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researchtrends

Welcome to the 14th issue of Research Trends. The *h*-index certainly needs no introduction here: since its launch four years ago, it has rapidly become the standard for evaluating an individual researcher's impact. In a rare interview, Jorge Hirsch – the man behind the metric – tells us what inspired him and how he feels about his success in the world of bibliometrics.

In the **last issue**, we focused on research into environmental issues, inspired by the 2009 Times/Smith School World Forum on Enterprise and the Environment. Continuing our focus on international challenges that require multidisciplinary approaches, in this issue we measure science's contribution to the global effort to halt the incidence of HIV/AIDS, malaria and tuberculosis by 2015.

Research into global issues also benefits from international collaboration, and this has been on the increase in recent years. We investigate which countries are reaching out most often, and discover that some of the smallest nations are proportionally the biggest collaborators.

Another multidisciplinary subject is energy, and we have discussed this from many angles in the past. In this issue, we discuss the inherent challenges involved in analyzing any multidisciplinary field, comparing specialization and collaboration against impact.

And finally, we investigate scientific output in Iran, finding that publications, citations and international exposure are all on the rise, led by a core group of leading universities.

If you would like to comment on any of the topics covered, please use our **feedback** facility.

Kind regards,
The Research Trends Editorial Board

DID YOU KNOW?

Germany is a world leader in fuel-cells research

Even though Germany is only ranked sixth in the world for output of research papers on fuel cells, it carries out the most in-depth research in this area *(1)*. This is according to a new method that measures multidisciplinarity in science and has revealed some very surprising results. In fact, while Germany's total number of papers is lower than the USA, its percentage of papers in so-called Distinctive Competencies (indicating in-depth research) is higher.

The Distinctive Competency method measures multidisciplinarity by revealing research strengths that reference literature from a single discipline as well as those that are highly interdisciplinary. Identifying Distinctive Competencies rather than simply replying on citation counts shows where competition could come from in the future. While Germany may not yet be leading alternative-energy research, it is developing deep expertise in a wide range of disciplines, which could result in breakthroughs in the near future.

References
(1) Katzen, J., Klavans, D. and Boyack, K. (2009) Research Leadership Redefined… Measuring Performance in a Multidisciplinary Landscape, Elsevier Webinar

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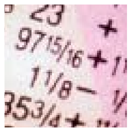
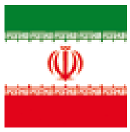




Behind the data

Research supports UN millennium development goals

SARAH HUGGETT

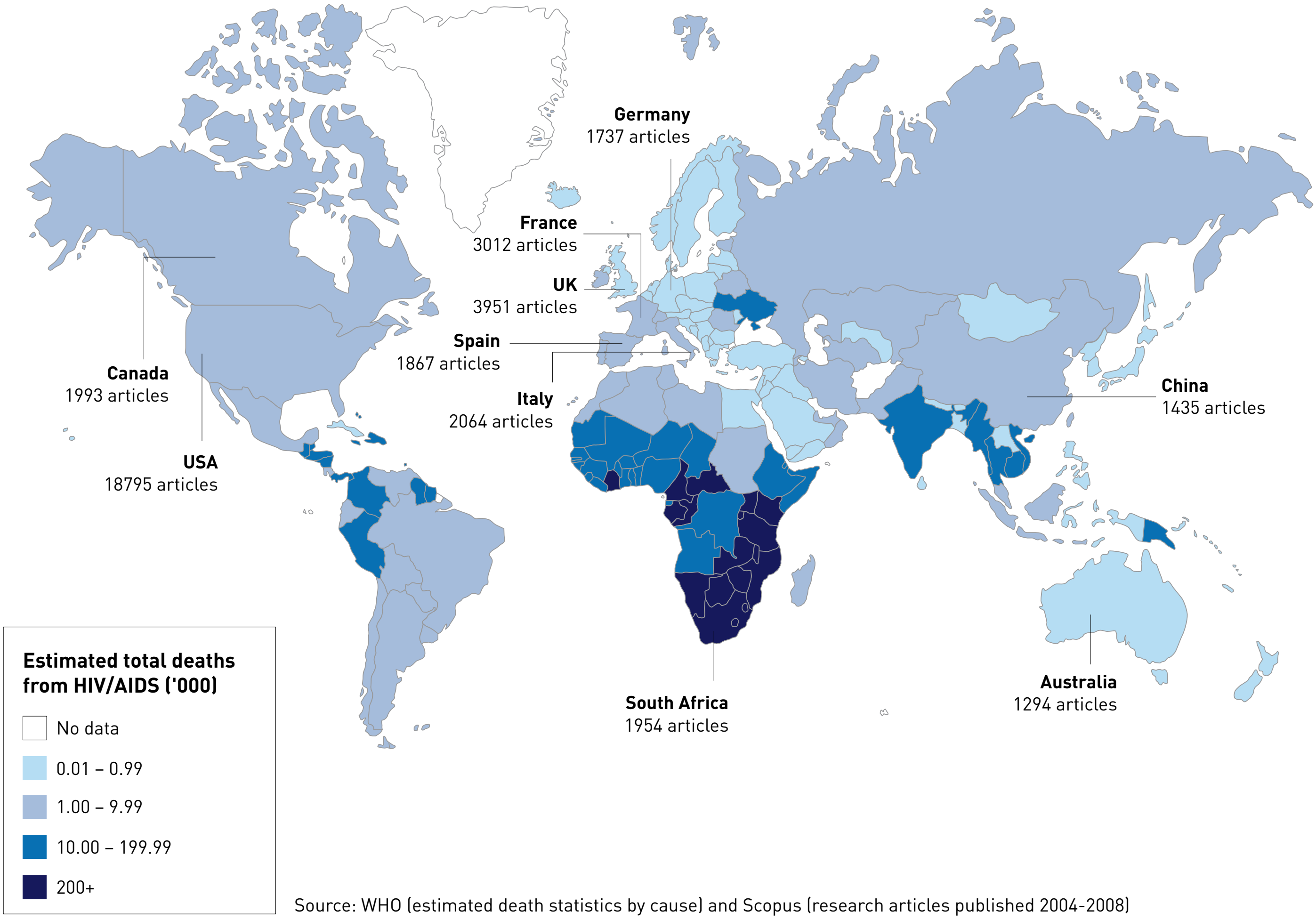
In September 2000, the United Nations (UN) gathered at the Millennium Summit in New York to discuss their role at the beginning of the 21st century *(1)*. The meeting culminated in the adoption of the UN Millennium Declaration by the present heads of state *(2)*. The Millennium Development Goals (MDGs) were derived from this declaration, and include targets that were adopted in 2001 by 192 UN member states and at least 23 international organizations *(3)*.

