international panorama of scientometrics

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Historical background

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The 'Perspective Shift'

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Challenges and present tasks

New challenges force the development of new techniques and methodologies, the exploration and creation of new data sources and the foundation of regional and national research and service centres.

Historical background

In order to understand the present situation of scientometrics we have to go back to the roots of the field:

- History of science (D. de Solla Price)
- Philosophy (V.V. Nalimov)
- Information science (E. Grafield)
- Sociology of science (R.K. Merton)
- Mathematics (S.D. Haitun, A.I. Yablonsky)

Historical background

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- Monitoring, describing and modelling of the production, dissemination and use of knowledge was originally in the foreground.

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- The journal *Impact Factor* (Garfield & Sher, 1963) was used to help select journals for the *Science Citation Index* (SCI).
- The co-citation based *Atlas of Science* developed and issued by the Institute for Scientific Information (ISI) was considered a new kind of "review literature" which is also suited to help students in choice of career in science (Garfield, 1975).

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- The application to science policy has brought a new perspective, and resulted in re-interpretation of bibliometric conceptions.
- The 'science indicators' movement in the US with the discussion about the possible use of bibliometrics in science policy in the 1970s marked the begin of a new era in bibliometrics.

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- As a consequence of this perspective shift, new fields of applications and challenges opened to bibliometrics; but many tools were still designed for use in scientific information, information retrieval and libraries. Those became used in a context for which these were not designed.
- Data sources have to be improved and extended, new methods have to be developed to make bibliometrics fit for present-day and future tasks.

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- Sociology of science laid the theoretical groundwork for the paradigmatic perspective shift.
- However, advancement of bibliometric methodology could not always keep pace with the demands and the breathtaking development in data processing.

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- The level of aggregation decreased from the national level over the institutional level down to the level of the evaluation of research groups or even individual scientists.
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- A necessary requirements are high quality of data and watertight methodology (cf., Glänzel, 1996).
- Consequences are possible repercussions on the scientists' publication and citation behaviour (Glänzel & Debackere, 2003).

The situation

The new situation implies several new tasks and challenges in bibliometric research and technology requiring new methods and instruments.

- Extending bibliometrics to the technical sciences, social sciences and humanities
- Exploring and building new ("bibliometrics-ready") databases
- Development of advanced subject-delineation techniques ("bibliometrics-aided retrieval") and improvement of subject classification
- Inclusion of bibliometrics in funding formulas
- Using bibliometrics in the evaluation of institutes, departments and research groups
- Ranking issues and "multi-dimensional bibliometrics"

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The situation

In order to take on these challenges, also new centres for science, technology and innovation research have been founded world wide. Nowadays public and commercial institutes are searching for new solutions in bibliometrics and related fields.

Among these institutes, we find research centres with long tradition like ISI (USA), ISSRU (Hungary), VINITI (Russia), CWTS (Netherlands) or NISTADS (India) but also newer ones like OST (France), REPP (Australia), NIFU STEP (Norway), SOOI (Belgium), KAWAX (Chile), WISELAB (China) and IFQ (Germany), the companies Science-Metrix (Canada), Evaluametrics (UK), Evindence (UK) and others.

Extending bibliometrics

Scientometrics was designed to measure scholarly communication in basic research. But what happens when information sources and/or targets are outside the community (Glänzel & Schoepflin, 1999)?

Extending bibliometrics to the technical sciences, social sciences and humanities is faced with the following problems.

- Coverage (document type)
- Journal coverage
- National representation
- Language representation
- Role and interpretation of citations
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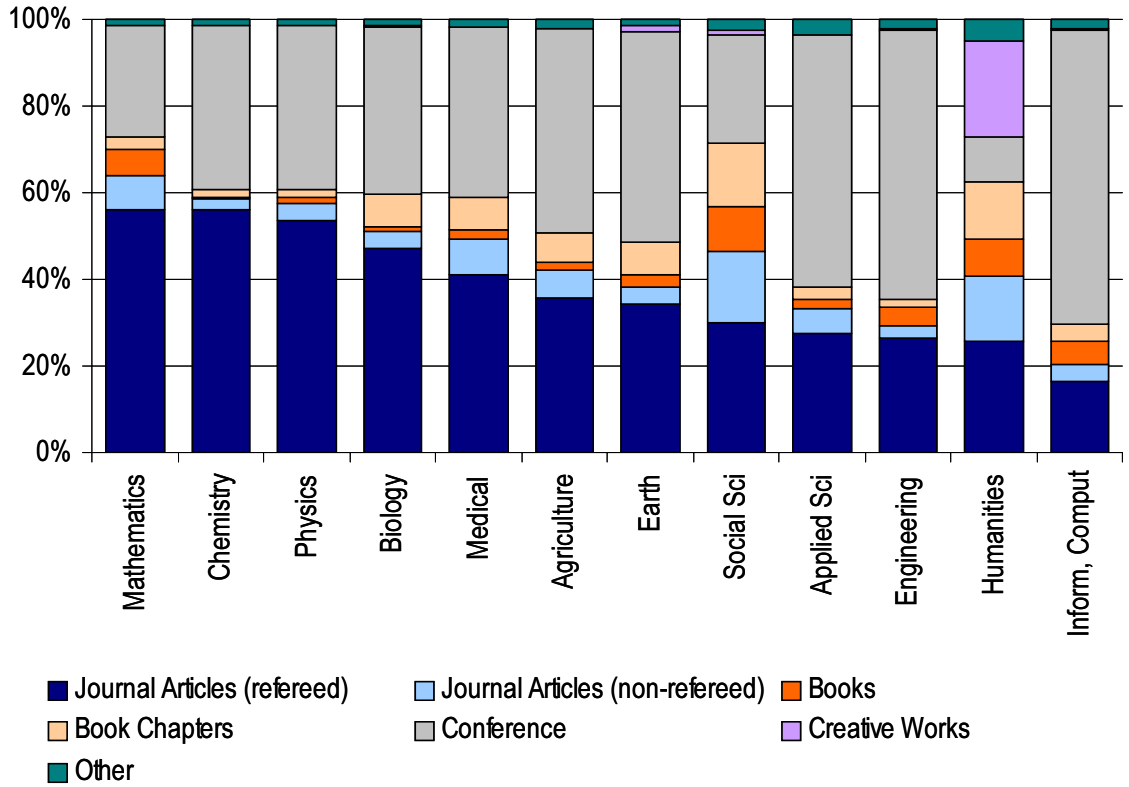
Extending bibliometrics

Academic output by field of research and publication type



Source: ISI (2000) and Linda Butler (2003)

New databases

While *Scopus* (Elsevier) evolves to a competitive product to the WoS with similar coverage and similar features, *Google Scholar* is rather a product for the semi-professional user.

