

# Internal and international migration of scholars worldwide

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## Extended Abstract

The literature perceives academics as globetrotters wandering the world in search of other scientists who understand their research<sup>1-4</sup>. Migrant academics contribute to innovation in the host country and increase natives' inventiveness<sup>5</sup>. This contribution is robust to counterfactual scenario analysis<sup>6</sup>, i.e., what share of innovation would have been lost, if academics had not migrated. Academics who are internationally mobile, are also more productive in the earlier stages of their career, and self-report more positive effects for the mobility event<sup>7</sup>. They transfer ideas with their mobility<sup>8,9</sup>. Hence, the global competition<sup>10</sup> to attract these innovators is a well-known phenomenon. Efforts to attract academic talent has been called by different names: A) brain drain<sup>11</sup>, from the origin country perspective, B) brain gain, or attracting the best and the brightest<sup>12</sup>, from the destination country perspective, and more recently, C) brain circulation<sup>13,14</sup>, return migration and reversed brain drain<sup>15</sup>. These names highlight the (dis)advantages of scholarly migration for origin and destination locations, and for the global scientific growth<sup>16</sup>. It is important to study the migration of academics, where they come from and where they are headed, and the reasons behind their move, and its changes over time, since they contribute to innovation and knowledge circulation<sup>16,17</sup>. Especially, having international migration experience increases this contribution to home<sup>18,19</sup> or host<sup>20</sup> countries of migrant scholars. Studying academic mobility enables tracing which countries send and which ones gain scholars and maps the ongoing dynamics of global brain circulation for more impactful policymaking. Due to this importance, policies have been enacted to foster academic migration and attract talent, or inspire the return of migrated brains<sup>13,21,22</sup>. This has lead to some studies of migration of scholars while some aspects of it, for instance the interrelation between internal and international migration, are still understudied. The literature has often studied the migration of academics across countries worldwide. These studies have rarely focused on sub-national regions.

We used data on 28+ million Scopus publications of 8+ million unique authors and geo-coded the affiliation addresses. Our results show that by focusing on the sub-national regions to complement the country level, the share of mobile scholars increases from 8% to 12.4%. See Figure 1 for our integrated database covering both internal and international migration of scholars. We found that in all continents when a sub-national region is attractive for international migrants, it is also attractive for internal ones. The reverse is not true, though. This could indicate that for most continents, a depopulation is happening where scholars move abroad and their position is taken up by scholars arriving from other sub-national regions inside the country. In the US, as an example, states in the mid-eastern area have the highest count of scholars leaving for other destinations inside the US, mostly on the western side. In Germany, all four federations receiving scholars internally are sending scholars to international destinations (see Figure 1).

Results of Generalized Additive Mixed Models (GAMM) conditional on random effects showed that in all continents, the in-migration rates for both international and internal movements are larger than the out-migration rate for international and internal moves (see Figures 2 and 3). This indicates that migration of scholars is to a much higher degree an internal phenomenon and the internationalization discussed in the literature is showing only a small fraction of academic workforce's mobility. It is clear that some regions send scholars to international destinations and in turn receive scholars from internal origins.

Our results have implications for the global circulation of academic talent by showing the interrelation between internal and international migration, specifically for regions constantly losing their academic labour.

