Research Trends

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Small countries lead international collaboration

Judith Kamalski
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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%.

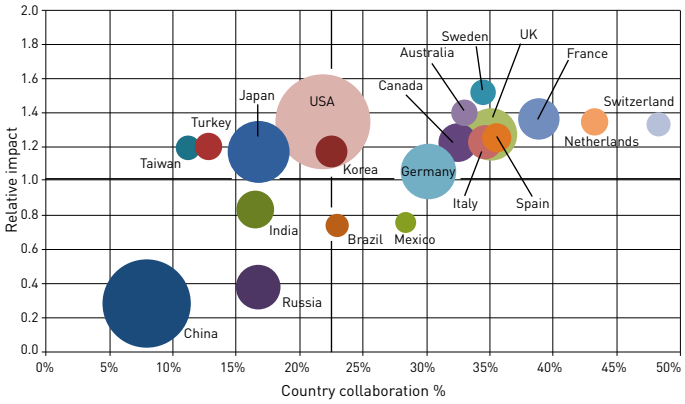

Figure 2 – Country collaboration versus Impact for the 20 most-prolific countries in the subject area "Energy", 1996–2007. Source: Scopus

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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(1) Archambault, E. et al (2009) Bibliometric analysis of leading countries in energy research. Science-Metrix.
(2) Scival Spotlight – Information Website.
(3) McKenna, P. (2009) 'Obama says US in global race to develop clean energy', New Scientist.
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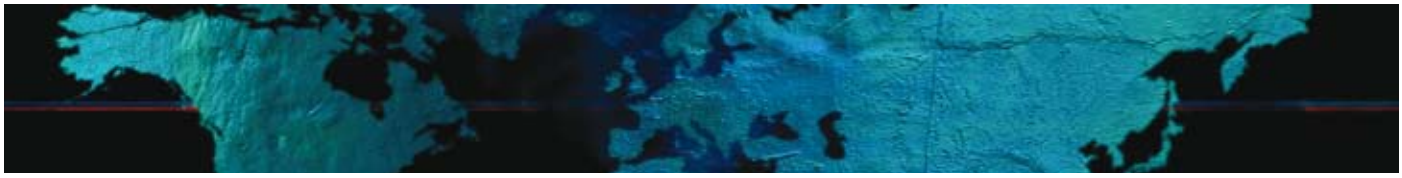
Country trends



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

(1) Leydesdorff, L. and Wagner, C.S. (2008) 'International collaboration in science and the formation of a core group', Informetrics, 2, pp. 317–325.

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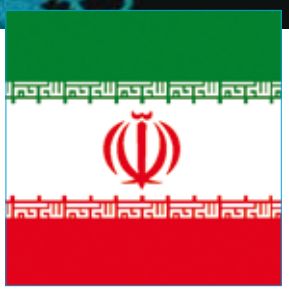
Regional focus

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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