

# Should we use bibliometric indices to evaluate research?

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CNRS-LAMSADE

SPECIF Campus 2013  
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(based on joint work with **Thierry Marchant**, Ghent University, Belgium)

If you do not know Thierry...



- 1 Bibliometrics
- 2 Model & Results
- 3 Discussion

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# Academia

## General context

- globalization
- knowledge economy
- financial and economic crisis

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## General context

- globalization
- knowledge economy
- financial and economic crisis

## Impacts on academia

- budget cuts
- arrival of new players (China, India)
- increased mobility of staff & students
- proliferation of evaluation & funding agencies
- proliferation of indices & rankings
- industrialization of academia

# Industrialization of academia

## Symptoms

- AERES + LRU + ANR + fusions of Universities + teaching in English + LESR
- students' demonstrations (*Printemps érable* & UK) + students' debt crisis
- fraud & plagiarism increase
- evaluation fever
  - **bibliometric indices everywhere**



# Bibliometrics

## Two extreme positions

- bibliometrics is an *absolute evil*
- bibliometrics brings *objectivity* and *fairness*



# Bibliometrics

## Two extreme positions

- bibliometrics is an *absolute evil*
- bibliometrics brings *objectivity* and *fairness*

Thesis: both positions are plainly wrong!



# Bibliometrics

## Bibliometrics defined

- using mathematical and statistical techniques to study publishing and communication patterns

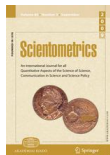
# Bibliometrics

## Bibliometrics defined

- using mathematical and statistical techniques to study publishing and communication patterns

## The field of Bibliometrics

- active scientific field
  - journals: *Scientometrics*, *Journal of Informetrics*, *Journal of the American Society for Information Science and Technology*, *Research Policy*, ...
  - ISSI: International Society for Scientometrics and Informetrics
  - regular International Conferences



