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An inquiry into the return mobility of scientific researchers in Europe

Cañibano, C., Vértesy, D.
and Vezzulli, A.

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Contact information

Name: Daniel Vertesy
Address: Via E. Fermi 2749
Email: daniel.vertesy@ec.europa.eu
Tel.: +39 0332 783556

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Authors

Carolina Cañibano, Dániel Vértsey and Andrea Vezzulli

Abstract

Against the current of scientific researchers moving to universities and research institutes outside their home countries, there is also an observable flow of researchers who relocate back to their home countries following a foreign stay. The aim of this report is to take stock of conceptual and measurement issues related to this phenomenon, referred to as the “return mobility” of researchers. In the context of European policies striving to promote excellent research while realizing it by efficient spending, there are fears that researcher mobility towards centers of excellence (seen as “brain drain” in “net exporter” countries) further widens the gap between regions of Europe. This fear is behind a growing concern for fostering the return mobility of talented researchers to ensure a more equal distribution of research capacity.

The in-depth literature survey carried out in the framework of this study suggests that the very concepts of “brain drain” or “brain gain” are associated with a specific understanding of researcher mobility, which rests on rather strict assumptions that strongly influences the framing of research problems and policy interventions. This most widely diffused “allocative approach”, mainly based on economic neo-classical and general equilibrium-based models and concepts, conceptualizes researcher mobility under the assumptions that human capital, embodied in rational agents, is efficiently used by the productive system. The study shows that at least two other approaches may be distinguished. These approaches may be more aligned with how scientific research activity is carried out and how it is embedded in the socio-economic fabric. An eventual shift of focus from the “allocative” to the “connective” approach (which, based on evolutionary economics, conceives human capital as inherently networked, in a complex, evolving system) would point in the direction of changing the object of study. Rather than on the changing stock of researchers, it would focus on the heterogeneity of research actors and networks, the impact of reconfigurations of scientific, technological and social networks in which researchers’ work is embedded. As one of the case studies reviewed shows, a research system of a given country can substantially benefit from the establishment of new academic and social network connections due to a temporary mobility event even if the mobile researcher has physically “emigrated” from a given country. Alternatively, a focus on the “creativity” approach (which considers changes of contexts as inherent to creating the conditions for knowledge recombination) would lead to putting greater emphasis on the study of the evolution of ideas, research agendas and research careers. The possibilities for improving our knowledge regarding the role played by researcher mobility within the epistemic and organizational dynamics of the European Research Area are extensive, particularly if we do not only think of mobility as a re/allocative phenomenon.

The empirical section of the study provides evidence on country-level return mobility patterns of researchers, following the “allocative approach”, using data collected in the context of the MORE2 survey, a Study on Mobility Patterns and Career Paths of Researchers. Return mobility patterns are identified by highlighting differences across gender, discipline, seniority, country of citizenship as well as of PhD degree completion. To the possible extent, motivations for return mobility of researchers are also investigated, which highlight the importance of personal and family ties apart from academic ones. Potential alternative data sources are also examined, including the Career of Doctorate Holders Survey, the Labour Force Survey as well as novel “big data” sources, highlighting the limitations in the former and the vast potential in the latter. A final contrast of return mobility of researchers with the scientific and technological excellence of national research systems of destination countries presents a mixed picture, showing that countries on the entire spectrum of research excellence may experience high shares of returning researchers.

1 Introduction

Advances in information and communication technologies (ICT) have simplified and accelerated the exchange of ideas and knowledge so dramatically that some observers were ready to state that distance was “dead” (Cairncross, 1997). The “end of geography” logic implied a complete reorganization of economic and social activities, and most of all, scientific research, for which the exchange of ideas and knowledge is central. However, as clusters of agglomerated economic activities have continued to thrive in the new era brought about by ICT (see i.e. Asheim et al, 2006), so have poles of scientific excellence remained in place. Distance is less and less of a barrier for the transmission of knowledge codified in writing or audio-visual format. However, when it comes to exchanging tacit knowledge, the importance of physical proximity does not fade. This is probably a major driver behind the incessant flow of scientific researchers across the world.

Some of the most recognizable patterns of researcher mobility are the attraction of talents by regions which lead in producing science at the world frontier, helping excellence to continue to produce excellence. In fact, the United States as well as North Western European regions that are top performers in terms of scientific and technological research have persistently held their position over time (see i.e. Dosi et al, 2006; Hardeman et al, 2013 or Hardeman and Vertesy, 2015). At the same time, fear of “brain drain” from other regions have triggered policies to retain or attract back researchers to “net exporter” countries. The main expectation from a reversal of brain drain is that return mobility may act as a booster of research capacity in areas lagging in terms of research excellence. Such expectations are, however, rooted in a rather stylized understanding of how scientific research is performed and how it is linked to (what policy is eventually aiming for) economic growth.

The aim of this report is to take stock of conceptual and measurement issues related to the return mobility of scientific researchers, which is crucial for understanding the potential role that (return-)mobility of researchers may play in steering research excellence. The in-depth literature review presented in section 2 of this study argues that the very concepts of “brain drain” or “brain gain” are associated with a specific understanding of researcher mobility, which rests upon assumptions that are worth to be questioned. This leads to the recognition that alongside what Cañibano and Woolley (2015) referred to as the general equilibrium model-based “allocative approach”, there may be other approaches to conceptualize and approach return mobility of researchers, which trigger rather different questions and problems for academic research as well as policy design. As section 2 shows, substantial scholarly work has centered around two alternative approaches, the “connective approach” founded on evolutionary economics which emphasizes the importance of structures, and the “creativity approach” which focuses on the inherent uncertainty related to the creative spark. The purpose of these investigations is whether a better understanding of the phenomenon and patterns of “return mobility” of researchers may lead to more efficient policies.

In subsequent empirical sections 3, evidence is presented on country-level return mobility patterns of researchers. While the main focus of this part is exploiting data collected in the context of the Study on Mobility Patterns and Career Paths of Researchers, more specifically with the MORE2 survey, potential alternative data sources are also discussed, including the Career of Doctorate Holders Survey as well as bibliometric data. Data obtained from the MORE2 survey is used to identify patterns (by gender, discipline, experience, country of citizenship as well as of PhD), and to the extent possible, motivations for return mobility of researchers. Finally, measures of return mobility of researchers are contrasted with the research excellence of countries. The study ends with an outlook for future research (section 4), which suggests that policy design can benefit from departing from the brain-drain / brain-gain paradigm and further exploiting “big data” sources, such as a combination of bibliometric and CV data at a larger scale.