The advantage of Google Scholar is its availability and open access, the disadvantage is the lacking documentation and the unclear standards.

At present, none of these databases is able to meet the requirements of present-day research evaluation.

New databases

In order to meet the emerging requirements of research evaluation, the possibility of extending existing databases (CWTS, SOOI) or building new, "bibliometric-ready", databases (e.g., REPP, Australia; NIFU STEP, Norway; VABB-SHW, Flanders) is considered. Some of these databases are already in use.

Different quality criteria, the weight of document types and lacking international harmonisation remain problematic.

Building advanced bibliometric indicators for data extracted from these databases remains an unresolved problem as well. Measures of reception and impact are practically not available.

Subject delineation

The lack a appropriate subject-classification schemes for fields, subfields and topics resulted in the following tasks.

- Improving subject delineation and classification based on hybrid methods, i.e., combinations of text mining, and bibliometric techniques (Zitt & Bassecoulrad, 2006, Glänzel et al., 2006, Glenisson et al., 2005, Janssens et al., 2008, 2009, Glänzel et al., 2009)
- Identification of emerging and converging fields, visualisation of structure and field dynamics, domain studies (University of Granada; Information Visualization Lab, Indiana University; Science-Metrix; CWTS, Leiden University; SOOI, KU Leuven; ASCoR, University Amsterdam)

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Subject delineation

In several studies, "intellectual" subject-classification schemes have been analysed for "goodness" of classification and compared with the results of hybrid clustering.

Example: The 22-field subject classification scheme of the Essential Science Indicators (ESI) is evaluated. In a second step, the hybrid clustering method is applied to classify WoS journals. The choice of 22 clusters also allows a direct field-to-cluster comparison, and we substantiate that the science areas resulting from cluster analysis form a more coherent structure than the "intellectual" reference scheme, the ESI subject scheme. Observed *migration* of journals among science fields can then be adopted to improve classification.

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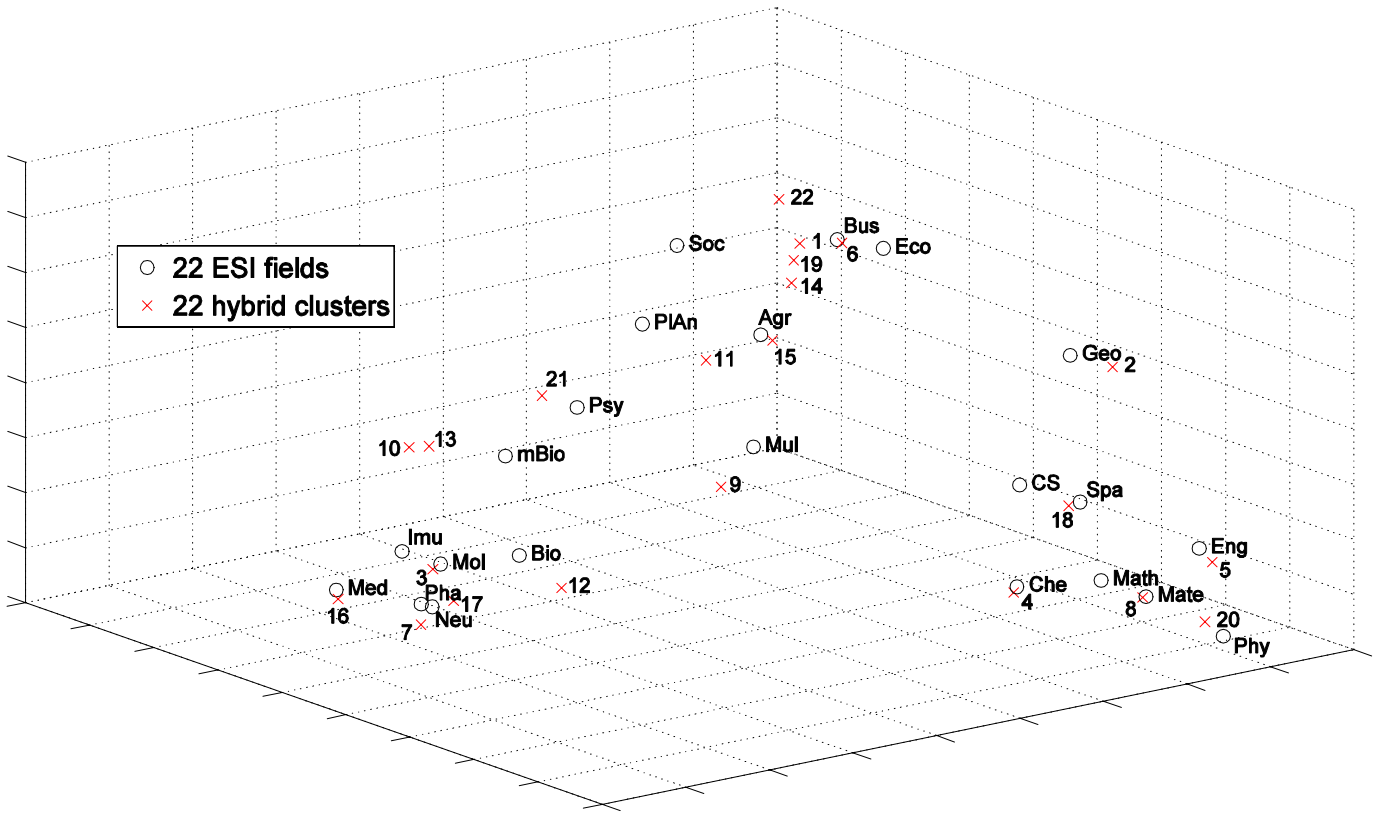


Three-dimensional MDS map visualising distances between the centres (centroids) of the 22 ESI fields and the 22 journal clusters

Bibliometrics and funding

In several countries bibliometric indicators are used as components of funding formulas.

