

# Going abroad to do science: Mobility trends and motivations of Portuguese researchers

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This paper addresses the issue of scientific mobility from the standpoint of a departure country, Portugal. The analysis is focused on the conditions and motivations for leaving the home country, the choices made regarding host countries and institutions and the constraints and opportunities that bear weight on the decision to return. Mobility decisions are examined in light of the interplay between structural conditions (the global and national science and technology systems), career paths and personal choices. Differences in attitudes, perceptions and behaviours of mobile scientists by gender, age, year of migration, career status and scientific disciplines are taken into consideration. This research is mainly based on a survey of Portuguese researchers abroad.

*Keywords:* International scientific mobility, Portugal, Scientific careers

The international mobility of academics and researchers is one of the most frequently debated issues in Science and Technology policies and it has been the subject of numerous studies in recent years. There has been work focusing on mobility programmes, such as the Marie Curie fellowships (Ackers et al, 2001; Van de Sande et al, 2005) or the Erasmus exchange (King and Ruiz-Gelices, 2003), other on particular sending countries (Ferro, 2004; Todisco et al, 2003; Morano-Foadi, 2006) or regions (De La Vega and Vessuri, 2008), other on receiving countries (Alarcon, 1999; Mahroum, 2000; Millard, 2005; Szelenyi, 2006; Baruch et al, 2007), other still on specific scientific disciplines (Casey et al, 2001; Laudel, 2005; Fontes, 2007).

This paper proposes to analyse mobility trends and motivations from the perspective of a sending country, Portugal. Even though science is by principle universal and many behaviours and attitudes of scientists are more strongly influenced by the rules and values of the “republic of science” than by national considerations, the positions of countries in the world system of science and the national institutional framework (Science and Technology policies, the internal workings of the scientific field and scientific careers) cannot be overlooked when considering the international mobility of researchers. National case studies can shed light both on general trends (accumulating knowledge on what is universal) and on regional

particularities (groups of countries that share similar characteristics) and also on country-specific issues (that can serve for policy purposes but also can fuel comparative studies).

Thus, on the one hand, Portugal may be representative of the trends occurring in other, less studied, Southern European countries (namely Spain and Greece). These countries have several traits in common that set them apart from other geographical aggregations (such as the Eastern European countries or the core Western European countries): a recent history of political repression and economic backwardness that delayed the development of their scientific systems; systematically low positions in European rankings pertaining R&D expenditures, personnel and productivity<sup>1</sup>, despite high growth levels in recent years; traditional academic structures heavily reliant on personal patronage, generating inbreeding and conservativeness<sup>2</sup>. Additionally, as part of European Union, they have benefited both from general advantages (free circulation agreements, mutual recognition of diplomas – (see Tremblay, 2002; Ackers, 2005; Morano-Foadi, 2005; Recchi, 2006) and specific financial support (cohesion funds, partly diverted to science), which place these countries in different conditions to those in the periphery of the world system (Africa, Latin America), whose scientists face more incentives for moving (“pushing” factors) but also more stringent barriers to their mobility.

On the other hand, Portugal may show some specificity that makes it a relevant case study. In the past two decades Portuguese science has shown astonishing growth levels: R&D intensity has almost trebled and the number of researchers has increased more than 6 times. According to 2007 data, there

are 51,443 active researchers (28,175.9 in Full-Time Equivalent), of which 32% are doctorate holders (9,017.9 in FTE)<sup>3</sup>. A substantial part of S&T policies and funding have been geared towards to the training of human resources<sup>4</sup>, through the allocation of doctoral and postdoctoral grants: between 1994 and 2007 the Portuguese government has granted 13,382 PhD fellowships and more than 4,173 post-doctoral fellowships. International mobility has been strongly encouraged: in the same period, 27% of these PhD (3,571) and 16% of these post-doctoral (559) fellowships were granted to Portuguese citizens for performing research abroad; other 19% of these PhD (2,592) and 20% of these post-doctoral (842) fellowships were granted for combining periods of research at home and abroad (mixed fellowships)<sup>5</sup>.

However, this strong investment on training and mobility has not been properly evaluated yet. Unlike in other programmes (for instance, in Brazil), beneficiaries of grants are under no obligation of returning to the home country nor there is any reintegration scheme in place. Although post-doctoral grants and a recent scheme of 5-year work contracts may be partly aimed at attracting back expatriate scientists, these programmes are open to researchers who have never left the country. Official statistics on the rate of return to the home country are inexistent and there is no census of the Portuguese researchers abroad.

This paper, and the research project in which it is based, tries not only to describe the patterns of mobility of Portuguese researchers but also to assess whether the growth of the Portuguese scientific system and its training and mobility policies, which have in part been responsible for the exit of scientists, can also motivate

them to return. This information ought to be of value for further studies and for policy design, and not exclusively in the national context of Portugal.

### **Analytical Framework and Methodology**

This research intends to examine the mobility patterns and motivations of Portuguese researchers at three interlocking levels: the structural level of the world system of science; the intermediate level of the internal workings of the scientific field and scientific careers; and the individual level of personal choices and constraints.

On a structural level, the imbalances between national science and technology systems inside the “world system of science” drive international mobility fluxes along predictable patterns: from the periphery to the centre and among core countries and institutions (Mahroum, 2000; Ackers, 2005; Millard, 2005; Morano-Foadi, 2006; De La Vega and Vessuri, 2008). Core countries generally offer more resources for research (funding, infrastructures) and attractive labour markets (employment opportunities and rewards), and tend to amass more scientific prestige and influence (that can be measured by publications and citations - see King, 2004). Portugal is clearly located in the semi-periphery of the system, in between the core countries of Western Europe and Northern America and the peripheral countries of the South. International mobility is also affected by other structural factors, such as membership of supra-national entities (such as the European Union in the case of Portugal) and national policies regarding immigration (exit and entry requisites and procedures) and science (mobility programmes, availability of grants and

fellowships for funding stays abroad or attracting foreign scientists) (see Morano-Foadi, 2006; Laveney, 2006). Additionally, in historical terms, Portugal has been a source country not only for less qualified immigration (see Recchi, 2006), creating a cultural familiarity with migration (see Rizvi, 2005), but also for scientific exodus (see Carneiro and Simões, 2000).

