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The globalisation of scientific mobility, 1970–2014☆

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ABSTRACT

This article provides an empirical assessment of global scientific mobility over the past four decades, based on bibliometric data. We find (i) an increasing diversity of origin and destination countries integrated in global scientific mobility, with (ii) the centre of gravity of scientific knowledge production and migration destinations moving continuously eastwards by about 1300 km per decade, (iii) an increase in average migration distances of scientists reflecting integration of global peripheries into the global science system, (iv) significantly lower mobility frictions for internationally mobile scientists compared to non-scientist migrants, (v) with visa restrictions establishing a statistically significant barrier affecting international mobility of scientists hampering the global diffusion of scientific knowledge.

1. Introduction

International mobility is a key feature of careers in science and may contribute to the creation and international diffusion of scientific knowledge, with hope for mutual benefits accruing to the origin and destination societies alike. There is, however, a lack of sound empirical evidence to underpin such claims (Horlings & van den Besselaar, 2013). From a theoretical point of view, it is far from certain that the international mobility of scientists leads to greater global scientific equality. While mobile researchers may gain individually by increasing their scientific productivity and expanding their professional networks — for instance through international conference attendance, visiting fellowships, undertaking PhDs and post-doctoral fellowship abroad, or even temporary or permanent migration for academic employment — it cannot be taken for granted that each national scientific system benefits equally from this scientific mobility (Guellec & Cervantes, 2001, pp. 71–99). In fact, we can hypothesise that under certain circumstances an academic 'brain drain' will reinforce global scientific inequalities by draining developing countries of their scientific talent, thus undermining their future scientific capacity. Consequently, while globalisation may create new scientific opportunities and better access to scientific knowledge by making it easier for scholars to work anywhere, in many respects, mobility of scientists may also reinforce existing scientific inequalities and potentially erect new barriers to the diffusion of knowledge (Altbach, 2004).

This raises fundamental questions about the extent to which scientific knowledge production and collaboration disseminate universally and lead to convergence between national science systems. In this paper, we provide empirical evidence on the patterns and dynamics of academic mobility in global scientific knowledge production and dissemination processes over the last four decades.

It is often assumed that a globalisation of science facilitates increasing dissemination and improved access to scientific knowledge; however, the bulk of global scientific knowledge production (of about three million scientific publications per year) is still concentrated in a few hundred major universities and research institutions in economically developed, mostly Western, countries, which produce the lion's share of global scientific output (Altbach, 2004; Czaika & Toma, 2017; Royal Society, 2011; Shils, 1972).

It is unclear how international scientific mobility has affected such inequalities over the past four decades. Some argue that the growing interconnectivity through developments in communication and transport technologies have made physical mobility less important, and thus global access to scientific opportunities and knowledge more egalitarian, akin to more general arguments that globalisation processes have 'flattened' the world by making global opportunity structures more equal (Friedman, 2005; Saxenian, 2005). Other scholars have argued that the globalisation of science is a highly asymmetrical process that furthers the concentration of scientific activity in particular countries and institutions (Florida, 2005; Horlings & van den Besselaar, 2013). For instance, while international research collaborations appear to be highly concentrated within various global scientific hubs with vast disparities across wider and more peripheral world regions (Horlings & van den Besselaar, 2013; Leydesdorff, Wagner, Park, & Adams, 2013),

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an increasing number of research institutions in some emerging Asian and Latin American economies are gradually expanding their scientific capacities to world class standards, which is often seen as evidence of a scientific catching up process (OECD, 2008, pp. 1–165; Freeman, 2006). However, these developments seem to shift global scientific imbalances only at the margin, and the question whether diffusion of scientific knowledge from global scientific hubs to peripheries is leading to a global scientific convergence remains open.

Overall, the links between increasing academic mobility, scientific collaboration and knowledge diffusion are theoretically and empirically under-explored. Academic mobility can be seen as an integral part of the global scientific system, in which the mobility of researchers is not only a driver of knowledge transfer, but also a consequence of international and inter-institutional opportunity differentials for conducting high-level scientific research (Ackers, 2005; DTI, 2002; King, 2002). The prestige and the scientific quality of an institution, or even a country, in a particular scientific discipline are seen as important pull factors, but social and professional networks have also been found to influence the mobility decisions of scientists (Bauder, 2015; Williams, Baláž, & Wallace, 2004). Beyond professional motives, economic and non-economic factors, such as those related to individual life-cycles, seem to be influential in academics' mobility decisions (Stephan, 2010, pp. 217–273; Oliver & Ackers, 2005). The motivation to move, collaborate and exchange knowledge with other researchers is often linked to collegial affinity and intellectual complementarity to overcome cognitive, scientific and other resource limitations (Katz & Martin, 1997). While the organisation of collaborative research seems to be largely driven by an autonomous process among individual researchers, the availability of information and communication technology (ICT) that facilitates long-distance collaboration does not seem to make 'physical mobility' superfluous in acting as a replacement, but instead makes such face-to-face contact even more important (Gaspar & Glaeser, 1996; Orazbayev, 2017b; Stichweh, 1996).

