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Geographic mobility and research productivity in a selection of top world economics departments

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Abstract In this paper, we study the spatial characteristics of a sample of 2605 highly productive economists, and a subsample of 332 economists with outstanding productivity. Individual productivity is measured in terms of a quality index that weights the number of publications up to 2007 in four journal classes. We analyze the following four issues. (1) The "funneling effect" towards the US and the clustering of scholars in the top US institutions. (2) The high degree of collective inbreeding in the training of elite members. (3) The partition of those born in a given country into *brain drain* (who work in a country different from their country of origin), *brain circulation* (who study and/or work abroad followed by a return to the home country), and *stayers* (whose entire academic career takes place in their country of origin). We also study the partition of the economists working in 2007 in a given geographical area into *nationals* (stayers plus brain circulation) and *mi grants* (brain drained from other countries). (4) Finally, we estimate the research output in different geographical areas in two instances: when we classify researchers by the insti tution where they work in 2007, or by their country of origin.

Keywords Brain circulation · Brain drain · Geographic mobility · Individual productivity · Scientific elite · US research advantage

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Introduction

Given the skewness of science in so many dimensions (for individual productivity distributions, see *inter alia* Lotka 1926; Ruiz Castillo and Costas 2015), the analysis of top world research institutions is an essential ingredient for understanding the workings of any scientific discipline. In universities, research institutes, and research departments in public or private firms, the *research group* is the basic organizational entity at the lowest aggregation level in the natural sciences, engineering, and the medical research fields (Van Raan 2006a, b, 2008). At the same time, in the social sciences the *university department* is the key organizational unit (Biglan 1973; Agasisti et al. 2012; Perianes Rodriguez and Ruiz Castillo 2015).

In this paper, we focus on the faculty members working in 2007 in a selection of the best 81 economics departments in the world according to the Econphd (2004) ranking. We measure individual productivity in terms of a quality index that weights the number of publications up to 2007 in four journal classes. Using this dataset, in previous contributions we have initiated a research program on the characteristics of top academic institutions in economics.[1] In this paper, we analyse some issues arising from the world geographic distribution of top researchers in any scientific field.

In the first place, in all sciences we observe a heavy concentration of the most productive and influential researchers in top US research institutions (Batty 2003; Basu 2006; Parker et al. 2010). Moreover, we also observe that a large contingent of scientists working in the US have obtained their first college degree in their country of origin, giving rise to what Hunter et al. (2009) call the *elite brain drain*. On the other hand, the recent literature on immigration emphasizes different channels through which sending countries may benefit from international mobility in a context of increasing globalization of scientific activity. In particular, there is a second group of scientists who study and/or work abroad followed by a return to the home country — a phenomenon known as *brain circulation*. Therefore, we find it important to study the partition of scientists born in any geographical area into three groups: brain drain, brain circulation — which will be referred to as *movers* — and *stayers*, who are those who study and work in their country of origin. From the point of view of destinations, we will also study the partition of scientists working in 2007 in a given area into *nationals* — namely, stayers and brain circulation — and *migrants*, or brain drained from other areas.[2]

In the second place, given the concentration of talent in the US, in all sciences there is a considerable difference between the research output obtained in this country and elsewhere. However, part of the scientific success achieved by US institutions must be attributed to researchers born in other countries that either remained in the US after obtaining a Ph.D. there or moved to the US after attending graduate school at home. Therefore, we find it interesting to compare the US research advantage when we classify individuals by their current job in 2007, or by their country of origin.

[1] In Carrasco and Ruiz Castillo (2014) we studied the evolution of productivity inequality, and the extent of rank reversals between the first eight years and the remainder of the academic career for several cohorts, while in Perianes Rodriguez and Ruiz Castillo (2015) we studied the within and between department variability in productivity distributions.

[2] For the economics of immigration, see Borjas (1999), and Stark (2005), and for a survey of four decades of economics research on the brain drain, see Doquier and Rapoport (2012). Since this literature refers to the migration of low or highly educated individuals from developing to developed countries, we appeal to it here by analogy.

By construction, the economists in our dataset belong to the best departments, not only in the world at large, but also in the countries represented in the sample. In so far as they are highly productive, receive a very similar type of graduate education, and are influential both in the world and the countries where they work in 2007, they can be viewed as an elite in its own right. However, their productivity is very unequal, and a minority of them account for a large share of the weighted publications. Moreover, there must be other economists as productive as this minority who are working in 2007 outside our sample departments. Hence, for the purposes of this paper, we construct a sequence of world elites combining two sources: economists from our original subset with above average pro ductivity according to different productivity thresholds, plus economists from other institutions that had received an important professional distinction a fellowship in the Econometrics Society, a membership in the American Academy of Sciences, or a Nobel Prize. From the point of view of their origins, we distinguish between three areas: the US, the EU the 15 countries forming the European Union before the 2004 accession and the rest of the world (RW hereafter). From the point of view of their destinations, we dis tinguish between two areas: the US, and other countries with at least one department in the original sample, referred to as Other Sample Countries, or OSC hereafter. We investigate the following three questions as we move from the total sample to the most selective elite:

1. The funneling effect towards the US, and the clustering of Ph.D. students and scholars in a handful of US institutions.
2. The double partition of movers *versus* stayers, and nationals *versus* migrants.
3. The difference in research output across geographical areas when we compare the output of economists classified by their current job in 2007 or by their country of origin.[3]

Spatial mobility is a widespread phenomenon in science, particularly among the elite. However, the literature is not large, and each contribution studies one of the above aspects at a time.[4] In particular, the most complete study of elite scientists we know of, namely, Parker et al. (2010, 2013), only covers the concentration of environmental scientists and ecologists in the US and Western Europe. Clearly, the reason for this situation is the difficulty of obtaining the necessary information. Large bibliographic databases such as the Web of Science, presently distributed by Clarivate Analytics, or Scopus, distributed by Elsevier contain information about the characteristics of documents appearing in the periodical literature, including the place where authors work at the time of publication. Therefore, at best these databases allow the investigation of the extent to which scientific elites reside in the US (included in point 1 above). If one adds information about where elite members are born or earn their B.A., then it is possible to study the elite brain drain phenomenon, and the role of migrants in the research output attributed to the institutions where they work. Finally, additional knowledge concerning where individuals earn their

[3] Drèze and Estevan (2007) provide an excellent survey for the academic economics profession as a whole concerning the funneling effect towards the U.S., the clustering effect in a few top U.S. institutions, and the extent of the research gap between the U.S. and the EU around the year 2000. However, they use different types of information, often of an aggregate type at the department level, which does not include data on individual productivity, the country of origin, the geographic mobility, or the age of individual researchers.

[4] Together with Hunter et al. (2009), on the elite brain drain see Zuckerman (1977), Stephan and Levin (2001), Laudel (2003, 2005), and Ali et al. (2007). On brain circulation, see *inter alia* Borjas and Bratsberg (1996), Velema (2012), and Khan and MacGarvie (2016). For the research gap in favor of the U.S., see Dosi et al. (2006), and Bauwens et al. (2008). For the importance of foreigners' contribution to U.S. science, see *inter alia* section 2 in Doquier and Rapoport (2012), and chapter 8 in Stephan (2012).

Ph.D. or work for some time abroad makes it possible to investigate everyone's graduate education, and the brain circulation phenomenon. To our knowledge, only Panaretos and Malesios (2012) for mathematics study simultaneously the first two research questions but not the last one described above.

The rest of this paper is organized into three sections. Section two discusses the construction of the dataset, and the identification of the different elites. Section three contains the empirical results concerning the funneling and clustering effects, the distinction between movers and stayers and between nationals and migrants in different geographical areas, and the extent of the research gap between the US and other areas. Section four offers some concluding comments. To save space, we include a Supplementary Material section SM hereafter. When required, references will be made to the Working Paper version of this article in Albarrán et al. (2014).

The data

The construction of the dataset involves the following four methodological questions: the selection of the top world departments, the collection of the faculty members' individual information, the definition of the productivity measure, and the identification of the elites.