At the level of institutional settings, the functioning of the scientific field also influences researchers’ strategies and choices. According to P. Bourdieu (1975), scientific careers are constructed on the accumulation of “scientific capital”, a specific kind of symbolic power that refers to academic degree, technical expertise and social authority, recognised by the peers. This capital is acquired by publishing (in peer reviewed journals) and by studying or working in prestigious institutions, in turn giving access to better positions in other institutions (see, for instance, Allison and Long, 1987). The “scientific capital” of institutions and countries varies according to scientific disciplines and the internal structure of academic systems (hierarchical organisation, recruitment procedures, qualification requisites, formal and informal networks) is fairly country-specific, influencing researchers’ trajectories and careers (see Enders and de Weert, 2004). In recent years, the drive towards internationalisation (see Enders and de Weert, 2004) and the scarcity of tenure positions have made international mobility more a necessity than an option (Morano-Foadi, 2005). Researchers are pushed towards a “stint abroad” as a means to acquire “scientific capital” and to generate or take part in transnational networks, increasing their chances of obtaining employment in their home country or abroad (see Enders and de Weert, 2004).

Finally, on an individual level, mobility decisions, like other career choices (see, for instance, Duberley et al, 2006), are also affected by personal factors such as family situation, lifestyle preferences and aspirations, lived experiences. This also means that variables such as gender, age, marital status also bear relevance to the analysis of mobility behaviour and perception.

It is thus against this complex backdrop that mobility choices are being made by Portuguese scientists. Do more dynamic S&T systems in neighbouring countries still attract a significant amount of researchers? Has the growth of the Portuguese system retained or lured back talented scientists? How do mobile scientists see the opportunities and constraints of moving between countries? What different patterns of attitudes and practices emerge due to social and scientific cleavages?

This article tries to answer some of these questions, based on official statistics<sup>6</sup> and on an online survey applied to a convenience sample of Portuguese researchers abroad, carried out in June 2007. Although convenience samples pose extrapolation problems, it was the only option to reach a population whose size and composition are virtually unknown. Furthermore, scientists constitute a fairly homogenous social group and an effort has been made to identify expatriate researchers from several different sources (an online database, newspaper articles, membership lists of associations, university WebPages, Google searches). Thus, 803 researchers were contacted by email and 525 answers were received, which amounts to 65% of the original sample (although the actual response rate should be lower, since the researchers were asked to forward the email to other people in the same circumstances and

the survey was publicised by several associations of researchers)<sup>7</sup>. The survey was devised to encompass both senior researchers (PhD holders) and early stage career researchers (PhD students), who may end up not pursuing a scientific career but are nonetheless producing science.

The design of the questionnaire and the size of the sample were crucial for obtaining new insights into the issue on scientific mobility. By combining questions of an objective (regarding actions and behaviours) and subjective (regarding attitudes and valuations, measured by Likert-type scales) nature, it was possible to draw a more complete picture of the practices and representations of mobile scientists. The inclusion of open-ended questions allowed some qualitative analysis. The relatively high number of responses<sup>8</sup> made possible to perform statistical tests to assess the significance of associations between variables in the questionnaire and independent variables (gender, career situation, scientific area, host country, year of departure). Only statistically significant bivariate associations are mentioned in this paper and its tables<sup>9</sup>. On the whole, this methodological strategy was based on the attempt to make use of sociological tools and concepts (which are not very common in these types of studies) in order to obtain fairly reliable results.

### **Departure: Conditions and Motivations for Leaving Portugal**

There is no reliable statistical data on the number of Portuguese expatriate researchers abroad. The closest proxy indicators may be the number of Portuguese-born science-related professionals residing in other OECD

countries (2,420)<sup>10</sup> but this figure is based on census carried out in 2000 and has important data missing (for Germany, The Netherlands, the US), or the number of Portuguese doctoral students in the EU27 (approximately 2,400 – IPTS-JRC, 2007: 58), but this figure leaves out many other host countries and researchers in more senior career positions.

Just like other studies on highly skilled mobility have shown (see Alarcon, 1999; Mahroum, 2000; Avveduto, 2001; Tremblay, 2002; Ferro, 2004; Millard, 2005; Rizvi, 2005; Szelenyi, 2006; Baruch et al, 2007), this survey indicates that post-graduate education in a foreign country is by far the main exit route for Portuguese researchers. PhD students make up 62% of the respondents and 76% of senior researchers currently working abroad also obtained their PhDs outside the home country, many of whom have mentioned post-graduate education as one of the main motivations for leaving (see below).

As seen above, in the past two decades, post-graduate education abroad has received substantial support from the Portuguese government. Up until recently the conditions of the national S&T system made it almost mandatory for researchers and academics to study abroad: lack of financial resources, outdated equipment, and absence of post-graduate courses. Nowadays, not only the material resources available have increased but also all universities offer PhD courses in a wide range of scientific disciplines, following a trend set by European universities in the 80's and 90's (see Enders and de Weert, 2004). As a result, the relative number of fellowships for PhD studies abroad has been declining steadily, as more young researchers opt to remain in the country: in the first half of the 90's, 43% of PhD fellowships were granted to students enrolled in foreign

institutions; in the second half of the decade this figure had fallen to 41%; in the first five years of the new century, it reached only 25%<sup>11</sup>. Nevertheless, according to a study carried out by IPTS-JRC (2007: 58) Portugal is still one of the European countries with higher ratios of expatriate doctoral students (13%), though surpassed by Ireland (26%), Greece (18%) and Slovenia (15%).

The majority of Portuguese researchers currently abroad did start off from the Portuguese scientific system: 96% of the respondents to this survey obtained their undergraduate degree (ISCED 5) in Portugal. However, 36% of the respondents left immediately after obtaining the undergraduate degree and 45% in the ensuing 2 to 5 years (see Table 1). Statistically significant differences were found both in scientific and career variables (career situation, decade of migration and scientific area, but not by host country) and in socio-demographic variables (gender and age). Current PhD students tend to have left the country sooner after graduation than their senior counterparts, and the most recent the migration, the more premature the departure. Scientists in the exact sciences (mathematics, physics, astronomy, and chemistry) tend to go abroad after graduation earlier than engineering graduates, which may be due to more employment opportunities for engineers, who can experience other professional activities before enrolling in post-graduate education. Younger researchers more frequently have left the country almost immediately after graduation than older ones. Male expatriate researchers tend to have left the country in an earlier career phase than the female ones, which implies a slightly more cautious approach to international migration.