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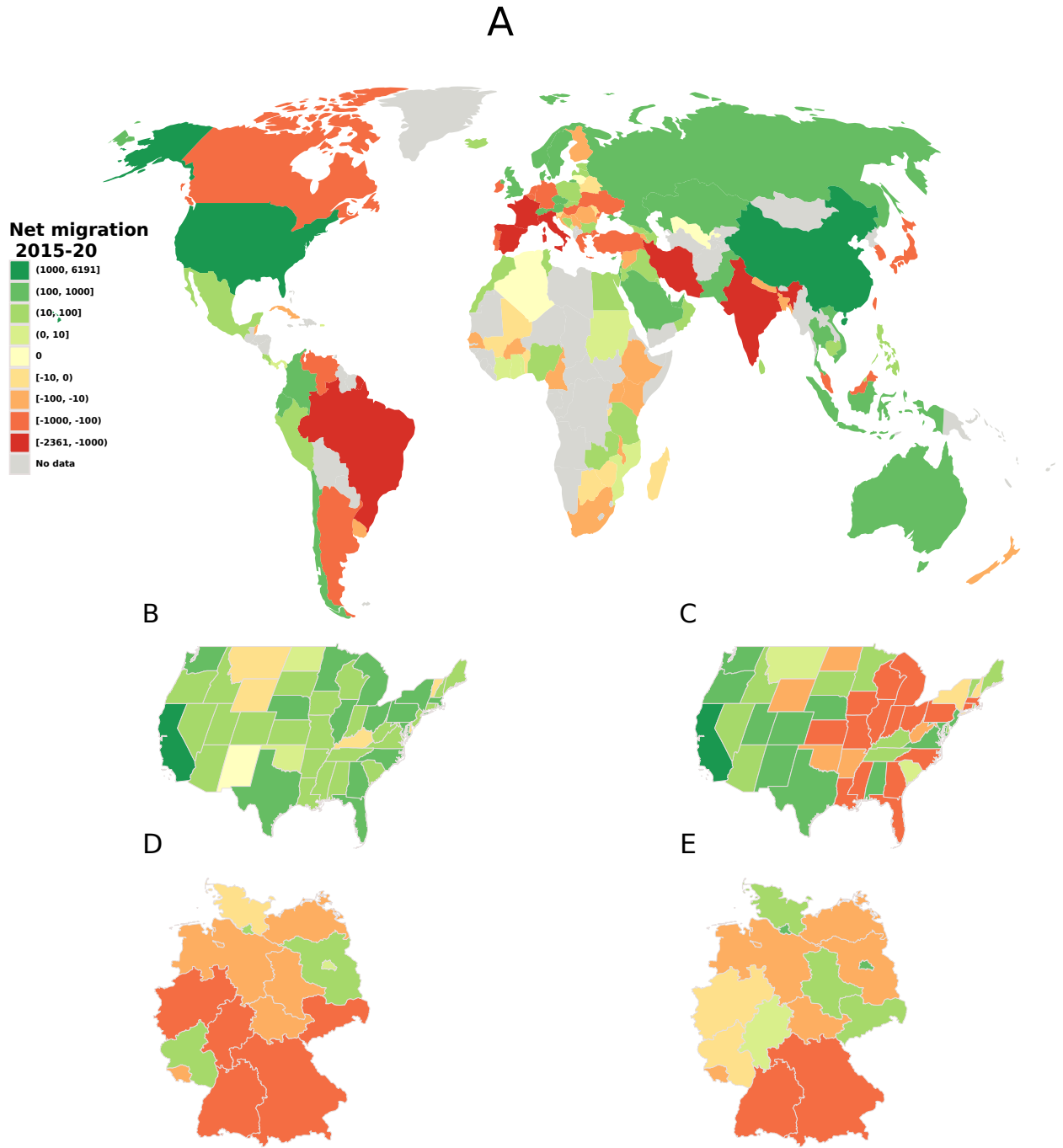


Figure 1: International migration of scholars at the country level (A), international (B, D), and national (C, E) migration at the province level. Colors present the net count of scholars sent (negative, red colors) or received (positive, green colors), and yellow shows a balanced flow resulting in a zero net count. Color scales for countries or regions are kept similar in all maps using 9 classes to allow comparison. Numbers printed on the legend are actual net count of scholars sent or received. At the country level, US is a talent hub and magnet, but that is not the same case for all sub-national regions inside the US. While some sub-national regions are attractive at both internal and international levels (see California in the US, Berlin and Hamburg in Germany), some are more attractive for one of these two types of migration (see cases of Florida, Michigan, or most mid-eastern states in the US and cases of Rhineland-Palatinate, Brandenburg, Schleswig-Holstein, Saxony-Anhalt, or Saxony in Germany, where in international (B, D) versus internal (C, E) migration, their color changes from green (receiving regions) to red (sending regions) or the reverse. Note that for simplification only continental map of the contiguous USA is presented.