Targeting the biggest killers

The eight MDGs represent a global commitment to improve the most basic indicators of standard of living for all (see box).

Millennium Development Goals

1. End poverty and hunger
2. Universal education
3. Gender equality
4. Child health
5. Maternal health
6. Combat HIV/AIDS
7. Environmental sustainability
8. Global partnership



Source: WHO (estimated death statistics by cause) and Scopus (research articles published 2004-2008)

Figure 1 – Deaths from HIV/AIDS are highest in Sub-Saharan Africa

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Goal 6 is to combat HIV/AIDS, as well as other diseases, such as malaria and tuberculosis, and is divided into three main targets:

1. Target 6.A: Have halted by 2015 and begun to reverse the spread of HIV/AIDS
2. Target 6.B: Achieve, by 2010, universal access to treatment for HIV/AIDS for all those who need it
3. Target 6.C: Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases (including tuberculosis)

Nearly a decade on, progress has been made, but will the 2015 targets be reached? According to a recent UN report, "most countries are struggling to meet the Goal 6 targets of achieving universal access to treatment for HIV/AIDS by 2010 and of halting and reversing the spread of HIV/AIDS by 2015. [...] Large increases in funding and attention to malaria have accelerated malaria-control activities in many countries. [...] The incidence of TB is expected to be halted and begin to decline before the target date of 2015." *(4)*

A little help goes a long way

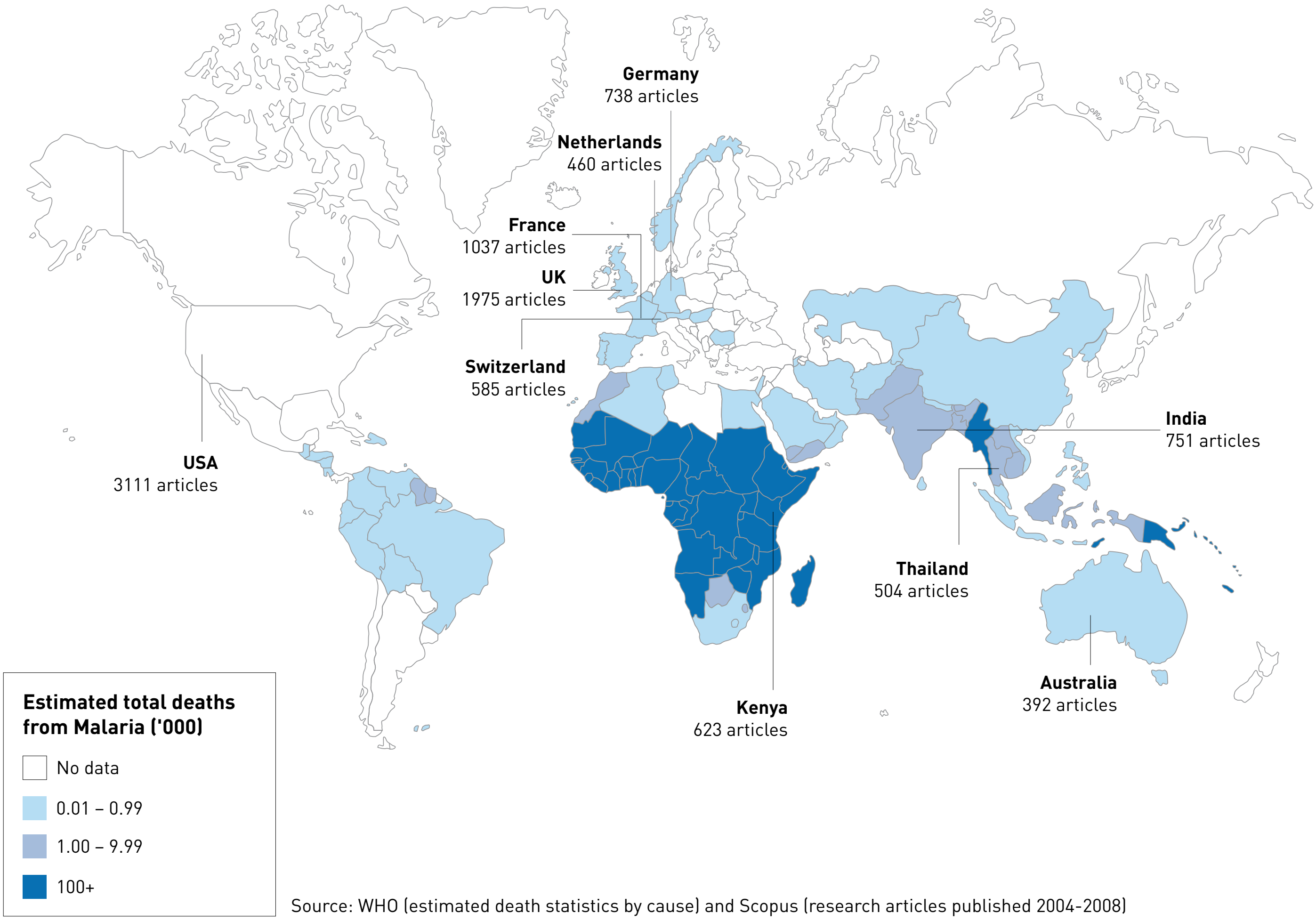
By highlighting inequalities between countries, the UN Millennium Declaration also stands as a moral imperative for wealthier countries to assist in relieving the burden of disease in the most-afflicted countries. An analysis of research output in HIV, malaria and tuberculosis reveals the commitment of developed nations to help, even though these diseases are less prevalent in their populations.