2 Conceptualization of return mobility of researchers

2.1 Introduction: the geographic mobility of researchers

Voyages are inherent to the exercise of the scientific enterprise. Historians give accounts of the *peregrinatio academica* of students and professors between the main European universities from their creation until the XVth Century and in the early decades of the Renaissance, referred to as the 'golden age' of voyaging students (Albiñana and Palao 2004, p.48). The connection between geographical mobility and the circulation and production of scientific knowledge became evident from the birth of the first European universities. The volume and direction of scientists' geographical flows have since then been shaped by a large number of factors including political convulsions, differences in economic development, cultural affinities, technology and transport systems, the effect of policy mechanisms and the attractiveness of the higher education and research systems in different countries. The role and dynamics of the geographical mobility of researchers has attracted the attention of scholars from a wide range of disciplinary backgrounds including history, sociology, economics, science policy, higher education, migration studies and organization and management studies.

The geographical mobility of researchers is acknowledged to be a key mechanism for the diffusion of knowledge that cannot be transmitted without physical proximity – tacit knowledge – (Collins 1974, Frenken 2010), for the incorporation of young researchers to transnational elite scientific networks (Laudel 2005) and for the utilization of instruments or access to infrastructures that are fixed, such as big observatories or historical archives (Bielick and Laudel 2016, Jöns 2007). Experiencing life and work throughout a number of different institutional, cultural and social contexts is also perceived as an essential element to guarantee the necessary open-mindedness required for a fruitful performance of scientific research (Costa 2004).

The geographical mobility of researchers is also undoubtedly a mechanism for the allocation of human resources in research labor markets. Researchers move to access jobs, positions and promotions in labor markets that are largely internationalized (Stephan 2012, Lepori et al. 2015). In some cases, young researchers move to meet the requirements of their disciplinary communities as proof of taking steps towards the development of independent research programs (Bielick and Laudel 2016). Nowadays they also move to meet policy requirements that are increasingly considering geographical mobility as a "rite of passage" for the development of research and academic careers (Ackers 2008, 2010)¹. Mobility also builds and enhances the international networks that will encourage and strengthen the international collaborations, as increasingly expected by scholarly communities and by evaluation norms and schemes.

The geographical mobility of researchers is a multifaceted and complex phenomenon that shapes transnational knowledge flows and networks and, at the same time, conditions the pool of research human resources available in particular spatial locations (organizations, regions, countries) at particular points in time. Mobility can have different meanings, adopt different forms and have varied effects: it can be temporary mobility or permanent migration; it can be motivated by a variety of push and pull factors; it can be associated with a maintenance of connections in the country of origin but also with a definitive rupture with the home context. This inherent complexity of the phenomenon has opened up a variety of possibilities for its conceptualization, as well as for empirical investigations from a variety of disciplinary perspectives, giving rise to a significant and diverse body of literature.

¹ In Spain, researchers need to prove international mobility of certain duration to be eligible for post-doctoral positions funded by regional governments (2 years abroad requested in Madrid and Galicia programs for instance). Obtaining national and regional accreditations giving access to permanent and civil servant positions is also conditioned by the proof of international research experience.

This report derives from the European Commission's interest in understanding the dynamics and impact of return mobility of researchers in European countries. Policy makers, particularly in the context of the making of the European Research Area (European Commission 2000, 2010), are highly interested in the effects of the different facets of the researcher mobility phenomenon. The policy focus is often put on the quantitative dimension and the need to assure the existence of a sufficient pool of researchers in order to meet the requirements of research and innovation systems. This implies the systematic measurement of national stocks of researchers resulting from in-house training and mobility outflows and inflows, often referred to as 'brain drain, gain and circulation'. Policy schemes in different countries attempt to encourage the attraction of foreign researchers and the return of national researchers who are living and working abroad. At the same time, mobility is also perceived in policy arenas as an essential training and knowledge diffusion mechanism, which underlies the rationale for policy programs encouraging researchers to leave their home countries in order to be enriched by experiences and knowledge acquired abroad. This variety of policy schemes, which could somehow be seen as mutually inconsistent, is a reflection of the complexity of the mobility phenomenon and its consequences, and of the different ways in which it can be conceptualized. This proliferation of policy approaches is also a reflection of the goals of specific programs and the level at which they are targeted (city, region, country, supra-national). For example, more than 35 mobility programs or measures have been identified in the Nordic countries alone (NordForsk 2013).

The following section of this report (Section 2) provides a framework to organize contributions to the literature on the geographical circulation of researchers by distinguishing between three main underlying conceptualizations of mobility which we label as i) the allocative approach, ii) the connective approach, iii) the creativity approach. This classification allows us to systematize a literature review which is inevitably incomplete due to the large amount of work in the field, but provides a useful template to associate further contributions with these conceptual categories. As will be shown, the way in which return mobility may be addressed also varies substantially depending on the underlying conceptual model or approach. The type of research questions that can be raised from each conceptual framework varies as well as the type of empirical data needed to address them. The way in which mobility is conceptualized also has direct implications for how policy might be designed to tackle selected problems.

Section 3 of the report focuses on the analysis of patterns of return mobility of European researchers deriving from the exploitation of the MORE2 survey project dataset on 'Support for Continued Data collection and Analysis Concerning Mobility Patterns and Career Paths of Researchers'. The information contained in the survey regarding the geographical trajectories of researchers is used to address return dynamics by gender, field, current career stage and countries, along with other available variables in the survey. As will be explained, the quantitative analysis presented is conducted in line with the allocative conceptualization of mobility.

Section 4 offers a final discussion regarding the implications of the empirical results presented for understanding return mobility and some considerations on the potential and the limitations of the MORE2 survey data. The section closes with a general discussion regarding the avenues that the proposed classification of conceptual approaches opens up for future research and policy studies on researchers' mobility.

