Yenilmez *Applied Network Science* (2026) 11:65
https://doi.org/10.1007/s41109-026-00840-0

Applied Network Science

RESEARCH Open Access

# Fifty years of the world academic migration network

Taylan Yenilmez[1*]

*Correspondence:
Taylan Yenilmez
taylan.yenilmez@istanbul.edu.tr
[1]Department of Quantitative Methods, School of Business, Istanbul University, Istanbul, Turkey

**Abstract**
This study investigates how globalization has reshaped the world academic migration network. Using affiliation changes across almost 50 million Scopus articles, I construct five-decade-aggregated networks covering the period from 1974 to 2023. Three findings stand out. The network densifies and grows more equal: more country pairs are connected in each successive decade, and the share of flows captured by the largest hubs falls steadily, even as the United States retains the central position throughout. Reciprocity stays high at every threshold and in every decade, so academic migration is circulatory in structure rather than a one-directional drain from periphery to core. The rise of Asia takes the form of integration of China, India, and South Korea into the US-centered core, not a separate Asian cluster.

**Keywords** Academic migration, Network analysis, Bibliometric data, Globalization, Centrality, Migration networks

## Introduction

The world has changed fundamentally from the 1970s to the present. This period has been characterized by a steady rise in globalization and greater connectedness across all global systems. A key feature of this shift is the movement of the world's economic center of gravity toward the East (Balsa-Barreiro et al. 2019). The mobility of academics and other talent is essential to understanding these changes. Historically, the evolution of intellectual and economic centers has been driven by the mobility of scholars and the presence of immigrant talent (Koch et al. 2024; Mokyr 2016; Schich et al. 2014).

Global academic flows do not operate in isolated country pairs. They form a network with hubs and clusters, with a structure that provides valuable information beyond bilateral flows. Given this context, systematically analyzing the academic migration network is critical to answering some important questions. How has the worldwide network of academic migration evolved over the past 50 years, a period marked by rapid globalization? Have the dramatic global changes of the past five decades been reflected in patterns of academic mobility?

Answering these questions requires global data. Although assembling such data over a long time span may appear daunting, large-scale bibliometric data have been successfully

© The Author(s) 2026. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

Springer

used to infer academic migration (Moed et al. 2013; Moed and Halevi 2014; Czaika and Orazbayev 2018; Miranda-González et al. 2020; Aref et al. 2019; Subbotin and Aref 2021; Zhao et al. 2023; Sanliturk et al. 2023; Sanlitürk et al. 2024; Akbaritabar et al. 2024, 2025). Also, there are studies using network methods to analyze the academic migration flows (Chinchilla-Rodríguez et al. 2018; Verginer and Riccaboni 2020, 2021; Urbinati et al. 2021; Wang et al. 2020; Vaccario et al. 2021; Pei et al. 2024). However, there is still a gap in the literature for mapping the global academic migration network over a long span, focusing on its evolution in relation to global changes over the past decades. Filling this gap, this study reconstructs and analyzes the worldwide academic migration network over five decades and examines how its structure, country clusters, and country centralities have changed in relation to global transformations of the past decades.

The analysis shows that the academic migration network reflects the worldwide impacts of globalization. The network has significantly densified and become less concentrated around its dominant hub: the United States retains the central position throughout, but its share of global flows declines steadily as the system integrates more countries and inequality in degree distribution falls. China and other rising Asian countries emerge as new local hubs in the network. They have integrated into the US-led core rather than forming a separate cluster.

In the following sections, section "The relevant literature" reviews the relevant literature, laying the groundwork for understanding existing research in general and academic migration networks. Section "Definitions of the network variables" defines the variables critical for the network analysis. Section "Data" details the bibliometric dataset and the methodology employed to construct the academic migration network. Section "The network and the clusters in 50 years" presents a comprehensive network analysis and its results over the decades. Finally, section "Conclusion and further research" summarizes findings and suggests future research directions that could extend the insights gained from this study.

## The relevant literature

This study follows a macro perspective on migration and analyzes the world academic migration network where the countries form the nodes, and migration flows form the edges, while the micro perspective investigates the structure and impact of networks among individuals in migrant communities (Bilecen et al. 2018; Bilecen and Lubbers 2021; Bilecen 2021; Wissink and Mazzucato 2018; Popielarz and Cserpes 2018; Verdery et al. 2018; Vacca et al. 2018; Bilecen and Cardona 2018; Bojarczuk and Mühlau 2018; Poros 2001). Previous studies document rising interconnectivity and globalization in the world migration network, with persistent multi-cluster structures. They also identify key countries using centrality-based rankings and provide detailed snapshots of cluster structures and subnetworks (Davis et al. 2013; Danchev and Porter 2018; Aleskerov et al. 2017; Akbari 2021. Other work models the structure of migration networks, and finds that migration networks are closely linked to international trade patterns, consistent with gravity-type mechanisms (Windzio 2018; Fagiolo and Mastrorillo 2013; Leal and Harder 2021; Pitoski et al. 2024).

Academic migration is a subset of high-skilled migration, whose drivers, policies, and labour-market dynamics across countries and occupations are surveyed comprehensively in Czaika (2018). A growing body of literature infers academic migration from

bibliometric data by tracking changes in authors' affiliations across publications. Early studies established core measurement principles, while later work leveraged large-scale datasets to quantify global scholarly migration flows, assess the effects of shocks, and link academic mobility to economic development. Bibliometric data have been used to infer migration not only at the international level but also at the inter-city level within countries (Moed et al. 2013; Moed and Halevi 2014; Miranda-González et al. 2020; Subbotin and Aref 2021; Zhao et al. 2023; Sanliturk et al. 2023; Sanlitürk et al. 2024; Akbaritabar et al. 2024, 2025; Verginer and Riccaboni 2020, 2021; Vaccario et al. 2021; Bircan 2024; Bircan and Qi 2025). Most similarly to this paper, Scopus data covering between 1970 and 2014 has been used to analyze academic migration data by using gravity models, and an eastward shift in the center of gravity of scientific mobility has been documented (Czaika and Orazbayev 2018).

Many studies have applied network methods to academic migration. Academic migration flows for the 2000–2016 period have been extracted from the ORCID data, and HITS centrality has been applied to the network to identify influential countries (Urbinati et al. 2021). A complex network of scientific talent migration has been constructed for 37 countries over 2001–2013 using the data of patent applicants (Wang et al. 2020). PageRank centrality and community detection have been applied to the mobility of life scientists from the 1990s to the 2000s based on the MEDLINE database (Verginer and Riccaboni 2020, 2021). Using affiliation data in the Web of Science, a long temporal window of 1956–2016 has been employed for academic migration across all disciplines, with attention restricted to the small subset of super-movers who published from three or more countries (Aref et al. 2019). The networks of academic collaboration and mobility have been compared based on Web of Science data for 2008–2015 (Chinchilla-Rodríguez et al. 2018). Similarly, the co-evolutionary relationship between global scientific mobility and international research collaboration networks has been examined using Scopus bibliometric data spanning from 1788 to 2020 (Pei et al. 2024).

A gap remains for a network reconstruction that spans a long enough horizon to capture the globalization era, covers nearly all countries and disciplines, and is read explicitly as a record of how globalization has reshaped academic mobility. The network studies cited above either cover shorter spans, restrict attention to a subset of disciplines or countries, or focus on questions other than globalization itself.

This paper makes two contributions. First, it reconstructs the world academic migration network across five decade-aggregated snapshots from 1974 to 2023, covering all countries and all scientific disciplines, from affiliation changes in almost 50 million Scopus articles. Second, it uses this network to trace the footprint of globalization on academic mobility, applying a set of structural metrics (density, weighted in- and out-degree, HITS authority and hub scores, the Herfindahl-Hirschman Index, reciprocity, average path length, and modularity-based community detection) to each decade and reading the changes across decades as the structural signature of five decades of globalization.

## Definitions of the network variables

The academic migration network is represented as a directed weighted graph where countries are nodes and migration flows between them form directed edges. Let $N$ denote the total number of countries. We use two matrix representations: a weight matrix $\mathbb{W}$ and an adjacency matrix A.