The maps (see Figures 1, 2 and 3) show estimated 2004 death rates per 100,000 for HIV/AIDS, malaria and tuberculosis in each country *(5)*, as well as the 10 most prolific countries in terms of research articles published between 2004 and 2008 on these diseases.

The burden of HIV/AIDS is heaviest in sub-Saharan Africa. Although research on HIV is concentrated in the Western world (North America, Europe and Australia), it is interesting to note that China and South Africa are exceptions to this generalization, ranking respectively second and fifth in terms of article output on the subject.

The world's highest reported death rates due to malaria are in Sub-Saharan Africa. The bulk of recent research on the disease comes from the USA, Europe and Australia, where disease burden is low; however, Thailand, Kenya and India do suffer significant malaria death rates and are also some of the most productive countries in terms of research on malaria.

Population-adjusted deaths from tuberculosis are greatest in Sub-Saharan Africa and Eurasia. The USA and Europe publish a large proportion of the research on tuberculosis but other



Source: WHO (estimated death statistics by cause) and Scopus (research articles published 2004-2008)

Figure 2 – Malaria death rates and research high in Thailand, Kenya and India

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countries such as Brazil, China, South Africa, Japan and India (with significant death rates due to the disease) also make it into the top-10 most-prolific countries.

"India's focus on tuberculosis research right now is phenomenal – and this is matched by the volume of publication emerging from the country," observes Dr Brian D. Robertson, Deputy Director of the Centre for Integrative Systems Biology at Imperial College London.

Alan D. Lopez, University of Queensland, Australia, adds: "it is no surprise that most articles come from the countries shown, and in particular the USA. However, the five-fold variation in HIV/AIDS papers compared with malaria and tuberculosis from the USA is interesting, given that there is at most a two-fold variation in death rates."

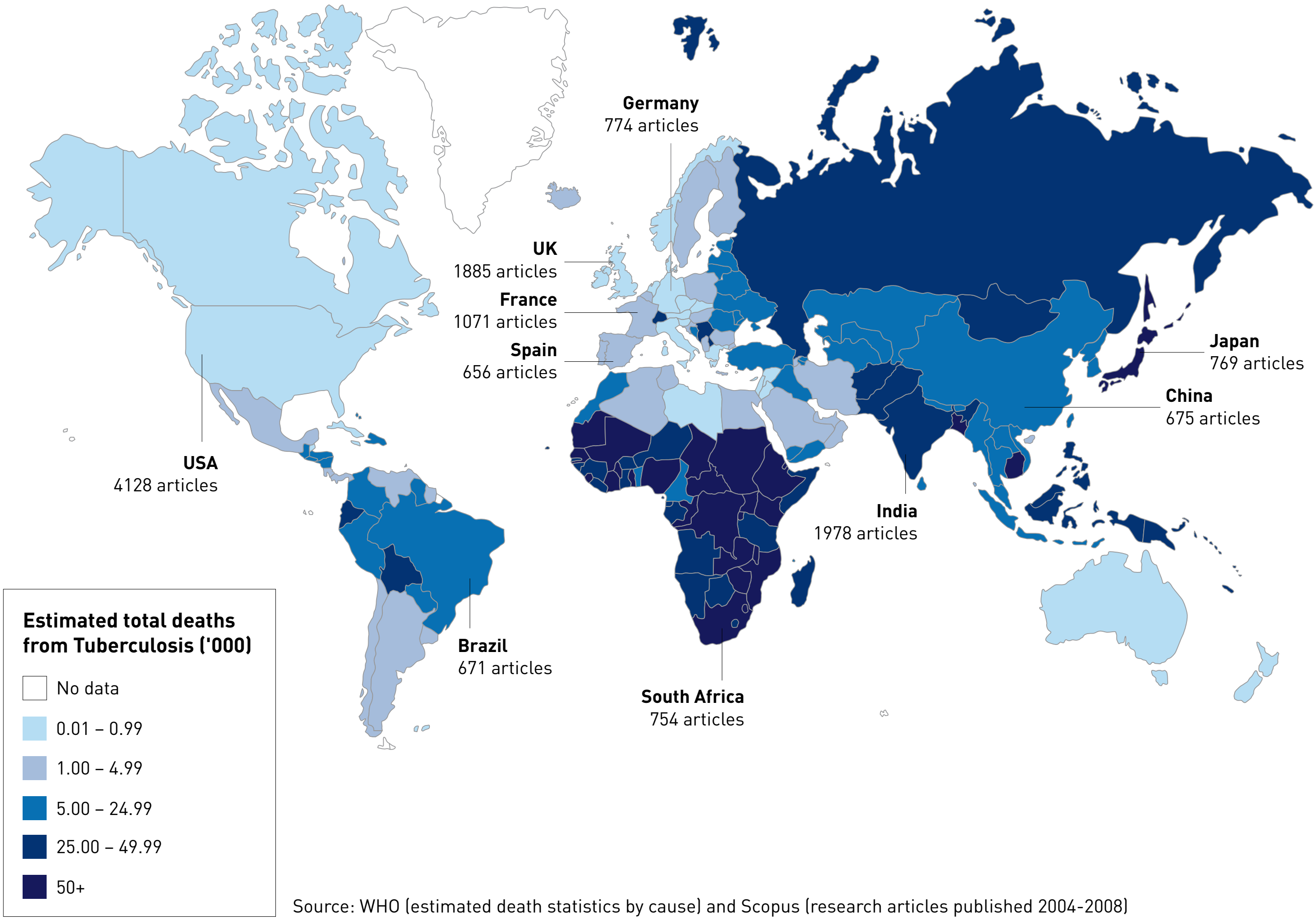
This analysis shows that as far as HIV, malaria and tuberculosis are concerned, countries do seem to be pulling together, regardless of their respective burden of disease, in an effort to meet the MDGs. However, as highlighted in the recent UN report, there is still much to be done, and only time will tell if current efforts are sufficient to reach the 2015 targets.

