

Evidence based policy: handle with care

SIGNIFICANT DIGITS

Responsible Use of Quantitative Information
A workshop of the Joint Research Centre of the
European Commission
Brussels, Fondation Universitaire
9-10 June 2015

Andrea Saltelli
(@andreasaltelli)

Centre for the Study of the Sciences and the
Humanities (SVT) - University of Bergen (UIB), and
Institut de Ciència i Tecnologia Ambientals (ICTA) -
Universitat Autònoma de Barcelona (UAB).

The perfect storm



The use of science for policy is at the core of a perfect storm generated by the insurgence of several concurrent crises.

The prevailing modern positivistic model of science for policy, known as ‘evidence based policy’, is based on dramatic simplifications ...

... and on a flawed epistemology (Demarcation Model, Cartesian dream)

“the great ideas which once inspired Europe seem to have lost their attraction, only to be replaced by the bureaucratic technicalities of its institutions.”



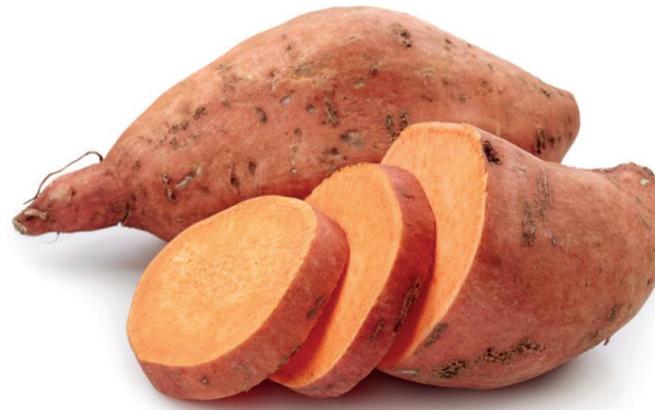
“As the European Union has expanded, there has been growing mistrust on the part of citizens towards institutions considered to be aloof, engaged in laying down rules perceived as insensitive to individual peoples, if not downright harmful” (Strasbourg, November 25, 2014)



More controversy - wicked issues



More and more issues become 'wicked', meaning by this deeply entangled in a web of hardly separable facts, interests and values... (GMO, climate, the use of statistics in Education (PISA), bees and pesticides, children born to gay couples, culling of badgers, ...)



“Science still commands enormous—if sometimes bemused—respect. But its privileged status is founded on the capacity to be right most of the time and to correct its mistakes when it gets things wrong. [...] The false trails laid down by shoddy research are an unforgivable barrier to understanding”



Issues with trust / quality in the scientific enterprise

Laboratory experiments cannot be trusted without independent verification (Sanderson 2013), rules are proposed to spot “suspected work [...in] the majority of preclinical cancer papers in top tier journals” (Begley 2013).

Begley CG 2013 Reproducibility: Six red flags for suspect work *Nature* 497 433–434.

Ioannidis J P A 2005 Why Most Published Research Findings Are False *PLoS Medicine* 2(8) 696-701.

Sanderson K 2013 Bloggers put chemical reactions through the replication mill *Nature* 21 January 2013.

Issues with trust / quality in the scientific enterprise

In a landmark study of results in cancer science Begley and Ellis were able to reproduce only 11 per cent of the original findings (2012).

Begley, C. G., and Lee M. E., 2012, Drug Development: Raise Standards for Preclinical Cancer Research, *Nature*, 483, 531–533.

Issues with trust / quality in the scientific enterprise

Initiatives:

<http://retractionwatch.wordpress.com>)

<http://www.reproducibilityinitiative.org>

Fixing the mess is not easy:

‘Sluggish data sharing hampers reproducibility effort’,
(Van Noorden, 2015).

Nature biotechnology. Further Confirmation Needed, Editorial, Nature Biotechnology 30, 2012, 806.

Van Noorden, R., Sluggish data sharing hampers reproducibility effort, Nature, News, June 3rd 2015.

“Currently, many published research findings are false or exaggerated, and an estimated 85% of research resources are wasted”

For Lancet (2015) an estimated US\$200 billion were wasted in the US in 2010.

Ioannidis, J. P. (2014). How to Make More Published Research True. PLoS medicine, 11(10), e1001747
Lancet, Editorial, 2015, Rewarding true inquiry and diligence in research, 385, p. 2121.



“Springer and Université Joseph Fourier release SciDetect to discover fake scientific papers”



“The open source software discovers text that has been generated with the SCIgen computer program and other fake-paper generators like Mathgen and Physgen [...]

SciDetect [...] is a valuable building block for the future of academic publishing”

<https://www.springer.com/gp/about-springer/media/press-releases/corporate/springer-and-universit%C3%A9-joseph-fourier-release-scidetect-to-discover-fake-scientific-papers--/54166>



“Shoddy science” is not confined to natural sciences: social sciences are also affected; “I see a train wreck looming” warns Daniel Kahneman; Joseph Stiglitz condemns perverse incentives in the modelling of financial products at the hearth of the present crisis.



Daniel
Kahneman



Joseph Stiglitz

Yong, E., Nobel laureate challenges psychologists to clean up their act, *Nature, News*, 03 October 2012.

Stiglitz, J. (2010) *Freefall, Free Markets and the Sinking of the Global Economy*, Penguin, London.



The New York Times

‘Scientists Who Cheat’

nature

Misplaced faith.

The public trusts scientists much more than scientists think. But should it?’

New York Times, 2015, Scientists Who Cheat, Editorial, June 1.

Nature, 2015, Misplaced faith, Editorial, June 2. The public trusts scientists much more than scientists think. But should it?



Solutions from within:

Four international conferences have already been held on science integrity between 2007 and 2015 (May 31, 2015, about 600 delegates from over 50 countries and all continents, Rio de Janeiro)

San Francisco declaration, (2012), as of June 2015 signed by 12,000 individuals, and 570 organizations.

“Do not use journal-based metrics, such as Journal Impact Factor, as a surrogate measure of the quality of individual research articles to assess an individual scientist’s contributions, or in hiring, promotion, or funding decisions.”

Declaration: <http://am.ascb.org/dora/> , drafted by publishers, with separate recommendations for institutions, publishers, organizations that supply metrics and researchers.

Lancet, Editorial, 2015, Rewarding true inquiry and diligence in research, 385, p. 2121.

Solutions from within:

How to Make More Published Research True (Ioannides 2014)



John P. A. Ioannides

“[...] adoption of large-scale collaborative research; replication culture; registration; sharing; reproducibility practices; better statistical methods; [...] and improvement in study design standards, peer review, reporting and dissemination of research, and training of the scientific workforce”

Ioannidis, J. P. (2014). How to Make More Published Research True. PLoS medicine, 11(10), e1001747.

Solutions from within – randomization & counterfactuals!

How to Make More Published Research True (Ioannides 2014)



John P. A. Ioannides

“Selection of interventions to improve research practices requires rigorous examination and experimental testing whenever feasible”

Ioannidis, J. P. (2014). How to Make More Published Research True. PLoS medicine, 11(10), e1001747.

Solutions from within – incentives & currencies

How to Make More Published Research True (Ioannides 2014)



John P. A. Ioannides

“Modifications [] in the reward system for science, affecting the exchange rates for currencies (e.g., publications and grants) and purchased academic goods (e.g., promotion and other academic or administrative power) and introducing currencies that are better aligned with translatable and reproducible research”

Ioannidis, J. P. (2014). How to Make More Published Research True. PLoS medicine, 11(10), e1001747.



For The Lancet:

The coming together of the three themes—research integrity; research reward systems; and increasing value and reducing waste in research—is helpful and has greater potential in effecting change than each on its own [...] the true challenge we face is creating a sustainable research environment that fulfils science’s true purpose—inquiry to deliver progress for society and our planet.

Lancet, Editorial, 2015, Rewarding true inquiry and diligence in research, 385, p. 2121.

Brave efforts from within:

Jeffrey Beall, librarian, University of Colorado, Denver.
Monitors predatory open access publishers.



Timothy Gowers, mathematician, Fields medalist,
boycott of Elsevier, slogans: ‘Academic Spring’, ‘Occupy
Elsevier’.



