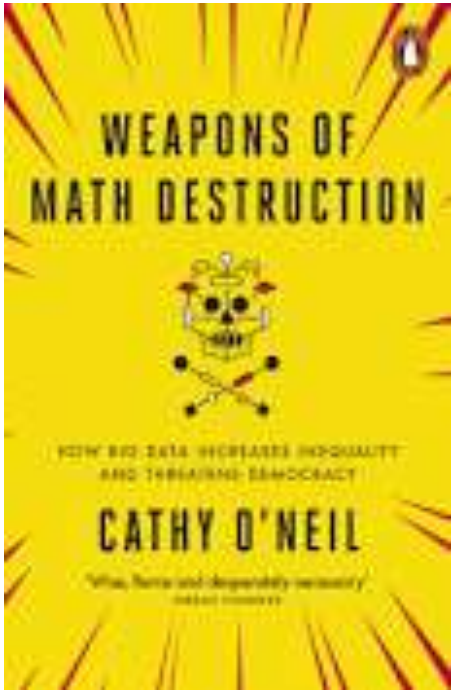
Time: 15m

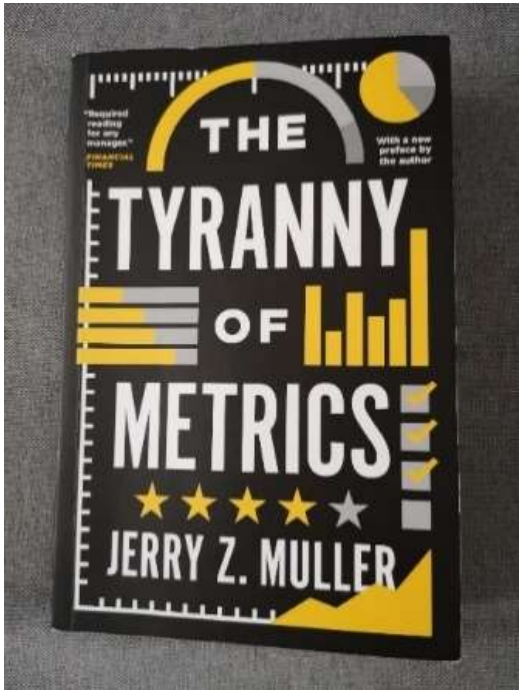


Can composite indicators do harm?

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

Unintended consequences of indicators/expert systems





Examples from

- Education,
- Healthcare,
- Policing & Crime,
- Academic Research,
- Military & Intelligence,
- Business & Finance,
- Employment,
- Workplace analytics and surveillance

Since composite indicators are here to stay, how can we make them defensible?

… or how can we deconstruct them?

3.

Deconstructing

How to detect inconsistencies or contradictions in sustainability studies; deconstructing the technical or normative framing of an indicator

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Tools for evidence appraisal such sensitivity analysis and sensitivity auditing can be useful to gauge (and possibly deconstruct or reinforce) these measures

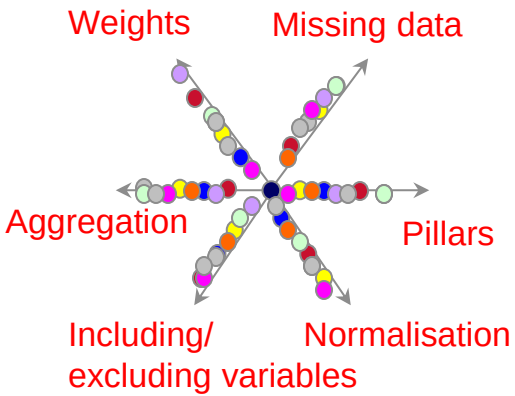
Sensitivity analysis to make composite indicators better?

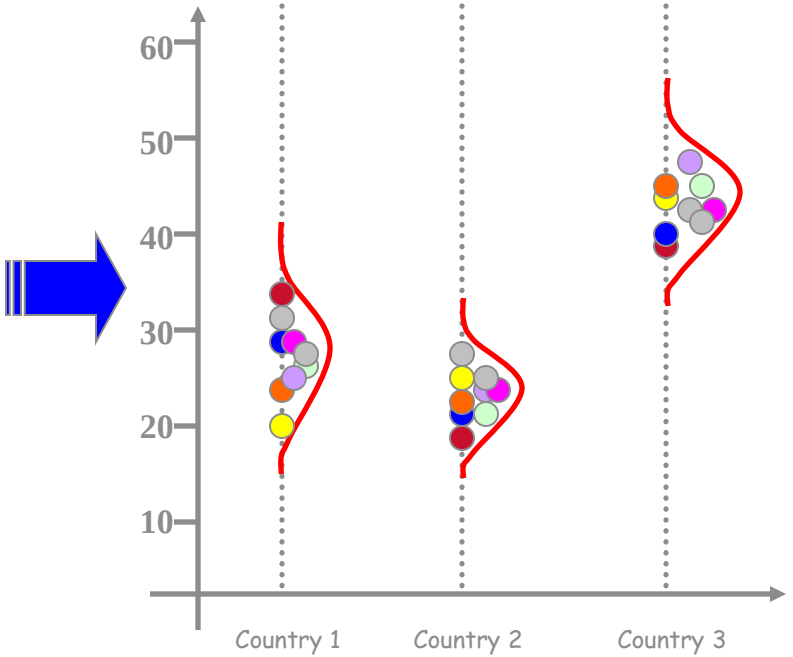
Can we ‘shake’ a composite indicator to see how much the ranking changes

Source: Dreamstime.com

Assumption	Alternatives
Number of indicators	▪ all six indicators included or one-at-time excluded (6 options)
Weighting method	▪ original set of weights, ▪ factor analysis, ▪ equal weighting, ▪ data envelopment analysis
Aggregation rule	▪ additive, ▪ multiplicative, ▪ Borda multi-criterion

Space of alternatives





For example: how vulnerable are university ranking to the shaking?