As a result of this early departure, more than one third of respondents

**Table 1.** Number of years between graduation and leaving the country by career situation, decade of migration, scientific area, gender and age (%)

	0-1 year	2-5 years	6-10 years	More than 10 years
Total	35.6	45.4	13.6	5.4
PhD students	37.7	49.2	12.1	1.0
Senior researcher	31.8	38.7	16.2	13.3
80's and before	21.1	36.8	15.8	26.3
1990's	38.4	43.0	10.5	8.1
2000-2007	35.7	46.4	14.2	3.8
Exact Sciences	58.1	29.0	9.7	3.2
Natural Sciences	36.4	49.0	10.6	4.0
Health Sciences	45.7	40.0	10.0	4.3
Engineering Sc.	24.0	48.0	14.0	14.0
Social Sc. Human.	16.8	51.6	25.3	6.3
Male	40.4	41.8	10.6	7.7
Female	29.3	50.2	16.6	3.9
< 30 years of age	50.8	47.7	1.5	
30-34 years	22.5	52.9	24.6	
35-39 years	23.2	39.3	25.0	12.5
Over 40 years of age	11.6	27.9	20.9	39.5

(37%) stated that they had no previous experience of research in Portugal. On the one hand, this may mean that there are not enough opportunities for undergraduates or recent graduates to be involved in research in Portugal and that many embark in post-graduate studies abroad (presumably leading to a career in research) without having first tested their abilities and interests<sup>12</sup>. On the other hand, it may signify that some recent graduates that are not drawn into research projects by senior scientists (either by not demonstrating sufficient academic merit or by not following a pattern of mentoring or sponsorship—see Cameron and Blackburn, 1981) but still

intend to pursue a scientific career are pushed towards studying abroad. Indeed, 31% of students stated that they had had difficulties in enrolling for a PhD in Portugal:

In Portugal I never had the chance of developing any scientific activity. I finished my degree with an average grade of 14 [out of 20] and none of my professors ever encouraged me to do anything. Only abroad do people see what we are worth beyond academic grades (PhD student, US)

The host institution of the first degree is not the only variable that can influence

the decision to go abroad. The “taste for mobility” can also be acquired by other life experiences: 83% of the Portuguese PhD students surveyed stated that they had had some kind of temporary scientific experience abroad before leaving the home country<sup>13</sup>. Approximately half of the respondents stated that they had participated in international scientific conferences (53%) or had done an internship in or made a visit to a foreign research institution (47%). A little over one third mentioned participation in an international research project (36%) or doing fieldwork in a foreign country (34%). Participation in the European programmes for students in higher education (Erasmus or Socrates) is also quite frequent (33%), which demonstrates the role these initiatives play in stimulating international mobility in later stages of life (see King and Ruiz-Gelices, 2003; Ackers et al, 2001; Gill, 2005; Recchi, 2006; Szelenyi, 2006).

When asked to rate the importance of several factors in the decision to leave Portugal to study or work in research abroad, Portuguese researchers stress chiefly scientific and professional reasons (see Table 2). Scientific factors concern mainly the opportunity to learn new theories or methodologies, to establish scientific networks, to work in specific scientific areas and to use equipment unavailable in Portugal. Professional reasons consist of the added value that an international experience has in terms of career development, such as improving one’s CV, obtaining a job either at home or abroad. The salience of these scientific and professional motivations is consistent with other studies on skilled mobility (Alarcon, 1999; Mahroum, 2000; Ackers et al, 2001; Casey et al, 2001; Ferro, 2004; Millard, 2005; Thorn and Holm-Nielsen, 2006; Carr et al, 2005; Baruch et al, 2007).

**Table 2.** Motivations for leaving Portugal to work in research abroad (mean scores\*)

To learn new techniques/methodologies/theories	4.36
It is important for the scientific CV	4.24
Possibility to establish international scientific networks	4.19
To work in an underdeveloped area in Portugal	4.07
To use means or equipments unavailable in Portugal	4.00
To experience life in another country	3.77
Difficulties in enrolling in a PhD or finding a job in Portugal	2.70
Personal reasons (to be close to family and friends)	2.50
PhD students	
Quality of training is higher than in Portugal	3.73
To increase the possibility of working abroad after the PhD	3.52
To increase the possibility of finding work in Portugal	3.36
Senior researchers	
To obtain post-graduate training abroad	4.13
Getting a job in a foreign institution	3.55

\* Likert scale: mean score between 5 (very important) and 1 (Not at all important)

**Table 3.** Motivations for leaving Portugal by decade of departure (mean scores)

	PhD students	Senior researchers
Possibility to establish international scientific networks	4.29	4.03
To use means or equipments unavailable in Portugal	4.18	3.71
To experience life in another country	3.94	3.48

Some of these motivations also show statistically significant differences according to structural factors, such as career situation (Table 3), the decade of migration (Table 4) and scientific discipline (Table 5). PhD students and researchers who have left the country more recently, tend to value more networking opportunities brought about by doing research abroad, as well as the opportunity of using state-of-the-art equipment and experiencing life abroad<sup>14</sup>. Again, learning opportunities appear to have been a more common driving force for going abroad for older generations, not least because they have left the home country at a time when its scientific system was under-developed.

Regarding the differences by scientific discipline, researchers in engineering sciences value less the possibility of improving their scientific CV, obtaining employment in Portugal or using new resources through an experience

abroad, which may be interpreted as signalling a higher level of satisfaction with the conditions in the home country. Conversely, social scientists show more dissatisfaction with the quality of training in Portugal (which may be due to the fact that PhD programmes in Portugal in these scientific disciplines are very recent) and value more the possibility of obtaining employment abroad.

Some respondents also mentioned (in an additional open-ended question) the financial advantages of doing research abroad as a motivation for leaving Portugal: fellowships from the Portuguese government for studying abroad are better paid; researchers' wages and benefits are more attractive in other countries. Others highlighted the disappointment with the Portuguese academic system:

The mentality in the research environment abroad is less institutionalised and hierarchical.