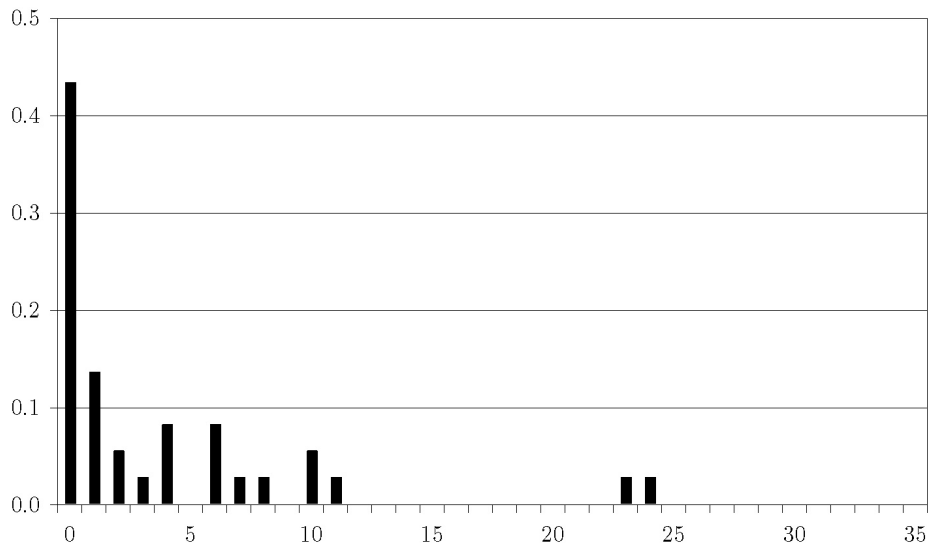
# Bibliometrics

## Some research questions

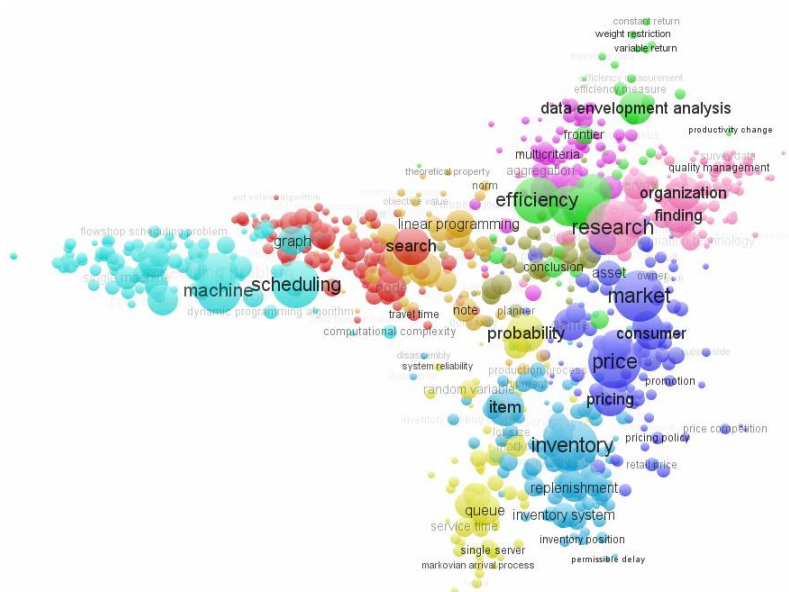
- bibliometric laws: Lotka, Bradford
- social network of {scientists, papers, fields}
- efficiency of research policy of a country
- factors influencing transfer of knowledge towards industry
- which journals should libraries subscribe to?
- impact of open access on diffusion on knowledge
- strong and weak research fields of a country
- emerging fields

Journal of Economic Literature 2008 IF (3.65)

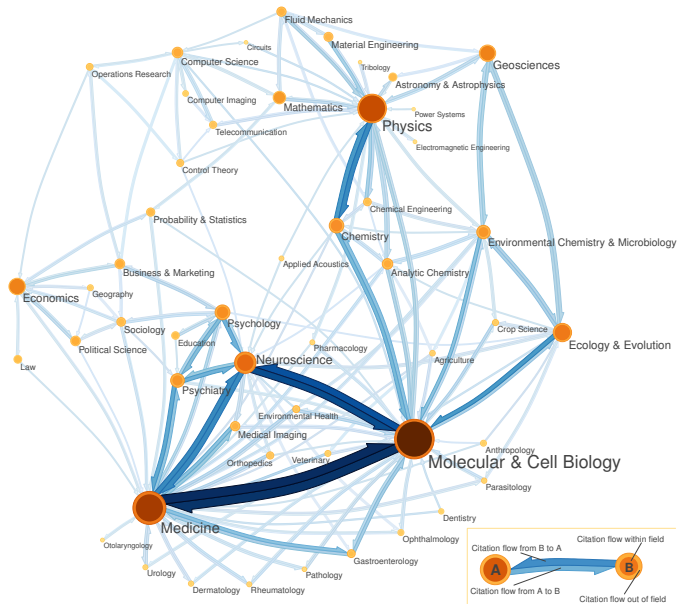
(frequency of number of citations in 2008 to paper published in 2006–2007)



# Map of 800 terms co-occurring in abstracts of OR journals (VOSviewer)



# Map of ISI fields (VOSviewer)



# Evaluative bibliometrics and bibliometric indices

## Evaluative bibliometrics

- publications in journals are the central research output
- citations to publications are important signs of recognition
- the more publication & citations you have the better

“bibliometrically limited view of a complex reality” (A. van Raan, 2005)



# Evaluative bibliometrics and bibliometric indices

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- publications in journals are the central research output
- citations to publications are important signs of recognition
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“bibliometrically limited view of a complex reality” (A. van Raan, 2005)

- count publications & citations
- summarize these counts by indices

# Evaluative bibliometrics and bibliometric indices

## Databases

- Web of Science (ISI, Thomson Reuters)
- Scopus (Elsevier)
- Google Scholar

Record publications and citations

Online uses during evaluation committees by often uninformed users



ISI Web of  
**SCIENCE.**

Powered by ISI Web of Knowledge<sup>SM</sup>



Google  
scholar

DB: 456 papers, 3464 citations,  $h$ -index = 27

**Harzing's Publish or Perish**

File Edit View Tools Help

Author impact analysis - Perform a citation analysis for one or more authors

Author's name:

Exclude these names:

Year of publication between:  and:

**Results**

Papers:	456	Cites/paper:	7.60	h-index:	27	d bouyssou: all
Citations:	3464	Cites/author:	2181.20	g-index:	51	Query date: 2013-05-24
Years:	56	Papers/author:	200.63	hc-index:	16	Papers: 456
Cites/year:	61.86	Authors/paper:	3.06	hi_norm:	21	Citations: 3464
						Years: 56