Research Policy

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

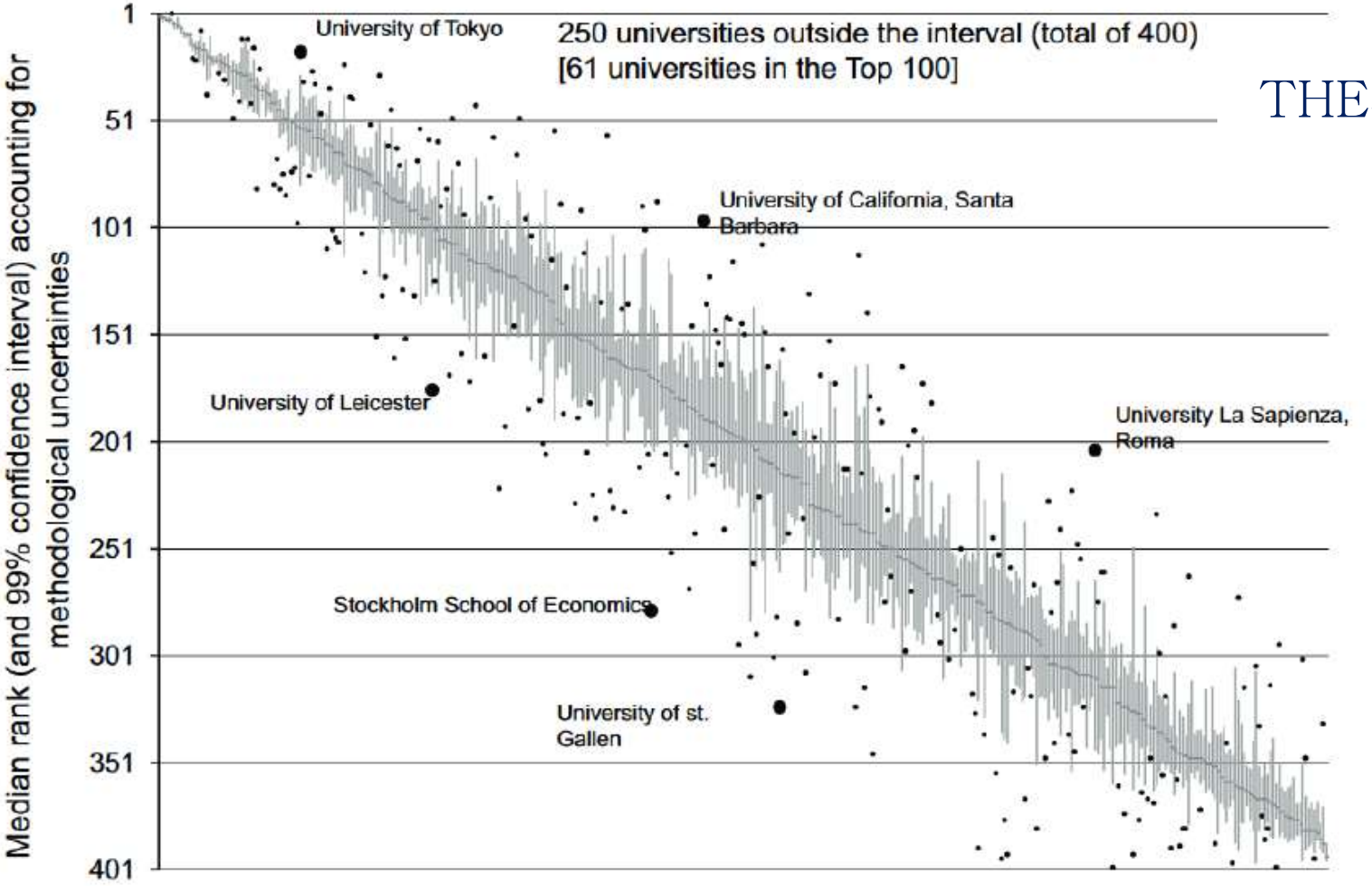
Rickety numbers: Volatility of university rankings and policy implications