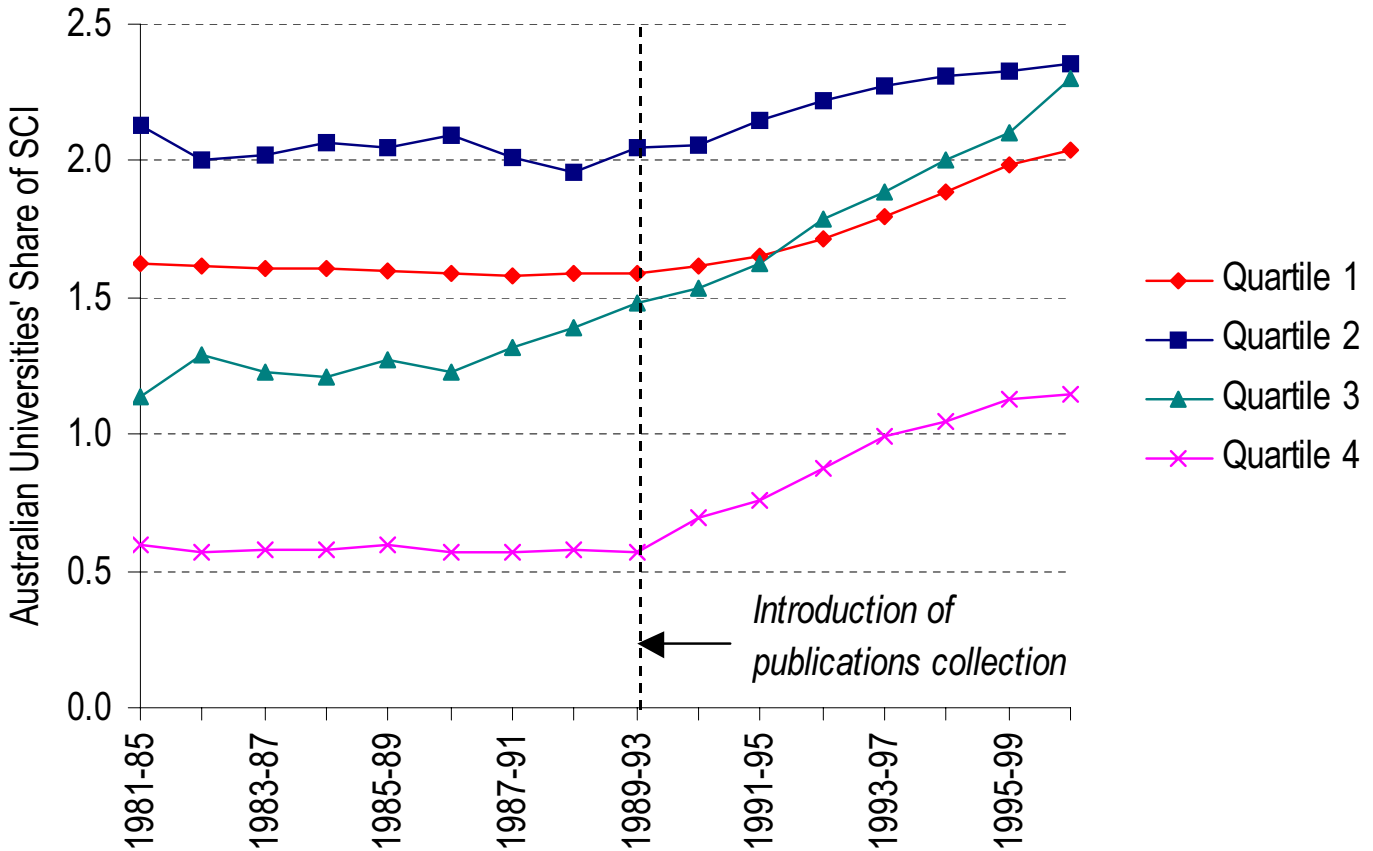
Example: One of the major funding mechanisms for basic science in Flanders is the BOF-mechanism. The *Bijzonder Onderzoeksfonds* is a research fund of the Flemish government that is distributed to the six Flemish universities on the basis of a specific allocation model. This allocation key comprises both input and output measures on the research performance of the universities involved. Part of the key is based on publication and citation data as derived from WoS and ISI Proceedings.

Bibliometrics and funding

The use of bibliometrics in funding mechanims might also have undesired consequences, as has reported by Linda Butler.

Example: The publications component of the Composite Index used for allocating university block funding in Australia has stimulated an increased publication activity in the lower impact journals (Butler, 2004).

