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# EDITORIAL

## Board Meeting News

Dear Society Members,
Many of you know, from personal experience, that the 12th ISSI conference was a big success. Colleagues Jacqueline Leta, Abel Packer, Sonia Vasconselos, Elenice de Castro and their team members did a splendid job, making this conference one of the more pleasant ones. Thanks again to all our Brazilian colleagues. Of course, we organize *scientific* conferences, hence lectures, presentations, personal and professional contacts are at least equally important. I am convinced that most of you are very satisfied with these aspects too.

In what follows, I would like to inform you about some important decisions that have been taken at our Board meeting in Rio de Janeiro. First, we have confirmed that the next ISSI conference (2011) will be held in Durban (South Africa), supported by six national universities and South Africa's National Science Council. Local conference organizers are Dennis Ocholla and Daisy Jacobs. During the board meeting in Rio we also decided that the 2013 conference will be held in Vienna, giving the organizers ample opportunity to obtain funding from different sources. I am sure you all know that the proceedings of the 1999 (Colima), 2001 (Sydney), 2005 (Stockholm) and 2007 (Madrid) are incorporated in the Web of Science. We have contacted Thomson Reuters to assure that also the proceedings of the 2003 (Beijing) and 2009 (Rio de Janeiro) conferences will be included. Recall that the 2003, 2005 and 2007 proceedings are already freely available for members at the ISSI website. In a few months also the ISSI 2009 proceedings will become

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# EDITORIAL BOARD

available. Make sure to take advantage of this opportunity (and afterward cite your colleagues appropriately). In addition, we have launched a series of Festschrifts which are freely available for everybody. So far the Festschrifts for Tibor Braun (2007) and Olle Persson (2009) have appeared.

ISSI joined the Global Alliance, an initiative of ASIS&T. The goal of this alliance is (quoting from the proposed guidelines): to create a common space in which national and international scholarly and professional not-for-profit societies active in whole or part of the broad field of information sciences, technologies and services will be able to:

- jointly offer an attractive image to prospective entrants in the information professions
- facilitate the sharing of public information resources
- facilitate the identification and implementation of joint activities
- facilitate for their members exposure to international activities and resources and international networking
- therefore better respond to the needs of their members with regard to the growing importance of the international dimensions of the field.

The joint ASIS&T - ISSI pre-conference on informetrics to be held in Vancouver (Canada) on November 7, 2009, is an excellent example of the type of collaboration aimed at by the Alliance.

One last point: we, the president and the secretary-treasurer, have sometimes problems reaching you. Could you, please, send us an e-mail message (then we are sure that we have a correct e-mail address) including, if possible, a back-up address. Thanks in advance.

Friendly greetings,

Ronald Rousseau, President ISSI
ronald.rousseau@khbo.be

# 12TH INTERNATIONAL CONFERENCE OF THE INTERNATIONAL SOCIETY FOR SCIENTOMETRICS AND INFORMETRICS

## RIO DE JANEIRO, BRAZIL (JULY 14-17)

### Conference Report by Jacqueline Leta

The 12th International Conference of the International Society for Scientometrics and Informetrics (ISSI 2009), hold at the Federal University of Rio de Janeiro, Brazil, ends under a positive evaluation in terms of scientific program, participation, social events, venue and city.

During the four days of Conference, participants have experienced an extensive and dense scientific program. On the first day, which encompassed three workshops and the doctoral forum, ten PhD students and seven senior researchers discussed the students' projects. As for the other three days, the program comprised two keynotes, 23 thematic sessions, where 74 full papers and 22 research-in-progress papers were presented, as well as a poster session with 57 presentations. In all, the scientific program with its amazing number of presentations proved a high level forum for addressing and sharing new ideas, information and knowledge on the evolution and state-of-the-art of the worldwide research in Bibliometrics and Scientometrics.

Comparing with previous Conferences, ISSI 2009 has not only brought together the largest number of participants ever but it also appeared to be the most international one. Among the 230 participants, 70 were from Brazil while 160 participants came from 39 other countries. As for the country of the corresponding author of accepted papers (n=103), Brazil has still

Opening *(photo by Zsuzsanna Glänzel)*

Doctoral forum *(photo by Alex Salim)*

Poster session *(photo courtesy of BIREME)*

Price award ceremony *(photo by Zsuzsanna Glänzel)*

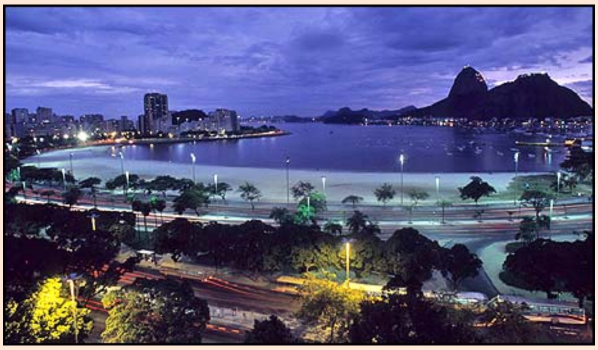
Main entrance of the university *(photo by Alex Salim)*

Music by Turibio Santos & his band *(photo by Alex Salim)*

Networking *(photo courtesy of BIREME)*

Closing ceremony *(photo courtesy of BIREME)*

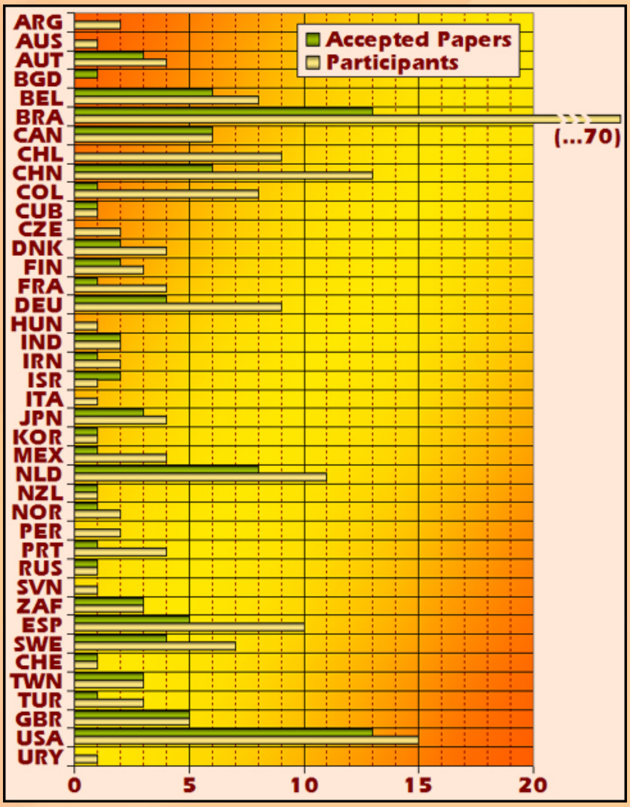
Sugar Loaf Mountain *(photo by Zsuzsanna Glänzel)*



Rio de Janeiro *(photo by Alex Salim)*

prevailed (see Figure 1) but also authors from other 38 countries have submitted and/or presented their paper at the Conference. Such international diversity could easily be noted either during the sessions or at the coffee-break. It was a clear indication that the research in the field is widespread in all continents.

