Investigating the Potential of Data from an Academic Social Network (GPS)

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Abstract. There are several references in the literature highlighting the importance of the international scientific mobility studies and several examples of how this academic population has been characterized. Typically, the analysis of academic mobility has been conducted by applying extensive surveys to a "representative" sample, in a specific moment in time, in which the profile of the researchers, that are working or studying in a foreign country, is then inferred. These analyses may suffer of structural lack of representativeness since the target population is unknown. As a structural and inherent issue in this research field, this article presents the results provided by the Portuguese academic social network GPS (Global Portuguese Scientists). It uses a valuable and exclusive data set of the research experiences, provided by Portuguese researchers, to describe and understand the academic dynamic of these researchers over the last years. The analysis considers different socio-demographic characteristics and the type of research (position, scientific research area, duration of the experience) they have been doing. The analysis shows that GPS users are pulled to the core countries of the science world system and points out that each destination of the Portuguese diaspora is associated with specific features of the mobile researchers and their research activity.

Keywords: International scientific mobility · Academic social network · Mobile Portuguese Researchers · Career path · Data collection · Empirical research

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1 Introduction

Leaving one's own domestic research system to carry out research-related tasks elsewhere in the world has always been a common trait of the life of researchers and scientists.

Geographic mobility is shaped not only by professional and personal factors (see, for example, [1] and by the characteristics of the scientific field and the nature of research [2–4], but also by the institutional structure that oversees the research practice [5, 6]. International mobility fluxes develop along predictable patterns and are driven by differences in national science and technology systems alongside other country-specific factors. The world's most successful national research systems, which generally offer more resources for research and better professional rewards, attract researchers from trailing countries [7], and additional fluxes tend to exist amongst top scientific institutions, as a consequence of the competition for leading scientists. However, Ackers [4] warns us about the tendency to associate geographic mobility with the excellence of the receiving institution. Scientific mobility is more driven by limited opportunities within the home country's research system rather than the authentic scientific appeal of the destination. In fact, as observed by Smetherham [8] for the British context, the national scientific labour market is becoming increasingly global, not only because the recruitment and retention of capable researchers is necessary for world-stage institutions to keep their competitive advantage, but also because foreign staff need to be hired for positions in scientific fields where there is a shortage of local candidates.

Such a move could be intended to seize the best opportunities and to expose oneself to new scientific contexts, which in return can play a role, amongst other things, in increasing the value of one's contribution to science and the promotion of knowledge sharing among multiple scientific research systems. Mobility may, however, have a negative impact on the research system that has invested in their qualification or has previously employed them. Continuous outward flows could potentially weaken and contribute to the decline of the scientific national community, due to the inability to easily renew and further strengthen the human factor within the scientific national community.

In countries that are not yet competitive players on the global academic market, national governments also have an interest in establishing and consolidating a scientific system capable of increasing their productivity and global competitiveness [9]. This awareness about the strategic role of knowledge production and the growing importance of research is evident in Portugal, as proven by the increasing public investment in R&D in recent decades (between 1986 and 2017, public research and development budget allocations as a percentage of GDP more than tripled: from 0.2% to 0.7%), its increasing presence in international research facilities (such as CERN, since 1986), and the fact that more Portuguese people are achieving higher levels of education. In 1986, the year Portugal joined the European Union, 216 doctoral degrees were awarded, but in 2017 the number of new PhDs awarded per year was close to 3,000. Between 1986 and 2017, the total number of researchers increased almost eightfold: from 5,723 to 44,938 (there was a decline between 2011 and 2013, the period during which Portugal

