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INTERNATIONAL MOBILITY PATTERNS OF RESEARCHERS AND THEIR DETERMINANTS

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Abstract:
With the conversion of most industrialized countries to the knowledge economy, worries about the alleged brain drain of researchers to the United States are growing. We study the international mobility decisions and their determinants of a sample of foreign PhD holders who came to the US to obtain a PhD in economics. We find that around 50% settle permanently in the US after their PhD. Of the remaining 50%, one third returns to the home country and two thirds take up a job in a third country. Graduates from a top university are more likely to move internationally, as are men.

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1   Introduction

In today's high-tech knowledge economy, the importance of science and technology for economic growth and societal welfare is undeniable. Science and technology have increasingly come to economists' attention and given rise to their own branches of literature, the economics of science and the economics of innovation. Solow's seminal article on the importance of technical change for growth (Solow, 1957) spurred a line of research that studies the impact of innovation on growth (Romer, 1991; Grossman and Helpman, 1991). Other authors study more direct economic impacts of science, for example the effects of science on high-tech startups (Zucker and Darby, 2006 & 2007) and on attracting foreign R&D (Belderbos et al., 2009). Stephan (1996) provides an overview of the various lines of research on the impacts of science on economic growth.

Given the importance of science and technology for growth and welfare, policy makers have been increasingly worried about the perceived outflow of scientists from the EU to other parts of the world, mainly to the Anglo-Saxon countries, with the US on top of the list (Cervantes and Guellec, 2002; Basri and Box, 2008). There is indeed evidence of an asymmetrical flow of scientists between Europe and the US: far more EU scientists move to the US than US scientists move to the EU (Tritah, 2008). A large part of this migration towards the United States occurs in workers' higher education years (Moguérou, 2006) and a large fraction of students stay to work in the US later on (Finn, 2007). A non-negligible share migrates permanently, i.e. these researchers acquire the nationality of their host country (Auriol, 2007).

The growing concern of policy makers about the loss of highly skilled human capital have prompted our present enquiry into the international mobility patterns of researchers. More specifically, we analyze the international mobility decisions of a sample of foreigners who came to the US to obtain a PhD. Do these researchers stay in the US, return to their home country or move on to a third country? What personal factors influence the decision to, first, become internationally mobile, and second, return back home or move elsewhere? How do the mobility patterns of foreign PhD holders compare to that of their US peers? A deeper look at the answers to these questions should add new insights to the brain drain debate, especially to the worry that

young researchers are lured away during their higher education years and remain in the host country upon graduation.

We contribute to the literature in several ways. First, we have access to a unique database of PhD holders from US institutions. Defining the population of researchers is not easy, and much of the previous literature has either relied on census data or studied a subpopulation such as the elite scientists within a particular field. Our database contains all the recipients of a PhD in the field of economics from a US institution, thereby allowing us to study a big part of the population of academic researchers in economics. Second, quite a few studies use a narrow definition of international mobility, i.e. comparing researchers' birthplace to their current location. There are very few in-depth studies that focus on international mobility throughout researchers' careers. As our database contains information on all the institutions where the researchers have worked throughout their careers, our picture of international mobility is much more complete.

The remainder of the paper is structured as follows. The second section reviews the literature on international mobility of researchers. The third section presents the data we have gathered. The fourth section contains some descriptive analyses. In the fifth section we investigate the factors that influence the decision to become internationally mobile and the choice of destination. The final section discusses the present findings and the work to be done, and concludes.

2   Literature Review

International mobility of researchers

Researchers are a small subgroup of the highly skilled, but an economically important one as they produce the research that precedes the R&D developments that drive economic growth in the knowledge economy. Therefore there is a growing interest in mapping their mobility patterns and understanding what drives them. International mobility is far from a recent phenomenon in the academic world though. Scholars have been internationally mobile for centuries, and this has generally been considered to have positive effects both for the researcher and his environment (Meyer et al., 2001). The perception is that there is an "expectation of mobility" in research careers, depending on country and discipline. However, reintegration into the national research system is not always easy in certain European countries (Morano-Foadi, 2005). Melin (2005) also finds that reintegration upon return is not always smooth: 10-20% of Swedish postdocs

sometimes found it difficult to transfer the knowledge they had gathered abroad to their department back home.

Traditions, expectations and individual experiences aside, international mobility is a growing phenomenon and scholars and policy makers alike are increasingly interested in quantifying it. However, gathering data on the population of researchers is difficult. Some studies look at the population of doctoral holders.[1] A study performed by IISER (2007) finds that intra EU mobility of doctoral candidates is comparatively low (5.5% of total doctoral candidates). There is, however, considerable mobility from the EU to the US (2.4% of all US doctorates are granted to a European). Mobility from the US to the EU is negligible, although the EU does receive a considerable number of doctoral students from Asia and North Africa (IISER, 2007). In a large OECD study, Auriol (2007) studies mobility of doctoral holders from 7 OECD countries. She finds that although Switzerland and Canada have higher shares of foreign doctorates, the US remains the main destination in absolute terms. There is very little international mobility among US doctoral holders. Finn (2005) finds that the stay rates of foreign doctorate recipients in the US are high (on average 66%), but vary by discipline and source country and have declined in recent years. Bekhradnia and Sastry (2005) conclude that the perceived brain drain from the UK to the US does not adequately reflect reality, as the UK is a net importer of young academic staff (at the postdoctoral level) and manages to attract back highly productive academics who spent some time abroad to establish their research reputations.