Michaela Saisana*, Béatrice d'Hombres, Andrea Saltelli

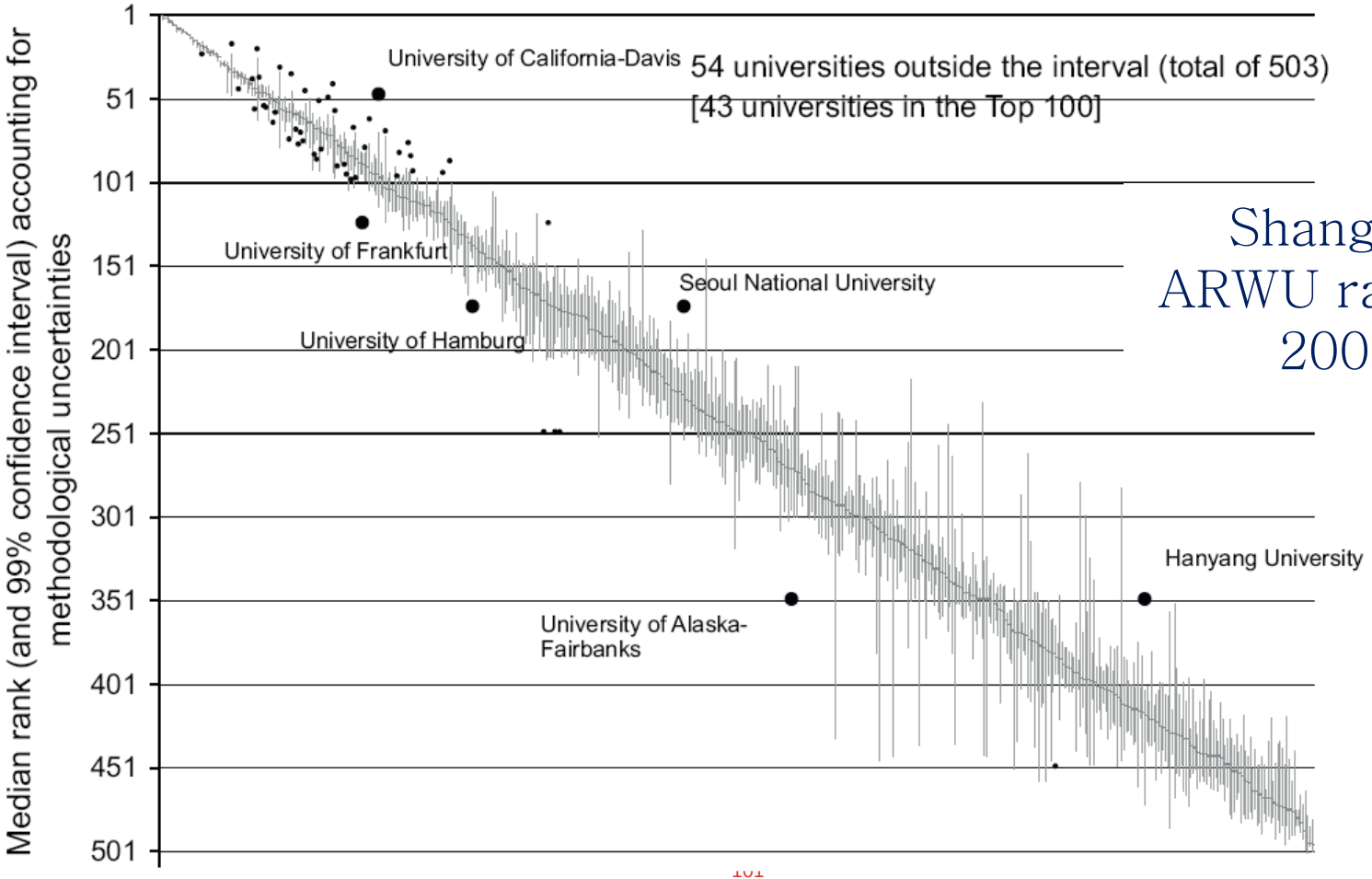
ACADEMIC RANKING OF WORLD UNIVERSITIES

ACADEMIC RANKING OF WORLD UNIVERSITIES SINCE 2003

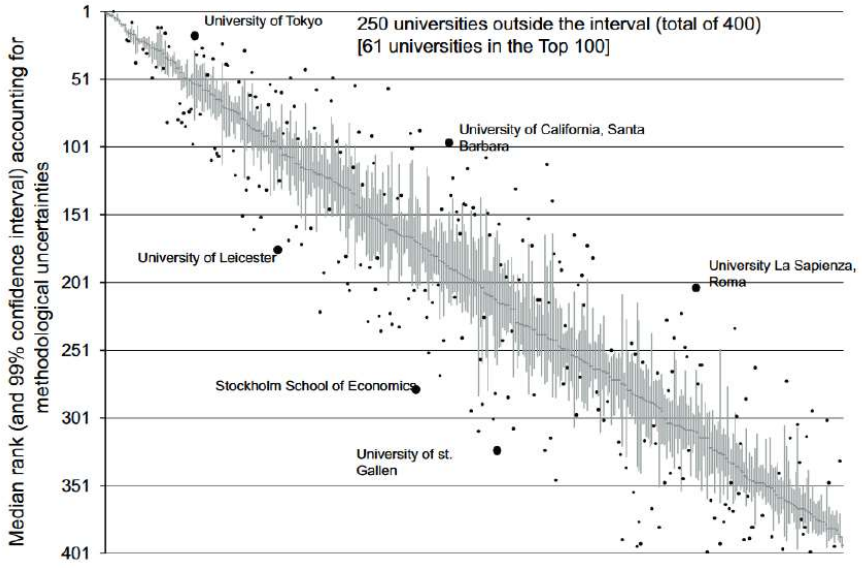
THE WORLD UNIVERSITY RANKINGS



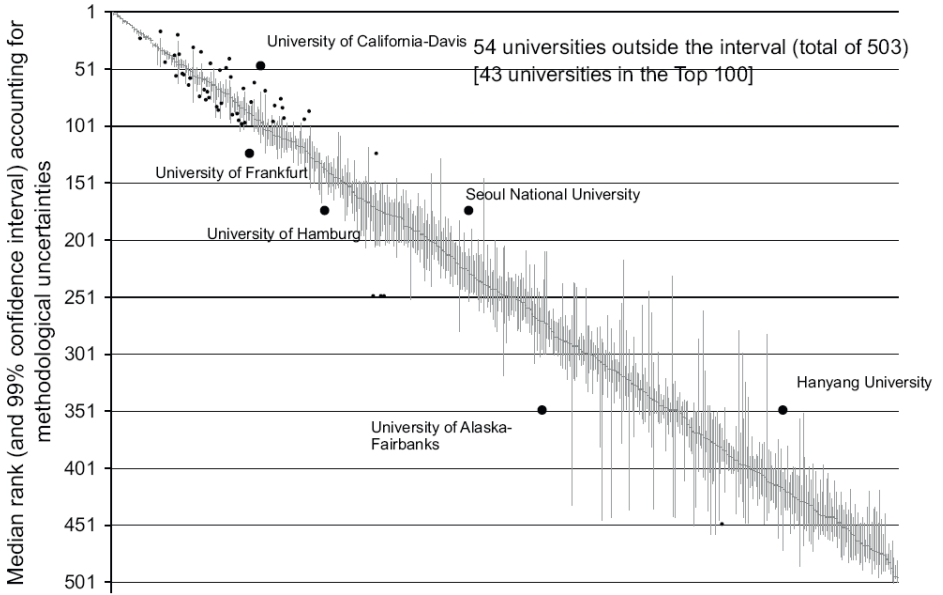
THES ranking 2008



Shanghai ARWU ranking 2008



THES ranking
2008



Shanghai
ARWU ranking
2008

Incidentally: these university rankings have also damaged the educational systems

« processus de Bologne (en 1999) + stratégie de Lisbonne (en 2000), → passage d'une logique de service public à une logique de marché, concurrentielle et gestionnaire »

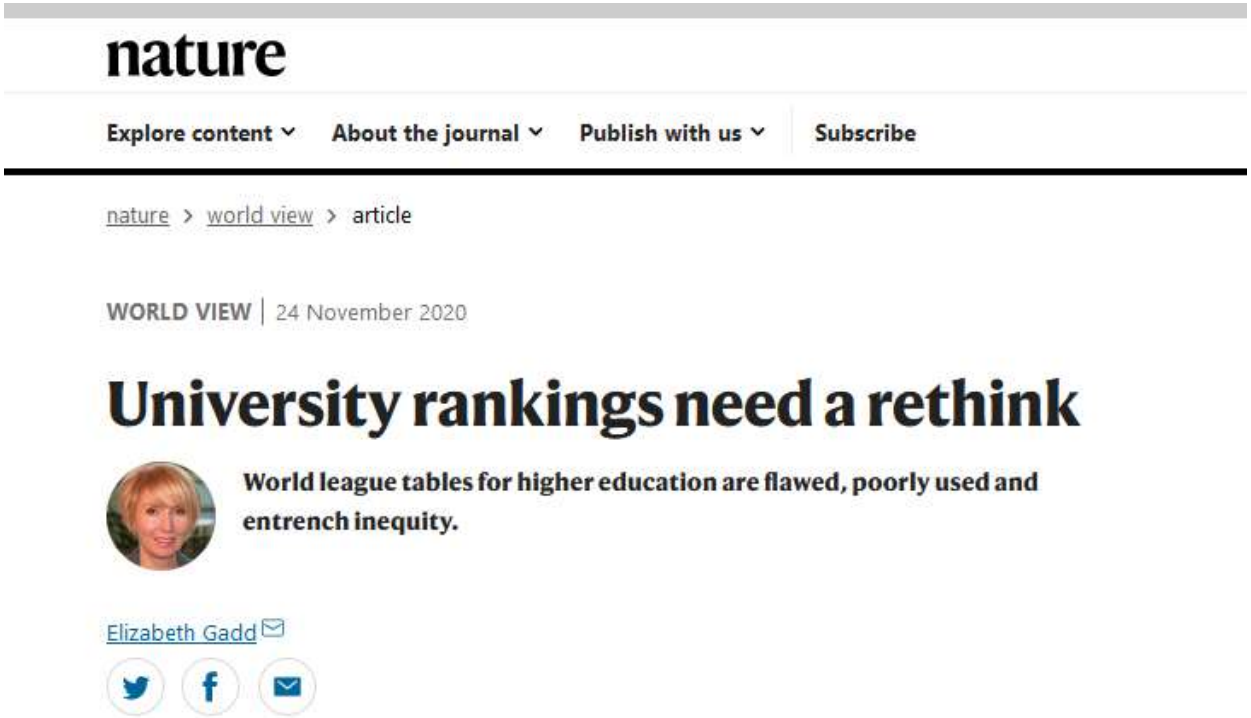
Le classement de Shanghai. Histoire, analyse et critique

Fabien Eloire

DANS L'HOMME & LA SOCIÉTÉ **2010/4 (n° 178)**, PAGES 17 À 38

"The University of Saskatchewan is hiring a University Ranking Strategist at an annual salary of $81K-135K. Reporting into their TWO rankings groups" (Gadd 2020)

Perverse incentives, Goodhart's (Campbell) law ….



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WORLD VIEW | 24 November 2020

University rankings need a rethink

World league tables for higher education are flawed, poorly used and entrench inequity.

Elizabeth Gadd

upf. BARCELONA SCHOOL OF MANAGEMENT

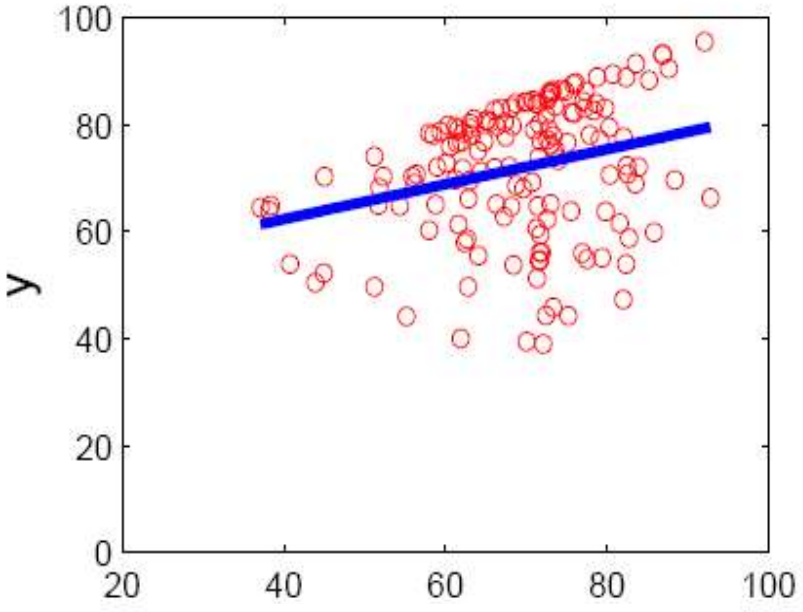
Linear aggregation paradox: **weights are used as if they were importance coefficients** while they are trade off coefficients