was under an external financial aid programme under the supervision of the International Monetary Fund, the European Central Bank and the European Union). It should be noted that in the last two decades, the number of teachers in higher education in Portugal has decreased slightly (from 35,740 in 2001 to 34,227 in 2017). This implies that the new doctoral graduates now have fewer job opportunities at universities and polytechnics. The significant increase in the number of doctorates in Portugal and the shortage of employment opportunities, especially during the years of the financial aid programme, probably encouraged the international mobility of Portuguese scientists. Additionally, many Portuguese researchers may simply be attracted to more productive scientific systems. This was, in fact, encouraged by various public policies, such as the grants to pursue a PhD in foreign countries, funded by Fundação para a Ciência e Tecnologia (FCT), the main public science funding agency in Portugal. Between 1994 and 2015, FCT awarded 4,599 grants for doctorates abroad (19% of the total grants) and 5,476 for doctorates partially pursued abroad. Although Portugal has been mainly an exit country, in the last decades it has also attracted researchers from abroad [10]. Between 1994 and 2015, FCT awarded 2,229 PhD grants to foreign citizens (9.2% of the total grants). Also, regarding the 'Compromisso com a Ciência' programme, which awarded five-year research contracts in Portuguese research institutions between 2007 and 2008, forty-one per cent of the beneficiaries were foreign. These numbers suggest an inflow and outflow of researchers, albeit with fewer entries.

Further insights on the geographic mobility of Portuguese researchers are offered by the European Commission's MORE surveys. Despite their great contribution in monitoring the European Research Policy, current technologies offer the possibility to go beyond the survey approach, by building a dynamic data gathering system able to monitor the population under study. A concrete opportunity to potentially reach each Portuguese researcher experiencing international mobility is given by the Portuguese academic social network GPS (Global Portuguese Scientists) which aims to virtually connect the Portuguese researchers who have experienced a period abroad for research purposes. GPS was launched in November 2016 and its members, who will be defined later in this work as GPS scientists, amounted to almost 2,000 units approximately one year after its launch.

As opposed to other social networks, the GPS platform has a homepage (https://gps.pt/) incorporating a map with markers, which correspond to the coordinates of community members' workplaces at any specific time. This feature allows members to easily search for other potential Portuguese scientific partners according to their location or to a specific academic research interest, which is undoubtedly an interesting characteristic for those who want to contact or establish networks in a specific country but have no acquaintances there yet. The social network then, not only facilitates interactions and the exchange of information between people that, sharing the same nationality, are supposed to have a strong degree of communality, but also allow rich geographic data to be stored concerning the mobility trajectory of the Portuguese scientific community.

The main purpose of this article is to present a statistical analysis to characterize the patterns of territorial mobility of Portuguese researchers registered on the GPS platform. Being a social network platform, is also highlighted the potential of this platform

to analyse where, when and on what Portuguese scientists have been working in recent years.

In addition to this introductory section this article is organized as follows: Sect. 2 presents a brief review of empirical research into the geographical mobility of researchers; it focuses on the definitional and methodological challenges and summarizes previous studies on mobility flows of Portuguese researchers; Sect. 3 focuses on the data analysis, characterizing the GPS scientists using the most appropriate parametric and non-parametric bivariate tests; finally, Sect. 4 concludes, highlighting the relevant findings of this research and the contribution of the GPS platform in the context of policy making.

2 Background

The research on the geographic mobility of scientists and researchers is vast and pluridisciplinary. Quantitative studies regarding mobility have tended to either provide a characterization of the population under study and analyse factors affecting mobility decisions [amongst others, 1, 11, 12], or have searched for evidence of links between mobility and knowledge creation, recombination and diffusion [for example, 13–18]. It should be noted that, in recent years, the persistent and widespread recognition of gender inequalities has generated a proliferation of studies on female scientists in academia and mobility [see 15, 19–21]. It is beyond the scope of the article to review such literature thoughtfully; what seems relevant here is to consider the relevant definitional and methodological challenges in academic mobility studies.

The first challenge concerns the definition of 'researcher' and the identification of the population being studied. A wide range of jobs establish research as their primary goal, but researchers are not grouped into an independent and comprehensive statistical employment category. Moreover, in many geographical contexts doctoral candidates are not recognized as workers, but as students instead. In order to bypass these difficulties, the population under study may be defined as whoever is pursuing and/or holds a doctorate, regardless of how their activity is classified for statistical purposes [22]. However, as Børing et al. [1] underline, being awarded a PhD is not a condition for being a researcher, and not all researchers are necessarily doctorate holders. Some authors argue that the focus of mobility research should only be placed on leading scientists, as opposed to the broader category of researchers, for the former have a greater impact in terms of knowledge creation. In this case, publication and patents can be used to pinpoint the most productive scientists (see, for example, [23]).