Another strand of the literature studies the elite researchers within a certain discipline. The definition of 'elite' varies, but usually entails winning a certain award (e.g. the Nobel prize), publishing in certain prestigious journals (e.g. Science and Nature), receiving an exceptional number of citations to one's work (e.g. ISI's list of highly cited authors) or working at a prestigious institution. Oswald and Rahlsmark (2008) study young professors at top economics departments and find that a considerable number come from abroad, the majority of which migrated to the US at some stage of their higher education. Maier et al. (2007) analyze the international mobility of the ISI highly cited over various disciplines and find a high concentration of scholars in Western countries, especially in the US. Laudel (2003, 2005), using a broad definition of elite scientists including winning the Nobel prize and publishing in Science

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[1] Although not all doctoral holders move on to become researchers, and not all researchers are doctoral holders.

and Nature, points out that it is usually not the established elite scientists that move, but the young, potential elite. Finally, Hunter et al. (2009) look at highly cited physicists and find considerable mobility towards nations with high R&D spending.

Studying a elite scientists merits special attention, as these researchers often make the greatest contributions to science and by extension, to society at large. Most studies find that this group of scientists is especially mobile, and tends to concentrate in a few places, notably in the US. Tritah (2008) finds that the average human capital of European migrants to the US has increased over the past decades and that highly skilled European migrants earn a wage premium in the US which has increased over time since 1990. Moreover, Ioannidis (2004) observes that countries without a critical mass of top researchers are more likely to lose their best researchers to other countries, and specifically the US.

Drivers of international mobility

Portes (1976) identifies three levels on which determinants can be situated: the international economy, the national social structure and individual influences and orientations. Although the international economy plays its role, the majority of the empirical literature appears to focus on national (and sometimes regional) social structure and individual factors. Florida (2002) finds that 'diversity' attracts the highly skilled to certain regions, more so than climatic factors and urban amenities. Kannankutty and Burelli (2007) observe that the primary reasons for immigrant scientists and engineers to come to the US are family-related reasons, educational opportunities, and job or economic opportunities. A survey conducted among EU researchers found that in Europe, the 'status' connected to international mobility is insufficient for mobility to be an important factor in career progression. Furthermore, researchers who would like to be mobile in the future perceive a range of practical factors as a hindrance, from funding for mobility to the effects on pension rights. Nevertheless, mobility is generally regarded in a positive way (Rindicate, 2008). De Grip et al. (2008) find that previous mobility experience and differences in wages and R&D expenditures are the strongest predictors of researcher mobility. Furthermore, they point out that the best graduates are also most likely to migrate. Similarly, Davis and Patterson (2000) find that doctoral holders in economics from top-ranked school are more likely to move abroad or to another US region to accept their first job, as are those who work in academia or for the government. Finally, van Heeringen and Dijkwel (1987) note that

researchers who change jobs are on average more productive ex-ante than peers who do not change jobs.

3   Data

We have compiled a unique dataset with information on the careers of more than 1,000 academic researchers. The starting point for our dataset is the ProQuest Dissertation database, which contains information on all PhDs awarded at US institutions as well as some Canadian universities. Our initial dataset contains 115,056 degrees, awarded at 707 different institutions between 1950 and 2006 in the fields of economics and business. We only retain the Ph.D.-degrees (as the dataset also contains degrees such as D.B.A., M.C.S., M.B.A., M.S. and D.S.S.) in the field of economics. Furthermore, we only retain those PhDs awarded as from 1992, for reasons of compatibility with the SSCI publication database.[2] This yields a subset of 18,190 PhD-holders.

We then match these names to the Institute of Scientific Information (ISI)'s Social Science Citation Index (SSCI), yielding another subset of 4,761 PhD-holders with at least 1 publication. From these we draw a stratified sample, oversampling those researchers with multiple publications. More specifically, we sample 100% of those researchers with 5 or more publications, and draw smaller samples among the groups of researchers with less than 5 as well as 0 publications. The cumulative distribution of publications over researchers and the detailed sampling strategy are given in table I.

For these 1,493 researchers, we collect information on their nationality, education and career by searching the web for faculty profile pages, personal web pages or curriculum vitae. We find a total of 1,005 web pages and 668 curricula, thus obtaining (at least partial) information for 1,095 researchers. The probability of finding a web page or a CV depends on the number of publications a researcher has, ranging from 34% (17%) for a researcher with zero publications to 97% (66%) for a researcher with more than 15 publications for a web page (for a pdf CV, respectively). All analyses will be weighted to account for the stratified sampling and the decreasing hit rates.

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[2] The ISI SSCI publication database only has satisfactory coverage of social science journals from 1992 onwards, hence the need to limit our dataset to researchers who have graduated in this year or later.

From these web pages and CVs we collect the researchers' personal information (birth year, gender, nationality, marital status, etc.) as well as information on professional activities (grant activities, professional affiliations, previous work experience), education (institutions, graduation years and fields of undergraduate and graduate education), career track (names, entry and exit years and positions occupied at various institutions) and visiting positions (both short and long-term visiting positions). From this collected information, a number of additional variables are derived, including mobility statistics.