The selection of a sample of economics departments

Both in the US, the EU, and other parts of the world, Economics and Business are closely related but separate academic disciplines generally organized into economics departments and business schools. Of course, a good number of the scholars working in the former might be engaged in research on finance, management, and other traditional business topics. However, as members of economics departments, we will consider them as professionals mainly devoted to economics. Similarly, many scholars working in business schools, research institutes, central banks, or international organizations are regularly doing valuable research in economics. However, with the exceptions discussed below, they are excluded from this study. Thus, we begin by selecting the top 81 economics departments worldwide according to the Econphd (2004) university ranking. This ranking takes into account the publications in the period 1993 2003 in the top 63 economics journals in the Kalaitzidakis et al. (2003) weighted journal ranking, where the weights reflect journal citation counts adjusted for factors such as the annual number of pages and the age of the journal (for further methodological details, see Econphd 2004).

In principle, in any science it is relatively easy to agree on a short list of the most prestigious and influential departments in the world. However, as the list expands, the more controversial the inclusion of new departments becomes, and the greater is the cost of collecting additional individual information. In our case, we select 81 out of the 321 departments ranked in Econphd (2004) because this set constitutes a sufficiently representative sample of the outstanding departments in a relatively small science as is economics. The eighty first department the University of Bonn allowed us to include Germany as one of the countries represented in the sample.

As can be observed in Table A in SM, the original 81 departments are distributed as follows: 52 in the US, and 29 in what we call the OSC. Among the latter, there are 21 departments in eight member countries of the EU (eight departments in the UK, four in the Netherlands, three in Spain, two in Sweden, and one in France, Germany, Belgium, and

Denmark), plus the European Institute in Florence, and seven departments in the RW (four in Canada, two in Israel, and one in China). We have compared this list with the first 81 economics departments listed in two other equally acceptable university rankings in Coupé (2003).[5] The main conclusion is that, apart from differences in the order in which each institution appears in the various rankings, our list has between 70 and 73 departments in common with each of the other lists.[6]

Collecting individual information

We found 2755 full time researchers listed in the 81 departmental web pages in 2007. Of course, this was not an easy task. In many instances, it is hard to distinguish between tenure track and tenured faculty our desired contingent and visiting faculty, part time or full time teaching staff, and other personnel sometimes included in department web pages.

The minimum information we require for each individual includes the nationality, the university where a Ph.D. is obtained, the age, and the publications in the periodical lit erature up to 2007. The information concerning the country of birth is very often lacking. Therefore, we generally assign the nationality in terms of the country where each indi vidual obtains a B.A. or an equivalent first college degree. In turn, since people's age is not generally available, we use the academic age, namely, the number of years elapsed since obtaining a Ph.D. (or equivalent degree) up to 2007. Whenever educational information could not be found through the Internet, we wrote to the person in question. Many people answered providing the required information. Otherwise, we proceeded as follows. There were 30 cases in which we lacked information on a person's B.A., but the nationality could be safely inferred from the remaining information on the person's last name, the country where s/he did her Ph.D., and the country where s/he worked in 2007.[7]

We register the information available in the Internet (personal web pages, *RePEc*, *Publish or Perish*, etc.) concerning the publications up to 2007 of these 2755 people. In 50 cases, we could not find information about a person's education and/or publications. Therefore, the initial sample consists of only 2705 economists.

[5] They are based on the mean rank over 11 different rankings, and the mean rank that would result when only taking the five, 25, and 50 best performing scholars, thereby (partially) correcting for the size bias of the first (Tables 9 and 13 in Coupé 2003, respectively).

[6] Three additional rankings of a more limited coverage should be mentioned. Firstly, Winkler et al. (2014) classify 771 four year colleges and universities distinguished by the Carnegie Foundation (1994) in the U.S. into several groups. All of the 30 members of the top group, and 22 out of the 25 members of the second group among those granting Ph.D.s belong to our list. Secondly, Amir and Knauff (2008) rank 58 economics departments worldwide in terms of graduate education in 2006. The first 36 institutions in this ranking are included in ours, while only eight institutions five of them from the EU, one from the U.S., and two from the RW of the remaining 22 are missing in our list. Finally, Van Bouwell and Veugelers (2012) compile a list of "top institutes" using three different rankings. All of the 11 super top, 21 mid top, and eight sub top institutions in Canada, the U.S., and Europe listed in their Table I are also included in our list. Therefore, we conclude that our 81 institutions constitute a useful sample of the best economics departments in the world in 2007.

[7] One person whose nationality was known never obtained an undergraduate degree. At the same time, for people whose higher university degree is an M.A. (mainly older people working in the UK), academic age is counted from that date up to 2007. For the only scholar that never obtained a Ph.D. or an M.A., academic age is counted from the B.A. up to 2007. In the 29 cases where the only missing data is the date of obtaining a Ph.D., this piece of information was imputed taking into account the first published Working Paper or professional article.

The measurement of individual productivity

Because of budgetary restrictions, our information on productivity suffers from two limitations. Firstly, the article count in our dataset made no distinction between single and multiple authorship. Consequently, no correction for co authorship could be implemented. This amounts to assigning full credit to all authors in co authored publications. Although at an aggregate level they recommend fractional counting for co authored publications, Waltman and Van Eck (2015) argue that the multiplicative practice we adopt here is admissible at the individual level. Moreover, the average number of authors per article in Economics and Business in 2003–2011 is 1.8, whereas the mean and standard deviation for 30 broad scientific disciplines is 3.1 and 1.1 (Ruiz Castillo and Costas 2015). Therefore, under the assumption that the assignment of equal responsibility for co authored publications is a more acceptable option when the number of authors per publication is small, the alternative we adopted is a lesser problem in our case. Secondly, although we know the journal where each article is published, it was impossible to search for the citation impact achieved by every article. Therefore, we are constrained to measuring individual productivity as a function of the total number of publications per person over her academic career up to 2007.

In every science, there is broad agreement about the different merit associated to publishing in a reduced number of top journals, a larger set of excellent field journals, or the remaining international or local journals. Starting from the top 63 journals in the Kalaitzidakis et al. (2003) journal ranking, and also taking into account the rankings in Lubrano et al. (2003), and Kodrzycki and Yu (2006), in this paper we distinguish between four journal classes.[8]

Although any specific classification will always be controversial, a consensus on how to weight the different journal classes in order to reach a scalar productivity measure is possibly even harder to reach. This paper studies faculty members in top world departments, and seeks to isolate among them at least part of a true world elite with remarkable or outstanding productivity. In this context, we believe that it is desirable to value very highly class A journals, to stress the difference between top and local journals, and to recognize the role of excellent field journals. Thus, in our preferred weighting scheme the four classes are assigned weights equal to 40, 15, 7, and 1 point, respectively.[9] The resulting quality index is denoted by $\boldsymbol{Q}$.

[8] Classes A, B, and C consist of 5, 34, and 47 journals, while class D consists of any other journal. Class A includes the *American Economic Review*, *Econometrica*, *Journal of Political Economy*, *Quarterly Journal of Economics*, and *Review of Economic Studies*. By way of example, the following 12 journals are in class B: *Economic Journal*, *Games and Economic Behavior*, *International Economic Review*, *Journal of Econometrics*, *Journal of Economic Growth*, *Journal of Economic Theory*, *Journal of Finance*, *Journal of Labor Economics*, *Journal of Monetary Economics*, *Journal of Public Economics*, *Rand Journal of Economics*, and *Review of Economics and Statistics*. See Appendix II in Albarrán et al. (2014) for further details concerning this construction, including the listing of all journals in classes B and C.

[9] Oster and Hammermesch (1998) use the Laband and Piette (1994) weights that, as in our case, imply large differences between journal classes. Rauber and Ursprung (2008) use the Combes and Linnemer (2003) weights that lie between unity for five top journals, 2/3 for sixteen journals, down to 1/12 for the lowest quality journals – a very different scheme from our own. Coupé et al. (2006) use the average of the rankings based on different weighting schemes computed in Coupé (2003). For a classification of different schemes in an elitist egalitarian axis, see Ruiz Castillo (2008). For the consequences of adopting an alternative weighting scheme to our own see below.

The total sample and the identification of the elites

There are 175 faculty members without any publication at all (typically because they are at the beginning of their career). For reasons that will be apparent in a moment, consider the partition into four categories of the individual productivity distribution for the remaining 2530 faculty of members with a positive quality index (or at least one publication). Let μ_1 be the mean of the productivity distribution, and let μ_2 and μ_3 be the mean productivity of individuals with productivity greater than μ_1 or greater than μ_2, respectively. The four categories consist of individuals (1) with low productivity smaller than or equal to μ_1, (2) intermediate productivity between μ_1 and μ_2, (3) remarkable productivity between μ_2 and μ_3, and (4) outstanding productivity greater than μ_3. The information concerning the three means, the proportion of people in the four categories, as well as the proportion of the total Q index points accounted for by each category is in Table 1.

The following two characteristics of distribution Q are worth noting. Firstly, the 2530 individuals in the sample are very productive: average productivity is 307.3 quality points *per capita*, equivalent to more than seven articles of class A or about 20 articles of class B. Alternatively, the average quality index is 16.1 per year during an academic life (the period from the first year after receiving a Ph.D. up to 2007), a quantity that can be compared with the 15 points assigned to one article in class B.[10]

Secondly, the distribution of individual productivity is highly skewed. As many as 36.9% of the sample have no class A publication, while 25% published once or twice, and the remaining 38.1% published three or more times in the top journal class. On the other hand, the average productivity μ_1 is 17 percentage points above the median, and the top 11.5% of researchers in categories 3 and 4 account for 43.6% of all quality points.[11] In this context, we suggest working with elites defined in terms of increasing productivity thresholds: (1) a group of 833 researchers with Q above μ_1; (2) the subset of 302 researchers among them with Q above $\mu_2 = 707.4$, and (3) a final group of 111 researchers with Q greater than $\mu_3 = 1165.2$.

As announced in note 9, we have experimented with a system that places less weight on top journals: journals in class A, B, C, and D receive 20, 10, 5, and 1 point, respectively. The corresponding cut off points separating the three elites are $\mu'_1 = 187.6$; $\mu'_2 = 419.8$, and $\mu'_3 = 670.1$. The main consequence is that a relatively small number of individuals lose their status, while a few others improve their situation (for the details, see Albarrán et al. 2014). In brief, changing the journal weighting system in a less elitist direction does not dramatically alter the identity of the most productive researchers. Therefore, in the sequel we stick to the original, more discriminating weighting system.

Although the previous elites constitute an interesting starting point, it would be con venient to extend them with equally productive researchers who, having received an important professional distinction, were not considered before because they work outside the initial set of top 81 departments. Specifically, we turn towards the most prestigious professional association in our field, namely, the Econometric Society. Thus, we consider the set of Econometric Society Fellows (ESF hereafter) that satisfy two criteria: they

[10] In contrast, only 42.8% of European academic economists published at least once in *EconLit* during 1971 2000 (Combes and Linnemer 2003), while 122,889 researchers in Economics and Business published 0.25 articles per year during 2003 2011 (Ruiz Castillo and Costas 2015).

[11] Interestingly, these figures are of the same order of magnitude as those found in Ruiz Castillo and Costas (2015) who study the productivity of 17.2 million authors in 30 broad scientific fields with publications in the period 2003 2011.

Table 1 The skewness of the productivity distribution for the 2530 economists in the 81 Departments with at least one publication in 2007

	Percentage of individuals				Percentage of quality points			
	In category				Accounted for by category			
	1	2	3	4	1	2	3	4
Quality index, Q	67.1	21.4	7.1	4.4	24.2	32.2	20.2	23.4

Category 1 = individuals with low productivity, smaller than or equal to $\mu_1 = 307.3$

Category 2 = individuals with an intermediate productivity, above μ_1 and smaller or equal to $\mu_2 = 707.4$

Category 3 = individuals with a remarkable productivity, above μ_2 and smaller or equal to $\mu_3 = 1165.2$

Category 4 = individuals with an outstanding productivity above μ_3

where

μ_1 = mean of the productivity distribution

μ_2 = mean productivity of individuals with productivity above μ_1

μ_3 = mean productivity of individuals with productivity above μ_2

remain active in 2007, in the sense that they have some publications in the 2005 2009 period, and they have above average productivity with a Q index above μ_1.[12] It is worth noting that all members of the American Academy of Sciences satisfying these two criteria are also ESF.

Out of the 444 Fellows so selected, 369 are already included in some of the original 81 economics departments (some as Emeritus Professors). This speaks very eloquently of the appropriateness of our initial selection of top world departments. Among the rest, 34 ESF are found in Business Schools, and 41 belong to some other institutions.[13] The complete listing of institutions, together with information on the number of faculty members and their publications in classes A to D, is in Table A in the SM.

The sample of individuals with at least one publication referred to in the sequel as the *total sample* consists of 2605 economists, of whom 123, 332 and 908 belong to what we call Elite I, Elite II, and Elite III, respectively. These elites include 22, 9, and 6 scholars that have received a Nobel Prize up to 2007. The members of the three elites with their Q value, nationality, and the university where they are associated with in 2007 are listed in Table B in the SM. Of course, it must be recognized that we are missing economists from all over the world that, in spite of being very productive according to our own definition, have had no chance of being considered because they are working in 2007 in departments not included in our sample, or they are not members of the Econometric Society. However, we believe that the total sample and the three elites we have isolated constitute a reliable set of top researchers that is inclusive enough to be of interest to everyone.

[12] We attempted a similar exercise taking into account highly placed scholars in the RePEc ranking (https://ideas.repec.org/top/). Unfortunately, matching the two lists of last names by an automatic procedure proved impossible.

[13] To simplify matters, the ESF have been classified into three categories, namely, economic departments in the U.S. (13 people), Europe (15 people), and the RW (13 people). Thus, the original 2755 economists plus the 75 ESF are classified into 85 categories: the 81 economics departments, plus four types of institutions for the latter.

Empirical results

A number of important studies use an alternative notion of elite, consisting of the 250 most highly cited researchers (HCRs hereafter) during 1981–1999 in 21 broad scientific disciplines distinguished in the Web of Science (Bauwens et al. 2008; Panaretos and Malesios 2012). Similarly Parker et al. (2010, 2013) focus on the 0.1% most cited environmental scientists and ecologists consisting of 345 scholars. Therefore, to facilitate the reading of our empirical results, as well as the comparability with these contributions, in this section we only include the information on the total sample and the Elite II—referred simply as the *elite* hereafter—with 332 economists.[14] Nevertheless, the reader interested in the sequence of results for all elites can refer to Albarrán et al. (2014).

The funneling effect

The number of people classified by their nationality, the place where they obtained a Ph.D., and their current job in 2007 is in Panel A in Table 2. The number of countries at every stage is classified the same way in Panel B in Table 2. We emphasize the following two points. Firstly, in both samples, the data show a clear funneling effect towards the US (Panel A in Table 1). Figure 1 illustrates the situation in the total sample and the elite. Secondly, besides the US, the economists in the total sample belong to 61 different countries, obtained a Ph.D. in 24 countries, and in 2007 worked in only 20 countries. In the elite, these amounts become 23, 11, and 15 (Panel B in Table 2). Figure 2 illustrates the consequences of the funneling effect, showing the percentage of people in the two samples working in 2007 in the three geographical areas.

As we said, Panaretos and Malesios (2012) study a different elite notion. With regard to the percentage distribution of HCRs by geographical area (Table 4.A in Panaretos and Malesios 2012), two points should be noted. Firstly, when the 21 disciplines are ordered according to the proportion of HCRs residing in the US, the Social Sciences, Economics and Business, and Psychiatry and Psychology occupy the first three positions. In particular, the percentage of HCRs working in the US in Economics and Business is, approximately, 85%. This percentage is 81.3% in our elite based on the Q index. It is reassuring that the geographical distribution of our elite—based on the weighted number of publications in four journal classes—is so close to the one in Panaretos and Malesios (2012) based on citation impact. Secondly, on average over all disciplines, only about two thirds of the 6103 HCRs work in the US. We must conclude that the dominance of US institutions in economics is considerably stronger than in most other disciplines.

The clustering effect

It turns out that the proportion of US institutions where people earn their B.A. and their Ph.D., or where they work in 2007, increases as we move from the total sample to the elite. The situation is illustrated in Fig. 3 (drawn from Table 4 in Albarrán et al. 2014). Furthermore, a large part of this clustering is towards a rather reduced number of leading US economics departments. As we move from the total sample to the elite, people working in the top ten US departments in 2007 represent an increasing percentage of the total: from 15.8% in the total sample to 43.5% in the elite (see Fig. 4 drawn from Table C in SM).

[14] We thank a referee for this suggestion.

Table 2 The funneling effect for a partition of the world into the U.S., the European Union (EU), and the rest of the world (RW)

	Total sample			Elite		
	B.A.	Ph.D.	CJ	B.A.	Ph.D.	CJ
(A) People						
U.S.	1019	1790	1612	192	263	270
EU	965	707	806	73	52	44
RW	621	107	187	67	16	18
Missing	0	1	0	0	1	0
Total	2605	2604	2605	332	331	332
(B) Countries (besides the U.S.)						
EU	14	12	10	10	7	8
RW	47	12	10	13	5	7
Total	61	24	20	23	11	15

CJ current job in 2007

Using the 250 HCRs in each field, as do Panaretos and Malesios (2012), Bauwens et al. (2008) analyze 5597 HCRs in 21 disciplines who in 1999 work in 1329 institutions all over the world. The main finding is that the clustering towards a reduced number of US institutions is present in all sciences. However, as before, this phenomenon is stronger in our elite than in all disciplines taken as a whole for the HCRs.

It is interesting to analyze this phenomenon in relation to graduate education. Inspiring ourselves in Amir and Knauff (2008) a contribution that ranks 58 Economics depart ments worldwide in terms of graduate education in 2006 we partition the people working in 2007 into three classes: (1) a selection of ten top Ph.D. granting institutions in the US[15]; (2) the remaining US institutions; and (3) the institutions in the OSC. For each class i in this partition, we compute the number of people who have obtained their Ph.D. in any of the institutions in this class, as well as in any of the other j classes with $j \neq i$. A summary of results for both samples is presented in Table C in SM and Fig. 5 (further details can be found in Table D in Appendix I in Albarrán et al. 2014). The concentration of Ph.D. graduates from the top 10 US departments among the elite in the three geographical areas goes from somewhat less than 50.0% in the total sample to approximately two thirds in the elite (Table C in SM). The degree of inbreeding among the elite, and the special role of the two graduate schools training the largest number of scholars Harvard and MIT are impressive (Fig. 5). Note, however, that this inbreeding is a collective phenomenon not present at the individual departmental level.

We do not have complete information on the entire academic career of every individual but, whenever possible, we have recorded where the 2605 economists in the total sample held their first job immediately after obtaining a Ph.D. The percentage of people in the total sample studying a Ph.D., holding their first job, and working in the same university in the US is a rare event affecting only 1.7% of those individuals with a US job in 2007. This trend contrasts with what we find in the EU. As we move from the total sample towards the elite, the percentage of economists either working in the EU or who have obtained a Ph.D. in the EU decreases. Furthermore, those in the total sample earning a Ph.D., holding their

[15] Nine of these departments also occupy the first nine positions in the Econphd ranking. The tenth, the University of Minnesota, ranked 29th in Econphd, has been selected among the top ten in this Section be cause of the high number of its Ph.D.s among the elite. It should be noted that these top ten departments coincide with the top ten in Amir and Knauff (2008).

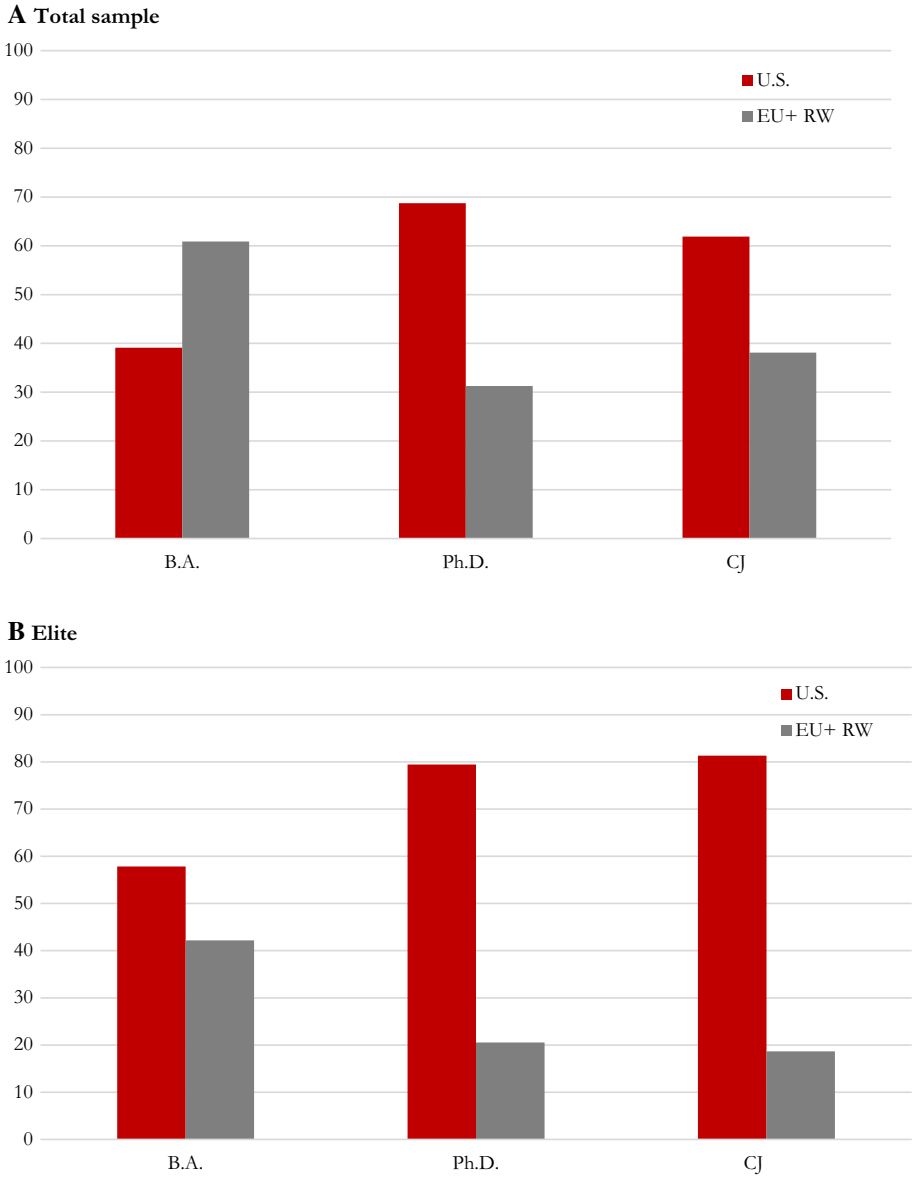

Fig. 1 The funneling effect. Percentage of people in the total sample and the elite earning a B.A., a Ph.D., and working in 2007 inside and outside the US

first job, and working in the same university represent 16.0% of the total a much larger percentage than in the US.

At any rate, almost 70% of all economists in the total sample obtain their Ph.D. in the US. We should add that 12% attend graduate school in the UK or Canada. Furthermore, the Ph.D. program in some of the remaining institutions in the EU or the RW is inspired in the type of program we find in these Anglo Saxon countries. Thus, a vast majority of the total

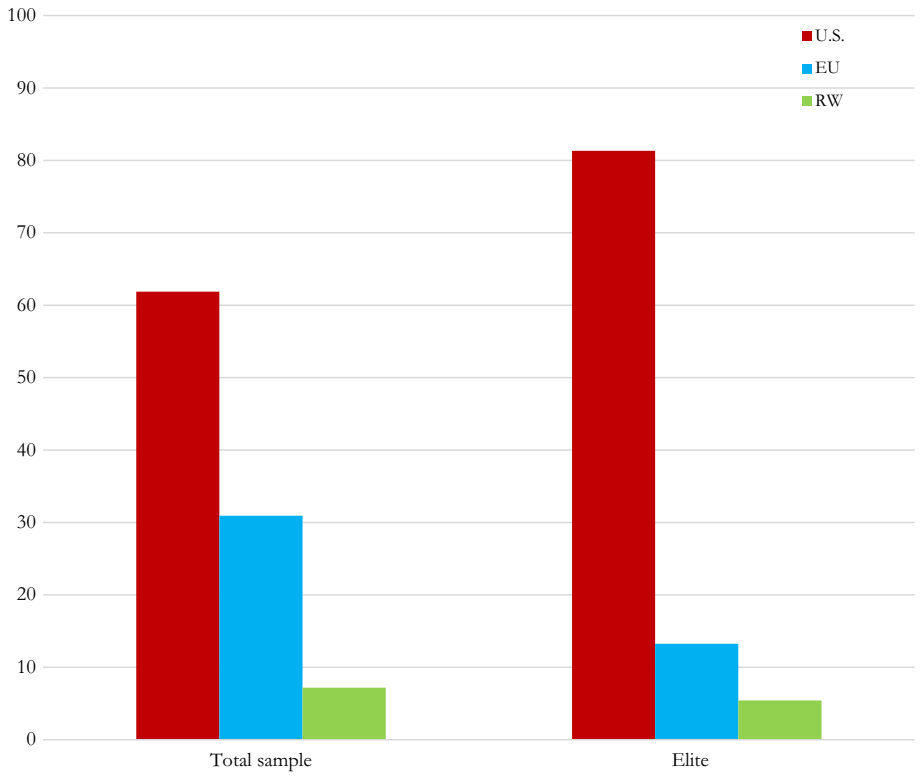

Fig. 2 Consequences of the funneling effect. Percentage of people in the total sample and the elite working in 2007 in the three geographical areas

sample receives a very similar type of graduate education. Consequently, they share a very similar methodological outlook, as well as a common view of what it takes for a piece of research to be of high quality. Taking into account that they belong to a subset of the best economics departments of the world or they are active members of the Econometric Society, we maintain that, relative to the world as a whole, the 2605 economists in the total sample form an academic elite in its own right.

Geographical mobility

Geographical mobility is a key characteristic of all sciences. Our information concerning this phenomenon in economics is limited but interesting. We only know the country where people earn a B.A. or a Ph.D., and the country where they work in 2007. Therefore, any move that takes place during the period between obtaining a Ph.D. and 2007 is ignored. This means that we cannot separate permanent migration from temporary mobility. Nev ertheless, among the nationals born in the US or in any of the eleven OSC we can distinguish between: (1) economists completing all their studies and working in the same country (*stayers*); (2) those who study their Ph.D. abroad but come back to the country of origin (*brain circulation*), and (3) those who work in 2007 in a different country than the one where they originate (*brain drain*).

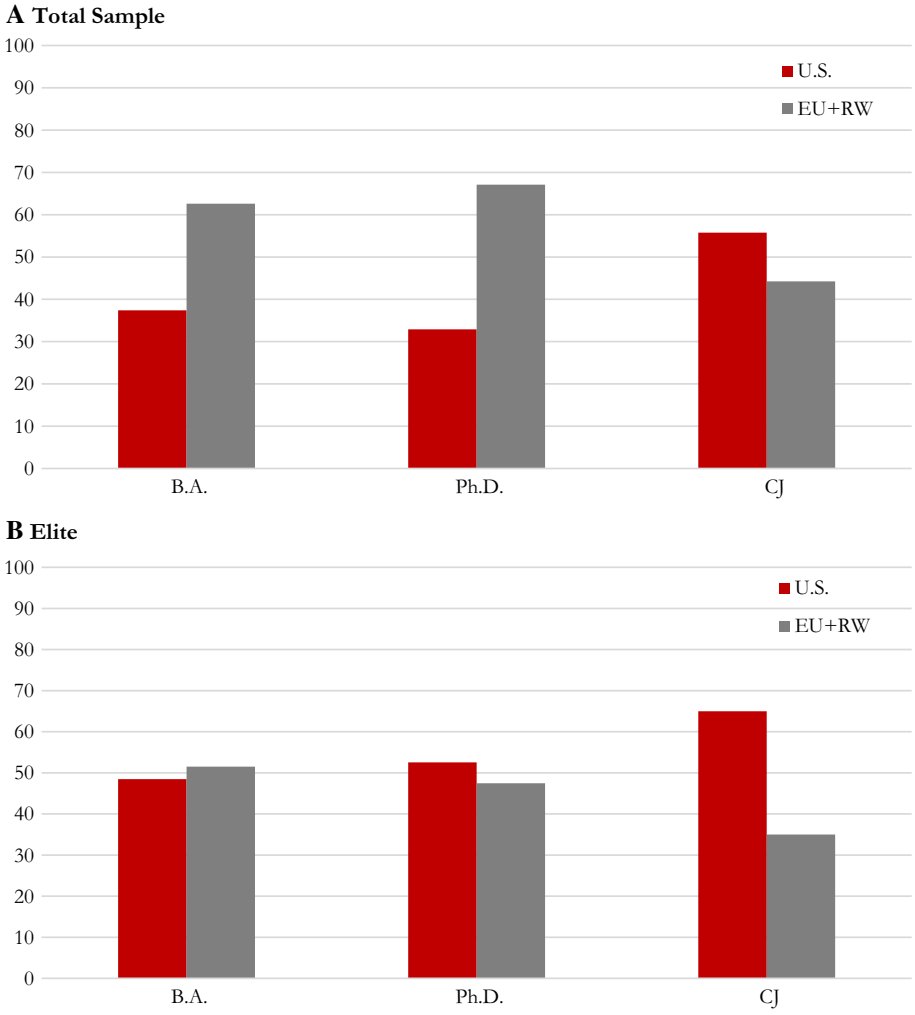

Fig. 3 The clustering effect. Percentage of institutions in the total sample and the elite where economists earn their B.A., their Ph.D., and work in 2007 inside and outside the US

Based on Table 3, we analyze two partitions: the partition into movers (brain circulation and brain drain) and stayers among those born in the US or the OSC, and the partition into nationals (brain circulation and stayers) and migrants, or those brain drained from other countries, among those working in 2007 in the US or the OSC.

We begin with the first partition in the total sample. The first fact to emphasize is the importance of geographic mobility: 47.7% of economists in our dataset are movers (left hand side in Fig. 6a). However, the partition into movers and stayers is very different in each geographical area. The US manages to retain most of its B.A.s for graduate work, as well as most of its Ph.Ds. as faculty members in US institutions. Thus, 92% of economists born in the US are stayers. In the OSC, the situation is exactly the opposite: stayers only represent 26.3%, while brain drain represents 61.2%. Given the large percentage of economists that attended graduate school in the US (Table C in the SM; Fig. 5), the fact

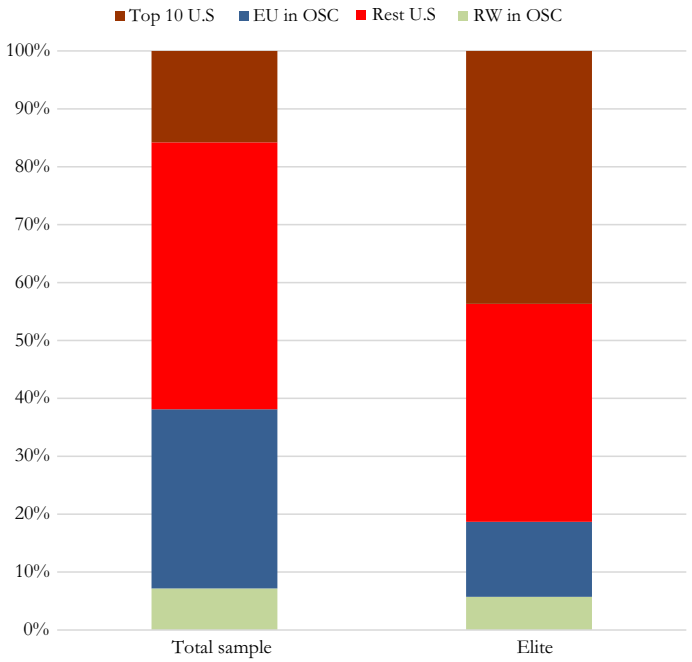

Fig. 4 The clustering towards US institutions in 2007 in the total sample and the elite

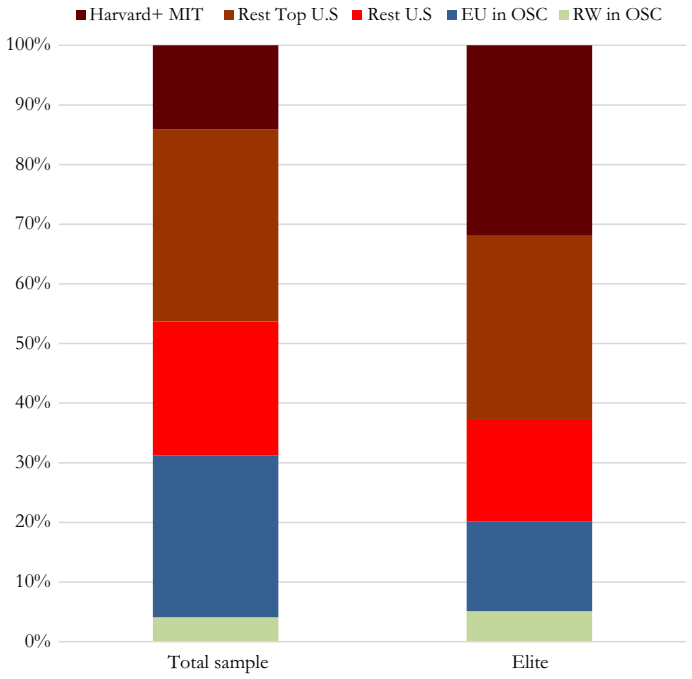

Fig. 5 The types of graduate schools attended by economists in the total sample and the elite

Table 3 Partition of the people originating in each geographical area into movers (brain circulation and brain drain to other countries) and stayers, and partition of those working in each area in 2007 into nationals (stayers and brain circulation) and foreigners (brain drain from other areas)

	Individuals classified by their area of origin				Individuals classified by the area where they work in 2007		
	Stayers (1)	Brain circulation (2)	Brain drain[a] (3)	Total = (1) + (2) + (3)	Migrants[b] (4)	Nationals = (1) + (2)	Total = (1) + (2) + (4)
Total sample							
Area							
U S	943	17	58	1018	652	960	1612
OSC	418	198	489	1105	377	616	993
Other	–	–	482	482	–	–	–
Total	1361	215	1029	2605	1029	1576	2605
Elite							
Area							
U S	181	6	4	191	83	187	270
OSC	24	20	67	111	18	44	62
Other	–	–	30	30	–	–	–
Total	205	26	101	332	101	231	332

[a] Brain drain *to* other areas

[b] Brain drain *from* other areas

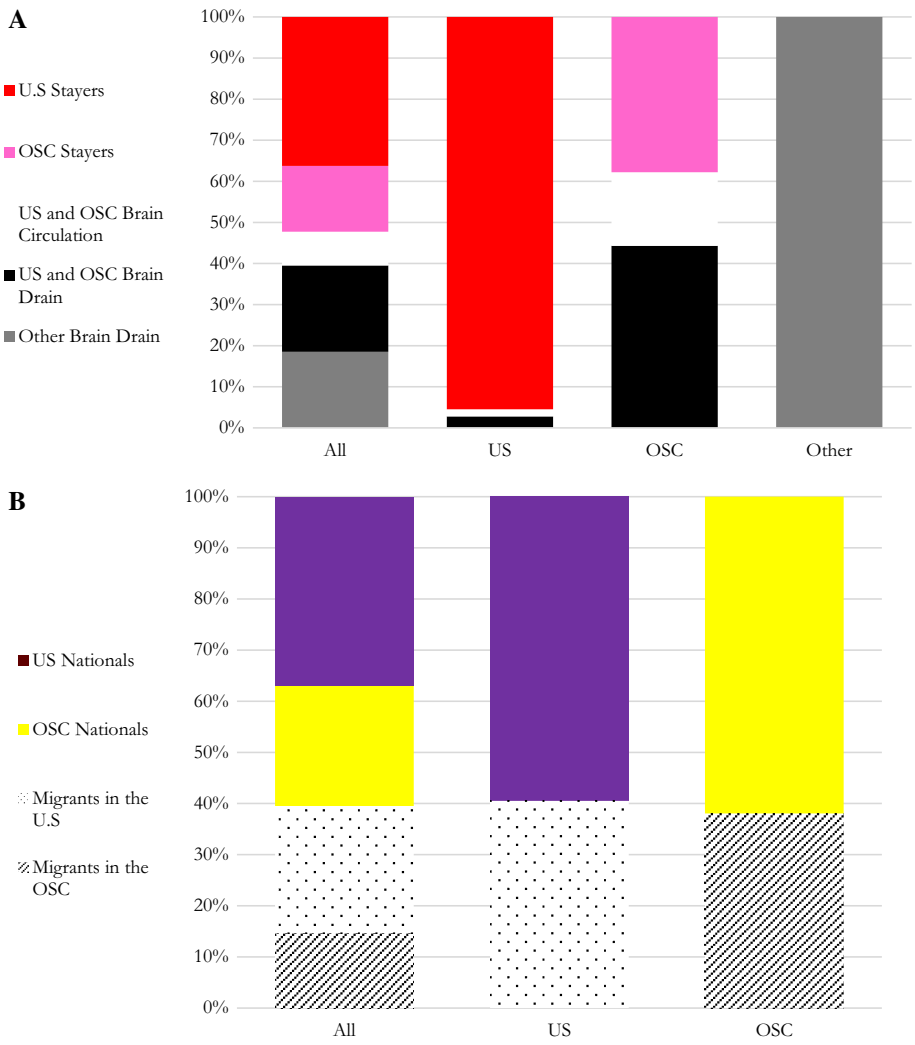

Fig. 6 **a** The partition into movers (brain circulation and brain drain) and stayers in the US, the OSC, and the other countries. The total sample. **b** The partition into nationals (stayers and brain circulation) and migrants in the US and the OSC. The total sample

that brain circulation is an important phenomenon representing 17.9% of those working in the OSC comes as no surprise. Finally, of course, all those born outside the US and the OSC are classified as brain drain (Fig. 6a). Regarding the distinction between nationals and migrants, the brain drain towards the US represents 25% of the total sample. However, when we examine the distribution between nationals and migrants in the US and the OSC, we observe that they are practically identical, that is, the percentage of migrants in the OSC is much greater than expected (right hand side of Fig. 6b).

When we move to the elite, the first change to note is the increased role of stayers *versus* movers. However, we should emphasize that while US stayers increase by approximately

18 percentage points, OSC stayers experience a nine point reduction. The remaining off setting reduction takes place in the brain drain originating in countries different from the US and the OSC (left hand side in Fig. 7a). As far as the partition of OSC economists into movers and stayers, the decrease of the latter is offset by an increase in the brain drain, with brain circulation essentially constant. In line with these changes, there is an increase in the percentage of nationals *versus* migrants in the elite as a whole. Interestingly enough, the percentage of migrants in the US relative to the total elite remains constant at 25%. Finally, the distribution between nationals and migrants within the US and the OSC, changes from, approximately 60/40 in the total sample to 70/30 in the elite (right hand side in Fig. 7).

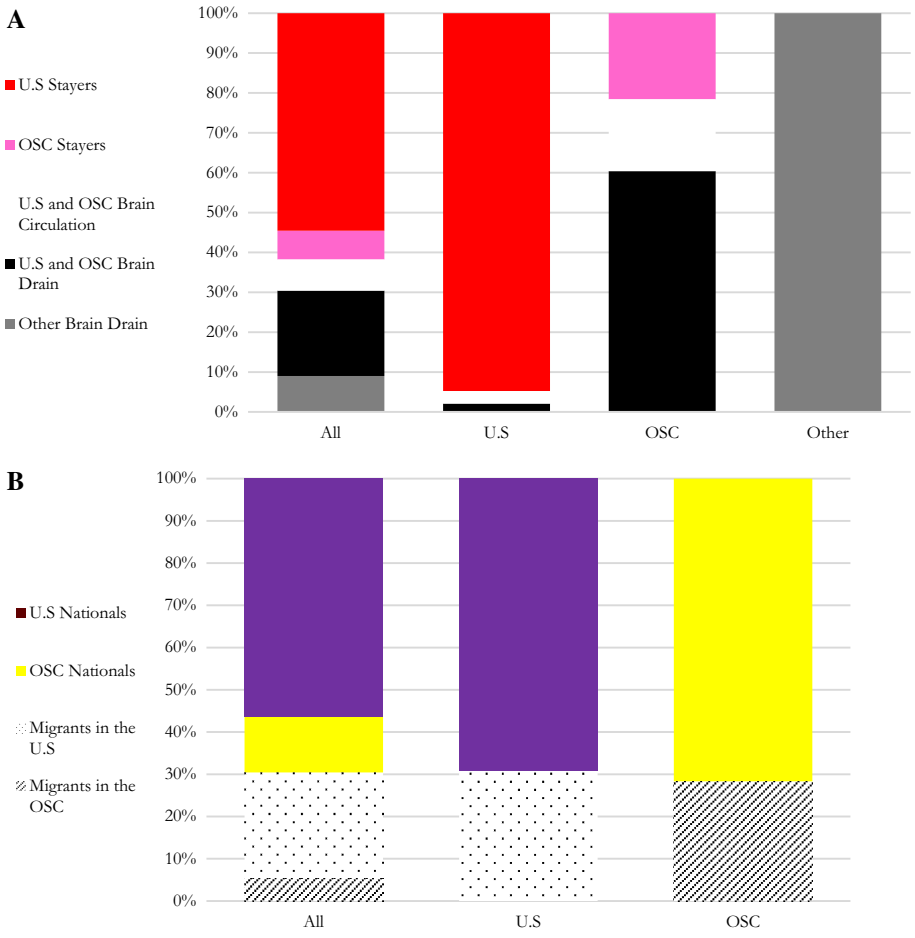

Fig. 7 **a** The partition into movers (brain circulation and brain drain) and stayers in the US, the OSC, and the other countries. The elite. **b** The partition into nationals (stayers and brain circulation) and migrants in the US and the OSC

Differences in research output between the US and other geographical areas

A good part of the bibliometric literature in economics has focused on the difference between the output produced in institutions located in the US and the EU using aggregate information for wide sets of economists (Drèze and Estevan 2007). Based on the microeconomic information presented in Table 4, Fig. 8 illustrates the clustering towards a handful of US institutions in the total sample and the elite. The top ten US departments contribute approximately one third of all quality points in the total sample, a contribution almost ten points greater than the one by the eleven countries in the OSC (left hand side in Fig. 8).

However, part of the output produced in US institutions should be attributed to migrants. Consequently, when we turn to the classification of researchers by their country of origin, things change dramatically. The quality output of US nationals, representing 51.8% of the total, is 24 percentage points lower than the output attributed to US institutions (Table 4 versus 5). How can we account for this difference? The output attributed to economists born in all EU member countries is eight points greater than the output attributed to economists working in 2007 in 22 EU institutions in the OSC, whereas the output attributed to economists born outside the US and the EU is 16 points greater than the output attributed to economists working in 2007 in seven RW institutions in the OSC.

In the elite, the dominance of US institutions is overwhelming: the percentage of total quality points contributed by economists of all nationalities working in Harvard and MIT is three percentage points greater than the contribution by all departments in the OSC (right hand side in Fig. 8). However, the quality output of US nationals, representing 61.0% of the total, is again almost 24 percentage points lower than the output attributed to US institutions. The contribution of EU nationals and those born in the RW is of the same order of magnitude. This means that the increase relative to UE and RW institutions is again of eight and 15.4 percentage points, respectively (Table 4 versus 5).

Table 4 The allocation of the total quality points according to the institutions where economists work in 2007

Geogr. areas	Total sample		Elite	
	Number of people	Quality points	Number of people	Quality points
I. Total U.S. = 1 + 2 +3	61.9	75.6	81.3	84.4
1. Harvard + MIT	3.7	10.5	14.5	19.2
2. Other top ten U.S.	12.1	23.3	28.9	32.5
3. Rest of U.S.	46.1	41.8	37.9	32.7
II. Total OSC = 4 + 5	38.1	24.4	18.7	15.6
4. EU in OSC[a]	30.9	18.2	13.0	11.4
5. RW in OSC[b]	7.2	6.2	5.7	4.2
Total	100.0	100.0	100.0	100.0

Percentage distribution

[a] European countries with at least one department in the sample = Denmark, Belgium, France, Germany, Netherlands, Spain, UK, Sweden

[b] Non European countries with at least one department in the sample = China, Israel, Canada

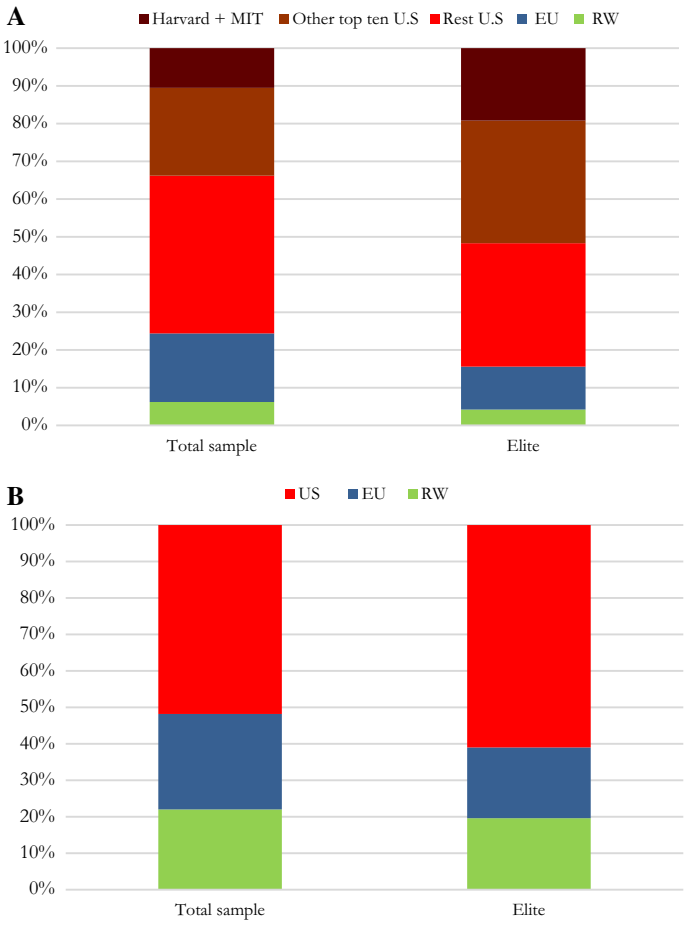

Fig. 8 **a** The distribution of quality points according to the institutions where economists work in 2007 in the total sample and elite. **b** The distribution of quality points according to the geographical area where economists are born in the total sample and elite

We should pay some attention to three changes when we move from the total sample to the elite. Firstly, the increase of almost ten percentage points in the contribution by US nationals is surely due to the absolute and relative increase in the number of US stayers ("Geographical mobility" section, Table 5). Secondly, we have already emphasized that the brain drain into the US represents 25% of the total number of economists in the total sample and the elite. Interestingly, these two groups of people contribute also approxi mately 25% of the total quality points. Thirdly, taken together, the first two points explain the increase in the contribution by US institutions. The other side of the coin is the reduction in the contribution by OSC institutions and non US nationals. This is due to the reduction of numbers and quality points experienced by OSC stayers and EU and RW brain drain to OSC, respectively.

Table 5 The allocations of people and the total quality points according to the geographical area where economists are born

Nationality	Total sample		Elite	
	Number of people	Quality points	Number of people	Quality points
I. U.S. = 1 + 2	39.1	51.8	57.5	61.0
1. Stayers + brain circulation	36.8	50.0	56.3	59.7
2. Brain drain to other countries	2.3	1.8	1.2	1.3
II. EU = 3 + 4 + 5	38.6	26.2	22.3	19.4
3. Stayers + brain circulation in OSC[a]	19.8	12.6	9.9	8.3
4. Brain drain to the U.S.	11.1	9.5	8.5	8.2
5. Brain drain elsewhere	7.7	4.1	3.9	2.9
III. RW = 6 + 7 + 8	22.3	22.0	20.2	19.6
6. Stayers + brain circulation in OSC[b]	3.8	4.1	3.3	2.7
7. Brain drain to the U.S.	13.9	15.9	16.6	16.6
8. Brain drain elsewhere	4.6	2.0	0.3	0.3
Total = I + II + III	100.0	100.0	100.0	100.0

Percentage distributions

[a] European countries with at least one department in the sample = Denmark, Belgium, France, Germany, Netherlands, Spain, UK, Sweden

[b] Non European countries with at least one department in the sample = China, Israel, Canada

Summary and discussion

From the supply side, it is safe to assume that all scientists try to be hired at the best possible institutions. Publications, seminars, and conferences provide a continuous vehicle for communicating research results and signaling one's professional merits to prospective demanders. Han Kim et al. (2009) argue that top researchers agglomerate in institutions with prestigious undergraduate programs and in departments with high past research reputations. Such agglomeration could be due to the utility and the prestige of co location with other creative minds. On the demand side, Ali et al. (2007) forcefully argue that the key characteristic of a world class university is the quality of its research staff. "This quality drives reputation and influence with the funders of research, within the global higher education and research community, with national and international governments and agencies; it enhances a university's ability to recruit the best staff and students; it helps attract donors and commercial enterprises to their doors" (Ali et al. 2007, p. 17). There fore, world class centers would typically attempt to hire several outstanding researchers in as many areas as possible. Thus, as long as the matching process between supply and demand works reasonable well, we should expect a heavy concentration of the most talented scientists in top research institutions.

Explaining the dominance of US institutions in economics and other sciences is beyond the scope of this paper. Nevertheless, we note that good governance favoring research over any other aim, the capacity of attracting public and private resources, greater salaries and facilities, and a reasonable degree of ability in hiring and promoting decisions, guided by meritocratic criteria, help to account for the geographic concentration of the best science in

the US since the 1930s (Ali et al. 2007; Bauwens et al. 2008; Aghion et al. 2008; Veugelers and Van der Ploeg 2008; Drèze and Estevan 2007; Panaretos and Malesios 2012). Using the faculty working in 2007 in the top 81 economics departments in the world, plus a subset of very productive ESF working in other departments, in "The funneling effect" section we have illustrated how this concentration is specially strong in economics.

US institutions are particularly attractive to young people that, willing to pursue an academic career, must earn a Ph.D. (or spend a period as post docs in the natural and medical sciences) in the best possible department. In the case of economics, we have documented in "The clustering effect" section a high degree of collective inbreeding in the training of elite members: a large proportion of the most productive economists obtain their Ph.D. in a handful of US graduate schools.

A fair amount of non US nationals in the total sample having earned a Ph.D. abroad return to their country of origin as brain circulation. An even larger proportion becomes permanent migrants after attending graduate school at home or abroad. When we add these groups together, movers in the total sample are almost as numerous as stayers. Interest ingly, the proportion of migrants within the OSC is as important as the proportion of migrants within the US. In the elite, the share of US stayers goes up, while the share of the brain drain remains equal to the 25% already obtained in the total sample. In the OSC, the amounts of stayers and the brain drain to countries different from the US go down. Thus, the dominance of US nationals and US institutions in the elite becomes even stronger than in the total sample ("Geographical mobility" section).

US stayers and the elite brain drain constitute a large contingent representing 62% of the total sample, and accounting for 75% of the total quality points. In the elite, this contingent increases its share and its percentage of quality points by approximately nine percentage points. However, in both the total sample and the elite, the research gap between the US and other countries decreases when we classify researchers by their country of origin: interestingly, in both cases the contribution by US nationals is approximately 24 points smaller than the contribution by US economics departments. The slack is taken up by EU nationals and, above all, by RW nationals ("Differences in research output between the US and other geographical areas" section).

Recall that all phenomena studied in this paper are general features in all sciences. Nevertheless, between field differences are surely worth studying. This is not easy because of lack of information on origins and destinations in most sciences. However, Panaretos and Malesios (2012) study a set of 337 highly cited mathematicians comparable with our elite. This is an interesting comparison because economics is a relatively new social science historically dominated by UK scholars and, after World War II, by US researchers, while mathematics is a discipline much older than economics, its original intellectual leaders can be found in many countries, and its basic and applied research as in eco nomics does not require capital intensive facilities.

The main results are the following (for details, see Section III.5 in Albarrán et al. 2014). (1) There is an almost uniform distribution of mathematicians by the geographical area where a first college degree is obtained (35.8, 36.4, and 27.8% in the US, the EU, and the RW, respectively). (2) Non US mathematicians are less attracted to US graduate schools than their counterparts in economics are. Therefore, the percentage of brain circulation in mathematics is smaller than in economics. However, a large percentage of non US mathematicians migrate after earning their Ph.D. in their own countries. The end result is that the share of movers in mathematics is even greater than in economics. In particular, the share of elite brain drain mathematicians is greater than in economics. (3) Since there are considerably more mathematicians than economists born outside the US, the

percentage of non US stayers is greater than in economics while the opposite is the case for US stayers.

Conclusions

The study of the national origins and destinations of elite scientists constitute a key topic in understanding the workings of the academic profession in any discipline. Using a unique dataset with microeconomic information on the universities where researchers earn their B.A., their Ph.D., and where they hold their current job in 2007, we have quantified different aspects arising from the world geographic distribution of top researchers in economics. We will emphasize three limitations.

1. Our dataset is already ten years old. Moreover, our productivity measure favors older individuals. Thus, to have a glimpse into the situation in 2030, we have investigated a dataset of younger individuals. For that purpose, we eliminate individuals earning their Ph.D. before 1982. Thus, the remaining individuals are, approximately, at most 55 years of age in 2007. The results indicate that, perhaps, the characteristics of top researchers in two decades will be changing in the direction of a reduction in the extraordinary US dominance experienced so far: the percentage of economists working in 2007 in the US and, above all, the percentage of US nationals' decrease (for details, see Section V in Albarrán et al. 2014).
2. In this paper, we have measured individual productivity in terms of a quality index that weights publications in different journal classes. This index has been used for selecting a subset of elite researchers, and for estimating the research performance in different geographical areas. However, many studies of scientific elites focus on highly cited researchers (Stephan and Levin 2001; Ali et al. 2007; Bauwens et al. 2008; Hunter et al. 2009; Panaretos and Malesios 2012; Parker et al. 2010, 2013). Although we are primarily interested in analyzing top world departments rather than elites per se, it would have been interesting to measure the individual (and aggregate) research performance of the faculty members and ESF in our study in terms of citation impact. This could be particularly important for the selection of the elite: using university professors in the province of Quebec, Canada, Larivière et al. (2010) conclude that, although there is a relationship between highly productive and highly cited researchers (as well as other indicators of research performance), the variance is large enough for the individuals identified by each variable to diverge considerably.
3. In this paper, we have analysed the (unconditional) distribution of the total quality points in three geographical areas. However, it would be interesting to use regression methods for explaining individual productivity differences in terms of nationality, controlling for demographic characteristics, such as age and gender, as well as career variables such as the university where the Ph.D. is earned, and where the first and current job are held. In this way, one could study whether migrant scientists are more productive than stayers in a given geographical area, exacerbating the brain drain problem from the point of view of the sending countries. One could also study whether scientists in brain circulation are more productive than stayers from the same area, providing an argument for facilitating this type of spatial mobility. These issues are investigated elsewhere using the data on the 81 top departments worldwide analysed in this paper (Albarrán et al. 2015, 2016).

Even if one accepts as a first approximation that the matching between demand and supply forces works well at the world level, it is likely that the degree of concentration of the best scientific talent in the US constitutes only a second best. Better governance and some additional resources in the EU and the RW may give rise to an improved situation with an elite less concentrated in the US. At any rate, it is understandable that the US dominance, as well as the perception of a large brain drain in all sciences has preoccupied the scientific community and the political representatives of specific countries, as well as the EU authorities themselves. However, even at the EU level, a necessary condition for the formulation of policy proposals is to recognize the heterogeneity within the union. In the case of economics, recall that only eight European countries have at least one department in our sample. Therefore, in order to make any progress, we need to incor porate as many new departments as necessary to construct in any country an elite pro portional to the country's demographic weight.

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