The weight $W_{ij}$ records the share of the global academic migration flow that runs from country $i$ to country $j$, computed as $W_{ij} = M_{ij}/T$, where $M_{ij}$ is the count of inferred migrations from $i$ to $j$ and $T = \sum_{i,j} M_{ij}$ is the world total. The binary adjacency matrix is $A_{ij} = 1$ if $W_{ij} > \theta$ and $A_{ij} = 0$ otherwise.

Among prior network analyses of academic migration, most studies work directly with raw counts of mobile scholars on the edges (Verginer and Riccaboni 2020, 2021; Urbinati et al. 2021; Pei et al. 2024). I depart from the count-based convention and follow the share-based construction for two reasons. First, shares preserve the relative scale of countries within the global system, which is necessary to track how the structural weight of regions such as Asia has shifted over the past five decades, the central phenomenon this paper documents. I also do not normalize by country population, researcher stock, or any other size measure, since doing so would erase precisely the cross-country scale differences that the analysis is designed to capture. Second, the share approach permits consistent threshold-based comparisons of network architecture across decade snapshots. Table 1 summarizes the network-structural metrics computed in this study.

## Data

This study uses extensive bibliometric data from the Scopus database, which includes English-language journal articles published between 1970 and 2023. The dataset comprises 49,335,767 articles authored by 32,252,350 individuals, providing a comprehensive basis for analyzing academic migration patterns. The key information extracted from these articles is the affiliation data of the authors, specifically the countries associated with these affiliations. Each author in the Scopus database is assigned a unique Scopus ID, which enables tracking of their publication records over time. Linking this ID to the affiliation information provided in each article makes it possible to follow the

**Table 1** Network-structural metrics used in this study

| Metric | Definition |
|---|---|
| Density | $p = \sum_{i,j} A_{ij}/[N(N-1)]$. Share of possible directed links that are realized. |
| Reciprocity | $r = \sum_{i,j} A_{ij}A_{ji}/\sum_{i,j} A_{ij}$. Share of links whose reverse direction is also present. |
| Average path length | Mean shortest-path distance over all reachable directed node pairs. Unreachable pairs are excluded. |
| In/out-degree | $k^{in}(i) = \sum_j A_{ji}$, $k^{out}(i) = \sum_j A_{ij}$. Number of incoming or outgoing links. |
| Weighted in/out-degree | $w^{in}(i) = \sum_j W_{ji}$, $w^{out}(i) = \sum_j W_{ij}$. Country's share of incoming or outgoing global flows. |
| HITS hub and authority scores (Kleinberg 1999) | Mutually recursive scores $h(i) \propto \sum_j W_{ij}\, a(j)$ and $a(j) \propto \sum_i W_{ij}\, h(i)$, where $h(i)$ measures how well $i$ points to authorities and $a(j)$ measures how well $j$ is pointed to by hubs. Computed on $\mathbb{W}$. |
| HHI of weighted in/out-degree | $HHI^{in} = \sum_i w^{in}(i)^2$, $HHI^{out} = \sum_i w^{out}(i)^2$. Concentration of incoming or outgoing flows across countries. |

changes in an author's country of affiliation. There are 2,317,361 authors with more than one country of affiliation during the study period.

If an author has multiple country affiliations in a year, the country for that year is taken from the nearest adjacent year (preceding first, then subsequent) in which the author has a single country, if that country is also one of the affiliations in the ambiguous year. If no such adjacent year exists, the country most frequently associated with the author across the full publishing history is used. A migration event from country  to country $j$ is recorded whenever an author's assigned country in two consecutive observed years differs, and is dated to the year of arrival. By checking both preceding and subsequent years, the procedure avoids treating short-term affiliations as migrations when the author returns to the original country shortly after.

This data-processing method yields annual matrices of migration flows between countries. These annual matrices were aggregated into decade matrices as the basis for the analysis. As a result, five decade matrices were constructed, covering the periods 1974–1983, 1984–1993, 1994–2003, 2004–2013, and 2014–2023, where each matrix records the total number of inferred migrations from one country to another. The 1970–1973 period was excluded because migration is inferred from changes in affiliation over time, and the earliest years lack a prior window to establish a baseline; starting the first decade in 1974 gives each decade a comparable opportunity to capture migration events.

In the data files, the country names for ex-Soviet republics vary between USSR, Russia, and other Soviet republic names. To address this inconsistency, migration data from the pre-1993 period involving the Soviet Union was unified under the name USSR. Similarly, migration flows involving Yugoslavia were consolidated under a single entity. Czechoslovakia was treated as a single entity until 1993, after which its data were separated into the Czech Republic and Slovakia. Because the dissolutions of the USSR (1991), Yugoslavia (1991), and Czechoslovakia (1992) all fall within the 1984–1993 decade, merge cutoffs were aligned with the decade boundary rather than the historical dissolution year, so that a dissolved entity and its successor states do not coexist within the same decade matrix. Migration data for the Federal Republic of Germany (FRG), the German Democratic Republic (DDR), and unified Germany were merged into a single entity throughout the dataset, ensuring a consistent representation of Germany. Hong Kong and China were also merged into a single entity to address many entries from Hong Kong that reported the country of affiliation as China. Additionally, many data entries mistakenly recorded articles from Yugoslavia as originating from Czechoslovakia. To address this issue, migration flows between Yugoslavia and Czechoslovakia in the 1970s were set to zero.

It is important to note that changes in academic affiliation do not correspond directly to physical migration. Authors may report new affiliations due to sabbaticals, short visits, or joint appointments, any of which can result in an affiliation change without actual relocation. The adjacent-year rule described above addresses the most common cases but cannot fully resolve this limitation. This issue is inherent to all bibliometric reconstructions of academic migration and has been extensively discussed in the literature (Moed et al. 2013; Moed and Halevi 2014; Aref et al. 2019; Subbotin and Aref 2021; Sanliturk et al. 2023; Akbaritabar et al. 2024).

A second limitation arises from restricting the data to English-language articles, excluding authors who publish exclusively in non-English venues unobservable in the

reconstruction, regardless of their mobility. This exclusion introduces two potential biases. First, the academic mobility of researchers in countries where domestic-language publishing remains significant, such as China and Brazil, is underrepresented compared to researchers publishing in English. Second, the proportion of English-language output from non-Western countries has increased during the study period, so the apparent rise of these countries in the network may reflect increased English-language publishing rather than a genuine increase in mobility. The constant-author-count robustness check described in Appendix B partially addresses the second bias by maintaining a constant author pool size across decades.

## The network and the clusters in 50 years

In this section, I examine the structure and patterns of the world academic migration network from the 1970s to the present. Table 2 presents the descriptive statistics of the network for each decade. The number of migrations increased steadily over time. The number of binary links also increases over time across all thresholds. The network density, the percentage of network capacity used, decreases during the 1990s due to the rise in the number of countries after the collapse of the Soviet Union. Otherwise, network density also joins the increasing trend of connectedness[1], which may have two causes:

**Table 2** Network statistics by decade for different thresholds

| Metric / Threshold | 1974–1983 | 1984–1993 | 1994–2003 | 2004–2013 | 2014–2023 |
|---|---|---|---|---|---|
| Number of Migrations | 115957 | 232473 | 398753 | 564862 | 936888 |
| Number of Active Countries | 157 | 163 | 191 | 192 | 192 |
| **Number of Links** | | | | | |
| 0% | 2953 | 4281 | 6341 | 8370 | 11562 |
| 0.001% | 1954 | 2362 | 3189 | 3559 | 4162 |
| 0.01% | 722 | 799 | 938 | 1040 | 1206 |
| 0.1% | 163 | 174 | 182 | 188 | 187 |
| 1% | 18 | 16 | 10 | 13 | 7 |
| **Density (%)** | | | | | |
| 0% | 12.06 | 16.21 | 17.47 | 22.82 | 31.53 |
| 0.001% | 7.98 | 8.94 | 8.79 | 9.70 | 11.35 |
| 0.01% | 2.95 | 3.03 | 2.58 | 2.84 | 3.29 |
| 0.1% | 0.67 | 0.66 | 0.50 | 0.51 | 0.51 |
| 1% | 0.07 | 0.06 | 0.03 | 0.04 | 0.02 |
| **Reciprocity (%)** | | | | | |
| 0% | 76.26 | 77.51 | 78.13 | 80.48 | 82.67 |
| 0.001% | 80.96 | 84.42 | 84.73 | 86.43 | 87.46 |
| 0.01% | 89.75 | 91.61 | 88.91 | 87.69 | 85.07 |
| 0.1% | 90.80 | 88.51 | 89.01 | 85.11 | 81.28 |
| 1% | 77.78 | 100.00 | 100.00 | 76.92 | 85.71 |
| **Average Path Length** | | | | | |
| 0% | 2.00 | 1.88 | 1.86 | 1.79 | 1.69 |
| 0.001% | 2.09 | 1.98 | 2.00 | 1.99 | 1.97 |
| 0.01% | 2.03 | 2.04 | 2.11 | 2.14 | 2.13 |
| 0.1% | 1.93 | 1.90 | 1.96 | 1.96 | 2.03 |
| 1% | 1.75 | 1.78 | 1.67 | 1.74 | 1.56 |
| HH Index Weighted In-degree | 0.12 | 0.11 | 0.09 | 0.07 | 0.06 |
| HH Index Weighted Out-degree | 0.12 | 0.10 | 0.08 | 0.07 | 0.05 |

[1] The fall in the number of links and density for the 1% threshold is due to the fall in inequality in the network and will be explained below.

first is the exponential increase in the number of articles (Fig. 1), leading to an increase in the recorded movements of academics. The growing number of authors and publications may mechanically inflate the observed number of affiliation changes and, thus, the recorded number of academic migrations. Second, the strong globalization effect in these decades may make academic mobility easier and more probable. Globalization-based increase in connectivity aligns with studies linking recent waves of globalization to increasing academic mobility (Kim 2009; Bauder 2015; Teichler 2015). To check whether the rising connectivity simply reflects the growth in the number of authors and publications, the decade networks were rebuilt based on a subsample. For each decade, the same number of authors, equal to the active author count of the 1974–1983 decade, was randomly drawn, and all metrics were recomputed. The results are similar, indicating that the patterns reported below are not due to the growing author base (Table 5). In addition, all subsequent network analyses will use proportions of academic migrations relative to the world total as network weights. This approach ensures that the results focus solely on changes in network patterns, independent of absolute growth in migration numbers over time.

At zero threshold, where every observed flow counts as a link, density almost triples over the five decades, from 12% in 1974–1983 to 32% in 2014–2023, reflecting the effects of globalization. The same monotone rise holds at the 0.001% threshold, where density grows from 8% to 11%, and at the 0.01% threshold, where it moves from 2.9% to 3.3%. The direction reverses only at the very high thresholds: at 0.1% density falls from 0.67% to 0.51%, and at 1% from 0.07% to 0.02%. This reversal is not a contradiction but a consequence of the same globalization process. As new hubs emerge and the flows that were once concentrated on a few corridors are spread across many, fewer individual links cross the very high share thresholds, even though the network as a whole grows denser.

Reciprocity in the academic migration network is high at every threshold and in every decade, never falling below 76% at the 0% threshold and reaching above 90% at the 0.01%

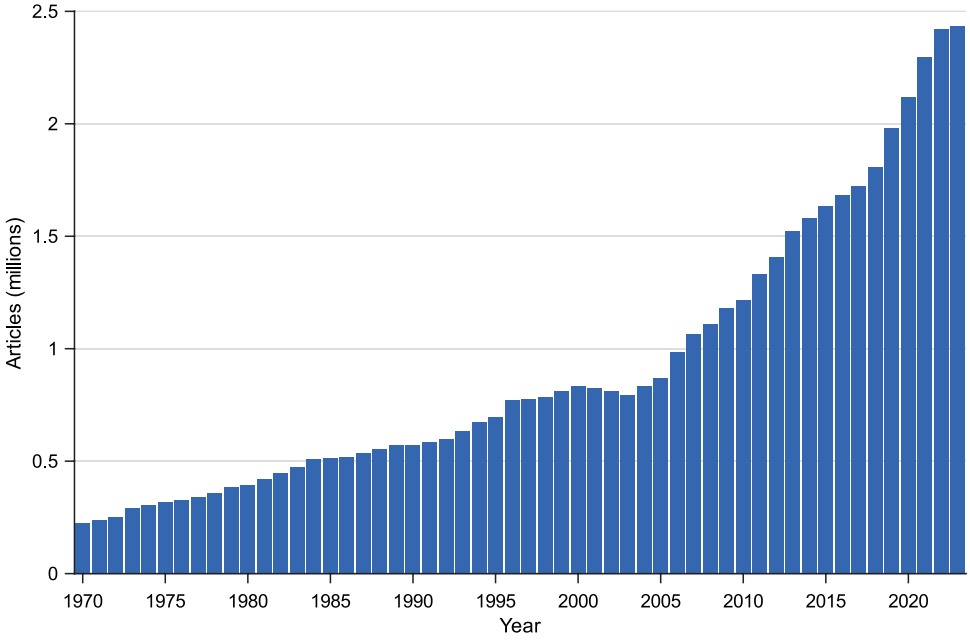



**Fig. 1** Number of articles by year in the data

and 0.1% thresholds in the early decades. As high reciprocity holds across the full span and across the full range of threshold choices, it is a property of the academic migration process itself rather than an artifact of network construction.

To better understand the structure, Figs. 2 and 3 present graphical representations of the network for each decade. In the first figure, directed connections with a migration share above 0.1% are shown for readability. The second figure represents the top 50 connections for each decade. Figure 4 depicts weighted in- and out-degree centralities. Finally, Tables 3 and 4 list the top countries by weighted in- and out-degree centrality, and Tables 6 and 7 list the top countries by HITS authority and hub scores.

The United States' sole dominance is evident in the network from the 1970s to the present. The US has a weighted in- and out-degree centrality that decreases from approximately 30% in the 1970s to approximately 20% in the 2020s. This means one in three to five academic migrations in the data is to or from the US. Throughout the period, the strongest academic migration ties of the US have been with large economies like the UK, Canada, Germany, France, and Japan. At the same time, in the last two decades, China has also emerged as a key partner. The US also gathers many other smaller economies around it and acts as the main center in the network. This is clearly seen in Fig. 2 and more evidently seen in Fig. 3. The average finite shortest path length (Table 2) is around 2 at almost all thresholds[2], indicating that most countries are connected through a few central nodes rather than directly to each other[3].

While the UK, Canada, Germany, and China are other central nodes, none exhibit a comparable centrality or dominance within the network to the US, which has been the leading hub, maintaining connections with many countries worldwide for decades. As the world's largest economy and home to numerous prominent universities and research institutions, the US is expected to attract academics from many countries, and many will leave the US to return to their home countries. The high reciprocity of its links and in- and out-centralities supports this idea of a two-way academic flow to and from the US.

Although the US dominance persists, inequality in the academic migration network has decreased over the past five decades. The Herfindahl-Hirschman Index (HHI) of weighted in and outdegree centralities has steadily declined (Table 2). While the United States remains the primary hub, its dominance has decreased as other countries, particularly in Asia, have become increasingly significant nodes. New local hubs have emerged, and the growing importance of Asian countries has balanced the network's structure, reducing the United States' centrality. This broader distribution of influence indicates a less concentrated pattern in global academic migration flows, despite still having the US as the unique center.

As additional evidence of declining inequality, Appendix A lists the links above a weight of 1%. These links highlight the changing dynamics of academic migration flows as new countries establish significant bilateral connections. For example, while the 1970s were characterized by strong reciprocal ties among the United States, the United Kingdom, and Canada, subsequent decades saw the emergence of Asian countries, such

[2] At the 1% threshold, most countries are disconnected, so the few finite paths that remain are between a small set of highly connected nodes and the average is computed over very few pairs.

