

# **Assessing Scientific Mobility Dynamics and Impact: drawing on the potential of electronic CV databases**

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## Abstract

The mobility of scientists has become, in the last few years, a hot topic in the context of highly skilled migrations. Although it is not a new phenomenon - since historically these movements have always been present - there is evidence of the fast growth of scientific mobility as we move towards an increasingly globalised world. Along this process, the asymmetries between countries in terms of mobility flows became more evident. However, the early emphasis on the loss of highly skilled resources by less advanced regions – coined in the “brain drain” concept - is being increasingly replaced by the “brain circulation” approach, which rejects the idea of unidirectional flows and addresses scientific mobility as a complex phenomenon, whose effective role on knowledge production and transmission is still far from being understood. Despite the growing relevance of scientific mobility, researchers are confronted with a lack of reliable data on mobility flows. This led to a search for new methods that would permit to capture the complexity and multidimensionality of the phenomenon. Since mobility increasingly consists of a sequence of events that take place along a scientist’s career (rather than a one-off move), the analysis of scientists’ trajectories emerged as a promising methodology, and the Curriculum Vitae (CV) as a rich source of information. In addition, because CVs report career evolution and outputs, they could equally provide information enabling the assessment of mobility impacts.

However, CV’s have a number of problems, concerning data format, contents and data treatment, that have so far limited their usefulness. The recent introduction of electronic CV databases, which present information in a standardized format and in an electronic support, may contribute to overcome at least some of these problems. The objective of this paper is exactly to use a novel electronic CV database - the Portuguese DeGóis Platform - to explore the possibility of building meaningful mobility indicators and of using them to understand scientific mobility dynamics, as well as to address the impact of mobility upon knowledge production and circulation, both at an individual and at an organizational or country level.

**Key Words:** Highly Skilled Migrations; Scientific Mobility; Knowledge Flows; Career Trajectories; CV Analysis

## 1. Introduction

The mobility of scientists and researchers has become, in the last few years, a hot topic in the context of highly skilled migrations. Although it is not a new phenomenon, since historically these movements have always been present, there is evidence of the fast growth of scientific mobility as we move towards an increasingly globalised world (Mahroum, 2001; Iredale, 2001). Along this process, the asymmetries between countries/regions in terms of mobility flows became more evident, reinforcing the disadvantages of those that are not able to keep their scientists, bringing this issue to the policy arena and raising the attention of social scientists. The concept of “brain drain” was coined to encompass the perceived loss of highly skilled resources, but more recently the idea of mobility as an exclusively “unidirectional flow” that deprived less advanced regions from their knowledge resources started to receive some critics, due to its overly simplistic approach to the problem (Ackers, 2005). A new approach has emerged – the “brain circulation” paradigm (Meyer, 2001) – that addresses mobility as complex phenomenon and that recognizes its role on knowledge production and transmission. The new approach was acknowledged by government officials, most notably in Europe, who introduced specific policies aimed at encouraging the mobility of scientists. The European Commission goes as far as pointing out, in the context of the ERA program, that high levels of researcher’s mobility should become “a standard feature of a successful research career” (CEC, 2007: 8).

However, despite the increased political interest, the mobility of researchers remains a relatively unknown phenomenon. There is insufficient data about mobility flows along their varied dimensions. With the possible exception of some Nordic countries that can rely on rich local databases (Nerdrum and Sarpebakken, 2006), most European countries find it very difficult to collect information on scientific mobility. This has led to debates about the research methods that could be more adequate to capture and empirically interpret mobility, given its complexity and multi-dimensionality (Fontes, 2007; Cañibano *et al.*, 2008; Auriol *et al.*, 2007; Laudel, 2003).

This paper aims to contribute to this debate. Focusing on a recent methodological approach to the study of scientists’ career trajectories – the analysis of Curricula Vitae (CV) - this research uses a recently introduced electronic CV database, the Portuguese DeGóis Platform, to explore the possibilities of using the CV to build indicators that can contribute to advance our understanding of scientific mobility<sup>1</sup>.

## 2. Scientific Mobility

### 2.1 The problem

The mobility of scientists has been studied by authors from different disciplines and with a wide variety of research (and sometimes also political) agendas. Because mobility is a complex phenomenon, whose frontiers are still fuzzy and which still lacks a widely agreed conceptual definition and a comprehensive analytical framework, this variety led to the emergence of a wide array of perspectives and approaches, often contingent to the specific features being addressed or to the methodological constraints faced. This exploratory period produced a large number of contributions that added up to our understanding of the field, leading more recent authors to acknowledge and start addressing the multidimensional character of mobility.