An example. A dean wants to rank teachers based on ‘hours of teaching’ and ‘number of publications …

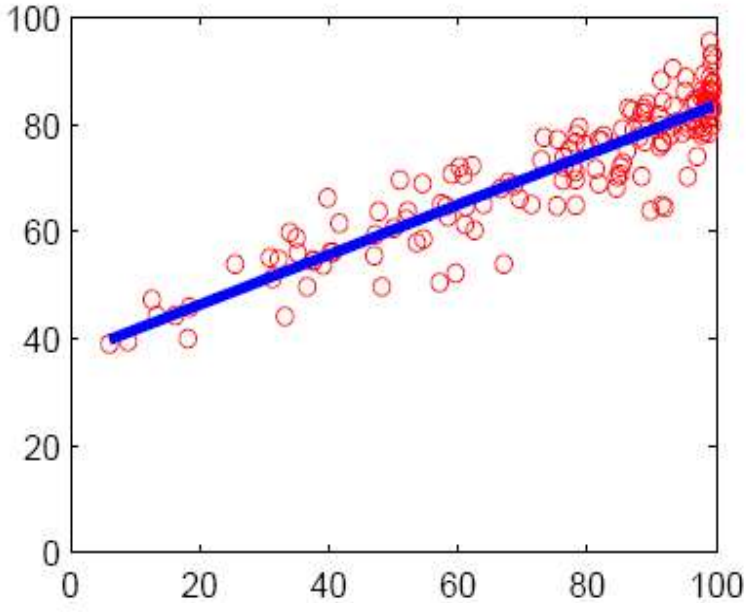
$$Y=0.5X_1 + 0.5X_2$$

X_1: hours of teaching
X_2: number of publications

… adding these two variables up she sees that teachers are practically ranked by publications alone



hours of teaching



number of publications

Dean's example: $y=x_1+x_2$.

Estimated $R_{ht}^2 = 0.0759$, $R_{np}^2 = 0.826$

To obviate this the dean substitutes the model

$$y=0.5x_1+0.5x_2$$

with

$$y=0.7x_1+0.3x_2$$

to rebalance hours of teaching.

X_1: hours of teaching
X_2: number of publication

A professor comes by, looks at the last formula, and complains that publishing is disregarded in the department …

To escape the paradox of weights you may either correct the weights or abandon linear aggregation and move to a non-compensatory aggregation approach, e.g. using the method of Condorcet

Why compensatory is bad?

Example: would you prefer to live in a country that scores 666 or 369 ?

6 variable 1
6 variable 2
6 variable 3

Or in a country

3 variable 1
6 variable 2
9 variable 3

What if

variable 1 = Fundamental rights
variable 2 = Education
variable 3 = GDP

Human Development Reports

Till 2009 the HDI three dimensions were a sum then they became a product

Journal of the Royal Statistical Society
Series A (Statistics in Society)
J. R. Statist. Soc. A (2013)
176, Part 3, pp. 609–634

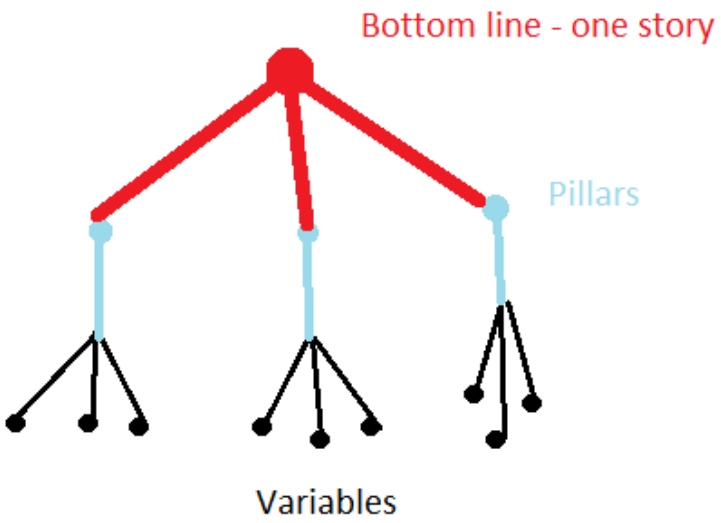
Ratings and rankings: voodoo or science?

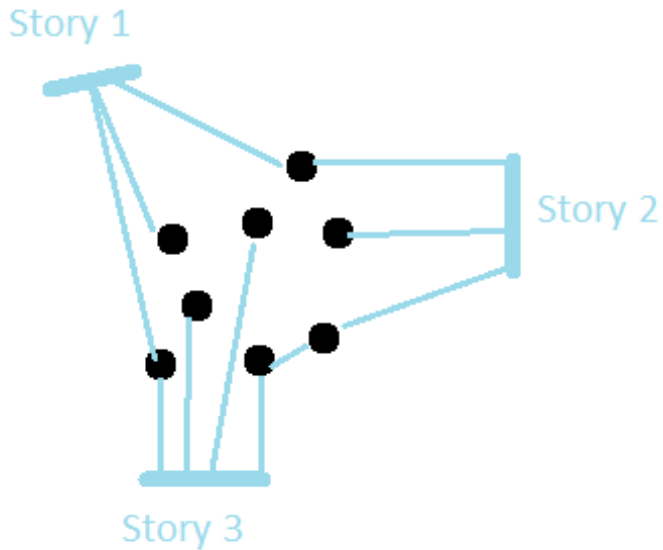
Paolo Paruolo
University of Insubria, Varese, Italy
and Michaela Saisana and Andrea Saltelli
European Commission, Ispra, Italy

What if different stakeholders have different preferences? A test case of EU convergence analysis;