<http://scholarlyoa.com/2015/01/02/bealls-list-of-predatory-publishers-2015/#more-4719>. Additionally
“**Misleading metrics** list includes companies that “calculate” and publish counterfeit impact factors [...] The
Hijacked journals list includes journals for which someone has created a counterfeit website, stealing the
journal’s identity and soliciting articles submissions using the author-pays model (gold open-access)”

Whitfield, J., 2012, Elsevier boycott gathers pace: Rebel academics ponder how to break free of commercial publishers, Nature, doi:10.1038/nature.2012.10010

BUT...

What if solutions from within simply miss the point?



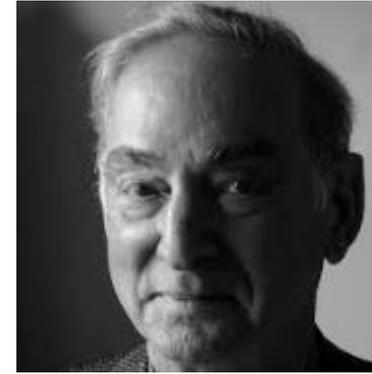
"You take the blue pill, the story ends. You wake up in your bed and believe whatever you want to believe. You take the red pill, you stay in wonderland, and I show you how deep the rabbit hole goes"

- Science/knowledge degenerates when it becomes a commodity for Ravetz (1971), Lyotard (1979) and Mirowski (2011).

Ravetz, J., 1971, *Scientific Knowledge and its Social Problems*, Oxford University Press, p.22.

Lyotard, J.-F. 1979. *La Condition postmoderne. Rapport sur le savoir*, Paris : Minuit, Chapter 10.

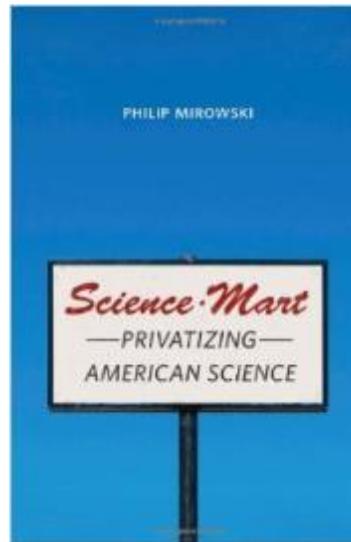
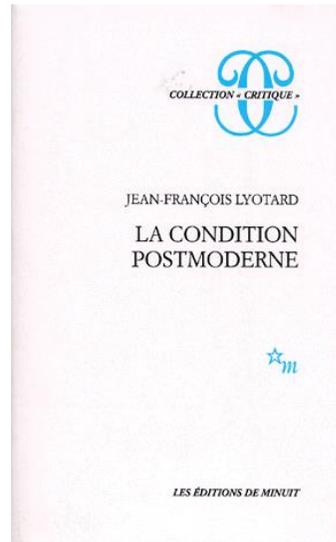
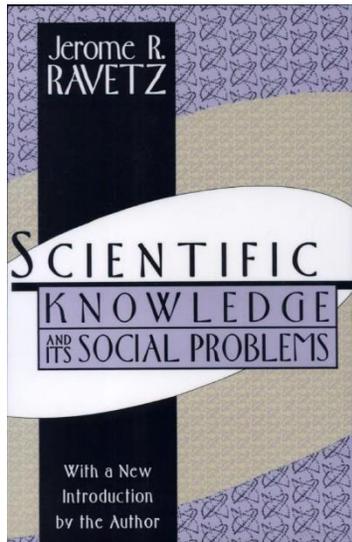
Mirowski, P. 2011. *Science-Mart: Privatizing American Science*, Harvard University Press.



Jerome R. Ravetz



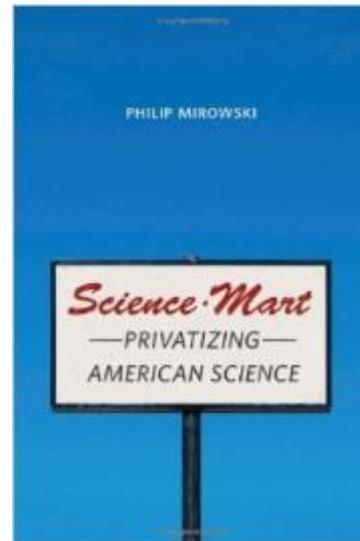
Jean-François Lyotard



Philip Mirowski

After the eighties neoliberal ideologies succeeded in decreasing state intervention in the funding of science, which became increasingly privatized... ...Knowledge as a monetized commodity replaces knowledge as public good...

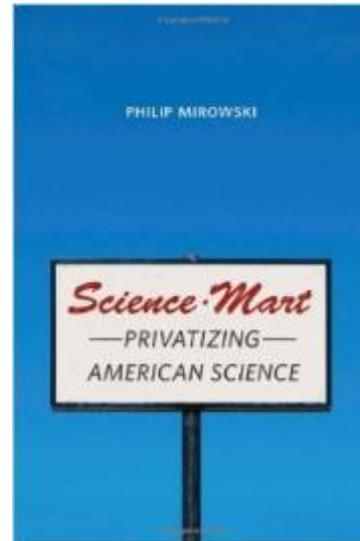
Mirowski, P. 2011. *Science-Mart: Privatizing American Science*, Harvard University Press.



Philip Mirowski

In house science labs of major corporation were closed and research outsourced to universities which ... became more and more looking as profit seeking organization (technology transfer offices in every campus) ... then research ended up outsourced again to contract-based research organizations (CRO's)...

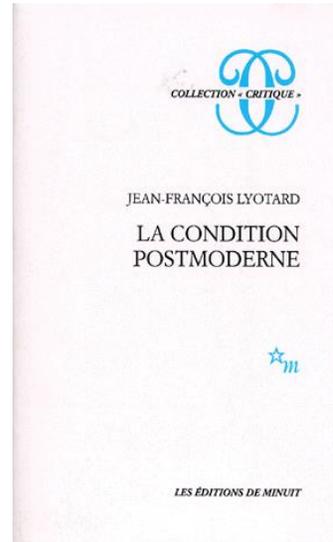
Mirowski, P. 2011. *Science-Mart: Privatizing American Science*, Harvard University Press.



Philip Mirowski

“The question of the legitimacy of science has been indissociably linked to that of the legitimation of the legislator since the time of Plato. From this point of view, the right to decide what is true is not independent of the right to decide what is just,[...] there is a strict interlinkage between the kind of language called science and the kind called ethics and politics ...”

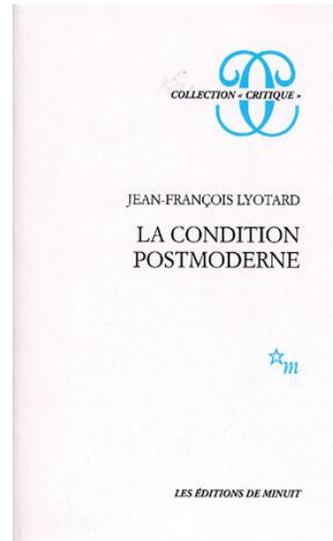
Lyotard, J.-F. 1979. *La Condition postmoderne. Rapport sur le savoir*, Paris : Minuit, Chapter 10.



Jean-François Lyotard

Chapter 10 on delegitimation: “[...] The grand narrative has lost its credibility, regardless of what mode of unification it uses, regardless of whether it is a speculative narrative or a narrative of emancipation”

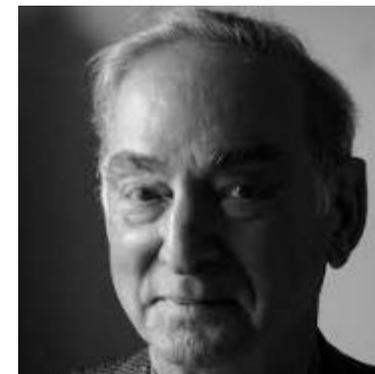
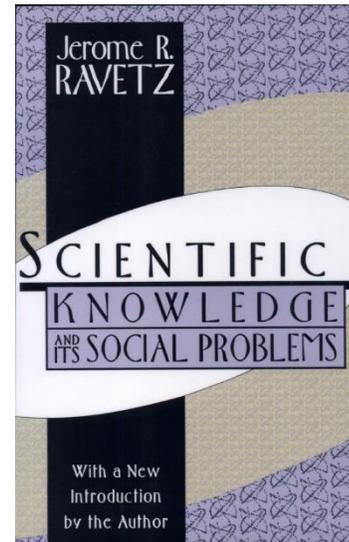
Lyotard, J.-F. 1979. *La Condition postmoderne. Rapport sur le savoir*, Paris : Minit, Chapter 10.