[3] An average path length of 2 is, in principle, also compatible with a uniformly dense network in which most country pairs are linked directly. The moderate densities reported above (12% to 32% at the 0% threshold) rule this out: at these densities a typical pair is not directly connected, so the short paths must be mediated by a small set of high-degree countries.

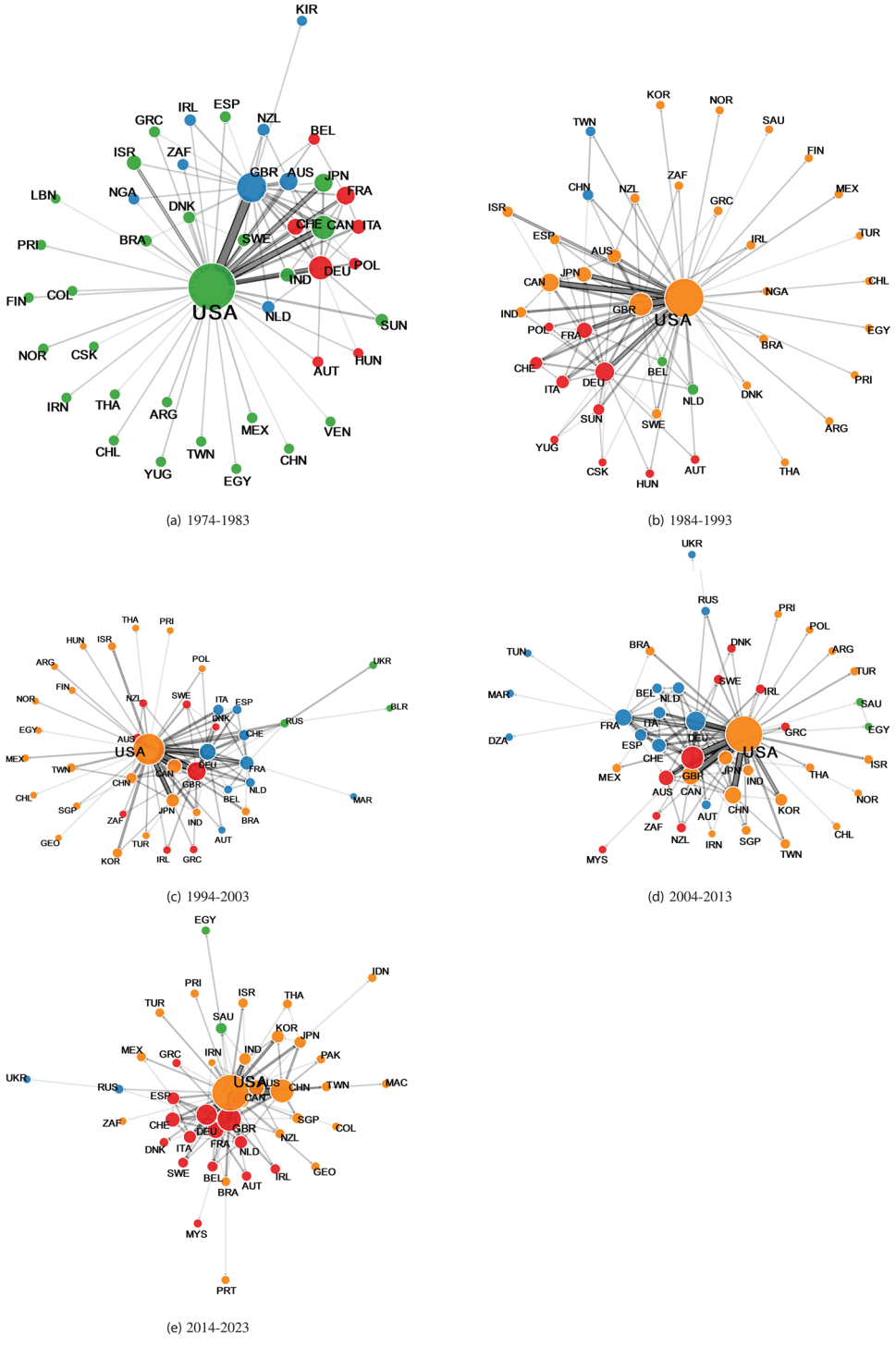



**Fig. 2** Academic migration network by decade. Links with weight above 0.1% are shown. Node size is proportional to weighted indegree centrality, edge width to link weight. Clusters are obtained by the Louvain algorithm (Rubinov 2016); each color denotes a different cluster

as China, as major players. By the 2010s and 2020s, China developed strong ties with the United States and established significant inflows and outflows with other countries. The patterns in Appendix A underscore the diversification of primary migration links, reflecting a redistribution of influence in the academic migration network. This

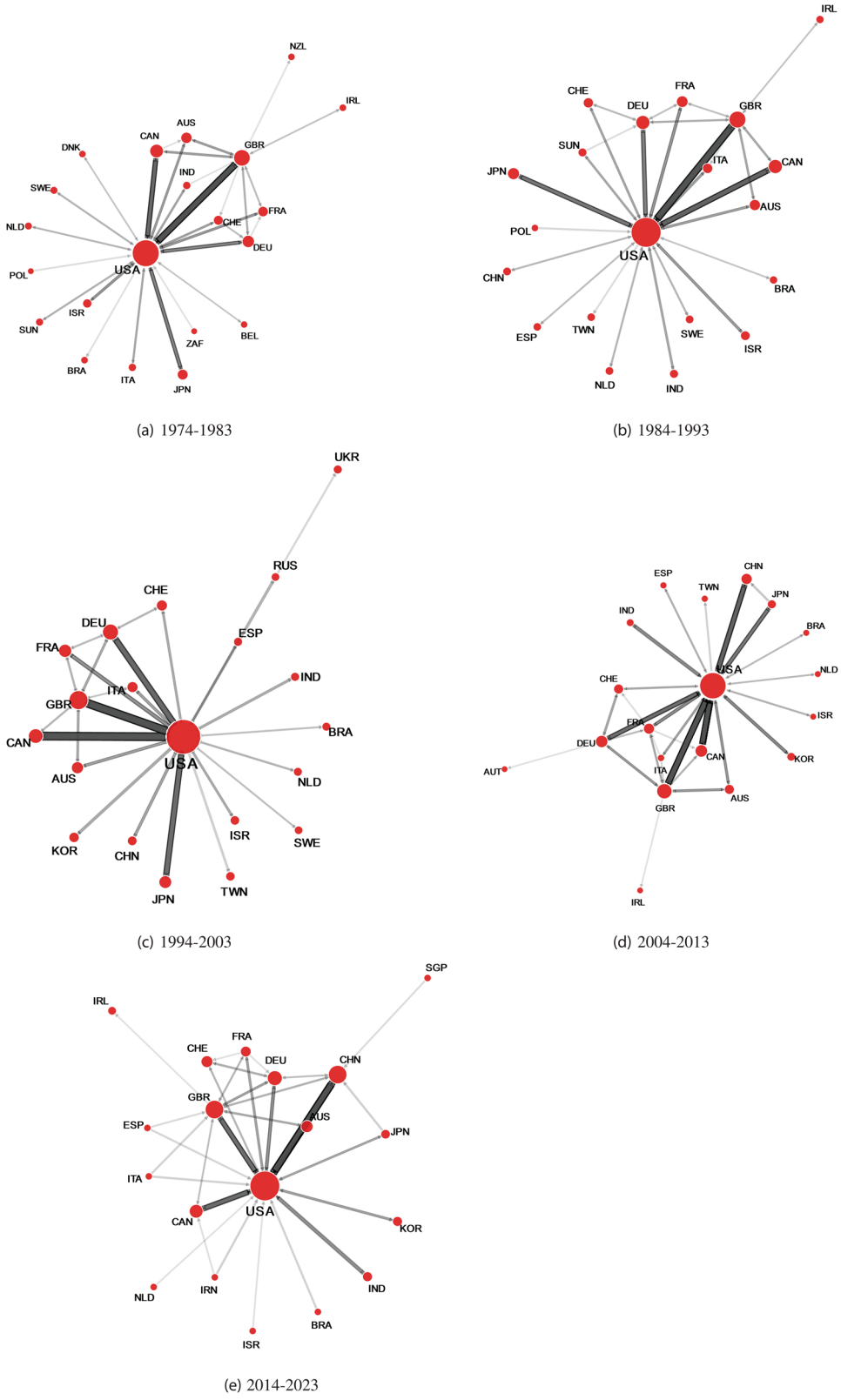



**Fig. 3** Academic migration network by decade, top 50 links only. Node size is proportional to weighted indegree centrality, edge width to link weight

