Researchers on the move: The impact of brain circulation

As researchers move across institutions, at home or abroad, they help knowledge circulate worldwide. A newly developed indicator for the OECD Science, Technology and Industry Scoreboard 2013 tracks changes in the affiliation of scientific authors publishing in scholarly journals over 1996-2011. As researchers publish, they leave a trail of their mobility linked to changes in the institutions they are affiliated to, as reported on their publications (see Box on page 2). What is the impact of mobility? On average, the research impact of scientists who change affiliations across national boundaries is nearly 20% higher than that of those who never move abroad. For many economies, raising the performance of these “stayers” to the level of their internationally mobile researchers would allow them to catch up with leading research nations.

There are marked differences in the international mobility of scientists...

Swiss-based authors have the largest mobility rates; nearly 20% have a previous affiliation abroad. In Japan, Brazil and China, researcher mobility stands at less than 5%, which is also linked to the relatively large size of their research systems. Many mobile research scientists are not entirely new to the economy they currently work in. Some were initially affiliated to institutions in the same country but had interim publications under a foreign affiliation. This type of mobility (returnees) is typically just as important as that from new inflows. In some economies like the Czech Republic, Italy or the Russian Federation, a majority of inflows are returnees, while in Switzerland and Singapore the majority of researchers with an international mobility record are new inflows.

**Figure 1. International mobility of scientific authors, 1996-2011**
As a percentage of authors with two or more publications, by last reported affiliation

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*StatLink* [http://dx.doi.org/10.1787/888932891530](http://dx.doi.org/10.1787/888932891530)

*Note:* This is an experimental indicator.


The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities or third party. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

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Using bibliographic sources to track scientist mobility

Scientific authors are listed in the Scopus database of peer-reviewed scientific publications and identified by the unique author ID assigned by Elsevier. Episodes of international mobility and general profiles can be inferred from authors with at least two publications over the reference period, based on the sequence of changes in institutional affiliation revealed in those publications:

- **Stayers** maintain the same country of affiliation over their entire record.
- **Returnees** begin in the final country but “move” before returning, while new inflows are not first affiliated to institutions in their last recorded country.
- **Outflows** concern those who do not return to their first affiliation.

A proxy measure of scientific impact is estimated by calculating, for each author and mobility profile, the median journal source-normalised impact per paper (SNIP). SNIP measures citation impact by calculating the ratio of a journal’s citation count per paper and the citation potential in its subject field.

**Limitations**

Bibliometric indicators provide a complementary picture of researcher mobility at the global level. First developed by Elsevier (2011), these are experimental and require careful interpretation (Moed et al., 2013). Mobility records are less accurate for less prolific authors and for those who move from and into roles for which disclosure in scholarly journals is not the norm, like in the case of researchers working in industry. Expanding the reference period can help capture more complex mobility patterns (e.g. to show that an individual returns to an initial affiliation requires at least three observations) but can introduce other biases. Institutional affiliations are often recorded with a lag and may not reflect where the research took place. Affiliations may also be multiple and require disambiguation. Failure to assign author IDs consistently can also distort mobility estimates by understating mobility when an individual has multiple IDs or overstating it for individuals with common names. A global initiative – the open researcher and contributor ID (ORCID) – seeks to deal with this problem by assigning unique identifiers linkable to an individual’s research output.

...which has implications for the citation impact of scientists

The newly calculated indicators show that, with few exceptions, stayers are more likely to publish in journals of lower quality, as proxied by the SNIP measure of citation impact for journals. In economies with lower average research citation impact, outflows tend to have the largest impact factors. Returnees help to increase quality scores, as do new inflows (Figure 2).

**Figure 2. Impact of scientific authors, by category of mobility, 1996-2011**

Based on the median source-normalized impact per paper (SNIP)

Note: This is an experimental indicator.

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The international mobility of researchers is a potential source of concern for economies that invest in the training of scientists, a highly mobile population, on the basis that they may move abroad and take valuable knowledge with them without a countervening flow. Policy makers can thus ask themselves about the overall balance of international mobility. One specific question concerns whether leavers have a higher or lower citation impact than inflows. Over the period for which data are available, 1996-2011, for a large number of economies, including Portugal, Japan, Netherlands, and Switzerland, outflows and inflows publish in journals of comparable quality (Figure 3). In these cases, the “quality” of an incoming researcher approximately offsets the “loss” of citation impact associated with a departing researcher. In the cases where flows are of a comparable magnitude, mobility results in a significant degree of knowledge circulation without any specific “winners” or “losers”.

However, for many other economies, the “quality” of outflows exceeds that of inflows. This is the case for Italy, Korea, Chile, China, India, Brazil and especially the Russian Federation, where the gap is largest. For only a few economies, some of which attract large researcher inflows, the expected impact of inflows has exceeded that of outflows. This includes the United States, the United Kingdom, Singapore, Hong Kong (China), Chinese Taipei and also Spain, which managed to attract a significant number of researchers from abroad over the period considered. As discussed below, a wide range of factors affect the movement of researchers, thus changes in funding levels or stricter migration policies may contribute to changes in this trend after 2011.