This multidimensional character is particularly visible on the unclear demarcation of concepts (Keim and Teichler, 2007) and can partly explain the variety of approaches to mobility. In fact, different perspectives may effectively correspond to the consideration of different dimensions (sole or in combination) and to the nature of research questions that can be raised relative to them. Among the dimensions more frequently considered are those related with: duration (permanent vs. temporary; short vs. long term); space (regional, intra or international), occupational issues (across careers/categories, or across sectors); motivations and obstacles; contents (e.g. competence flows associated with the mobility of individuals); impacts (to the individual scientist, to organizations, to national scientific systems) (Mahroum, 1999; Morano-Foadi, 2005; Cañibano *et al.*, 2008; Ackers, 2005; Gill, 2005; Ackers, 2008). The numerous agents and different impacts that can be associated to the mobility of researchers also made it difficult to theorize and quantify.

The complexity of the phenomenon, which is being increasingly recognized, requires from researchers a clear delimitation of the dimensions being analyzed and a careful definition of the adequate analytical framework and methodology. On the other hand, it emphasizes the need for theoretical and methodological developments. But despite the conceptual difficulties, the intensification of the mobility flows and the political significance of the phenomenon, often reflected on public policies that encourage these movements, make this area a relevant setting for empirical research.

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## 2.2 The literature on the international mobility of scientists

The focus of this paper is on the international mobility of researchers, defined as the geographical movements of researchers between countries in order to develop their skills and to access the best opportunities in the academic scientific career (Ackers, 2005; Millard, 2005). In the literature it is possible to find contradictory views regarding this type of mobility. On one hand, mobility is acknowledged to be advantageous and constructive in itself, as researchers acquire and share knowledge throughout their mobility paths (Gill, 2005; Musselin, 2004). On the other hand, mobility is sometimes described as having potentially negative consequences for the researchers that, more often than not, tend to be penalized instead of rewarded (CEC, 2007: 12) and for the countries that are consistently in the “sending” position (Melin, 2005; Ackers, 2005; Richardson and Zikic, 2007). Nonetheless, the literature also stresses that international mobility is becoming an increasingly important asset in the research career, as what was formerly a voluntary choice seems to be turning into a requirement to early career progression, especially in some fields where there is currently an “expectation of mobility” (Morano-Foadi, 2005). This is particularly visible in Europe where the recent policies at European and national levels reflect the assumption that mobility has a direct link with excellence and competitiveness (Ackers, 2008). The creation of the European Research Area (ERA) is built upon this very idea.

But as was pointed out earlier, there was an evolution in the approaches to the international mobility of scientists. During some decades, the “Brain Drain” approach has dominated the attitude of researchers and policy makers towards international mobility, the emphasis being put on the potential unbalances caused by the unidirectional migration of highly skilled individuals from less to more developed countries. The main argument was that the large outflows of scientists associated with the continued inability to retain these highly qualified professionals or to attract them back, would result in a net loss of knowledge for a region/country (Gill, 2005; Ackers, 2005). The resulting “brain-drain” was perceived as a “zero-sum game” that could only be solved by compensatory inflows or by expanding the training of researchers. This perspective reflected the economic theories of the 60’s, namely the Human Capital theory that put a great emphasis on the North/South dichotomy (Giannoccolo, 2006).

It was not until the 1990’s that a new perspective began to arise, according to which some authors started to question the simplistic nature of the “brain-drain” approach. The concept of “brain circulation” proposed by Johnson and Regets (1998) was a first attempt to introduce a wider perspective that could account for the complex knowledge flows increasingly assumed to be associated with mobility. The idea of circular movements started to replace the traditional one-way migration view, which assumed that scientists moved elsewhere and stayed there for good. As Ackers (2005) points out, the major transformation took place in the conceptualization of scientific mobility as an ongoing process instead of a single permanent move, an approach that clashes with the “brain drain” view of mobility as a cumulative phenomenon (Cañibano *et al.*, 2007). What derives from this is that the intense circulation of skilled individuals from their home country to different locations, not only contributes to develop their competences, but also facilitates integration in transnational networks that bolster knowledge creation and diffusion.

Moreover, there is a growing notion that the process of knowledge transfer may be independent of the physical presence of the individual (Ackers, 2005; Williams *et al.*, 2004). It is often argued that knowledge exchange (particularly in the case of knowledge that has a stronger tacit component) is geographically bound and frequently requires physical proximity (Mahroum, 2000; OCDE, 2008). However, the importance attributed to physical proximity in knowledge transmission, lies in the role played by co-location in the creation of other forms of proximity, that *effectively* facilitate such transmission: namely social and cognitive proximity (Boschma, 2005). But mobility events may enable the establishment of relationships characterized by these types of proximity. The development of social proximity favors the continuity of relationships when co-location finishes, while the development of cognitive proximity facilitates knowledge sharing among scientists who are physically distant but belong to the same “epistemic communities” (Steinmueller, 2000). Advances in information and communication technologies, that make access to information at a distance easier and affordable (Amin and Cohendet, 2006) and new opportunities for temporary co-location (e.g. short-term mobility for training or joint work; project meetings or even presence in at international events that join the main actors in a given field (Wink, 2008), provide the setting for nurturing the social relationship and create the conditions for maintaining co-production of knowledge and thus cognitive proximity (Breschi and Lissoni, 2001).