Four different viewpoints are compared

Classical vs. Variable geometry CI

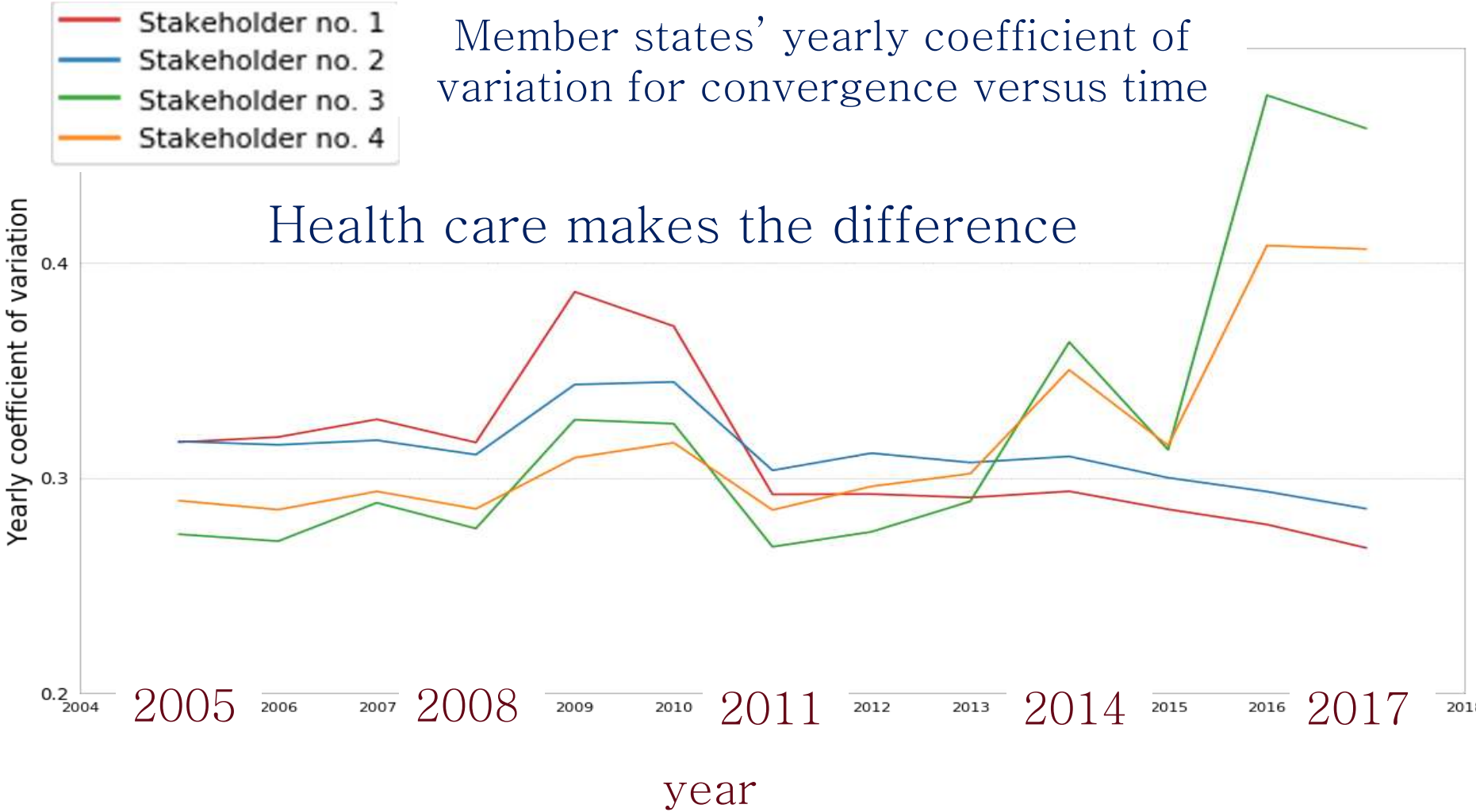




Stakeholder 1	Stakeholder 2	Stakeholder 3	Stakeholder 4
Access to labour market	Access to labour market	Access to labour market	Access to labour market
Fair working conditions	Fair working conditions	Fair working conditions	Fair working conditions
Social protection	Social protection	Social protection	Social protection
	Fairness	Health care	Fairness
			Health care

Member states' yearly coefficient of variation for convergence versus time

Health care makes the difference



Every measure – including a CI, reflects the disciplinary orientation, the worldview, the *mentalité*, the style of though, the *habitus* …of a person, a group, a class, a profession, an epoch …

There was an epoch for daemons and witches, one for the goddess Reason, one for eugenics …

But different styles of reasoning can be brought to bear on an issue

Source (both images): https://www.alamy.com/

Specifically, the act of quantifying in itself may be the result of a specific view that can be opened by some form of comparative epistemology …

The example of genetically modified organisms: proponents and opponents battle to define the nature of the problem

The Economist: **Vermont v science, The little state that could kneecap the biotech industry**, May 10th 2014

The Economist

"The fatuous fear of Frankenfoods … Repeated studies have found no threat to human health from GM ingredients"

Odd priorities

Global annual deaths from:

malnutrition*	genetically modified food
3,100,000	0

Sources: The *Lancet*; *The Economist*

*Among children under five, 2013 estimate

Source: https://www.economist.com/united-states/2014/05/10/vermont-v-science

For The Economist GMO are a solution to food problems, and are safe to consume. For The Economist the opponents of GMO erroneously fear adverse health effects from GMO consumption (they push a 'food scare')

For the opponents the problem is not safety. The was the result of a study now 20 y old … but the dispute is still ongoing

Citizens' worries (Marris, 2001, excerpts)

- Who decided that they should be developed and how?
- Why are we not given an effective choice about whether or not to buy and consume these products?
- Do regulatory authorities have sufficient powers and resources to effectively counter-balance large companies who wish to develop these products?

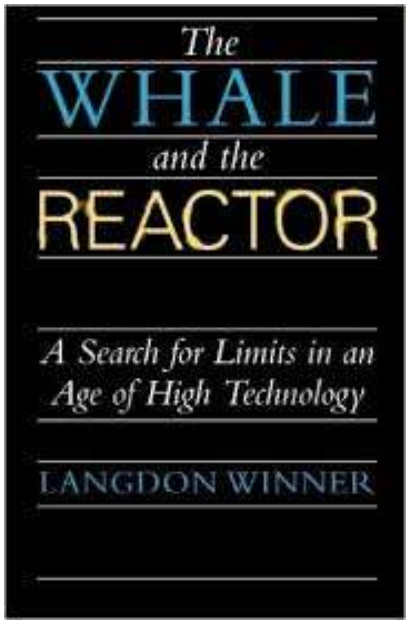

Public Perceptions of
Agricultural Biotechnologies in Europe

Final Report of the PABE research project

December 2001

Marris, C., Wynne, B., Simmons P., and Weldon, S. 2001. Final Report of the PABE research project funded by the Commission of European Communities, Contract number: FAIR CT98-3844 (DG12 - SSMI), December 2001
Source: https://www.lancaster.ac.uk/fss/projects/ieppp/pabe/docs/pabe_finalreport.doc

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



8

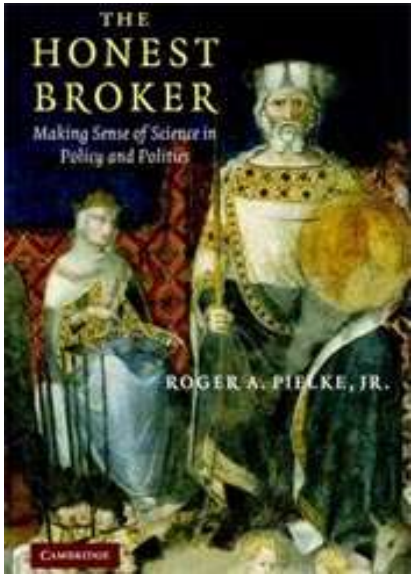
ON NOT HITTING THE TAR-BABY

Langdon Winner

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

The problem is not the non-neutrality of a measure but its purported neutrality (R. Pielke's Jr 'stealth advocacy')

➔ Next lecture



One could test instead different ‘lenses’ or way to look at an issue; for example, instead to check if a new technology is safe one can check:

- feasibility (e.g. natural resources);
- viability (e.g. existing legal constraints); and
- desirability (e.g. do voters want it).

THE CONVERSATION
Academic rigour, journalistic flair

International PISA tests show how evidence-based policy can go wrong

June 12, 2017 3.55pm AEST

In 2014 a battle between educationalists and the OECD was fought in the public arena about the OECD-PISA study (an aggregate indicators for the competence of young students)

IJCED
19,1

20

Do PISA data justify PISA-based education policy?