It is also necessary to understand that scientists engage in different forms of international mobility experiences, which vary as to their scope, duration and impact. Mobility experiences may be mostly distinguished between those that entail moving to another country to take up research positions and the moves which researchers undertake during the course of their employment or doctoral studies, usually for research visits or guest professorships [24]. The former, which can be permanent or temporary situation, implies a change of affiliation, and it is often the consequence of better research positions and more rewarding and stable working conditions available abroad. It may also be linked to methods of recruitment being based on merit rather

than other biased methods of selection and nomination. The latter form of mobility is clearly intended to be time-limited, as it is mostly undertaken to access new collaborators, or use specific research resources such as equipment, training, and data. The length of the stay does not determine the success of an international experience per se. For example, extended periods abroad might not always be positive for those who would like to return [6]. In fact, for the mobile researcher returning to the home research system, it can be just as difficult to find a receptive environment where the newly acquired knowledge may be applied and developed [25], as it is to be reintegrated back into the home scientific labour market [5]. On the other hand, short stays abroad allow continued engagement with the home scientific community, while at the same time enhancing scientific capital and personal prestige [4].

An issue also of great most importance is data gathering and analytical methodology. Survey questionnaires are the most popular instruments for tracking the geographic mobility of researchers through time and space [26]. However, the analysis of curricula vitae (CV) has recently gained increasing importance as a data source in science and technology studies [27]. CV analysis has gone from being a simple supplement source of information to an autonomous research approach in mobility studies [28]. The CV does indeed provide relevant information about the shift from one work setting to the next and, as it is in reality an important individual marketing resource, researchers feel the need to provide accurate data and to keep it updated. Despite its great potential as a data source, there are some major methodological problems, such as the heterogeneity of contents, incomplete or missing information, and the problem of the conversion of CV data into a suitable set of variables for analysis. The issue of the availability of bibliographic data and the proper means of obtaining them also cannot be neglected. Requests for CV are usually sent to the sample of researchers under study, but accessing electronic platforms containing CV and downloading them is in reality a more non-intrusive and cost-effective approach to collecting information on academic mobility (see, for example, [14]). Another emerging data opportunity is given by bibliometric data, which, as it contains information on institutional affiliation, can contribute to the study of global mobility patterns [29, 30], present interesting methodological frameworks, for example). However, given that scientific publication is not a necessary component of all research experiences abroad, its use when a heterogeneous set of people working in science is considered should be prudent. In order not to underrepresent mobility episodes, it seems more appropriate to use bibliometric data in conjunction with other sources (see [31, 32]) rather than an autonomous approach.

As illustrated in the introduction and also backed up recently in Delicado [10], there is a strong case for studying the mobility experiences of Portuguese scientists. Exploratory quantitative research has already been conducted [23, 33, 34] and other works of a more qualitative nature concerning Portugal have been undertaken. This latter group of publications concerns the relationship between mobility, career and personal situation [4]; gender dimensions in long-term international mobility [35]; the impact of long-term international mobility on the creation of international knowledge networks; and the participation of Portuguese female researchers in science and their international scientific mobility [36].

From a quantitative perspective, Fontes [23] studies the mobility flows of Portuguese scientists who were classified as inventors in biotechnology patent applications filed by non-Portuguese organizations and that were resident outside of Portugal at the time of patent filing. The analysis shows that as regards the destination countries, the United States of America (USA) was the preferred destination for the first move, closely followed by the United Kingdom (UK) and France. Other European countries gained importance in subsequent moves, including some destinations such as Spain and Switzerland, places that were not popular in the first mobility episode.