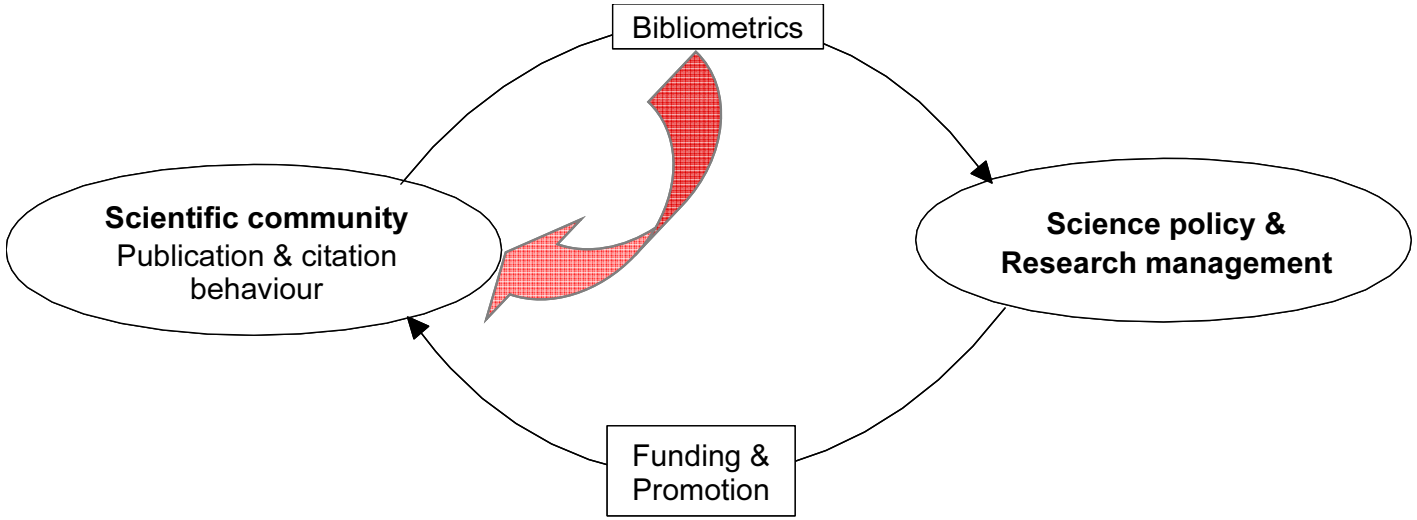
Bibliometrics and funding



Source: ISI (2000) and Linda Butler (2004)

Australian universities' share of publication in the SCI, by journal impact quartile: five-year windows, 1981–1985 to 1996–2000

Bibliometrics and funding



Schematic visualisation of the feedback of policy use of bibliometrics on the scientific community

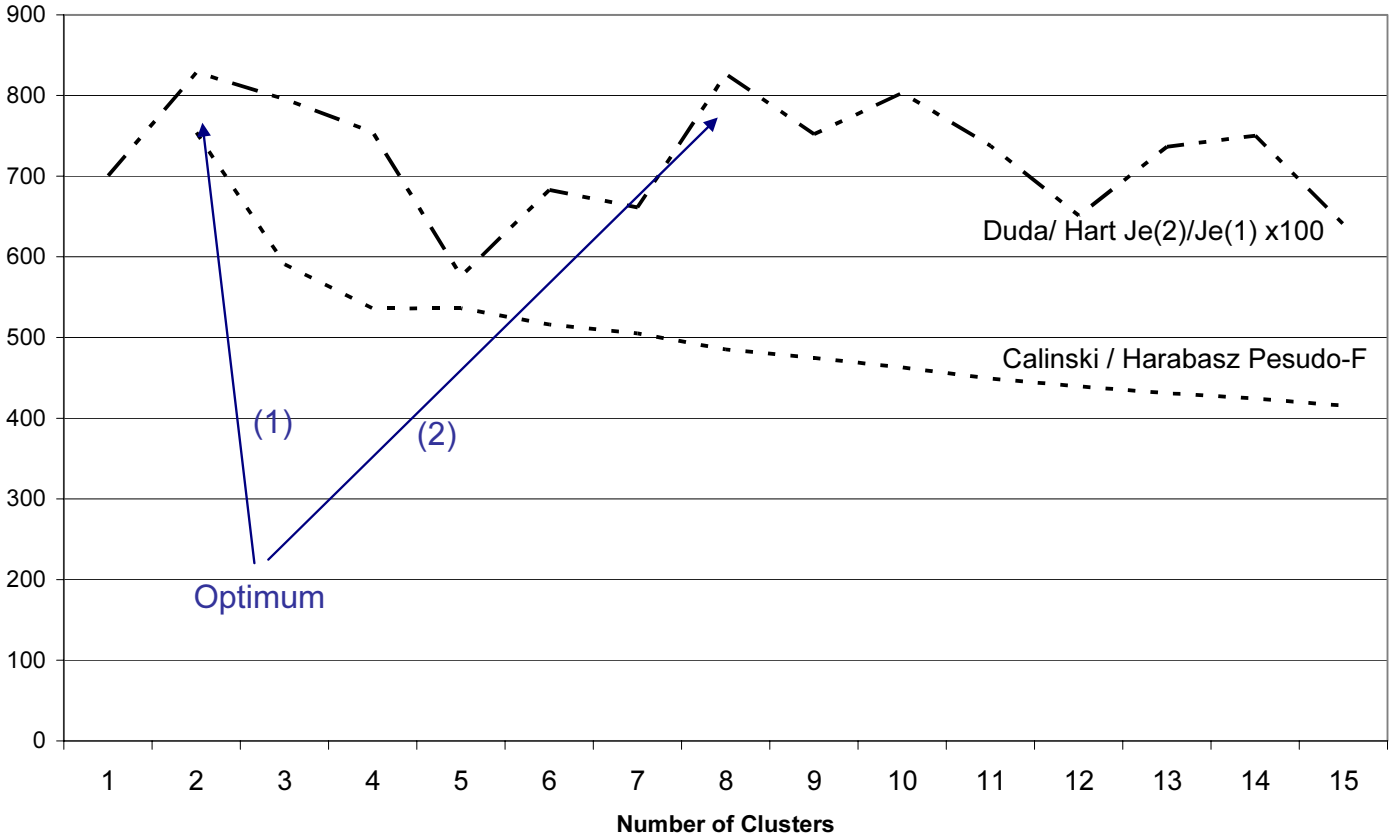
Specific problems

- Institute/group-specific *specialisation* (different profiles might cause biases)
- *Diversification* (might result in deviations from the assumed field standard)
- Avoiding "comparing apples with pears" (e.g. medical school with business school)