Thus while mobility provides the conditions for the establishment of knowledge networks among scientists, it is possible for scientists who return to less advanced contexts to continue benefiting from the advantages of these networks at a distance (Williams *et al.*, 2004). Conversely, it is equally possible for these scientists who remain abroad to maintain similar relationships with their home country, giving to what has been described as a “*scientific diaspora*” (Meyer, 2001). The networks established between expatriates and the local scientific community can similarly be used as channels for knowledge exchange,

enabling local scientists to gain access to knowledge generated in more advanced contexts (Gaillard and Gaillard, 1998).

### **3. Framing Mobility**

#### **3.1 Methodological caveats**

The recent perspectives about researcher's mobility have presented new challenges for empirical analysis. One basic problem concerns the lack of reliable data that enables researchers to document and analyze the diversity of mobility flows and to assess their impacts at individual, organizational and country levels on issues such as individual career development and knowledge dissemination. In fact, the literature is unanimous in stressing that there is still a long way to go before it is possible to obtain the information required to understand mobility in all its dimensions (Fontes, 2007; Cañibano *et als.*, 2008).

However, it is important to emphasize that this difficulty is as much methodological as it is theoretical. In fact, even if the variety of *movements* enacted by scientists introduces an additional source of complexity in terms of measurement, the very definition of what constitutes a "mobile" researcher is also subject to discussion. Additionally, researcher's career paths are far from being predictable and their international mobility is highly decentralized and ultimately depends on individual choice. Although there are some periods in the research career when mobility seems more likely, we can only trace it by analyzing the professional trajectories of individual researchers (Dietz *et al.*, 2000). This fact poses enormous challenges that are still far from being solved.

First of all, there's the question of the "delimitation of the population" (Fontes, 2007). Because we are dealing with expatriate and/or returned researchers, measuring mobility implies the knowledge of their whereabouts which is a hard and costly task to do. For this reason, most mobility studies focus on "convenience samples" provided by specific funding programs or particular countries or regions (Fontes, 2007). However, the problem remains and the population is still largely unknown. On the other hand, traditional sources like migration statistics also prove themselves inaccurate because they usually leave out important information like academic and professional achievements (Auriol, 2007). These considerations help us to understand why most mobility studies are qualitatively oriented and only address a very small portion of the population. There is, therefore, a need to develop new methods and instruments that are both inclusive and longitudinal in their approach to mobility.

#### **3.2 The potential of CV analysis: mapping the terrain**

The Curriculum Vitae has recently started to be seen as a potentially rich source of information about researchers' career and mobility. The CV is a universal type of document that keeps a chronological record of the most relevant academic and professional events, summarizing the career trajectory as well as providing data on some key undertakings (projects, collaborations, etc) and their outcomes (publications, patents, etc). The CV is an important professional instrument for researchers, serving different purposes (job and grant applications; career progression; search for funding, etc.) and thus being frequently updated. For this reason, it has the unique feature of being a repository of information that evolves over time in very much the same way that the professional career does, making it perhaps the most complete longitudinal information source about career trajectories (Dietz *et al.*, 2000). Moreover, the CV is a relatively easy document to get, displays an extended amount of information that would take a long time and money to gather otherwise and allows the return to the original source whenever required (Dietz, 2004). It is also possible to complement the information provided by the CV with more traditional and qualitative methods like interviews or questionnaires (Lee and Bozeman, 2005; Lenzi, 2007). All of these features have made CV analysis a valuable methodology to examine the professional trajectory of scientists and engineers (Dietz, 2004), to determine doctorate holders activities and profiles (Sabatier *et al.*, 2006), to assess the impact of mobility on scientific productivity (Cañibano *et al.* 2008) or on academic collaborations (Bozeman and Corley, 2004).

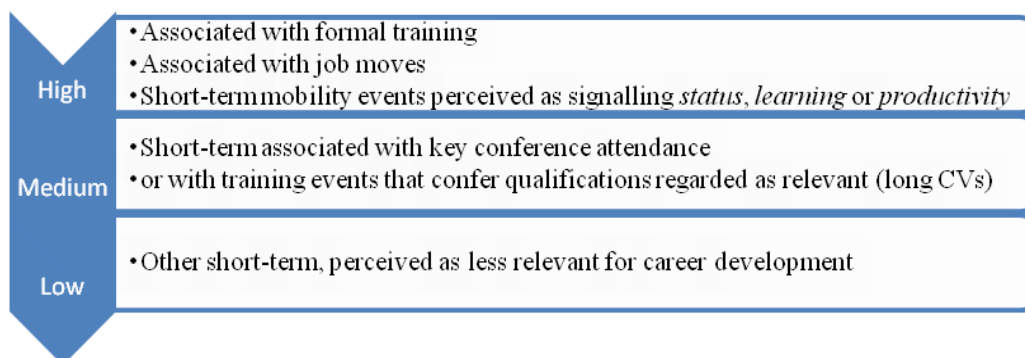
However, CV analysis also has some methodological caveats. Usually, CVs are not presented in a standard format and they can differ in size, data organization and data contents (Dietz, 2004). Their structure and contents can also be influenced by differences in institutional contexts, which pose an additional obstacle when it comes to cross country or even cross organizational comparisons. This means that the codification of CV data requires high levels of abstraction, in order to coordinate information from different CV structures. It can therefore be a very lengthy task and highly susceptible to coding errors. On the other hand, there is also the possibility of CV "embellishment" (Dietz, 2004), which illustrates the difficulty to control reliability of the information contained.