More recently, Delicado [34] enlarges the object of the analysis, by examining the patterns and the motivations that drive mobility decisions of a sample of Portuguese expatriate researchers who produce science abroad in all scientific fields. Regarding destination countries, the results show that about three fifths of the respondents were in the European Union (the UK alone hosted more than twenty-eight per cent) and over a quarter in the USA. PhD students were more concentrated in the European Union, whereas senior researchers were more dispersed and were most frequently located in the USA. Differences in the geographical distribution of expatriate researchers emerge when a breakdown according to scientific fields is analysed. The UK and the USA were popular recipient countries for researchers in the field of social sciences, while researchers in the engineering sciences favoured Switzerland and those in the life sciences chose mainly European countries as destinations (with Germany, Spain and the Nordic countries being prevalent).

The major difference between the above-mentioned empirical work concerning Portuguese researchers and our analysis is based on the instrument used for collecting data on the geographic mobility Portuguese researchers. The GPS platform allows us to perform CV-based research by exploiting the data concerning the educational and professional experience provided by the registered members.

3 Characterization of the GPS Community

As shown in [37], the GPS platform is a social network, in which, is possible to identify the coordinates of community members' workplaces at any specific time. It is structured on three complementary levels, allowing members to search for Portuguese scientific partners corresponding to a specific location or to an academic research interest. In short, i) *Communities* are a macro-organizing entity, defined by default - all GPS users are associated with the 'general community'; ii) the creation of *groups*, allows joining together users with a common background, interest or characteristic; iii) and finally, users of the GPS platform are able to create a *profile* where they share relevant information about themselves: photo, name, birth date, the place of origin, professional information. In the professional information fields, GPS members can also insert locations and the name of the research institutions where they have been

working, indicating the dates for their stay in that specific location; their scientific fields[1] and their scientific experience[2] at a specific workplace and select.

This information, provided by the GPS scientist (a classification used to characterize scientists that have at least one experience outside Portugal, for a minimum of 3 months), allows to infer about: the *evolution* of the Portuguese academic mobility (see Table 1); their socio-demographic characteristics (sex and age); *what* job they have being doing (scientific area of research and type of scientific experience) and *where* they have being working (the exact location of the research experience).

Table 1. Evolution of GPS scientists, breakdown by national and/or international dimension of the scientific experience (1990, 1995, 2000, 2005, 2010, 2015, 2017)

Date	One experience abroad (No and %)		Two or more experiences abroad (No and %)		One experience in Portugal (No and %)		Two or more experiences in Portugal (No and %)		One experience in Portugal and abroad (No and %)		Other cases (No and %)		Total (No)
2017	1,133	79.6	39	2.7	204	14.3	16	1.1	26	1.8	5	0.3	1,423
2015	840	74.5	29	2.6	211	18.7	18	1.6	25	2.2	5	0.4	1,128
2010	335	58.2	13	2.3	205	35.6	11	1.9	9	1.6	3	0.5	576
2005	182	62.3	5	1.7	92	31.5	6	2.1	6	2.1	1	0.3	292
2000	83	53.5	2	1.3	61	39.4	5	3.2	2	1.3	2	1.3	155
1995	31	44.9	1	1.4	28	40.6	5	7.2	3	4.3	1	1.4	69
1990	15	34.9	1	2.3	23	53.5	2	4.7	2	4.7	0	0.0	43

How Many Users Are on GPS?

The GPS platform, during the first ten months of existence (2017), gathered approximately 1,700 Portuguese scientists spread around the world, totalizing almost 4,000 research experiences. This means that, on average, a GPS scientist had more than two research activities (see [37] for a more detail information about the process of data cleaning and criteria used to select reliable cases and to remove outliers). Table 1 summarizes the evolution of the number of members according to the national and/or international dimension of their scientific experience.

Where Have They Been Working?

A total of seventy-nine countries (excluding Portugal) were registered in the GPS platform and the eleven most popular destination countries themselves hosted seventy-nine per cent of the research experiences. Figure 1 shows the geographical distribution of all research experiences registered on the GPS platform.

[1] (a) Agrarian Sciences, (b) Medical Sciences, (c) Natural Sciences, (d) Social Sciences, (e) Engineering and Technology; and (f) Humanities.