Useful links:

UN Millennium Declaration

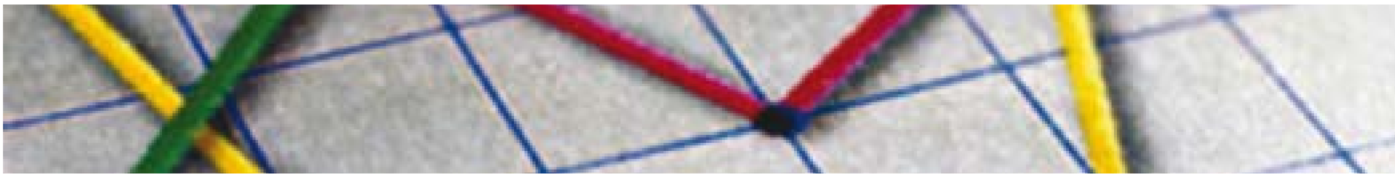
Millennium Development Goals

References
(1) The Millennium Assembly of the United Nations – Millennium Summit
(2) United Nations Millennium Declaration
(3) The United Nations Millennium Development Goals
(4) United Nations (September 2008) 'Fact Sheet – Goal 6: Combat HIV/AIDS, malaria and other diseases', UN Department of Public Information, DPI/2517 L.
(5) World Health Organization – Department of Measurement and Health Information (February 2009) 'Global disease burden'.



Source: WHO (estimated death statistics by cause) and Scopus (research articles published 2004-2008)

Figure 3 – Tuberculosis death rates high in Sub-Saharan Africa and Eurasia



Analyzing a multidisciplinary research field

ASCHWIN WIJNSMA

A researcher who consults a bibliographic database and looks for articles using the keywords "CO_2" and "greenhouse" could be a climatologist working on atmospheric models or a botanist interested in boosting crop yields.

This simple example demonstrates the importance of reviewing the context of keywords and finding ways to delineate the field of research. Extending the combination of keywords usually delivers more precise results, but it will inevitably lead to reduced completeness, or recall. To increase recall without losing precision, data sets can be expanded using the information in the references from, and citations to, the initial data set. This approach was employed by Eric Archambault et al *(1)* to chart leading countries in the energy research field, using Scopus data for his analysis.

Setting a context

As "energy" is such a generic term in many scientific areas with numerous definitions, Archambault describes the context in his article as "research related to human society". Archambault also uses the following definition for "energy R&D", formulated by the Global Climate Change Group (GCCG) at Pacific Northwest National Laboratory, USA:

> "['Energy R+D' is] the linked process by which an energy supply, energy end-use or carbon-management technology moves from its conception in theory to its feasibility testing and small-scale deployment. [...It] encompasses activities such as basic and applied research as well as technology development and demonstration in all aspects of production, power generation, transmission, distribution and energy storage and energy-efficiency technologies."

Archambault's approach shares common ground with the **SciVal** method developed by Dick Klavans and Kevin Boyack. The latter employs keyword and co-citation analysis to define dynamic research paradigms or clusters *(2)*. According to this method, a paper is not simply allocated a research cluster based on its subject-area classification, making this mapping of science more realistic and sensitive to trends, notably in the multidisciplinary sciences. (See Research Trends, Issue 12, **'Analyzing the multidisciplinary landscape'**.

Scopus classifies journals in major subject areas, one of which is "Energy". Journals can be allocated to multiple subject areas as appropriate to their scope. The classification of journals in the "Energy" subject area is based on criteria that bear resemblance to the GCCG "energy R&D" definition. Interestingly, the average number of subject areas that journals in the "Energy" papers belong to (2.09) is higher than the average value of all science (1.37), indicating that they exhibit a strong degree of interdisciplinarity.

Measuring specialization against impact

Within the Scopus "Energy" subject area data set, a country analysis yields a bubble chart of the 20 most prolific countries (see Figure 1). On the horizontal axis is the Specialization Index, which is a country's share of the "Energy" subject area compared to all subject areas in which that country has published, relative to the world's share (1.37%). On the vertical axis, Relative Impact is plotted, which is defined as all citations in 1996–2007 to all articles in the "Energy" subject area produced by one country, relative to the world's impact in the "Energy" subject area (3.952). The bubble size is proportional to the total article output in 1996–2007.

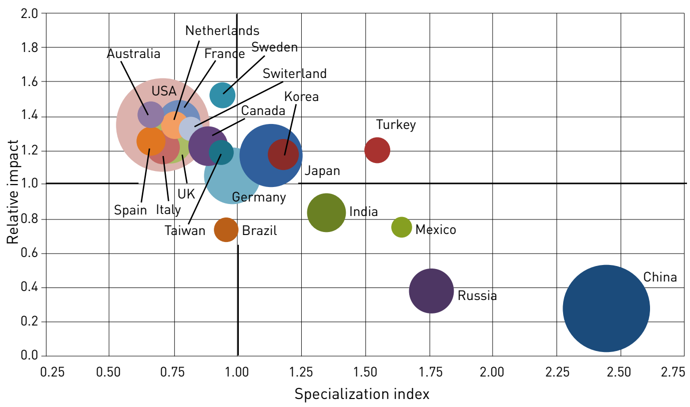


Figure 1 – Specialization versus Impact for the 20 most-prolific countries in the subject area "Energy", 1996–2007. Source: Scopus

Archambault presented a similar bubble chart, but he used another definition of the impact. He weighted the citations by their subject fields, took multiple, smaller citation time windows and averaged the results over 1996–2007 afterwards.