The social program started in the evening of July 14. Just after the opening ceremony, participants could join the cocktail as well as enjoy the guitar of one of the best Brazilian musicians, Turibio Santos. Turibio was accompanied by four young musicians; all of them had taken part of a social project (carried out and supported by Turibio) that aims at giving formal music lessons to young people from poor communities. On July 15, the visit to Sugar Loaf, which was very close to the Conference venue, was canceled because of bad weather conditions. Nevertheless, those who wanted to join in this venture anyway could appreciate the beauty of Rio de Janeiro. The dinner party was scheduled for July 16. Participants have tasted the Brazilian cuisine as well as *caipirinha*, the most famous Brazilian drink. As some of them have expressed: "This was the best ISSI party of all". As a final social event, just after the closing ceremony, participants could attend the stirring performance presented by a Brazilian children's choir.




The ISSI 2009 venue, one of the most charming places of the Federal University of Rio de Janeiro, was located in a fascinating and secure neighborhood very close to Sugar Loaf Mountain and in front of the Rio de Janeiro Yacht Club. Thus, participants could enjoy both the splendor of the neoclassical architecture of the venue's building and the fresh air and green nature of the area. This perfect combination has been much appreciated by the participants.

Despite the city's social problems, none of the participants have reported any kind of problems regarding violence during the days of the Conference. On the other hand, most of them have expressed their fascination with the city's beauties and inhabitants. Definitely, the "Cidade Maravilhosa" ("The Marvelous City"), the nickname for Rio de Janeiro, with its stunning landscape and friendly atmosphere has contributed to the success of the ISSI 2009.

In all, ISSI 2009's scientific and social program, the venue and city have facilitated the creation and the strength of networks among individuals, groups and institutions. This is of a special interest, if we consider the international nature of the conference, where 230 participants from 40 countries could share their experiences in our field and launch genuine cooperation.

Hence, during and after the conference I have received many messages from participants indicating what memorable and rewarding experience the ISSI 2009 in Rio was. Such feeling has also appeared in Jane M. Russell's words in the closing ceremony: "I know we all want to join in the words of thanks to the local organizing committee for making this successful and enjoyable conference and experience. I think we all realized how much work it takes to get these conferences together. We are all very happy; we will leave this city with very happy memories of the conference, of Rio and Brazil".

As one of the organizers, I am, of course, much proud of all these manifestations. My feeling is that we – organizers – have done our best to organize the Conference and we were successful. Now, let's start a new stage and contribute to the success of the next ISSI Conference to be held in South Africa!

I cannot end this brief report without thanking Wolfgang Glänzel, Birger Larsen and Sonia Vasconcelos for the friendship and for all the support on the daily issues regarding the conference and one special thanks to Alex Salim, my husband, who was always standing by me.

## CONFERENCE CALL

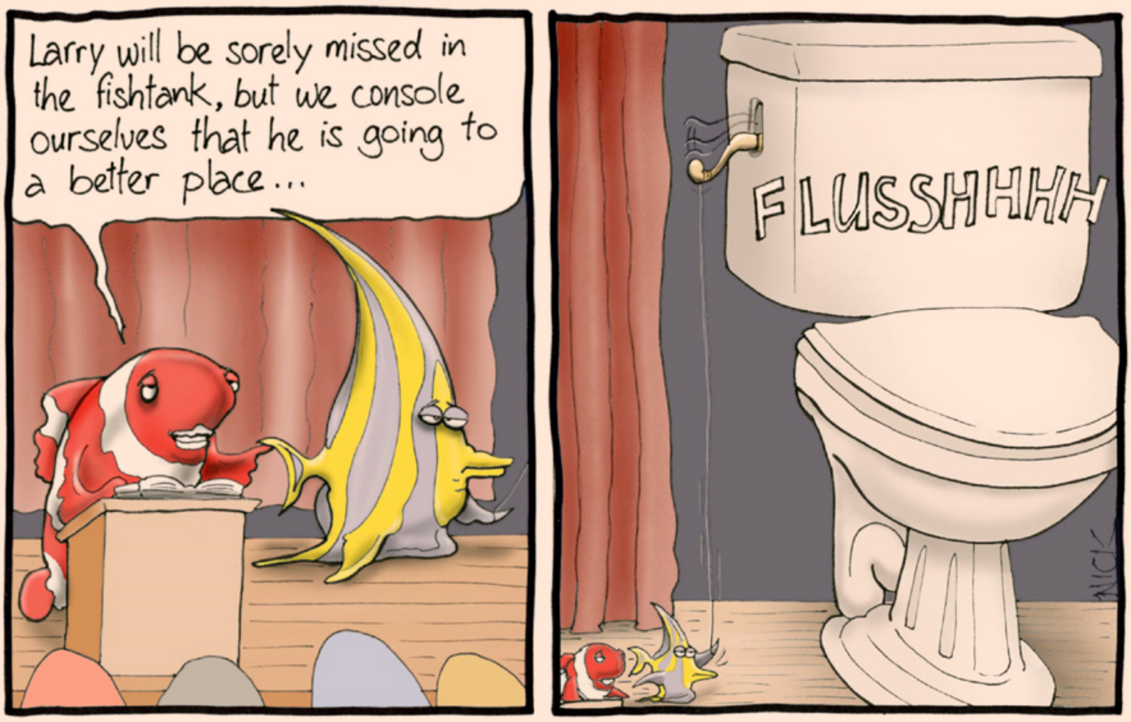
The Canadian Association for Information Science (CAIS/ACSI) calls for papers for its 2010 conference entitled *Information Science: Synergy through Diversity*. The conference will be held in Montreal, Canada, from 2 to 4 June 2010.

Papers dealing with any aspect of information and library science are warmly invited. Visit the conference website for more information: http://www.cais-acsi.ca/cfp2010.htm

## NEWS

A few month ago ISSI launched a new service: ISSI members were given access to the online versions of proceedings volumes of the latest ISSI conferences. Thanks to the fast (nevertheless thorough) postprocessing and editing work of Birger Larsen, the online proceedings volumes of the 2009 ISSI conference have already become available here (enter your usual ISSI username and password): http://www.issi-society.info/proceedings/

## CARTOON

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# A SIMPLE ALTERNATIVE TO THE H-INDEX


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## Introduction

Within a short period of time, the *h*-index proposed by Hirsch (2005) has become a very popular bibliometric performance indicator. The following properties of the *h*-index seem to be the main reason for its popularity:

- The *h*-index is relatively insensitive to large numbers of lowly cited publications.
- The *h*-index is relatively insensitive to a few very highly cited publications.
- The calculation of the *h*-index is easy to understand.

Researchers have also identified various weak points of the *h*-index. Most of these weak points can be dealt with relatively easily without the need to abandon the basic ideas underlying the *h*-index. This has resulted in a large number of *h*-index variants (for an overview, see Egghe, in press). In this paper, we focus on a more fundamental problem of the *h*-index. We refer to this problem as the problem of inconsistency. The problem of inconsistency cannot be solved by introducing yet another variant of the *h*-index. In fact, the problem is shared by all *h*-index variants. However, there turns out to be a very simple (and well-known) indicator that has similar properties as the *h*-index and that does not suffer from the inconsistency problem. We argue that the use of this indicator is preferable over the use of the *h*-index.

## The problem of inconsistency

To illustrate the problem of inconsistency, consider the following example. Suppose that researchers A and B both have four publications. Researcher A has three publications with five citations each and one publication with zero citations. Researcher B has four publications with four citations each. Suppose next that researchers A and B both achieve the same performance improvement. More specifically, suppose that they both obtain two new publications with five citations each. Researcher A's *h*-index then increases from three to five, while researcher B's *h*-index remains equal to four. This means that the ranking of researchers A and B relative to each other has reversed. Initially researcher A was ranked below researcher B, but after adding the new publications the situation is exactly the other way around. We regard this as a highly undesirable outcome. Researchers A and B have both achieved the same performance improvement, but despite of that their ranking relative to each other has reversed. In our opinion, this is unnatural and very difficult to justify.