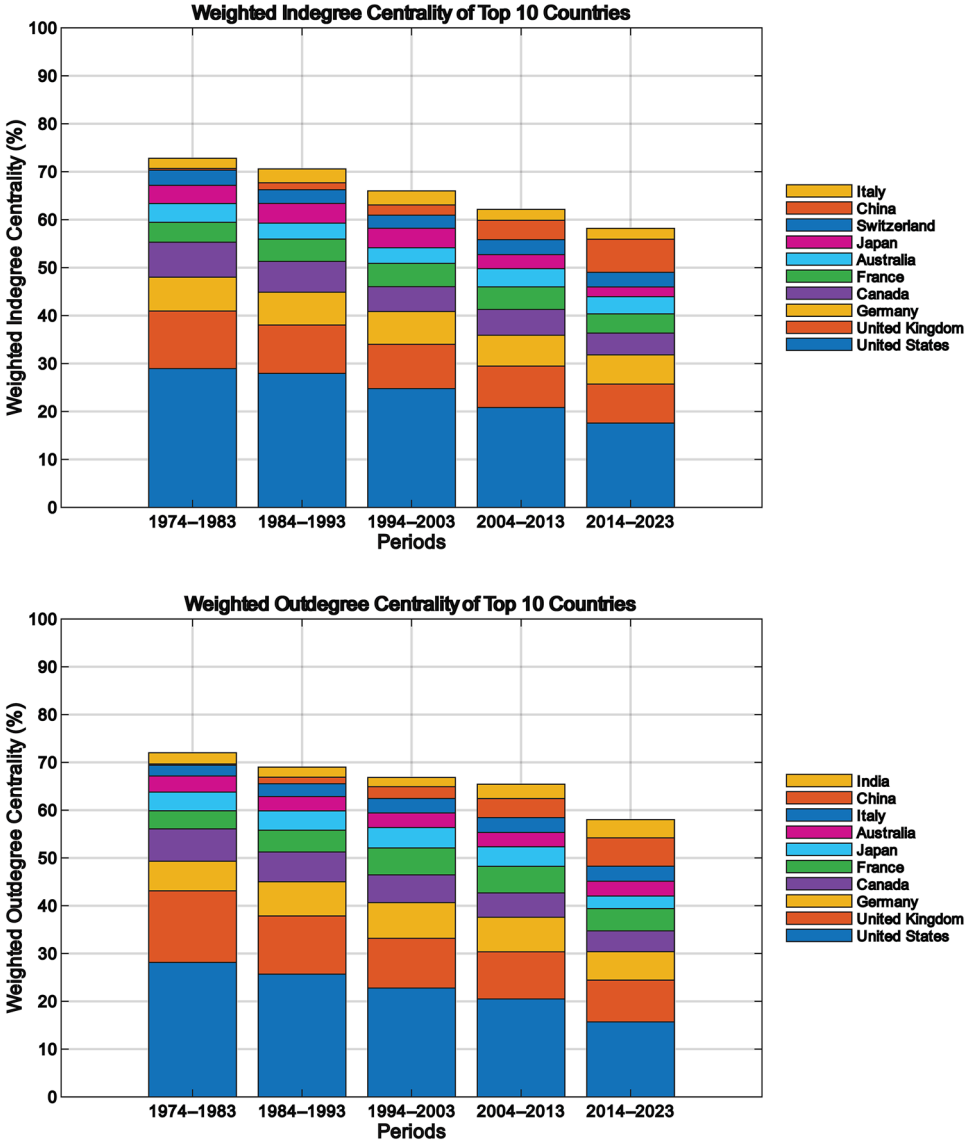



**Fig. 4** Weighted in and out-degree centralities by decade

evolution highlights how the dominance of the US and a few Western economies persists within a broader, more interconnected network in which countries such as China and India play increasingly pivotal roles.

Figure 2 shows the cluster structure for each decade at the 0.1% threshold. The most persistent feature is a two-part split: a US-led cluster covering most of the world and a European cluster anchored by Germany and France. The European cluster is geographically concentrated throughout the period, comprising Italy, Switzerland, the Netherlands, Belgium, Spain, Sweden, and the other continental European countries.

The UK sits with a Commonwealth-style grouping in 1974–1983 (alongside Canada, Australia, Japan, and the Netherlands), merges into the US cluster from the 1980s through the 2000s, and falls into the European cluster by 2014–2023. Canada stays with the US cluster throughout. The Soviet bloc countries remain attached to the European cluster during the Cold War decades, with the USSR positioned among the continental European countries rather than in a bloc of its own. After 1990, the Eastern European

**Table 3** Top 20 countries by weighted in-degree centrality

| 1974–1983 | 1984–1993 | 1994–2003 | 2004–2013 | 2014–2023 |
|---|---|---|---|---|
| United States | United States | United States | United States | United States |
| United Kingdom | United Kingdom | United Kingdom | United Kingdom | United Kingdom |
| Canada | Germany | Germany | Germany | China |
| Germany | Canada | Canada | Canada | Germany |
| France | France | France | France | Canada |
| Australia | Japan | Japan | China | France |
| Japan | Australia | Australia | Australia | Australia |
| Switzerland | Italy | Italy | Switzerland | Switzerland |
| Italy | Switzerland | Switzerland | Japan | Netherlands |
| Israel | USSR | Netherlands | Spain | Italy |
| India | Netherlands | China | Italy | Spain |
| Netherlands | Sweden | Spain | Netherlands | India |
| Sweden | Israel | Sweden | South Korea | Japan |
| USSR | India | Russian Federation | India | Sweden |
| Denmark | China | South Korea | Sweden | South Korea |
| Belgium | Spain | Brazil | Belgium | Belgium |
| Poland | Belgium | Belgium | Brazil | Saudi Arabia |
| New Zealand | Poland | Israel | Austria | Brazil |
| Brazil | Brazil | India | Singapore | Austria |
| South Africa | Taiwan | Taiwan | Taiwan | Singapore |

countries integrate fully with the European cluster, and Russia drifts to the periphery in the most recent decade.

Asia is the most informative case. In the 1970s and 1980s, Asian countries are peripheral to the US cluster, with India and Japan already inside it. From the 1990s onward, China, Korea, Taiwan, Singapore, and the other rising Asian economies join the US cluster rather than forming one of their own. By 2014–2023, China sits at the core of the US cluster as a top node alongside the US itself. No Asian cluster forms across the five decades. The structural counterpart of the rise of Asia in academic migration is integration into the US-led core, not separation from it.

We report weighted in- and out-degree rankings by decade in Tables 3 and 4, and complement them with HITS authority and hub scores in Tables 6 and 7 as other studies do (Verginer and Riccaboni 2020; Urbinati et al. 2021; Pei et al. 2024). The HITS algorithm computes two scores for each country in the weighted bilateral network. The authority score of a country is high when it receives flows from countries that themselves send to important receivers; the hub score is high when it sends flows to countries that themselves receive from important senders. In the academic migration context, the authority score captures the brain-gain role and the hub score captures the brain-drain role.