It is clear that there is a negative relationship between specialization and impact, which is strongly influenced by the posi-

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tions of Russia and China on the chart. China pairs the highest level of specialization with the lowest impact of the top 20 countries. However, cultural influences, such as a tendency to publish in the Chinese language, may still hide many citations from view.

There are three countries that score higher than average on both indices: Japan, South Korea and Turkey – the latter being most notable outlier.

Specialization and international collaboration are vital

In the next chart (see Figure 2), we have replaced the Specialization index with another Scopus indicator: Country collaboration, which measures the international character of research. The average world collaboration rate in this context is 22.5%.

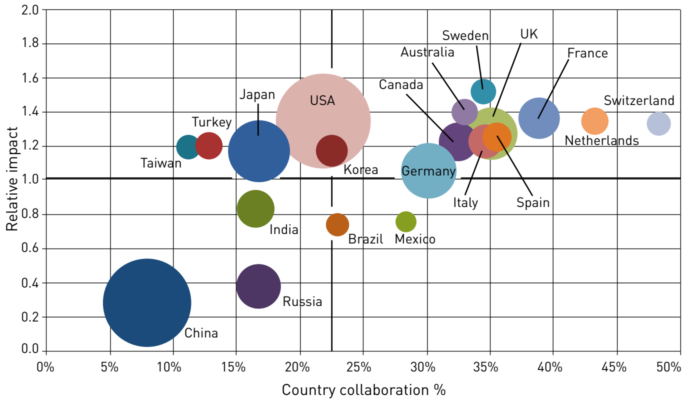

Figure 2 – Country collaboration versus Impact for the 20 most-prolific countries in the subject area "Energy", 1996–2007. Source: Scopus

We observe a weak positive relationship, where international collaboration is associated with higher citation impact. A closer examination reveals that the horizontal positions of the bubbles on this chart are practically mirrored in Figure 1: countries with a high specialization index generally have a low collaboration rate. Exceptions are the USA, Japan, Turkey and Taiwan, whose impacts are high, even with a relatively low collaboration rate. It must be emphasized that removing China and Russia from this analysis destroys the positive correlation.

To analyze multidisciplinary research fields, advanced bibliographic analysis methods can be advantageous. A simple keyword search to delineate a multidisciplinary field may be insufficient, with unsatisfactory rates of recall and precision. However, this analysis, based on a dataset of papers that are classified under the generic subject area of "Energy", largely reproduces the same relationships that Archambault found.

The importance of energy research needs no further explanation, but the choice of strategy and approach partially depends on the effectiveness of specialization and international collaboration. In a recent speech at MIT, US President Barack Obama advocated US leadership in the development of clean-energy technologies, which alludes to specialization *(3)*, while he also reached out for international collaboration to mitigate global warming – another energy-related issue *(4)*. Future bibliometric analyses may reveal the effectiveness of his plans in terms of scientific quality.

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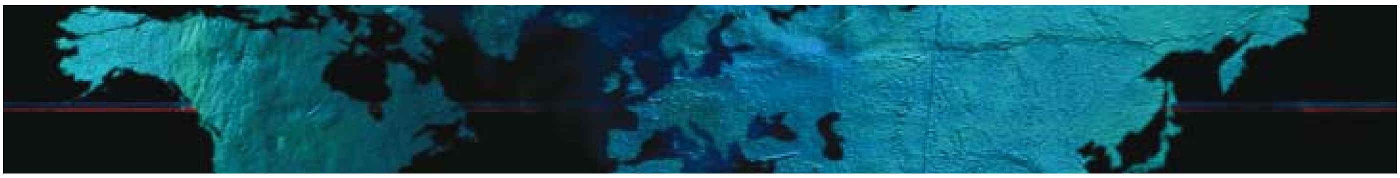
(2) **Scival Spotlight – Information Website.**
(3) **McKenna, P. (2009) 'Obama says US in global race to develop clean energy', New Scientist**.
(4) **Goldenberg, S. and Watts, J. (2009) 'US aims for bilateral climate change deals with China and India', The Guardian**.

Country trends



Small countries lead international collaboration

JUDITH KAMALSKI

Recent research has shown that international research collaboration is growing rapidly *(1)*. This is unsurprising given the fact that many of the most pressing challenges in science are global in nature *(2)*. Think about climate change or the H1N1 flu virus: these clearly cross borders and demand a global response. Analyzing data on international collaborative article output by country reveals that smaller countries proportionally carry out more international research than those in larger countries (see Table 1).

Professor Jean-Claude Thill from the Department of Geography and Earth Sciences at UNC Charlotte explains: "There seems to be an inverse relationship between the degree of

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Rank	Country	Collaboration % 2007
1	Switzerland	55.9%
2	Chile	53.8%
3	Denmark	51.6%
4	Belgium	51.6%
5	Bulgaria	50.9%
6	Hong Kong	50.7%
7	Austria	50.0%
8	Sweden	48.0%
9	Norway	48.0%
10	Portugal	47.0%
11	Romania	46.7%
12	Slovakia	46.5%
13	New Zealand	46.2%
14	Ireland	45.9%
15	Hungary	45.7%
16	Netherlands	45.5%
17	Thailand	45.3%
18	France	43.8%
19	South Africa	43.6%
20	Finland	43.2%
21	Argentina	42.4%
22	Germany	41.9%
23	Canada	39.8%
24	Mexico	39.5%
25	Ukraine	39.5%