Because of the above problem, we call the *h*-index an inconsistent indicator (for a formal definition of the notion of consistency, see Waltman and Van Eck, 2009). The inconsistency problem of the *h*-index has also been recognized by Marchant (2009a, 2009b; see also an earlier contribution to the *ISSI Newsletter* by Rousseau, 2008). Marchant (2009a, p. 335) concludes that because of the inconsistency problem "the ranking based on the *h*-index is in many circumstances probably not reasonable". We fully agree with this conclusion.

The following example provides another illustration of the inconsistency problem of the *h*-index. Suppose that the *h*-index is used to compare the performance of two research groups, research group A and research group B. Research group A consists of five researchers. Each researcher in research group A has five publications with five citations each. Hence, in total research group A has 25 publications with five citations each. Research group B also consists of five researchers. Each researcher in research group B has two publications with ten citations each and three publications with zero citations each. Hence, in total research group B has ten publications with ten citations each and fifteen publications with zero citations each. It is clear that each researcher in research group A has an *h*-index of five while each researcher in research group B has an *h*-index of two. This means that according to the *h*-index each researcher in research group A outperforms each researcher in research group B. Based on this result, it seems natural to expect that research group A as a whole outperforms research group B as a whole. However, this is not the case. Research group A has an *h*-index of five, while research group B has an *h*-index of ten. Hence, the *h*-index indicates that research group A is outperformed by research group B rather than the other way around. This means that the *h*-index calculated at the level of research groups contradicts the *h*-index calculated at the level of individual researchers. We regard this as a rather odd result.

## An alternative indicator

To avoid the problem of inconsistency, we propose a simple alternative to the *h*-index. This alternative is the number of highly cited publications, that is, the number of publications for which the number of citations exceeds a certain threshold. The number of highly cited publications is a well-known indicator (e.g., Plomp, 1990) that has a number of similar properties as the *h*-index, namely insensitivity to large numbers of lowly cited publications, insensitivity to a few very highly cited publications, and an easy-to-understand calculation. There is one very important difference between the highly cited publications (HCP) indicator and the *h*-index. This difference is that unlike the *h*-index the HCP indicator does not suffer from the problem of inconsistency (Waltman and Van Eck, 2009; see also Marchant, 2009a). Because of this difference, we believe that the use of the HCP indicator is preferable over the use of the *h*-index.

In his proposal for the *h*-index, Hirsch (2005) also discusses the possibility of using the number of highly cited publications as a bibliometric performance indicator. According to Hirsch, the HCP indicator has a significant disadvantage. This disadvantage is that the threshold for determining what counts as highly cited and what does not "is arbitrary and will randomly favor or disfavor individuals" (Hirsch, 2005, p. 16569). We agree with Hirsch that this is a weak point of the HCP indicator. However, unlike what Hirsch claims, the *h*-index has a similar weak point. As we all know, the *h*-index is defined as follows: A researcher has *h*-index $h$ if $h$ of his $n$ publications have at least $h$ citations each and the other $n - h$ publications have fewer than $h + 1$ citations each. This definition involves some arbitrariness because the *h*-index could equally well have been defined in, for example, the following way: A researcher has *h*-index $h$ if $h$ of his $n$ publications have at least $2h$ citations each and the other $n - h$ publications have fewer than $2(h + 1)$ citations each. Or the following definition of the *h*-index could have been given: A researcher has *h*-index $h$ if $h$ of his $n$ publications have at least $h / 2$ citations each and the other $n - h$ publications have fewer than $(h + 1) / 2$ citations each. Hirsch does not provide any argument why his definition of the *h*-index would be better than alternative definitions such as those given above. Because of this, the way in which Hirsch defines the *h*-index is somewhat arbitrary (Van Eck and Waltman, 2008). The arbitrariness of the definition of the *h*-index is also pointed out by Lehmann, Jackson, and Lautrup (2006, 2008), who note that the *h*-index is based on a comparison of two quantities that have different units (publications vs. citations). Because not only the use of the HCP indicator involves arbitrariness but the use of the *h*-index does so as well, we do not agree with

Hirsch that arbitrariness is a good reason to reject the HCP indicator in favor of the *h*-index.

A related issue has to do with differences among scientific fields. In the case of the HCP indicator, it is best to use different citation thresholds for different fields. In this way, one can take into account that on average publications in, for example, biochemistry receive many more citations than publications in, for example, mathematics. Of course, the use of different citation thresholds for different fields makes the application of the HCP indicator somewhat more complicated. To choose an appropriate threshold for a field, one needs to have some knowledge of the citation distribution that characterizes the field. It might be argued that the *h*-index has the advantage that it does not require any knowledge of citation distributions. In our opinion, however, this is not really an advantage of the *h*-index. It is simply a consequence of the fact that the *h*-index does not take field differences into account. If one wants to adapt the *h*-index in such a way that field differences are taken into account, one inevitably needs to have some knowledge of the citation distributions by which different fields are characterized (e.g., Radicchi, Fortunato, and Castellano, 2008). In this respect, the *h*-index does not differ from the HCP indicator.

## Conclusion

The *h*-index and the HCP indicator have quite similar properties. However, the *h*-index suffers from a fundamental problem, namely the problem of inconsistency. Because the HCP indicator does not suffer from this problem, we consider the use of this indicator preferable over the use of the *h*-index. The use of the HCP indicator indeed involves some arbitrariness, as noted by Hirsch (2005), but the same holds for the use of the *h*-index. Arbitrariness is therefore not a valid argument for rejecting the HCP indicator in favor of the *h*-index.

## Acknowledgment

We thank an anonymous referee for various comments on an earlier draft of this paper.

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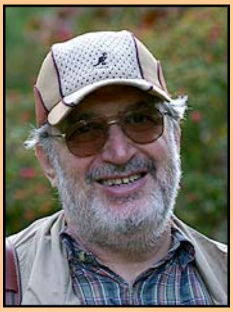
# ERRATUM

Dear Reader, due to a technical error, pages of the ISSI e-Newsletter's previous (18th) issue were numbered incorrectly. The wrong page numbers have been replaced and the new version has been uploaded to the ISSI website. Please, download the file again, overwrite the old version and **please, use the correct page numbering when citing any article**.
We apologise for the inconvenience caused.

# MULTI- AND INTER-DISCIPLINARITY IN MEDICAL AND VETERINARY LITERATURE: APPROACHES AND ASSERTIONS



András Schubert
MTA-KSZI, Budapest

**Significance of multidisciplinarity**

The significance of inter- and multidisciplinary research cannot be overestimated in the 21st century science. It is emphatically present in the basic documents of several major science policy agencies:

"Interdisciplinary research (IDR) can be one of the most productive and inspiring of human pursuits – one that provides a format for conversations and connections that lead to new knowledge." (COSEPUP, 2004)

"Interdisciplinary research integrates the analytical strengths of two or more often disparate scientific disciplines to create a new hybrid discipline. By engaging seemingly unrelated disciplines, traditional gaps in terminology, approach, and methodology might be gradually eliminated." (OPASI, 2006)

"Multidisciplinary research takes place at the edges of traditional disciplines and across traditional subject boundaries. The Research Councils believe that novel multidisciplinary research is needed to solve many, if not all, of the next decade's major research challenges." (Research Councils UK, 2006)

In academic discourse and practice, there are four realms to which the term "interdisciplinarity" is most commonly applied (Braun & Schubert, 2003). *Interdisciplinary knowledge* involves familiarity with distinctive components of two or more disciplines. Interdisciplinary knowledge is a necessary, but not sufficient, condition for *interdisciplinary research*: combining distinctive components of two or more disciplines while searching or creating new knowledge, operational procedures, or artistic expressions.