Luisa Araujo
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International Journal of Comparative Education and Development
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2396-7404
DOI 10.1108/IJCED-12-2016-0023

OECD and Pisa tests are damaging education worldwide - academics

In this letter to Dr Andreas Schleicher, director of the OECD's Programme for International Student Assessment, academics from around the world express deep concern about the impact of Pisa tests and call for a halt to the next round of testing

The Guardian

Supporters of PISA present it as a tool for comparative analysis and evidence-based policy:

"If every EU Member State achieved an improvement of 25 points in its PISA score [...] the GDP of the whole EU would increase by between 4% and 6% by 2090; such an 6% increase would correspond to 35 trillion Euro" (Woessmann, 2014)

Woessmann, L. (2014), "The economic case for education", EENEE Analytical Report 20, European Expert Network on Economics of Education (EENEE), Institute and University of Munich, Munich.

Opponents of PISA present it as damaging

(1) The goal of education becomes preparation for gainful employment;
(2) With PIA OECD highjacks power from regional and state authorities;
(3) PISA creates a cottage-industry of private service providers;
(4) School subjects have been excluded by PISA;
(5) PISA stresses school pupils and their teachers;
(6) PISA fosters short-termism in education policy.

See 'OECD and Pisa tests are damaging', The Guardian, 6 May 2014
https://www.theguardian.com/education/2014/may/06/oecd-pisa-tests-damaging-education-academics

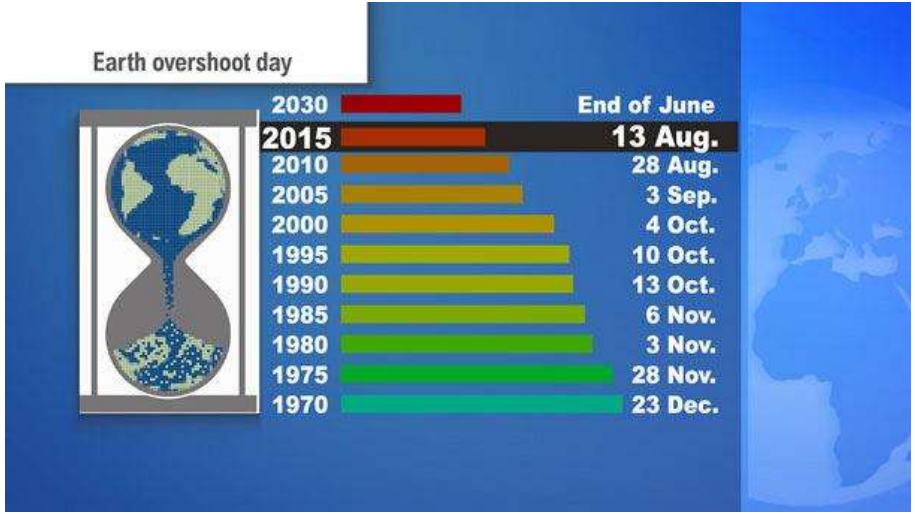
The Ecological Footprint; can we measure when the capacity of the planet is 'overshot' by humanity with a single numbers? Proponent and opponents battle on

An argument that lasted 4 articles

- Giampietro, M., and Saltelli, A., November 2014, **Footprints to nowhere**, Ecological Indicators, 46, 610–621.
- Goldfinger, S., Wackernagel, M., Galli, A., Lazarus, E., Lin, D., November 2014, **Footprint facts and fallacies: A response to Giampietro and Saltelli, "Footprints to Nowhere"**, 46, 622–632.
- Giampietro, M., and Saltelli, A., November 2014, **Footworking in Circles**, Ecological Indicators, 46, 260–263.
- Alessandro Galli, Mario Giampietro , Steve Goldfinger , Elias Lazarus, David Lin, Andrea Saltelli, Mathis Wackernagel, Felix Müller, 2016, **Questioning the ecological footprint , Ecological Indicators, 69, 224–232.**

The Ecological Footprint suggests compressing sustainability to a single metric: all human activity is converted to acres of equivalent land using a complex aggregation procedure

For the opponents this leads to paradoxical policy implications – e.g. intensive non sustainable agricultural practices promoted



Conclusions: CI – instructions for use

Beware the imperfections and non-neutrality of measures

Beware damage; mind the interpretant

Investigate properties and assumptions (uncertainty and sensitivity analysis, sensitivity auditing)

Use for social discovery; deliberative extended participation; quality as fitness for purpose (interpretant)

Final exercise: become a deconstructor

Source CartoonStock

"What follows is a hypothetical executive summary from an imagined Food and Agriculture Organization (FAO) report on the state of the world's food systems, written from the perspective of the 2050s"

https://www.thesolutionsjournal.com/article/pathways-leading-sustainable-healthy-global-food-system/

Executive Summary: FAO State of World Agriculture in 2050 Draft Report

"[…]this FAO report presents evidence that the international food system of the second half of the 21st century is more sustainable than the food system of the late 20th or early 21st centuries.

↓

[…] today more people are being fed on less land and agriculture is requiring fewer inputs"

Executive Summary: FAO State of World Agriculture in 2050 Draft Report

"[…] despite there being 10 billion people on the planet, today agriculture requires 438 million hectares* less land than it did in 2015, yet produces more adequate nutrition for all."

*Authors' estimate

This [438 Mha] figure was arrived at by assuming that:

- Agriculture shifts away from over production of cereals, oils, and sugars, but increases fruit and vegetables;
- Agricultural yields increase ~1%/y between now and 2050.
- Protein consumption shifts from 86% animals and 14% plants to 50% animal and 50% plant.

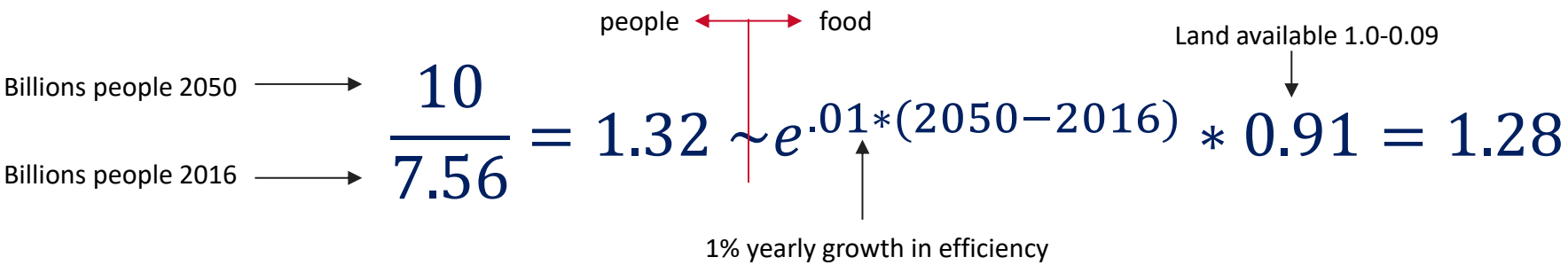
"Please contact the authors for references etc. pertaining to these calculations"

Over to you

Some elements for discussions

- Gain in number of hectares: three significant digits (438 millions)?

- Balancing yield yearly increase of 1% and population growth (our computation) results in little change in food per capita at planetary scale



- Neglect of diminishing returns and ecosystem stress (fertilizers, pesticides)
- More adults (higher caloric intake) in 2050 population
- Can one educate citizens globally? The case of tobacco

In conclusion the

"mismatch between what the world needed for everyone to enjoy a nutritious diet and what the world was actually producing"

is the substitution of a political problem with a technical one

Food ethics (2017) 1:173–179
DOI 10.1007/s41055-017-0002-6

DISCUSSION PAPER

Problematic Quantifications: a Critical Appraisal of Scenario Making for a Global 'Sustainable' Food Production

Andrea Saltelli[1,2,3] · Samuele Lo Piano[1]

Accepted: 4 August 2017 / Published online: 15 August 2017
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4.