2.2 Conceptual approaches to researcher mobility and their implications: a three-category framework

A number of scholarly contributions claim the need for theoretical reflection to address the researcher mobility phenomenon (i.e. Ackers and Gill 2008, Fontes 2007). This is partly due to the fact that numerous contributions to the literature on the topic are

focused on the empirical investigation of its patterns and effects without explicitly providing a theoretical framework to assist interpretation and explanation. However, most studies rely on an implicit way of understanding the phenomenon. This implicit conceptualization nevertheless has a clear impact on how research questions are selected and addressed in many studies, and therefore on the corresponding policy recommendations derived. Based on a systematic review of the literature on researcher mobility, this section offers a framework categorizing existing conceptualizations of mobility in three main approaches. Each approach has implications for the assessment of return mobility.

2.2.1 The allocative approach

2.2.1.1 Theoretical considerations

Much of the debate regarding the consequences of the international mobility of the highly skilled and researchers has been driven by economists and their interest in assessing the economic consequences of international human capital flows for sending and receiving countries. The debate commenced in the 1960s, when the term “brain drain” emerged to convey the loss suffered by the countries of origin of emigrated brains. In the 1970s a number of economic models were developed to explain the mechanisms leading to draining effects in sending economies, notably in developing countries. Cañibano and Woolley (2015) presents a systematic analysis of this literature, which is termed the ‘neoclassical economics of the brain drain’ since the models build on the assumptions of general equilibrium economics and neoclassical human capital literature (Becker 1993 [1964])².

The assumptions of these models can be summarized: “general equilibrium-based brain drain models provide formal descriptions of human capital accumulation (or un-accumulation) [...] Economic growth and welfare automatically benefit from the aggregation of human capital units, which are accumulated through the training of new people within the national education system and their incorporation to the labor force or through immigration. In turn, human capital is mainly lost through emigration, retirement or mortality of skilled personnel.” (Cañibano and Woolley 2015, 122).

In addition, general equilibrium-based brain drain/gain models rely on a set of fundamental assumptions deriving from human capital theory and neo-Walrasian economic growth models, according to which:

1. Human capital is embodied in autonomous agents that respond to market signals when adopting their decisions regarding their investments in education and labor activities, including the decisions to migrate or move.
2. Human capital is efficiently used by the productive system. This applies to human capital devoted to R&D as shown for instance in models by Romer (1990a; 1990b)
3. The accumulation of particular forms of human capital, notably human capital devoted to R&D, increases the innovativeness and productivity of the productive system, allowing therefore the growth of per capita income (see for example Nelson and Phelps 1966).

Assumptions 2) and 3) above imply that researchers are treated in these models as inputs to a production function the output of which can be manifold (number of innovations, scientific publications, per capital income, etc.). We label as the *allocative approach to researcher mobility* that which – implicitly or explicitly – builds on the above premises and which derives originally from economic general equilibrium-based models. From this perspective human capital is conceptualized as an aggregate and human

² We refer here mainly to the work by Bhagwati and colleagues (notably Bhagwati and Dellarf (1973), Bhagwati and Hamada (1974), Bhagwati and Rodriguez (1975), Bhagwati (1979)), more recently supported by Wong and Yip (1999), Pieretti and Zou (2009) and Di Maria and Strykowski (2009).

capital mobility – therefore researcher mobility – as an allocative phenomenon which alters the level of inputs to production functions causing gains in recipient countries and losses (drains) in origin countries, the volume of which depends on the specifications and the level of sophistication of the estimating models³.

From a policy perspective, the implications of this approach are straightforward: a way to assure an increase in the selected output measure (innovations, income, publications) is to guarantee an increase in the inputs that are allocated to production (production of research in our focus of interest). In other words, from a national policy point of view, it is desirable to assure the availability of a large pool of researchers. Considering that researchers move internationally, policies oriented to achieve net positive flows of researchers are consistent with this allocative view. The European Union's policies and strategies to 'train and retain' researchers, as well as to 'attract and attract back' those who are trained or working abroad are in perfect consonance with this approach (European Commission 2005, 2007). The focus on return as a way to recuperate the investment in emigrated researchers follows from the same logic, just as does the terminology regarding the 'competition and race' for scientific talent (Stephan et al. 2016; Teitelbaum 2014), or contests for "the best and the brightest" (Kapur and Mc Hale 2005). From this conceptual perspective, return mobility or migration is seen as a re-allocation process generating a 'reverse brain drain' (Song 1997) that is necessarily beneficial for the receiving country (formerly the sending country).

It is important to note that general equilibrium-based models operate in a timeless theoretical context (Schackle 1977), where processes deployed in real (not only logical) time ⁴, technically, cannot be addressed. Allocation is therefore analytically 'instantaneous'. This is compatible with modeling a series of instantaneous allocations at different theoretical points in time t_0, t_1, \dots, t_n . An agent named "Researcher" may move at t_0 from country *A* to country *B* and may go to country *C* at t_1 , returning to her country of origin *A* at t_2 . While 'circulating', this researcher is being reallocated across countries. Equally, at t_0 *Researcher_X* may go from *A* to *B* and *Researcher_Y* may go from *B* to *A*. These two researchers are also reallocated across countries. The idea of geographical 'circulation' is compatible with the conceptualization of mobility as an allocative dynamics, implying only a series of (re)allocations in theoretical (logical) time. The traces that each researcher leaves in every particular geographical location are measured, from the allocative perspective, in terms of the outputs generated while contributing to each particular localized production function.

The concepts of 'circulation' (Johnson and Regets 1998) or 'nomadism' (Meyer et al. 2001) do not take us away from the allocative perspective. In this sense, we do not see an opposition between a 'brain drain/gain paradigm' and a 'brain circulation paradigm' as it is often argued. A focus on the more or less frequent reallocation / circulation of individuals across the geographical space does not allow us to move away from the atomistic (Lawson 2015) and timeless general equilibrium framework. A change in paradigm requires a conceptual approach that allows the analytical treatment of real processes deployed in time and of inter-connection (and inter-dependence) among agents. Some elements of the so-called circulation paradigm (Gaillard and Meyer 1996, Meyer 2001) go in this direction, without going as far as offering a paradigm shift from the allocative model, as will be argued in section 2.2. The following section illustrates how the allocative approach is applied to empirical studies and some of the evidence obtained up to date, with a specific focus on studies addressing researcher return

³ Some models are designed around the assumption that migration prospects raise the expected potential returns from education and encourage higher levels of investment in human capital, with positive overall productivity effects (Stark 1998, 2004). This is called the 'brain gain effect' deriving from a brain drain dynamics (Beine et al. 2001, 2008)

⁴ Acknowledging the temporal dimension of social phenomena and therefore 'process', implies also the acknowledgement of time irreversibility (Prigogine 2005), path dependency and radical uncertainty regarding the future (Knight 1921) all of which are incommensurable with the assumptions underlying neo-Walrasian general equilibrium-based models.

dynamics and its impact. We focus on recent contributions to the literature that address empirically the quantitative effects of the international mobility of researchers, with a special focus on return effects.