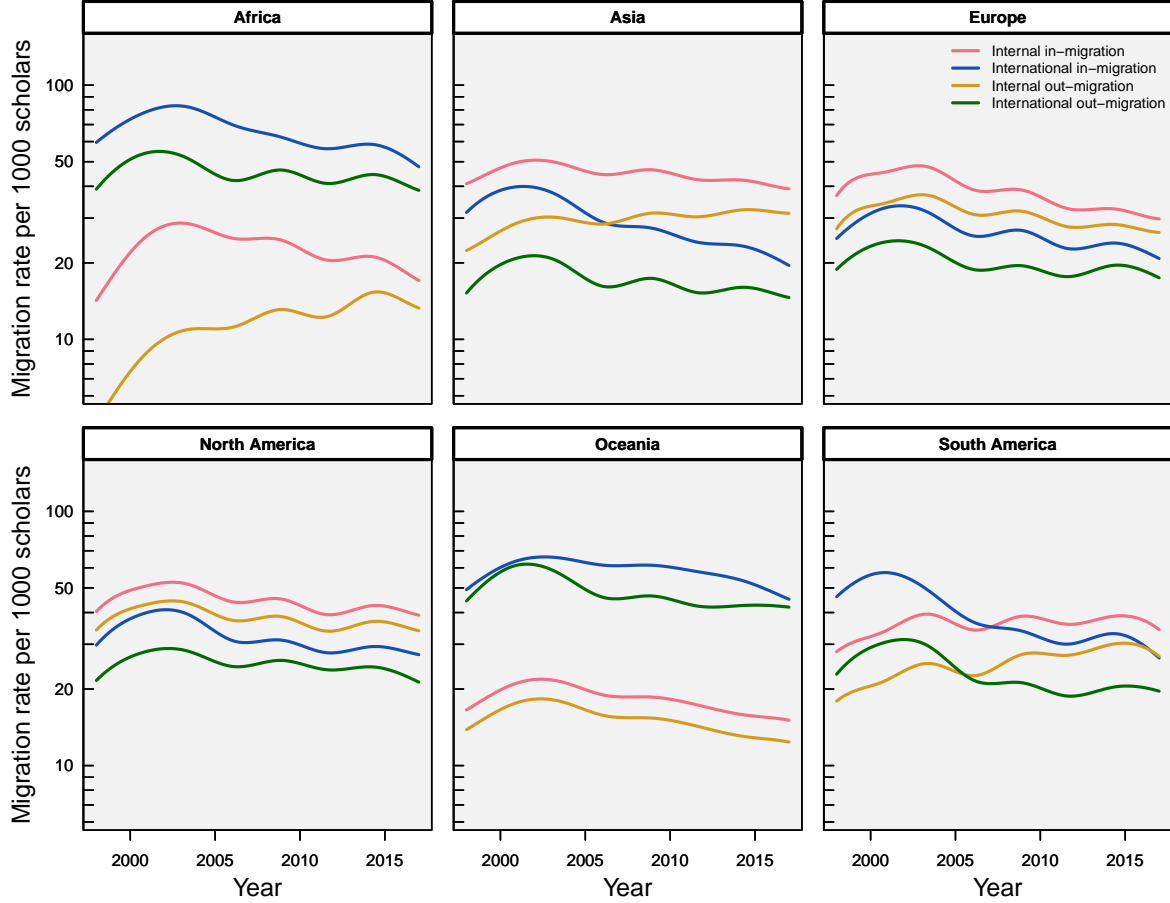


Figure 2: Predicted migration rates, conditional on random effects, for different types of migration, year, and continent estimated via GAMMs. Each line represent an independent model visualized together to show temporal trends. While random effects of regions are included in models, however they are excluded from the model predictions. In all continents, the in-migration for both international (blue line) and internal (red line) stays above the out-migration for international (green line) and internal (yellow line) rates meaning more scholars arrive than those leaving. In Africa and Oceania the two darker lines (blue and green) which are international have a large gap with the internal lines (yellow and red) and the order of magnitude in internal trends is much higher (close to twice the international one). In Europe and North America the reverse is happening and the two internal lines (yellow and red) are above the two international lines (blue and green) but the order of magnitude is closer and gap is less pronounce. In most continents and cases the trends are decreasing over time meaning scholarly migration is decreasing with the exception of internal emigration in Africa, Asia and South America and internal immigration in South America. These trends are further investigated per sub-national region in the next figure.