Table I: Sampling strategy

> pubs	# authors	cum. dist.	percentiles	sample	# obs
50	2	0.00			
40	5	0.00			
30	11	0.00	top 5%	100%	311
20	43	0.01			
10	311	0.07			
9	380	0.08			
8	453	0.10			
7	587	0.12	middle 15%	100%	664
6	755	0.16			
5	977	0.21			
4	1345	0.28			
3	1869	0.39	bottom 80%	10%	377
2	2735	0.57			
1	4761	1.00			
0	18961		zeroes	1.0%	141
				total	1493

As a last step, we add information from various sources to the dataset. The researchers' advisors are matched to ISI's list of highly cited researchers, to obtain an indicator of the advisors' quality and reputation. The researchers' various higher education institutions are matched to several rankings of economics departments compiled by Tom Coupé (Coupé, 2003) to serve as indicators of educational quality.

A few key figures and observations about the final dataset:

- Researchers' PhD graduation years range from 1992 to 2006. Due to the oversampling of researchers with many publications, earlier years are more heavily represented than more recent years.

- More productive researchers are generally older and have made more international moves, which makes sense since older researchers have had more time both to publish and to move abroad.

- Only 18% of our sample consists of women. Their share is generally larger in later graduation years, reflecting the rising share of women in more recent cohorts of PhD students.

- Of the 1,047 researchers whose nationality we record, only 211 mention their nationality explicitly on their CV. The other 836 researchers' nationality is derived from the country where they obtained their BA. The majority of researchers obtain their BA in their country of origin (MacGarvie, 2007; Gaughan, 2007).

- The average researcher in our sample is male, was born in 1967, obtained his PhD in 1997 and has made 2 international moves in his career. He starts as an assistant professor, and has made full professor by 2005. He works in the academic or public research sector and has worked at his current institution since 2001.

4   International mobility patterns: descriptive analysis

Due to the limitations of our data sources, our sample is not representative of the whole population of PhD holders in economics. There are no geographical restrictions on the researchers' pre-PhD educational backgrounds and their post-PhD career tracks, but they all have a PhD from a US institution. This inevitably imposes a selection bias. Suppose that the returns of a PhD are increasing in the quality of the PhD program and that the higher the quality of a PhD program, the higher the ability of the applicants must be to enter. A student who considers applying for a PhD program of a particular quality level, must weigh the returns of that PhD to the costs of obtaining it. The returns can be assumed to be equal across US students and foreign students; the costs, however, cannot. Both US and foreign students incur the 'normal' costs of obtaining a PhD (e.g. foregone earnings during the years of study, tuition fees, housing, etc.). On top of that, foreign students incur an additional moving cost (e.g. travelling costs, psychological

costs of separation from family and friends, language barriers, etc.). Therefore, foreign students are not willing to enter lower quality PhD programs, as the lower returns of these programs do not offset their higher costs. By comparison, there are US students who do not have the required ability to enter into higher quality programs but who may find enrolling into these lower quality PhD programs worthwhile because the lower returns still exceed their comparatively lower costs. As a result, US PhD students represent a larger portion of the ability spectrum compared to their foreign peers, who are selected from among the top students in their countries.

Table II: Population coverage of our sample

	US	non-US
Nationality (country of birth)		
Undergraduate education (BA)		
Graduate education (MA)		
Ph.D.		
Further research career		

Our data corroborate this theory: being a US citizen, i.e., doing your PhD in your home country, is negatively and significantly correlated to various measures of advisor and PhD institution quality. The observation that foreign PhD students are more often enrolled in higher quality PhD programs with high quality advisors is an indication of their higher average ability. As a consequence US PhD holders cannot be compared to the foreign PhD holders. Lumping them together into one group would bias the analysis. Therefore, from now on, we treat each group separately, labeling them 'US'[3] and 'Rest of World (RoW)'. The US sample contains 477 researchers, as it also contains a few Canadian researchers with a Canadian PhD.[4] The RoW sample contains a total 586 researchers. The main focus will be on the RoW sample, but where possible, the comparison is made with the US sample. The final RoW sample contains

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[3] As the ProQuest database also covers a number of Canadian universities, the 'US' group also includes a few Canadian citizens who obtained their PhD in Canada.
[4] For brevity, we just call this sample US instead of US/Canada. Moreover, a number of Canadian researchers obtained a PhD in the US and are therefore part of the RoW sample. Renaming the US sample 'US/Canada' may cause confusion.

researchers of 63 different nationalities.. Table IV displays the top 5 nationalities: Italy has the most researchers in our sample, with 70, followed by India, Canada, Germany and Japan.

