Methodological aspects of a new generation of relational charts for comparative assessment of citation impact

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   • Objectives – Problems – Solutions
   • Data sources and data processing

3 Methods
   • Profile analysis of research institutions
   • Field-depth for subject normalised indicators
   • Choosing the citation window

4 Normalised citation indicators
   • Measuring high impact
   • The indicator toolbox

5 Applications

6 Conclusions
Main objective of the study

Adjusting and refining bibliometric indicators for the use at the meso level
Objectives

Main objective of the study

Adjusting and refining bibliometric indicators for the use at the meso level

Challenges

- institute/group-specific specialisation (different profiles might cause biases)
- diversification (might result in deviations from the assumed field standard)
Objectives – Problems – Solutions

Problems

- Avoid “comparing apples with pears” (e.g. medical school and business school)

- Development of methodology for intra- and inter-class comparison whenever possible

- Application of consistent subject normalisation and standardisation of citation windows.

We use the methods developed in Budapest and Leuven and proceed along the following logical scheme.
Solutions

1. Classification of institutions by their publication profiles. We use multidisciplinary and specialised clusters to check normalisation for adequacy and robustness.

2. Validation of the choice of the standard citation window.

3. Measuring the high-end of research by means of subject-normalised indicators.
Solutions

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Solutions

1. Classification of institutions by their publication profiles. We use multidisciplinary and specialised clusters to check normalisation for adequacy and robustness.

2. Validation of the choice of the standard citation window.

3. Measuring the high-end of research by means of subject-normalised indicators.
Bibliographic data were taken from the Web of Science database of Thomson-Scientific (Philadelphia, PA, USA), and processed to bibliometric indicators.

Only papers of the document types article, letter, note and review indexed in the 1999-2001 volumes have been selected.

Papers were assigned to fifteen major fields in the sciences, social sciences and humanities according to the Leuven/Budapest scheme.
Profile analysis of research institutions

Profile analysis

The eight clusters resulting from the second optimum solution

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster 1 (Biology)</td>
<td>BIO</td>
</tr>
<tr>
<td>Cluster 2 (Agriculture)</td>
<td>AGR</td>
</tr>
<tr>
<td>Cluster 3 (Multidisciplinary)</td>
<td>MDS</td>
</tr>
<tr>
<td>Cluster 4 (Geo &amp; Space Science)</td>
<td>GSS</td>
</tr>
<tr>
<td>Cluster 5 (Technical &amp; Natural Sciences)</td>
<td>TNS</td>
</tr>
<tr>
<td>Cluster 6 (Chemistry)</td>
<td>CHE</td>
</tr>
<tr>
<td>Cluster 7 (General &amp; Research Medicine)</td>
<td>GRM</td>
</tr>
<tr>
<td>Cluster 8 (Specialised Medicine)</td>
<td>SPM</td>
</tr>
</tbody>
</table>
Profile analysis

Example for the deviating field structure of different clusters:

<table>
<thead>
<tr>
<th>Subfield</th>
<th>MDS</th>
<th>TNS</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>25%</td>
<td>18%</td>
</tr>
<tr>
<td>C2</td>
<td>10%</td>
<td>12%</td>
</tr>
<tr>
<td>C3</td>
<td>18%</td>
<td>6%</td>
</tr>
<tr>
<td>C4</td>
<td>23%</td>
<td>24%</td>
</tr>
<tr>
<td>C5</td>
<td>6%</td>
<td>8%</td>
</tr>
<tr>
<td>C6</td>
<td>23%</td>
<td>40%</td>
</tr>
</tbody>
</table>

Source: Thijs & Glänzel, 2008 based on WoS, Thomson Scientific

C1 - analytical, inorganic & nuclear chemistry
C2 - applied chemistry & chemical engineering
C3 - organic & medicinal chemistry
C4 - physical chemistry
C5 - polymer science
C6 - materials science

Significant deviation based on $\chi^2$-test
Profile analysis of research institutions

Profile analysis

### Major science field

<table>
<thead>
<tr>
<th>Major Science Field</th>
<th>MOCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGRICULTURE &amp; ENVIRONMENT</td>
<td>2.16</td>
</tr>
<tr>
<td>BIO SCIENCES</td>
<td>7.83</td>
</tr>
<tr>
<td>BIOMEDICAL RESEARCH</td>
<td>4.81</td>
</tr>
<tr>
<td>NEUROSCIENCES &amp; BEHAVIOR</td>
<td>5.02</td>
</tr>
<tr>
<td>CHEMISTRY</td>
<td>3.16</td>
</tr>
<tr>
<td>PHYSICS</td>
<td>3.21</td>
</tr>
<tr>
<td>ENGINEERING</td>
<td>1.42</td>
</tr>
<tr>
<td>MATHEMATICS</td>
<td>1.17</td>
</tr>
</tbody>
</table>

