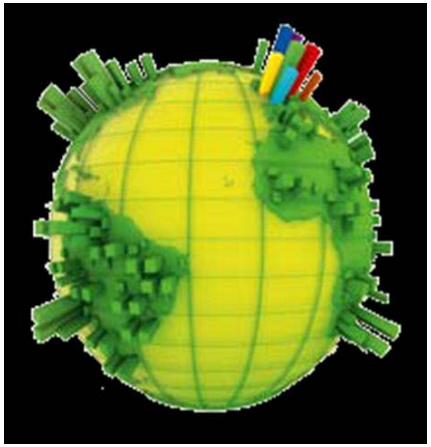


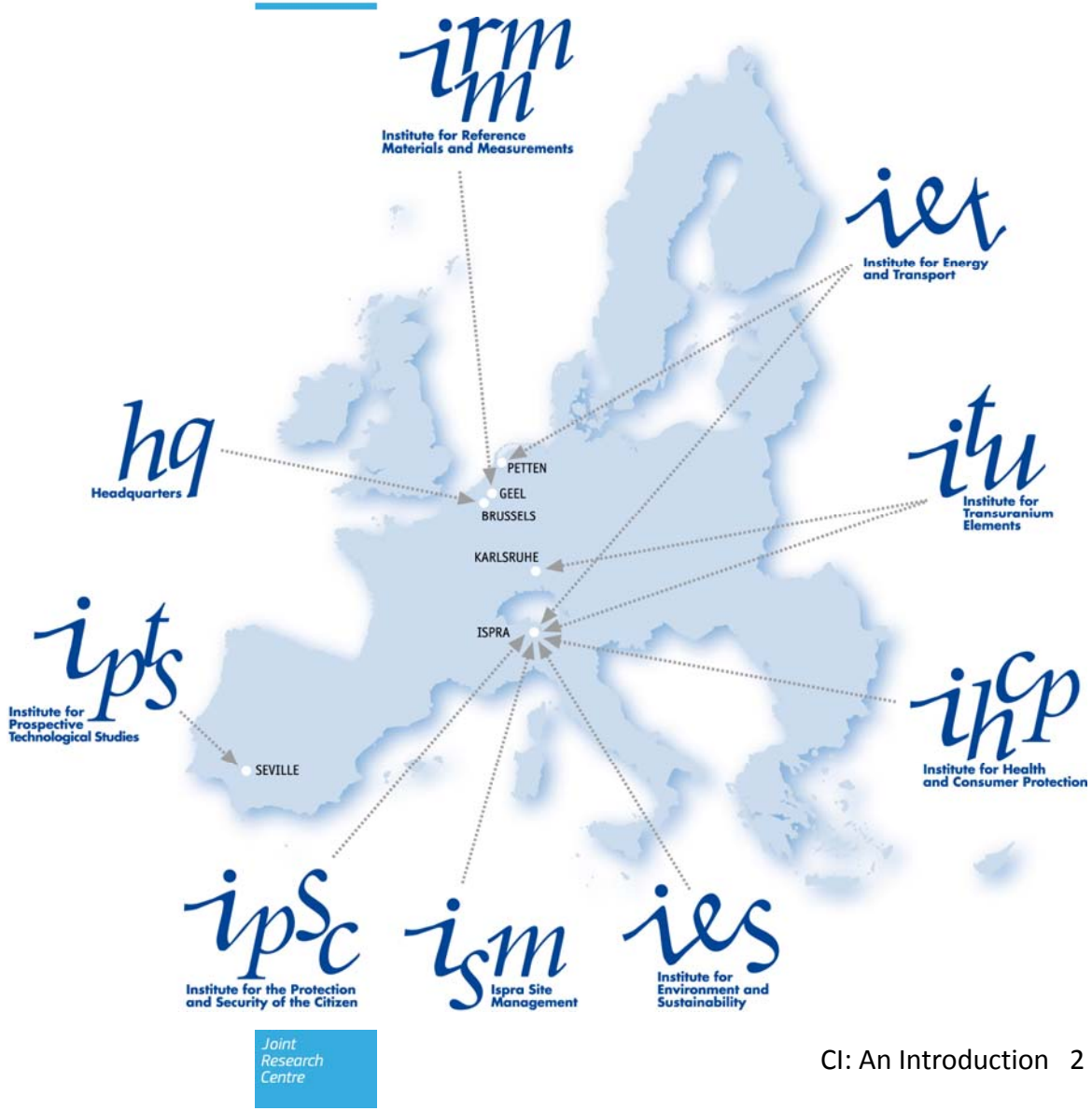
Communicating uncertainty: some applications of indicators and their validity

WORKSHOP

Capturing Culture in Sustainable Development Assessments
October, 22-24, 2012
Innsbruck, Austria

Andrea Saltelli
European Commission,
Joint Research Centre

Joint Research Centre



Indicators

Composite Indicators

THE ROLE OF COMPOSITE INDICATORS FOR MEASURING SOCIETAL PROGRESS

➔Ubiquitous; 5-fold increase in 6 y

➔Hallmark of post-modernity?

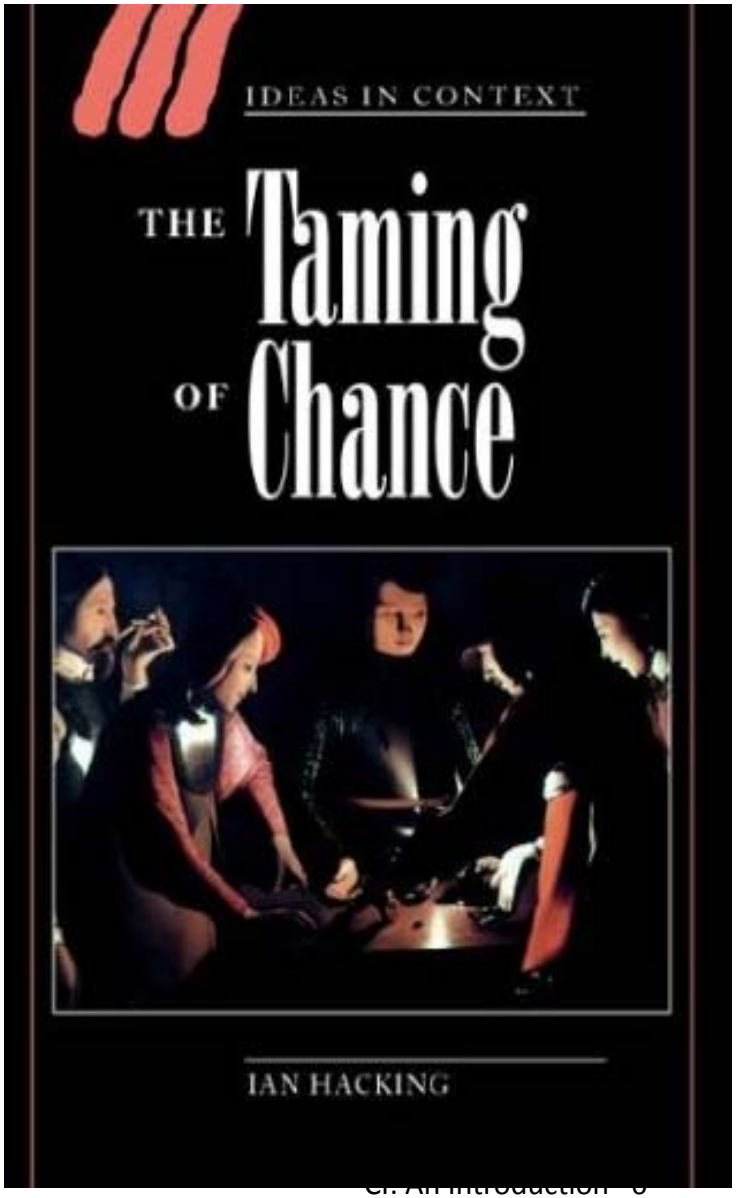
➔Statistics' best known face (to general public & media)

➔Open the floor to plurality of norms and views

➔Can provide analytic input to policy

➔ Hallmark of post-modernity?

$$\frac{\text{Modernity}}{\text{Official statistics}} = \frac{\text{Post-Modernity}}{\text{Composites}}$$



Report by the Commission on the Measurement of Economic Performance and Social Progress

Professor Joseph E. Stiglitz, Chair, Columbia University

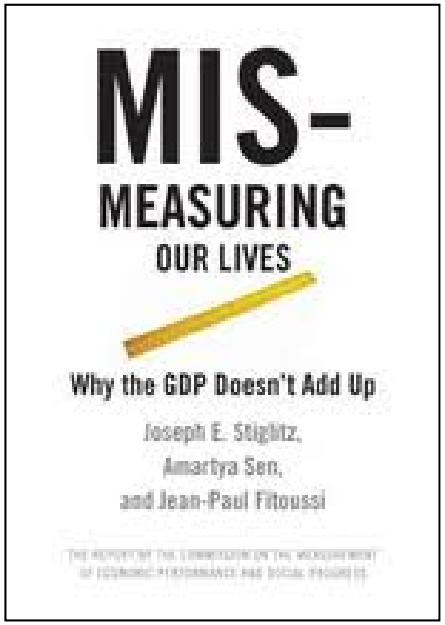
Professor Amartya Sen, Chair Adviser, Harvard University

Professor Jean-Paul Fitoussi, Coordinator of the Commission, IEP

More ICT + More statistical literacy + More appreciation of complexity ➔

➔ **"the role of statistical indicators has increased over the last two decades"**

(Stiglitz report, 2009)



Why?