Jean-François Lyotard

p.22: “with the industrialization of science, certain changes have occurred which weaken the operation of the traditional mechanism of quality control and direction at the highest level. [...]The problem of quality control in science is thus at the centre of the social problems of the industrialized science of the present period. If it fails to resolve this problem [...] then the immediate consequences for morale and recruitment will be serious; and those for the survival of science itself, grave”

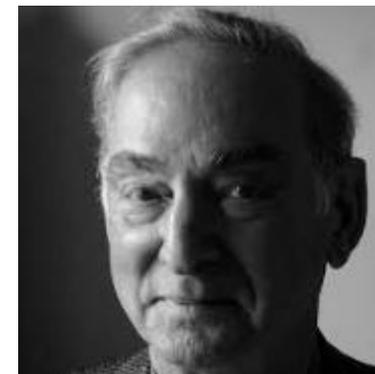
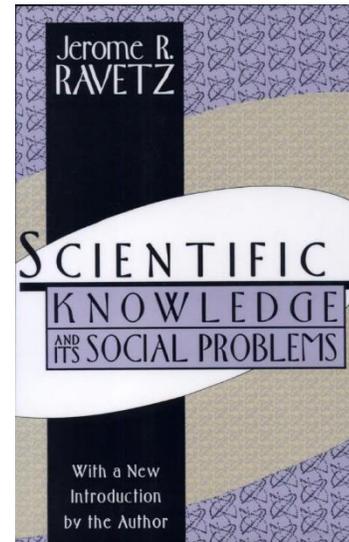
Ravetz, J., 1971, *Scientific Knowledge and its Social Problems*, Oxford University Press, p.22.



Jerome R. Ravetz

p. 22-23: “Two separate factors are necessary for the achievement of worthwhile scientific results: a community of scholars with a shared knowledge of the standards of quality appropriate for their work and a shared commitment to enforce those standards by the informal sanctions the community possesses; and individuals whose personal integrity sets standards at least as high as those required by their community...”

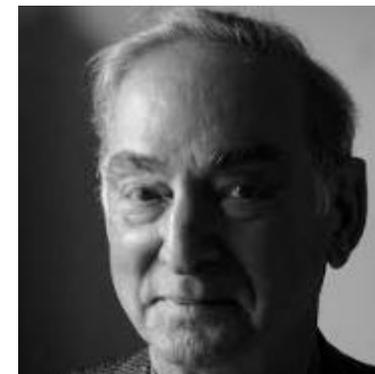
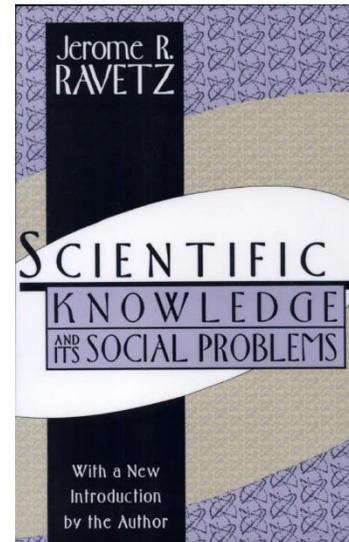
Ravetz, J., 1971, *Scientific Knowledge and its Social Problems*, Oxford University Press, p.22.



Jerome R. Ravetz

“...If either of these conditions is lacking [...] then bad work will be produced [...] 'morale' is an important component of scientific activity; and any view of science which fails to recognize the special conditions necessary for the maintenance of morale in science is bound to make disastrous blunders in the planning of science”

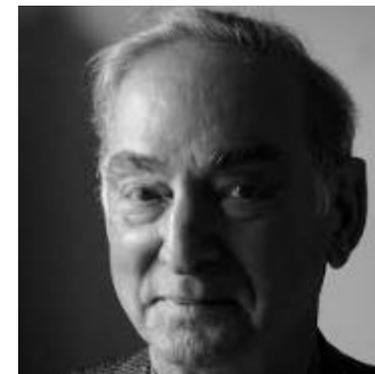
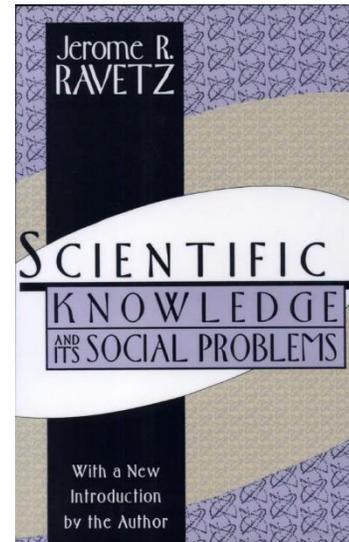
Ravetz, J., 1971, *Scientific Knowledge and its Social Problems*, Oxford University Press, p.22.



Jerome R. Ravetz

p. 176: “If there were not a test of each paper before its acceptance by a journal, then every intending user would be forced to examine it at length before investing any of his resources in work which relied on it. Under such circumstances, the co-operative work of science as we know it could not take place”

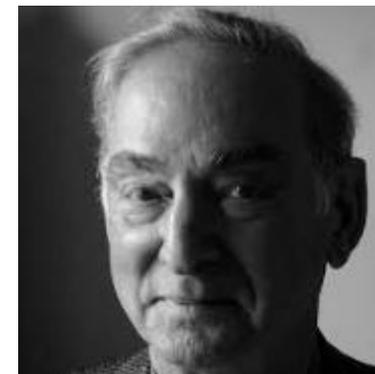
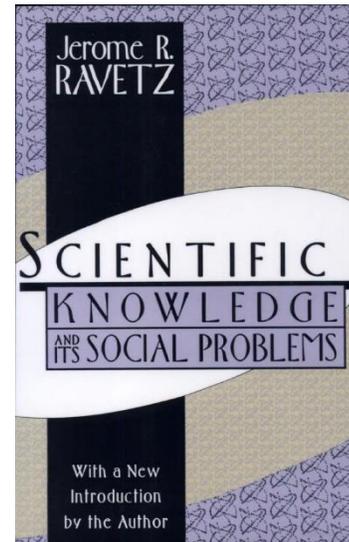
Ravetz, J., 1971, *Scientific Knowledge and its Social Problems*, Oxford University Press, p.22.



Jerome R. Ravetz

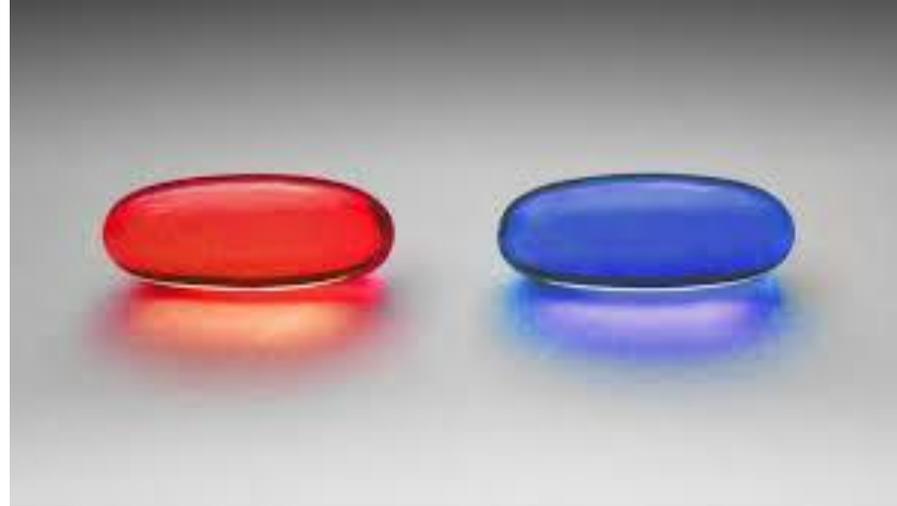
p. 407: “No formal system of imposed penalties and rewards will guarantee the maintenance of quality, for the tasks of scientific inquiry are generally too subtle to be so crudely assessed; nor will the advantages to an individual of a good reputation of his group be sufficient to induce a self-interested individual to make sacrifices to maintain it. Only the identification with his colleagues, and the pride in his work, both requiring good morale, will ensure good work”

Ravetz, J., 1971, *Scientific Knowledge and its Social Problems*, Oxford University Press, p.22.



Jerome R. Ravetz

In a quest for a solution what to believe then?