**Table 4.** Motivations for leaving Portugal by decade of migration (mean scores)

	80's and before	1990's	2000-2007
To learn new techniques/ methodologies/theories	4.63	4.18	4.38
To use means or equipments unavailable in Portugal	3.95	3.53	4.12
To experience life in another country	2.83	3.49	3.88
Possibility to establish international scientific networks	3.68	3.91	4.28



**Table 5.** Motivations for leaving Portugal by scientific area (mean scores)

	Exact Sc	Natural Sc	Health Sc	Engineering Sc	Social Sc H
To learn new techniques/ methodologies/theories	4.44	4.35	4.50	3.96	4.45
To use means or equipments unavailable in Portugal	4.12	4.00	4.25	3.57	3.95
It is important for the scientific CV	4.11	4.26	4.37	3.87	4.33
Quality of training is higher than in Portugal	3.73	3.55	3.60	3.68	4.30
To increase the possibility of working abroad after the PhD	3.62	3.32	3.43	3.76	3.84
To increase the possibility of finding work in Portugal	3.57	3.38	3.65	2.54	3.25
To obtain post-graduate training abroad	4.04	3.75	4.73	4.28	4.41

Merit is more important than pulling strings (PhD student, UK)

Maybe the most important factor for being abroad is not the university or the quality of research and teaching, but the way in which universities are intertwined with the social and economic fabric of American society. Here universities are still the motor that feeds innovation in the business sector (...) In Portugal, the academic world is completely separated from the business and social worlds (PhD student, US).

This dissatisfaction with the scientific system of the home country has also been found in other mobility studies, especially in European countries with traditional, more rigid, academic structures, which favour inbreeding, sponsorship between senior and junior researchers and informal recruitment procedures (Ackers, 2001; Avveduto, 2001; Casey et al, 2001; Gill, 2005; Millard, 2005; Morano-Foadi, 2005 and 2006; Szelenyi, 2006).

Career choices are dictated also by extra-scientific and extra-professional motivations. Personal reasons for going abroad (Table 6) are more often highlighted by women, by older researchers and by researchers with families (married, with children) residing with them abroad. This is in line with similar research carried out regarding the academic mobility of women (Ackers, 2001, 2004; Kulis and Sicotte 2002: 6): women more often than men are “tied” movers, whose career decisions are conditioned by their partners.

Having discussed when and why researchers make the decision to leave Portugal, it is then relevant to examine where they are headed and how they select their destination.

**Arrival: Choosing a Host Country and Institution**

Any mobility process has an arrival point and the destination of the migration tells us much about the resources, the strategies and the purposes of the movers.

**Table 6.** Importance allocated to personal reasons (to be close to family and friends) for leaving the home country, by gender, age and family situation (mean scores)

Male	2.16
Female	2.80
< 30 years of age	2.28
30-34 years	2.40
35-39 years	2.59
Over 40 years of age	3.36
Married	2.80
Single	2.19
Divorced/widower	2.57
With children	3.15
Without children	2.29
Family residing abroad	2.79
Family residing in the home country	2.19

This survey indicates that Portuguese researchers abroad are located mainly in what can be considered the “core” of the scientific world system: Europe and North America (see table 7).

This geographical distribution of expatriate researchers, though no doubt slightly skewed by sampling procedures, does resemble the allotment by country of doctoral fellowships granted by the Portuguese government<sup>15</sup> and of PhDs awarded to Portuguese researchers by foreign universities (database mentioned below). Following parallel trends to those observed in other studies (see Alarcon, 1999; Mahroum, 2000; Casey et al, 2001; Florida, 2005; Laudel, 2005; Millard, 2005; Morano-Foadi, 2005 and 2006; Szelenyi,

**Table 7.** Host countries of Portuguese expatriate researchers (%)

European Union	64.9
UK	28.8
France	7.9
Netherlands	6.5
Germany	6.1
Spain	4.4
Other EU countries	11.2
Europe (non EU)	4.8
United States	26.9
Rest of the world	3.5

2006; Baruch et al, 2007; Fontes, 2007; De La Vega and Vessuri, 2008), as well as in official statistics<sup>16</sup>, the UK and the US attract more than half of the researchers in this sample. This is certainly due to the similar reasons to those pointed out by the above mentioned studies: familiarity with the English language<sup>17</sup> and culture and the characteristics of the S&T system in these two countries, namely not only its material (infra-structures, availability of funding, employment opportunities, post-graduate education market) but also perceived conditions (prestige of the institutions, openness and fairness of recruitment procedures).

A third of Portuguese researchers abroad are currently studying or working in European Union countries (other than the UK), which can be explained by several factors, such as geographical proximity<sup>18</sup> (especially with Spain, close enough for cross-border commuting and whose cultural and linguistic nearness also makes it a favoured destination), EU programmes such as Socrates, Erasmus and Marie Curie and the political agreements of free circulation and recognition of diplomas (see Tremblay, 2002; Ackers, 2005; Recchi, 2006; Laveney,

2006). This trend follows closely the data on intra-European mobility of doctoral students collected by IPTS-JRC (2007: 58), in which the UK, France and Spain appear as main recipient countries (there is no information on Germany and the Netherlands), and of Marie Curie scholars (van de Sande et al 2005). However, traditional host countries for Portuguese immigration, which have large Portuguese communities, also attract mobile scientists: Switzerland (5% of researchers) and Canada (2%).

Statistically significant relationships can be found between the geographical distribution of expatriate researchers and career situation, scientific discipline, age and decade of migration (Table 8).

Regarding career stages, PhD students (and, accordingly, younger researchers) are more concentrated in the European Union, whereas senior researchers are more scattered throughout the world and more frequently located in the US. The breakdown by scientific discipline reveals that researchers in the social sciences prefer the UK and the US<sup>19</sup>, in the engineering sciences favour Switzerland, and in the life sciences choose the EU (especially Germany, Spain and the Nordic countries). These trends may be due to the expertise some countries have developed in specific areas (excellence centres, with state-of-the-art facilities and equipment and world-renowned scientists) (see King, 2004). Finally, those

**Table 8.** Host countries of Portuguese expatriate researchers by career situation, scientific discipline, age and decade of migration (%)

	UK	Other EU	Other Europe	US	Rest of the world
PhD students	30.5	41.4	5.9	19.9	2.2
Senior researchers	26.0	27.5	3.0	38.0	5.5
80's and before	7.7	34.6		46.2	11.5
1990's	26.3	32.6	1.1	36.8	3.2
2000-2007	30.7	37.6	4.9	26.4	3.5
Exact Sciences	27.3	43.9	6.1	18.2	4.5
Natural Sciences	28.1	38.1	4.3	28.1	1.4
Health Sciences	23.5	34.6	6.2	25.9	9.9
Engineering Sc.	23.6	34.5	9.1	29.1	3.6
Social Sc. Human.	39.2	28.4	2.0	28.4	2.0
< 30 years of age	31.2	43.9	4.4	19.0	1.5
30-34 years	27.8	31.3	9.0	28.5	3.5
35-39 years	32.8	27.9		36.1	3.3
Over 40 years of age	18.0	36.0	2.0	36.0	8.0

who have left the country more recently can be found especially in the EU and the UK, whereas expatriate researchers that emigrated in the 80's or before that settled in the US.