(i) more literacy,

(ii) more complexity,

(iii) more information society

(Stiglitz report, 2009)

➔Statistics' best known face (to general public & media)

An example, about Mauritius,
Economist October 16, 2008

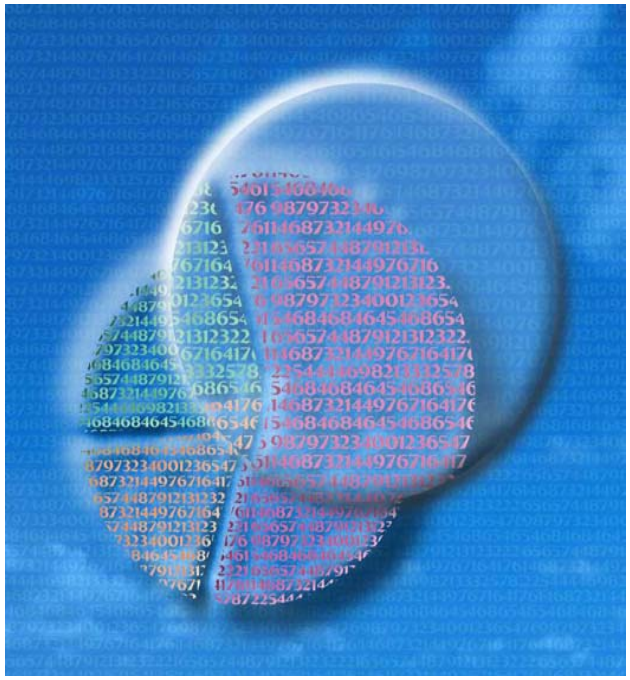
THE 1.3m people of Mauritius love to prove famous people wrong. On independence from Britain in 1968, pundits such as a Nobel prize-winning economist, James Meade, and a novelist, V.S. Naipaul, did not give much of a chance to this tiny, isolated Indian Ocean island 1,800km (1,100 miles) off the coast 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.com

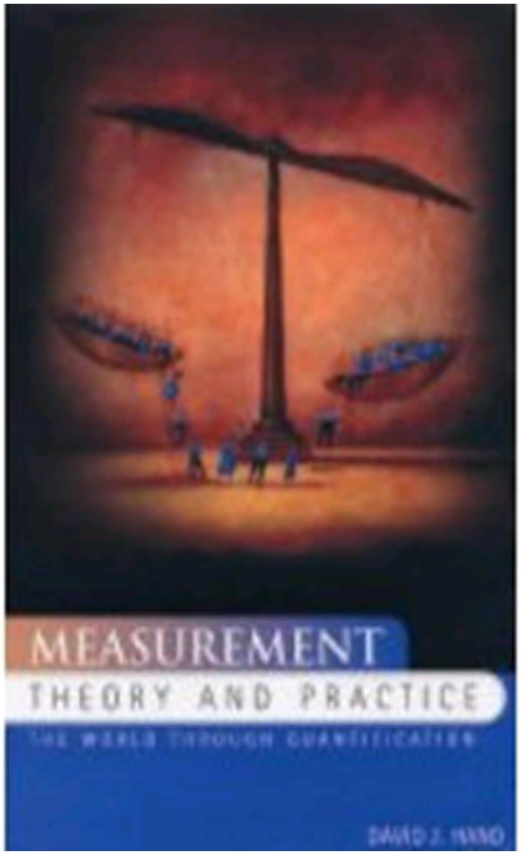
➔Ubiquitous; 5-fold increase in 6 y

June 2006	1,440
May 2007	1,900
October 2008	3,030
September 2009	4,420
August 2010	5,240
May 2011	5,900
October 2012	7,650

Searching "composite indicators" on Scholar Google:



Caveats



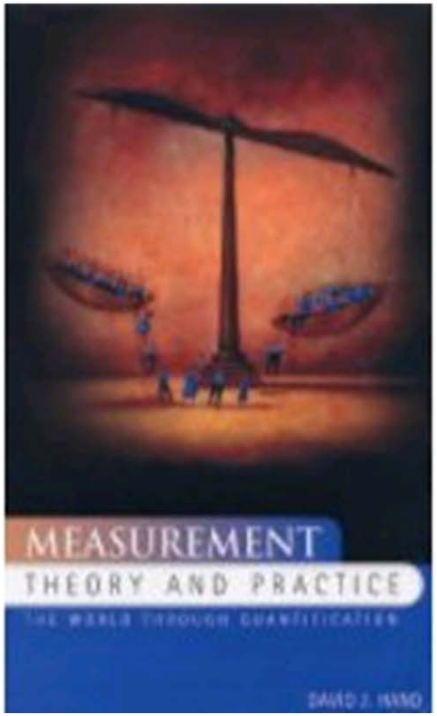
"League tables […] are an easy target for criticism.

[…] surgeon can refuse to operate on the difficult cases, schools can refuse to enter those pupils likely to do poor in examinations, health authorities can defer making appointments for some patients, so that the waiting lists look smaller, and so on."

"League tables [..] are not perfect, and they can never be […] but they are certainly better than nothing […]"

David Hand, president of the UK Royal statistical Society

…measurement procedures have two fundamentally different aspect, which we will term *representational* and *pragmatic* …



The Stiglitz report, on page 65, mentions: *[…] a general criticism that is frequently addressed at composite indicators, i.e. the arbitrary character of the procedures used to weight their various components.*

Adding: *[…] 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. The problem is rather that their normative implications are seldom made explicit or justified.*

Statistics for policy: three models

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

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

Strategic model (statistics is used by parties competing for a given constituency).

see 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.

But:

It is possible to disentangle evidence based policy from policy based evidence?

see Benoît GODIN on eugenics and the birth of R&D stats: The Culture of Numbers: 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.

… but many other data based stories as well: Tobacco & health, capital punishment & crime rate …

•Oreskes, N., Conway E. M., 2010, *Merchants of Doubt*, Bloomsbury Press

•Leamer, E. E., Tantalus on the Road to Asymptopia, 2010, *Journal of Economic Perspectives*, 24, (2), 31–46.

➔Open the floor to plurality of norms and views

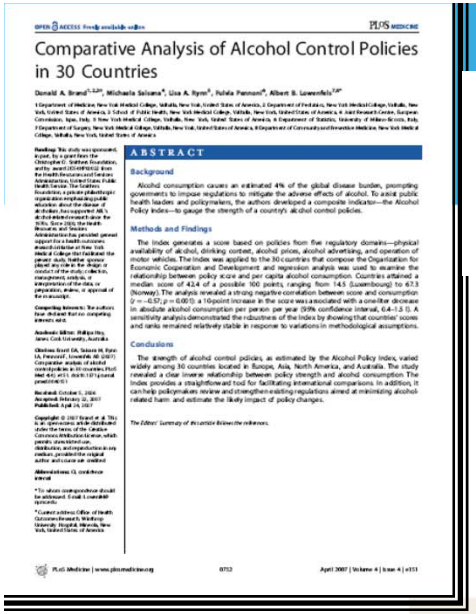
Composite indicators for measuring progress? Stiglitz's report, p. 75

3.4 - Uncertainty is also normative

184. In addition to raising technological issues, measuring sustainability with a single index number would confront us with severe normative questions. The point is that there can be as many indices of sustainability as there are normative definitions of **what** we want to sustain. In standard national accounting practice, the normative issue of defining preferences is

The point is that there can be as many indices of sustainability as there are normative definitions of **what** we want to sustain.

computed, whose values will strongly depend upon normative choices.