Table IV: Top 5 nationalities (RoW)

Italy	70
India	56
Canada	46
Germany	43
Japan	40

Figure I divides the researchers of the total sample into broad world regions on the basis of their nationalities[5]. As expected, the majority originates in North America, with little over 500 researchers in the sample. Next is Western Europe, with slightly over 200 researchers, followed by East Asia, with nearly 100. Oceania, Africa and Central Asia contribute the smallest numbers of researchers to the sample. Our sample's distribution of researchers' nationalities over world regions is largely in line with that of the population of doctoral recipients in the United States. We compare our sample to the National Science Foundation's (NSF) Science & Engineering indicators on the BA-country of doctoral recipients in the United States between 1997 and 2006. The main differences are that Western Europe and South Asia seem somewhat overrepresented, whereas North America and East Asia appear slightly underrepresented. There are two potential explanations for this. First, the NSF covers all scientific fields, whereas our sample only covers economics. Countries are known to differ in their research orientations (Glänzel, 2000) and foreign students' choices of discipline may reflect those differences. Second, our sample covers

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[5] North America: USA, Canada
 Western Europe: Italy, Germany, Spain, Greece, UK, France, Denmark, Austria, Belgium, Ireland, Switzerland, the Netherlands, the Czech Republic, Sweden, Finland, Iceland, Norway, Portugal.
Central and Eastern Europe: Russia, Hungary, Poland, Bulgaria, Romania, Serbia, Slovakia, Armenia, Belarus, Cyprus, Slovenia
South Asia: India, Singapore, Thailand, the Philippines, Bangladesh, Nepal
East Asia: Japan, China, South Korea, Taiwan
Latin America: Brazil, Argentina, Chile, Mexico, Colombia, Uruguay, Costa Rica, Nicaragua, Peru, Venezuela
Middle East: Turkey, Israel
Africa: Ghana, Algeria, Ethiopia, Ivory Coast, Morocco, South Africa, Congo
Oceania: Australia, New Zealand

the years 1992-1997 additional to the years 1997-2006 covered by the NSF. China's opening up to the world starting in 1997 may account for the higher proportion of East Asian doctoral recipients in the NSF data compared to our sample, which also covers the 5 years prior to this change in Chinese foreign policy.

The aim of this paper is to analyze these researchers' international mobility behavior. We choose a strict definition of international mobility: a researcher is internationally mobile if she takes up a permanent position in an institution in a country different from the country of the institution she was previously affiliated to. Research visits, even extended fixed term visiting positions, are not taken into account.[6] A few descriptive statistics make for an interesting first look into the general mobility patterns observed in our sample.

Figure I: Distribution of researchers' nationalities over world regions
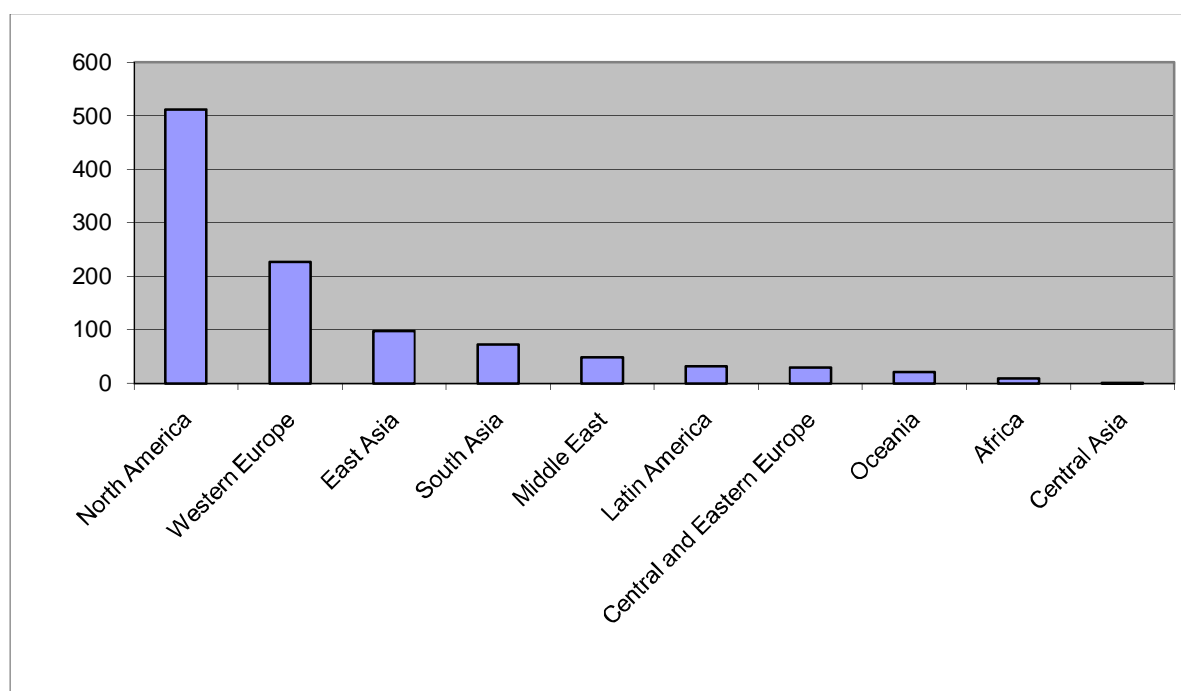
Starting with the RoW sample, figure II displays the histogram of the distribution of international moves over researchers. The distribution is skewed towards zero, over 40% of researchers making no international move after their PhD. The group of researchers with at least 1 international move comprises over 35% though, and a few researchers have made as many as 6

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[6] In the future, we would like to relax our definition and take extended research visits into account as well.

international moves in their professional careers so far. Top destination countries are the UK (76 moves), Canada (74 moves), Japan (54 moves), Italy (43 moves) and Australia (42 moves).