Rank	Country	Collaboration % 2007
26	Czech Republic	39.3%
27	United Kingdom	39.0%
28	Australia	38.7%
29	Israel	38.4%
30	Singapore	38.4%
31	Slovenia	37.6%
32	Italy	36.4%
33	Malaysia	35.9%
34	Egypt	35.3%
35	Spain	34.9%
36	Greece	33.7%
37	Russian Federation	33.1%
38	Poland	31.3%
39	Pakistan	27.7%
40	Brazil	27.2%
41	Croatia	27.0%
42	USA	26.4%
43	Korea, Republic of	23.8%
44	Japan	21.0%
45	Iran, Islamic Republic of	20.3%
46	India	17.8%
47	Taiwan, Province of China	15.7%
48	Turkey	15.3%
49	China	13.4%

Table 1 – Countries with an output of more than 5,000 articles in 2007 are ranked on their collaboration percentage. This percentage is calculated by counting the number of articles on which authors from more than one country have collaborated, divided by the total number of articles.
Source: Scopus

internationalization and the size of the country. Small countries offer fewer opportunities for interaction within their borders and therefore present a strong incentive (push factor) for international collaboration. Conversely, large countries offer internally plenty of research collaboration opportunities."

Professor Richard Sternberg from the University of Washington discusses the particular situation of the USA in this ranking: "In Europe, where many countries are tied together in a union, when a French scientist does field work with a Spanish scientist on a beach near the French/Spanish border and they publish a paper together, it's considered international collaboration. In America, when a scientist from Oregon does field work with a scientist from North Carolina on a beach on the outer banks of Carolina (5,000km away from Oregon) and they publish a paper together, it's not considered international collaboration."

Professor Markus Fischer from the University of Bern, Switzerland – the country that ranked first for international collaboration – agrees: "My first idea is that small countries have higher outside collaboration". Switzerland occupies first place, even in comparison to smaller countries. Professor Fischer suspects that additional factors, such as high overall output, higher-quality research and some cultural and/or language differences may explain some of the remaining variation.

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Funding cross-border research

Funding issues can also play a part, encouraging internationalization in some regions while stifling it in others. Professor Stenberg says: "In the European Community, scientific research money is dedicated to fund collaborative research projects between scientists from different member states. The US government does not have such a mandate, per se."

Professor Thill agrees: "The structure of national research funding agencies in the USA is such that there are few funding opportunities for cross-national research." And, even where opportunities do exist, it can take a long time before research can even begin. Professor Stenberg explains that in his experience, "it took at least two, and usually more, years of planning and negotiating to get funded."

Internationalism as national policy

Ranking second in our table is Chile. Atilio Bustos González, Director Sistema de Biblioteca from the Pontificia Universidad Católica de Valparaíso in Chile, is not at all surprised by Chile's high ranking: "The research community in Chile is small, with just 2.96 researchers per 1,000 citizens of working age. Therefore, international collaboration is mandatory. We even have a national agency of research and universities, CONICYT, to stimulate international collaboration."

Part of this high level of international collaboration can be attributed to astrophysics, one of the main areas of output and impact of Chilean research. Bustos González explains: "European South Observatory and Cerro Tololo (USA Observatory) are the main astrophysical installations in the southern hemisphere. American and European researchers work together with Chile on projects financed by these governments. This results in many international publications. The main countries with which Chile collaborates are the USA, Spain, Germany, France, England, Brazil and Argentina."

Another contributing factor is that many researchers are educated abroad. "For many years, the nation's strategy for developing researchers has been to stimulate education in developed countries. One consequence of this strategy is that Chilean researchers often publish with their international colleagues," he adds.

While the nature of contemporary research questions often demands collaboration with researchers across national boundaries, many countries are also forced by geographical limitations or encouraged by national policies to pursue more internationalization than others. The size and resources of a country have a clear effect on the frequency with which local researchers will seek foreign collaborators, but in those regions where government policy restricts or slows the ability of researchers to reach out, even research topics that require international collaboration can be stifled.

Useful links:

In Issue 11, Jamo Saarti at Kuopio University, Finland, also underlined the importance of international collaboration in research, especially with regard to improving institutional rankings.

References

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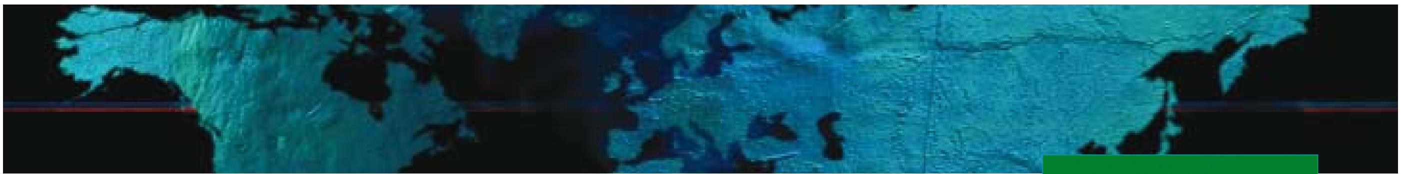
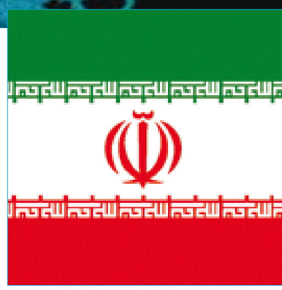
Regional focus



Iranian universities pushing ahead



JUDITH KAMALSKI

Europe may have eclipsed the Middle East during the Renaissance, but as the number of publications from Iran grows, a revival seems to be gathering pace. It has been suggested that this may be related to the importance that Iran attaches to the development of nuclear technology. Another reason could be the positive effects of reformist president Mohammad Khatami, who has shown a strong commitment to higher education *(1)*.

In a recent study *(2)*, Zouhayr Hayati and Saeideh Ebrahimy analyzed the scientific output produced by institutes and organizations in Iran, motivated by the observation that the "recent policy of government officials to increase participation has substantially increased the number of Iranian scholars in international journals."