In the last few years, we have seen the rise of a potential solution to these CV analysis methodological shortcomings through the creation and development of electronic databases in several European and South-American countries. These databases, by presenting CV's in a standardized format, avoid a significant part of the problems that are associated with its use. More specifically, data collection and

codification can be done more easily and almost cost free, with obvious advantages in terms of comparability and completeness of data.

But while CVs have been shown to be a useful instrument for data collection on scientific careers, it is important to be aware of their limitations in what concerns mobility-related data. In fact, the CV basically documents career evolution and its outputs and, therefore, it enables the collection of data on mobility along the scientist career by indicating the location (geographical and institutional) where main career events took place. However, events that involve mobility differ in importance, from a career development viewpoint, and thus scientists may choose not to report all of them in a CV. That is to say that short-term mobility is less likely to be reported, unless the events it is associated with are perceived as particularly relevant, indicating professional or learning status or productivity levels.

Figure 1 – Likelihood of mobility events being reported in the CV



Mobility events are particularly vulnerable to the purpose of the CV, which influences the type of events the scientist chooses to report and the degree of detail he/she supplies. To be more precise, this means that long CVs are more likely to provide information on short time events such as attendance to conferences or short courses, while short CVs will seldom include them. The high scope for self-selection of the information included (or excluded) can also have some perverse effects: in fact, it is possible to avoid presenting information judged detrimental for some purposes or rather, as pointed out above, to embellish the information for marketing purposes (Cañibano *et al.*, 2007).

In summary, the CV is particularly useful when it comes to draw a general picture of mobility trajectories along the career. However, in order to use it adequately, it is necessary to take in consideration its limitations and to assess which is the data that can be really be obtained from CVs and which needs to be obtained from complementary sources, as well as how to capture all this information.

#### 4. The Portuguese Case

##### 4.1 Studying Mobility flows in Portugal

Like most European governments, and in accordance with the principles of the Lisbon Agenda, the Portuguese Government has been making a significant effort to foster the increase of human resources devoted to Research & Development. This effort was coordinated by the Foundation for Science and Technology (FCT) - an organism of the Ministry of Higher Education and Science dedicated to the promotion of scientific and technological advancement – and involved a high investment in the advanced training of human resources, mainly through the award of doctoral, post doctoral and other research-oriented grants. From 1994 to 2007, a total of 13382 PhD grants and 4173 Post Doctoral grants were awarded, of which 44% and 36% respectively were abroad or included a period abroad (mixed grants). There are also some private organizations, like the Gulbenkian Foundation, that play a significant role in the funding of similar scientific programs.

While a substantial proportion of these grants involved graduate and post graduate training abroad, there is very little knowledge about the impact of this training effort, specially regarding the level of integration of these scientists in the Portuguese S&T system and regarding the impacts of that training on the evolution of their scientific careers and on their ability to build international scientific networks. In fact, despite this heavy investment on outward mobility, there is very scarce information regarding return mobility, a very pertinent issue for small, peripheral countries like Portugal, which are likely to have a lower capacity to attract back and/or retain their best scientists (Fontes, 2007). The only official data about return mobility comes from a series of four surveys conducted some years ago by the Observatory for Science and Higher Education (OCES) to PhD grant holders one year after the end of their grant. However, the final results of the survey were only partially disclosed and all we know is that from a total of 3,122 respondents, 15% were still abroad one year after the end of their grant (Gonçalves *et al.*, 2006).

Nevertheless, these results have been used to perpetuate the idea that most individuals return home after finishing their training abroad, which might not be necessarily the case, particularly in some fields. Also, number of returns *per se* may be insufficient and needs to be complemented with an assessment of the scientific quality of those who return as compared with the ones who do not (Fontes, 2007).

On the other hand, the literature about the Portuguese researchers' scientific mobility is still relatively scarce, although it is slowly growing. Recent studies have shed some light on the ongoing mobility dynamics of particular sets of researchers. Fontes (2007) addressed the case of expatriate scientists and developed a methodology that used patent data as a strategy to identify and locate Portuguese scientists who were inventors in biotechnology patents filed by foreign organizations and thus could qualify as "productive scientists". Delicado (2007) used a variety of sources to identify Portuguese researchers and PhD students abroad in a wider variety of fields. Both studies gathered information through questionnaires that inquired expatriate scientists about their current situation, their relationship with the home country and their perspectives concerning an eventual return. But although these studies raised a number of relevant issues, they only provide partial snapshots of a broader mobility scenario. In the absence of comprehensive datasets containing information on mobility and its outcomes, specific surveys have been, so far, the only means to gather systematic data that could assist researchers and policy makers in the assessment of mobility dynamics and impacts.