*Interdisciplinary education* merges distinctive components of two or more disciplines in a single program of instruction. *Interdisciplinary theory* takes interdisciplinary knowledge, research, or education as its main objects of study.

The degree of interdisciplinarity in any realm may vary, of course. The degree of interdisciplinary integration is characterized according to four criteria (Weingart & Stehr, 2000):

- the number of disciplines which are involved;
- the degree of similarity between them (e.g., mathematics and physics are similar, molecular genetics and electronics are less similar);
- the novelty and creativity involved in the combination, and
- the degree of integration.

**Possibilities of scientometrics in studying multidisciplinarity**

Scientometrics has unique possibilities both in the quantitative characterization and in the impact assessment of inter- and multidisciplinary research.

- Multidisciplinarity can be studied on different objects and levels
  - Researchers, research groups, institutions
  - Research areas, subfields, fields
  - Papers, journals, etc.

- Multidisciplinarity can be characterized by
  - Use of specific keywords
  - Collaboration of authors, institutions from various disciplines
  - Publication in journals from various disciplines
  - Citing references from various disciplines
  - Being cited by papers from various disciplines
- The impact of multidisciplinary works can be assessed, e.g., by their citation rate as compared to the average of the respective discipline(s)

**"Multidisciplinarity in title"**

In a recent publication (Braun & Schubert, 2007), the occurence of the words "interdisciplinarity" and "multidisciplinarity" has been studied in the titles of scientific and scholarly publications (6183 papers between 1975–2006).

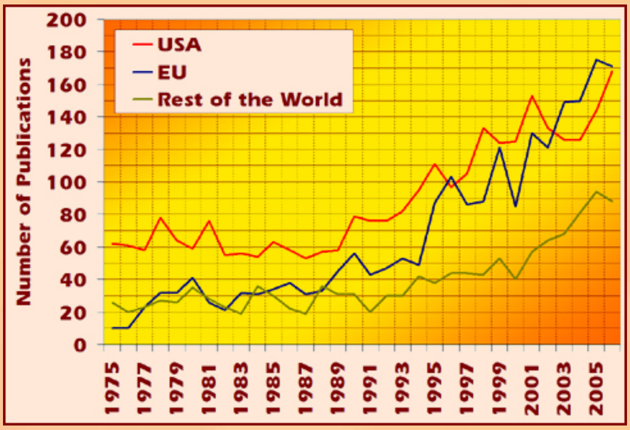



*Figure 1* Number of publications with "interdisciplinarity" or "multidisciplinarity" in their titles (Source: Thomson WoS, SCI & SSCI)

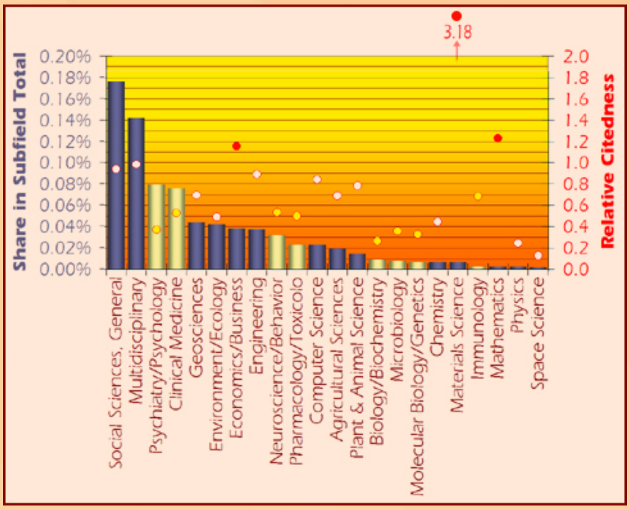



*Figure 2* Relative weight of "multi" papers by subfields. (Source: Thomson WoS; both publications and citations were counted for the period 1996-2006; ESI subfield categorization was used.)

Among the major regions of the world, Europe appears to be the most dynamically growing.

The weight of "multi" papers can be assessed by comparing their number and citation rate to the subfield totals/averages. Health related subfields are shaded in Figure 2 in yellow. Strikingly, only on 3 of the 22 subfields "multi" papers attracted higher citation rate than the subfield average.

**"Institutional multidisciplinarity" and "reference multidisciplinarity": case studies in dentistry, surgery and veterinary medicine**

In what follows, multidisciplinarity in three medical subfields are studied in greater detail:

- dentistry
- surgery
- veterinary medicine

Three samples of 1000 papers published in 2003 were taken from journals having the stems "DENT", "SURG" and "VETERIN" in their titles, respectively. For each sample, three criteria of multidisciplinary were considered:

- "keyword multidisciplinarity": special keywords in title, abstract, etc.
- "institutional multidisciplinarity": off-disciplinary co-authoring institutions
- "reference multidisciplinarity": off-disciplinary references

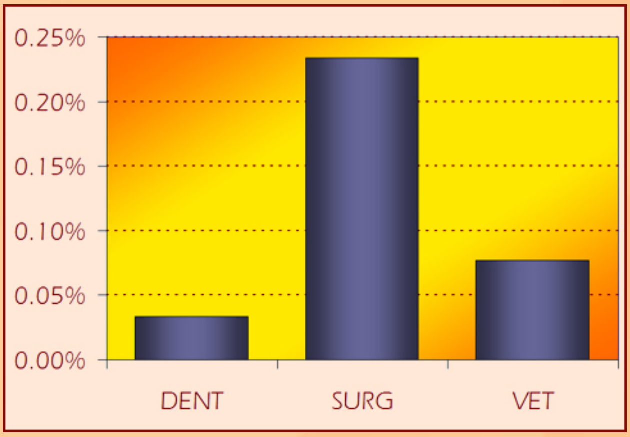



*Figure 3* "Keyword multidisciplinarity" of dentistry (DENT), surgery (SURG) and veterinary medicine (VET). (Source: Thomson WoS, 1975-2007.)

In Figure 3, "keyword multidisciplinarity" of the three subjects fields is shown: inter- and multidisciplinarity were searched as key terms in the title, abstracts and keywords of the papers.

"Institutional multidisciplinarity" is measured by the share of off-disciplinary institutions among the affiliations of the co-authors (Figure 4). A

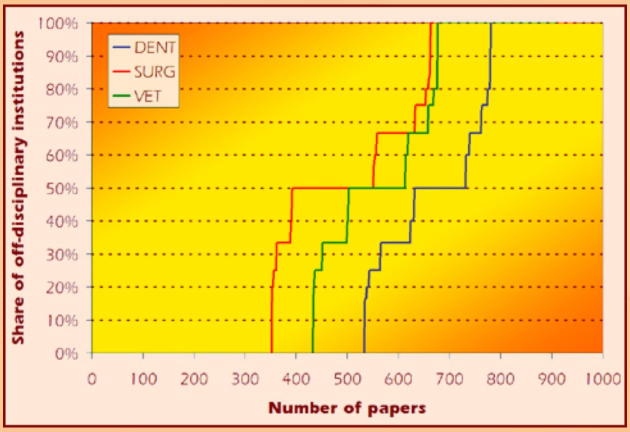



*Figure 4* "Institutional multidisciplinarity" of dentistry (DENT), surgery (SURG) and veterinary medicine (VET). (Source: Thomson WoS, 1975-2007.)