Specific solutions

1. Clustering institutions by publication profiles
2. Standardisation and normalisation for intra- and inter-class comparison whenever possible
3. Development of indicators for identifying the "high-impact" of research and for comparison of performance across different levels of aggregation

1. Profile clusters



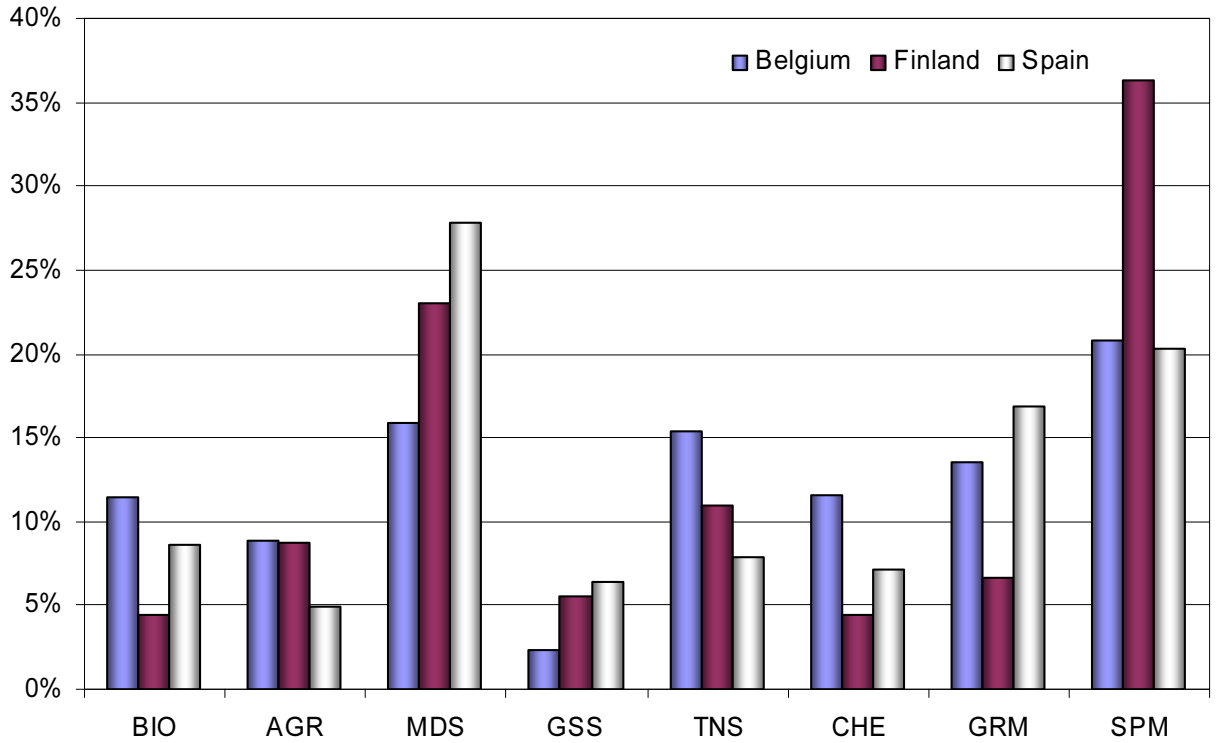
Optimum number of classes according to Duda & Hart

1. Profile clusters

The eight clusters resulting from the second optimum solution

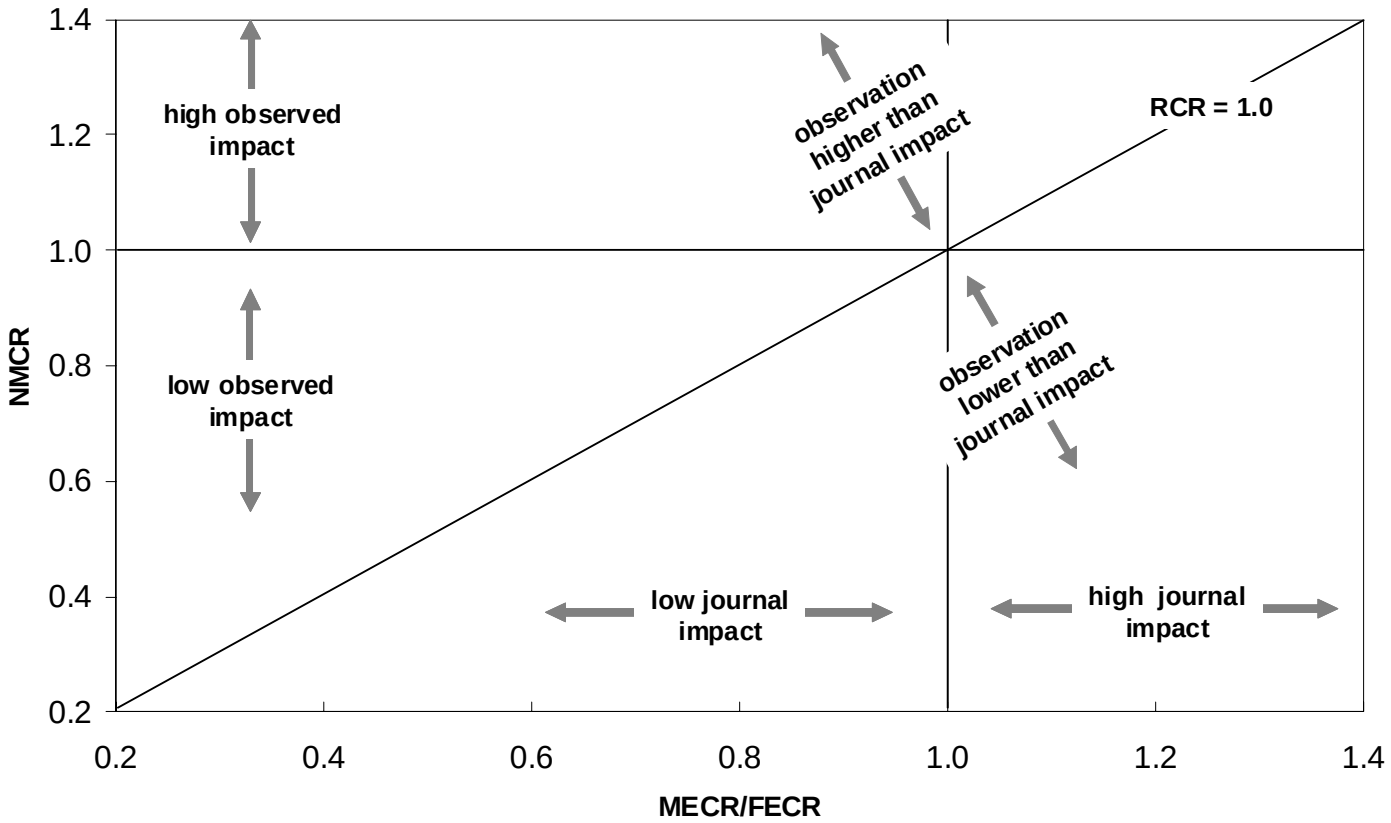
Cluster	Code
Cluster 1 (Biology)	BIO
Cluster 2 (Agriculture)	AGR
Cluster 3 (Multidisciplinary)	MDS
Cluster 4 (Geo & Space Science)	GSS
Cluster 5 (Technical & Natural Sciences)	TNS
Cluster 6 (Chemistry)	CHE
Cluster 7 (General & Research Medicine)	GRM
Cluster 8 (Specialised Medicine)	SPM