Figure II : Number of international moves per researcher (RoW sample)
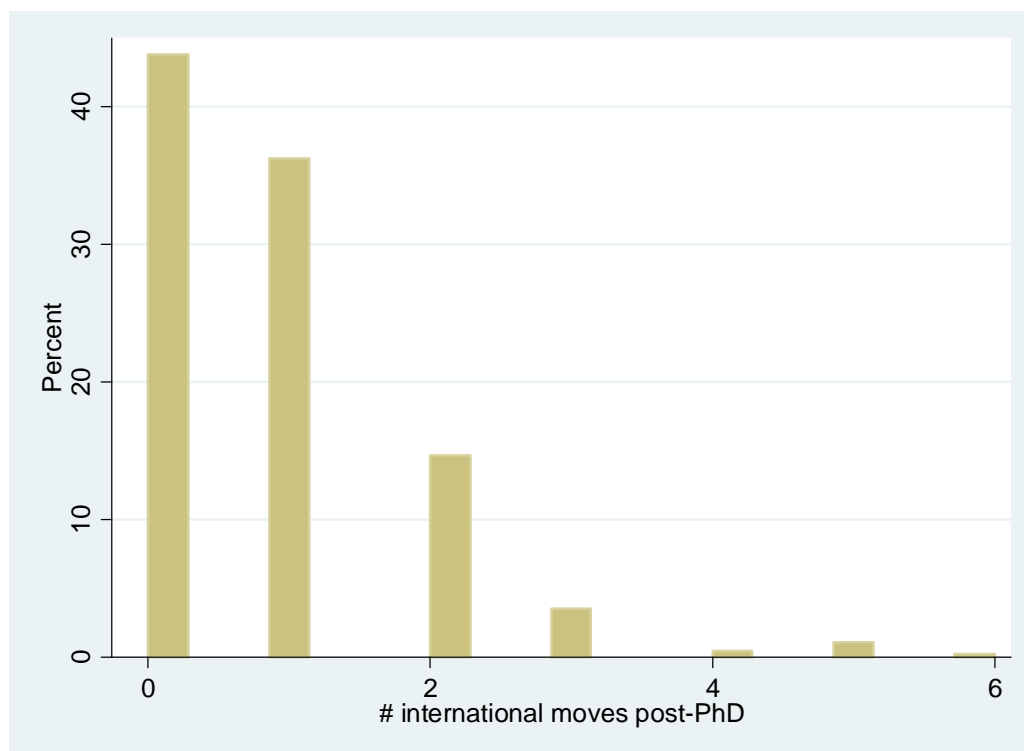

Table V divides the researchers into two groups, those who have made at least one international move after their PhD, and those who have not. The sample splits almost evenly between movers and non-movers, with a slight majority of researchers making at least one international move after their PhD.

Table V : Distribution of pre/post PhD international mobility (RoW sample)

mobile post PhD	
0	1
0.48	0.52

The question remains whether these researchers are really more internationally mobile in the sense that they move on to work in countries different than the ones where they were raised and

educated, or if the bulk of these observed international move constitute return migration to their countries of origin. Table VI divides the part of the RoW sample that is internationally mobile post-PhD into researchers who have taken up at least one job in their home country (i.e., return migration), researchers who have taken up at least one job in a third country (i.e., neither in their home country nor in their PhD country) and researchers who have done both. The majority, 52%, has taken up a job in a third country without ever returning home for a permanent position. By contrast, 33% have taken up a position in their home country, without ever working in a third country. A respectable 15% have worked both at home and in a third country, bringing the total share of mobile researchers who have worked in a third country on 67%. In this group, international mobility does not seem to be driven solely by return migration; the researchers in this sample appear more willing to move to another country than the researchers from the US sample. This could be due to a selection effect, where only researchers with a high enough 'willingness to move' get a PhD in the US in the first place, and continue being mobile from there on. A learning effect may also play a role: a researcher that has had one positive experience with moving abroad, may develop lower informational and motivational barriers to move again.

Table VI : Distribution of international moves over home/third countries (RoW sample)

min one job in third		min one job at home		
		0	1	
	0	0.00	0.33	0.33
	1	0.52	0.15	0.67
		0.52	0.48	1.00