Similar findings can be seen in the choice of countries in which senior researchers obtained their PhD. Out of the 75% that pursued post-graduate education outside of Portugal, the majority studied in the UK (31%), and the US (18%), followed by France (9%) and other EU countries (15%). As to post-doctoral mobility, 57% of researchers remained in the same country in which they obtained their PhD. Although the number of cases is not enough for achieving statistical significance, "immobility" rates are higher in the US, Ireland, France and the Netherlands. However, it is probably more significant that over one third of respondents moved to a third country and that a quarter of respondents had already worked in two or more countries (besides the current one), which indicates that scientific mobility is far more complex than fluxes between home/host country, frequently encompassing short or longer stays in several countries and temporary returns (see Mahroum, 2000; Ferro, 2004; Gill, 2005; Ackers, 2005; Morano-Foadi, 2005 and 2006).

National S&T systems usually have a high level of internal diversity, so the choice of host institution is also vital. Mobile researchers are attracted to "gravity centres", the best institutions in terms of material and symbolic resources (Mahroum, 2000; Millard, 2005; Gill, 2005; Van de Sande et al, 2005; Morano-Foadi, 2006). In terms of a scientific CV, the university where a researcher's PhD was obtained is of crucial importance for career development (see, for instance, Allison and Long, 1987; Debackere and

Rappa, 1995; Casey et al, 2001; Mahroum, 2000). As such, the host universities of Portuguese PhD students abroad are mainly world-renowned institutions, top of the list in international rankings<sup>20</sup>: for example, in the UK, the universities of London (Imperial College and University College), Cambridge, Oxford and Edinburgh; in the US the Universities of Harvard, Yale, California, New York, Carnegie Mellon, Stanford and MIT; in France the University of Paris, Institut Pasteur, École des Hautes Études en Sciences Sociales and INSEAD; in Germany the Universities of Dresden, Munich, Freiburg; in the Netherlands the Universities of Delft, Utrecht, Amsterdam, Twente, Wageningen. Although sampling procedures may also account for this distribution, other sources of information confirm these preferences. On the one hand, senior researchers in this survey often obtained their diplomas from the same list of institutions and most still work in the cities where they are located (at the universities or in public or private research centres), which can be described as "creative cities" (Florida, 2005) or science clusters (Millard, 2005). The database of PhDs awarded to Portuguese researchers by foreign universities (mentioned below) also shows similar trends in the choice of prestigious host institutions.

Scientific institutions tend to operate in a "virtuous cycle": more material and symbolic resources attract better human resources from the "international pool of talent" (Florida, 2005), which in turn allow for more productivity and better quality research, which in turn draws more resources. Thus, Allison and Long (1990) have concluded that scientists that move to better departments (in terms of prestige, material conditions, intellectual stimulation) are more

productive (higher rates of publication and citation) and Mahroum (2000) has found that institutions in the UK with a higher percentage of foreign academics tend to rate higher in evaluation exercises (and increase their funding accordingly). Additionally, larger institutions also offer more employment opportunities for dual-career couples (Ackers et al 2001).

The Portuguese researchers abroad surveyed were also asked to rate the importance of a set of factors for choosing their host institution (table 9). As expected (see Mahroum, 2000; Ackers,2001; Avveduto, 2001; Tremblay, 2002; Millard, 2005; Van de Sande et al, 2005; Morano-Foadi, 2006; Thorn and Holm-Nielsen, 2006), the prestige of the institution came first in their preferences, followed by other scientific motivations, such as the resources available and the makeup of the research team (leading scientist, multidisciplinary).

Regarding the statistically significant variations by career situation (Table 10), personal contacts and networks do play a substantial role (see Casey et al, 2001; Millard, 2005; Diaz-Briquets and Cheney, 2005; Mahroum, 2000; van de Sande et al, 2005; Szelenyi, 2006; Avveduto, 2001): senior researchers generally confer high importance to having received an invitation from the institution and PhD students tend to value more the opportunity to work with a particular scientist, the recommendation from a professor, a previous experience at the same university and the existence of Portuguese researchers in the same team. For PhD students, the choice of a supervisor is crucial for scientific socialisation and for the successful outcome of their studies (see Golde, 1998; Baird, 1992; Hirt and Muffo, 1998). Although the existence of Portuguese researchers in the team is one of the

**Table 9.** Motivations for choosing a host institution (mean scores\*)

Prestige of the institution	4.34
Available resources (labs, computers, library)	4.10
Having received an invitation to work at the institution (senior researchers)	4.03
Wish to work with a particular scientist	3.74
Multidisciplinary team	3.54
Country where is situated	3.35
Having previously met a member of the institution (PhD students)	3.28
Multinational team	3.10
Contacts with business companies	2.78
Recommendation from a professor or colleague in Portugal	2.76
Having already studied at this institution	2.40
Exchange or collaboration agreements with Portuguese institutions	2.29
Portuguese researchers in the team	1.51

\* Likert scale: mean score between 5 (very important) and 1 (not at all important)

**Table 10.** Motivations for choosing a host institution by career situation (mean scores)

	PhD students	Senior researchers
Wish to work with a particular scientist	3.88	3.50
Country where is situated	3.44	3.20
Recommendation from a professor or colleague in Portugal	2.97	2.25
Having already studied at this institution	2.56	2.02
Portuguese researchers in the team	1.62	1.29

less valued aspects in choosing a host institution, PhD students confer to it more bearing, which means that nationality-based networks are also relevant in scientific mobility (albeit not as significant as in less skilled migrations) (see Alarcon, 1999; Diaz-Briquets and Cheney, 2002; Ferro, 2004; Carr et al, 2005; Rizvi, 2005, Recchi, 2006).

Career situation is closely connected to the decade of migration, so the trends are somewhat similar (Table 11), but the importance allocated to multinational teams stands out in more recent generations of scientific migrants, which can be due to the growing worth attributed to the internationalisation of science and the establishment of international networks (see, for instance Crawford et al, 1993).