Cites	Per year	GS Rank	Authors	Title	Year
<input checked="" type="checkbox"/> <b>h</b> 329	23.50	1	D Bouyssou	Evaluation and Decision Models: A Critical Perspective	2000
<input checked="" type="checkbox"/> <b>h</b> 238	9.92	2	D Bouyssou	Building criteria: A prerequisite for MCDA	1990
<input checked="" type="checkbox"/> <b>h</b> 170	6.07	3	D Bouyssou	Some remarks on the notion of compensation in MCDM	1986
<input checked="" type="checkbox"/> <b>h</b> 151	18.88	4	D Bouyssou, T Marchant, M Pirlot, A Tsouki...	Evaluation and decision models with multiple criteria: Stepping stones for the analyst	2006
<input checked="" type="checkbox"/> <b>h</b> 105	15.00	5	F Aleskerov, D Bouyssou, B Monjardet, D B...	Utility maximization, choice and preference	2007
<input checked="" type="checkbox"/> <b>h</b> 102	3.64	7	D Bouyssou, JC Vansnick	Noncompensatory and generalized noncompensatory preference structures	1986
<input checked="" type="checkbox"/> <b>h</b> 98	6.53	6	D Bouyssou	Using DEA as a tool for MCDM: some remarks	1999
<input checked="" type="checkbox"/> <b>h</b> 92	5.11	8	D Bouyssou	Outranking relations: do they have special properties?	1996
<input checked="" type="checkbox"/> <b>h</b> 80	3.64	10	D Bouyssou	Ranking methods based on valued preference relations: a characterization of the n...	1992
<input checked="" type="checkbox"/> <b>h</b> 78	6.50	9	D Bouyssou, M Pirlot	Nontransitive decomposable conjoint measurement	2002
<input checked="" type="checkbox"/> <b>h</b> 71	2.54	11	B Roy, D Bouyssou	Comparison of two decision-aid models applied to a nuclear power plant siting exam...	1986
<input checked="" type="checkbox"/> <b>h</b> 61	2.77	14	D Bouyssou, P Perny	Ranking methods for valued preference relations: A characterization of a method b...	1992
<input checked="" type="checkbox"/> <b>h</b> 56	8.00	12	D Bouyssou, T Marchant	An axiomatic approach to noncompensatory sorting methods in MCDM, II: More th...	2007
<input checked="" type="checkbox"/> <b>h</b> 56	14.00	13	JC Billaut, D Bouyssou, P Vincke	Should you believe in the Shanghai ranking?	2010
<input checked="" type="checkbox"/> <b>h</b> 49	1.96	15	D Bouyssou	Modelling inaccurate determination, uncertainty, imprecision using multiple criteria	1989
<input checked="" type="checkbox"/> <b>h</b> 49	2.23	18	D Bouyssou	On some properties of outranking relations based on a concordance-discordance pr...	1992
<input checked="" type="checkbox"/> <b>h</b> 48	2.82	20	D Bouyssou, P Vincke	Ranking alternatives on the basis of preference relations: a progress report with s...	1997

DB: 42 papers, 415 citations,  $h$ -index = 12

## Web of Science®

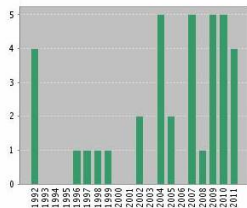
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### Citation Report AU=(bouyssou d\*)

Timespan=All years. Databases=IC, SCI-EXPANDED, A&HCI, SSCI, CPCI-SSH, CPCI-S.

This report reflects citations to source items indexed within Web of Science. Perform a Cited Reference Search to include citations to items not indexed within Web of Science.

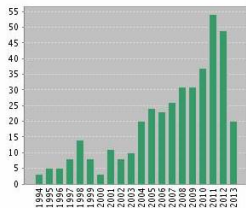
Published Items in Each Year



The latest 20 years are displayed.

[View a graph with all years.](#)

Citations in Each Year



The latest 20 years are displayed.