Recent work argues that eigencentrality-based measures, including HITS and PageRank lose discriminating power in migration networks with high reciprocity, because mutual exchange between the same pair of nodes erodes the directional information these measures rely on (Pitoski et al. 2024, 2021a, 2021b). Our network exhibits

**Table 4** Top 20 countries by weighted out-degree centrality

| 1974–1983 | 1984–1993 | 1994–2003 | 2004–2013 | 2014–2023 |
|---|---|---|---|---|
| United States | United States | United States | United States | United States |
| United Kingdom | United Kingdom | United Kingdom | United Kingdom | United Kingdom |
| Canada | Germany | Germany | Germany | Germany |
| Germany | Canada | Canada | France | China |
| Japan | France | France | Canada | France |
| France | Japan | Japan | Japan | Canada |
| Australia | Australia | Russian Federation | China | India |
| Switzerland | Italy | Australia | Italy | Italy |
| India | USSR | Italy | India | Australia |
| Italy | Switzerland | Switzerland | Australia | Spain |
| Israel | India | China | Switzerland | Japan |
| USSR | Netherlands | Netherlands | Spain | Switzerland |
| Sweden | Sweden | India | Netherlands | Netherlands |
| Netherlands | Israel | Spain | Sweden | Iran |
| Poland | Poland | Sweden | South Korea | South Korea |
| Belgium | China | Belgium | Russian Federation | Brazil |
| Denmark | Belgium | Israel | Belgium | Belgium |
| New Zealand | Spain | Brazil | Brazil | Sweden |
| South Africa | Hungary | Denmark | Austria | Malaysia |
| Yugoslavia | Denmark | Austria | Israel | Singapore |

weighted reciprocity around 80% in every decade, and the prediction is quite validated: HITS authority rankings track weighted in-degree rankings almost exactly, and HITS hub rankings track weighted out-degree rankings almost exactly.

The United States is the top destination and the top sender in every decade, with the United Kingdom in second place on both measures throughout. Canada, Germany, France, and Australia are present in the top 10 on both incoming and outgoing flows in every decade. The overlap is the substantive fact: the world academic migration network is composed of a small core of countries that exchange researchers with each other at high volume, rather than a set of sources flowing into a separate set of destinations.

The most informative movement within this core is the rise of China. China is absent from the top 20 in 1974–1983, enters the incoming flow ranking at rank 15 in 1984–1993, climbs to rank 11 in 1994–2003, rank 6 in 2004–2013, and reaches rank 3 by 2014–2023. The outgoing flow ranking tracks the same trajectory: rank 16 in 1984–1993, rank 11 in 1994–2003, rank 7 in 2004–2013, and rank 4 in 2014–2023. South Korea enters the top 20 on incoming flows in 1994–2003 at rank 15 and on outgoing flows in 2004–2013 at rank 15, holding rank 15 on both measures in 2014–2023. India is present in the top 20 throughout the entire period on both measures and moves into the top 12 in the most recent decade, at rank 12 on incoming and rank 7 on outgoing flows. By 2014–2023, China, India, and South Korea sit alongside the established Western nodes in the top 15 on both measures rather than below or apart from them. The rise of Asia in academic migration is the rise of these countries inside the core, not the formation of a separate Asian core.

In conclusion, these findings provide a comprehensive overview of the structural patterns and dynamics within the world academic migration network, offering valuable insights into their evolution over time.

## Conclusion and further research

This paper reconstructs the global academic migration network from 1970 to 2023 using affiliation changes in almost 50 million Scopus articles, and analyzes its structure decade by decade.

The network has globalized. More country pairs are connected in every successive decade, and the share of flows captured by the largest senders and receivers has fallen steadily across all five decades.

Reciprocity has remained high throughout the period. Countries that are connected at all are almost always connected in both directions, and the most central countries are simultaneously major senders and major receivers. Academic migration is circulatory by structure, not by accident of any particular decade.

The rise of Asia is the integration of China, India, and South Korea into the existing core rather than the formation of a separate Asian cluster. China sits second behind the United States in HITS authority score in the most recent decade.

The structural changes documented here sit within a wider geo-economic transformation. The wave of globalization over the past decades has reshaped many global systems, and the rising prominence of China and other Asian countries in the academic migration network is consistent with the broader shift in the world's economic center of gravity (Balsa-Barreiro et al. 2019). An open question is whether academic mobility anticipates or follows these economic transitions in emerging countries. The recent geopolitical turn toward deglobalization (Balsa-Barreiro et al. 2020) raises the complementary question of whether the trends documented here will persist in the next decade or reverse. Tracking the network forward as data accumulates is a natural avenue for future research.

Another extension is temporal network analysis. Instead of comparing decade snapshots, the data could be analyzed year by year, modeling how links form, persist, and decay over time. This would allow the response to specific shocks, such as Brexit, the COVID-19 disruption, and the surge in publication volume driven by AI, to be measured directly rather than absorbed into a decade average.

## A migration links above 1%

**A.1** 1974–1983

| Out | In | Weight (%) |
|---|---|---|
| United Kingdom | United States | 5.49 |
| United States | United Kingdom | 4.63 |
| United States | Canada | 3.72 |
| Canada | United States | 3.70 |
| Japan | United States | 2.63 |
| United States | Japan | 2.53 |
| United States | Germany | 2.51 |
| Germany | United States | 2.29 |
| Israel | United States | 1.49 |
| United States | France | 1.40 |
| United States | Israel | 1.39 |
| United Kingdom | Canada | 1.34 |
| France | United States | 1.33 |
| United Kingdom | Australia | 1.30 |
| United States | Australia | 1.29 |
| Australia | United States | 1.22 |
| United States | Switzerland | 1.06 |
| India | United States | 1.03 |

**A.2** 1984–1993

| Out | In | Weight (%) |
|---|---|---|
| United Kingdom | United States | 4.37 |
| United States | United Kingdom | 3.59 |
| Canada | United States | 3.30 |
| United States | Canada | 3.07 |
| United States | Japan | 2.42 |
| Japan | United States | 2.40 |
| Germany | United States | 2.33 |
| United States | Germany | 2.05 |
| France | United States | 1.39 |
| United States | France | 1.36 |
| Israel | United States | 1.24 |
| Australia | United States | 1.07 |
| United States | Israel | 1.04 |
| United States | Australia | 1.03 |
| United States | Italy | 1.02 |
| Italy | United States | 1.01 |

**A.3** 1994–2003

| Out | In | Weight (%) |
|---|---|---|
| United Kingdom | United States | 2.98 |
| Canada | United States | 2.98 |
| United States | United Kingdom | 2.55 |
| United States | Canada | 2.25 |
| Germany | United States | 2.19 |
| Japan | United States | 2.06 |
| United States | Japan | 1.92 |
| United States | Germany | 1.90 |
| France | United States | 1.31 |
| United States | France | 1.11 |

**A.4** 2004–2013

| Out | In | Weight (%) |
|---|---|---|
| Canada | United States | 2.23 |
| United Kingdom | United States | 2.20 |
| United States | Canada | 2.10 |
| United States | United Kingdom | 2.03 |
| China | United States | 1.79 |
| United States | China | 1.62 |
| Germany | United States | 1.55 |
| Japan | United States | 1.38 |
| United States | Germany | 1.36 |
| United States | Japan | 1.17 |
| India | United States | 1.15 |
| United States | South Korea | 1.05 |
| France | United States | 1.01 |

**A.5** 2014–2023

| Out | In | Weight (%) |
|---|---|---|
| United States | China | 2.33 |
| China | United States | 2.16 |
| Canada | United States | 1.72 |
| United Kingdom | United States | 1.61 |
| United States | United Kingdom | 1.42 |
| United States | Canada | 1.40 |
| India | United States | 1.15 |