Multi-criteria analysis

Ways to build composite indicators that are better than linear aggregation: Some elements of the methods of Borda and Condorcet

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Building CI using using methods such as Borda, Condorcet, Balinski-Laraki …




Some of these methods have a long history
(including in Catalonia)




Ramon Llull (Catalan, ca. 1232 – ca. 1315) proposed first what would then become known as the method of Condorcet. Nicholas of Kues (1401 – August 11, 1464), also referred to as Nicolaus Cusanus and Nicholas of Cusa developed what would later be known as the method of Borda. Nicolas de Condorcet, (17 September 1743 – 28 March 1794) developed the eponymous method. Jean-Charles, chevalier de Borda (May 4, 1733 – February 19, 1799) developed the Borda count

Images from Wikipedia Commons

An impact matrix

	Indic.	GDP ↑	Unemp. Rate ↓	Solid wastes ↓	Income dispar. ↓	Crime rate ↓
Country						
A		25,000	0.15	0.4	9.2	40
B		45,000	0.10	0.7	13.2	52
C		20,000	0.08	0.35	5.3	80
weights		.166	.166	0.333	.166	.166

We can say that
GDP 'votes' for B>A>C (countries / options)
UR 'votes' for C>B>A
SW 'votes' for C>A>B
ID 'votes' for C>A>B
CR 'votes' for A>B>C

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	Indic.	GDP	Unemp. Rate	Solid wastes	Income dispar.	Crime rate
Country						
A		25,000	0.15	0.4	9.2	40
B		45,000	0.10	0.7	13.2	52
C		20,000	0.08	0.35	5.3	80
weights		.166	.166	0.333	.166	.166

# of indicators	2	1	1	1
1st position	*c*	*b*	*c*	*a*
2nd position	*a*	*a*	*b*	*b*
3rd position	*b*	*c*	*a*	*c*

GDP: B>A>C
UR: C>B>A
SW: C>A>B
ID: C>A>B
CR: A>B>C

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# of indicators	2	1	1	1
1st position	*c*	*b*	*c*	*a*
2nd position	*a*	*a*	*b*	*b*
3rd position	*b*	*c*	*a*	*c*

Rank	*a*	*b*	*c*
1st	1	1	3
2nd	3	2	0
3rd	1	2	2

Different ways to organize the same information: building a frequency matrix

Three countries [options/candidates] and five indicators [criteria/voters]

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# of indicators	2	1	1	1
1st position	*c*	*b*	*c*	*a*
2nd position	*a*	*a*	*b*	*b*
3rd position	*b*	*c*	*a*	*c*

Rank	*a*	*b*	*c*
1st	1	1	3
2nd	3	2	0
3rd	~~1~~	~~2~~	~~2~~

For a case with three candidates Borda gives 3 minus 1 for each first rank , 2 minus 1 for each second rank and zero to the third; so

a gets 2∗1+ 1∗3=5
b gets 2∗1+ 1∗2=4
c gets 2∗3+ 1∗0=6

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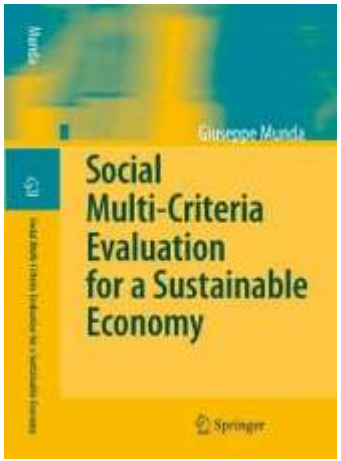
But lets try Borda on a more interesting case: (from Moulin, 21 criteria 4 options, cited in Munda 2008)



21 criteria 4 alternatives

Note:3+ 5+ 7+ 6=21

# of indicators	3	5	7	6
1st position	*a*	*a*	***b***	***c***
2nd position	***b***	***c***	***d***	***b***
3rd position	***c***	***b***	***c***	***d***
4th position	***d***	***d***	*a*	*a*

Rank	*a*	*b*	*c*	*d*	Points
1st	**8**	**7**	**6**	**0**	**3**
2nd	**0**	**9**	**5**	**7**	**2**
3rd	**0**	**5**	**10**	**6**	**1**
4th	**13**	**0**	**0**	**8**	**0**

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Borda count – Frequency matrix (Moulin, 21 criteria 4 options)

Columns add up to the number of criteria / voters=21

3 points if first
2 if second
1 if third
0 if last

Rank	*a*	*b*	*c*	*d*	Points
1st	**8**	**7**	**6**	**0**	**3**
2nd	**0**	**9**	**5**	**7**	**2**
3rd	**0**	**5**	**10**	**6**	**1**
4th	**13**	**0**	**0**	**8**	**0**

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Borda score:

$a = 8 \times 3 = 24$

$b = 5 + 9 \times 2 + 7 \times 3 = 44$

$c = 10 + 5 \times 2 + 6 \times 3 = 38$

$d = 6 + 7 \times 2 = 20$

Borda solution:
b→c→a→d

Frequency matrix (21 criteria 4 alternatives)

Rank	*a*	*b*	*c*	*d*	Points
1st	**8**	**7**	**6**	**0**	**3**
2nd	**0**	**9**	**5**	**7**	**2**
3rd	**0**	**5**	**10**	**6**	**1**
4th	**13**	**0**	**0**	**8**	**0**

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The Borda count was developed independently several times, (e.g. by Nicolaus Cusanus beginning XV century) but is named for Jean-Charles de Borda, who devised the system in 1770.

It is currently used for the election of two ethnic minority members of the National Assembly of Slovenia (https://www.electoral-reform.org.uk/how-do-elections-work-in-slovenia/)

It is used throughout the world by various organisations and competitions [e.g. in academia]

Jean-Charles, chevalier de Borda

Borda was a mariner and a scientist. Worked on chronometers. Between 1777 and 1778, he participated in the American Revolutionary War.

The French Academy of Sciences used Borda's method to elect its members for about two decades [till Napoleon Bonaparte became president…]

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Condorcet disagrees …

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Condorcet's outscoring matrix (21 criteria 4 alternatives)

# of indicators	3	5	7	6
1st position	*a*	*a*	*b*	*c*
2nd position	*b*	*c*	*d*	*b*
3rd position	*c*	*b*	*c*	*d*
4th position	*d*	*d*	*a*	*a*

Frequency matrix

	a	*b*	*c*	*d*
a	0	8	8	8
b	13	0	10	21
c	13	11	0	14
d	13	0	7	0

Outscoring matrix

b better than a 7+6=13 times

b better than c 7+3=10 times

How to move from frequency to outscoring (again)

# of indicators	3	5	7	6
1st position	*a*	*a*	*b*	*c*
2nd position	*b*	*c*	*d*	*b*
3rd position	*c*	*b*	*c*	*d*
4th position	*d*	*d*	*a*	*a*

Frequency matrix

$$\begin{bmatrix} & a & b & c & d \\ a & 0 & 8 & 8 & 8 \\ b & 13 & 0 & 10 & 21 \\ c & 13 & 11 & 0 & 14 \\ d & 13 & 0 & 7 & 0 \end{bmatrix}$$

Outscoring matrix

Condorcet's outscoring matrix (21 criteria 4 alternatives)

For each pair of countries a concordance index is computed by counting how many indicators/voters are in favour of each country (e.g. 13 voters prefer b to a).