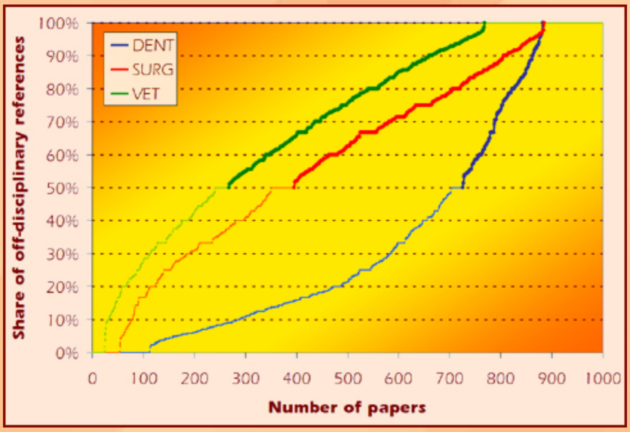



*Figure 5* "Reference multidisciplinarity" of dentistry (DENT), surgery (SURG) and veterinary medicine (VET). (Source: Thomson WoS, 1975-2007.)

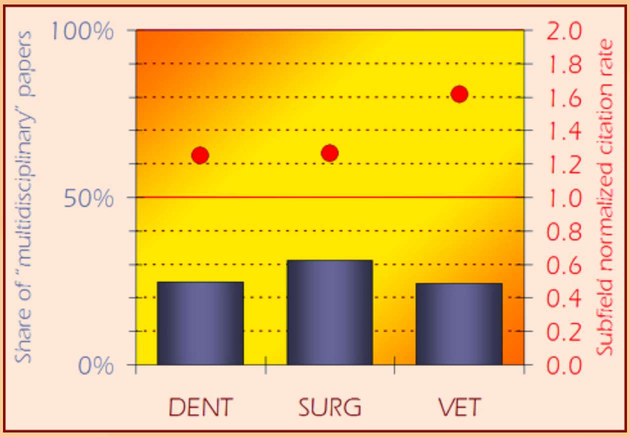



*Figure 6* Subfield shares of "institutional multidisciplinarity" and its effect on citation impact (Source: Thomson WoS; publication year: 2003; citations were counted for the period 2003-2007.)

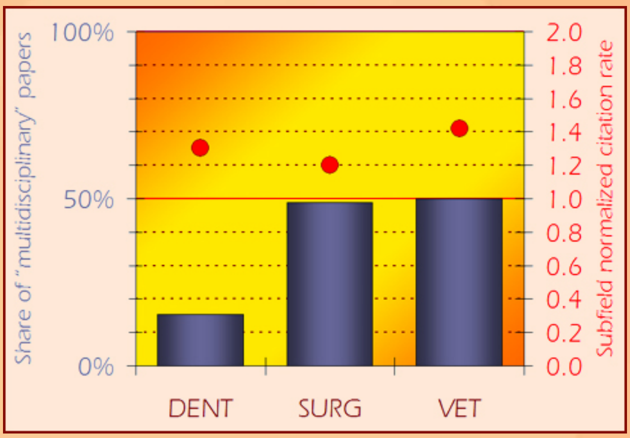



*Figure 7* Subfield shares of "reference multidisciplinarity" and its effect on citation impact (Source: Thomson WoS; publication year: 2003; citations were counted for the period 2003-2007.)

paper is considered "institutionally multidisciplinary" if at least one (but not all) of the contributing institutions is off-discipline.

"Reference multidisciplinarity" is measured by the share of off-disciplinary references in the bibliography of a paper (Figure 5). A paper is considered multidisciplinary in this respect if more than 50% (but not all) of the cited references are off-discipline.

As it was mentioned in connection with Figure 2, in spite of the emphasized interest in multi- and interdisciplinary papers, "keyword multidisciplinarity" does not attract above-average citation rates. The situation is dramatically different if "institutional multidisciplinarity" or "reference multidisciplinarity" are considered (Figures 6 and 7).

### Subfield shares of "institutional multidisciplinarity" and its effect on citation impact

The results suggest that actual multidisciplinarity (as reflected in institutional co-operations or cross-disciplinary references) is more effective in attracting wider interest than using it as advertising slogan in the title of publications.

## Summary and conclusions

- Scientometrics has various effective tools to assess the extent and impact of multi- and interdisciplinarity. It can be asserted that both are remarkable and are constantly growing.
- Among the three medical subfields studied in detail, dentistry shows the lowest, surgery the highest level of multidisciplinarity, the latter successfully challenged by veterinary medicine in "reference multidisciplinarity".
- The citation impact of papers with higher "institutional" or "reference" multidisciplinarity is definitely higher than the subfield average. This is not the case for "keyword multidisciplinarity", suggesting that, among others, multidisciplinarity is also more effective if practiced than if just talked about.

## Acknowledgements

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RESEARCH FOCUS: EUROPE

# SCIENCE IN A CHANGING EUROPE: EAST VS. WEST

## NATIONAL SCIENTIFIC PROFILES BY SUBJECT FIELDS


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■ **Abstract:** In the end of the twentieth century, Europe underwent major geopolitical changes. Our study is devoted to investigate whether the effect of these political, economical and social changes made on the scientific landscapes of the countries in question is visible and measurable by scientometric indicators. The study also draws up a parallel in this regard between countries joined the European Union earlier and recently.


### 1. Introduction

In 2002, when this project was started up, Europe's geo-political map was still different from the one we use nowadays. Politicians were talking about the challenge of the *forthcoming* expansion of the European Union. After long-lasting accession talks and preparations, on the first of May 2004 ten new member countries – mainly from Central & Eastern Europe – joined the EU. Although the economical, political and social differences to be bridged were, of course, still huge, after several decades of political split, Eastern and Western Europe seemed to re-unite again. Our study is devoted to explore a few aspects of the scientific structures of the 'newcomer'

Central & Eastern European (CEE) countries (in comparison to Western European (WE) ones), with special regard to the situation *before*, *during* and *after* the year(s) of the political-economical turning point in Eastern Europe.

## 2. Data Sources & Data Processing

Data were extracted from the annual volumes of the *Science Citation Index* (SCI) for the period 1980-1990 and the *Science Citation Index Expanded* (SCIE) for 1991-2003 of Thomson Reuters, consequently social sciences and arts & humanities are not included in this study.

As the raw bibliographic data communicated in the SCI and SCIE databases are not ready for immediate bibliometric use, a thorough cleaning procedure had to be carried out before the actual bibliometric work started. In the course of this procedure special attention was paid not only to name variants of countries, cities and institutions, but also to geopolitical difficulties in several regions of Central and Eastern Europe.

Due to the long refereeing procedures and printing times of certain journals, the older country names kept on appearing for years, parallel to the correct denominations of the states in question. It was particularly typical in case of the Czech Republic and Slovakia (former Czechoslovakia) as well as in case of Slovenia (formerly being part of Yugoslavia). The Baltic States (Estonia, Latvia, Lithuania) constituted a different group, as the abbreviations of the member states of the former Soviet Union had most of the cases been indicated in the by-lines of SCI and SCIE databases, even in times long before the political and economical changes. However, even in these cases special attention had to be paid to retrieve those publications that had mistakenly (outdatedly) been published under the name of any of the Baltic "SSRs" (Soviet member states) after the Soviet Union had actually fallen apart.

In a lot of troublesome cases around the years of the birth of newly formed states (mainly in the case of Czechoslovakia), publications were assigned to countries on the basis of manual classification of towns where the authors' scientific institutions operated.

This careful cleaning-up procedure paid off when the results mirrored no significant decline from the cluster empirically identified as typical scientific profile of East-European countries.