OPEN ACCESS Freely available online PLoS MEDICINE

Comparative Analysis of Alcohol Control Policies in 30 Countries

Donald A. Brand[1,2,3], Michaela Saisana[4], Lisa A. Rynn[5], Paola Pennoni[6], Albert B. Lowenfels[7,8*]

1 Department of Medicine, New York Medical College, Valhalla, New York, United States of America, 2 Department of Pediatrics, New York Medical College, Valhalla, New York, United States of America, 3 School of Public Health, New York Medical College, Valhalla, New York, United States of America, 4 Joint Research Centre, European Commission, Ispra, Italy, 5 New York Medical College, Valhalla, New York, United States of America, 6 Department of Statistics, University of Milano-Bicocca, Italy, 7 Department of Surgery, New York Medical College, Valhalla, New York, United States of America, 8 Department of Community and Preventive Medicine, New York Medical College, Valhalla, New York, United States of America

Funding: This study was sponsored, in part, by a grant from the Christopher D. Stephen Foundation, and by award (U01HP00032) from the Health Resources and Services Administration, Office of Rural Health Policy. The Stephen Foundation, a private philanthropic organization emphasizing public education about the disease of alcoholism, has supported ALL's alcohol-related research since the 1970s. Since 2002, the Health Resources and Services Administration has provided general support for a health-outcomes research initiative at New York Medical College that facilitated the present study. Neither sponsor played any role in the design or conduct of the study; collection, analysis, and interpretation of the data; or preparation, review, or approval of the manuscript.

Competing Interests: The authors have declared that no competing interests exist.

Academic Editor: Philip Hill, James Cook University, Australia

Citation: Brand DA, Saisana M, Rynn LA, Pennoni F, Lowenfels AB (2007) Comparative analysis of alcohol control policies in 30 countries. PLoS Medicine 4: e51. doi:10.1371/journal.pmed.0040051

Received: October 5, 2006
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Published: April 24, 2007

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Abbreviations: CI, confidence interval

* To whom correspondence should be addressed. E-mail: lowenfel@nymc.edu

* Current address: Office of Health Outcomes Research, Winthrop-University Hospital, Mineola, New York, United States of America

ABSTRACT

Background

Alcohol consumption causes an estimated 4% of the global disease burden, prompting governments to impose regulations to mitigate the adverse effects of alcohol. To assist public health leaders and policymakers, the authors developed a composite indicator—the Alcohol Policy Index—to gauge the strength of a country's alcohol control policies.

Methods and Findings

The Index generates a score based on policies from five regulatory domains—physical availability of alcohol, drinking context, alcohol price, alcohol advertising, and operation of motor vehicles. The Index was applied to the 30 countries that compose the Organization for Economic Cooperation and Development and regression analysis was used to examine the relationship between policy score and per capita alcohol consumption. Countries attained a median score of 42.4 of a possible 100 points, ranging from 14.5 (Luxembourg) to 67.3 (Norway). The analysis revealed a strong negative correlation between score and consumption ($r = -0.57$; $p = 0.001$): a 10-point increase in the score was associated with a one-liter decrease in absolute alcohol consumption per person per year (95% confidence interval, 0.4–1.5 l). A sensitivity analysis demonstrated the robustness of the Index by showing that countries' scores and ranks remained relatively stable in response to variations in methodological assumptions.

Conclusions

The strength of alcohol control policies, as estimated by the Alcohol Policy Index, varied widely among 30 countries located in Europe, Asia, North America, and Australia. The study revealed a clear inverse relationship between policy strength and alcohol consumption. The Index provides a straightforward tool for facilitating international comparisons. In addition, it can help policymakers review and strengthen existing regulations aimed at minimizing alcohol-related harm and estimate the likely impact of policy changes.

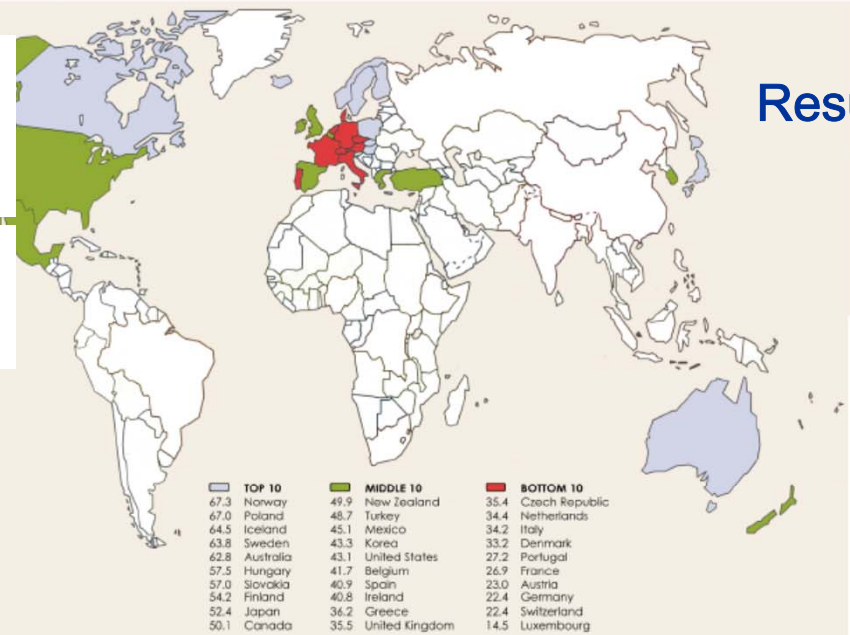
The Editors' Summary of this article follows the references.

Concept: (WHO report)

Domains	Ratings	Topics	Policies
ical availability (32 points)	☆☆☆	Legal alcohol purchase age (y)	16, 17, 18, 19, 20+
	☆☆☆	Alcohol server liability for damages caused by actions of patrons	No, Yes
	☆☆	Restrictions on types of alcoholic beverages sold in retail stores	None; Partial government monopoly; Full government monopoly
	☆☆	Restrictions on density of stores selling alcoholic beverages in a given locale	None; On wine only; On wine and spirits; On wine, spirits, and beer
	☆☆	Restrictions on business hours for selling alcohol	None; On hours or days; On both hours and days
ding context (8 points)	☆☆	Community mobilization programs to increase public awareness of, and prevent alcohol problems	No, Yes
	☆	Mandatory training of alcohol servers to prevent and manage aggression	No, Yes
Alcohol prices[a] (24 points)	☆☆☆	Beer price index	0–0.29, 0.30–0.59, 0.60–0.89, 0.90+
	☆☆☆	Wine price index	0–0.9, 1.0–1.9, 2.0–2.9, 3.0+
	☆☆☆	Spirit price index	0–2.9, 3.0–5.9, 6.0–8.9, 9.0+
Alcohol advertising (3 points)	☆	Number of different media (print, broadcast, billboards) with advertising restrictions	0, 1, 2, 3
Motor vehicles (34 points)	☆☆☆	Random breath testing	None,[b] Rare, Occasional, Often, Very often
	☆☆☆	Legal blood alcohol limit—adult (mg/dl)	0.08+, 0.03–0.07, 0–0.02
	☆☆☆	Legal blood alcohol limit—youth (mg/dl)	0.04+, 0.02–0.03, 0–0.01
	☆☆	Mandatory penalty for exceeding legal limit	Fine, License suspension
	☆☆	Graduated licensing for young drivers	No, Yes