1. Profile analysis



Examples for different national cluster profiles

2. The effect of subject normalisation



Prototype of a subject-normalised relational chart plotting NMCR vs. MECR/FECR

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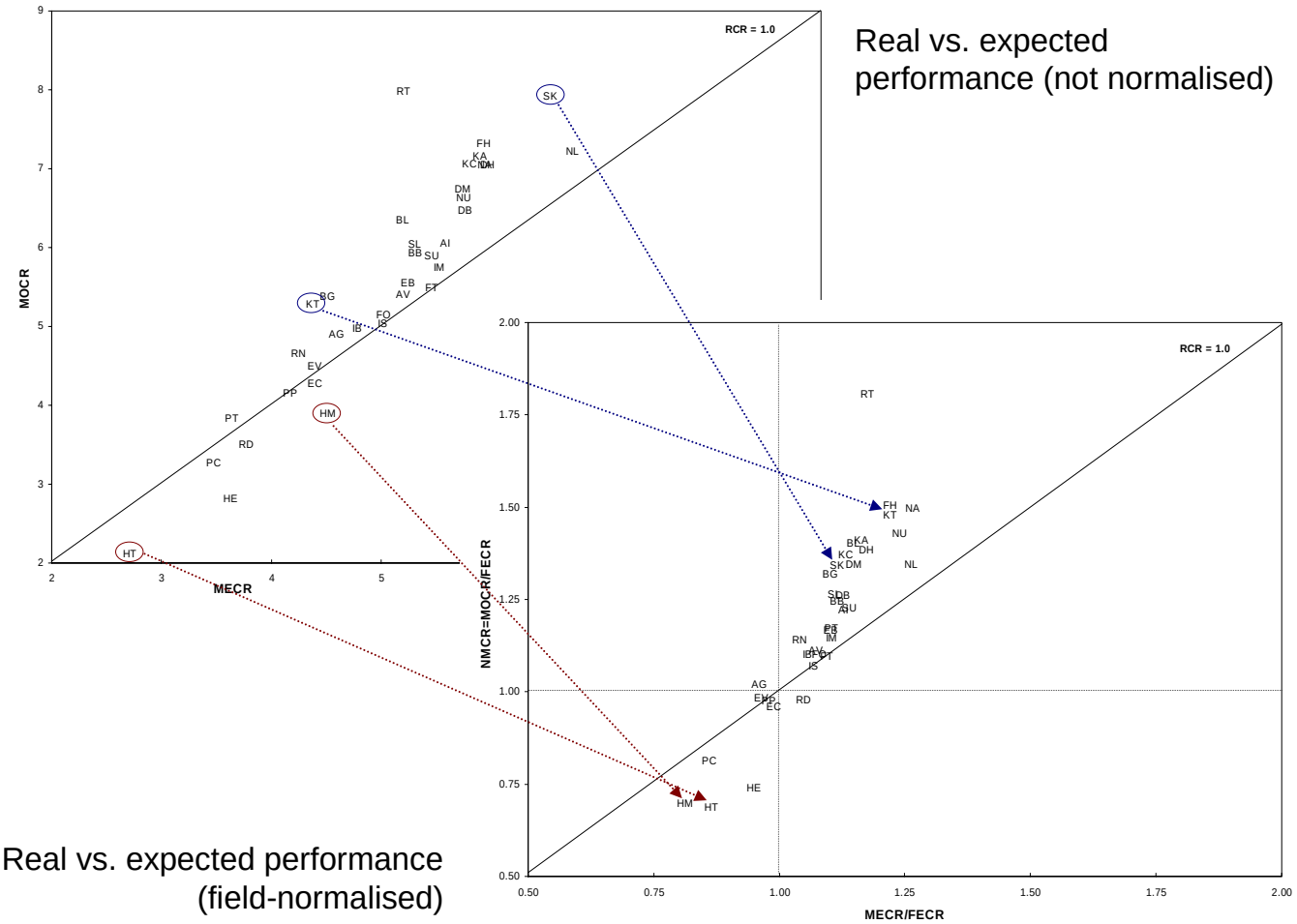

Real vs. expected performance (not normalised)

Real vs. expected performance (field-normalised)