Continuing with the US sample, figure III displays a comparable histogram of the number of international moves per researcher after the PhD was obtained. The distribution of moves is more skewed than for the RoW sample, with an overwhelming majority of over 80% of researchers making zero international moves throughout their research career. Only a handful of individuals have made more than 3 international moves in their career. For those who move, the top destination countries are Canada (48 moves), the UK (16 moves) and the Netherlands (5 moves).
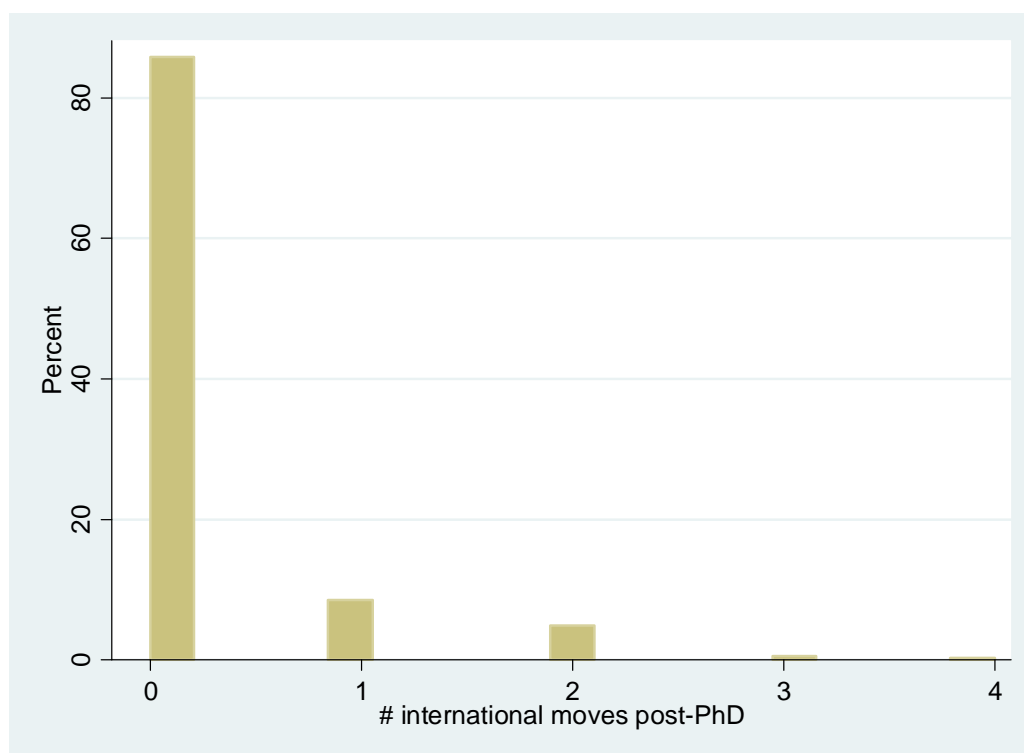
Figure III: Number of international moves per researchers (US sample)

Table VI divides the US sample into the same four groups as table III for the RoW sample: researchers who have never moved internationally, researchers who have moved internationally pre-PhD, researchers who have moved internationally post-PhD, and researchers who have moved internationally both before and after obtaining their PhD. As expected from the above histogram, the majority have never moved internationally, neither as a student nor as a researcher after their PhD. By contrast, 5% of researchers in this group have made an international move before their PhD, 12% after their PhD, and 2% both before and after their PhD.

Finally, we look at the mobility patterns of the full sample (US and RoW taken together) in a little more detail: where did the researchers come from, and where did they go? The columns of table VIII display the researchers' world regions of origin, and the rows show the world region of the researchers' current principal affiliation. The result is a matrix of which the elements are the probability of a researcher currently being in a particular world region, conditional on the region of origin of said researcher. The last row also reports the number of researchers per region of origin; some regions only produce a few researchers, and the probabilities are therefore only rough estimates that should be interpreted with caution.

Table VI: Distribution of pre/post PhD international mobility (US sample)

mobile pre PhD	mobile post PhD		
	0	1	
0	0.82	0.12	0.94
1	0.05	0.02	0.06
	0.86	0.14	1.00

Table VIII: Distribution of researchers of world regions of origin and current employment

Current world region	Nationality (by world region)									
		afr	c.asia	cee	e.asia	l.am	m.east	n.am	oc	s.asia	w.eur
	Africa (afr)	0.56	0	0	0	0	0	0	0	0	0
	Central Asia (c.asia)	0	0	0	0	0	0	0	0	0	0
	Central and Eastern Europe (cee)	0	0	0.21	0	0	0	0	0	0	0
	East Asia (e.asia)	0	0	0	0.59	0	0	0.01	0	0	0
	Latin America (l.am)	0	0	0.03	0	0.50	0.02	0	0	0.01	0
	Middle East (m.east)	0	0	0	0	0	0.36	0	0	0	0
	North America (n.am)	0.44	1	0.72	0.35	0.43	0.55	0.96	0.45	0.65	0.58
	Oceania (oc)	0	0	0	0.04	0.03	0.02	0.01	0.55	0.04	0.01
	South Asia (s.asia)	0	0	0	0.01	0	0	0	0	0.18	0.01
	Western Europe (w.eur)	0	0	0.03	0.01	0.03	0.04	0.02	0	0.11	0.39
	Number of individuals	9	1	29	98	31	48	512	20	72	227

All researchers from every world region of origin have a positive probability of currently being in North America, mostly because of the large group that stays in the US after graduating. There is also some evidence of return migration, as the probability of currently being in your home world region is almost always positive. Western Europe, Oceania and Latin America attract

some researchers from other world regions as well. By contrast, most other world regions do not seem so attractive to researchers who did not originate there.

The descriptive analysis yields an interesting picture of prevailing mobility patterns among researchers. But what determines a researcher's choice to become internationally mobile? Are certain factors associated with particular mobility patterns? What factors drive the decision to return to the home country, or to move on to a third country? The next two sections delve a little deeper into these questions.

5   The determinants of international mobility: limited dependent variable analysis

In this section, we analyze the factors that drive the decision to become internationally mobile. The dependent variable is a binary variable that indicates whether a researcher has made at least one international move throughout her career *after* the PhD was obtained. We only count international moves if a permanent position was taken up in another country; hence, we leave out fixed-term visiting positions, even long term ones. We then use probit regression to relate this dependent variable to a number of independent variables.