Published in PLoSMedicine

Results

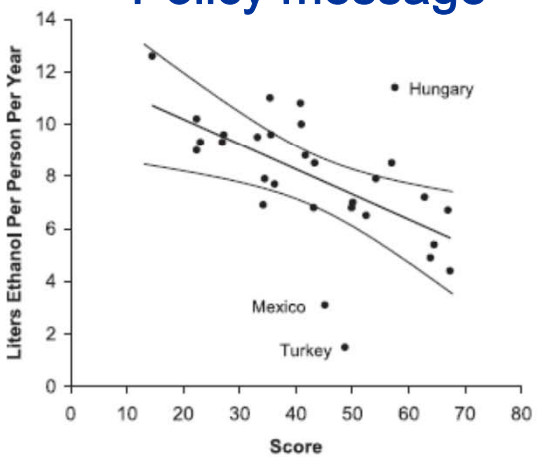


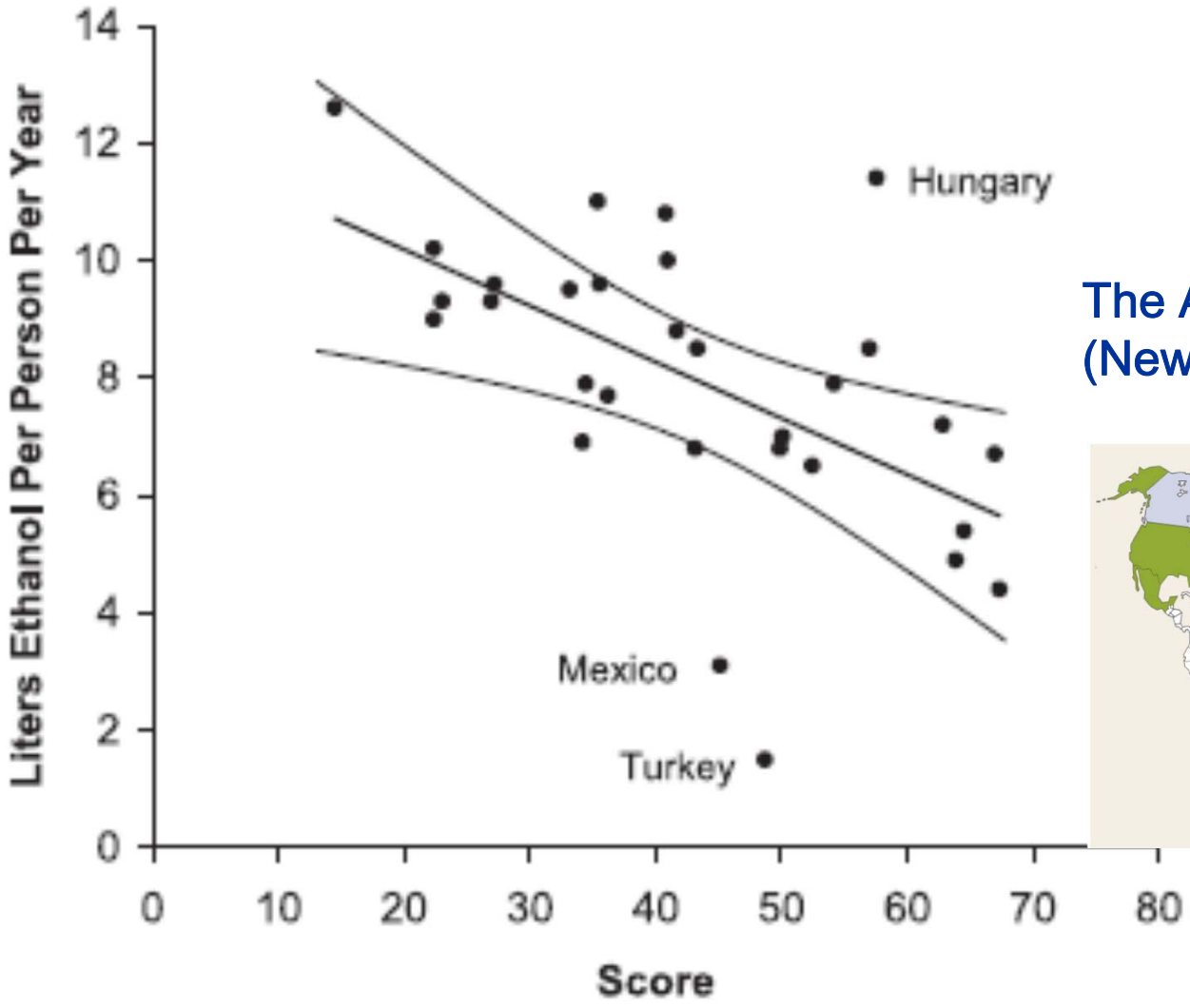
Sensitivity analysis

Norway	1	1	1–2	67.3	71.1	63–77
Poland	2	2	1–4	67.0	70.6	67–76
Iceland	3	4	2–6	64.5	63.4	56–74
Sweden	4	4	2–5	63.8	64.3	60–73
Australia	5	5	3–7	62.8	62.9	56–65
Hungary	6	8.5	6–12	57.5	51.4	46–62
Slovakia	7	7.5	6–12	57.0	54.9	46–63
Finland	8	7	4–10	54.2	57.3	50–65
Japan	9	10.5	6–17	52.4	50.1	38–55
Canada	10	10	7–14	50.1	50.1	46–52
New Zealand	11	10	6–12	49.9	50.1	47–59
Turkey	12	12	6–16	48.7	48.8	41–57
Mexico	13	13	11–17	45.1	43.8	39–49
Korea	14	13	8–18	43.3	47.0	39–53
United States	15	16.5	13–27	43.1	40.2	19–47
Belgium	16	16	14–20	41.7	39.8	36–43
Spain	17	18	14–21	40.9	38.4	32–47
Ireland	18	17.5	15–19	40.8	38.7	36–45
Greece	19	18.5	15–23	36.2	37.6	32–42
United Kingdom	20	21.5	20–23	35.5	33.9	28–36
Czech Republic	21	23	19–26	35.4	31.8	25–36
Netherlands	22	21	17–24	34.4	35.0	29–40
Italy	23	22	16–24	34.2	33.6	30–39
Denmark	24	22	18–24	33.2	32.1	28–37
Portugal	25	25.5	23–27	27.2	25.1	21–28
France	26	26	24–27	26.9	24.3	20–28
Austria	27	27.5	27–28	23.0	19.4	15–23
Germany	28	29	28–29	22.4	17.3	11–22
Switzerland	29	27	24–29	22.4	21.7	14–30
Luxembourg	30	30	30–30	14.5	12.1	6–16

The Alcohol Policy Index (New York Medical College)

Policy message





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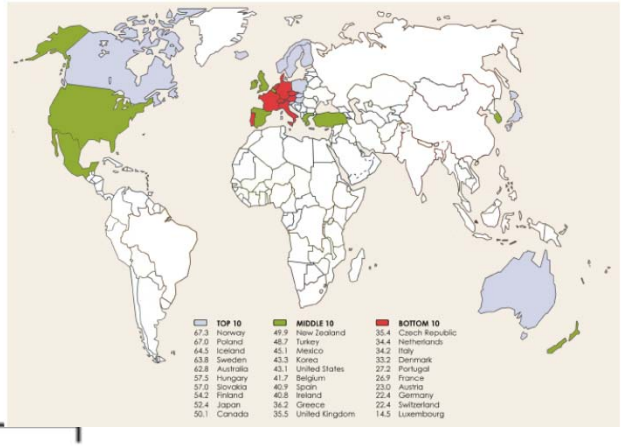


JRC work on dimensions of progress

European Commission

Recent in house (European Commission) releases: Regional Competitiveness Index, Consumer empowerment, Youth Civic Competencies Index, Regional Innovation Index, Research Excellence. In the **pipeline:** Quality-of-Life sub-dimensions.

On culture?:

-ISTAT's indicatore sintetico del livello di artecipazione culturale (part of **BES**)

- Limited unpublished work on indicators about 'R. Florida, The Rise of the Creative Class, Basic Books 2003'.