[View a graph with all years.](#)

<b>Results found:</b>	<b>42</b>
<b>Sum of the Times Cited [?]:</b>	<b>415</b>
<b>Sum of Times Cited without self-citations [?]:</b>	<b>345</b>
<b>Citing Articles[?]:</b>	<b>288</b>
<b>Citing Articles without self-citations [?]:</b>	<b>262</b>
<b>Average Citations per Item [?]:</b>	<b>9.88</b>
<b>h-index [?]:</b>	<b>12</b>

DB: 2929 citations,  $h$ -index = 27



Changer de photo

**Denis Bouyssou** [Modifier](#)

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Google scholar

Rechercher des auteurs

Mes citations - Aide

### Citations

	Toutes	Depuis 2008
Citations	2929	1317
indice h	27	17
indice i10	59	33

### Citations des articles de l'auteur



Sélectionner : Tous, Aucun [Actions](#)

Afficher : 20 1-20 Suivante >

Titre/Auteur

Citée par

Année

Evaluation and Decision Models: A Critical Perspective

D Bouyssou  
Kluwer Academic Pub

330

2000

Building criteria: A prerequisite for MCDA

D Bouyssou  
Readings in multiple criteria decision aid, 58-80

238

1990

Some remarks on the notion of compensation in MCDM

D Bouyssou  
European Journal of Operational Research 26 (1), 150-160

170

1986

Evaluation and decision models with multiple criteria: Stepping stones for the analyst

D Bouyssou, T Marchant, M Pirlot, A Tsoukias, P Vincke  
International Series in Operations Research and Management Science 86

151

2006

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Silvano Martello	<a href="#">Ajouter</a> - <a href="#">X</a>
Roman Slowinski	<a href="#">Ajouter</a> - <a href="#">X</a>
Elke Weber	<a href="#">Ajouter</a> - <a href="#">X</a>
birger Wernerfelt	<a href="#">Ajouter</a> - <a href="#">X</a>
Philip M. Parker	<a href="#">Ajouter</a> - <a href="#">X</a>
Mousseau Vincent	<a href="#">Ajouter</a> - <a href="#">X</a>
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Nom

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DB: 42 papers, 390 citations,  $h$ -index = 9



## Bouyssou, Denis

▼ Find potential

### Personal

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E-mail	<a href="mailto:bouyssou@lamsade.dauphine.fr">bouyssou@lamsade.dauphine.fr</a>
Affiliation	CNRS Centre National de la Recherche Scientifique, Paris France

### Research

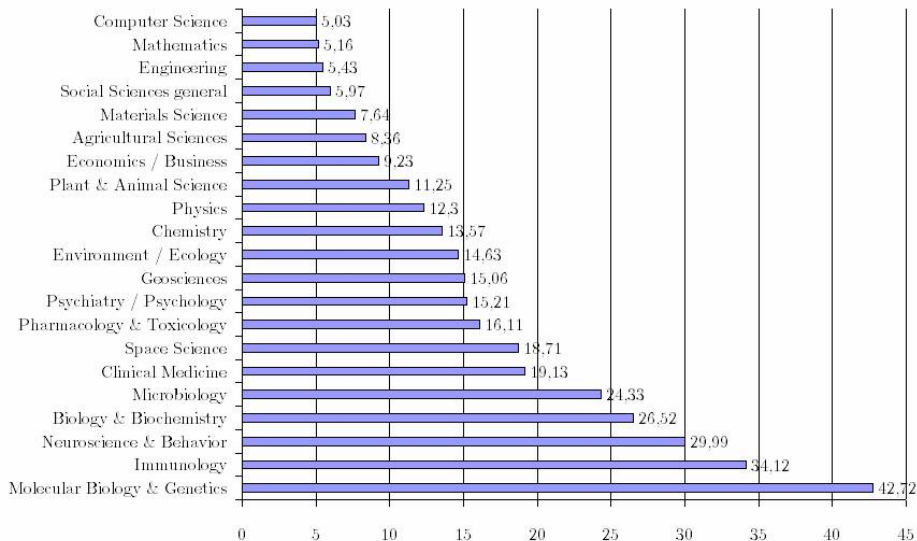
Documents	42	 <a href="#">View Author Evaluator</a>    <a href="#">Add to my list</a>    <a href="#">Set alert</a>    <a href="#">Set feed</a>
References	748	
Citations	390 total citations by 272 documents	 <a href="#">View citation overview</a>    <a href="#">Set alert</a>
$h$ Index	9	 <a href="#">View h-Graph</a> <span>The <math>h</math> Index considers Scopus articles published after 1995.</span>
Co-authors	21	
Web search	1028	
Subject area	Decision Sciences Mathematics Social Sciences <a href="#">More...</a>	