2.2.1.2 Empirical evidence

Empirical research on researcher mobility built around the premises of the allocative perspective focuses on the measurement of stocks and flows of individuals across geographical boundaries, and on the quantitative assessment of the contribution of the mobile individuals to several measures of output, with a particular focus on scientific publications and international co-authorships⁵.

The search for quantitative evidence of the causal effects of geographical mobility on productivity always faces the problem of selection. Productivity differences across collectives with different geographical trajectories may be the result of selection effects (Gibson & McKenzie 2014). As Franzoni et al. (2015, 49) point out, there are reasons to believe that emigrants are positively selected among national populations of researchers and that returnees are negatively selected, if it is reasonable to think that those that do not manage to perform at internationally competitive levels that are more likely to return. However, these same authors find similar levels of performance between returnees and their compatriots who remain abroad in their analysis of the GlobSci⁶ survey, refuting the hypothesis of a negative selection of returnees. They also find that the publication productivity of researcher migrants (including returnees) is higher than that of researchers who did not migrate. Finally, they find that the collaboration networks of mobile researchers are larger than those of non-migrants and that migrants have a tendency to collaborate with their compatriots, whether these have migrated to a third country or remain at home (Franzoni et al. 2014, Franzoni et al. 2015).

Like the GlobSci study, research on the impact of scientists' international mobility is increasingly using bibliometric data in combination with other data sources as suggested by Moed and Halevi (2014). A combination of register-data analysis, CV analysis and bibliometric methods lead Asknes and colleagues (2013, 221) to conclude that Norwegian researchers with an international mobility experience publish more and have more citation impact than non-mobile individuals. Similarly, using survey data and bibliometrics, Jonkers and Cruz-Castro (2013) find that Argentinian researchers who have had an international experience publish more articles in high impact factor journals than their counterparts who have not been abroad. Like in the case of the work performed by Franzoni and colleagues cited above, the hypothesis of negative selection effect on returnees is not confirmed in this study, which also finds a significant tendency among Argentinean returnees to co-publish with researchers from their foreign host organizations (Jonkers and Cruz-Castro 2013).

Similarly, Lu and Zhang (2015) use a multi-method approach to study a sample of 1,079 scholars working in research institutions and universities in China with an overseas work or study experience. They find positive significant differences in the performance of this collective compared to 'domestic scholars' for a number of productivity variables including publications in SCI journals, publications in Chinese journals, patents and

⁵ There is a considerable number of quantitative empirical studies devoted to the description of researcher mobility patterns according to different variables and categorizations, such as mobility by scientific field (Jöns 2007, Cañibano et al. 2011), by gender (Jöns 2011, Cañibano et al. 2015), by geographical destinations (Jöns 2015, Van der Wende 2015) and mobility types (Boring et al. 2015). This work has substantially contributed to describing the nature and patterns of the researcher mobility phenomenon. However, the review we present in this section does not include a detailed reference to this type of study unless they also address some specific effects of mobility.

⁶ GlobSci provides information on active researchers working or studying in 16 different countries and scientific disciplines who were surveyed in 2011. Information regarding the "Global Science project" may be found at: [http://www.nber.org/workinggroups/ipe/ipe_researchproject.html]

research grants, which according to the authors points to the success of Chinese governmental efforts to encourage the return of emigrated researchers (Lu and Zhang 2015, 288). Such programs include the provision of positions with very beneficial conditions for returned scholars such as higher salaries (2 or 3 times more than local scholars), faster promotion tracks and availability of funding to start labs and recruiting researchers and personnel, all of which raises the question regarding the attribution of causal relationships between the overseas experience and the observed higher performance levels for returnees considering the gap in the work conditions in China between the two collectives (returnees / domestic). These results are consistent, however, with those obtained earlier by Jonkers and Tijssen (2008) in their study of molecular biologists returned to China, who showed high levels of publication productivity. These authors also observed a positive correlation between foreign experience in a particular region and the number of international co-publications with researchers from this region (Jonkers and Tijssen 2008: 330).

Recent studies based only on bibliometric information contribute to the production of empirical evidence, with inconclusive overall results regarding the potential impact of international and return mobility on publication productivity and citation impact. The OECD finds higher publication productivity and citation impact values among emigrant researchers compared to 'stayers' and 'returnees' (OECD 2015). Moed and colleagues (2013) find, for a study based on five countries⁷, a strong correlation between the degree of migration from one country to another and the level of co-authorship between the two. However, a more recent study focused on the top 100 authors in seven disciplines does not observe a specific positive effect of country mobility upon publication productivity and citation impact⁸ (Halevi et al. 2016). In a bibliometric-based study comparing a sample of more than 10,000 Dutch and Spanish researchers, we find that mobile early career researchers who returned to the country where they signed their first publication after a period abroad show higher levels of publication productivity than non-returned mobile researchers. In contrast, we do not find evidence of larger or smaller citation impact according to the returnee/ non-returnee categories, quite probably due to their early career status (Robinson et al. 2016).

The bibliometric method is acknowledged as useful and somewhat promising for tracing researchers' trajectories through their organizational affiliations, but has a number of key limitations that should be taken into account, including the fact that it traces researchers who keep publishing in scholarly journals but is unable to capture those who do not publish, like those moving to business or other sectors where publishing is not the norm (Appelt et al. 2015; Moed and Halevi 2014). Most of the available results from bibliometric studies are still only rather preliminary and exploratory, as acknowledged by their authors.