#### **4.2 CV based data in Portugal: the DeGóis Platform**

As was pointed out above, CVs display a large amount of very useful information on researchers' careers and mobility, which make them a potentially useful instrument to study mobility and its impacts. The Foundation for Science and Technology (FCT) has introduced in the late 1990s the electronic submission of applications for most of its funding programs (both for research and advanced training), this including CV submission in electronic format. The rise in public funding led to a steep increase in the number the applications for these programs and thus, the CVs submitted by the respective candidates and included in the so called "System of Information and Management" (FCT/SIG), could provide a valuable repository of data<sup>2</sup>. However, the system currently used to collect and store the CV information does not ensure data standardization and does not allow the systematic retrieval of the data. On addition, the information thus obtained is confidential and the nature of the data does not allow the extraction of unidentified datasets. This means that this specific "electronic CV" does not present the characteristics that make this type of source particularly advantageous.

The limitations of the existing system led FCT to contract the development of a more sophisticated instrument, which could provide for the collection and systematization of information on the S&T system and assist in its management: the "Plataforma DeGóis"<sup>3</sup>. One of the key components of the Platform is an electronic CV database – the DeGóis Curriculum - that started being developed in 2001, being first experimentally applied to a set of pioneer universities and only becoming more extensively used in the last two years. The goal of the database is to gather information about Portuguese researchers and its main features include the individual management of curricular information, the visualization of science and technology indicators and the search for curricula according to content related queries. Individual information is collected on-line through a structured CV form, which is expected to guarantee a high level of data standardization and data accuracy in a number of fields regarded as key for the building of S&T indicators. The DeGóis CV comprises information about: academic background, professional trajectory, scientific, technical and cultural production and scientific activities. The latter include research projects, participation in a variety of academic activities (e.g. supervisions; juries; evaluation committees, etc); participation in scientific events; prizes and other awards, affiliations to societies, as well as publications and patents.

With the exception of personal data (the identification card), all the information introduced in the DeGóis CV is public. Data on a number of key fields has to be filled using a pre-defined terminology, which implied a previous work of categorization, with the purpose of achieving the highest possible data uniformity. In addition, some of these fields are mandatory and thus final submission is not allowed if they are missing or are incorrectly filled. Allegedly, this will lead to a high level of standardization of the information stored in the database. It also enables the automatic generation of a number of indicators, available at the Platform website, such as: the distribution of scientists by gender and age, field of work, academic level and field of knowledge (FOS), as well as global scientific production. International comparability is ensured through the adoption of international classifications for the field of work (ISCED) and for the scientific domain (OECD/FOS). Additionally, the DeGóis Platform is also a member

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<sup>2</sup> The FCT /SIG comprises around 15000 CVs.

<sup>3</sup> Information on DeGóis Platform was obtained from the respective website (<http://www.degois.pt>) and from a Manual developed by the Platform management team (FCT, 2008).

of a number of international networks concerned with development of international CVs and working to ensure the inter-operability between countries.

Despite all these encouraging features, the implementation of the DeGóis platform proved to be slower than expected. The filling of DeGóis CV is very time consuming and thus it may take some time for those scientists who had already filled a CV in the previous system to move to the new system. Furthermore, many researchers react against the lack of confidentiality, once their CVs are part of the DeGóis database. Thus, despite the initial plans to make the DeGóis CV mandatory to all researchers who apply to FCT funding, this is still far from happening. The introduction of new CVs depends on the initiative of individual scientists, as well as on the agreements established with some universities with a view to achieve the migration of data from local CV systems to the Platform. As a result, the number of CVs registered in the DeGóis database is still low (around 6000 in May 2005) and there is a strong bias towards some institutions, namely those that joined the Platform in the experimental stage and whose researchers' CVs were already introduced in the database (manually or electronically). Therefore, this database is still far from mirroring the Portuguese S&T system, both in terms of numbers<sup>4</sup> and in terms of institutional and field representativeness.

## **5. Building Mobility Indicators**

### **5.1 An exploratory appraisal to indicator building**

As was already pointed out, despite the widespread assumption, namely among policy makers, that tends to relate mobility to research excellence and professional success, the actual connection between the two has seldom been empirically demonstrated (Ackers, 2008). Even so, there are some immediate benefits to a researcher's career that derive from mobility: the establishment of new networks, the exposure to new scientific and cultural contexts, the acquisition of professional experience leading to an enhancement of the professional capabilities, are all commonly assumed features of mobility (Avveduto, 2001; Ackers, 2005). But in the European context, the notion that mobility and scientific credibility amongst its peers are mutually empowering (Mahroum, 2000) has pushed forward a frequently quantitative approach: the higher the mobility, the better for national scientific systems (Cañibano *et al.*, 2008). However, the simple measurement of the inflows and outflows is not enough to understand the specific context of mobility neither to assess the added value it potentially brings to researchers' career and performance (Ackers, 2008) and to the scientific improvement of the respective research organizations or countries/regions. As discussed, mobility is a rather complex and multi-dimensional phenomenon that largely consists of qualitative processes, which need to be taken into account for a meaningful analysis. In addition the dimensions of mobility that are effectively being addressed need to be explicitly acknowledged, since results may vary depending on which specific processes are being considered and on the respective interactions.