# A few words of warning

## Databases

- cleaning is needed and not easy to do!
  - spelling errors + incorrect citations
  - names: diacritical signs, T<sub>E</sub>X ligatures, transliteration, homonyms (Martel in Québec, Park in Korea)
  - correct affiliations are **extremely difficult** to determine
  - counting: original articles, letters, notes, erratum, obituaries, reviews, editorials
  - lost citations (up to 30%)
- important differences between fields
  - publication intensity
  - citation intensity & behavior
  - longevity of papers (months vs decades)

## Citation intensity for the 21 ISI categories





# A few more words of warning

## Science is not immune to social effects

- peer review has documented defects (tests / retests)
- motives for citation are diverse (negative citations, perfunctory citations)
- self citations and network effects
- manipulation of the JIF by editors

Humbolt & Merton vs Bourdieu

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Humbolt & Merton vs Bourdieu

## Nightmares

- how to deal with **multiple authors** (sometimes more than 1 000)
- how to deal with **multiple affiliations**
- what is an **author**? (ghost authors, unequal contributions, ...)
- people react and adapt quickly: **perverse effects** are pervasive
- epistemology: normal science vs paradigm shifts (Kuhn)

## Examples of papers with many authors

Papers with highest numbers of authors, by year, 2002-2011		
Year	Paper	Number of authors
2011	ATLAS Collaboration (G. Aad, <i>et al.</i> ), "Search for quark contact interactions in dijet angular distributions in pp collisions at root s=7 TeV measured with the ATLAS detector," <i>Phys. Lett. B</i> , 694(4-5): 327-45, 2011.	3,179
2010	ATLAS Collaboration (G. Aad, <i>et al.</i> ), "Charged-particle multiplicities in pp interactions at root s=900 GeV measured with the ATLAS detector at the LHC ATLAS Collaboration," <i>Phys. Lett. B</i> , 688(1): 21-42, 2010.	3,221
2009	LIGO Sci. Collaboration, Virgo Collaboration (B.P Abbott, <i>et al.</i> ), "An upper limit on the stochastic gravitational-wave background of cosmological origin," <i>Nature</i> , 460(7258): 990-4, 2009.	657
2008	CMS Collaboration (S. Chatrchyan, <i>et al.</i> ), "The CMS experiment at the CERN LHC," <i>J. Instrumentation</i> , 3: No. S08004, 2008.	3,101
2007	CMS Collaboration (G.L. Bayatian, <i>et al.</i> ), "CMS physic technical design report, volume II: Physics performance," <i>J. Phys. G-Nucl. Part. Phys.</i>	2,011
2006	ALEPH, DELPHI, L3, OPAL, and SLD Collaborations (S. Schael, <i>et al.</i> ), "Precision electroweak measurements on the Z resonance," <i>Phys. Reports</i> , 427(5-6): 257-454, 2006.	2,517
2005	Antiretroviral Therapy Cohort Collaboration (D. Costagliola, <i>et al.</i> ), "Incidence of tuberculosis among HIV-infected patients receiving highly active antiretroviral therapy in Europe and North America," <i>Clin. Infect. Diseases</i> , 41(12): 1772-82, 2005.	859
2004	MEGA Study Group (H. Nakamura, <i>et al.</i> ), "Design and baseline characteristics of a study of primary prevention of coronary events with pravastatin among Japanese with mildly elevated cholesterol levels," <i>Circulation J.</i> , 68(9): 860-7, 2004.	2,459
2003	D. Acosta, <i>et al.</i> (CDF II Collaboration), "Measurement of the mass difference $M(D(s^{+})-m(D^{+}))$ at CDF II," <i>Phys. Rev. D</i> , 68(7): No 072004, 2003.	818
2002	B. Aubert, <i>et al.</i> (BABAR Collaboration), "The BABAR detector," <i>Nucl. Instr. Meth. Phys. Res. Sect. A</i> , 479(1): 1-116, 2002.	824

# Bibliometric indices

## Hypotheses

- all above problems have been taken care of
- you have a good verified and cleaned database

## Many possible indices

- counting of papers
- counting of citations
- sum of Impact Factors
- Markovian indices (PageRank)
- *h*-index and its variants

# Properties of Bibliometric indices

## Bibliometric Indices

- what properties?
- how to compare them?
- how to combine them?