[2] (a) PhD researcher, (b) PhD student, (c) Non-doctoral researcher, (d) Researcher/visiting professor, (e) Leadership functions, (f) Research technician, (g) Science communicator or science manager, (h) Other.

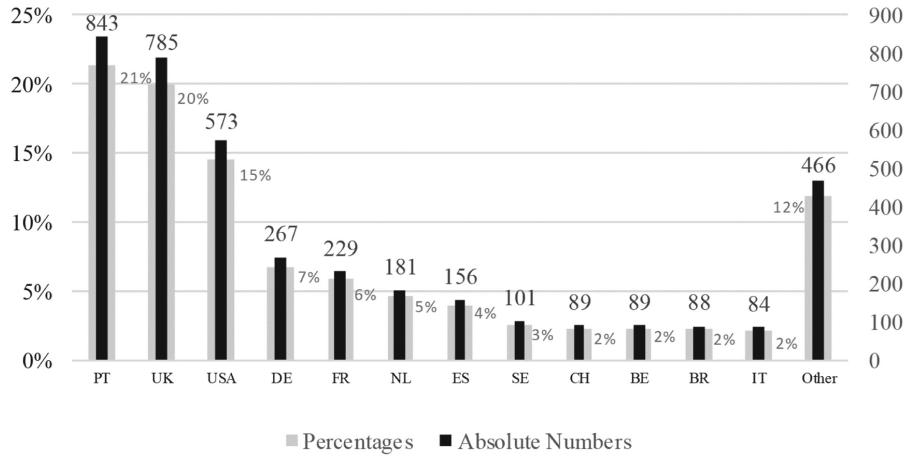

Fig. 1. Research experiences, by country

The UK is the most popular destination with 785 research experiences (20%), followed by the USA with 573 experiences (15%), then Germany and France. The other country outside the European continent in this list is Brazil, which shares the Portuguese language, hosting two per cent of all experiences. It is also worth noticing that the sole country that shares the border with Portugal (that is, Spain) is only the sixth most popular destination.

When considering again only those scientists who had only one research experience on those specific dates, either in Portugal or abroad, the analysis shows that GPS scientists went from being concentrated only in Europe (France, UK, Norway and Germany) and North America (the USA) in 1990 to being present first in South America and Africa, from 1995, and then also in Oceania and Asia from 2010 onwards. France, during this period became less and less predominant. In 1990, France was the first country (excluding Portugal) with most experiences (13%), then it was overtaken by United Kingdom in 1995 (14% in UK vs. 12% in France) and by the United States in 2000 (15% in USA vs. 10% in France), consequently falling to third position in the ranking of the most popular destinations. In 2015, France is in fourth place, with Germany taking third place, a ranking that was maintained in 2017.

The GPS scientists are spread across continents. When diving into detail, Fig. 2 shows that in Europe, twenty-five different countries (apart from Portugal) turn out to be the destinations of the GPS scientists, hosting more than 2,200 research experiences (56% of the total – yet again not including Portugal). The other most popular continent is America, mainly North America. The presence of Portuguese scientists in Asia is rather diversified (they have been in twenty different countries, which corresponds to a quarter of the total) but it is less relevant in terms of number of experiences (less than 2%).

Considering only those users who had only one research experience on those specific dates, either in Portugal or abroad, the analysis reveals that in 1990 and 1995 Portugal hosted the highest percentage of research experiences. Then, destinations