## B network derived from a subsample of authors

**Table 5** Network statistics by period

| Metric / Threshold | 1974–1983 | 1984–1993 | 1994–2003 | 2004–2013 | 2014–2023 |
|---|---|---|---|---|---|
| Number of Migrations | 132272 | 157134 | 141202 | 110140 | 87205 |
| Number of Active Countries | 184 | 186 | 192 | 193 | 193 |
| **Number of Links** | | | | | |
| 0% | 3529 | 4353 | 4568 | 5100 | 5474 |
| 0.001% | 2319 | 2804 | 2966 | 3211 | 5474 |
| 0.01% | 734 | 835 | 929 | 1043 | 1248 |
| 0.1% | 169 | 172 | 185 | 189 | 194 |
| 1% | 20 | 13 | 10 | 12 | 7 |
| **Density (%)** | | | | | |
| 0% | 10.48 | 12.65 | 12.46 | 13.76 | 14.77 |
| 0.001% | 6.89 | 8.15 | 8.09 | 8.67 | 14.77 |
| 0.01% | 2.18 | 2.43 | 2.53 | 2.81 | 3.37 |
| 0.1% | 0.50 | 0.50 | 0.50 | 0.51 | 0.52 |
| 1% | 0.06 | 0.04 | 0.03 | 0.03 | 0.02 |
| **Reciprocity (%)** | | | | | |
| 0% | 75.77 | 76.82 | 76.66 | 75.92 | 76.47 |
| 0.001% | 80.21 | 80.81 | 81.19 | 79.17 | 76.47 |
| 0.01% | 89.65 | 90.30 | 86.98 | 83.99 | 84.46 |
| 0.1% | 93.49 | 93.02 | 86.49 | 85.71 | 79.38 |
| 1% | 90.00 | 92.31 | 100.00 | 83.33 | 85.71 |
| **Average Path Length** | | | | | |
| 0% | 2.04 | 1.95 | 2.00 | 1.98 | 1.94 |
| 0.001% | 2.13 | 2.05 | 2.04 | 2.05 | 1.94 |
| 0.01% | 2.19 | 2.19 | 2.12 | 2.23 | 2.17 |
| 0.1% | 2.10 | 2.10 | 1.99 | 1.99 | 2.11 |
| 1% | 1.67 | 1.66 | 1.67 | 1.72 | 1.56 |
| HH Index Weighted In-degree | 0.09 | 0.08 | 0.08 | 0.07 | 0.06 |
| HH Index Weighted Out-degree | 0.09 | 0.08 | 0.08 | 0.07 | 0.05 |

## C HITS authority and hub score rankings

**Table 6** Top 20 countries by HITS authority score

| 1974–1983 | 1984–1993 | 1994–2003 | 2004–2013 | 2014–2023 |
|---|---|---|---|---|
| United States | United States | United States | United States | United States |
| United Kingdom | United Kingdom | United Kingdom | United Kingdom | China |
| Canada | Canada | Germany | Canada | United Kingdom |
| Germany | Germany | Canada | Germany | Germany |
| Japan | Japan | Japan | China | Canada |
| Australia | France | France | France | Australia |
| France | Australia | Australia | Australia | France |
| Switzerland | Italy | Italy | Japan | Switzerland |
| Israel | Switzerland | Switzerland | Switzerland | India |
| India | Israel | China | South Korea | Japan |
| Italy | India | Netherlands | Italy | South Korea |
| Netherlands | Netherlands | South Korea | Spain | Netherlands |
| Sweden | USSR | Spain | India | Italy |
| USSR | Sweden | Israel | Netherlands | Spain |
| New Zealand | China | Brazil | Taiwan | Sweden |
| Denmark | Spain | Sweden | Sweden | Singapore |
| Brazil | Poland | India | Brazil | Saudi Arabia |
| Ireland | Brazil | Taiwan | Singapore | Belgium |
| Belgium | Belgium | Russian Federation | Belgium | Brazil |
| Poland | New Zealand | Belgium | Ireland | Israel |

**Table 7** Top 20 countries by HITS hub score

| 1974–1983 | 1984–1993 | 1994–2003 | 2004–2013 | 2014–2023 |
|---|---|---|---|---|
| United Kingdom | United Kingdom | United States | United States | United States |
| United States | United States | United Kingdom | United Kingdom | United Kingdom |
| Canada | Canada | Canada | Canada | China |
| Germany | Germany | Germany | Germany | Canada |
| Japan | Japan | Japan | China | Germany |
| Australia | France | France | Japan | India |
| France | Australia | Australia | France | France |
| Israel | Israel | Italy | India | Australia |
| Switzerland | Italy | China | Australia | Italy |
| India | India | Russian Federation | Italy | Japan |
| Italy | Switzerland | Switzerland | Switzerland | Spain |
| Sweden | USSR | India | South Korea | South Korea |
| USSR | Netherlands | Netherlands | Spain | Switzerland |
| Netherlands | Poland | Israel | Netherlands | Iran |
| Poland | Sweden | Spain | Israel | Netherlands |
| Denmark | China | Sweden | Sweden | Brazil |
| New Zealand | Spain | South Korea | Brazil | Singapore |
| Belgium | Belgium | Brazil | Russian Federation | Israel |
| South Africa | Brazil | Belgium | Belgium | Sweden |
| Brazil | Hungary | Poland | Taiwan | Belgium |

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1007/s41109-026-00840-0.

Supplementary Material 1

**Acknowledgements**
I thank two anonymous referees for their valuable comments and suggestions. I sincerely thank Bozkurt Toral for his invaluable assistance in gathering the bibliometric data.

**Author contributions**
The sole author developed the research idea, collected and processed the data, conducted the analysis, and wrote the manuscript.

**Funding**
No funds, grants, or other support was received.

**Data availability**
The dataset supporting the conclusions of this article is included in the supplementary files. The data were extracted from the Scopus database and processed by the author.

## Declarations

**Ethics approval and consent to participate**
Not applicable.

**Consent for publication**
The author consented to publication of this work.

**Competing interests**
The author declares no competing interests.

Received: 17 January 2026 / Accepted: 13 October 2026
Published online: 26 October 2026

**References**

Akbari H (2021) Exploratory social-spatial network analysis of global migration structure. Soc Networks 64:181–193. https://doi.org/10.1016/j.socnet.2020.09.007

Akbaritabar A, Dańko MJ, Zhao X, Zagheni E (2025) Global subnational estimates of migration of scientists reveal large disparities in internal and international flows. Proc Natl Acad Sci USA 122(15):e2424521122. https://doi.org/10.1073/pnas.2424521122