In this paper, our aim is to explore the possibilities of using electronic CV based data to build mobility indicators that can help to clarify these unknown relationships. The analysis is based on data compiled in the electronic CV database from DeGóis Platform up to November of 2008<sup>5</sup>. Given the stage of development of DeGóis Platform, the data available still suffer from some shortcomings. These include: the small number of CVs and their institutional bias, which result in the already mentioned limited representativeness; problems at the level of data completeness, namely in some key variables (e.g. publications); some "teething problems" in what concerns the level of standardization and accuracy of the data (often associated with the migration of data from other systems, which was not subjected to the control mechanisms implemented for on-line CV filling), which undermine this basic advantage of electronic CVs. Because of these problems an empirical analysis based on the data available at this stage would be meaningless. Nevertheless, we consider that these deficiencies may be conjunctural. Data problems can be partly solved by an effort towards the correction of the data that was not introduced on-line. Representativeness and also data completeness problems can be solved when FCT makes DeGóis CV mandatory to all researchers in order to receive public funding.

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<sup>4</sup> According to the most recent S&T survey (IPCTN: <http://www.gpeari.mctes.pt>), the number of researchers in the Higher Education sector was 26700 in 2007. This figure does not include the State Laboratories (which are accounted for in the Government sector), neither a large number of research institutes that adopted the "Private Non-profit Organisations" status. If we added these two sectors we would reach a total of about 37000 researchers.

<sup>5</sup> For this purpose, we asked FCT authorisation to use this data, which was granted provided that confidentiality was maintained. The data was supplied by the DeGóis management team at Gavea/Universidade do Minho and consisted of unidentified datasets for all PhD holders, containing a sub-set of variables that were judged to be relevant for an analysis of mobility and its impacts, and that displayed a reasonable degree of completeness. The availability and support of Gavea researchers and particularly of Doutor Leonel Santos, who contributed to the definition of the relevant variables, is gratefully acknowledged.

We believe that once DeGóis Platform is working as foreseen, it can provide important information to support mobility analysis. Therefore, our objective, for the time being, is to define a series of indicators, based on electronic CV data, that will enable us to study mobility trajectories associated with formal training and professional activities in order to identify mobility patterns (through data categorization and analysis of longitudinal career data) and to evaluate impacts of mobility on career evolution and on scientific productivity.

The type of indicators we are aiming to build are part of what has been described as a new rationale for S&T indicators: the *positioning indicators* (Lepori *et als.*, 2008). The main difference relatively to the traditional approach is that this type of indicators takes into account the position of the actors – identity, relationships, immaterial assets – that are as important as the formal inputs and outputs normally associated with mobility analysis, and that enable us to position actors “in a complex and fragmented institutional space, where local effects are relevant and strategic choices are determinant” (Lepori *et als.*, 2008). Because mobility relates with career and research performance in several ways, it can be problematical to directly associate a specific mobility event with a specific outcome. To deal with this difficulty, the best solution is to focus on the trajectory – academic, professional, productive – followed by the researcher throughout his/her career, in order to put together a multidimensional map that enables us to compare actors; to characterize and evaluate mobility trajectories and impacts; to identify specific mobility patterns that combine individual characteristics, modes of mobility and career evolution. Following this approach, our task is to identify dimensions and build indicators that can account, not only for the modes assumed by mobility, but also for the very different ways that mobility relates with the researcher career (in terms of evolution and outcomes/performance).

## 5.2 Using CV Data to measure mobility dynamics

Since our objective is to assess the type of mobility indicators that can be obtained from this specific electronic CV database, the definition of the focus of our analysis had to take in consideration the already mentioned structural limitations of the CV as source of information on mobility – focus on professional activities and key training events and lower reliability regarding short-term mobility events – as well as the specific characteristics of the DeGóis Platform, which targets particularly (although not exclusively) scientists who are in the academic/research career and are located in Portuguese organizations. Therefore we focus on medium to long term international mobility for professional or advanced training purposes, by scientists who are active in academic/research careers.

Our unit of analysis consists of scientists with a doctoral degree and the PhD is used as the reference period for our analysis. The focus on PhD holders can be explained by the fact that this group, being the highest educated among highly skilled workers, is regarded as the most likely to have a role on the advancement and diffusion of knowledge and technology (Auriol *et als.*, 2007), being crucial for knowledge-based economical growth, as well for the education and research training of young researchers in the national scientific systems (Moguérrou, 2006). The choice of PhD as reference period relates to the fact that the PhD is frequently the moment when long term international mobility first occurs. In fact, the share of foreign students in several countries is greater at doctorate level than at the undergraduate level (OECD, 2002).