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- what properties?
- how to compare them?
- how to combine them?

## Motivation

- choosing bibliometric indices should be a subject of scientific investigation
- this choice should not be in the hands of evaluation bureaucrats

# Potential problems with the $h$ -index (1/2)

## Evaluation of authors

- $h$ -index
  - the  $h$ -index of an author is  $x$  if this author  $x$  papers having at least  $x$  citations each (and her other papers have at most  $x$  citations each)
  - author  $f$ : 4 papers with 4 citations each
  - author  $g$ : 3 papers with 6 citations each
- $i_h(f) = 4 > i_h(g) = 3$

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- both authors publish a new paper with 6 citations
- $i_h(f^*) = 4 = i_h(g^*) = 4$



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- $i_h(f^{**}) = 4 < i_h(g^{**}) = 5$

# Potential problems with the $h$ -index (2/2)

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- author  $a_2$ : 4 papers each one cited 4 times
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### Department $b = (b_1, b_2)$

- author  $b_1$ : 3 papers each one cited 6 times
- author  $b_2$ : 3 papers each one cited 6 times
  - $h$ -index of both authors is 3
  - $h$ -index of the department is 6

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- the “best” department contains the “worst” authors!

# Outline

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# Model of Authors

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## Important Limitation

- coauthors are ignored in this talk

# Notation and remarks

## Notation

- $\mathbf{0}$  is an author without any paper
- $\mathbf{1}_x$  is an author with 1 paper having received  $x$  citations

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## Remarks

Authors are modelled as **functions**

- it makes sense to add two authors  $f$  and  $g$ :  $f + g$
- it makes sense to multiply an author  $f$  by an integer  $n$ :  $n \cdot f$

# Model of Departments

## Departments

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## Limitations

- multiple affiliations are ignored
- field normalization is ignored



# Axioms

## Consistency

Let  $A = (a_1, a_2, \dots, a_k)$  and  $B = (b_1, b_2, \dots, b_k)$  be two departments of size  $k$ .

If  $a_i \succsim b_i$ , for all  $i \in \{1, 2, \dots, k\}$  then  $A \succeq B$

Furthermore if  $a_i \succ b_i$ , for some  $i \in \{1, 2, \dots, k\}$  then  $A \triangleright B$

# Axioms

## Consistency

Let  $A = (a_1, a_2, \dots, a_k)$  and  $B = (b_1, b_2, \dots, b_k)$  be two departments of size  $k$ .

If  $a_i \succsim b_i$ , for all  $i \in \{1, 2, \dots, k\}$  then  $A \succeq B$

Furthermore if  $a_i \succ b_i$ , for some  $i \in \{1, 2, \dots, k\}$  then  $A \triangleright B$

## Independence

For all  $f, g \in \mathcal{A}$  and all  $x \in \mathbb{N}$

$$f \succsim g \Leftrightarrow f + \mathbf{1}_x \succsim g + \mathbf{1}_x$$

# Axioms

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## Transfer

For all  $A = (a_1, a_2, \dots, a_k) \in \mathcal{D}$ , all  $i, j \in \{1, 2, \dots, k\}$  and all  $x \in \mathbb{N}$

$$(a_1, \dots, a_i + \mathbf{1}_x, \dots, a_k) \triangleq (a_1, \dots, a_j + \mathbf{1}_x, \dots, a_k)$$

# Interpretation and Results

## Interpretation

- Consistency appears uncontroversial
- Independence appears uncontroversial
- Transfer is strong (but used quite often)
  - “Inequalities” within departments are ignored

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## Proposition 1

If  $\succsim$  and  $\triangleright$  are linked by Consistency and if  $\triangleright$  satisfies Transfer then  $\succsim$  satisfies Independence

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## Corollary

If  $\succsim$  is the ranking of authors based on the  $h$ -index then there is no  $\triangleright$  such that Transfer and Consistency hold

# Scoring rules for scientists

## Definition 1

$\succsim$  is a scoring rule for scientists (**s-scoring rule**) if there is a real valued function  $u$  on  $\mathbb{N}$  such that

$$f \succsim g \Leftrightarrow \sum_{x \in \mathbb{N}} f(x)u(x) \geq \sum_{x \in \mathbb{N}} g(x)u(x)$$