In all the cases concerned, integer counting was applied. That is, whenever a publication had authors from different countries, the publication was fully assigned to each country indicated in the by-line of the paper. Because of the duplicating (multiplying) nature of this counting scheme, summing up the given countries' publication counts over larger levels of aggregation (like the level of the EU) would exceed the actual publication count of the given level, therefore summations like this were avoided.

## 3. Methodology

In order to compare CEE and WE countries in terms of scientific structures over time, bibliometric indicators were applied.

### 3.1. Coverage of the study

#### *3.1.1. Geographical scope*

As the current study began in 2004 (the year of the largest EU enlargement so far), the investigations aimed to include all the 25 countries of the EU as it existed from 1st May 2004, that is, countries of the latest enlargement in 2007, when Bulgaria and Romania were accepted to join the EU, are not included.

Three very small countries (Luxembourg, Malta, Cyprus) had to be dropped out from the final country list. Their relatively low publication output

| | Countries of the EU[1] | ISO Country Code | Accession Year[2] | Former Country |
|---|---|---|---|---|
| Commonly referred to as EU15 | Austria | AUT | 1995 | |
| | Belgium | BEL | 1952 | |
| | Denmark | DNK | 1973 | |
| | Finland | FIN | 1995 | |
| | France | FRA | 1952 | |
| | Germany[3] | DEU | 1952 | West Germ. + East Germ. |
| | Greece | GRC | 1981 | |
| | Ireland | IRL | 1973 | |
| | Italy | ITA | 1952 | |
| | Luxemburg[4] | LUX | 1952 | |
| | Netherlands | NLD | 1952 | |
| | Portugal | PRT | 1986 | |
| | Spain | ESP | 1986 | |
| | Sweden | SWE | 1995 | |
| | United Kingdom | GBR | 1973 | |
| "Newcomer" EU countries | Cyprus[4] | CYP | 2004 | |
| | Czech Republic | CZE | 2004 | Czechoslovakia |
| | Estonia | EST | 2004 | USSR |
| | Hungary | HUN | 2004 | |
| | Latvia | LVA | 2004 | USSR |
| | Lithuania | LTU | 2004 | USSR |
| | Malta[4] | MLT | 2004 | |
| | Poland | POL | 2004 | |
| | Slovakia | SVK | 2004 | Czechoslovakia |
| | Slovenia | SVN | 2004 | Yugoslavia |

*Table 1* Geographical scope of the study. Remarks:
[1] on 1 May 2004 (that is, Romania and Bulgaria not included)
[2] Accession to the EU or its predecessor organizations
[3] German reunification took place in 1990
[4] due to size-related problems, country is not included in the study
Source: http://en.wikipedia.org/wiki/Enlargement_of_the_European_Union

(stemming from their small size and population) should have been further distributed amongst 12 subject fields, at which point statistical reliability could not have been guaranteed anymore.

Country-specific data were identified on the basis of the addresses in the by-lines of the papers (as they appear in the SCI and SCIE databases).

*3.1.2 Temporal scope*

In the present study we used three snapshots: 1983, 1993 and 2003; representing the (political-economical) pre-transitional period, transition itself and the post-transitional period of CEE countries. In order to make our results comparable, we used the same time-series for all the CEE and WE countries. The above snapshots were selected after careful deliberation of some pieces of historical background information.

Although the Eastern European political-economical transition started in Romania, Hungary, East Germany and Czechoslovakia in 1989, the CEE transition procedure was far not completed in that year. The German reunification took place in 1990, the Baltic States were released from the Soviet Union in 1991, Slovenia also ended its 10 days war for independence in 1991, and Czechoslovakia was separated into two independent states from 1 January 1993.

From the above dates it is clearly seen that our choice was largely restricted by the fact that 1993 was the first 'transition year' applicable for *all* the newly formed CEE countries in question. The 10-10 years before and after 1993 was determined by the fact that the current study started in 2004.

*3.1.3 Coverage of document types*

In accordance with the widespread practice, raw data for the bibliometric indicators were retrieved from publications belonging to any of the following 4 publication types: *articles, letters, notes* and *reviews.*

*3.1.4 Coverage of subject fields*

In line with the profiles of the SCI and SCIE databases, the current study covers all fields of the

- bio- & lifesciences,
- nature sciences, and
- engineering & applied sciences.

Every one of the publications have been categorised and assigned to one (or more) main subject field(s) of a 12-field classification system. Designation of the 12 subject fields, as well as categorisation and assignment of publications were carried out on the basis of the first (top) level of the 2-level hierarchical classification system developed in Leuven and Budapest by Glänzel and Schubert (2003). This classification system was worked out for sciences, social sciences and arts & humanities, however the present study makes use of the part concerning the sciences (bio- & lifesciences, natural sciences and applied sciences) only. The thirteenth (X0) category of "multidisciplinary fields" was not used here either.

For reason of statistical reliability, only the twelve main subject categories (out of the 60 corresponding subfields) were used in our study. These fields comprise the disciplines Agriculture & Environment, Biology (Organismic & Supraorganismic Level), Biosciences (General, Cellular & Subcellular Biology, Genetics), Biomedical Research, Clinical and Experimental Medicine I (General & Internal Medicine), Clinical and Experimental Medicine II (Non-Internal Medicine Specialties), Neuroscience & Behaviour, Chemistry, Physics, Geosciences & Space Sciences, Engineering and Mathematics. Further in-depth classification would have led to the undesired situation of too little sample sets in certain scientific fields in certain countries or in certain snapshots in time.

## 3.2 Indicators Used

As one of the most characterising indicators describing a particular country's scientific profile, publication profiles by disciplines (also known as Activity Index profile) were calculated first, then these results were transformed into an easily comparable, relative form (indicator used is also known as Relative Specialisation Index).

22 out of 25 EU countries were selected (exceptions: Malta, Cyprus and Luxemburg) and their Activity Indices were calculated for each subject field.

In scientometric literature the *Activity Index* (AI) is used to measure a unit's relative publication activity in a selected field with respect to a given reference standard. For instance, this measure indicates whether a country has a relatively higher or lower share in world publications in a particular field of science than its overall share in world total publications. As known from the literature (e.g., Frame, 1977; Schubert & al., 1989), Activity Index (AI) of a particular science field is defined as follows:

$$AI = \frac{\dfrac{CP_{given\_field}}{WP_{given\_field}}}{\dfrac{\sum_{CP}}{\sum_{WP}}}$$

or equivalently:

$$AI = \frac{\dfrac{CP_{given\_field}}{\sum_{CP}}}{\dfrac{WP_{given\_field}}{\sum_{WP}}}$$

where

$CP_{given\_field}$ is the number of publications a given country produces in a given field;

$WP_{given\_field}$ is the number of publications the whole world produces in a given field;

$S_{CP}$ is the total number of publications in a given country; and

$S_{WP}$ is the total number of publications of the world.

For practical reasons, the Relative Specialisation Index (RSI) (cf. REIST-2, 1997), a derivative of the Activity Index, was used:

RSI, which takes values in the range ]–1, +1[, indicates a lower-than-average attitude if RSI<0, and reflects a higher-than-average activity if RSI>0. When RSI=0 it represents that the activity of the given group (country) in a given field is equal to the world average. The relative nature of this indicator makes it possible to examine and compare national scientific (publication) profiles directly, in-

$$RSI = \frac{AI_{given\_field} - 1}{AI_{given\_field} + 1}$$

dependently of such disturbing factors as the sizes and overall publication outputs of the countries. At the same time, the closed interval of RSI values facilitates the visualisation, easy comprehension, comparison and interpretation of the results.