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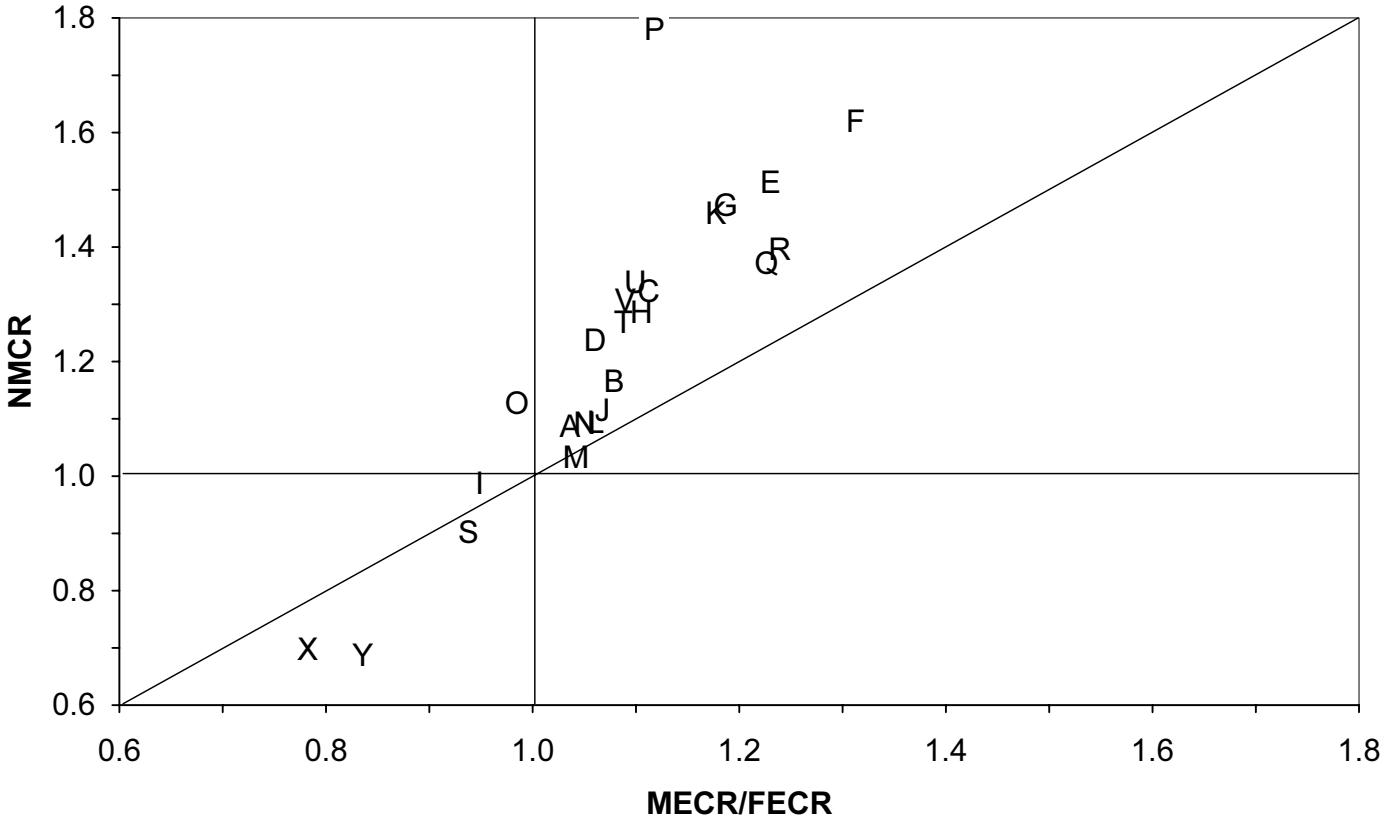

Subfield-based relational chart of expected and observed citation impact for 24 selected universities

3. Characteristic Scores and Scales

- Characteristic scores and scales (Glänzel & Schubert, 1988) provide subject-sensitive, self-adjusting thresholds for citation distributions.
- This method can be summarised as iteratively truncating samples at their mean value and recalculating the mean of the truncated sample until the procedure is stopped or the sample is empty.
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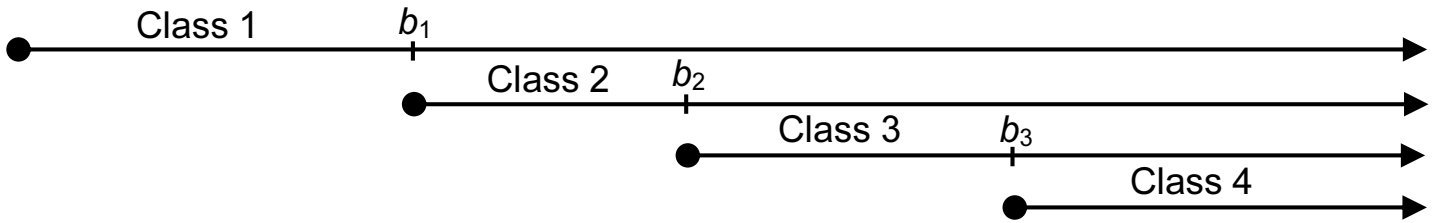

Visualisation of characteristic scores and scales for four classes

3. Characteristic Scores and Scales

- As was shown in earlier studies (e.g., Glänzel, 2007), the scores b_k are *time-dependent* and strongly *sensitive to the subject matter* but the share of papers in the individual zones is relatively stable over the citation window, and does not noticeably vary among different subfields either.
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Bibliometrics and ranking

Ranking of college and universities, has become one of the most favourite issues in the assessment of higher education institutions and thus one of the new challenges in policy-relevant evaluation.

Since the first edition of the Shanghai Jiao Tong world university ranking and the successor lists, such as the Times Higher Education Supplement - QS World University Rankings, the comparative evaluation of the quality of Education Institutions has been brought into the focus of public and policy interest.

Methodology and discussion is, however, controversal. Even the recently elaborated “Berlin principles” (2006) could not solve the problems. And, as expected, bibliometrics is part of this ranking as well.