‘Better incentives’ or ‘shared commitment’?

If the latter ...



... look at the interplay between new forms of science and peer review and quality control in science.

Funtowicz, S., and Ravetz, J. R. 2015, Peer Review and Quality Control, International Encyclopedia of the Social & Behavioral Sciences, 2nd edition, 2015.

Ravetz, J. R. and Funtowicz, S., 2015, New Forms of Science, ibidem.

McQuillan, D., 2014, The Countercultural Potential of Citizen Science, Media and Communication Journal, Vol. 17, No. 6 (2014) - 'counterculture',
<http://journal.media-culture.org.au/index.php/mcjournal/article/view/919>

Evidence based policy

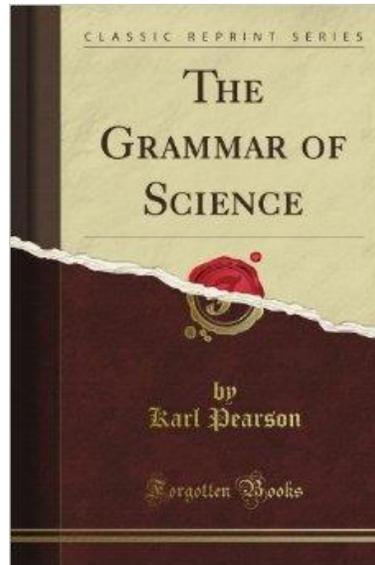
Science as a solution?

Karl Pearson (a social Darwinist) suggests not wasting resources on social programs as:

“No degenerate and feeble stock will ever be converted into healthy and sound stock by the accumulated effects of education, good laws, and sanitary surroundings”



Karl Pearson



Pearson, K., 1892, *The Grammar of Science*, Walter Scott Publisher, London, p.32.

Evidence based policy – in the prevailing positivistic narrative - is predicated on a separation of facts from values, of scientists from their customers, on clear separation and demarcation of roles but:

“the more knowledge is produced in hybrid arrangements, the more the protagonists will insist on the integrity, even veracity of their findings” ...

Grundmann, R., 2009, The role of expertise in governance processes, *Forest Policy and Economics* 11, 398–403, citing Latour, B., 1993. *We Have Never Been Modern*. Cambridge, Harvard UP.

'Demarcation model' of science's input to policy

- Protecting science from the political interference...
- Preventing possible abuse of science...
- ... and scientific information driven by agendas...
- Prescribes a clear demarcation between the institutions (and individuals) who provide the science, and those where it is used.

Funtowicz, S. 2006. What is Knowledge Assessment? In Guimarães Pereira, Â., Guedes Vaz, S. and Tognetti, S. (eds) *Interfaces between Science and Society*. Greenleaf Publishers, Sheffield.



Silvio Funtowicz

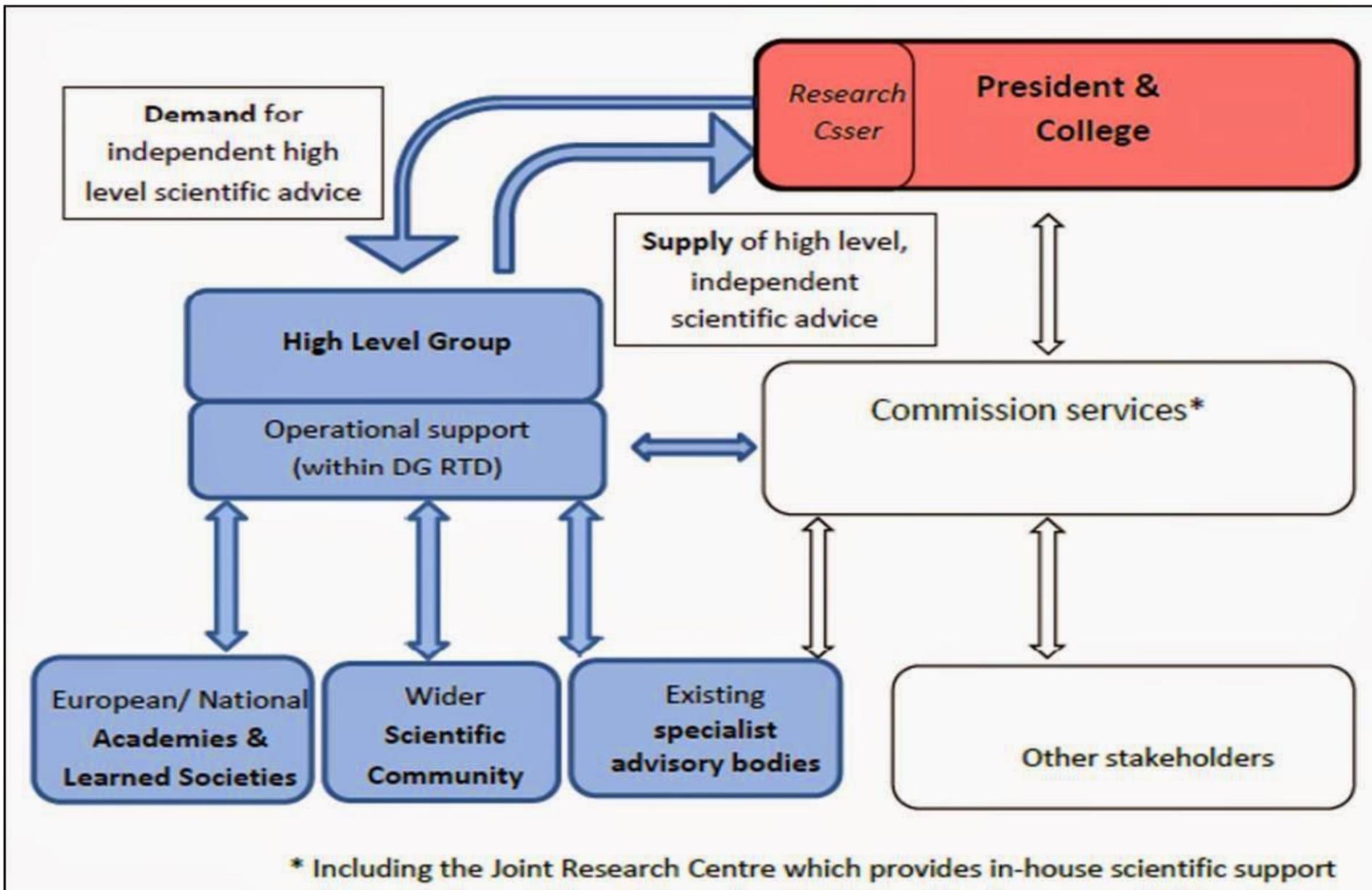
On demarcation:

“the incoming commission must find better ways of separating evidence-gathering processes from the ‘political imperative’”, A. Glover, former Chief Science Adviser of President Barroso (Wildson, 2014).

Wildson, J. 2014. Evidence-based Union? A new alliance for science advice in Europe. In The Guardian. Available at: <http://www.theguardian.com/science/political-science/2014/jun/23/evidence-based-union-a-new-alliance-for-science-advice-in-europe>.



Anne Glover



A new model of advice: more or less demarcation?



Francis Bacon
(1561-1626)

Magnalia Naturae, in the New
Atlantis (1627), '*Wonders of
nature, in particular with respect to
human use*'

Demarcation is part of the
Cartesian dream of man as master
and possessor of nature, of
prediction and control, of Bacon's
Magnalia Naturae.