There are a few statistically significant differences by scientific discipline (Table 12). Contacts with business companies are valued more highly by researchers in the engineering sciences, whereas

the availability of specific resources or a particular researchers and agreements with Portuguese institutions are more important in the health sciences, since several Portuguese universities have doctoral programmes in these disciplines that require a short stay abroad, usually in partnership with certain foreign universities or research centres. The host country is valued more highly in the social sciences, probably due to language and disciplinary traditions (such as the prominence of French institutions in History or English ones in Sociology).

Considering the variance of motivations by host country (Table 13), the 'pull' of working with a particular scientist or in multinational teams is stronger in countries outside the EU or the US (where the cultural diversity is practically a given in most top institutions). However, the small dimension of this group of researchers in the sample (just 3.5%) can distort the results. The presence of other Portuguese researchers is valued more

**Table 11.** Motivations for choosing a host institution by decade of migration (mean scores)

	80's and before	1990's	2000-2007
Wish to work with a particular scientist	2.79	3.51	3.84
Recommendation from a professor or colleague in Portugal	2.27	2.12	2.90
Multinational team	2.43	3.01	3.10

**Table 12.** Motivations for choosing a host institution by scientific area (mean scores)

	Exact Sc	Natural Sc	Health Sc	Engineering Sc	Social Sc H
Available resources (labs, computers, library)	3.84	4.11	4.43	3.88	4.10
Wish to work with a particular scientist	3.70	3.94	3.75	3.07	3.63
Contacts with business companies	2.85	2.64	2.97	3.34	2.51
Country where is situated	3.32	3.15	3.47	3.45	3.62
Exchange or collaboration agreements with Portuguese institutions	2.57	2.17	2.91	2.03	2.02

highly in European countries outside the EU and a past experience in the host institution is particularly important for researchers located in the UK.

Regarding personal traits, some gender differences can also be found (Table 14), in the sense that women seem to be more motivated than men by the prestige of the host institution. One of the reasons may well be that women often feel discriminated when competing for a position (Ackers et al 2001: 74; Aaltio 2006: 121), and opting for a high-status

institution will increase the value of their CVs (Mahroum 2000: 27; Casey et al, 2001: 29, 42; Tremblay 2002: 59; Millard 2005: 345; Van de Sande et al 2005: 17) and evens their odds of employment. Women researchers have been said also to value ‘mobility with a safety net’, conferring more relevance to issues of personal and institutional trust and pre-existing networks (Avveduto 2001: 234; Millard 2005: 355); and indeed, they appear to assess as more important working with a particular scientist, a recommendation

**Table 13.** Motivations for choosing a host institution by host country (mean scores)

	UK	Other EU	Other Europe	US	Rest of the world
Wish to work with a particular scientist	3.95	3.54	3.89	3.69	4.17
Multinational team	2.99	3.27	3.44	2.88	3.50
Exchange or collaboration agreements with Portuguese institutions	2.19	2.59	2.43	1.89	3.00
Portuguese researchers in the team	1.45	1.68	1.94	1.26	1.50
Having already studied at this institution	2.82	2.53	2.18	1.91	1.67
Country where is situated	3.63	3.22	3.88	3.16	3.71

from a professor or colleague, having already studied at the same institution and exchange or collaboration agreements with Portuguese institutions.

In an open-ended question, the researchers also mentioned other motivational factors, such as the quality of the institution, the work environment, the material rewards (in terms of salary and career development) and personal justifications (employment opportunities for their partners, quality of life in the host town).

The final section of this paper deals with the trends and motivations of Portuguese researchers to return to the home country.

### Return?: deciding on going back home

One of the issues more commonly discussed regarding the mobility of scientists is the return to the home country. This is often seen as a condition for turning “brain drain” into “brain circulation”, as well as a subject for policy intervention (see, for instance the Reintegration Grants of the Marie Curie Programme and various national initiatives– see Laudel, 2005). Returnee researchers are considered an asset, since they bring with them not only international experience and know-how, but also transnational links and networks, which can benefit their new host institution.

The recent growth of the Portuguese S&T system is assumed to have created favourable conditions for the return of scientists. The establishment of new higher education institutions (in the 70’s and 80’s) and new research centres (in the 90’s) and the steep increase in funding for science (partly based on European cohesion funds) ought to have generated more employment opportunities and an improvement in research infrastructures and resources. Having invested heavily in training human resources outside the country, the Portuguese government has also been trying to lure back researchers, through grants, post-doctoral fellowships and 5-year contracts at research centres (a few hundred in associated laboratories since 2003 and 1,000 new positions opened in 2007-08)<sup>21</sup>, although none of these initiatives is exclusively dedicated to expatriate researchers. However, in line with what happens in most countries (see, for instance, Morano-Foadi, 2006) there is no official data on how many Portuguese researchers have returned home after studying or working abroad. Some proxy indicators may be used, but they have some limitations.

A survey of doctorate holders conducted in 2006 found that 29% of Portuguese doctorate holders (3,200) had obtained their PhDs abroad<sup>22</sup>. A database of PhDs awarded or recognised by Portuguese universities<sup>23</sup> shows that between 1970 and 2006, 25% of the

**Table 14.** Motivations for choosing a host institution by gender (mean scores)

	Male	Female
Prestige of the team/department/university	4.25	4.43
Wish to work with a particular scientist	3.59	3.89
Recommendation from a professor or colleague in Portugal	2.54	2.94
Having already studied at this institution	2.16	2.61
Exchange or collaboration agreements with Portuguese institutions	2.03	2.59



diplomas (3,821) were obtained abroad (mostly by Portuguese but also some by foreign citizens). As to their distribution in time, the number of returnees per year has risen steadily until 1998 (reaching 197 on that year) and has been declining since then, falling below 100 in 2006<sup>24</sup>. However, this database covers mostly higher education personnel (who needs to have their foreign diplomas recognised), leaving out researchers that work in other institutions (State Laboratories,

business companies, research centres) so the amount of returnees is probably slightly higher. Though it is not possible to determine the exact balance of out-bound and in-bound flows, the data collected shows that return migration does exist (see Pereira, 2002).