Akbaritabar A, Theile T, Zagheni E (2024) Bilateral flows and rates of international migration of scholars for 210 countries for the period 1998–2020. Sci Data 11(1):816. https://doi.org/10.1038/s41597-024-03655-9
Aleskerov F, Meshcheryakova N, Rezyapova A, Shvydun S (2017) Network analysis of international migration. Springer Proceedings in Mathematics & Statistics. Springer International Publishing. pp 177–185 https://doi.org/10.1007/978-3-319-56829-4_13
Aref S, Zagheni E, West J (2019) The demography of the peripatetic researcher: evidence on highly mobile scholars from the web of science. In International conference on social informatics. Springer; pp 50–65 https://doi.org/10.1007/978-3-030-34971-4_4
Balsa-Barreiro J, Vié A, Morales AJ, Cebrián M (2020) Deglobalization in a hyper-connected world. Palgrave Commun 6(1):28. https://doi.org/10.1057/s41599-020-0403-x
Balsa-Barreiro J, Li Y, Morales A, Pentland AS (2019) Globalization and the shifting centers of gravity of world's human dynamics: implications for sustainability. J Cleaner Prod 239:117923. https://doi.org/10.1016/j.jclepro.2019.117923
Bauder H (2015) The international mobility of academics: a labour market perspective. Int Migr 53(1):83–96. https://doi.org/10.1111/j.1468-2435.2012.00783.x
Bilecen B (2021) Personal network analysis from an intersectional perspective: how to overcome ethnicity bias in migration research. Global Networks 21(3):470–486. https://doi.org/10.1111/glob.12318
Bilecen B, Cardona A (2018) Do transnational brokers always win? a multilevel analysis of social support. Soc Networks 53:90–100. https://doi.org/10.1016/j.socnet.2017.03.001
Bilecen B, Gamper M, Lubbers MJ (2018) The missing link: social network analysis in migration and transnationalism. Soc Networks 53:1–3. https://doi.org/10.1016/j.socnet.2017.07.001
Bilecen B, Lubbers MJ (2021) The networked character of migration and transnationalism. Global Networks 21(4):837–852. https://doi.org/10.1111/glob.12317
Bircan T (2024) Augmentation or replication? assessing big data's role in migration studies. Data & Policy 6(e51). https://doi.org/10.1017/dap.2024.57
Bircan T, Qi H (2025) Editorial: new methodological approaches for migration and mobility studies: from traditional to big data. Front Hum Dyn 7(1710558). https://doi.org/10.3389/fhumd.2025.1710558
Bojarczuk S, Mühlau P (2018) Mobilising social network support for childcare: the case of Polish migrant mothers in Dublin. Soc Networks 53:101–110. https://doi.org/10.1016/j.socnet.2017.04.004
Chinchilla-Rodríguez Z, Miao L, Murray D, Robinson-García N, Costas R, Sugimoto CR (2018) A global comparison of scientific mobility and collaboration according to national scientific capacities. Front Res Metr Anal 3:17. https://doi.org/10.3389/frma.2018.00017
Czaika M (ed) (2018) High-skilled migration: drivers and policies. Oxford University Press. https://doi.org/10.1093/oso/9780198815273.001.0001
Czaika M, Orazbayev S (2018) The globalisation of scientific mobility, 1970–2014. Appl Geogr 96:1–10. https://doi.org/10.1016/j.apgeog.2018.04.017
Danchev V, Porter MA (2018) Neither global nor local: heterogeneous connectivity in spatial network structures of world migration. Soc Networks 53:4–19. https://doi.org/10.1016/j.socnet.2017.06.003
Davis KF, D'Odorico P, Laio F, Ridolfi L (2013) Global spatio-temporal patterns in human migration: a complex network perspective. PLoS One 8(1):e53723. https://doi.org/10.1371/journal.pone.0053723
Fagiolo G, Mastrorillo M (2013) Migration and trade: a complex-network approach. In 2013 International Conference on Signal-Image Technology & Internet-Based Systems. pp 538–545. https://doi.org/10.1109/sitis.2013.90
Kim T (2009) Shifting patterns of transnational academic mobility: a comparative and historical approach. Comp Educ 45(3):387–403. https://doi.org/10.1080/03050060903184957
Kleinberg JM (1999) Authoritative sources in a hyperlinked environment. J ACM 46(5):604–632. https://doi.org/10.1145/324133.324140
Koch P, Stojkoski V, Hidalgo CA (2024) The role of immigrants, emigrants and locals in the historical formation of European knowledge agglomerations. Reg Stud 58(9):1659–1673. https://doi.org/10.1080/00343404.2023.2275571
Leal DF, Harder NL (2021) Global dynamics of international migration systems across south–south, north–north, and north–south flows, 1990–2015. Appl Netw Sci 6(1):8. https://doi.org/10.1007/s41109-020-00322-x
Miranda-González A, Aref S, Theile T, Zagheni E (2020) Scholarly migration within Mexico: analyzing internal migration among researchers using scopus longitudinal bibliometric data. EPJ Data Sci 9(1). https://doi.org/10.1140/epjds/s13688-020-00252-9
Moed HF, Aisati M, Plume A (2013) Studying scientific migration in scopus. Scientometrics 94(3):929–942. https://doi.org/10.1007/s11192-012-0783-9
Moed HF, Halevi G (2014) A bibliometric approach to tracking international scientific migration. Scientometrics 101(3):1987–2001. https://doi.org/10.1007/s11192-014-1307-6
Mokyr J (2016) A culture of growth: the origins of the modern economy. Princeton University Press
Pei R, Li L, Yang Y, Zhou Q (2024) Co-evolution of international scientific mobility and international collaboration: a Scopus-based analysis. Scientometrics 129(7):4353–4378. https://doi.org/10.1007/s11192-024-05081-5
Pitoski D, Lampoltshammer TJ, Parycek P (2021a) Network analysis of internal migration in Austria. Digit Gov: Res Pract 2(3):1–24. https://doi.org/10.1145/3447539
Pitoski D, Lampoltshammer TJ, Parycek P (2021b) Network analysis of internal migration in Croatia. Comput Soc Networks 8(1):10. https://doi.org/10.1186/s40649-021-00093-0
Pitoski D, Meštrović A, Schmeets H (2024) The complex network patterns of human migration at different geographical scales: network science meets regression analysis. Appl Netw Sci 9(1):35. https://doi.org/10.1007/s41109-024-00635-1
Popielarz PA, Cserpes T (2018) Comparing the discussion networks and voluntary association memberships of immigrants and non-immigrants in US suburban gateways. Soc Networks 53:42–56. https://doi.org/10.1016/j.socnet.2017.03.004
Poros MV (2001) The role of migrant networks in linking local labour markets: the case of Asian Indian migration to New York and London. Global Networks 1(3):243–260. https://doi.org/10.1111/1471-0374.00015
Rubinov M (2016) Community_louvain.m. Accessed 2024 Oct 22 https://github.com/fieldtrip/fieldtrip/blob/master/external/bct/community_louvain.m

Sanlitürk E, Aref S, Zagheni E, Billari FC (2024) Homecoming after Brexit: evidence on academic migration from bibliometric data. Demography 61(6):1897–1921. https://doi.org/10.1215/00703370-11679804
Sanliturk E, Zagheni E, Dańko MJ, Theile T, Akbaritabar A (2023) Global patterns of migration of scholars with economic development. Proc Natl Acad Sci USA 120(4):e2217937120. https://doi.org/10.1073/pnas.2217937120
Schich M, Song C, Ahn Y-Y, Mirsky A, Martino M, Barabási A-L, Helbing D (2014) A network framework of cultural history. Science 345(6196):558–562. https://doi.org/10.1126/science.1240064
Subbotin A, Aref S (2021) Brain drain and brain gain in Russia: analyzing international migration of researchers by discipline using scopus bibliometric data 1996–2020. Scientometrics 126(9):7875–7900. https://doi.org/10.1007/s11192-021-04091-x
Teichler U (2015) Academic mobility and migration: what we know and what we do not know. Eur Rev 23(S1):S6–S37. https://doi.org/10.1017/S1062798714000787
Urbinati A, Galimberti E, Ruffo G (2021) Measuring scientific brain drain with hubs and authorities: a dual perspective. Online Soc Networks Media 24:100148. https://doi.org/10.1016/j.osnem.2021.100176
Vacca R, Solano G, Lubbers MJ, Molina JL , McCarty C (2018) A personal network approach to the study of immigrant structural assimilation and transnationalism. Soc Networks 53:72–89. https://doi.org/10.1016/j.socnet.2016.08.007
Vaccario G, Verginer L, Schweitzer F (2021) Reproducing scientists' mobility: a data-driven model. Sci Rep 11(1). https://doi.org/10.1038/s41598-021-90281-9
Verdery AM, Mouw T, Edelblute H, Chavez S (2018) Communication flows and the durability of a transnational social field. Soc Networks 53:57–71. https://doi.org/10.1016/j.socnet.2017.03.002
Verginer L, Riccaboni M (2020) Cities and countries in the global scientist mobility network. Appl Netw Sci 5(1). https://doi.org/10.1007/s41109-020-00276-0
Verginer L, Riccaboni M (2021) Talent goes to global cities: the world network of scientists' mobility. Res Policy 50(1):104127. https://doi.org/10.1016/j.respol.2020.104127
Wang Y, Luo H, Shi Y (2020) Complex network of scientific talent migration in discrete dynamics from 2001 to 2013. Discrete Dyn Nat Soc 2020:1–12. https://doi.org/10.1155/2020/9248983
Windzio M (2018) The network of global migration 1990–2013. Soc Networks 53:20–29. https://doi.org/10.1016/j.socnet.2017.08.006
Wissink M, Mazzucato V (2018) In transit: changing social networks of sub-Saharan African migrants in Turkey and Greece. Soc Networks 53:30–41. https://doi.org/10.1016/j.socnet.2017.03.005
Zhao X, Akbaritabar A, Kashyap R, Zagheni E (2023) A gender perspective on the global migration of scholars. Proc Natl Acad Sci U S A 120(10):e2214664120. https://doi.org/10.1073/pnas.2214664120

## Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.