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They compared universities to research institutes and other organizations and found that there was no difference in the citation impact of the papers produced by the three groups, but there was a difference in quantity: universities produce more papers.

Productivity reaps citations

Using Scopus data, Research Trends identified the top-five prolific and cited Iranian universities and institutes in 2007 (see Tables 1 and 2 respectively).

Top-five prolific institutes	Number of articles in 2007
1. University of Tehran	2,006
2. Sharif University of Technology	1,122
3. Daneshgahe Azad Eslami	1,011
4. Daneshgahe Tarbiat Modares	879
5. Amirkabir University of Technology	746

Table 1 – Scientific output of the most prolific institutes in Iran in 2007
Source: Scopus

Top-five cited institutes	Citations, two-year rolling
1. University of Tehran	1,960
2. Daneshgahe Tarbiat Modares	1,260
3. Sharif University of Technology	1,135
4. Daneshgahe Azad Eslami	1,027
5. Shiraz University	778

Table 2 – Number of citations in 2007 to publications from 2005 and 2006 for the most-cited institutes in Iran
Source: Scopus

There is little difference between the two Tables; the most productive institutes are typically also the most cited.

Indeed, Hayati and Ebrahimy show a positive correlation between an institute's scientific output and the number of citations for all three groups (Pearson's correlation = 0.94). They also found that the average number of citations per article – a measure of the impact these articles have had in the scientific community – was higher for more productive institutes (Pearson's correlation = 0.21).

When trying to replicate these correlations with Scopus data, we investigated articles published in 2005 and 2006, and citations to those articles in 2007. We did not distinguish between the three groups of institutions. We found a very strong positive correlation between article output and citations received (0.94), but this can hardly be considered surprising; as the number of articles written increases, it is a given that the number of citations will also increase.

To show that the number of citations per article rises as the number of articles that are published increases, there would need to be a positive correlation between output and citations per article. In Hayati and Ebrahimy's study the Pearson's correlation was low, and in this present study it is lower still, at a mere 0.0002. Taken together, this suggests that no such relationship between productivity and citation impact exists for universities and research institutes in Iran.

Attracting international attention

When looking at international collaboration, we see the same pattern. If an institute publishes many papers, the number of international collaborations is also high (Pearson's correlation = 0.73). However, when we look at the correlation between the number of papers and the percentage of articles that are written in collaboration with international partners, the correlation becomes less convincing (Pearson's correlation = 0.53).

In a broader context, Iran as a whole is on the right track. Figure 1 illustrates how the number of Iranian articles published has shown year-on-year growth of 25% over the last 12 years.

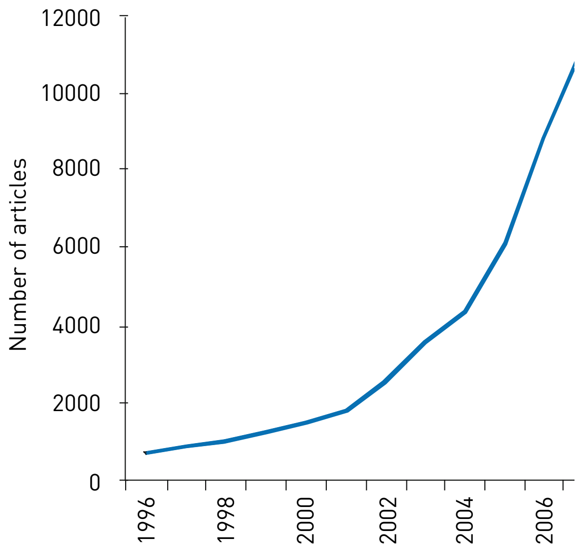

Figure 1 – Number of articles from Iran published between 1996 and 2007
Source: Scopus

Figure 2 shows how citations to Iranian research have also increased over the same time period, and that this increase cannot solely be explained by increased self-citations from Iran. Internationally, Iranian research is being cited more and more.

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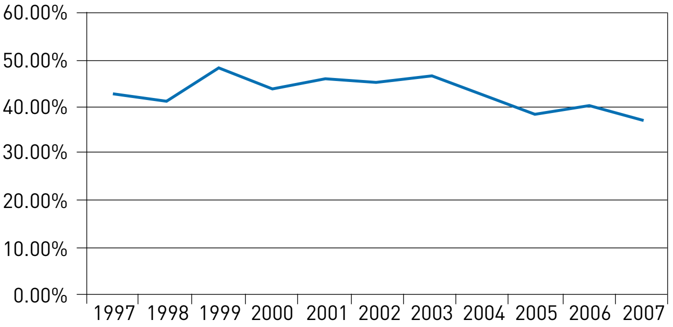

Figure 2 – Percentage of self-citations for Iran as a rolling two-year measure (citations in 2007 to articles published in 2005 and 2006)
Source: Scopus

Findings in both the article by Hayati and Ebrahimy and the present study show that Iranian institutes are on the right track when it comes to increasing the total number of articles and the total number of citations. Relatively speaking, citations per Iranian article remains constant, as there is not a strong correlation between increased output and the number of citations received per article. As global perceptions of Iranian science shift over the coming years, we may see Iran begin to take its place among the scientific nations of the world.