Note the "constant sum property" in the outranking matrix (13+ 8=21 number of indicators/voters)

	a	b	c	d
a	0	8	8	8
b	13	0	10	21
c	13	11	0	14
d	13	0	7	0

Outranking matrix

How to use Condorcet's outscoring matrix
(21 criteria 4 alternatives)

Pairs with concordance index > 50% of the indicators/voters are considered: majority threshold = 11 (i.e. a number of voters > 50% of voters=21)

Thus a is never better than anyone more than 11 times, while *bPa= 13, bPd=21(=always), cPa=13, cPb=11, cPd=14, dPa=13*.

c is better than a, b, d so it is the winner
b is better than the remaining a, d, it is the second best
d is better than a.

➔Condorcet solution: c → b→ d→ a

	a	*b*	*c*	*d*
a	0	8	8	8
b	13	0	10	21
c	13	11	0	14
d	13	0	7	0

Count row-wise discarding entries < 11 as there are 21voters/criteria

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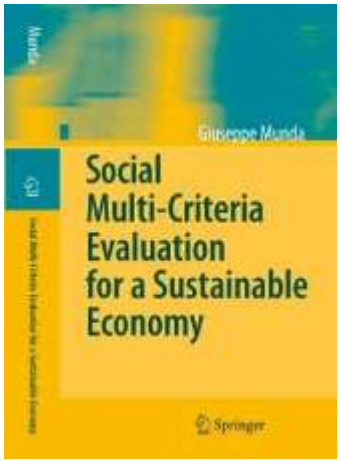
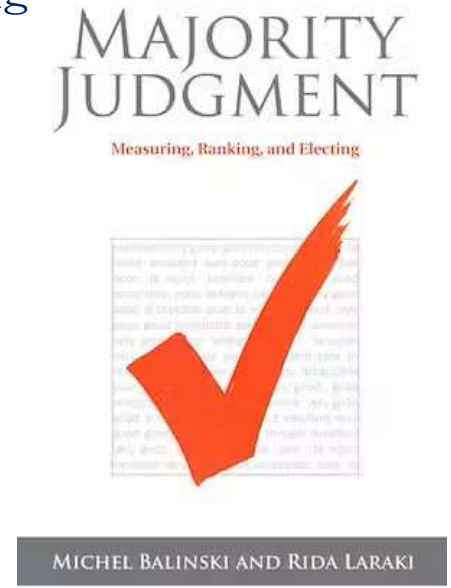
Borda solution: b → c → a → d
Condorcet solution: c → b → d → a

Can we choose between Borda and Condorcet on some theoretical and/or practical grounds?



Who should have won the 2007 French Election according to Balinski and Laraki?

Nicolas, Sarkozy, Ségolène Royal, François Bayrou



The winner in a classical 'majority of voters' election is strongly favoured by most but also strongly disfavoured by many … a better method is needed (same argument used in all MCDA methods), for example a methods that picks a candidate in between that no one dislikes too much (Bayrou in the example)

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Each voter provides a ranking of all candidates or options. The method seeks a "central" ranking that best represents the collective preference

Steps:
Collect rankings from all voters (Like in Borda)
Determine the medium rank for each candidate
Aggregate rankings based on medium rank

Voter	Candidate A	Candidate B	Candidate C
1	1	3	2
2	2	1	3
3	2	3	1
4	3	1	2
5	1	2	3
	9/5=1.8	10/5=2	11/5=2.2

4 5 4 ← Borda Rank

← Medium Rank

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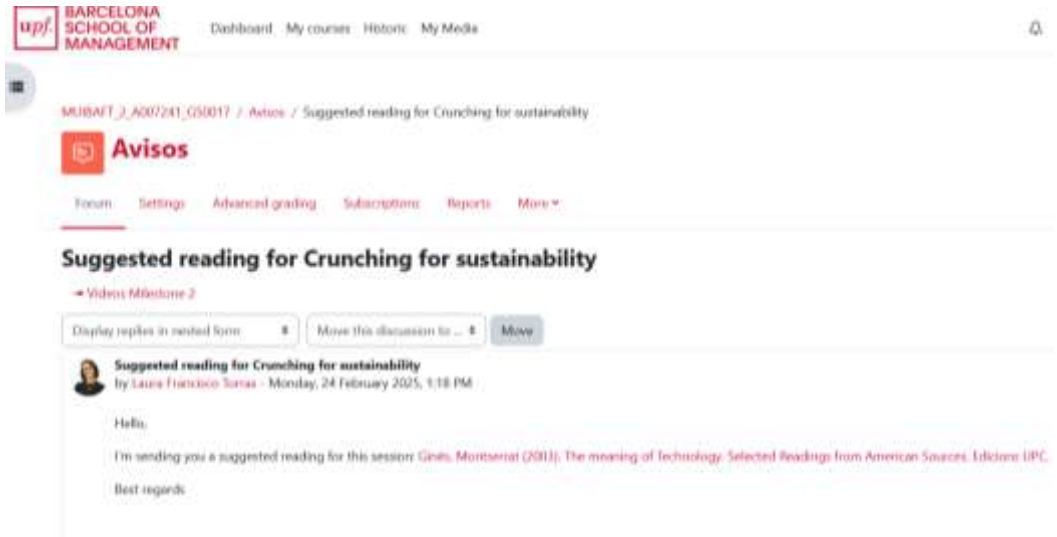
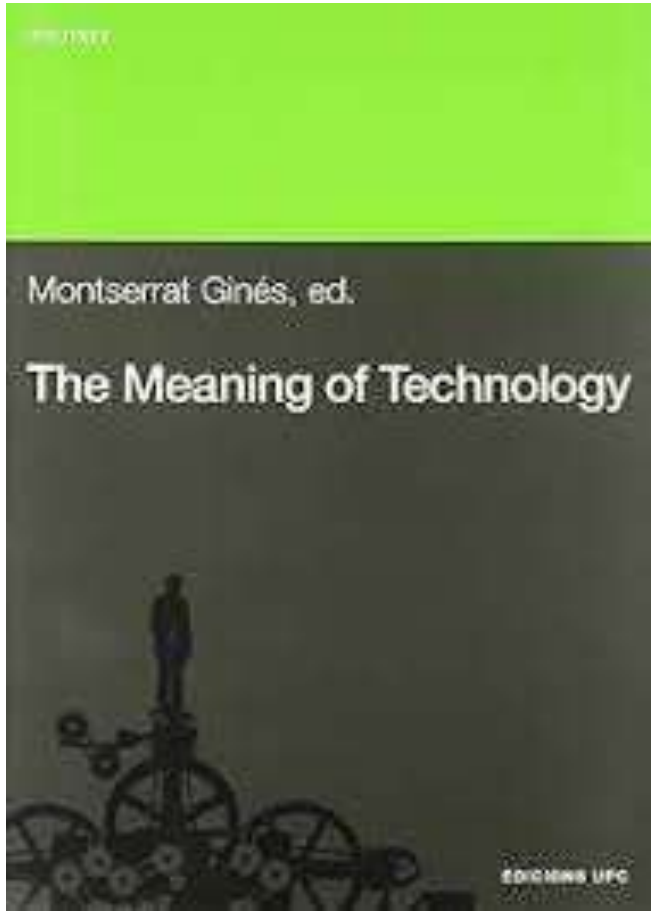
For next week, please read

F.W. Taylor, p.47
D. D. Eisenhover, p. 111





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Thank you

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https://www.youtube.com/channel/UCz26ZK04xchekUy4GevA3DA

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