- Measuring 'cultural consumption'. 'Learning through culture', a sub-pillar of the "Learning to Be" pillar of **Canadian Composite Learning Index** http://www.ccl-cca.ca/). See also ELLI in http://www.bertelsmann-stiftung.de/

Our experience with ISTAT's composite index of cultural participation, part of the dimension education and culture of the BES framework

Cultural participation:

Going out to see a show
Reading
Media

Sub-domain Going out to see a show

- Theatre
- Cinema
- Museums, exhibits
- Classic Music Concerts
- Other concerts
- Sport shows
- Disco, dance clubs, etc.
- Archeological sites and monuments

Sub-domain Reading

- Reading a newspaper at least once a week
- Reading a book (at least one in the 12 months before the interview)
- Reading nesweeks & other periodicals
- Having 200 books or more at home

Sub-domain MEDIA

- Using Internet last three months
- Using Internet last three month to download news or articles
- Using Internet last three month to buy cultural products
- Listening to radio
- Seing DVD
- Having a broad-band connection

The Canadian Council on Learning has developed the Composite Learning Index (http://www.ccl-cca.ca/). The framework:

Learning to Know

Learning to Do

Learning to Live Together

Learning to Be[*]

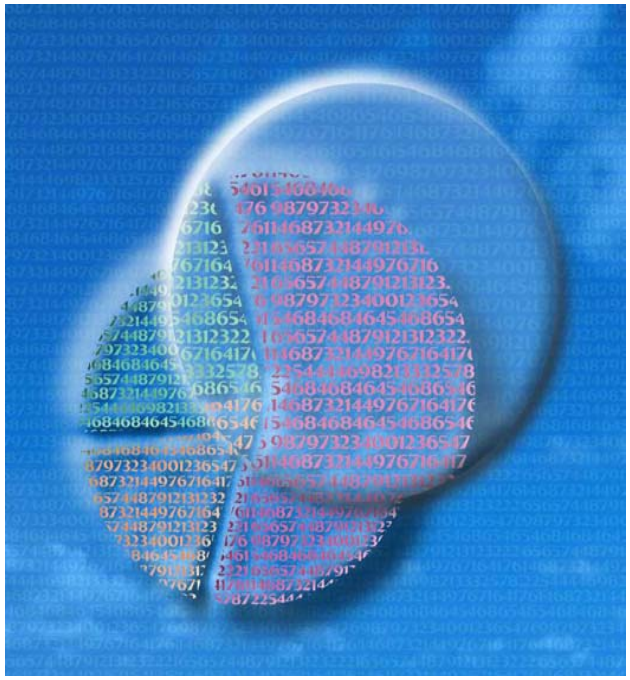
Jacques Delors

[*] Pillars from Jacques Delors' Task Force: UNESCO's International Commission on Education for the Twenty-first Century.

Major external cooperation:

OECD, WEF, INSEAD, WIPO, UN-IFAD, FAO, Transparency International, World Justice Project, Harvard, Yale, Columbia …

Joint Research Centre



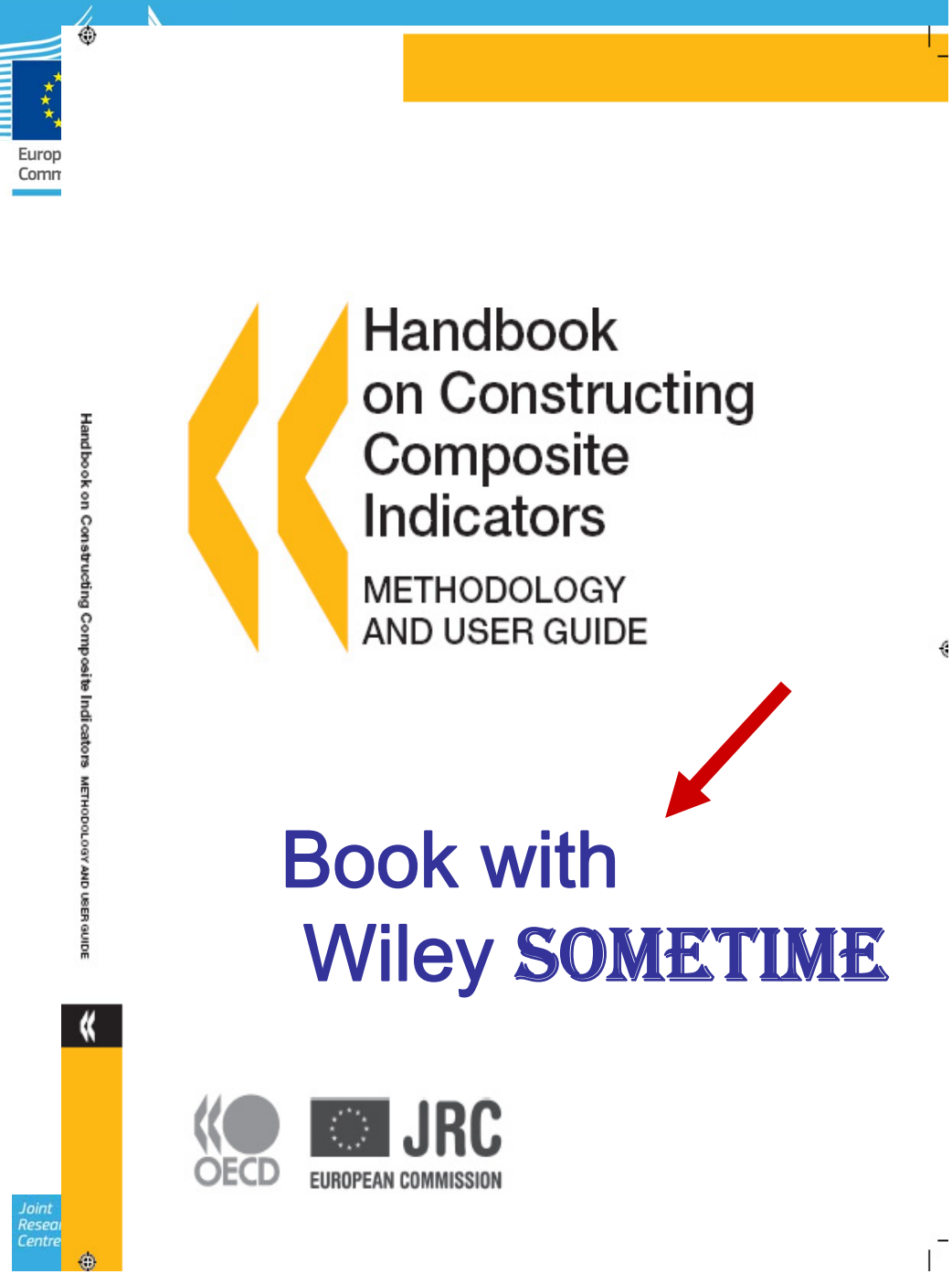
Methodology

Joint OECD-JRC handbook.

5 years of preparation,

2 rounds of consultation with OECD high level statistical committee,

finally endorsed March 2008 with one abstention



Book with Wiley SOMETIME

Composite indicators

European Commission

We propose

Ten recommended steps

Step 1. Developing a theoretical framework

Step 2. Selecting indicators

Step 3. Imputation of missing data

Step 4. Multivariate analysis

Step 5. Normalisation of data

Step 6. Weighting and aggregation

Step 7. Robustness and sensitivity

Step 8. Back to the details (indicators)

Step 9. Association with other variables

Step 10. Presentation and dissemination

Step 6. Weighting and aggregation

European Commission

The Stiglitz report, on page 65, mentions: *[…] a general criticism that is frequently addressed at composite indicators, i.e. the arbitrary character of the procedures used to weight their various components.*

Adding: *[…] 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. The problem is rather that their normative implications are seldom made explicit or justified.*

Are weightings 'very explicitly presented by authors'?

An example of the paradox: the 'Dean example'

Testing (composite) indicators: two approaches

Michaela Saisana, Andrea. Saltelli, and Stefano Tarantola (2005). Uncertainty and sensitivity analysis techniques as tools for the quality assessment of composite indicators. *J. R. Statist. Soc. A* **168**(2), 307–323.

Paolo Paruolo, Michaela Saisana, Andrea SaltelliRatings and rankings: Voodoo or Science?, *J. R. Statist. Soc. A*, **176** (2), 1-26

First: The invasive approach

Michaela Saisana, Béatrice d'Hombres, Andrea Saltelli, Rickety numbers: Volatility of university rankings and policy implications *Research Policy* (2011), **40**, 165-177

Classement de Shangai : les universités françaises à la traîne

Seules 23 universités françaises figurent dans le classement de Shanghai des 500 meilleurs établissements mondiaux.

C'est un électrochoc qui secoue chaque année les universités tricolores en pleine torpeur estivale. Le classement de Shanghai, qui évalue les performances des meilleurs établissements d'enseignement supérieur mondiaux, vient d'être dévoilé. Ni chute ni progression spectaculaire : avec 23 universités dans le top 500 (22 l'an passé), et 3 dans le top 100 (4 l'an passé), la France se classe au septième rang des 37 pays, rétrocédant une place à la Suède. Des résultats décevants : en légère baisse par rapport à l'an passé, la France ne parvient toujours pas à rattraper son retard sur ses homologues britanniques et allemandes, dont une quarantaine d'universités sont classées.