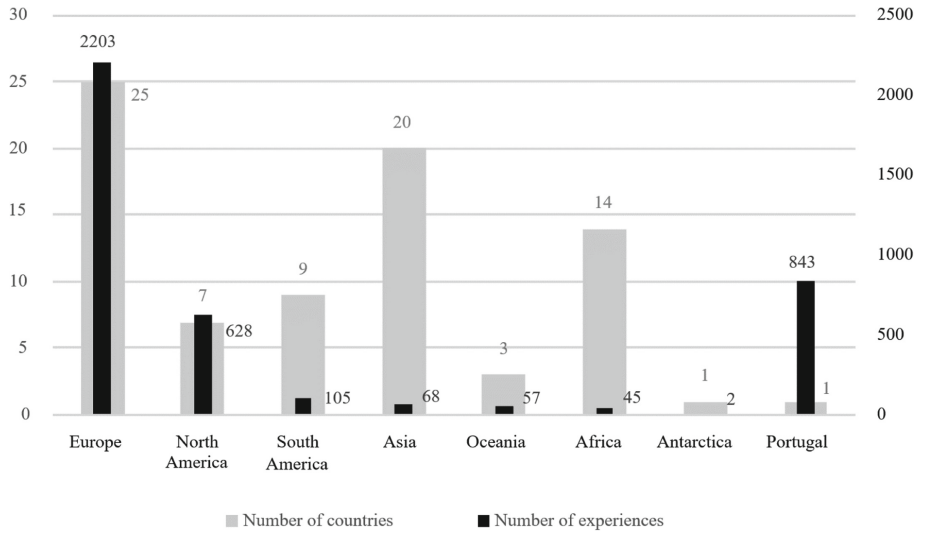

Fig. 2. Number of countries that hosted Portuguese scientists per continent and number of research experiences per continent

abroad started to be more popular than the home country and in 2005, Europe (except Portugal) started to have the highest percentage of research experience (46%, while Portugal had 34%), and the percentage increased considerably in 2015 and 2017 (59% and 64%, respectively). North America was always the second most searched macro-area. Until 2010, Africa was the third continent chosen as a destination for a research experience but, in 2015, it was exceeded by South America, which consolidated its position in 2017 (forty-five experiences, which corresponds to 3% of the total). The growth of this latter continent is mostly due to the role played by Brazil. It is worth noticing that up to 2015, Brazil was not even among the ten most popular destination countries, but in 2015 and 2017, it gradually established itself in the top ten 'receiving' countries (seventh and ninth place).

Considering Lisbon as the reference point for Portugal, each research experience abroad took place at an average distance of 3,582 km. Analysing the distance by sex, is possible to pinpoint that men stayed further away from Portugal than women did (3,730 km and 3,436 km). When performing the same exercise by position held, it seems that *Visiting researcher/professor*, *Leadership functions* and *Science Communicator* or *Science manager* are those work positions, on average, that were carried out further away from Portugal; while the scientific positions such as *PhD student* and *Non-PhD researcher* are, on average, closer to Portugal.

Using the most appropriate parametric and non-parametric inferential tests and a level of significance of five per cent, the analyse presented below highlights the main characteristics that emerged when considering the research experiences carried out outside Portugal by the GPS scientists.

The socio-demographic characteristics (age and sex), the position held and the scientific research areas that characterize each research experience are compared in ten