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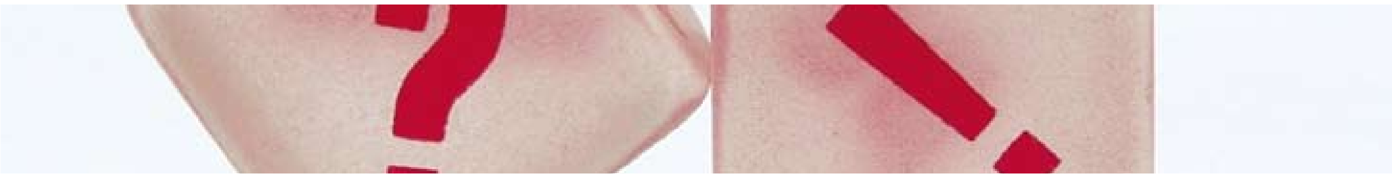
(2) Hayati Z. and Ebrahimi S. (2009) 'Correlation between quality and quantity in scientific production: A case study of Iranian organizations from 1997 to 2006', Scientometrics, Vol. 80 issue 3, pp. 625-636

People Focus



Jorge Hirsch: the man behind the metric

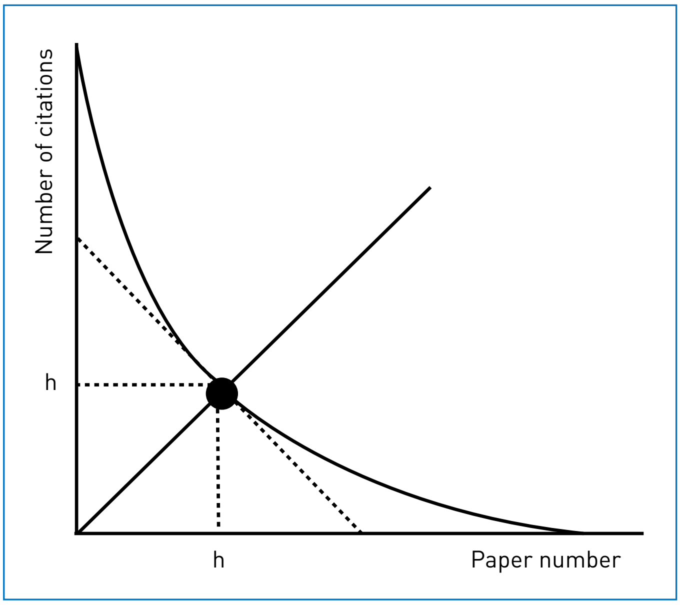
VICKY HAMPTON

The *h-index*, conceived in 2005, is the number of papers by a particular author that receive h or more citations. The letter 'h' stands for 'highly cited'. It has already become one of the most widely used metrics for research evaluation, and has been adopted by bibliometricians and non-bibliometricians alike. Professor Jorge Hirsch, whose academic career in physics has taken him from Buenos Aires to Chicago to San Diego, talks to Research Trends about where it all started.

Research Trends (RT): What triggered your interest in bibliometrics?

Professor Jorge Hirsch (JH): There were two main reasons: I had trouble getting papers accepted in journals with the highest Impact Factors because of the controversial nature of my research. Fortunately, there were journals with lower Impact Factors that did accept my papers. Nonetheless, they were well cited, meaning other researchers found them useful. A criterion often used in evaluating research achievement was to count papers published in high Impact-Factor journals; I wanted to provide an alternative criterion.

Secondly, I was on committees where I had to evaluate and compare research achievements of candidates for academic positions at my institution. I felt that too much weight was often placed on subjective criteria – such as letters of recommendation – rather than objective ones.



RT: How are bibliometrics perceived by physicists?

JH: Opinions are wide ranging: some hate them, some love

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them, and some have mixed feelings. There seems to be a strong correlation between how physicists perceive bibliometric indicators and how highly they rank with them as individuals. I imagine this is the case in other disciplines, too.

RT: How did you come up with the *h*-index?
JH: I have always paid a lot of attention to citations. If somebody writes a lot of papers that aren't cited, it is very difficult to judge whether those papers have any value. In exceptional cases – for example, when research is very novel and not yet understood by the community – it does. But in most cases, un-cited papers are and remain irrelevant. So the number of papers an author writes is not a good indicator of the research achievement of that individual. The cumulative total number of citations for an individual is often not very useful either, because currently most research is collaborative and an author may receive a lot of citations for papers in which his/her role was not very important.

In response, I tried to look carefully at the entire citation record of the individual I was evaluating – that is, at the citation numbers for a large number of his/her papers. This is both time consuming and often inconsistent between candidates, so I wanted to devise an indicator that could be applied simply and consistently, and reflected achievement as much as possible.

Looking at the citation index of many physicists, I came up with the *h*-index in 2003 and started applying it to physicists I knew, immediately finding a strong correlation between my subjective opinion of them and the value of their *h*-index. I shared the idea with colleagues, several of whom gave me very positive feedback. Two years later, I decided to write a paper on it.

RT: Did you foresee the influence that the *h*-index would have on academia?
JH: I had not worked in bibliometrics before and was not totally familiar with the literature on the subject. I had recently read an **article on bibliometrics by S. Redner in Physics Today (June 2005)** that I found very interesting, and it made me realize how important people find these issues. But I had no idea how my paper would be received, nor whether it would be publishable in a scientific journal.

So I am certainly surprised and happy that my work has been well received. I am especially pleased that it's attracted attention across all scientific disciplines, not just in physics or even natural sciences. I have some concern, however, that the *h*-index may sometimes be misused by over-relying on it, although I don't know of any specific instances.

RT: Do you intend to publish further work in bibliometrics?
JH: Yes. Although it is not the main focus of my research at present, I would like to understand the issues better and contribute to the subject.

RT: What do you think of the use of bibliometric indicators for evaluation purposes (e.g. grants, tenure, career advancement, funding, etc.)?
JH: I certainly think bibliometric indicators should play a role in evaluation, keeping in mind that there is a danger of over-reliance on them. Especially in life-changing decisions such as granting or denying tenure, the role of bibliometric indicators should be limited, and complemented by detailed analysis of the candidate and direct evaluation of the scientific content of their research. Such analysis should be especially thorough in cases where there is a large discrepancy between the direct evaluation and the collective evaluation of the scientific community as reflected in the bibliometric indicators.

I believe bibliometric indicators can be particularly useful in aiding decisions on distributing grant support; although it should be kept in mind that non-mainstream research can be undervalued by bibliometric indicators, and could still be highly deserving of support. Bibliometric indicators should always be used alongside other indicators and good judgment.