Comment sauver l'université française

Des pistes pour remédier à la rétrogradation de nos établissements d'enseignement supérieur dans les classements internationaux

Le classement de Shanghaï, qui fait désormais référence quels que soient ses défauts, vient de rétrograder encore une fois les universités françaises par rapport à leurs sœurs étrangères. Dans les cent premières, il n'en accepte plus que trois : Paris-VI (42e), Paris-XI (49e) et l'Ecole normale supérieure (73e).

Jacques Blamont

Membre de l'Académie des sciences

0 ; revenus : 0. Ses ressources totales seraient donc sept fois inférieures à celles du Michigan. Les chiffres relatifs à d'autres universités américaines donne-

les entreprises abonderaient les bourses. La gestion des droits d'inscription et des bourses ressortirait à l'autonomie universitaire.

Une deuxième leçon à tirer de la pratique internationale est que l'université ne doit pas être asphyxiée par des gens qui n'y ont pas leur place. Une sélection à l'entrée s'impose, soit par une meilleure utilisation du baccalauréat (seuls seraient admis les titulaires d'une mention), soit

University rankings are used to judge about the performance of university systems

Joint Research Centre

ARWU and THES

European Commission

Innsbruck, October 22, 2012

Academic Ranking of World Universities

ACADEMIC RANKING OF WORLD UNIVERSITIES SINCE 2003

上海交通大學 SHANGHAI JIAO TONG UNIVERSITY

Times Higher Education UNIVERSITY

POWERED BY THOMSON REUTERS

Joint Research Centre

Variables and weights

European Commission

ARWU

Alumni of an institution winning Nobel Prizes and Fields Medals	10%
Staff of an institution winning Nobel Prizes and Fields Medals	20%
Highly cited researchers in 21 broad subject categories	20%
Articles published in Nature and Science	20%
Articles in Science Cit. Index Expanded, Social Sciences Cit. Index	20%
Academic performance with respect to the size of an institution	10%

THES

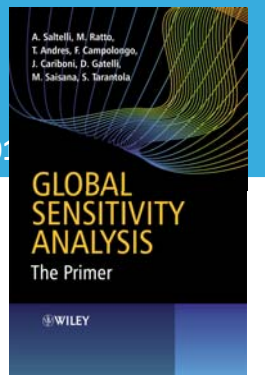
Academic peer review opinion, 6354 academics	40%
Employers' opinion, 2339 recruiters	10%
Student faculty: full-time equivalent faculty/student ratio	20%
Citations per faculty: total citation/full time equivalent faculty	20%
International faculty: percentage of full-time international staff	5%
International students: percentage of full-time international students	5%

Robustness analysis of ARWU and THES

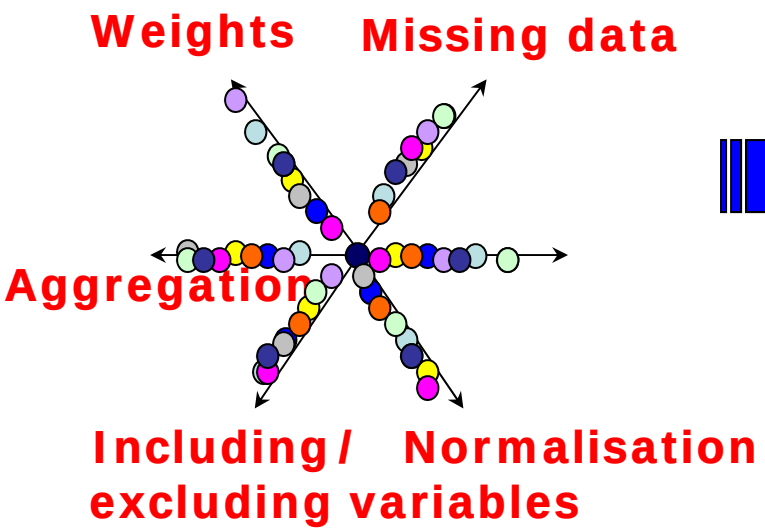
Assumption	Alternatives
Number of indicators	▪ all six indicators included or one-at-time excluded (6 options)
Weighting method	▪ original set of weights, ▪ factor analysis, ▪ equal weighting, ▪ data envelopment analysis
Aggregation rule	▪ additive, ▪ multiplicative, ▪ Borda multi-criterion

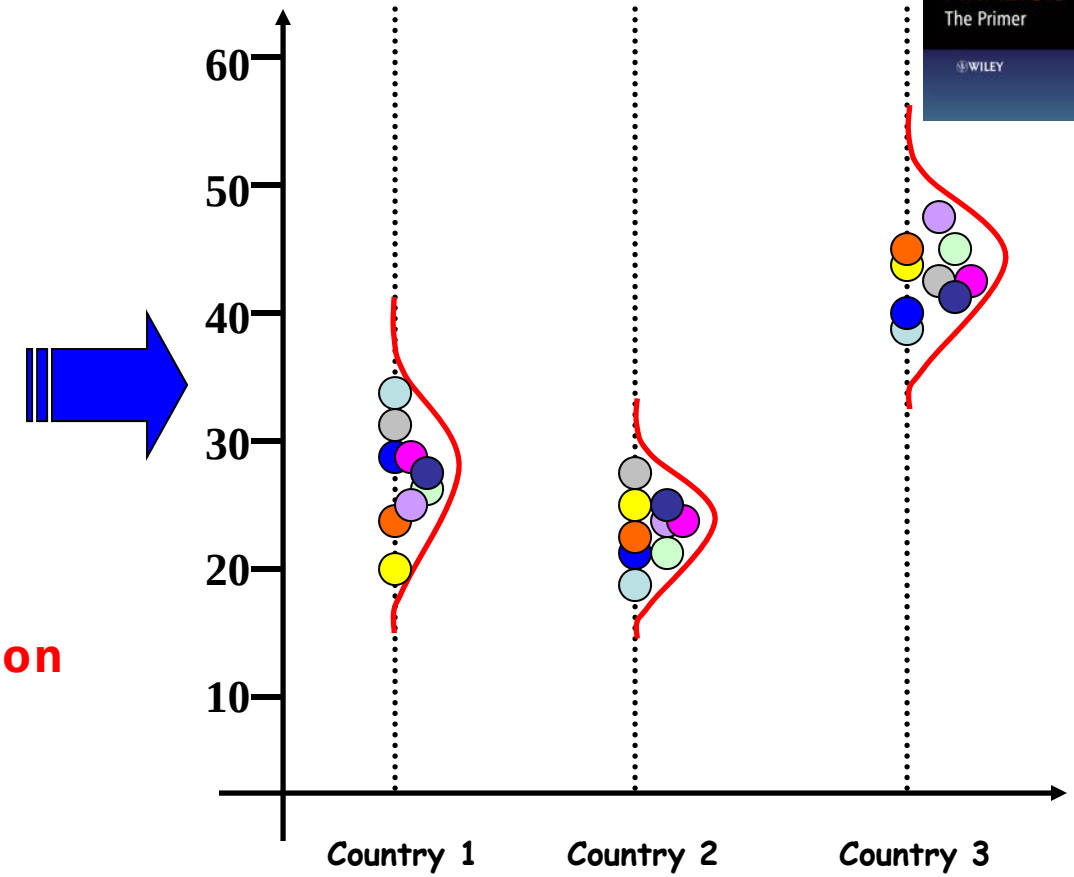
Sensitivity analysis

Andrea Saltelli



Space of alternatives





ARWU: simulated ranks – Top20

Inns

Legend:
Frequency lower 15%
Frequency between 15 and 30%
Frequency between 30 and 50%
Frequency greater than 50%
Note: Frequencies lower than 4% are not shown