René Descartes
(1596-1650)

Discourse on Method (1637)

In the formulation of Condorcet:

“All the errors in politics and in morals are founded upon philosophical mistakes, which, themselves, are connected with physical errors”



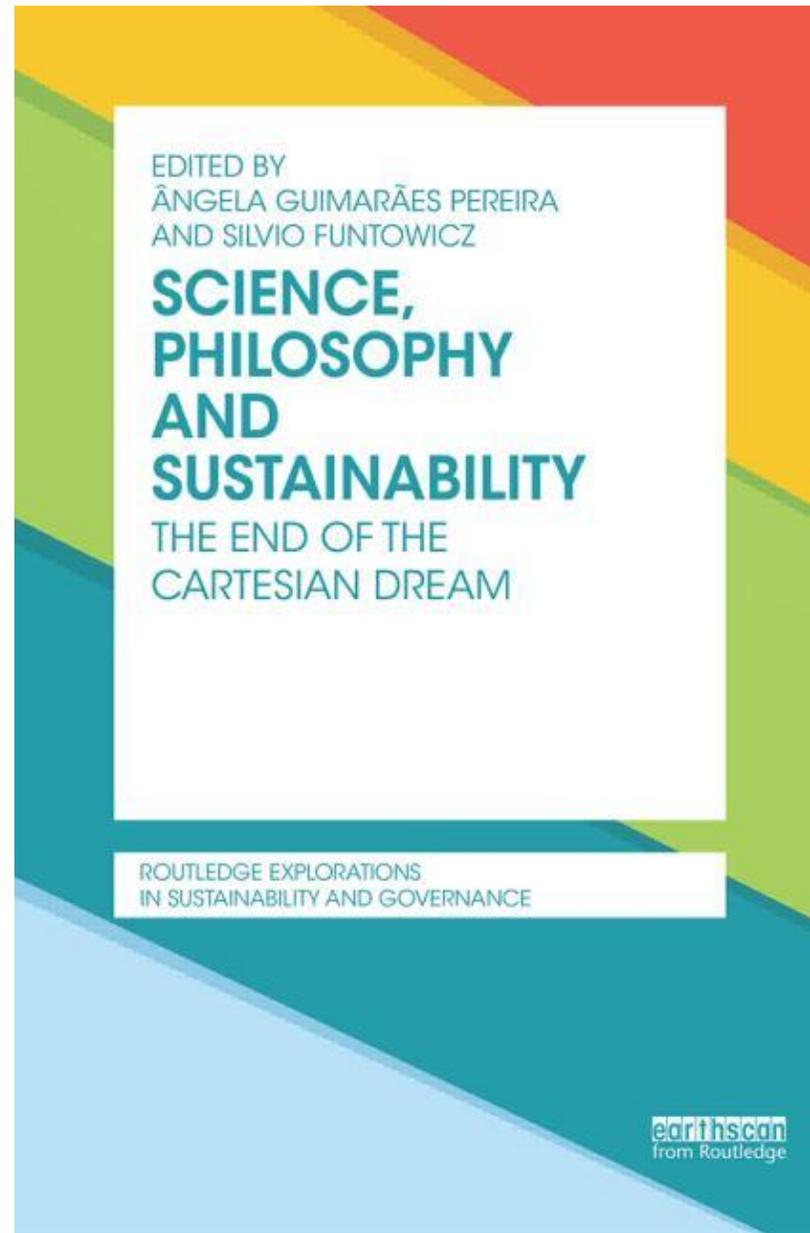
Nicolas de Caritat, marquis de
Condorcet
(1743- 1794)

‘Sketch for a Historical Picture of the Progress of the
Human Spirit’, Ninth Epoch.

More reading

Contributors:

Jerry Ravetz, Silvio Funtowicz,
Ângela Guimarães Pereira,
Ragnar Fjelland, David Waltner-Toews,
Edvin Schei, Roger Strand,
Fern Wickson, Alice Benessia,
Mariachiara Tallacchini, Paula Curvelo,
Daniel Sarewitz, Andrea Saltelli



2015

The demarcation model is challenged in more recent epistemologies:

‘Post Normal Science’ (Funtowicz and Ravetz, 1993), ‘Co-production of knowledge’ model (Jasanoff, 1996).

Funtowicz, S. O. & Ravetz, J. R. 1993. Science for the post-normal age. *Futures*, 25(7), 739–755.

Jasanoff, S. 1996, Beyond Epistemology: Relativism and Engagement in the Politics of Science. *Social Studies of Science*. 26(2) 393-418.



Sheila Jasanoff

PNS model of Extended Participation

- across disciplines – acknowledging that different disciplines see through different lenses, and
- across communities of both experts and stakeholders

From ‘speaking truth to power’ towards ‘working deliberatively within imperfections’

Science is but one among a plurality of relevant knowledges

Facts become ‘extended facts’



Peter Gluckman,
New Zealand's chief
science adviser, is for
PNS

Gluckman, P., 2015, The art of science advice to government, New Zealand's chief science adviser offers his ten principles for building trust, influence, engagement and independence, *Nature*, 507, p. 163-165.

PNS toolbox

NUSAP is a notational system called for the management and communication of uncertainty in science for policy, based on five categories for characterizing any quantitative statement: Numeral, Unit, Spread, Assessment and Pedigree.



Jeroen van der Sluijs,

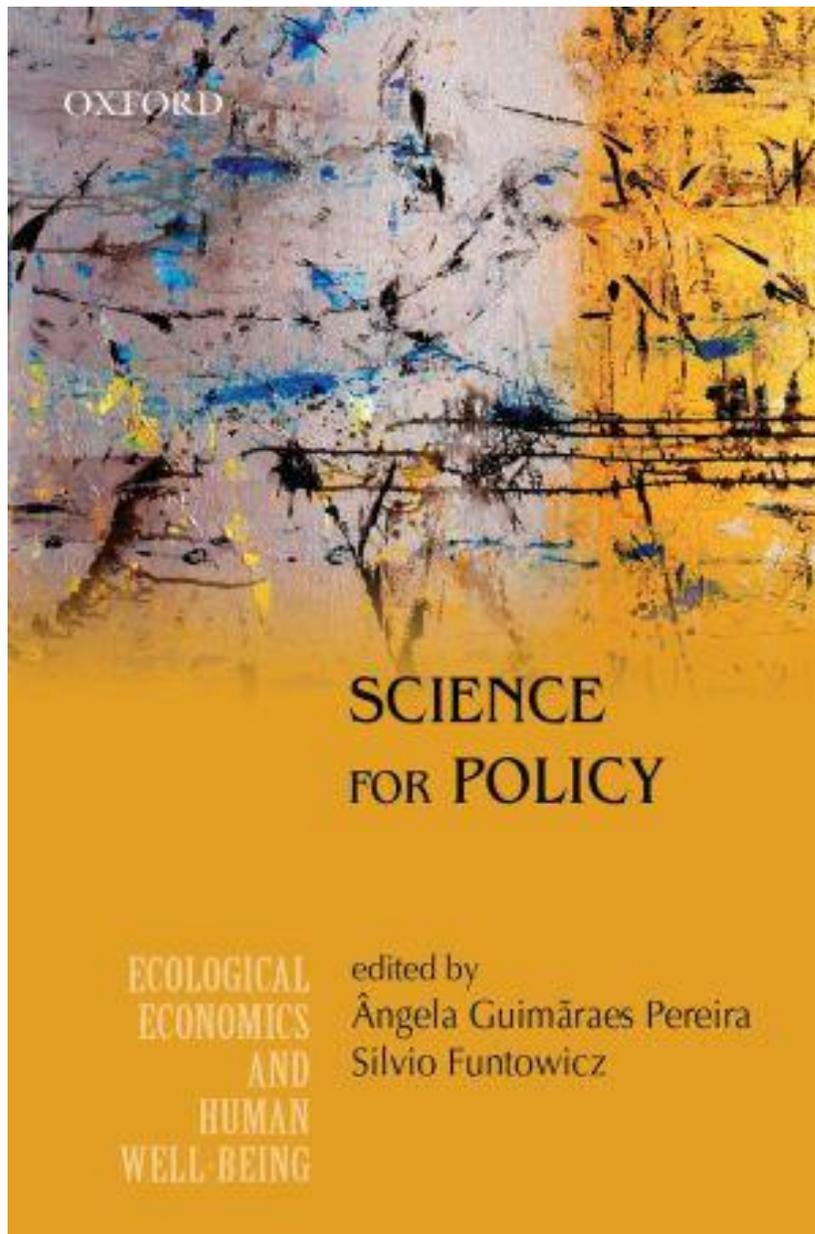
Funtowicz, S & Ravetz J 1990, *Uncertainty and Quality in Science for Policy*, Kluwer Academic Publishers, Dordrecht.

van der Sluijs, J., Craye, M., Funtowicz, S., Kloprogge, P., Ravetz, J., and Risbey, J. (2005) Combining Quantitative and Qualitative Measures of Uncertainty in Model based Environmental Assessment: the NUSAP System, *Risk Analysis*, 25 (2). p. 481-492. see also <http://www.nusap.net/>

PNS toolbox

Sensitivity auditing extends sensitivity analysis as used in the context of mathematical modelling to settings where the models are used to produce inference for policy. It questions the inference's process, frames, assumptions and legitimacy.