Despite increases in connectivity and bandwidth, physical co-location is still assumed to play a key role in the transfer and exchange of (tacit) knowledge through face-to-face interaction and informal communication (Stephan, 2010, pp. 217–273; Katz & Martin, 1997; Scellato, Franzoni, & Stephan, 2015). Consequently, scientific mobility is both the result of international collaboration and a pre-condition for new collaborative ties, but to what extent and in which ways is rather unclear.

We use bibliometric data from Scopus, Elsevier's abstract and citation database of peer-reviewed literature, to construct scientific mobility data which covers research-active scientists globally since the 1970s. Scopus assigns a unique identifier to every author, this identifier can be combined with scientist's affiliation to infer the international mobility of research-active scientists. An author who moves from an institution in one country to an institution in another country and keeps on publishing is hereby identified as a mobile scientist (Meho & Sugimoto, 2009; Moed & Halevi, 2014; Moed, Aisati, & Plume, 2013). This method allows us to capture the intensity, direction, and diversification of global scientific movements. We develop a stylised theoretical framework to assess the frictions to mobility of scientists relative to all migrants. Finally, we provide evidence on the role of administrative mobility restrictions driving the pattern and dynamics of academic mobility. Migration policy variables have only recently been incorporated in quantitative tests on overall migration flows (Czaika & Haas, 2017; Mayda, 2010; Ortega & Peri, 2013), high-skilled migration (Czaika & Parsons, 2017; Orazbayev, 2017a), international knowledge flows (Orazbayev, 2017b) and mobility of research scientists (Appelt, van Beuzekom, Galindo–Rueda, & de Pinho, 2015).

The remainder of the paper is structured as follows. Section 2 describes the data and construction of the main variable. Sections 3 and 4 describe the empirical patterns of intensification and de-concentration of scientific mobility. The stylised theoretical framework is developed in Section 5, and we apply this framework to examine the impact of visa restrictions in Section 6. Section 7 concludes the paper. Technical calculation details and additional figures are provided in the Appendix.

2. Data

The data on mobility of scientists is constructed using the bibliometric information in Elsevier's Scopus database following a similar approach as Moed et al. (2013), Moed and Halevi (2014), and Appelt et al. (2015).[1] The dataset contains information on a wide range of peer-reviewed journals, books, conference proceedings and other scientific documents, which allows us to study the output of research-active scientists. After extracting affiliation information of authors, based on the name disambiguation data provided by Scopus we can infer whether an author's country of affiliation has changed between different publications. There are several methodological considerations to be taken into account, and in constructing the mobility data we follow, with some adjustments, the procedures outlined in Moed et al. (2013) and Moed and Halevi (2014). The underlying assumption is that an author's country of affiliation in any given year can be used to infer their most likely place of residence in that year.[2] Also, since this approach requires at least two scientific outputs per author, the sample will include only those scientists that remain active in research.

About 95% of authors have affiliations that allow unique identification of country of residence per year. Information on an author with single-country affiliation in a given year was processed as follows: if information on the country of affiliation is missing for any given year, then this information is inferred based on past or future countries of affiliations using two approaches. The fill-forward approach assumes that the author did not change country of affiliation during the inactive years, i.e. during the years when there are no publications; the fill-backward approach assumes that the author changed the country of affiliation one year after the last known affiliation. Once the information on each author's country of affiliation in every year was obtained, the mobility episodes were identified whenever the author changed their country of affiliation. In contrast to Moed et al. (2013), who use diachroneous and synchronous approaches to identify episodes of out- and in-migration, respectively, we count episodes of mobility in a given year using information on all authors whose research activity includes this year, including the inferred location based on the fill-forward and fill-backward methods.

A small share of authors, about 5% in any given year, report affiliations in multiple countries. In such cases, mobility events were calculated assuming that the multi-country authors move between the (multiple) countries of their affiliation. For example, if a researcher was affiliated with countries A and B in year 2000, but her publications in 2005 show affiliation with countries C and D, then there are four distinct mobility events (A to C, A to D, B to C and B to D). The number of mobility events calculated using this approach is highly correlated with the number of mobility events estimated with single-country authors. The Pearson correlation between the number of mobility events estimated with single-country authors and the number of mobility events estimated using single- and multi-country authors is 0.95, and the Spearman correlation is 0.79.

To examine the robustness of our measures we also count more restricted episodes of mobility: mobility episodes within the first two, three, and five years of the research careers are ignored (this is similar to Moed et al., 2013's proxy for PhD students). The calculated aggregate measures are highly correlated with the measures obtained without the restrictions, with pairwise Pearson correlation in the high 0.90s. As a further check, the aggregate flows were compared with the measures from Appelt et al. (2015), who also use Scopus bibliometric data. Appelt

[1] The data was downloaded from Scopus API during 2015–2016 via http://api.elsevier.com and http://www.scopus.com.

[2] Note that this data might lag actual location due to the publishing lag.