	Simulated rank range - SJTU 2008																						
	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-100	Original rank	
Harvard Univ	100																				1	USA
Stanford Univ	89	11																			2	USA
Univ California - Berkeley	97																				3	USA
Univ Cambridge	90	10																			4	UK
Massachusetts Inst Tech (MIT)	74	26																			5	USA
California Inst Tech	27	53	19																		6	USA
Columbia Univ	23	77																			7	USA
Princeton Univ		71	9	11	7																8	USA
Univ Chicago		51	34	13																	9	USA
Univ Oxford		99																			10	UK
Yale Univ		47	53																		11	USA
Cornell Univ		27	73																		12	USA
Univ California - Los Angeles		9	84	7																	13	USA
Univ California - San Diego			41	46	9																14	USA
Univ Pennsylvania		6	71	23																	15	USA
Univ Washington - Seattle			7	71	21																16	USA
Univ Wisconsin - Madison			27	70																	17	USA
Univ California - San Francisco			14	9	14		11		7	10						6				6	18	USA
Tokyo Univ			16	16	49	20															19	Japan
Johns Hopkins Univ			7	54	21	17															20	USA

- Harvard, Stanford, Berkley, Cambridge, MIT: top 5 in more than 75% of our simulations.
- Univ California SF: original rank 18th but could be ranked anywhere between the 6th and 100th position
- Impact of assumptions: much stronger for the middle ranked universities

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THES: simulated ranks – Top 20

Inns

Legend:
Frequency lower 15%
Frequency between 15 and 30%
Frequency between 30 and 50%
Frequency greater than 50%
Note: Frequencies lower than 4% are not shown

Simulated rank range - THES 2008

	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-100		
HARVARD University	44	56																			1	USA
YALE University	40	49	11																		2	USA
University of CAMBRIDGE	99																				3	UK
University of OXFORD	93	7																			4	UK
CALIFORNIA Institute of Technology	46	50																			5	USA
IMPERIAL College London	74	24																			6	UK
UCL (University College London)	73	23																			7	UK
University of CHICAGO		80	19																		8	USA
MASSACHUSETTS Institute of Technology	14	13	17	16	11	11	7														9	USA
COLUMBIA University	6	13	17	11	10	7	10	14													10	USA
University of PENNSYLVANIA		37	56	6																	11	USA
PRINCETON University	6	59	27	9																	12	USA
DUKE University			27	11	9		7		10	6	9		6								13	USA
JOHNS HOPKINS University			20	10	9	9	7		10		6	6	7			6					13	USA
CORNELL University		6	24	11		7	6	7	9	9		7									15	USA
AUSTRALIAN National University	10	30	29	31																	16	Australia
STANFORD University			10	14	7	10	9	10	6	6		7									17	USA
University of MICHIGAN			6	27	17	9	10	7	14	6											18	USA
University of TOKYO				16	7	13	7										6		6		19	Japan
MCGILL University			7	19	41	13	9	7													20	Canada

- Impact of uncertainties on the university ranks is even more apparent.
- M.I.T.: ranked 9th, but confirmed only in 13% of simulations (plausible range [4, 35])
- Very high volatility also for universities ranked 10th-20th position, e.g., Duke Univ, John Hopkins Univ, Cornell Univ.

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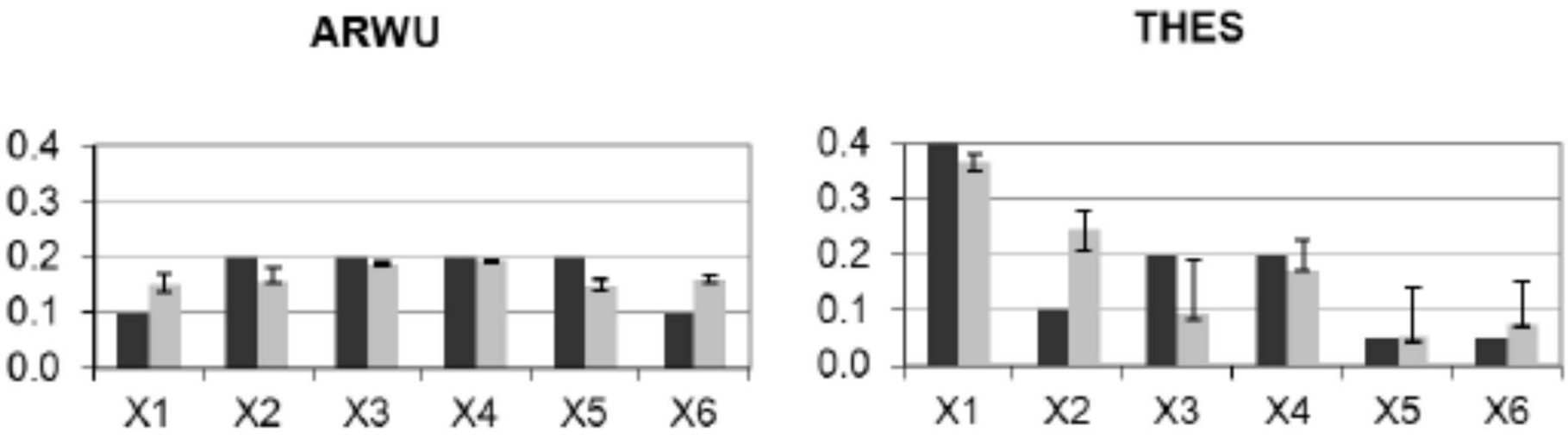
Second: The non-invasive approach

Comparing the weights as assigned by developers with 'effective weights' derived from sensitivity analysis.

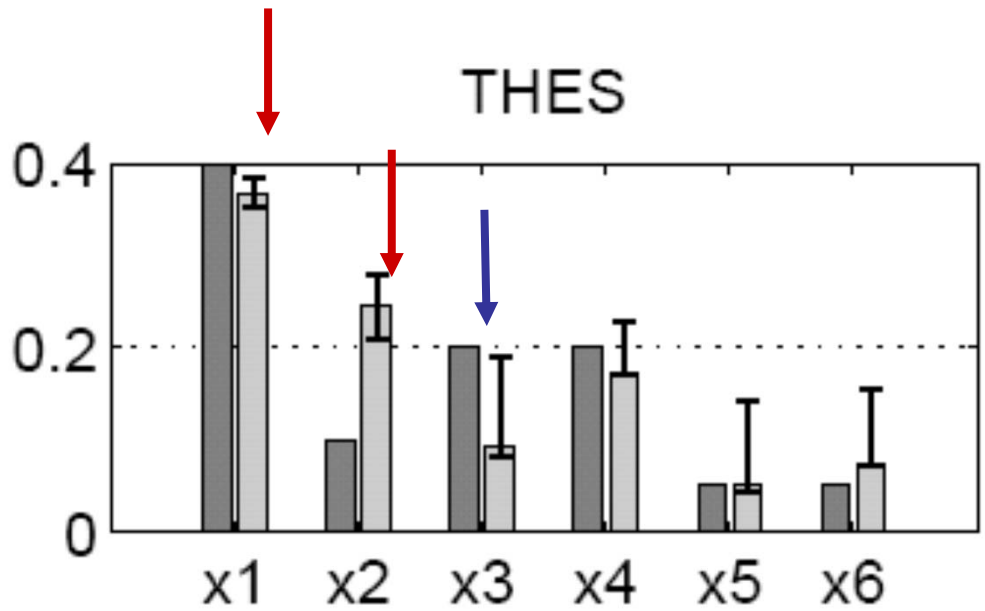
University Rankings



Comparing the internal coherence of ARWU versus THES by testing the weights declared by developers with 'effective' importance measures.

THES

X1_Academic opinion: 6354 academics	40%
X2_Recruiters' opinion: 2339 recruiters	10%
X3_Full-time equivalent faculty/student ratio	20%
X4_Total citation/full time equivalent faculty	20%
X5_Percentage of full-time international staff	5%
X6_Percentage of full-time international students	5%



Issues with THES:

a) 'Opinion' variables' weight overall: >60% instead of 50

b) Faculty/student ratio: 10% instead of 20%

Remember the sub-domain Going out to see a show?

- Theatre
- Cinema
- Museums, exhibits
- Classic Music Concerts
- Other concerts
- Sport shows
- Disco, dance clubs, etc.
- Archeological sites and monuments

Effective weights of subdomain 'Going out to see a show'

		Pearson Eta squared	Pearson R squared
teatro		*0.688*	*0.673*
cinema	Non accettabile	*0.034*	*0.002*
musei		*0.965*	*0.927*
concerti		*0.743*	*0.746*
altriconc		*0.3*	*0.321*
archeo		*0.829*	*0.717*
quotid		*0.903*	*0.874*
libri		*0.749*	*0.899*
riviste		*0.752*	*0.821*

More use of social choice theory methods both for building meaningful aggregated indicators …

(A pity that methods already available between the end of the XIII and the XV century are neglected by most developers)

… while they are used in comparing options in the context of impact assessment studies.