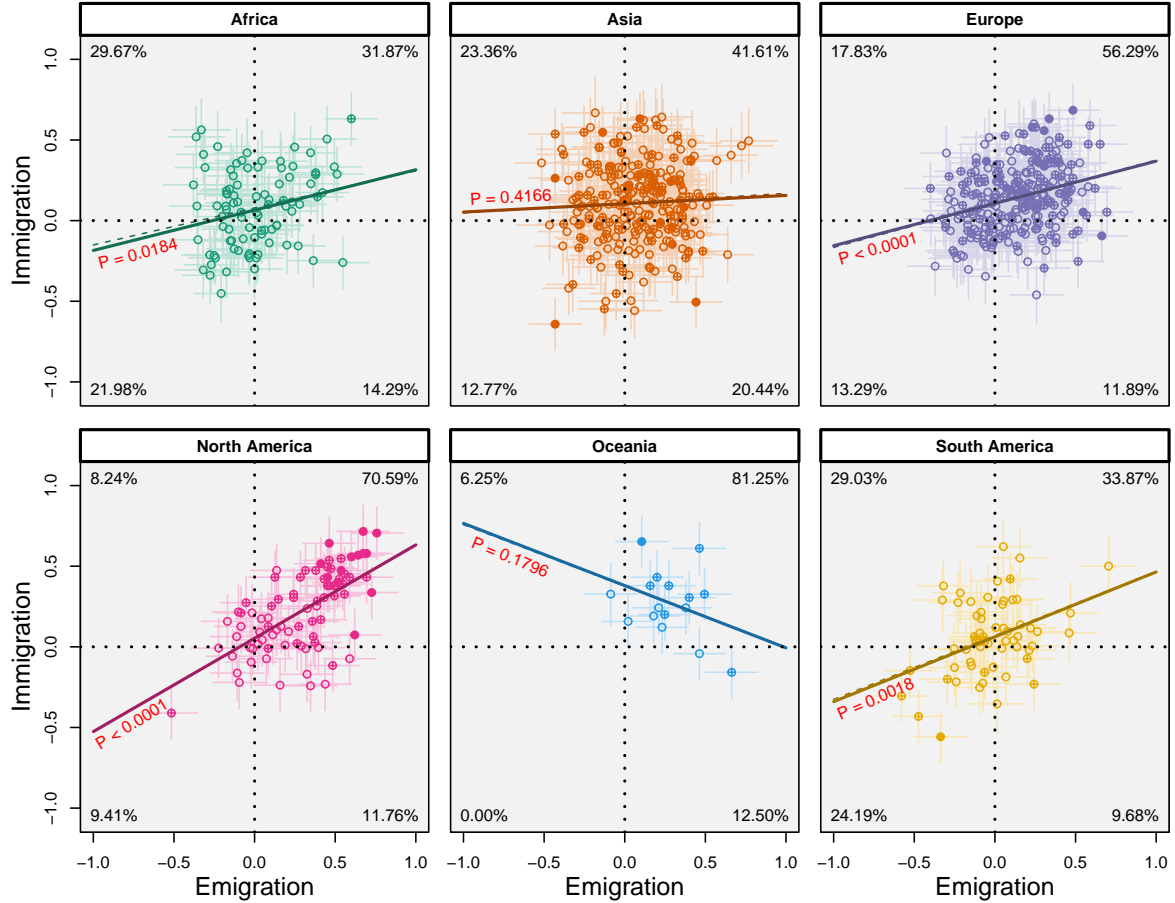


Figure 3: Kendall rank correlation coefficients between internal and international time trends for different sub-national regions (circles) investigating inter-relationship between internal and international emigration and immigration simultaneously. Filled circles: population of scholars higher than 10,000; semi-filled circles: population of scholars between 1000 and 10,000; open circles population of scholars equal or lower than 1000. Percent values in each corner denote a fraction of cases per each quadrant. In all continents, the largest part of the regions is located in the upper right quadrant, which determines the positive correlation between internal and international systems of migration for both emigration and immigration. Positive correlation means that either both internal and international trends are increasing over time, or both are decreasing. That is, if a region receives scholars, it consistently receives scholars from both domestic and foreign origins, and if a region sends scholars, it consistently sends scholars to both domestic and international destinations.