Therefore, in this research we define mobility as the conduction of professional or advanced training activities in organizations located in a country that is different from the country of origin, by doctorate holders who are active in academic/research careers.

In defining scientific mobility, we are effectively taking into consideration a number of dimensions that we judge relevant to delimit and characterize the phenomenon we are addressing: time, space, sector of activity. These dimensions can be used to build a framework that supports a clear delimitation of the concept of mobility used by the researcher, as well as the identification of patterns in researchers' mobility:

- a) the **temporal dimension** corresponds to the duration of mobility events: short, medium or long term mobility – *we chose to focus exclusively on medium to long term mobility.*
- b) the **spatial dimension** that refers to mobility between countries or regions and between organizations – *we chose to focus exclusively in mobility between countries (mobility between organizations being only considered when it involves change of country).*
- c) the **sectoral dimension** that refers to mobility between sectors of activity (e.g. research vs. non-research; public research organizations vs. industry) and between scientific areas – *we chose to focus exclusively on researchers in public research organizations, thus excluding mobility between sectors and addressing only mobility between scientific areas (including all scientific fields).*

Table 1 – Characterizing Dimensions of Mobility

	<b>Definition</b>	<b>Indicators</b>	<b>Mobility Dimensions</b>
<b>Medium/ Long - term mobility</b>	<b>More than a year stay in a different organization for professional or advanced training activities</b>	<b>Duration of Professional or Training Activity</b>	<b>Temporal</b>
<b>International Mobility</b>	<b>Different countries in which the researcher has worked or conducted advanced training activities</b>	<b>Location of Professional or Training Activity: Country/Organization</b>	<b>Spatial</b>
<b>Field Mobility</b>	<b>Change in scientific area</b>	<b>Field of knowledge FOS/OECD classification</b>	<b>Sectoral</b>

This table presents the characterizing dimensions of mobility we defined in our case and the type of data (available in DeGois Platform) that can be used for the respective mobility analysis.

The indicators resulting from the application of this framework can be used for different purposes. Firstly they can translate broad tendencies: by allowing the collection of aggregated data for host country, duration of stay, scientific area, time periods when mobility took place, they permit to globally characterize mobility flows. Combining them with individual characteristics of researchers (e.g. age, gender, nationality) they enable the further identification of patterns concerning the structure and dynamics of scientific mobility, for the whole population or for sub-sets of that population. They can also be associated with specific stages along the scientists' career trajectory with a view to obtain a more in-depth understanding of mobility dynamics. Secondly, these indicators can be related with additional dimensions, like career status or scientific productivity, in order to explore potential impacts of mobility. For instance, it is possible to conduct a comparison, along several indicators, of researchers who engaged in international mobility with those who did not, taking into consideration the patterns previously identified, e.g. regarding mobility differences in terms of scientific fields, time periods / age cohorts, host countries, gender, etc. The results of this analysis can be a useful contribution for an assessment of mobility policies.

The above arguments on the central role of PhDs in the S&T imply that the PhD has a distinctive impact in any researcher career. Since in many cases it equally provides an opportunity (often the first) for international mobility, it can be regarded as an important starting point for an analysis of mobility and its impacts. Following this line of thought, we can use the PhD as a reference point and consider three different types of mobility events, always assuming medium to long terms international mobility associated with professional or advanced training activities: 1) Outward mobility for PhD; 2) Return mobility after PhD; 3) Mobility after PhD.

The **outward mobility for the PhD**, i.e., the conduction of the PhD partly or totally *outside the country of origin*, is important to assess the immediate results of national investments in advanced training abroad. In addition, combined with other methods (ex: interviews and questionnaires), it can also be used to gain insight about the individual motivations and external influences that led to this choice. This particular mobility event can also express some relevant relationships with the main factors that, according to the literature, potentially influence the level of PhD mobility, e.g. differences between fields of knowledge, age cohorts and gender (Ackers, 2003). DeGois CV data (see Table 2) enable us to assess where the researcher got his PhD and to put together some quantitative measures about the incidence of PhD mobility, both in absolute numbers and in terms of distribution by specific dimensions: country, field or gender distribution, variation through time. Finally, this data can be combined with other specific indicators to express more detailed research questions.

Table 2 – DeGóis CV data to assess outward mobility

<b>Outward PhD mobility</b>	Personal Data: Age, Gender
	PhD Training Data: Country; Organization; Start-year; End-year; Field of knowledge

**Return mobility** refers to the conduction of professional activities after the PhD by those who did their doctoral training abroad, involving permanent or temporary position in an organization in the *country of origin*. There is currently in Europe a debate about how to attract back mobile scientists and how to lessen their difficulties in re-entering the scientific labor market (Ackers and Gill, 2005; Musselin, 2004). DeGóis CV data (Table 3), allows us to identify cases of return<sup>6</sup>, to assess the respective career status after return (as compared to the one they had before leaving) and also to compare their position with those who did the PhD in the home country. Once again, it is possible to combine this with other data to address specific research questions, such as rates of return between scientific areas.