**Figure 3. The impact of internationally mobile scientists, inflows versus outflows, 1996-2011**

Based on citation impact and changes in the affiliation of scientific authors

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Note: This is an experimental indicator.


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1 There is also some evidence that researchers, after having moved abroad, continue to work and publish with their previous co-authors networks. This implies that some of the alleged potential losses from outward mobility may be overstated.
The network of mobile scientists is highly interconnected

The experimental indicators on mobility enable an assessment of the size of bilateral researcher flows. The top nine international bilateral flows (Figure 4) involve exchanges with the United States. While the total inflow exceeds the outflow, more scientists who start by publishing in the United States move to affiliations in China and Korea than vice versa. The United Kingdom is the second most connected economy. German-based researchers moving to Swiss affiliations account for the largest flow between non-English speaking countries. These statistics do not account for the mobility of individuals before their first publication, e.g. as students. As a result, many of these flows may represent Chinese and Korean nationals returning to their home countries.

Although leading research economies tend to attract more scientific authors from abroad to offset outward flows, flows within each pair of countries tend to be of a similar order of magnitude in both directions, suggesting the existence of complex patterns of knowledge circulation representing the mobility of individuals at different stages of their careers, from students to established professors. The implied international mobility network of scientists (Figure 5) also displays a number of interesting patterns that reveal affinities between different economies based on linguistic, historical as well as political and cultural linkages.

Economic factors are also likely to play a major role in driving observed mobility patterns. Evidence from the OECD/UNESCO study on the Careers of Doctorate Holders (CDH) shows that median gross annual earnings, converted in purchasing power parities (PPPs), vary greatly across economies, ranging from 18 306 US dollar PPPs in the Russian Federation to 93 000 in the United States. Doctorate holders are least well paid in Central and Eastern European countries (with the exception of Slovenia), while the highest median gross annual earnings are found in the United States and the Netherlands. Although with a different target population, a large variation in the remuneration of researchers across countries was also noted in a study conducted by the European Commission in 2007 (EC, 2007).
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The recent GlobSci survey study by Franzoni et al. (2012) provides some confirmatory evidence for these findings. A high share of foreign-raised scientists study and work in a number of countries. The survey also shows that many economies, not only the United States, rely strongly on foreign talent. Their study also shows that there are some economies – including India, Italy, Japan, Brazil and Spain – where foreign scientists and engineers are extremely rare. Some of these are countries exhibit average mobility rates according to the new OECD indicator, thus suggesting that many of those mobile researchers are returning former students or academics. Consistently with the OECD bibliographic results, this survey also finds considerable variation in migration patterns across countries. Swiss and Indian scientists are the most mobile; those from the United States the least. The survey also documents that, as is the case in the CDH study, for virtually all the core countries studied, the United States is the dominant destination country.

Figure 5. International mobility network of scientific authors, 1996-2011
Counts of bilateral flows, by first and last affiliation

Note: This is an experimental indicator.

How to read this figure
The position of selected economies (nodes) is determined by the number of bilateral flows of publishing scientific authors from 1996 to 2011. A visualisation algorithm has been applied to the international mobility network to represent the linkages in a two-dimensional layout where distances reflect the combined strength of mobility forces between economies. Bubble sizes are proportional to the number of scientific authors who stay in the economy. The thickness of the arrows joining the nodes represents the number of moves between each pair. A difference in the size of the arrow tip within each pair denotes a marked difference in the volume of flows in each direction.

From mobility to collaboration, leadership and impact

Data from the OECD/UNESCO CDH study indicate that academic motivations are the main self-reported drivers of past and planned international mobility decisions. Subject to constraints, researchers appear to use international mobility as a mechanism to gain personal access to leading researchers, centres of expertise and networks that enable them to progress in their research careers. The central position of the United States in the mobility network thus comes as no surprise. The United States led the production of scientific publications over 2003-11. Although China accounts for the second largest number of scientific documents, it lags the United Kingdom and Germany in terms of numbers of highly cited documents.
Mobility is an important conduit to expand collaboration networks. Evidence also presented in the 2013 STI Scoreboard\(^2\) shows that economies with higher international collaboration rates tend to have higher average citation rates (Figure 6) and top-cited publications are more likely to involve scientific collaboration across institutions (especially international) than “average” publications. International collaboration appears to allow economies to attain higher citation impact rates than they would otherwise achieve. For many, this involves participating in projects led by experts in centres of excellence located abroad. Collaboration allows authors from countries to contribute to and get credit from highly cited papers. One possible approach to constructing scientific leadership indicators when there is international collaboration is to attribute each highly cited document to the country of affiliation of the corresponding author.

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Such an adjustment significantly reduces most economies’ share of top-cited over total domestic publications (Figure 7). For example, in Switzerland, this share drops from nearly 20% to 10%. However, for the United States, the adjustment is fairly minor, from 17% to 14% of domestic publications. It is therefore the economy with the largest share of high-impact, domestically led documents, followed by the Netherlands and the United Kingdom. This suggests that authors from these economies are more likely to feature as leading authors in international collaborations.

For further information, please see:

www.oecd.org/sti/scoreboard.htm

OECD/UNESCO Project on Careers of Doctorate Holders
www.oecd.org/sti/cdh

OECD work on international migration
www.oecd.org/migration

Other references:


