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Mobility decisions of European doctoral researchers

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Abstract[1,2]

Student mobility remains an important component for the completion of a European Higher Education and Research Area. Two issues at the forefront are increasing student mobility within Europe as well as worries about a 'brain drain' of talented graduate students to North America. Unfortunately, there is still relatively little evidence and analysis available to support policy making. In this paper, using a large sample of European researchers, we analyse the decision of students where to pursue their doctoral studies: at home, in another European country or in North America. We find that students from countries with a weaker research and innovation system are more likely to seek their doctoral degree abroad, particularly within Europe. Graduate student mobility within Europe appears more driven by push factors in the home country, i.e. lack of opportunities for researchers, whereas mobility towards North America seems more driven by pull factors within the North American research and education system.

[1] The dataset used for this paper was collected during the project on "Career paths and mobility for EU researchers" financed by Directorate-General for Research of the European Commission and was carried out in 2008-2010 by a consortium of European organizations led by IDEA Consult in Brussels. For more information, please visit: www.researchersmobility.eu.

[2] The authors gratefully acknowledge financial support from the IUAP project B6568-P6/09-P.

Introduction

For European policymakers, student mobility has gained increasing prominence on the policy agenda in the last few decades. The most visible policy at the European level has no doubt been the creation of the European Higher Education Area, in which students, researchers and teachers can circulate freely. The Bologna process has introduced reforms to make tertiary degrees more comparable and easier to be acknowledged in other member states. But student mobility is also part of the European Research Area objectives and of the goals of the EU2020 strategy and its Innovation Union Flagship (Luukkonen, 2010), and thus closely embedded in research and innovation policy.

Despite growing numbers of mobile students, the general conviction appears to be that Europe still has not reached the optimum amount of student mobility, and that more must be done to remove obstacles to mobility. At the same time, European policy makers remain worried about the large outflow of talented tertiary students to the United States, particularly at the graduate level. Moreover, very little is known about the return rates and the possible selection of students who return after graduate studies in North America.

For these reasons it is important to deepen our understanding of the factors that underpin student mobility. In this paper, we study the decisions of a sample of European researchers to pursue their doctoral degree in their home country, in another European country or in North America. In particular, our data allow linking these decisions to students' personal characteristics as well as to features of the research and innovation system in the students' birth country. We find that students from countries with a weaker research and innovation system are more likely to seek a doctoral degree abroad, and particularly within Europe. Graduate student mobility within Europe appears more driven by push factors in the home country, i.e. lack of opportunities for researchers, whereas mobility towards North America is probably more driven by pull factors within the North America research and education system.

A review of the evidence on tertiary student mobility

Several sources provide information on the international flows of tertiary students. In its 2010 Education at a Glance report, the OECD reports that 6.7% of all tertiary students in the OECD are international students. In advanced research programs this proportion is even higher, at 18.2%. Student mobility has increased with 70% between 2000 and 2008; the total number of foreign students enrolled outside their country of origin stood at 3.3 million in 2008. The US receives almost 19% of all these foreign students. 11.2% of all international students in the US are from Europe. By contrast, the ten most popular European countries[1] together receive about 35% of all foreign students. Within Europe, the UK and Germany are the most popular destinations for student flows. Switzerland boasts the highest foreign-to-native student ratio (OECD, 2010)

In a study of inward and intra-EU mobility of PhD students, IISER (2007) reports that 5.5% of doctoral candidates are studying in a member state of which they do not hold the nationality, whereas 16.9% come from outside the EU. Asia and Africa are the largest regions of origin of these extra-EU PhD students. For the United States, the National Science Foundation (NSF) collects detailed information on incoming foreign PhD students, especially through its Survey of Earned Doctorates (SED). In its latest Science and Engineering Indicators report, the NSF reports that 33% of all doctoral students in science and engineering fields were temporary residents. The proportion is more than half in fields like engineering, mathematics, computer sciences and economics (NSF, 2010). The majority of foreign PhD students studying in the US come from Asia: between 1987 and 2007, 82% of all foreign PhD recipients in the US were from Asia, versus 17% from Europe (NSF, 2010). Black and Stephan (2007) report that the increased inflow of foreign students in the 1980s and 1990s have fueled much of the growth of US PhD and postdoc programs, and consequently the proportion of foreigners in PhD programs has increased dramatically: in 1981, 20% of all doctoral students held a temporary visa, compared to 38.4% by 1992 (Black and Stephan, 2007). By 2006, this proportion had risen to almost 1 in 2 PhD students (Stephan, 2011).

A growing literature addresses the factors and motivations that drive student mobility. Many macro-studies trying to explain the size of flows between countries emphasize the importance of 'classic' migration factors such as relative size of host and home country, geographic and cultural distance, colonial and trade ties, relative economic strength and income differentials (Lee and Tan, 1984; Cummings, 1984; Agarwal and Winkler, 1985; McMahon, 1992; Bessey 2007). That classic migration factors play a role in student mobility as well is not surprising given that for many students obtaining a degree in a particular country is often a first step for migration into that country (Borjas, 2002; Tremblay, 2001).

However, there are certain driving factors that are more specific to student mobility. Many students go abroad in search of a higher-quality education than what they could have obtained at home (Van Bouwel and Veugelers, 2011; Alberts and Hazen, 2005; Gordon and Jallade 1996; Kemp et al. 1998; Aslanbeigui and Montecinos 1998; Mazzarol and Soutar 2000; Bourke 2000; Szelényi 2006). Getting a foreign degree from a prestigious overseas university is generally perceived as a valuable investment in human capital and future career opportunities. Moreover, students with mobility experience have better intercultural skills (King and Ruiz-Gelices, 2003) and are more likely to be internationally mobile later in their career (Parey and Waldinger, 2008; De Grip et al., 2009). A lack of availability of places in the desired program in the home country is also a push-factor for students to seek education abroad (Naidoo, 2007; Lee and Tan, 1984), especially at the graduate level (Van Bouwel and Veugelers, 2011).

Data

This paper is based on survey data on the EU-US mobility of researchers. The survey has been designed and implemented in the context of the MORE project funded by DG Research of the European Commission[2]. This survey specifically targets researchers, i.e. people who were carrying out or

supervising research, and who have mobility experience, be at as a student or a researcher, between the EU and the US. However, researchers with mobility experience within Europe or with no mobility experience were not excluded from the survey. The survey was carried out in 2010. The total net sample of the survey includes 5,544 observations.

The present paper focuses on the European-born[3] researchers in the MORE survey. We retain only researchers whose highest educational achievement is a doctoral degree, to keep our sample as homogeneous as possible with respect to educational attainment. After clearing out all observations with missing values, this subgroup accounts for 1,576 observations.

For this group of European-born researchers we study the factors related to their decision to pursue a PhD in the birth country or abroad, either elsewhere in Europe or in North America. We consider the United States and Canada as one region because the two countries are similar in their higher education and research systems, at least from the European perspective.

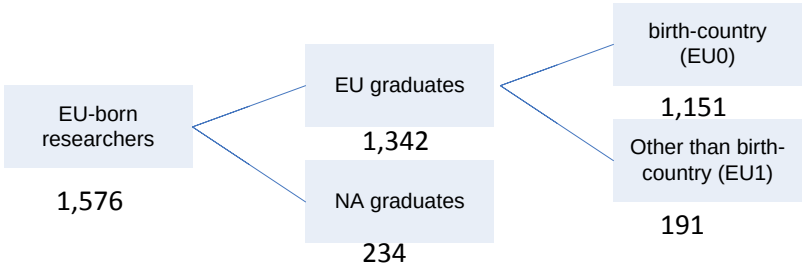
Among the PhD holders in our sample we distinguish three types of graduates:

a. EU-born researchers who have graduated in their birth country (EU0)
b. EU-born researchers who have graduated in a European country other than their birth country (EU1)
c. EU-born researchers who have graduated in North America (NA)

Figure 1 breaks down the sample into these 3 categories. Graduates from a European country (be it their birth country or not) amount to 1,342 researchers or 85.15% of the sample. Of these, 12.12% obtain their PhD degree in another European country than their birth country. The remaining 14.85% of the sample are NA graduates (European-born researchers who have graduated either in the USA or in Canada). All in all, 27% of the researchers in our sample obtained their doctoral degree outside their birth country.

As the survey specifically targeted researchers with EU-US mobility experience, it is not representative of the population of European researchers. To gauge how much our sample is biased towards mobile researchers, we compare the researchers in our sample who are currently residing in Belgium to the Belgian sample of the Careers of Doctorate Holders survey, which was conducted in 2006 in several European countries in cooperation with the OECD, Eurostat and UNESCO Institute of Statistics. The Belgian part of the survey targeted all PhD holders in Belgium based on census data, and should thus be representative of the population of PhD holders in Belgium. The comparison reveals that the rate of degree mobility is twice as large in our sample compared to the CDH. The results from the MORE dataset should therefore always be interpreted with this mobility bias present. Once corrected for degree mobility, the probability of being mobile to North America or within Europe is roughly comparable between the two samples. The selection of destination country among mobile students seems therefore less biased.

Figure 1: graduation groups



Results on factors for PhD degree mobility

Which students' and home countries' characteristics influence students' choice to become mobile for their PhD, and subsequently, their choice of destination? In the first subsection, we briefly present some descriptive statistics for the three mobility groups. We discuss differences between scientific disciplines and along personal characteristics. We also present the most important source and destination regions of doctoral students. In the second subsection, we turn to regression analysis to examine which home country and student characteristics influence the likelihood of a student to pursue doctoral studies abroad, and whether the effects of these characteristics differ for mobility within Europe or to North America.

1.1 Characteristics of mobile and non-mobile PhD students

As there is considerable heterogeneity among fields in terms of publication behavior (Stephan and Levin, 1992) and mobility behavior (Finn, 2010), we first look at differences in PhD degree mobility across degree field. The survey asked the respondents to indicate the broad field of specialization of their PhD degree. These fields are natural sciences, engineering and technology, medical and health sciences, agricultural sciences, social sciences and humanities.

Table I reports pre-doc mobility patterns by degree field. There are marked differences in pre-doc mobility among the different disciplines. Students of medical and health sciences and agricultural sciences are much more likely to study in their birth country, perhaps because these disciplines are very locally embedded. By contrast, students in social sciences are most likely to go North America for their PhD degree – this might be driven by strongly international disciplines such as economics.

Table I: Distribution over degree fields and degree regions

degree region categories	Natural Sciences		Engineering and Technology		Medical and Health Sciences		Agricultural Sciences		Social Sciences		Humanities		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
EU0	552	76.56	106	75.71	91	88.35	36	80	271	62.3	95	71.97	1151	73.03
EU1	82	11.37	15	10.71	5	4.85	6	13.33	64	14.71	19	14.39	191	12.12
NA	87	12.07	19	13.57	7	6.8	3	6.67	100	22.99	18	13.64	234	14.85
Total	721	100	140	100	103	100	45	100	435	100	132	100	1576	100
%	45.75		8.88		6.53		2.85		27.60		8.38			

Table II contains personal characteristics by degree region. In the sample as a whole, 71% of respondents are male, 80% are married and 65% have children, and the average respondent is almost 44 years old. The results of t-tests to determine whether differences in the personal characteristics of the two mobile groups differ significantly from the immobile group are reported.

Personal characteristics are rather similar over different degree regions, with the exception of those researchers who obtained their PhD in another EU country (EU1): they are on average 3 years younger, and are consequently less likely to be married. These differences remain significant if we compare only the two mobile groups to one another. Perhaps this indicates that obtaining a PhD in another EU country is a more recent phenomenon. More recent, and thus younger, cohorts are more likely to study elsewhere in Europe than older cohorts, who either stayed at home or went to the US. Surprisingly, individuals who obtain their doctoral degree in North America are more likely to have children than researchers who obtained their degree at home, even though the former group is not significantly older than the latter.

Table II: Personal characteristics by degree region

degree region categories	Mean Male	Mean age	Mean married/cohabiting	Mean children
EU0	0.71	44.45	0.81	0.64
EU1	0.67	41.17***/°°°	0.75*/°	0.61°°
NA	0.73	43.9	0.82	0.71**
Total	0.71	43.97	0.8	0.65

Note: * for t-tests done with EU0 as comparison group, ° for t-tests done comparing EU1 and NA

Table III contains the outflows of doctoral students by birth region and from the major birth countries, in absolute numbers and as a percentage of the 425 mobile doctoral students in the sample. The Mediterranean countries in the sample (Portugal, Spain, Italy and Greece) are the largest source region of mobile PhD students, with 36% of mobile students. Western Europe, comprising some of the largest countries in the sample like Germany and France, has the second largest share with 32%. The same pattern is reflected in the ranking of the individual birth countries: the three largest source countries - in absolute numbers - of mobile doctoral students are Italy, Germany and Greece who send abroad 62, 54 and 40 students respectively, which totals 37% of all the mobile students in the sample. Since Germany is the largest country in Europe, it is unsurprising that it supplies a large amount of mobile students. Italy and Greece have traditionally sent a large percentage of its student body abroad. Spain, the Netherlands, the United Kingdom and France each have over 20 mobile students in the sample as well.

Table III: Outflow of doctoral students by birth region/country

Birth region	frequency	percent
Western Europe	135	0.32
Central and Eastern Europe	78	0.18
Scandinavia	27	0.06
Mediterranean	153	0.36
Anglo-Saxon Europe	32	0.08

Major birth countries	frequency	percent
Italy	62	0.15
Germany	54	0.13
Greece	40	0.09
Spain	39	0.09
Netherlands	23	0.05
United Kingdom	22	0.05
France	21	0.05

Table IV summarizes the inflows of foreign students in the different degree regions and major receiving countries in our sample. North America receives the largest inflow, with 55% of the sample choosing it as a destination. This is mostly due to the popularity of the United States, with 53% of the mobile researchers in our sample pursuing their PhD there. Western Europe is the second most attractive region, with 19% of students moving there, followed by Anglo-Saxon Europe with 15% of the mobile PhD students. The latter region is mostly dominated by the United Kingdom, which receives 14% of the mobile students. The other major individual receiving countries are Switzerland, Germany and France, receiving around 4% of the mobile students each. Flows of PhD students appear to be more unidirectional than circular: most top sending countries are not among the top receiving countries. Only Germany and France are among the major sender countries as well as receiving countries. In appendix A, birth country – degree country dyadic flows are reported, which also illustrate that the largest

student flows are originating mostly in southern Europe and are largely directed to the United States and the United Kingdom.

Table IV: Foreign inflow by degree region/country

Degree region	frequency	percent
North America	234	0.55
Western Europe	79	0.19
Anglo-Saxon Europe	62	0.15
Scandinavia	20	0.05
Mediterranean	26	0.06
Central and Eastern Europe	4	0.01

Major degree countries	frequency	percent
United States of America	225	0.53
United Kingdom	59	0.14
Switzerland	18	0.04
Germany	17	0.04
France	16	0.04

1.2 Characterizing the research and innovation environment at home

In our search for factors influencing PhD degree mobility, we are specifically interested in how a researcher's country of origin influences the decision to study abroad, and more particularly how important the quality of the research environment at home is for pushing PhD students abroad. Are students from particular regions in Europe more likely to study abroad than students from other regions? Are students from countries with a weak record in research and innovation more likely to study abroad for lack of opportunities at home? We hypothesize that students from countries with a strong research and innovation record and a high-quality higher education system have less incentive to seek a PhD degree abroad.

We use various proxies for measuring the strength of the birth country in research and innovation. First, we use a measure that captures the research quality of a country by measuring the visibility and quality of a country's publications. Using data from the National Science Foundation's Science and Engineering Indicators 2004, we calculate the relative impact of a country's publications as the share of a country's citations in total world citations in a given year, divided by the share of a country's publications in total world publications in the three preceding years, with a two-year lag. If this measure is above 1, it indicates that a country's publications on average attract more citations than 'the average world publication' and therefore reflects a high quality research system. A second indicator measures more broadly the strength of the innovation system of the home country. To this end we use the information from the European Commission's European Innovation Scoreboard (EIS). The European Innovation Scoreboard collects a number of innovation indicators for all European countries, and on the basis of

those indicators it classifies them into 4 categories: catch-up countries, moderate innovators, innovation followers and innovation leaders. In our models, we include a dummy variable that indicates whether or not the birth country is labeled as a catch-up country by the EIS. A final measure for birth countries' research and innovation strength is a quality indicator for its universities. For this, we construct an indicator based on the Shanghai ranking. The indicator is the weighted sum of the number of universities the birth country has in the top 500 of the Shanghai ranking, with institutions higher up the ranking receiving a larger weight, divided by population to control for country size as suggested by Aghion et al. (2007)[4]. This measure should capture the 'density' of top quality institution in the birth country, and thus proxy for the availability of opportunities to pursue a PhD at a good institution at home.

Table V summarizes the three science and innovation strength indicators by birth country. The first column contains the relative impact of a country's publications. Countries with a score above 1 on this indicator attract, on average, more citations to their publications than the average world publication. Mostly northern European countries have a score above 1, including three Scandinavian countries. At the bottom, Bulgaria, Romania, Slovakia and Turkey's publications only manage to attract about a third of the citations that the average world publication attracts. Four countries belong in the catch up country group according to the European Innovation Scoreboard 2010: Latvia, Romania, Bulgaria and Turkey (column 2). Finally, the Shanghai ranking indicator (column 3) is highest for small countries with a few excellent universities like Switzerland, the Netherlands, Sweden, Denmark and Norway, but also for a larger country with a number of world-renowned top universities like the United Kingdom.

1.3. Econometric results on the factors driving PhD degree mobility

In the econometric analysis we examine how students' and home countries' characteristics are related to the probability of getting a degree abroad in a multivariate setting.

We first look at the decision to get a degree abroad versus getting a degree in the birth country. To this end we perform a simple logit regression. Next, we split 'getting a degree abroad' into 'getting a degree elsewhere in Europe (EU1)' and getting a degree in North America (NA)', and use a multinomial logit.

The explanatory variables include a set of personal characteristics consisting of gender, cohort (in 10-year dummies, measured as time since degree) and field (grouped together into 4 major fields, with humanities as the base group). We also include a series of birth country indicators. First, we include 4 birth region dummies for the Mediterranean countries, Scandinavia, Central and Eastern Europe (including many EU-members who joined in 2004 or 2007) and the Anglosaxon countries, i.e., the UK and Ireland. The base region consists of the continental Western European countries.

Table V: Science and innovation indicators: descriptive statistics

Panel A: Science and innovation indicators by country

Birth country	Relative impact	catch up country dummy	Shanghai ranking indicator
Austria	0.93	0	0.31
Belgium	0.97	0	0.56
Bulgaria	0.37	1	0.00
Cyprus	0.51	0	0.00
Czech Republic	0.52	0	0.06
Denmark	1.10	0	0.90
Estonia	0.66	0	0.00
Finland	1.05	0	0.55
France	0.96	0	0.27
Germany	1.03	0	0.38
Greece	0.55	0	0.08
Hungary	0.63	0	0.06
Ireland	0.89	0	0.23
Italy	0.92	0	0.16
Latvia	0.43	1	0.00
Lithuania	0.46	0	0.00
Netherlands	1.15	0	0.78
Norway	0.84	0	0.66
Poland	0.49	0	0.02
Portugal	0.63	0	0.02
Romania	0.32	1	0.00
Slovakia	0.36	0	0.00
Slovenia	0.58	0	0.05
Spain	0.79	0	0.09
Sweden	1.07	0	1.29
Switzerland	1.37	0	1.37
Turkey	0.37	1	0.00
United Kingdom	1.06	0	0.79

Panel B: Correlations of science and innovation indicators

correlation with… (* significant at the 1% level)		
catch up country dummy	-0.5590*	
shanghai ranking indicator	0.7472*	-0.2331*

Our main focus of attention is the impact of the quality of the research environment at home as driving factor for PhD mobility. As our three indicators for measuring the quality of the research environment are highly and significantly correlated, we do not include them together, as they would probably cancel each other's effect out (see table V, panel B).

Table VI: Logit for degree country: degree at home (EU0) or abroad (EU1 or NA)

VARIABLES	(1) PhD abroad	(2) PhD abroad	(3) PhD abroad	(4) PhD abroad
1 if male	0.0446	0.0806	0.0685	0.0488
	(0.131)	(0.133)	(0.132)	(0.131)
cohort 10-19	0.112	0.106	0.118	0.111
	(0.132)	(0.134)	(0.133)	(0.132)
cohort 20-29	-0.344*	-0.377*	-0.327	-0.343*
	(0.199)	(0.201)	(0.199)	(0.199)
cohort 30-49	-0.304	-0.298	-0.278	-0.305
	(0.225)	(0.228)	(0.226)	(0.225)
Exact Sciences	-0.277	-0.389*	-0.247	-0.285
	(0.215)	(0.219)	(0.217)	(0.216)
Life Sciences	-0.912***	-0.934***	-0.868***	-0.916***
	(0.309)	(0.312)	(0.310)	(0.309)
Social Sciences	0.407*	0.318	0.439**	0.400*
	(0.222)	(0.226)	(0.224)	(0.223)
Mediterranean	-0.101	-0.856***	-0.0987	-0.157
	(0.141)	(0.188)	(0.141)	(0.183)
Anglosaxon Europe	-0.201	-0.172	-0.205	-0.163
	(0.231)	(0.233)	(0.231)	(0.245)
Scandinavia	-0.533**	-0.506**	-0.534**	-0.468*
	(0.240)	(0.242)	(0.240)	(0.274)
Central and Eastern Europe	0.432**	-1.536***	0.0223	0.360
	(0.179)	(0.363)	(0.223)	(0.232)
relative impact home country publications		-3.446***		
		(0.552)		
catching-up countries			1.030***	
			(0.304)	
bsr_indic500				-0.157
				(0.324)
Constant	-0.871***	2.753***	-0.923***	-0.791***
	(0.234)	(0.623)	(0.236)	(0.286)
Observations	1,576	1,576	1,576	1,576

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

1.3.1. Logit results for PhD degree mobility: at home or abroad

Table VI reports the results for the logit analysis on whether to obtain a PhD degree at home or abroad. In the first logit model we include only the birth region dummies. In the subsequent three specifications we add each of the science and innovation indicators for the birth country in turn.

Across different specifications we observe that students who obtained their degree 20 to 29 years ago are less likely to have studied abroad, although the coefficient is only significantly different from zero at the 10% level. This is in line with the observations that international PhD degree mobility is on the rise over time. Students in the life sciences are significantly less likely to study abroad, as we already observed in the descriptive section. Students in social sciences are more likely to study abroad, although the effect is not very robust and mostly only significant at the 10% level. In line with the descriptive statistics, there is no significant gender dimension in outward PhD mobility.

When the birth region dummies are included on their own (column 1), Scandinavians appear less likely to go abroad – arguably because they can obtain high quality education in their home country. The opposite can be argued for the positive and significant coefficient for Central and Eastern Europe: a lack of sufficiently high quality education at home may drive these students to seek higher education abroad. To test this more explicitly, we include the quality of the birth country's research. The results confirm that students from countries that score well on the relative impact indicator are also less likely to seek higher education abroad (column 2). Also, once the quality of the home country's research is accounted for, the dummy for Central and Eastern Europe becomes negative and significant, i.e. students from these countries are less likely to seek higher education abroad, once their science and innovation quality has been accounted for. A similar result is found when the EIS dummy is included (column 3): countries with a weaker innovation system tend to send more students abroad for graduate degrees. The result for the Shanghai ranking indicator is similar, although the coefficient is not significantly different from zero (column 4). This is arguably because the Shanghai indicator is more skewed towards excellence and fails to capture heterogeneity in the tail.

1.3.2 Multinomial logit results for the destination of PhD degree mobility: North America versus Europe

In Table VII, we split 'getting a degree abroad' into 'getting a degree elsewhere in Europe (EU1)' and getting a degree in North America (NA)', and thus use a multinomial logit instead of a simple logit model. We now observe more distinct patterns in the cohort dummies: all cohorts save for the most recent one are less likely to study elsewhere in Europe. This indicates that the most recent cohort (the base group) is more likely to study elsewhere in Europe compared to older cohorts, which confirms the increasing attractiveness of the European Research Area for PhD degree mobility, in line with our earlier observations in the descriptive section. Conversely, the cohort that graduated between 10 and 20 years ago is more likely to have studied in North America; this reflects the rapid rise of foreign students in the United States in the 1990s and perhaps also the dip in foreign student admissions after 9/11.

Table VII: Multinomial logit for degree country (base outcome: EU0)

VARIABLES	(1) EU1	(2) NA	(3) EU1	(4) NA	(5) EU1	(6) NA	(7) EU1	(8) NA
1 if male	-0.0488	0.129	0.00290	0.152	-0.0273	0.155	-0.0153	0.114
	(0.174)	(0.169)	(0.178)	(0.170)	(0.175)	(0.170)	(0.175)	(0.169)
cohort 10-19	-0.350*	0.489***	-0.360*	0.477***	-0.345*	0.495***	-0.359*	0.499***
	(0.185)	(0.166)	(0.188)	(0.167)	(0.186)	(0.166)	(0.186)	(0.166)
cohort 20-29	-0.622**	-0.0847	-0.671**	-0.111	-0.604**	-0.0689	-0.618**	-0.0873
	(0.283)	(0.252)	(0.286)	(0.253)	(0.283)	(0.252)	(0.283)	(0.252)
cohort 30-49	-0.610*	-0.0310	-0.597*	-0.0331	-0.583*	-0.00603	-0.616*	-0.0232
	(0.330)	(0.279)	(0.333)	(0.280)	(0.331)	(0.280)	(0.331)	(0.279)
Exact Sciences	-0.387	-0.176	-0.526*	-0.264	-0.358	-0.147	-0.438	-0.139
	(0.282)	(0.283)	(0.288)	(0.285)	(0.284)	(0.285)	(0.284)	(0.285)
Life Sciences	-0.928**	-0.906**	-0.941**	-0.931**	-0.881**	-0.865**	-0.954**	-0.886**
	(0.408)	(0.421)	(0.413)	(0.422)	(0.410)	(0.422)	(0.409)	(0.422)
Social Sciences	0.0648	0.685**	-0.0433	0.611**	0.0974	0.717**	0.0255	0.718**
	(0.294)	(0.288)	(0.300)	(0.289)	(0.296)	(0.289)	(0.296)	(0.289)
Mediterranean	-0.0412	-0.159	-1.026***	-0.713***	-0.0395	-0.157	-0.516**	0.0512
	(0.193)	(0.178)	(0.260)	(0.236)	(0.193)	(0.179)	(0.258)	(0.232)
Anglosaxon Europe	-0.597	0.0100	-0.550	0.0268	-0.601	0.00636	-0.220	-0.114
	(0.380)	(0.270)	(0.381)	(0.271)	(0.380)	(0.270)	(0.409)	(0.282)
Scandinavia	-0.567	-0.517*	-0.523	-0.501*	-0.569	-0.519*	0.0108	-0.750**
	(0.348)	(0.300)	(0.350)	(0.301)	(0.348)	(0.300)	(0.410)	(0.340)
Central and Eastern Europe	0.580**	0.288	-1.949***	-1.171**	0.218	-0.170	-0.0358	0.551*
	(0.232)	(0.230)	(0.482)	(0.459)	(0.287)	(0.297)	(0.324)	(0.295)
relative impact home country publications			-4.409***	-2.570***				
			(0.731)	(0.696)				
catching-up countries					0.925**	1.135***		
					(0.373)	(0.390)		
bsr_indic500							-1.455**	0.545
							(0.569)	(0.372)
bsr_indic500_2								
Constant	-1.262***	-1.858***	3.348***	0.864	-1.311***	-1.912***	-0.592	-2.160***
	(0.304)	(0.310)	(0.817)	(0.794)	(0.307)	(0.312)	(0.392)	(0.376)
Observations	1,576	1,576	1,576	1,576	1,576	1,576	1,576	1,576

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Students in the social sciences are more likely to go to North America, whereas students in the life sciences are less likely to study abroad, no matter the destination. Researchers from Scandinavia are less likely to go to North America for their PhD.

In most models, the academic birth country quality indicators have larger negative coefficients for studying in Europe than for studying in North America. The Shanghai ranking indicator is negative and significant for intra-EU mobility, but remains non-significant for mobility to North America. This suggests that degree mobility within Europe is more attractive for students from countries with a weak academic and innovation environment than mobility to North America. It appears that graduate student mobility in Europe is driven more by push factors, i.e. lack of opportunities in the home country, whereas mobility to North America is probably to a larger extent the result from pull factors within North America, arguably the lure of its top institutions.

Conclusion

Student mobility remains an important item on European policy makers' agendas, which contains both issues of increasing student mobility within Europe as well as worries about a 'brain drain' of talented graduate students to North America. Therefore it is important to deepen our understanding of the factors that underpin student mobility flows. In this paper, we address the decision of a sample of European researchers to pursue the doctoral degree at home, in another European country or in North America. We find that for more recent cohorts of researchers, PhD mobility intra-EU has become a more frequently chosen option, relative to staying at home or going to North America, thus confirming that a European Higher Education and Research Area is gradually being realized.

We find that European students from countries with a weaker research and innovation system are more likely to seek their doctoral degree abroad, particularly within Europe. Graduate student mobility within Europe appears more driven by push factors in the home country, i.e. lack of opportunities for researchers. This confirms that a European Higher Education and Research Area is an effective tool for catching-up strategies through stimulating the mobility of PhD students from catching-up countries to study in another EU country, more so than the option of going to the US, which may be too distant for these catching-up countries. To fully evaluate the effectiveness of stimulating student mobility for catching-up, we need to look beyond the outward mobility to assess the post-PhD degree mobility: are these students returning to their home country and/or do they stay connected? In the near future, more comprehensive data collection and further analysis is needed to deepen our understanding of these issues.

Endnotes

[1] United Kingdom, Germany, France, Italy, Spain, Austria, Switzerland, Belgium, the Netherlands and Sweden.

[2] The project on "Career paths and mobility for EU researchers" was financed by the Directorate-General for Research of the European Commission and was carried out in 2008-2010 by a consortium of European organizations led by IDEA Consult in Brussels. For more information, please visit: www.researchersmobility.eu.

[3] We define Europe as the EU 27 + Norway, Switzerland and Turkey. Although our definition of Europe extends somewhat beyond the borders of the actual European Union, we will use the terms 'EU' and 'Europe' interchangeably throughout the paper.

[4] The Shanghai ranking measure is robust to variations in the weighting scheme, to using only institutions in the top 200 instead of the top 500 for the construction of the indicator, as well as to using simple counts of universities per country.

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Appendix

Table A.I: Mobility flows between birth country and degree country

degree mobility flow	Freq.	Percent
Italy - United States of America	33	7.76
Germany - United States of America	30	7.06
Greece - United States of America	23	5.41
Spain - United States of America	20	4.71
United Kingdom - United States of Ameri	15	3.53
Netherlands - United States of America	14	3.29
Italy - United Kingdom	10	2.35
Turkey - United States of America	10	2.35
Belgium - United States of America	8	1.88
France - United States of America	8	1.88
Greece - United Kingdom	8	1.88
Romania - United States of America	8	1.88
Switzerland - United States of America	8	1.88
Germany - United Kingdom	6	1.41
Ireland - United States of America	6	1.41
Portugal - United Kingdom	6	1.41
Spain - United Kingdom	6	1.41
Sweden - United States of America	6	1.41
Austria - United States of America	5	1.18
Germany - Switzerland	5	1.18
Poland - United States of America	5	1.18
Denmark - United States of America	4	0.94
Italy - Belgium	4	0.94
Slovakia - United States of America	4	0.94
Cyprus - United Kingdom	3	0.71
Estonia - United States of America	3	0.71
Finland - United States of America	3	0.71
France - Switzerland	3	0.71
France - United Kingdom	3	0.71
Germany - Belgium	3	0.71
Germany - Netherlands	3	0.71
Ireland - United Kingdom	3	0.71
Netherlands - Canada	3	0.71
Netherlands - United Kingdom	3	0.71
Norway - United States of America	3	0.71
Spain - Italy	3	0.71

Turkey - Spain	3	0.71
Austria - Germany	2	0.47
Belgium - France	2	0.47
Belgium - Italy	2	0.47
Belgium - United Kingdom	2	0.47
Bulgaria - United States of America	2	0.47
Cyprus - United States of America	2	0.47
Czech Republic - Netherlands	2	0.47
Denmark - United Kingdom	2	0.47
France - Belgium	2	0.47
France - Netherlands	2	0.47
Germany - Austria	2	0.47
Greece - France	2	0.47
Greece - Italy	2	0.47
Italy - France	2	0.47
Italy - Germany	2	0.47
Italy - Netherlands	2	0.47
Italy - Sweden	2	0.47
Italy - Switzerland	2	0.47
Norway - France	2	0.47
Portugal - Norway	2	0.47
Portugal - United States of America	2	0.47
Romania - Hungary	2	0.47
Romania - Italy	2	0.47
Spain - Belgium	2	0.47
Spain - France	2	0.47
Spain - Switzerland	2	0.47
Turkey - Germany	2	0.47
United Kingdom - Switzerland	2	0.47
Austria - Denmark	1	0.24
Austria - Italy	1	0.24
Austria - Switzerland	1	0.24
Austria - United Kingdom	1	0.24
Belgium - Netherlands	1	0.24
Bulgaria - Germany	1	0.24
Bulgaria - Norway	1	0.24
Bulgaria - United Kingdom	1	0.24
Czech Republic - Denmark	1	0.24
Czech Republic - Germany	1	0.24
Czech Republic - Switzerland	1	0.24
Czech Republic - United States of Ameri	1	0.24
Denmark - France	1	0.24
Denmark - Norway	1	0.24

Finland - Spain	1	0.24
Finland - United Kingdom	1	0.24
France - Austria	1	0.24
France - Denmark	1	0.24
France - Germany	1	0.24
Germany - Ireland	1	0.24
Germany - Italy	1	0.24
Germany - Portugal	1	0.24
Germany - Spain	1	0.24
Germany - Sweden	1	0.24
Greece - Austria	1	0.24
Greece - Canada	1	0.24
Greece - Germany	1	0.24
Greece - Ireland	1	0.24
Greece - Sweden	1	0.24
Hungary - Switzerland	1	0.24
Hungary - United States of America	1	0.24
Ireland - Canada	1	0.24
Italy - Canada	1	0.24
Italy - Denmark	1	0.24
Italy - Ireland	1	0.24
Italy - Portugal	1	0.24
Italy - Spain	1	0.24
Lithuania - Denmark	1	0.24
Lithuania - Sweden	1	0.24
Netherlands - Belgium	1	0.24
Netherlands - Spain	1	0.24
Netherlands - Sweden	1	0.24
Norway - Germany	1	0.24
Norway - Sweden	1	0.24
Poland - Czech Republic	1	0.24
Poland - France	1	0.24
Poland - Germany	1	0.24
Poland - Italy	1	0.24
Poland - Netherlands	1	0.24
Portugal - France	1	0.24
Portugal - Spain	1	0.24
Romania - France	1	0.24
Romania - Germany	1	0.24
Romania - Netherlands	1	0.24
Romania - Spain	1	0.24
Romania - Sweden	1	0.24
Romania - Switzerland	1	0.24

Romania - United Kingdom	1	0.24
Slovakia - Czech Republic	1	0.24
Slovenia - Germany	1	0.24
Slovenia - Sweden	1	0.24
Slovenia - United Kingdom	1	0.24
Slovenia - United States of America	1	0.24
Spain - Canada	1	0.24
Spain - Finland	1	0.24
Spain - Germany	1	0.24
Spain - Portugal	1	0.24
Sweden - France	1	0.24
Switzerland - Canada	1	0.24
Switzerland - Germany	1	0.24
Switzerland - United Kingdom	1	0.24
Turkey - Portugal	1	0.24
Turkey - United Kingdom	1	0.24
United Kingdom - Canada	1	0.24
United Kingdom - France	1	0.24
United Kingdom - Germany	1	0.24
United Kingdom - Greece	1	0.24
United Kingdom - Norway	1	0.24
Total	425	100