### 3.3 Visualisation

Since each publication can be assigned to more than one subject field category, the sum of the share of subject fields practically exceeds 100%. It is the reason why "shares" of RSI values are not to be summed up and are preferably not presented in traditional pie charts. Instead, in accordance with the consistent practice at our institute, (because of the subdivision into 12 units) so-called clockwork diagrams have been used. This graphical representation makes the reading of the indicator easy. In order to facilitate the interpretation even further, a special "standardised" arrangement have been introduced, where subject fields are consistently placed at the same locations and are grouped together by subject fields in a systematic way:

- the upper right hand side of the chart incorporates all the bio-related science fields (BIOL, BIOSCI, BIOMED, respectively);
- the lower right hand side of the chart is dedicated to all branches of medical research (INT MED, NON-I MED, NEUR);
- this is followed by nature sciences in the lower-left quarter (CHEM, PHYS, GEO); and finally
- the group of engineering & applied sciences (ENG, MATH, AGRI) are arranged in the upper-left quarter.

## 4. Results

The RSI values were plotted on radar diagrams in accordance with the 12 subject fields. The breakdown was made for all countries; and three snapshots in time were plotted on each diagram representing the pre-transition (1983), transition (1993) and post-transition (2003) periods.

The publication profiles of WE countries are often very similar to the overall publication profile of the world. Taken into account that large countries like the United Kingdom or France strongly influence the world average just by the mere quantities of their publication outputs, it is not a surprising fact. But based on our diagrams 3 main groups of countries showing up somewhat different behaviours could have been isolated in Europe:

a) Nordic countries
b) Southern countries
c) CEE countries

All these three groups have their characteristic marks. In the following these peculiarities will be discussed using a few, but representative sample countries in each group.

*a) Nordic countries*

Although the Nordic countries (Figure 1) apparently went through a slight paradigmatic shift in the past 20 years, their publication profiles have always been very similar to each other, even in the dynamics of changes.

As the relative field-activities show, in the eighties it was undoubtedly the life science where the Scandinavians put the main emphasis, even on the expense of nature and applied sciences. Later on a clear tendency that works against this offset situation can be observed, and by the beginning of the new millennium all the investigated Nordic countries have reached a new state in their scientific profiles, which are much closer to the world average in terms of relative publication activity.

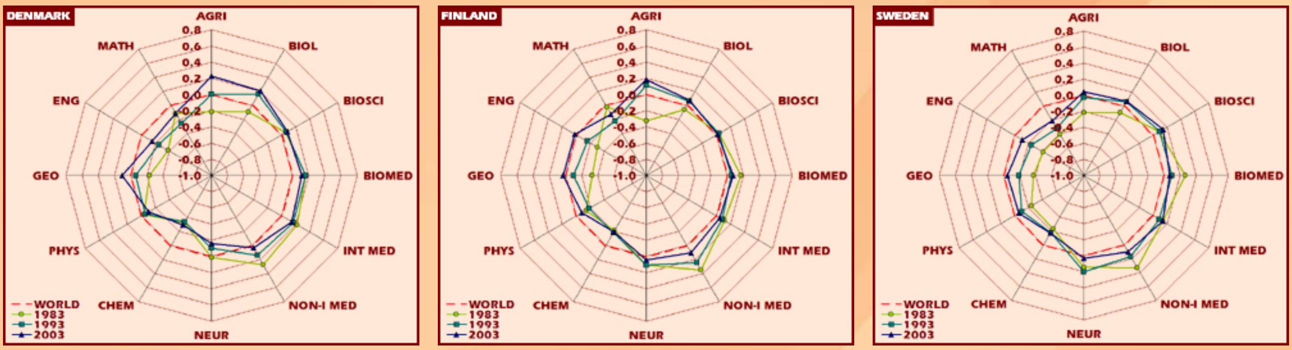


*Figure 1* Publication profiles of Denmark, Finland and Sweden. Observation years: 1983, 1993 and 2003.

Quite remarkable, however, that despite these efforts towards more "balanced" research profiles, chemistry remained continuously "underrepresented" during the last two decades. (To avoid misunderstandings, this does not mean, under any condition, any qualitative distinction, since AI and RSI are equilibrium indicators such that relative high activity in some fields is necessarily contrasted by relative low activity elsewhere.)

It is perhaps Sweden that is having the most "well-balanced" scientific profile today, that is, Sweden's relative field activities are the closest to the world's average field activities. At the same time, while basically showing up a similar tendency, Denmark and Finland both boosted their publication efforts over the world average in agriculture-related sciences during the last two decades.

*b) Southern countries*

While the Nordic countries were generally characterised by early overrepresentation of life sciences, gradually evolving towards more balanced profiles and as a consequence, with neither significant peaks, nor similar low ends in their publication profiles, the Southern countries (Figure 2) are on the contrary. Their initial profiles are quite biased toward a few particular fields and the structural changes often seem to be somewhat indefinite (except for Spain, where an unambiguous development can be observed).

In Greece, for example, the data from 1993 are almost the same as from ten years earlier, and only the data from 2003 show some distinct changes. In the eighties (and therefore also in the nineties), in the publication output of Greece the natural sciences (especially geo- & space sciences, but also physics and chemistry) and applied sciences were overrepresented, whereas the results of bio- and lifescience research constituted a lower-than-average activity group. The most interesting phenomenon is that the relative low activity in neuroscience practically remained for at least 20 years. This fact is even more spectacular if we take into account that a paradigmatic shift from the overrepresentation of natural and applied sciences has eventually started towards relative high activity in biomedicine and lifesciences – except neuroscience. Nonetheless, mathematics (including computer science) and engineering are still holding their strong positions, mainly on the expense of bio-related sciences.

As for Portugal, the case is even more complex. It is the *only* country out of the investigated 22 EU countries, where the observed structural transformation has gone *against* the main trends over the last two decades. Namely, all the medical sciences (internal medicine, non-internal medicine, neuroscience), that had originally been underrepresented already in the eighties, went even further on this downward slope. Parallel to this process, a remarkable evolution can be witnessed in the case of agriculture-related sciences. To a less extent, bio-related fields and chemistry have also strengthened.

Spain is a textbook scenario for a sustained evolution. In the eighties, its publication profile was strongly skewed to chemistry and bioscience, whereas geosciences, engineering, agriculture, biology and medical sciences were relatively less active than the world average. 20 years later relative activity in most of these below-average fields increased, at the same time the earlier peaks diminished so that Spain has developed a well-balanced scientific profile which is very similar to that of the world standard. The fact that the profile of 1993 lays nicely (and consistently) between the profiles of 1983 and 2003 suggests that the transition of Spain's scientific profile was part of a deliberate scientific policy, most likely stimulated by and in accordance with the scientific goals and initiatives of the European Union.