- age: We could consider international mobility an investment in human capital, as it stimulates particular skills in the area of languages and cultural and social abilities that are increasingly valued in a globalizing world. Human capital theory predicts that people are less likely to make human capital investments as they get older, because the time horizon over which the investment will yield pay-offs shortens (Becker, 1962). This would imply that researchers are less likely to make an international move as they get older. Conversely, as researchers age, they have had more time to build up a reputation and a solid CV, and are therefore more likely to receive job offers from abroad. We hypothesize that the effect of age on the probability to move has an inverse U-shape, and therefore include both age and age-squared into the model.

- pre-PhD mobility experience: Researchers who have been internationally mobile during their higher education years acquire general 'international' human capital. Their previous experience may affect their language skills, their openness to and knowledge of other cultures and their international social network, amongst others things. De Grip et al. (2008) find a positive effect of previous mobility experience in adolescence and of

student exchanges on the probability to move for the first or subsequent jobs. Therefore we hypothesize that pre-PhD mobility experience will affect the probability of moving internationally later on positively. We measure pre-PhD mobility as a dummy variable that is one if the researcher obtained some part of higher education in a country other than the country of birth and the country of the PhD. For example, we consider a researcher from India who did a BA in India, an MA in the UK and finally the PhD in the US as having pre-PhD mobility experience. By contrast, a Chinese researcher who did a BA in China, and then an MA and the PhD in the US is not considered to have pre-PhD mobility experience.

- gender: As pointed out in the literature review, Dumont et al. (2007) find that highly skilled women are more likely to emigrate than highly skilled men. Based on this finding, we would hypothesize the women are more likely than men to move internationally. However, intuitively, and despite the great leaps forward in terms of gender equality over the past decades, it remains difficult for women to achieve the highest positions in a research career. This may be related to the difficulties married women with children encounter to become internationally mobile. Consequently, we would hypothesize that women are less likely to move internationally.

- highly cited advisor & top PhD institution: Having a good reputation and an extensive curriculum probably increases the probability of receiving job offers from abroad. However, young researchers have not yet had the time to establish their research reputations. Employers may therefore use quality of education as an indicator of a young researcher's promise. De Grip et al. (2008) find that graduates with high grades are more likely to migrate for their first job. This leads us to hypothesize that having a highly cited advisor and earning a PhD from a prestigious institution increases the probability of receiving a job offer from abroad. Then again, institutions from the PhD country itself are likely to compete fiercely to keep the best graduates there, which could affect the probability of moving internationally negatively. The 'highly cited advisor' variable is a dummy that is one if a researcher's advisor is in the ISI highly cited list for economics. The 'top PhD institution' variable is another dummy that is one if the researcher's PhD institution is in the top 200 of Tom Coupé's ranking of economics departments based on the output of the department's 50 to publishing scholars.

Table IX: Probit regressions for international mobility (post-PhD)

	RoW	US
	internationally mobile post-PhD	internationally mobile post-PhD
age (BA year)	0.039	0.434
	(0.07)	(0.64)
age squared	-0.001	-0.005
	(0.22)	(0.68)
internationally mobile pre-PhD	0.806	1.628
	(1.41)	(3.46)***
female	-1.100	-0.415
	(2.65)***	(1.14)
highly cited advisor	-0.248	-0.684
	(0.50)	(1.60)
PhD institution in top 200 of TC top 50 scholars ranking	1.094	-0.122
	(2.40)**	(0.39)
origin Middle East	-0.113	
	(0.21)	
origin Latin America	0.091	
	(0.17)	
origin North America	0.495	
	(0.95)	
origin Central and Eastern Europe	-0.839	
	(1.24)	
origin East Asia	0.665	
	(1.75)*	
o. origin Central Asia	0.000	
	(.)	
origin South Asia	-0.517	
	(0.92)	
origin Oceania	-1.271	
	(1.78)*	
origin Africa	0.320	
	(0.35)	
Constant	0.765	-10.137
	(0.06)	(0.65)
Cohort dummies	yes	yes
Observations	380	326

Robust z statistics in parentheses * significant at 10%; ** significant at 5%; *** significant at 1%

Beside these explanatory variables, we control for world region of origin and cohort effects. Western Europe and 1992 are the base groups, respectively. The results for the RoW sample are displayed in the left column of table IX. The results for the US sample are added in the left column for comparison.

Age has the hypothesized inverse U-shape, but neither age nor age squared are significantly different from zero. Pre-PhD mobility experience has the hypothesized positive sign, and although this variable is highly significant for the US sample, it is not for the RoW sample. Intuition proved right for the gender dummy, as women are significantly less likely to move internationally than men. Having a highly cited advisor has a negative (albeit insignificant) effect, corroborating the hypothesis that the best PhD graduates are kept in the host country. On the contrary, a top PhD institution increases the likelihood of making an international move significantly, confirming the hypothesis that foreign employers perceive a PhD from a top institution as a signal for high ability. Of the region of origin dummies, only East Asia and Oceania are significantly different from zero. Researchers from the former are more likely to move internationally, whereas researchers from the latter are less likely to do so.