Saltelli A, Guimarães Pereira A, van der Sluijs JP & Funtowicz S 2013, 'What do I make of your Latinorum? Sensitivity auditing of mathematical modelling', *International Journal of Foresight and Innovation Policy*, vol. 9, no. 2-4, pp. 213–234.



More reading

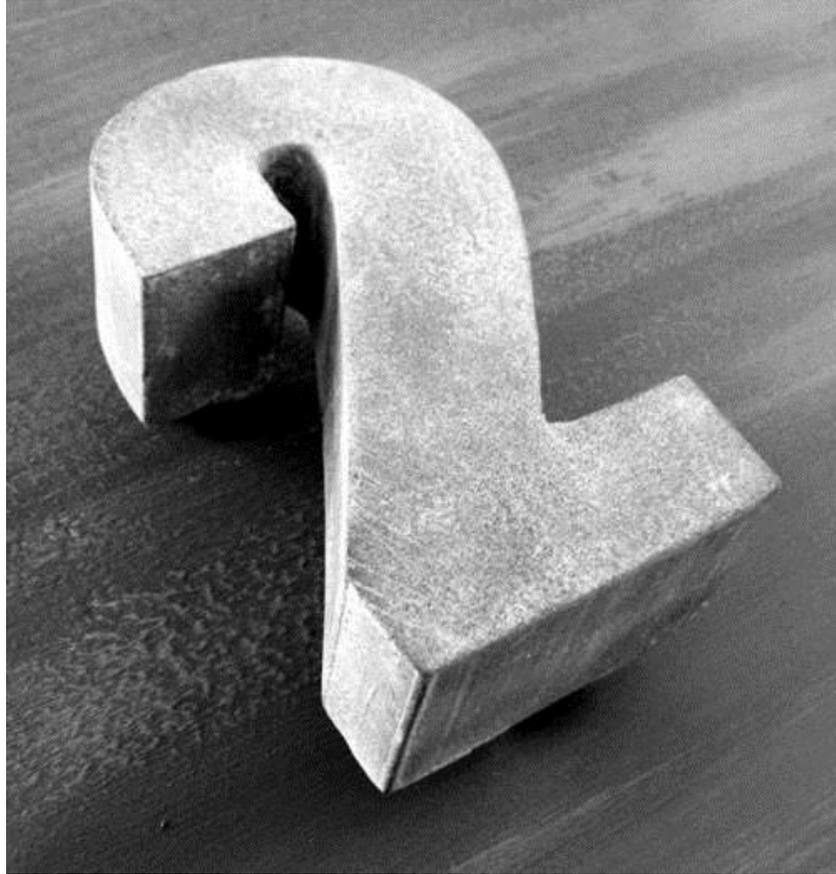
Contributors:

Sheila Jasanoff, Ângela Guimarães Pereira, Silvio Funtowicz, Jean-Marc Douguet, Martin O'Connor, Arthur Petersen, Peter H.M. Janssen, Jeroen van der Sluijs, Serafin Corral Quintana, Laura Maxim, Jeroen van der Sluijs, Mario Giampietro, Alejandro Nadal, Rosa Binimelis, Roger Strand, Lim Li Lin, Lim Li Ching, Samarthia Thankappan, Paul Baer, Clive L. Spash, Tiago De Sousa Pedrosa, Iulie Aslaksen, Solveig Glomsrød, Anne Ingeborg Myhr, Martin O'Connor, M.V. Ramana, J.Y. Suchitra, Matthieu Craye, Erik Laes, Andreas Thiel, Rajeswari S. Raina.

2009

Quantification

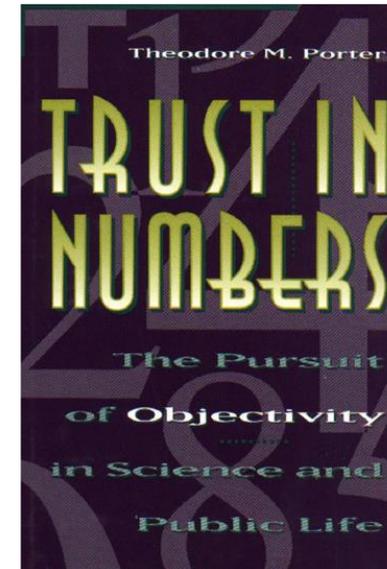
Concrete numbers: Evidence based policy and numbers -

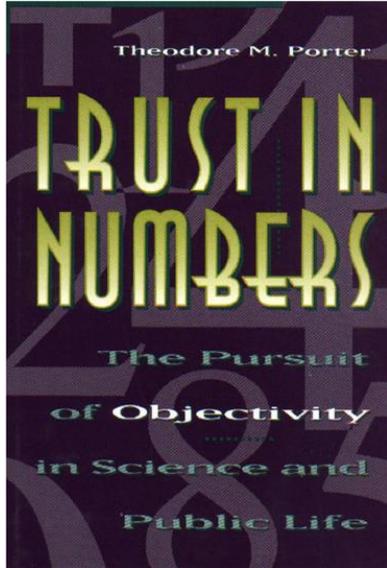


p. 8: “The appeal of numbers is especially compelling to bureaucratic officials who lack the mandate of a popular election, or divine right. Arbitrariness and bias are the most usual grounds upon which such officials are criticized. A decision made by the numbers (or by explicit rules of some other sort) has at least the appearance of being fair and impersonal.”



Theodor M. Porter

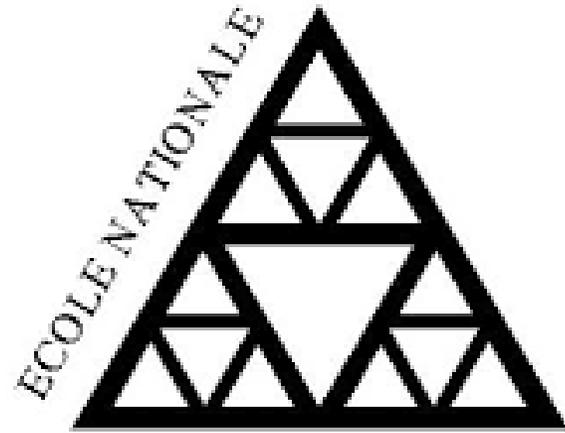




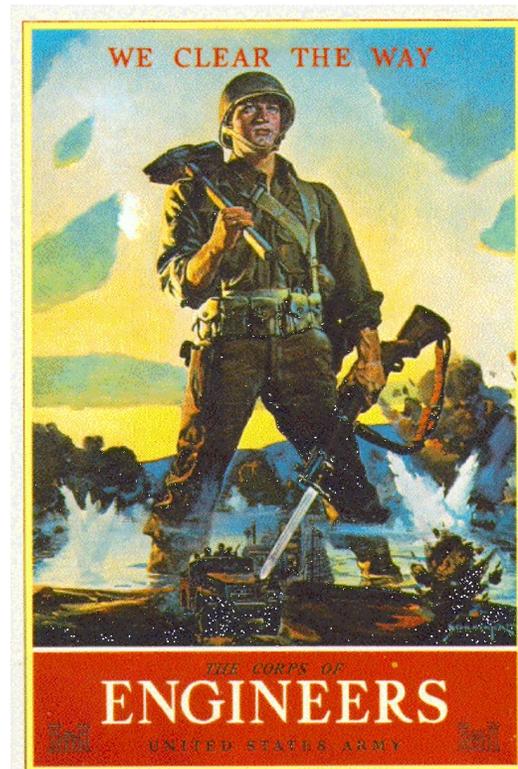
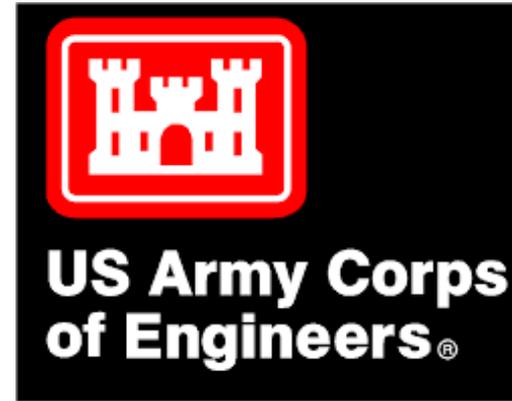
p. 8: “Scientific objectivity thus provides an answer to a moral demand for impartiality and fairness. Quantification is a way of making decisions without seeming to decide. Objectivity lends authority to officials who have very little of their own.”