Results from studies based on other methodologies provide additional evidence but remain partial and mutually incomparable. In a CV-data based study conducted on a sample of 266 mobile Spanish researchers from three disciplines we found no evidence of a positive impact of international mobility upon publication productivity. In fact, we even found evidence of higher levels of productivity being associated with lower levels of mobility in the case of molecular biologists. However, we also found a positive association between mobility and the participation in international research projects (Cañibano et al. 2008). Cruz-Castro and Sanz-Menéndez study a larger sample of Spanish researchers with an international experience from three other disciplines and find 'a modest yet significant positive link' between mobility and publication productivity (Cruz-Castro and Sanz-Menéndez 2010: 34). A positive association between

⁷ Germany, Italy, the Netherlands, the UK and the USA

⁸ A small effect is only found for the fields of Environmental Geology, Arts & Humanities and Business. This study finds evidence of correlation between the number of changes in institutional affiliations– which may take place within the same country – and publication productivity and impact, but does not find evidence of higher productivity being associated with mobility across countries (Halevi et al. 2016).

international post-doc mobility and publication productivity is also found by Fernández-Zubieta (2009) for a small sample of researchers from the UK.

A survey-based study targeting research migrants from New Zealand, Papua New Guinea and Tonga, Gibson and McKenzie (2014) find return migrants to be more actively engaged in international collaboration and networking than researchers who never migrated. They also find current migrants to be more productive than returnees and non-migrants in terms of research publications and citation impact, which they argue is unlikely to reflect negative selection of returnees, but rather relocation effects. Veugelers and Bouwel (2015) study the self-reported data concerning the effects of the international mobility experience from the MORE1 survey. Overall, researchers report positive outcomes from mobility regarding publication output, network effects, recognition and patent output among other.

In sum, a positive association between international mobility, publication productivity and citation impact is found in a non-negligible number of studies but there is also evidence of no impact found and even of negative impact. Table 1 summarizes the content of the literature reviewed focusing on the type of data that the different studies used, the countries they focused on and the main results obtained regarding the effects of mobility.

The effects of international mobility on the capacity to produce new knowledge will depend on a variety of complex factors, including the characteristics of the moving individuals – which takes us back to the selection problem – the institutional conditions that frame the mobility, the research field, the quality of mentoring and supervising received while moving, the prestige of hosts institutions and their capacity of hosting scholars, the infrastructures and resources available, the history of the moving researcher including career stage and family and personal status, etc. All these circumstances underlying the observed dynamics often remain black-boxed in studies based on an input-output or allocative logic. In the case of return mobility, the reasons for return and the eventual difficulties encountered for a re-integration into the home system are important factors conditioning post-return performance (Gaillard and Gaillard 2015, 425). The evidence regarding reasons to return point mainly to family and personal reasons (Franzoni et al. 2015), to the feeling of national identity and gravity towards home (Thorn and Holm-Nielsen 2006), and to the existence of collaboration links with the home country (Fontes 2007, Baruffaldi and Landoni 2012, Andújar et al. 2015), rather than to strictly scientific reasons.

Our review suggests that in fact there seems to be more empirical support regarding the connective power of mobility rather than its capacity to boost the stock of publications and citations. There is consistent evidence on the link between international flows of researchers and the emergence of associated international research collaborations. The analysis of connectivity and inter-dependence dynamics is limited by the analytical restrictions imposed by the allocative model. An alternative is to depart from a completely different conceptual approach that allows us to deal with mobility as a genuinely connective phenomenon.

Table 1 Summary of studies reviewed and addressing the effects of international mobility on publication productivity, citation impact and co-authorship networks

Authors - Year	Type of data	Studied countries	Results
Franzoni, Scellato, Stephan (2015)	Survey Bibliometrics	16 countries	Returnees and emigrants perform similarly Mobile researchers (migrants and returnees) perform better than the non-mobile Mobile researchers have larger networks of co-authors Performance measure: publication productivity
Asknes, --- (2013)	Register CV, Bibliometrics	Norway	Mobile researchers have higher levels of publication productivity compared to the non-mobile. They also have higher citation impact.
Jonkers, Cruz-Castro (2013)	Survey Bibliometrics	Argentina	Mobile researchers publish more papers in high impact factor journals than the non-mobile. Returnees perform similarly to non-returnees and have larger co-authorship networks.
Lu, Zhang (2015)	Interviews Survey Bibliometrics	China	Returnees are more productive than 'domestic' researchers. Productivity measures: publications, research grants, patents
Jonkers, Tijssen (2008)	Interviews, Bibliometrics	China	Returnees co-publish with researchers from the mobility hosting region.
OECD (2015)	Bibliometrics	OECD countries	Higher publication productivity and citation impact for emigrants compared to non-mobile and returnees
Moed,Aisati, Plume (2013)	Bibliometrics	Germany, Italy, the Netherlands, UK, USA	Migration to a particular country correlated with co-authorships with researchers from that country
Halevi, Moed,Bar-Ilan (2016)	Bibliometrics	Origin countries of 700 authors	Country mobility not associated with publication productivity or citation impact
Robinson, Cañibano, Woolley, Costas (2016)	Bibliometrics	Netherlands, Spain	Returnee early career researchers show higher levels of publication productivity than non-returnees. No difference in citation impact between returnees and non-returnees
Cañibano, Otamendi, Andújar (2008)	CV	Spain	No evidence of association between mobility and publication productivity (physics, philosophy) Evidence of negative association between mobility and publication productivity (molecular biology) Mobility associated with higher levels of participation in international research projects
Cruz-Castro, Sanz-Menendez (2010)	Survey Bibliometrics	Spain	Modest positive link between mobility and publication productivity.
Fernández-Zubieta (2009)	CV	UK	Positive association between international post-doctoral mobility and publication productivity
Gibson, McKenzie (2014)	Survey	New Zealand, Papua New Guinea, Tonga	Migrants are more productive than returnees and non-migrants.
MORE1	Survey	EU	Positive self-reported performance outcome from mobility

2.2.1 The connective approach

2.2.1.1 Theoretical considerations

The allocative model presented in the previous section is strongly influenced by the economic view that conceives knowledge as an investment good that is embedded and accumulated either in physical objects (texts, machines) or in human bodies and brains (as in human capital theory). Knowledge is treated as susceptible of being progressively stockpiled like a commodity. Measuring flows of knowledge in this context equals measuring the flows of its carriers; hence the drain/gain approach to human capital (researchers) mobility and the policies centered on the perception of a competition among nations for the accumulation of talent. This cumulative vision also influences the way in which scientific excellence seems to be increasingly understood in policy arenas, as almost exclusively expressed in the stock of scientific publications and citations. This approach has the advantage of being relatively easy to operationalize.