For the RoW sample, a simple probit analysis does not adequately represent the set of choices a researcher faces upon completion of the PhD. Where a US citizen faces a binary choice (stay here or go abroad), a foreign PhD student has three options: stay here, move abroad, or return home. Therefore we perform a multinomial analysis for the RoW sample. The dependent variable is based on current location, and takes one of three values: 'home' (if the researcher is currently in her home country), 'stay' (if the researcher is currently in her PhD country) or 'third' (if the researcher is in neither of the above). We include the same independent variables as in the above probit regression, as well as three additional dummies that indicate whether a researcher's PhD was funded by the PhD institution itself, another US institution (such as the NSF or the Alfred P. Sloan Foundation), or an institution from the home country. Some countries offer scholarships to students for a PhD abroad, but stipulate that the student has to come back to the home country for a certain amount of time. This may drive some of the return migration of foreign PhD students.

We opt for a multinomial logit model. Although the multinomial probit model does not assume independence of irrelevant alternatives and is generally considered to yield more precise estimates, there are authors who argue that in practice, multinomial logit performs just as well and is to be preferred due to its computational simplicity (Kropko, 2008). The base outcome, i.e. the outcome of a model where all coefficients are set to zero, is 'stay'. Column 1 displays the

coefficients for the outcome 'home'; column 2 for 'third'. For both the 'home' and the 'third' outcome, gender and funding source are significantly different from zero.

Table X: Multinomial logit regression for current location (RoW sample)

	(1) minimum one job home	(2) minimum one job in third country
age (BA year)	1.661	1.622
	(1.78)*	(1.58)
age squared	-0.015	-0.014
	(1.39)	(1.21)
female	-2.425	-6.861
	(2.99)***	(3.36)***
highly cited advisor	0.399	0.368
	(0.68)	(0.59)
PhD institution in top 200 of TC top 50 scholars ranking	0.311	0.428
	(0.46)	(0.65)
funding source: host institution	1.044	1.215
	(1.90)*	(1.87)*
funding source: other US institution	-3.085	-6.391
	(3.86)***	(5.04)***
funding source: home country	3.873	5.921
	(3.98)***	(5.70)***
origin Middle East	1.506	0.031
	(1.58)	(0.03)
origin Latin America	0.856	-1.989
	(0.66)	(1.39)
origin North America	-0.479	-47.201
	(0.45)	(.)
origin Central and Eastern Europe	2.456	-4.772
	(2.88)***	(2.92)***
origin East Asia	1.547	0.207
	(2.10)**	(0.30)
origin Oceania	-0.065	-42.995
	(0.05)	(42.39)***
origin South Asia	-2.079	-0.963
	(2.06)**	(1.25)
origin Africa	-2.272	-0.962
	(1.16)	(0.42)
Constant	-45.132	-46.883
	(2.18)**	(2.07)**
Observations	418	418

Robust z statistics in parentheses * significant at 10%; ** significant at 5%; *** significant at 1%

As with the probit regression, it appears that women have a lower propensity to make an international move, regardless of the destination. Researchers whose PhD was funded by a US

institution other than their PhD institution are less like to move, whereas researchers with PhD funding from their PhD institution or their home country are more likely to return home, but also, surprisingly, to move to a third country. Age again has the inverse U-shaped as hypothesized for the probit regressions, but only plays a significant role for the option 'home': the older the researcher, the higher the likelihood of currently having settled back home. Researchers from certain world regions also appear more prone to return home than their Western European peers, notably those from Central and Eastern Europe and East Asia.

6   Conclusion

Although much work remains to be done to obtain a complete picture of researchers' international mobility and its drivers, this paper contributes to the empirical literature on the subject by studying the international mobility patterns of PhD holders in economics. More specifically, we study the mobility decisions of a sample of foreign researchers who came to the US to obtain a PhD. We use a unique dataset with detailed information on the careers of a sample of economics PhD holders from US institutions.

We find that slightly less than half of foreign PhD holders do not move again internationally after they obtain their PhD, i.e. they stay and work in the US. The other half does become internationally mobile, and only around one third of this international mobility consists of return migration. The remaining two thirds take up at least one job in a third country during their careers. With regards to the destination of this mobility, even if the majority does not return to the home country, many settle in a country within the same world region. Beside North America, only Western Europe, Oceania and Latin America manage to attract researchers from other world regions. By comparison, US PhD holders are a lot less internationally mobile: 86% never move internationally, neither before nor after the PhD.

As for the personal factors that drive the decision to become internationally mobile, we find that having a PhD from a top institution and being male significantly increase the probability of making at least one international move during a foreign researcher's career. By contrast, in the US sample, pre-PhD mobility experience appears to be a decisive factor in the decision to become mobile later on.

Although this preliminary work yields an interesting first look on researchers' mobility patterns, much remains to be done to further complete our understanding of this increasingly important issue. In a later version, we hope to adopt a less strict definition of international mobility, to include extended research visits. More importantly, in future work we hope to tackle new research questions with regard to the effect of international mobility on research productivity and on researchers' collaboration networks. As highly skilled workers, and researchers specifically, gain importance in the workforce of the growing knowledge economies, the near future will undoubtedly see interesting new avenues of research emerge in the economics of science and innovation.

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