Quantification: the discrete charm of bureaucracies?

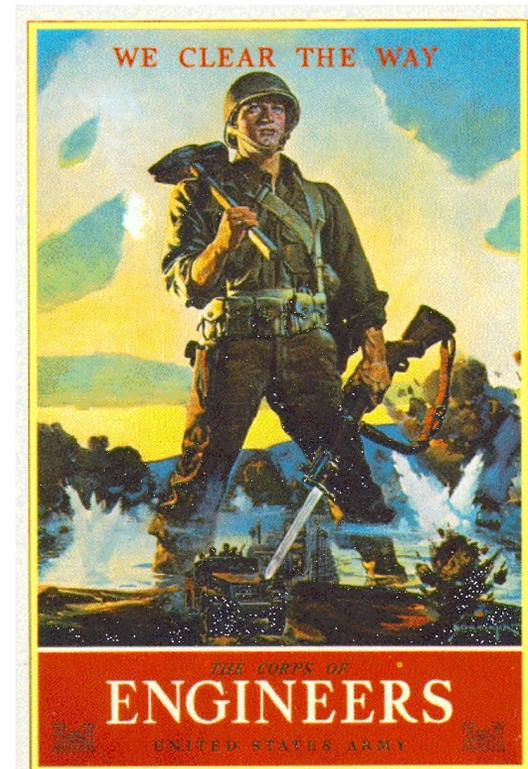
Trust, authority and styles of quantification: two different stories



● DES PONTS ET CHAUSSEES



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





Charles Goodhart

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

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

http://cyberlibris.typepad.com/blog/files/Goodharts_Law.pdf



Philip Stark

Troubles of evidence based policy: nowhere so evident as in the improper use of statistics and mathematical modelling.

New lingo: statisticulation, mathiness, quantifauxcation, assumptimation ...

Leek J.T., and Peng, R.D., 2015, P values are just the tip of the iceberg, *Nature*, 520, p. 612.

Assumptimation: To estimate by making unrealistic assumptions. Usage: They assumptimated the cost of climate change over the next 300 years. **Quantifauxcation:** To assign a meaningless number, then pretend that since it's quantitative, it's meaningful. Philip Stark, personal communication.

Mathiness: *'uses a mixture of words and symbols, but instead of making tight links, it leaves ample room for slippage between statements in natural versus formal language and between statements with theoretical as opposed to empirical content'*, Romer, P. M., Mathiness in the Theory of Economic Growth, *American Economic Review: Papers & Proceedings* 2015, 105(5): 89–93.

Statisticulation: Statistical manipulation, Huff, D., 1993, *How to lie with statistics*, Norton & Company

Mathematical modelling
errors, misuse, abuse

Error

THE NEW YORKER

“Carmen Reinhart and Kenneth Rogoff [...] famous (now infamous) research that conservative politicians around the world had seized upon to justify pennypinching Policies ...”

John Cassidy, April 2013 issue

Error

“... rising levels of government debt are associated with much weaker rates of economic growth, indeed negative ones ...”

It was instead a coding error uncovered by three researchers at the university of Michigan.

“In Britain and Europe, great damage has been done as a result.”

Saltelli, A. and Funtowicz, S., 2014, When all models are wrong: More stringent quality criteria are needed for models used at the science-policy interface, *Issues in Science and Technology*, vol. winter, pp. 79-85.



THE NEW YORKER

Error

Perils of placing faith in a thin theory



By Wolfgang Münchau

Reinhart and Rogoff told policy makers what they wanted to hear

John Kenneth Galbraith [about] Milton Friedman: “Milton’s misfortune was that his policies had been tried.” [...]

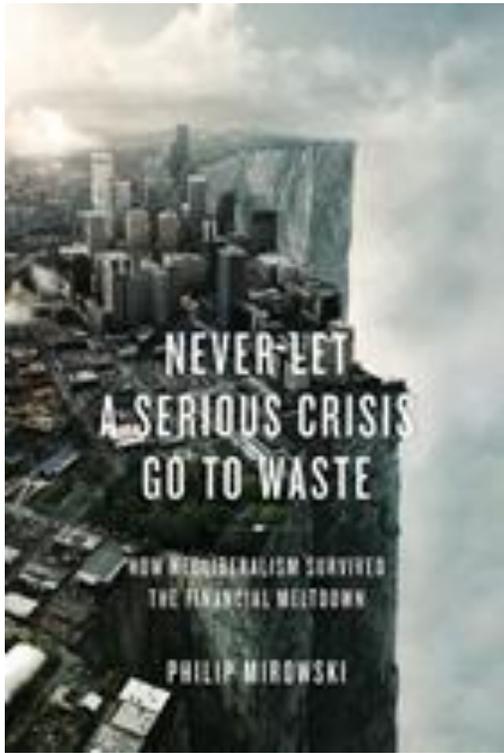
“As for Profs Reinhart and Rogoff, I suspect that they, too, will be mostly remembered for the fact that their policies have been tried”

Munchau, W., 2013, Perils of placing faith in a thin theory *Financial Times*, April 21.

Misuse

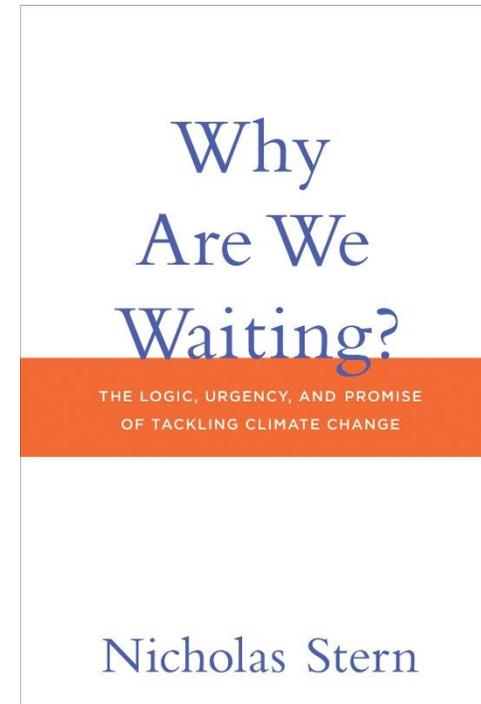
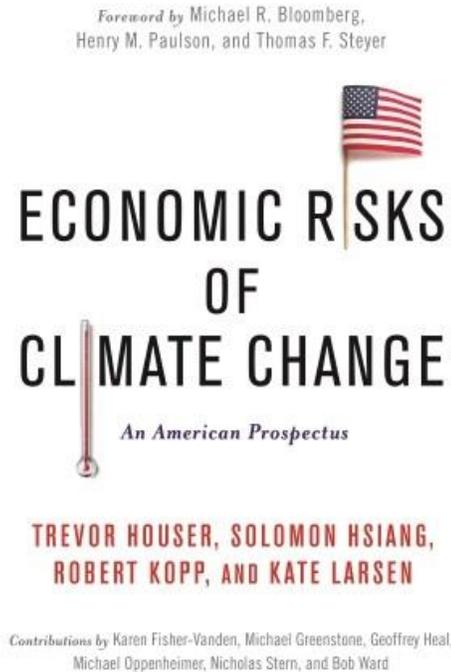
“To be fair, DSGE and similar macroeconomic models were first conceived as theorists’ tools. But why, then, are they being relied on as the platform upon which so much practical policy advice is formulated? And what has caused them to become, and to stay, so firmly entrenched?”

Quote from Miller, B., 2010, Opening Address, The Hearing Charter of the House Committee on Science and Technology and sworn testimony of economists Sidney Winter, Scott Page, Robert Solow, David Colander and V.V. Chari, in Mirowski, P., 2013, *Never Let a Serious Crisis Go to Waste: How Neoliberalism Survived the Financial Meltdown*, Verso Books.



Abuse

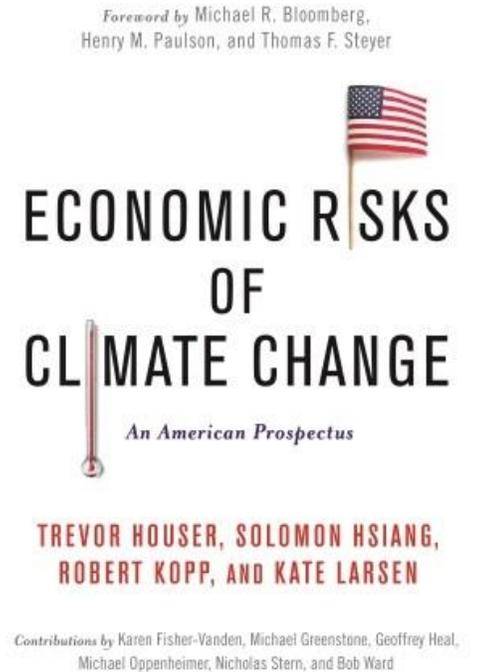
Counting climate's dollars. Occupational psychosis or valuable input?