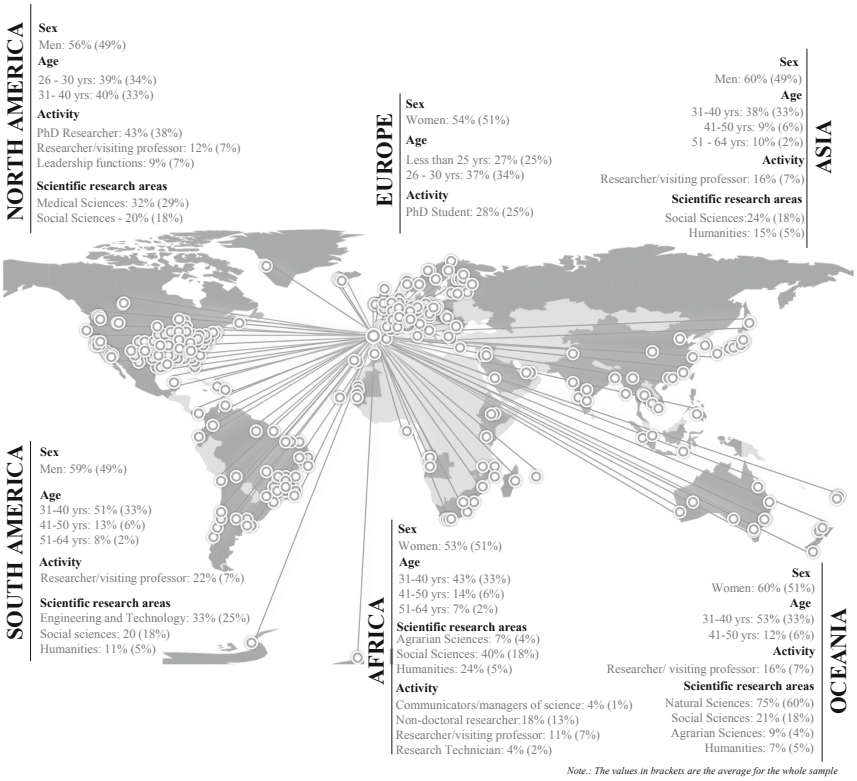

Fig. 3. GPS scientists' profile by continent

different geographical units: a macroscale approach considering the continents; and a microscale approach taking into account the four most popular destination countries representative of the Portuguese diaspora, that is the USA, the UK, Germany and France. The results of this analysis provide valuable insights concerning the mobility patterns of the Portuguese researchers that had at least one research experience outside of the country (Figs. 3, 4).

It worth recalling that the level of significance is not dependent on the magnitude that a value may have in a specific geographical unit, but rather based on a comparative analysis of the weight that a value of a specific variable has in other territorial contexts.

When comparing Europe (in this continent, excluding Portugal, where fifty-six per cent of the total number of experiences were hosted) with the other regions, significant differences emerge (Fig. 3). There is a predominant presence of women, fifty-four per cent (while the distribution of the GPS scientists by sex is approximately fifty-fifty in the overall sample). Other features are the presence of young people (aged thirty and below) and PhD students; for the former the value is sixty-four per cent, while for the latter the value is twenty-eight per cent, corresponding to a difference with the overall sample of about five per cent and three per cent. In Europe, there were no scientific

research areas identifiable as significant, suggesting that there is no specific demand for any research areas.

The generic pattern of GPS scientists in North America changes significantly when compared with Europe. In this part of the world, the percentage of Portuguese male scientists is fifty-six per cent. Another characteristic that differentiates this region is the age structure. North America captures fewer young scientists: the percentage of people aged twenty-five and below is twelve per cent (while the global average is 25%) but there are more scientists between twenty-six and forty years old than expected (79% comparing with the global average of 67%). The distance from Portugal and the higher travel and accommodation costs might justify the scarce attractiveness of North America for early career researchers. Job positions that reflect a state of greater scientific maturity, such as *PhD researchers*, *Researcher/visiting professors* and *Leadership functions* scientists are more representative here than in the other regions of the world, respectively, five per cent and two per cent more than the average. *Medical Sciences* and *Social Sciences* are the most significant scientific areas in North America, with approximately more than three per cent when compared with other regions.

There are some similarities between South and North America concerning the main characteristics of the research experiences. For example, male scientists are the majority (59%), and the predominant age group is people between thirty-one and fifty (64%). *Researcher/visiting professor* is the only work position that is particularly evident in this region with twenty-two per cent (note that this value for the overall sample represents just 7%). Among the scientific areas, *Social Sciences* and *Engineering and Technology* are relevant, as in North America, but in this case, *Humanities* emerges as an additional significant scientific area.

In Asia the Portuguese scientists are predominantly men (60%), about eleven per cent more than what would be expected, and the majority of the scientists belong to the age group between thirty-one and sixty-four years old (57% vs. the average of 41%). This fact confirms the argument that older age groups are in places farther from Portugal. Moreover, *Researcher/visiting professor* is the most representative scientific position in this region (9% more than the average) and *Social Sciences* and *Humanities* are the two major scientific research areas (6% and 10% more than the overall sample).

The fifty-seven research experiences hosted in Oceania are predominantly carried out by women (60%); scientists are predominantly between thirty-one and fifty years old (65%), a lot more than the overall average of thirty-nine per cent. The most significant research activity is *Researcher/visiting professor*, similar to the situation in Asia, and all scientific research areas, with the exception of *Medical Sciences* and *Engineering and Technology,* have a significant importance in this region.