An alternative view of knowledge is offered by evolutionary economics for whom economic evolution means essentially 'evolving knowledge' (Loasby 2001) and for whom knowledge is conceived as 'structure' and 'process' (Loasby 2012). In Cañibano and Potts (2016) we propose an evolutionary approach that conceives human capital as inherently networked (as opposed to the mainstream stock-like approach); as an open and evolving complex system. This section is based on that work and focuses on its implications for the conception of human capital (and therefore also researchers) mobility.

Our theoretical proposal builds on neo-Schumpeterian economics, complexity economics and the socio-economics of Michel Callon (1991, 2002) to conceptualize human capital as an evolving structure of complementarity where no description of skills is possible unless the networks "within which they are expressed and put to work are reconstituted" (Callon 1991, 138). Human capital "is a structure rather than an aggregate" (Boulding 1968);⁹ it is contextual and dependent on the set of complementary knowledge carriers that allow skills to be deployed and useful such as other complementary skills, infrastructure and technical equipment and codified knowledge (texts). In addition, it is the structure of complementarity between the network components that defines the nature of jobs (Cañibano and Potts 2016, 13). Callon proposes the term "convergence" to express the degree of complementarity and fitness among network components, that is "the way in which the activities of actors fit together despite their heterogeneity" (Callon 1991, 148). Achieving convergence requires a process of alignment and adaptation. Networks may evolve towards weaker or stronger convergence over time. "Strongly convergent networks only develop after long periods of investment, intense effort and coordination" (*Ibid*, 148).

We may now turn back to research and researchers' mobility. From this perspective, a researcher is conceptualized as a node in a network of complementarity where she performs a specific job. When moving – internationally –, researchers 'switch networks', which necessarily implies recombination of network elements and complementarities, and requires (re)adaptation in order to be successful. Researchers may move across productive settings, but their skills are not automatically transferred. A process of adaptation is required to take place in both the recipient network and the sending network. The 'job', that is the role of the person in the particular network, is therefore redefined in this process in a more or less radical manner.

The process of adaptation and convergence of circulating skills is simplified when their carriers (researchers) move across consolidated networks that are very similar¹⁰ (Woolley and Cañibano 2010, 17). In contrast, if they circulate across 'emergent networks' (Callon

⁹ Boulding (1968, 113) points out that "we do not necessarily increase the productive capacity of a society by adding another person to it, even if he is very expensively trained, if that person does not fit into the matrix of information flows in a way that increases the productivity of the society."

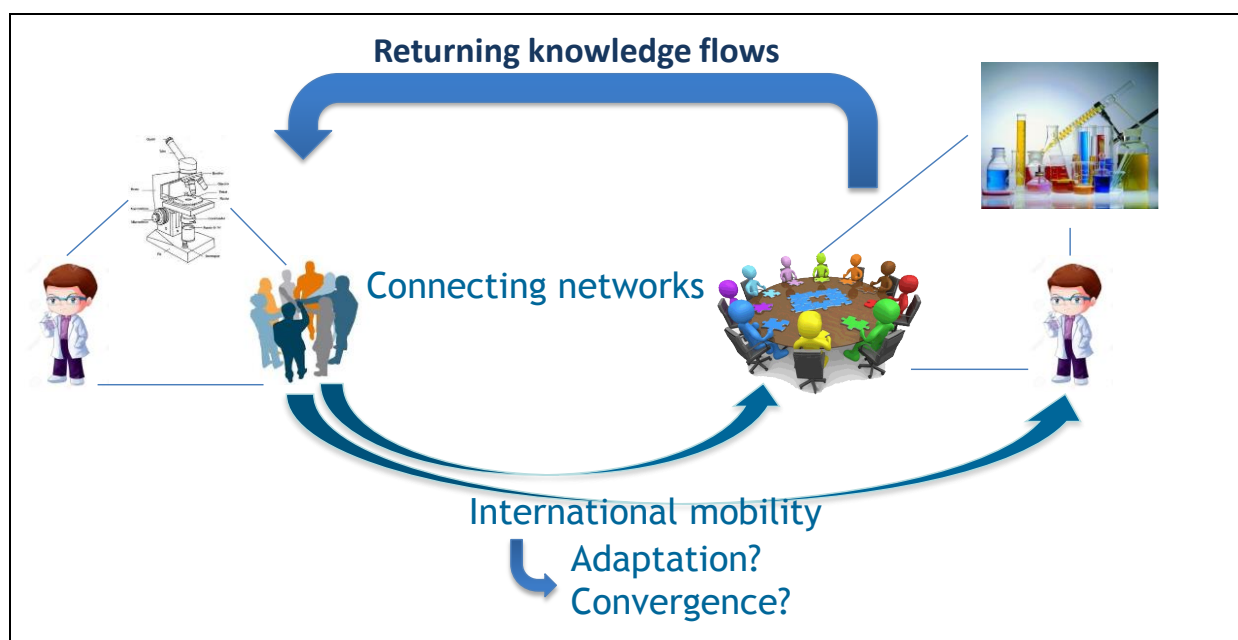
¹⁰ Callon refers to consolidated networks in which "competences and instruments have been duplicated in multiple copies and widely distributed" (Callon, 2002: 290).

2002) knowledge concerning their forming components and complementarities barely exists. Moving into such type of network will require a longer and more uncertain process of adaptation (Woolley and Cañibano 2010, 17; Cañibano and Potts 2016, 17).

It is also important to note that in this theoretical context, agents (researchers in our focus of interest) are located in real time (not only logical time as in the allocative model). They have to face and cope with uncertainty regarding the future and depend on the paths they have followed in the past. For example, as suggested by Fernández-Zubieta et al. (2015, 25) there might be a relationship between different mobility experiences over a researcher's career.