### ISI Subject Category

<table>
<thead>
<tr>
<th>ISI Subject Category</th>
<th>MOCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACOUSTICS</td>
<td>2.03</td>
</tr>
<tr>
<td>OPTICS</td>
<td>2.42</td>
</tr>
<tr>
<td>PHYSICS, FLUIDS &amp; PLASMAS</td>
<td>3.09</td>
</tr>
<tr>
<td>PHYSICS, CONDENSED MATTER</td>
<td>2.75</td>
</tr>
<tr>
<td>PHYSICS, NUCLEAR</td>
<td>2.94</td>
</tr>
<tr>
<td>PHYSICS, PARTICLES &amp; FIELDS</td>
<td>4.89</td>
</tr>
<tr>
<td>PHYSICS, MATHEMATICAL</td>
<td>2.61</td>
</tr>
<tr>
<td>PHYSICS, ATOMIC, MOLECULAR &amp; CHEMICAL</td>
<td>4.41</td>
</tr>
</tbody>
</table>

Different (sub)field standards of citation impact
SOOI subfields

Plot of NMCR based on subfields vs. ISI Subject Categories for 676 European institutions

\[ y = 1.011x \]
\[ R^2 = 0.971 \]
SOOI major fields

Plot of NMCR based on major fields vs. subfields for 676 European institutions
Multidisciplinary vs. specialised clusters

NMCR based on subfields (left) and major fields (right) vs. ISI Subject Categories
Choosing the citation window

Citation window

Plot of NMCR based on 5-year citation window vs. 3-year window for 676 European institutions
Characteristic scores and scales 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.

\[ b_k = E(X | X > b_{k-1}) \] with \( b_0 := 0 \).
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Measuring high impact

Characteristic Scores and Scales – Definition

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\[ b_k = E(X|X > b_{k-1}) \] with \( b_0 := 0. \)
For Paretian distributions we have

\[ b_k \approx \frac{\alpha}{\alpha - 1} \cdot b_{k-1} + b_1, \]

where \( \alpha \) is the parameter of the underlying Pareto distribution.

The choice of \( \alpha = 2 \) results in \( b_2 = 3 \cdot b_1 \) and \( b_3 = 7 \cdot b_1 \) for the thresholds \( k = 2 \) and \( k = 3 \), respectively.

The citation impact of each individual paper is compared with the three-fold or seven-fold of the corresponding subject standard, according as \( k = 2 \) or \( k = 3 \) is chosen.
Measuring high impact

Characteristic Scores and Scales – Properties

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The indicator toolbox

Observed citation impact

- Observed citation rates
  - Mean Observed Citation Rate (MOCR)

\[ MOCR = \frac{\sum_{i=1}^{n} c_i}{n} \]
Expected citation impact

- Expected citation rates
  - Mean Expected Observed Citation Rate (MECR)
    \[ MECR = \frac{\sum_{i=1}^{n} x_i}{n} \]
  - Field Expected Citation Rate (FECR)
    \[ FECR = \frac{\sum_{i=1}^{n} f_i}{n} \]
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Relative citation impact

- Relative citation rates
  - “Publication Strategy” (MECR/FECR)
  - Normalised Mean Citation Rate (NMCR)

\[
NMCR = \frac{MOCR}{FECR} = \frac{\sum_{i=1}^{n} c_i}{\sum_{i=1}^{n} f_i}
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- Relative Citation Rate (RCR)

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High-impact indicators

- High-impact Activity is the ratio of the unit’s share of highly cited papers in all papers and the corresponding world standard.
- High-impact Atractivity is the ratio of the unit’s share of citations attracted by its highly cited papers in all citations received by the unit under study and the corresponding world standard.

Indicators based on characteristic scores and scales are sub-field normalised by definition, and can therefore be used as direct supplement to the previous set of relative indicators.
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Prototype of a subject-normalised relational chart plotting NMCR vs. MECR/FECR
The effect of subject normalisation

Glänzel & Debackere

Real vs. expected performance (not normalised)

Real vs. expected performance (field-normalised)
Measuring high-impact activity and attractivity

Relational chart of high-impact activity and attractivity for 24 selected universities
Conclusions and discussion

- Normalised indicators are highly necessary if one does not want to compare “apples” and “pears”.

- The level of 60 subfields proved an acceptable choice and provided stable and consistent results.

- The normalised indicators can be used for both intra- and inter-cluster comparative analysis as well as for domain studies at this level of aggregation.
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In addition to the relative citation indicators, the high-end of institutional research is best reflected by highly cited papers. Two thresholds are suggested, depending on the underlying publication output.

The study has also shown that the use of a three-year citation window suffices for building both relative and high-impact citation indicators.
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