The research experiences carried out in Africa are characterized by the fact that are held mostly by women (54%), scientists between thirty-one and sixty-four years old (64% vs. 41% of the overall average), a somewhat different reality when compared with the other macroregions. The most representative work position and scientific research areas in this part of the world are those that have the lowest relevance in the total sample. *Social sciences,* for instance, represents twenty-two per cent more than the average.



Fig. 4. Profile of GPS scientists by the four most relevant countries of the Portuguese diaspora

Let us consider now the main characteristics of the four most important 'receiving' countries of the Portuguese diaspora, by grouping the UK and the USA, two English speaking countries, on one side, and France and Germany, two founding members of the European Economic Community, on the other (Fig. 4).

The UK and the USA are characterized by hosting Portuguese scientists that have roughly the same features: scientists between twenty-six and thirty, PhD researchers and in *Social Sciences*. The USA distinguishes itself according to three other characteristics, namely, people between thirty-one and forty years old, *Researcher/visiting professors* as position held and *Medical Sciences* as an additional scientific research area. They differ in terms of the predominant sex (women are slightly more than the average in the UK with a percentage of fifty-five per cent, the opposite occurs in the USA with fifty-five per cent of males).

Between Germany and France there are also some communalities, namely in the age of the GPS members (aged thirty and below) and position held (both having a single significant scientific position, *PhD students*). They are different in relation to the representativeness of the sex and the scientific research areas; in Germany GPS members are predominantly women (61%, that is, about more than 10% of the average), while in France the percentage of men is slightly higher (53%). Regarding the research areas, Germany does not have any specific core scientific area while France attracts Portuguese researchers from *Natural sciences* and *Engineering and Technology*.

4 Final Remarks

This paper presents an explanatory analysis of the characteristics and the patterns of geographic mobility of Portuguese researchers registered on the GPS platform (https://gps.pt).

The descriptive analysis of the geographical distribution of the research experiences over time, showed that the number of GPS Portuguese researchers that had or have an experience abroad has increased significantly in the last three decades and the tendency is to have more researchers in more diverse destinations across the world. The inferential analysis showed that destinations closer to Portugal (Europe and more specifically UK) tend to attract women and younger researchers; the more distant regions (North America and more specifically the USA) host more men and older researchers, and users with more mature positions in their careers, such as PhD researcher, Researcher/visiting professor and Leadership functions, as opposed to PhD students which is the most typical position held in Europe. Another interesting insight is that there are also significant differences regarding the research activity developed in different spatial contexts, whereas longer distances imply a specific vocation on the type of research, while shorter distances are more undifferentiated. Note that Europe, for instance, in comparison with other continents, does not have a scientific research area that differentiates this destination.

These results highlight the potential of the GPS platform to monitor the mobility of Portuguese researcher's diaspora. Beside promoting an environment of cooperation, is a powerful tool for mobility studies and for science policy-making: (a) providing a longitudinal perception of the scientific mobility phenomena; (b) analysing scientific returns; (c) understanding the reasons for mobility, i.e. what motivates highly skilled individuals to go abroad and what their future plans are regarding their possible return to Portugal; (d) studying the relation between mobility and scientific production; (e) identifying the academic institutions that attract most Portuguese researchers; and, finally (f) analysing whether there is evidence for geographic constraints on their scientific career (due to language barrier, family). In order to obtain answers for some of these questions, from point (b) to (f), it would be necessary, in the future, to complement the quantitative approach conducted in this study with qualitative data collection and analysis (e.g. a survey) or by integrating the platform with other data sources where other insights on the research activities of Portuguese researchers are available (e.g. ORCID and the portal of the Portuguese Scientific Foundation – FCT). We believe that the collection and analysis of data concerning outward flows such as those GPS platform are essential for designing effective policies that stimulate brain gain or encourage and support the mobility of scientists in pursuit of training, access to new knowledge and networks, and also for taking into account gender imbalances.

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