Surveyed expatriate researchers were asked whether they intended to return to Portugal within 5 years (table 15) and opinions were divided in half. However, the breakdown by career situation and

**Table 15.** Intention of returning to Portugal within 5 years, by career situation decade of migration, age and family situation (%)

	Intention of remaining abroad	Intention of returning to Portugal
Total	50.7	49.3
PhD students	43.5	56.5
Senior researchers	61.7	38.3
80's and before	91.7	8.3
1990's	67.4	32.6
2000-2007	43.6	56.4
< 30 years of age	45.7	54.3
30-34 years	45.4	54.5
35-39 years	57.4	42.6
Over 40 years of age	76.0	24.0
Married	58.1	41.9
Single	44.2	55.8
Divorced/widower	60.0	40.0
With children	62.5	37.5
Without children	47.6	52.4
Family residing abroad	63.0	37.0
Family residing in the home country	42.5	57.5

**Table 16.** Motivations for returning to Portugal

Family reasons	80.5
Wish to contribute to the Portuguese S&T system	73.9
Wish to contribute to the development of Portugal	69.9
Quality of life in Portugal	62.4
Contract with a Portuguese institution	15.9
Job offer in Portugal	12.4
Good conditions for research in Portugal	6.4

personal traits shows some statistically relevant variance. PhD students show a higher proclivity to return home than senior researchers and the earlier the date of migration, the less the intention of returning. Though gender does not seem to play a role, age and family situation do. Thus, most expatriate senior scientists are “locked in” their host countries (see Casey et al, 2001, Diaz-Briquets and Cheney, 2002; Fontes, 2007; Gill, 2005): they are usually older, with highly paid tenure positions, married (often with natives of the host country) and with children integrated in the local school system.

Among the researchers that intend to return to Portugal (Table 16), the most common reasons invoked are family related, namely to live closer to family (parents or partner and children) and friends. Three quarters of respondents state “moral responsibility” reasons, that is to say that they wish to contribute to the development of the country (mainly PhD students) and national science (mainly senior researchers) (see also Gill 2005; Rizvi, 2005; Szelenyi, 2006; Thorn and Holm-Nielsen, 2006; Fontes, 2007): “*I want to apply the knowledge I*

*have gained in my scientific field to help train better students, more interested in science”* (PhD student, US). The quality of life is also frequently mentioned: “*I miss the sun, the sea and the food”* (senior researcher, UK). A minority of respondents does have guaranteed return, by means of a contract or a job offer from a Portuguese institution. This is mainly the case of visiting professors on a sabbatical year or faculty members of Portuguese universities that enrolled for a PhD abroad.

**Table 17.** Motivations for remaining abroad

Lack of job opportunities in Portugal	65.1
Difficulty in performing high quality research in Portugal	58.2
Wish to extend the research experience abroad	56.0
Difficulties in career progression in Portugal	51.7
Low salaries in Portugal	46.6
Quality of life in the host country	44.4
Family reasons	28.0
Job offer in another country	26.3
Contract with an institution in the host country	22.0

Those that wish to remain abroad declare mainly professional and scientific reasons (Table 17), namely dissatisfaction with the conditions offered in the home country in terms of employment and resources for research (see Ackers et al, 2001; Casey et al, 2001; Thorn and Holm-Nielsen, 2006; Szelenyi, 2006; Baruch et al, 2007):

Due to the lack of investment in science in Portugal, the level of competition is significantly higher. I don't expect to obtain a position in Portugal at

the same level that I do in foreign countries. For instance, the CV of some researchers that apply to a post-doctoral fellowship in Portugal would be enough for securing an Assistant Professor position in the US (senior researcher, US)

PhD students are more prone to invoke career reasons (74% believe there is lack of employment, 61% that is difficult to progress in a scientific career in Portugal), but also the wish to prolong the experience of working abroad (71%):

I don't intent to return to Portugal right after the PhD, I want to spend more time abroad (who knows, even try the US), I want to work as a post-doc, to improve my CV and only then to return to Portugal to start my own research group. I don't intent to stay forever abroad due to personal and emotional reasons, but I also want to contribute to the improvement of Portuguese science and to its international recognition. I also think that the investment that the Neurosciences Centre and the Foundation for Science and Technology have made must have some return (PhD student, Ireland)

Senior researchers are more likely to state their families as a reason for remaining abroad. Some researchers did try to return, applying unsuccessfully to posts in Portuguese universities and facing suspicion and discrimination (see also Casey et al, 2001; Ackers, 2005; Morano-Foadi, 2006; Gill, 2005):

For the past 6 years I've been trying to return but I keep getting doors slammed in my face. I have come to learn and I have learnt; now I want to go home. But I can't. The justifications vary slightly, but always around the

same preconceived notions about scientists that have been abroad: that we are too arrogant, too young, too ambitious, etc. It is also said that we don't understand how things work in Portugal, that we want to 'rock the boat'. We are offered positions below the ones we have here, they prefer internal candidates over outsiders. Now there's funding to attract PhDs from abroad, but do they really think we would leave for positions outside the tenure track? Five year contracts, after which you have to start anew? (senior researcher, The Netherlands)

## Conclusion

This article has striven to explore both the trends and the motivations that drive the international mobility of researchers, based on the case study of the Portuguese S&T System.

Just like other semi-peripheral countries, Portugal remains a point of departure rather than arrival for mobile researchers. An incipient development of higher education and research structures has determined the need for policies that encouraged and supported the exit of junior scientists in pursuit of training. In terms of absolute numbers, exit flows seemed to have remained fairly steady in the past three decades. However, the proportion of researchers obtaining their PhD diploma at home has risen considerably. And although many Portuguese researchers stay on abroad after their training, pursuing scientific careers, return flows are also noteworthy. The expansion of the higher education and scientific systems seems to have absorbed (and been fed by) a fair number of scientists with foreign training and experience. Nevertheless, the effects of these trends on the scientific system are yet to be assessed.

The motivations behind these flows are fairly similar to scientists of other nationalities. Researchers leave the country fundamentally for scientific and professional reasons: they go in search of further training, more employment opportunities and improved conditions for performing research. They are usually young, recently graduated and have had previous international experiences. They move to prestigious institutions in core countries, where they find more compelling material and human resources. Quite a few intend to remain abroad and pursue a career in more competitive and rewarding scientific environment; others are dissuaded to return by a perception of lack of integration opportunities at home.

But personal motivations also play a role, especially in the decision to return. Many young expatriates feel pulled back by their families and by the wish to contribute to the home country's development, as well as by other well-being factors (quality of life, food, weather). Conversely, more senior expatriate are often "locked out" of the home country, barred from returning by family commitments.

This paper has also highlighted the fact that besides national context, other variables are also relevant for understanding the mobility phenomenon. Though scientists are a rather homogenous social group, various kinds of differences (gender, age, scientific discipline, career status, host country, time of migration) do play a part in affecting relocation choices, attitudes and representations.