In sum, from the connective perspective, researchers' geographical mobility reconfigures research networks (Woolley and Cañibano 2010). It alters the structure of complementarities in both the sending and the recipient networks. This alteration induces adaptation processes deployed in time¹¹. In addition, mobility may induce the emergence of new networks. New networks may take the form of emergent connections between recipient and sending networks (i.e. scientific collaborations) but also of new jobs and activities defined by recombination of network components (Cañibano and Potts 2016). Figure 1 is an attempt to illustrate these claims, stressing the networked nature of skills, the eventual connections that may emerge out of 'network switching' and the adaptation process required for a researcher to fit into a new research team and a new network.

Figure 1 A connective vision of researcher mobility



Source: Canibano, 2016

The relevant research questions that emerge from this connective vision differ substantially from the ones normally addressed from the perspective of the allocative model. For example, does researchers' mobility have an impact on the nature of knowledge generated by sending and receiving networks? Are there typical channels and connections built between sending and receiving networks? Are there institutional mechanisms to support network convergence after it receives or loses researchers? Are there institutional mechanisms supporting connectivity across the networks throughout which researchers circulate? How does mobility affect researchers' identity and their perception of their roles within different networks? What characterizes highly attractive

¹¹ This applies to return mobility as much as to any other type of mobility.

networks; are they highly consolidated? To what extent does mobility trigger the creation of emergent networks? Do different types of mobility (i.e. short-term / long-term) induce different types of network reconfiguration processes?

If we focus specifically on return mobility, how do returnees' skills fit into the structures in which they are re-integrated? Under what circumstances is the return option beneficial for a particular network; a particular research system; the researcher herself?

These questions are largely unexplored. Of course the analytical acknowledgement of the heterogeneity of agents and networks, along with the acknowledgement of the temporal dimension (uncertainty plus path-dependency) makes empirical enquiry into network reconfiguration processes very challenging. The conceptual approach described here and labeled as 'connective' is still under development. It does not yet explicitly underlie any empirical work, but is nevertheless in line with some interesting contributions that are briefly reviewed in the following sub-section.

2.2.1.1 Empirical evidence

Meyer and colleagues saw the limitations imposed by the neoclassical view of human capital (and therefore the allocative model) for addressing the transnational flows of knowledge associated with researchers' mobility. They pointed to the relational dimension of skills (Meyer 2001, 95) and to their dependence on other resources (Meyer and Brown 1999) and institutions (Meyer and Wattiaux 2006). As argued in Cañibano and Woolley (2015, 124), they pointed toward a distributed and connective theory of human capital without actually developing it. Instead, these authors focused their efforts in studying the dynamics of so-called Diaspora Knowledge Networks (DKN) as structures of researchers organized around national identity, capable of counteracting the knowledge drain caused by emigration from developing countries to some extent. However, actual empirical evidence on these supposed counteracting effects is limited (Gaillard and Gaillard 2003). The DKN literature has been influential nevertheless, encouraging the design of policies attempting to leverage knowledge from highly skilled nationals located offshore as an alternative to the 'return' option (Cañibano and Woolley 2015, 125).

The work by Anna Lee Saxenian provides empirical evidence for theoretical claims regarding the network building and reconfiguring power of geographical mobility. Her work does not focus on researchers *per se*, but on highly skilled Indian, Taiwanese and Chinese employees and entrepreneurs who circulate across Silicon Valley and their regions of origin, building professional networks and valuable connections that boost regional industrial development in their home countries. Business models, financial resources, people and knowledge flow constantly across the Pacific reconfiguring transnational productive networks and encouraging innovation and development. These processes have been encouraged by the progressive development of appropriate institutional and economic conditions in the countries of origin (Saxenian 1999, 2000, 2006; Saxenian and Hsu 2001). An equivalent to Saxenian's investigation on circulating entrepreneurs and the development of professional and productive networks has not been undertaken to address the circulation of researchers and the process of reconfiguration of international scientific networks. Her work sets the basis for an eventual inquiry regarding 'the new Argonauts' in the scientific profession, that is, mobile scientists who act as 'knowledge brokers' (Lam 2014) and who build bridges and networks across the geographical space.

We know that mobile researchers tend to be more involved in collaboration research networks because they co-publish more with researchers based in different geographical locations, as described in section 2.1.2. Woolley et al. (2008) go a step further distinguishing between the formation of social-capital networks (expressed in collaborative research projects) and the establishment of knowledge-producing collaborations (expressed in the production of publications, grant applications, patents and innovations) associated with research training and post-doctoral international experiences. Based on survey data, they find evidence of positive correlation between

mobility to certain locations and the emergence of productive collaborations involving colleagues from those same locations, for a sample of over 6,000 researchers from six countries in the Asia-Pacific region.

From the work by Fontes (2007) we know that emigrated researchers may keep a variety of formal and informal connections with institutions in their home countries including the organization of courses and seminars, exchange of students and researchers, development of joint projects, joint publications, doctoral co-supervision and advisory activities (Fontes 2007, 294). Portuguese researchers in this study did not have high returning prospects, which did not stop them from building a variety of channels for knowledge exchange across nodes in collaborative networks. Fontes and colleagues find also evidence of association between long-term scientific mobility and long-term collaborative and networking relationships with the organisations hosting mobility (Fontes et al. 2013).

Jöns' (2009) study of German academic mobility over an extended period of time confirms that "the formation of transnational knowledge networks through brain circulation includes many dimensions beyond the well-documented international co-authorship of journal articles". In particular, "it involves subsequent flows of students and professors" and other interactions including the collaboration in research projects (Jöns 2009, 334). Jöns work also shows that mobility contributes to shaping the evolution and consolidation of centres of knowledge production and their networks (Jöns 2009, 2015).

Edler and colleagues (2011) suggest that international mobility may also be associated with the sectoral expansion of networks, since they find evidence of associations between outward mobility (from Germany) and participation in knowledge and technology transfer activities to industry.

The above reported studies are mainly based on quantitative methods and on data collected through surveys and CVs. The qualitative findings obtained by Ackers and Gills (2008) regarding the mobility of European researchers they interviewed, support some of the fundamental claims of our networked and evolutionary approach to human capital and mobility. These authors point to the contextual circumstances that may jeopardize the exercise of scientific skills upon return after migration for example (Ackers and Gills 2008, 19). They describe internationalization as a 'continuum' over a researchers' career, which takes different forms at different points in time. Emigration, return, short-stays, virtual exchanges, etc. are different expressions of internationalization in that continuum that is in turn expressed in the emergence and development of projects and the evolution of research fields. "The position of individual scientists in the continuum of internationalization at any point in time reflects the interplay of diverse factors, and the potential gains and losses both to themselves and to the countries concerned" (Ackers and Gills 2008, 242).