- $u(x)$  gives the worth of one publication with  $x$  citations
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## Examples

- $u(x) = x$ : number of citations
- $u(x) = 1$ : number of publications
- $u(x) = 1$  if  $x \geq \alpha$ : number of highly cited publications



# Rules for departments

## Definition 2

$\succeq$  is a scoring rule for departments (**d-scoring rule**) if there is a real valued function  $v$  on  $\mathbb{N}$  such that

$$(a_1, a_2, \dots, a_k) \succeq (b_1, b_2, \dots, b_\ell) \Leftrightarrow \sum_{i=1}^k \sum_{x \in \mathbb{N}} a_i(x) v(x) \geq \sum_{i=1}^{\ell} \sum_{x \in \mathbb{N}} b_i(x) v(x)$$

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## Definition 3

$\succeq$  is an averaging rule for departments (**d-averaging rule**) if there is a real valued function  $v$  on  $\mathbb{N}$  such that

$$(a_1, a_2, \dots, a_k) \succeq (b_1, b_2, \dots, b_\ell) \Leftrightarrow \frac{1}{k} \sum_{i=1}^k \sum_{x \in \mathbb{N}} a_i(x)v(x) \geq \frac{1}{\ell} \sum_{i=1}^{\ell} \sum_{x \in \mathbb{N}} b_i(x)v(x)$$

# Axioms

## Archimedeaness

For all  $f, g, f', g' \in \mathcal{A}$  such that  $f \succ g$  there is  $n \in \mathbb{N}$  such that

$$f' + (n \cdot f) \succ g' + (n \cdot g)$$

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## Dummy Scientist

For all  $k \in \mathbb{N}$  and all  $(a_1, a_2, \dots, a_k) \in \mathcal{D}$   
 $(a_1, a_2, \dots, a_k) \stackrel{\Delta}{=} (a_1, a_2, \dots, a_k, \mathbf{0})$

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## Homogeneity

For all  $k, n \in \mathbb{N}$  and all  $(a_1, a_2, \dots, a_k) \in \mathcal{D}$   
 $(a_1, a_2, \dots, a_k) \triangleq (\underbrace{a_1, a_1, \dots, a_1}_n, \underbrace{a_2, a_2, \dots, a_2}_n, \dots, \underbrace{a_k, a_k, \dots, a_k}_n)$

# Remarks

- all s-scoring rules satisfy Archimedeaness
- Dummy Scientist is satisfied by d-scoring rules but not by d-averaging rules
- Homogeneity is satisfied by d-averaging rules but not by d-scoring rules

# Some results

## Theorem 1 (B & Marchant, 2011)

The relations  $\succsim$  and  $\succeq$  are linked by **Consistency**,  $\succeq$  satisfies **Transfer** and **Dummy Scientist**,  $\succsim$  satisfies **Archimedeaness**

**if and only if**

$\succsim$  is an s-scoring rule and  $\succeq$  is a d-scoring rule with  $u = v$

The function  $u$  is unique up to the multiplication by a positive constant

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# Extensions

## Extensions

- add additional conditions to restrict the shape of  $u$ 
  - $u$  is nondecreasing
  - $u$  is constant
  - $u$  is linear

Easy!

# Outline

- 1 Bibliometrics
- 2 Model & Results
- 3 Discussion**

# Discussion of results

## Axioms

- Consistency is highly desirable
- Independence is highly desirable (but violated by the  $h$ -index)
- Archimedeaness is technical
- Transfer is more debatable (anonymity & inequality)

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- coauthors
- multiple affiliations
- field normalization

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## Warning

- beware of institutions using the  $h$ -index!

I will not use the h-index anymore  
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# Messages

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## Evaluative bibliometrics in practice

- it should be used with much care
- it should not be in the hands of laypersons
- it should not be entrenched in formal rules
- it can be useful if used **together** with careful and impartial peer review



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## Bibliometrics


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- evaluative bibliometrics is an interesting field of study
- many wrong beliefs are floating around


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## Excellence: IDEX, LABEX, PES


- **excellence** is another word for **outliers**
  - not everyone can be excellent!
  - what should we do with people that are not excellent?
  - is the mantra of excellence a good motivating tool?

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C'EST  
TOUT  
POUR  
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