Social choice theory = Multi Criteria Analysis (see Social Choice and Multi Criteria Decision Making by Kenneth Arrow and Herve' Raynaud, 1986).

Ramon Llull (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). His 'Sketch for a Historical Picture of the Progress of the Human Spirit (1795)' can be considered as an ideological foundation for evidence based policy.

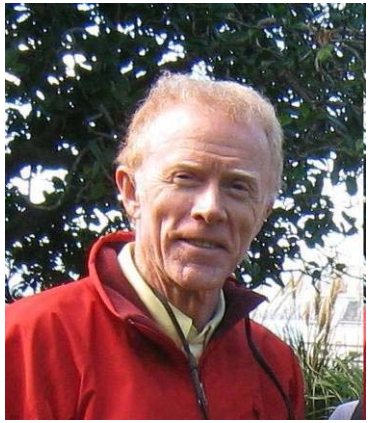
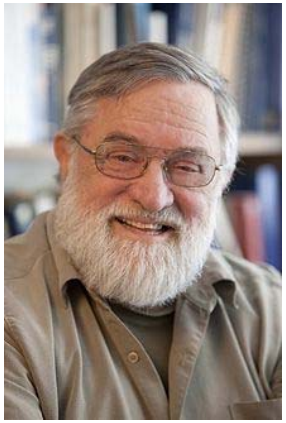
Jean-Charles, chevalier de Borda (May 4, 1733 – February 19, 1799) developed the Borda count.

Suggested reading ***Majority Judgment: Measuring, Ranking, and Electing*** *by Michel Balinski and Rida Laraki (2011).*

Final word on uncertainty

Sensitivity analysis / auditing

Some reasonable people (and guidelines) suggest that 'sensitivity analysis would help'…

…

JRC has worked on sensitivity analysis: books, schools, conferences…

Today we call it **sensitivity auditing** and teach it within the syllabus for impact assessment run by the SEC GEN.

Sensitivity auditing in pills (1): Check against rhetorical use of mathematical modelling;

The instrumental use of mathematical modelling to advance one's agenda can be termed rhetorical, or strategic, like the use of Latin by the elites and the clergy in the classic age.

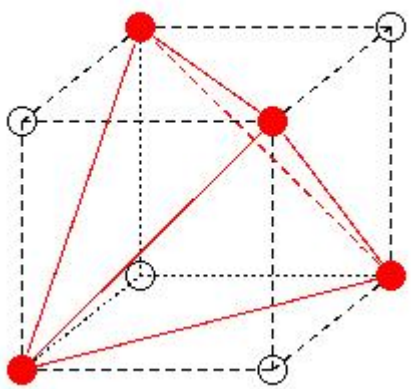
Sensitivity auditing in pills (2): adopt an 'assumption hunting' attitude;

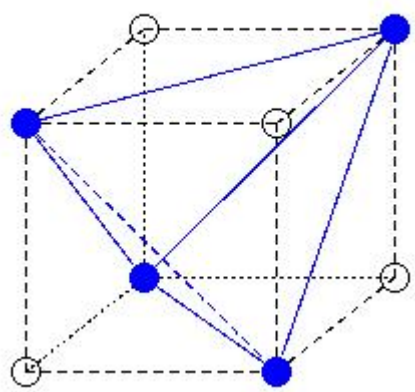
Work of John Kay
Lecture on 'Bogus Quantification: Uses and Abuses of Models' . Example: UK transport WebTAG model (the standard for transport policy simulation) which needs as input 'Annual Percentage Change in Car Occupancy up to 2036'

See also John Kay's article 'A wise man knows one thing – the limits of his knowledge', John Kay, FT November 30, 2011.

Sensitivity auditing in pills (3): <u>use tested methods</u>;

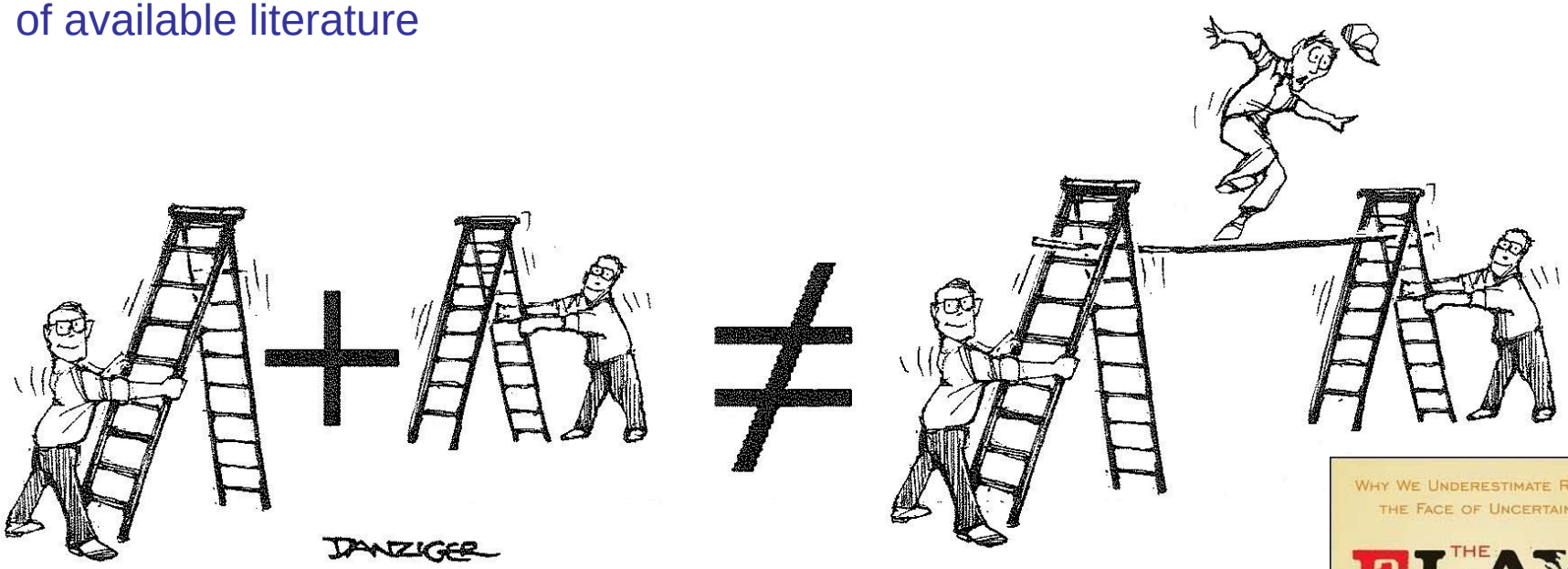
E.g.: Most sensitivity analyses seen in the literature do without a design.➔ Perfunctory analyses?

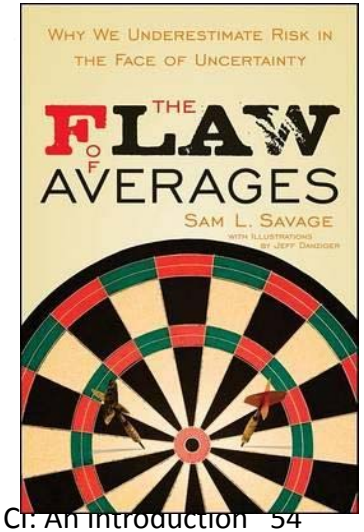




How coupled stairs are shaken in most of available literature

How to shake coupled stairs





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How to avoid a perfunctory sensitivity analysis

Andrea Saltelli*, Paola Annoni

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Sensitivity auditing in pills (4): find sensitivities before sensitivities find you;

Sensitivity analysis should be done before going public with the inference

Peter Kennedy's '**Thou shall confess in the presence of sensitivity. Thou shall anticipate criticism**' (from the ten commandments of applied econometrics).

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

Andrea Saltelli *, Beatrice D'Hombres

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

Sensitivity Analysis:

http://sensitivity-analysis.jrc.ec.europa.eu/

Sensitivity Auditing:

http://sensitivity-analysis.jrc.ec.europa.eu/Presentations/Saltelli-final-February-1-1.pdf

Quality of composite indicators:

http://ipsc.jrc.ec.europa.eu/index.php?id=739

Google™ **“composite indicators”**