**Post PhD mobility**, refers to the conduction of professional activities in two different situations:

- *Extended mobility*: the researcher remains in the country where he got his PhD or moves directly to another country that is not the country of origin. This particular trajectory can be related to a tendency, discussed in the literature, of young researchers to undertake a series of post-doctoral contracts in different organizations/countries as a mode of improving their CV and thus create better conditions to access a job at a country level (Musselin, 2004);
- *Mobility after return*: it can be associated with a situation, also discussed in the literature, where difficulties confronted upon return to the country of origin, whether for professional reasons (absence of contracts, slow career development, lack of conditions to conduct research) or for personal motives (difficulties to re-adapt to the country context, links in a previous location) lead researchers to subsequent outward job mobility (Gill, 2005). It is also possible that researchers occupy temporary research or academic positions abroad, still maintaining the link to an organization in the home country (e.g. profiting from sabbatical leaves) or having return as final objective.

DeGóis CV provide data on professional trajectory and by enabling us to identify each career move, the respective location and period as well as the corresponding career position, permits to assess whether there is effectively return after a period abroad that is longer than the PhD; whether there is a second job mobility period after return<sup>7</sup> and globally the importance of international mobility also at that stage.

By combining data regarding this type of mobility with other measures already described we can assess whether there are indications on changes in post-doctoral professional patterns (e.g. comparing age cohorts) and whether these take place in specific scientific fields or are associated with specific countries. It is also possible to compare cases of extended mobility with researchers who returned immediately and with those who did PhD in the home country, regarding career status and development.

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<sup>6</sup> Given the characteristics of DeGóis CV there is likely to always be a bias towards the scientists who return, as compared to the ones who do not and therefore see less advantage in filling or updating a CV. Thus it may not make sense to build indicators to quantify the level or return.

<sup>7</sup> Notice however that, although data on temporary job mobility can also be obtained, data on mobility associated with job difficulties is less likely to be available given the nature and objectives of these CVs.

Table 3 – DeGóis CV data to assess return mobility

<b>Return mobility or Post PhD Mobility</b>	Personal Data: Age, Gender
	PhD Training Data: Country; Organization; Start-year; End-year; Field of knowledge
	Professional Activities: Professional position before PhD; 1st position after PhD; 1st position in home country after PhD; Professional activities in a country different from the country of origin (Country; Organization; Position; Start-year; End-year)

This methodological approach will be subsequently applied to the DeGóis CV data available, whenever the current characteristics of that data enable its use for these purposes. However, at this stage the objective remains purely methodological: test the viability of the indicators and their quality as measures and assess the effectiveness of the methodology in capturing the various facets of the phenomenon under analysis. Any meaningful application to the Portuguese S&T system can only take place when DeGóis Platform is fully operational.

In the meanwhile, the methodology could also be applied to representative sub-sets of the population (e.g. specific institutions or other sub-groups of the population like women scientists, specific scientific areas, age cohorts, etc) in order to identify their specific mobility features. The methodological approach and indicators can also be expanded to include the analysis of other types of impacts, as/if the required data become available: e.g. scientific productivity - which requires at least data on publications (Dietz *et al.*, 2000; Dietz and Bozeman, 2005; Cañibano *et al.*, 2008) - or network building - which requires at least data on formal connections (Lee and Bozeman, 2005). It can also be combined with more qualitative information obtained through questionnaires or interviews (see Lee and Bozeman, 2005; Lenzi, 2007), although this combination of methods is currently precluded given the data confidentiality requirement.

## 6. Conclusion

Despite the growing relevance of scientific mobility, our understanding of the nature, extent and implications of this phenomenon remains limited. One basic problem is the lack of reliable data. CV data have recently emerged as a valuable source of information on mobility and on its association with career development and scientific performance; and electronic CV databases as an instrument that can overcome some of the limitations of traditional CVs.

In this paper we resort to a particular CV database – the Portuguese DeGóis Platform – to explore the possibility of using CV data to build indicators relevant for mobility analysis. Starting from the notion that mobility is a complex and multidimensional process, we define a number of dimensions, which provide a framework that can base a clear delimitation of the concept of mobility (a recurrent problem in mobility analysis) and support the definition of indicators. Combining insights from the literature on scientific mobility with an exploratory analysis of the structure and contents of the DeGóis CV database, we define a methodological approach to address the particular case of international mobility associated to the conduction of professional or advanced training activities and enacted by doctorate holders who are active in academic/research careers. This approach takes the PhD as reference point and is expected to enable us to trace mobility events along the scientists' career, identify mobility patterns and start exploring some impacts of mobility on career development.

This methodology will subsequently be tested on the data currently available. However, given the current shortcomings of the DeGóis Platform, an effective assessment of the mobility dynamics and impacts in the Portuguese S&T system will only be possible when the Platform is fully operational. This assessment is particularly important in the case of Portugal, where an evaluation of the strong investment made in the international training of young researchers and of the policies promoting international mobility, is still lacking. Thus, results from such analysis could provide relevant insights for new policy formulation or for the fine-tuning of existing policies.

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