Bibliometrics and ranking

In order to clarify the notion of *ranking*, the following comprehensible but nevertheless precise verbal definition is given.

Definition

Ranking is positioning comparable objects on an ordinal scale based on a (non-strict) weak order relation among (statistical) functions of, or a combination of functions of measures or scores associated with those objects.

Remark

These (mainly statistical) functions, which are usually called indicators. Different indicators X_i representing different aspects of quality, form the components of a composite indicator Y, being the basis of the ranking, particularly,

$$Y = \sum \lambda_i X_i \,,$$

where i $(i = 1, 2, \ldots, n)$ are n pre-defined weights. Without loss of generality, we can assume that $\sum \lambda_i = 1$.

The most problematic issues in applying composite indicators are as follows.

- The "cleanness" and hence the reliability of underlying data
- The time-variant nature of the underlying data sources
- Possible interdependence of components
- Altering weights can result in different ranking
- Methodology might result in obscure and irreproducible ranking
- Random errors of statistical functions are usually ignored
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In order to account for the complexity of university activities, two basic approaches are possible:

- The *selective ranking* focuses on measuring and ranking according to one selected activity whereas
- the *integrated* or 'holistic' ranking procedure attempts to capture the complex set of all or at least of the most important activities.

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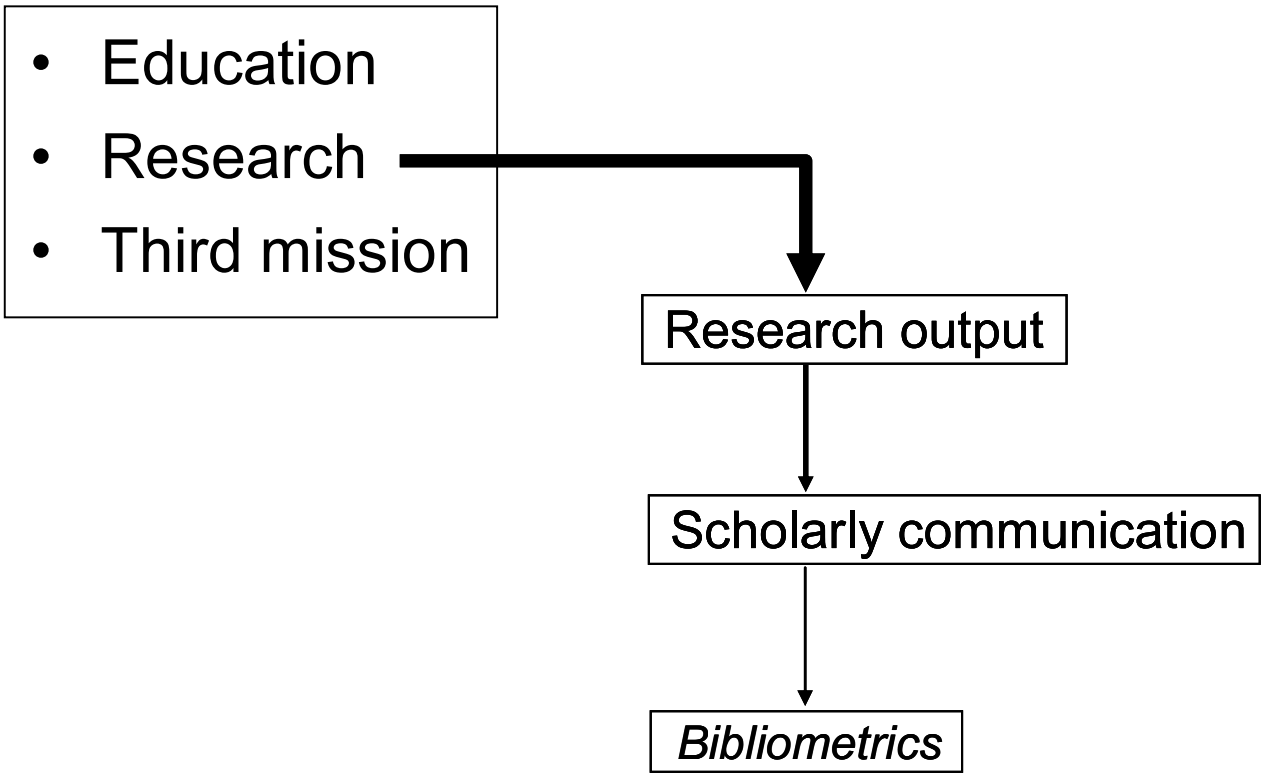
- '*Holistic approach*' The broader approach by THES-QS actually marks a new direction in university ranking, particularly, the trend towards integrated evaluation. It largely relies on peer review score. The holistic approach and a world-wide ranking based on all HEI activities, including education, research and third mission, however, remains at least for the present utopian.

  The question arises of whether there is really any need for an integrated ranking.

University activities



Function of bibliometrics in quantifying and measuring activities of HEIs

Bibliometrics and ranking

- Robustness is easily lost by building composite indicators with partially interdependent or incompatible components and arbitrary weights.
- Reality is more complex than can be described this way. Instead of any linear ranking a complex analysis is necessary to capture all aspects of performance among the manifold of a university's activities.
- Bibliometrics can contribute to evaluate at least *one* of these aspects. Standardisation and normalisation help eliminate biases and facilitate longitudinal analysis as well.
- Even normalisation of indicators cannot disguise that comparing HEIs with completely different profiles remains an exercise of 'comparing apples with oranges'.

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Conclusions and discussion

- Beyond any doubt, growing policy application turned ´little bibliometrics' into 'big bibliometrics'. However, this evolution also resulted in a clear 'perspective shift'.
- The changing shape of scientometrics can be observed world wise. New research and service centres are founded, new journals and conference series are launched. The "geographical" centre of gravity is further shifted towards East.
- This shift, in turn, has severe consequences for the field itself and the whole scientific community as well.
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Thank you very much