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## Emerging scientific networks

Gali Halevi  
*Elsevier*

Henk F. Moed Dr

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## Section 2: Country Trends

### Emerging scientific networks

Gali Halevi and Henk F. Moed

Examining the scientific output of countries around the world is an effective way to identify emerging scientific competencies on national, institutional and topical levels. Various studies in this area have identified up-and-coming countries in South America, Africa, Asia and Europe<sup>1-5</sup>. These studies not only describe how particular countries actually invest in their science by mapping publications by research topics and disciplines, but can also help identify the factors that stimulate or harm scientific development by pointing to over- or under-investment in particular fields and/or research groups.

#### Inward or outward?

In this piece we focus not only on the scientific output as seen in publications, but also on the formation of emerging scientific networks in a number of countries from different geographical regions. These networks were defined in terms of “Inward” and “Outward” connections. “Inward” connections denote scientific collaborations mostly conducted between institutions in the same country; “Outward” connections are those between institutions in different countries. Looking at the Inward/Outward

characteristics of these emerging scientific networks reveals the differences between institutions and countries at the level of international versus domestic scientific participation, and also helps identify the specific disciplines and topics that foster such scientific network exchanges.

#### Countries of interest

This study focuses on the analysis and identification of institutions in selected countries in Africa, Central America, Eastern Europe, Arab nations and South Asia, all of which have shown a surge in scientific output in the past 5 years. The analysis was conducted in four steps. In the first step, a selected list of countries per region was compiled (see [Table 1](#)). In the second step, these countries were searched using Scopus database for 2005–2010 publications. The country with the higher number of publications was then searched individually in the third step in order to identify the institution with the highest scientific output. Finally, using Scopus Affiliation Profile, further analysis into each institution’s topics and collaborations was completed. The results are presented in [Table 2](#).

Africa	South Africa, Nigeria, Egypt, Kenya, Tunisia, Algeria, Morocco, Tunisia, Uganda, Namibia, Ghana, Cameroon
Eastern Europe	Estonia, Latvia, Lithuania, Poland, Czech Republic, Slovakia, Hungary, Romania, Bulgaria, Slovenia, Croatia, Bosnia-Herzegovina, Serbia, Kosovo, Albania, Montenegro, Macedonia
Arab Countries	Iran, Iraq, Jordan, Lebanon, Qatar, Saudi Arabia, Syria, Turkey, United Arab Emirates, Yemen
Central & South America	Panama, Costa Rica, El Salvador, Nicaragua, Honduras, Guatemala, Belize, Argentina, Brazil, Bolivia, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela
South Asia	Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, Vietnam

**Table 1** – List of selected regions and countries.



Table 2 shows the five countries displaying the highest number of publications in the different regions, and the institutions that display the largest number of publications, for 2005–2010. These results suggest that the nature of scientific collaborations — Outward or Inward — are not determined by the scientific field under study. For example, both Singapore and Saudi Arabia published significantly in Engineering, yet these countries show different collaborative characteristics: the former tend to be Inward, while the latter are Outward. Similarly, while both South Africa and the Czech Republic are strong in Medicine, they typically engage in Inward and Outward collaborations, respectively.

**Close to sight, close to heart**

In fact, the distinction between Outward and Inward collaborations obscures the fact that both kinds of collaboration tend to occur between geographically close countries. For example, Saudi Arabia’s Outward collaborations are largely carried out with groups based in India and Pakistan, countries that are relatively close to Saudi Arabia compared with, say, the US or Western Europe. Likewise, while the Czech Republic collaborates with institutions outside its borders, they are typically geographically close (that is, other European countries).

This examination of disciplinary foci and collaborative formations shows that despite the differences in research activities and collaborative trends, collaborations are typically formed between institutions that show relative geographical proximity. This trend could be a result of many factors. For example, researchers may be more likely to form personal connections with colleagues from nearby countries, perhaps because they encounter each other at regional talks and conferences more often than colleagues from countries further afield. In addition, researchers may find it easier to work with colleagues who share the same language, or other cultural characteristics.

Region	Country	Most productive institution	Dominant disciplines in most productive institution	Collaborative orientation	Most productive institution’s major collaborators
Africa	South Africa	University of Cape Town	Medicine and Agricultural & Biological sciences	Inward	Univ Stellenbosch; Univ Witwatersrand; Groote Schuur Hospital; South African Medical Research Council
Central America	Costa Rica	Universidad de Costa Rica	Agricultural and Biological Sciences	Outward	Texas A and M Univ; Smithsonian Tropical Research Institute; Univ Nacional Autónoma de México; Univ Sao Paulo
Eastern Europe	Czech Republic	Univerzita Karlova v Praze (Charles Univ, Prague)	Medicine and Biochemistry	Outward	Institutions in Russia, France and the UK
Arab	Saudi Arabia	King Fahd Univ Petroleum and Minerals	Engineering	Outward	Institutions in IEEE, India and Pakistan
South Asia	Singapore	National University of Singapore	Engineering, Physics and Astronomy	Inward	Inst. Materials Research and Engineering, A-Star, Inst. Infocomm Research, A-Star, Yong Loo Lin School of Medicine

Table 2 – Most productive institutions and their collaborators in five countries.

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