Public policies geared towards encouraging migration and return have thus to take into consideration that mobility decisions are motivated by a complex array of factors. And the qualitative impact of mobility on scientific

systems, which remains fairly under-researched, must also be considered.

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### Notes

<sup>1</sup> According to Eurostat data (Statistics on Research and Development, <http://epp.eurostat.ec.europa.eu/>), in 2005 R&D expenditure represented only, 0.58% of GDP in Greece, 0.81% in Portugal and 1.12% in Spain (whereas the EU15 average is 1.9%), researchers amounted to 0.68% of the active population in Portugal, 0.69% in Greece and 0.87 in Spain (0.87% in the EU15). Portugal had just 0.37% of world publications and 0.29% of world citations between 1997-2001, Greece 0.42% and 0.25% respectively and Spain 2.85% and 2.55% (source: King, 2004: 312), but this indicator is affected by the number of researchers in each country. However, these figures show that Spain is clearly catching up with the EU15 average, while Portugal and Greece still lag behind.

<sup>2</sup> Inbreeding has been identified as a problem in several international evaluation exercises of Portuguese institutions – see, for instance, the report on Mathematics, Biology, Civil Engineering, Electronic Engineering, Psychology and Education Sciences, History (published by the Observatory of Sciences and Technology in 1999, <http://www.gpeari.mctes.pt/>). On inbreeding in Spain, see Cruz-Castro and Sanz-Menendez (2005: 47), and in Italy see Morano-Foadi (2006) and Gill, 2005.

- <sup>3</sup> Source: National R&D Survey 2007, GPEARl, <http://www.gpearl.mctes.pt/?idc=21&idi=340935>
- <sup>4</sup> For instance, in 2001 this item represented 30% of the expenditure of the main governmental funding institution, the Foundation for Science and Technology. Fairly similar policies and trends can be seen in the Spanish case detailed in Cruz-Castro and Sanz-Menendez (2005).
- <sup>5</sup> Source: official statistics, of the Foundation for Science and Technology (see <http://alfa.fct.mctes.pt/estatisticas/bolsas/>, accessed on January 11 2008). Fellowships can also be granted by private non-profit organisations (such as the Gulbenkian Foundation or the Luso-American Foundation for Development), supra-national entities (such as the Marie Curie grants from the European Commission) or even institutions in the host country, so the exact number of Portuguese post-graduate students going abroad is hard to determine.
- <sup>6</sup> From international bodies, such as Eurostat, and Portuguese institutions, namely the Foundation for Science and Technology and GPEARl (Office for Planning, Strategy, Evaluation and International Relations of the Ministry of Science, Technology and Higher Education).
- <sup>7</sup> 62% of the respondents were doctoral students and 38% senior researchers (with a PhD); 78% of senior researchers worked in universities, 14% in public research centres and 3% in business companies; 52% of the respondents were women; 45% were under 30 years of age, 31% between 30 and 34 years old, 13% between 35 and 39 years old and 11% over 40 years of age.
- <sup>8</sup> Incomparable to the large-scale studies, such as Van de Sande et al (3000 cases), but significantly larger than previous studies: Ferro, 2006 (128 cases), Mahroum, 2000 (78), or Todisco et al, 2003 (241). Other studies have been based on qualitative techniques, such as in-depth interviews (Casey et al, 2001; Morano-Foadi, 2006 and Gill, 2006).
- <sup>9</sup>  $p < 0,05$ , measured by correlation tests ( $\chi^2$ , Independent Sample T-Test, Oneway ANOVA).
- <sup>10</sup> Database on Immigrants in OECD Countries Immigrants, 2000, OECD, <http://stats.oecd.org>
- <sup>11</sup> Source: official statistics, of the Foundation for Science and Technology (see <http://alfa.fct.mctes.pt/estatisticas/bolsas/>).
- <sup>12</sup> Although there is no data regarding post-graduate attrition (see Golde, 1998; Baird, 1992; Hirt and Muffo, 1998) in Portuguese students abroad, a survey applied to recipients of Portuguese PhD fellowships (OCES, 2005) has found that 45% of recipients did not finish their degree in the allotted time. However, the rate of completion was higher for PhDs hosted by foreign universities (65%) than Portuguese ones (46%).
- <sup>13</sup> Similar results were obtained by Ackers et al (2001) regarding the participation in the EU's Marie Curie programme.
- <sup>14</sup> This is more clearly tied with the age of respondents. Other studies (see Ferro, 2004; Avveduto, 2001; Szelenyi, 2006; King and Ruiz-Gelices, 2003) also stressed the importance of personal growth brought about by travelling and living in other countries as a motivation for highly qualified mobility.
- <sup>15</sup> See <http://alfa.fct.mctes.pt/estatisticas/bolsas/>.

- <sup>16</sup> According to Universities UK (2007), foreign nationals make up 19% of total academic staff and 14% of students in UK institutions in the academic year 2005/06. Van de Sande et al (2005) indicate that the UK has been the host country of 28% of Marie Curie fellowships. In 2005-06, there were close to 97,000 foreign scholars in the US (IPTS-JRC, 2007: 69). Hirt and Muffo (1998) state that 30% of PhDs in the US are awarded to foreign nationals.
- <sup>17</sup> However, a growing number of institutions in several countries (Netherlands, Germany, Austria, Sweden) are opting for English as working language in research and post-graduate education (Casey et al, 2001; Tremblay, 2002).
- <sup>18</sup> This proximity, combined with the growth of low-cost travel, allows frequent visits to the home country: one fourth of respondents state that they travel to Portugal once a month.
- <sup>19</sup> In these disciplines, mastery of the language in which research is performed is usually of the utmost importance.
- <sup>20</sup> See, for instance, the World's Top 200 Universities of the Times Higher Education Supplement (November 2007).
- <sup>21</sup> These policies are fairly similar to the Ramon y Cajal programme in Spain (Cruz-Castro and Sanz-Menendez, 2005).
- <sup>22</sup> Source: GPEARI, <http://gpri-08-193.link.pt/main>.
- <sup>23</sup> Source: GPEARI, [http://www.estatisticas.gpeari.mctes.pt/?id\\_categoria=29&id\\_item=149837](http://www.estatisticas.gpeari.mctes.pt/?id_categoria=29&id_item=149837)
- <sup>24</sup> Conversely, the number of PhDs obtained in Portuguese institutions has grown exponentially, from 250 in 1990 to 694 in 2000 and 1,157 in 2006.

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