*c) Central & Eastern European countries*

Dealing with Central and Easter European countries brings (Figure 3) a fundamental methodo-

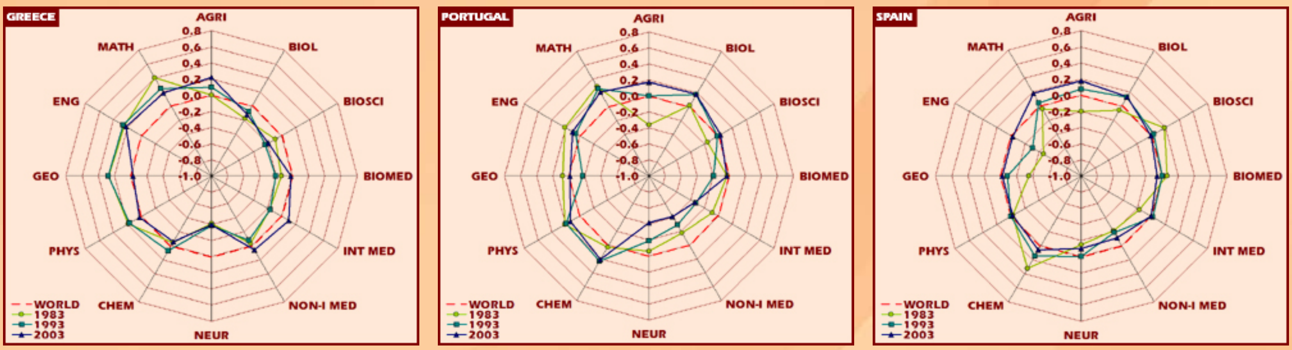


*Figure 2* Publication profiles of Greece, Portugal and Spain. Observation years: 1983, 1993 and 2003.

logical problem to the investigation, namely that the region underwent a major geopolitical change where only two out of eight CEE countries of the 2004 enlargement turn (Hungary and Poland) existed in the same form in all the three snapshot years of the study. Back in 1983 the three current Baltic countries were part of the Soviet Union, Slovenia was part of Yugoslavia, and the Czech Republic and Slovakia also constituted a joint country, not to mention East Germany that become part of the EU much earlier, in 1990 due to the German reunification.

Due to these various geopolitical conditions, direct comparisons over time (for example, comparing the Soviet Union to any of the small Baltic States) are rather pointless, but still, predecessor countries' scientific structures are also telling, regarding their heritage for the next decades. Besides, apart from the fact that all the CEE countries' publication profiles show up very different peculiarities, they share at least two very remarkable common characters: a) their profiles are very skewed (specialised), contain a lot of peaks especially in nature sciences; and b) a significant shortage can be observed in R&D efforts in the fields of medical sciences.

The fast economic development of the Czech Republic can be explained by its proximity to highly developed countries like Germany and Austria, as well as by its traditionally rich industrial culture. No wonder that the Czech Republic shows up the most similar tendencies to the dynamics of scientific profiles of WE countries. In 1983 Czechoslovakia was notably "underrepresented" in mathematics, engineering, internal and non-internal medicine, neurology and several bio-related fields, whereas chemical research was way over the expected level. The relative activity in agriculture- and biology-related papers were also above the world average. At the same time, internal and non-internal medicine were about 50% and 70% underrepresented in the Czechoslovakian publication output (relative to world standards). By contrast, the Czech Republic apparently started to put more emphasis on medical research, that is, a clearly visible equilibrating tendency can be witnessed.

East Germany was a completely unique case in terms of transition procedures in Central and Eastern Europe. Due to its reunification with West Germany, East Germany has become part of the EU much before the other CEE countries. East Germany's integration into the Western political, economical and social systems was part of German reunification and can as such not be compared with that of the other East-European accession countries. Studying this in detail would go far beyond the scope of this article. The reason why East Germany has been selected for inclusion here was that its 1983 research profile highly resembles to those of the other CEE countries, and at the same time, its diagram is nicely and instantly comparable to the research profile of West Germany, a typical WE country (of which it later became part of) on the very same chart. (West Germany is represented by dotted line in 1983 in Figure 3.)

Nevertheless, the most striking profiles were found in the Baltic States and in their predecessor, the former Soviet Union. Of course, the latter one cannot be a reference point for comparison in any regard, even if all the Baltic States have been carrying strong resemblances in their scientific profiles to that of the Soviet Union. Lithuania, our sample in this study, undoubtedly started to adjust its publication profile, nonetheless it is still distorted in the directions of chemistry, physics, engineering and especially mathematics, whereas the development of a well-balanced publication output level also in medical, neurological and some bioscience-related fields is still to come in the future. Similar tendencies apply to the two other Baltic States.

The other CEE countries' publication profiles are not shown in this study, but they are all skewed

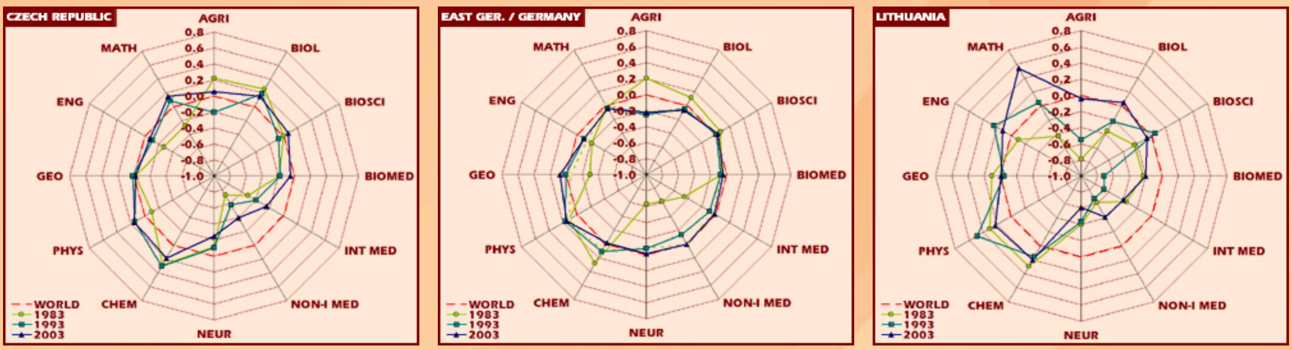


*Figure 3* Publication profiles of the Czech Republic, East Germany (&Germany) and Lithuania. Observation years: 1983, 1993 and 2003.

towards certain fields of sciences; their publication profiles are distinctly different from the profiles of the WE countries. It is very likely that the in-depth analysis can uncover the reasons of these deviations. This study is neither devoted to search for these factors, nor to prove them scientifically, but it does not seem to be very farfetched to assume that factors like *centralistic (non market-driven) strategic planning also in science policy, overemphasised role of political-ideological decision-making, directed or lacking patterns of scientific collaboration* all must have been contributing to the isolated and biased nature of scientific profiles of the CEE countries.

Of course, as the time passed and the communism slowly but surely marched to its collapse, all these distinguishing marks of the scientific landscape of the CEE countries were fading away and are less and less significant. But still in these very days, the 'heritage' of those times can be spotted in many features of the scientific structures of the CEE countries.

Despite the initial situation, in the mirror of longitudinal data series we can state that the CEE countries are on an orbit which is very similar to that of the Southern Countries after their EU enlargement turns. In a way it suggests that the research financing system and the general R&D policy of the EU do influence the member countries' science policies, and hence their scientific structures, too.

## 5. Conclusions

The politically-economically different Europe shows up several clusters in R&D publication profiles as well. The majority of the WE countries tend to near the world's overall publication output profile, but the Nordic research profiles reflect more emphasis on medical sciences. Southern European countries were the opposite, moreover, Portugal was the only one in the country set in question which was going against the general trend of increasing the share of medical publications within the national publication output in the clusters of the Southern European and the CEE countries.

Because of the Soviet influence in the post war period till the turn of the nineties, science policy and research organisation in CEE countries had specific characteristics. Due to specific reasons arising from the underlying political and economical systems, they have significantly biased profiles, sharing two major common features: a) frequent peaks toward natural sciences (especially chemistry and physics) and mathematics, and b) underrepresentation of medical research with respect to the world standard.

These phenomena tend to change over time, nevertheless expecting that national profiles might drastically change within a couple of years would be naïve. However, the process of re-integration of newcomer EU countries into the European science system and the Western world makes a good progress. The speed of this progress – like in the case of economic changes – somewhat differs among the countries in question. The accession countries of the fifth EU extensions (2004) tend to show up similar characteristics to the cluster of 'southern' EU countries.

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