Abuse

“[...] the report forecasts—at the level of individual counties in the U.S.—energy costs and demand, labor supply, mortality, violent crime rates, and real estate property prices up to the year 2100 [...] The report presents the amount of computer power and data generated as evidence of the scientific legitimacy of the enterprise. The authors note, however, that out of an abundance of caution they did not model deterioration in cognitive performance as temperatures rise”

Saltelli, A., Stark, P.B., Becker, W., and Stano, P., 2015, Climate Models As Economic Guides Scientific Challenge or Quixotic Quest? Spring issue of Science and Technology (IST) April 2015.

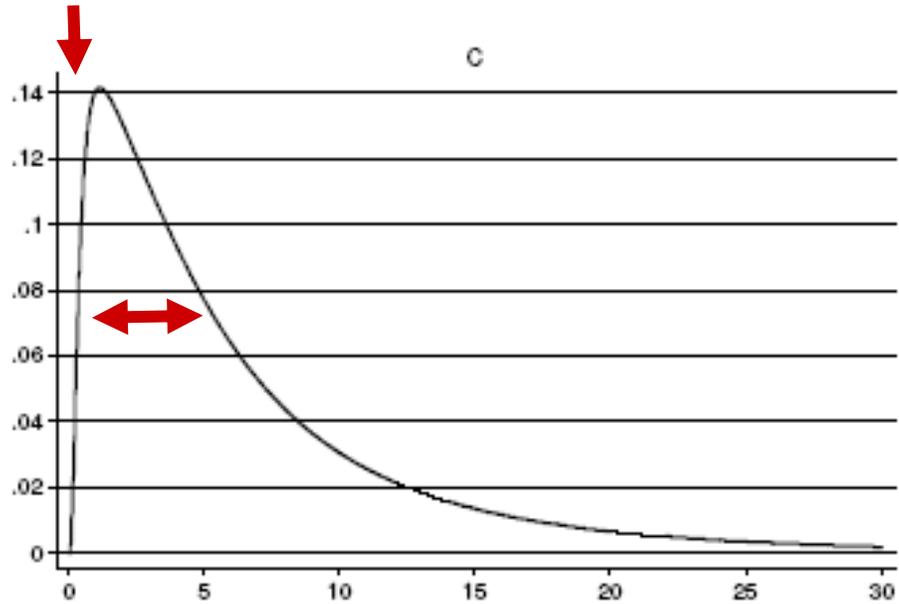


Abuse

The Stern review makes the case for urgent action against climate change based on a cost benefit analysis (CBA). We have shown that the stipulated uncertainties in the CBA do not allow any useful conclusion.



Missing points



Saltelli, A., and d’Hombres, B. 2010, ‘Sensitivity Analysis Didn’t Help. A Practitioner’s Critique of the Stern Review’, *Global Environmental Change*, vol. 20, pp. 298–302.

% loss in GDP per capita

Abuse

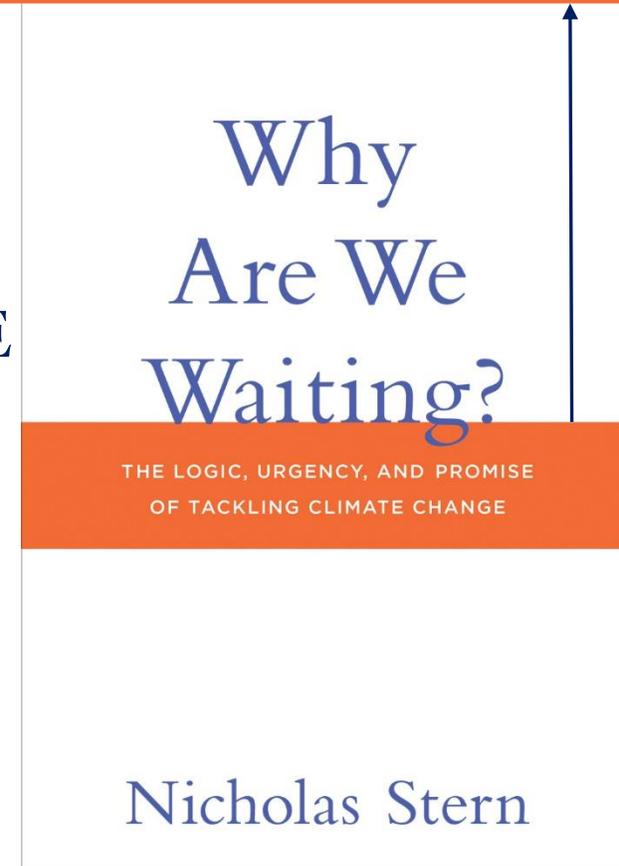
THE LOGIC, URGENCY, AND PROMISE OF TACKLING CLIMATE CHANGE

“Integrated assessment models have produced valuable insights” p. 139

“In Chapter six of the Stern review we made use of the PAGE model” p. 345

Then, after a list of criticism moved to the realism of IAM’s:

“[...] the point is that estimates based on these models are very sensitive to assumptions and are likely to lead to gross underestimation” p.139



Abuse

Things to be incorporated in ‘formal modelling’ [sic]

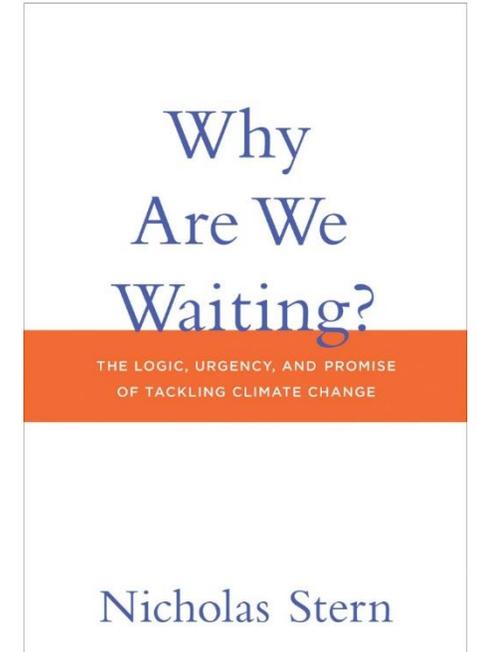
“Damage to social, organizational or environmental capital [...]

Damage to stock of capitals and land [...]

Damage to overall factor productivity [...]

Damage to learning and endogenous growth”, p. 145

‘formal modelling’ as to produce ‘numbers’?



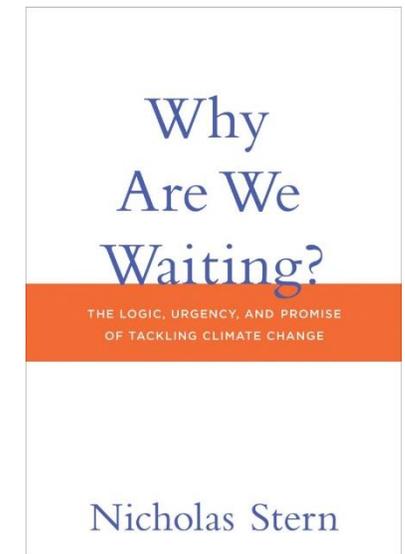
The high road

Michael Grubb is both swept away and frustrated by Nicholas Stern's argument for tackling climate change.



“However, Stern does not adequately delve into the fact that too much analysis, modelling and policy is still dominated by the idea that there is a natural ‘least-cost’ energy system, and that market forces would deliver it if we only corrected market failures”

Grubb, M., 2015, The high road, 614 Nature, 520, 614-615.



Key suggestions

Dont' ignore the twin crises of science and evidence based policy;

Beware the limits of the demarcation model, (where facts are separated from values and science from policy);

Be inquisitive of all quantifications;

Allow science and technology studies a voice in matters scientific.

END

 @andreasaltelli
www.andreasaltelli.eu