The policy implications of the connective approach are not straightforward. The heterogeneity of actors and networks implies that each case, or set of cases, will require specific assessment. Much still remains unknown. Steps forward can be made by studying the specific conditions leading to the enriching of connectivity associated with mobility, by identifying good practices, by tracing the evolution of networks and their knowledge production over time, by assessing the effect of certain connective instruments and the corresponding form of mobility. The connective approach opens up a large and interesting horizon for the design of research and policy agendas, but rules out the option of addressing complex social problems through simple uniform solutions like stock counting exercises.

2.2.1 The creativity approach

2.2.1.1 Theoretical considerations

The two approaches to geographical mobility previously described tell us that i) mobility re-allocates individuals across the geographical space altering therefore the

corresponding stocks of embodied knowledge (human capital) and ii) that it reconfigures the networks of complementarity in which researchers' work is embedded. By doing so it may induce a variety of knowledge flows that are *a-priori* undetermined.

A third line of thinking makes us face even more directly the implications of the radical uncertainty of time and the space for the exercise of imagination, entrepreneurship and for knowledge creation. This line of thinking values mobility as a liberating force, freeing the human mind for creative work that it would not otherwise produce (Johnson 1965). It is an agency of progress that interrupts the routine of existing habit and releases energies (Park 1928). Mobility exposes researchers to new contexts and unleashes creative forces that propel scientific knowledge production (Bauder 2012), since knowledge from distance sources is potentially more creative than local knowledge (Gibson & McKenzie 2014). Mobility enlarges the margins of what is familiar to individuals and contributes to the progressive shaping of their identity (Costa 2004, Lam 2016).

Mobility thus entails an exposure to novelty, change and recombination that have always made it attractive for scientists, since it is a source of creativity, learning and self-discovery, in the sense that the individual is reshaped by the mobility experience and might discover some new capabilities or develop new skills (Cañibano and Potts 2016). From this perspective, mobility is not seen as a process of transfer but of potential transformation. In this sense it is completely commensurable with the connective approach. Transformation and knowledge effects could actually be interpreted as part of the networks reconfiguration processes that mobility entails¹². Return mobility implies the reintegration of a researcher into a familiar context or network. From the creativity perspective, the potential of global knowledge gains from return would seem smaller than if the researcher moved to a third country for example. However, return may also be seen as a way for a country to benefit from the creative/transformational experiences undertaken elsewhere.

From a policy perspective, the creativity approach would perfectly justify programs encouraging researchers' mobility. These programs support the above processes of knowledge recombination and creation by allowing researchers to be exposed to different contexts. Assuming radical uncertainty of course also implies that there is also a risk associated with every move, and that the specific outcomes of mobility may never be predicted.

2.2.1.2 Empirical evidence

To the best of our knowledge, there is only one published scientific paper that addresses specifically the 'creativity dimension' of mobility. Spivak and Hubert (2012) address how the international experiences shaped researchers' ways of thinking, their research goals, questions and methods, their values and the ways in which they position themselves in the scientific community. The study is qualitative and traces the trajectories of two physicists returned to Argentina after an extended period abroad in different locations. Each trajectory leads to a very different orientation and mode of knowledge production upon return. One of the researchers is much more applied and development oriented and conducts research in strong connection with industry, which derives from his connections and experiences in Brazil and from his overseas experience in Japan (Univ. of Kyoto). The other researcher is much more oriented toward, and connected with the international scientific community. This researcher does more basic science and international mobility is an inherent part of his work practice. He originally did a post-doc at the University of Berkeley. The two stories show how the ways of understanding science of each

¹² At this point, we find useful to make the distinction between the connective and the creativity approaches to mobility in order to categorize theoretical and empirical contributions from the literature. However, since they are fundamentally commensurable, they could eventually be merged into one broad theoretical framework.

researcher have been shaped by the institutional and cultural contexts throughout which their careers have evolved.

Box 1 Conceptual approaches to researcher mobility and their implications: summary

The allocative approach

Basic theoretical assumptions:

- knowledge is a stock (like a commodity)
- knowledge is embedded in individuals in the form of human capital
- knowledge embedded in individuals travels with them
 - the human capital stock of the sending country diminishes (brain drain)
 - the human capital stock of the receiving country increases (brain gain)
 - human capital can be repeatedly reallocated across countries over time (brain circulation)
- the human capital stock is efficiently used by the productive system
- if the stock of research human capital increases the research output also increases (in the form of innovations, publications, etc.)

A priori hypotheses: retaining / attracting / attracting back - all policies and strategies targeting the increase of the stock of research human capital – will induce both, an increase in the stock of embodied knowledge + an increase in knowledge production capacity.

Empirical studies test these hypotheses. Many studies find a positive association between the international mobility of researchers and their publication productivity. A few studies do not find such an association.

The connective approach

Basic theoretical assumptions:

- knowledge is a structure, not an aggregate (not a stock).
- knowledge structures (including human capital structures) are formed by inter-dependent complementary elements
- knowledge structures evolve in time. They are strongly context-dependent, open and path dependent (they are complex systems). They evolve towards an uncertain future.
- individuals' mobility modifies the configuration of knowledge structures

There are *no a priori hypotheses* regarding how the structures' reconfiguration process takes place when its forming components (including individuals) are modified.

Available empirical studies address how connections change and emerge when people move across research networks. Researchers' mobility is positively associated with the emergence and change of transnational collaboration networks. Much remains to be done to understand the process of network reconfiguration deriving from researchers' mobility.

The creativity approach

Basic theoretical assumptions:

- the change of context (institutional, cultural) and connections that mobility entails contributes to creating the conditions for knowledge recombination processes and for self-discovery out of which any recombination or creative inspiration may emerge.
- the potential recombination process takes place in a context of radical uncertainty -> the outcome cannot be predicted (not even estimated).

A priori hypotheses regarding the specific outcome of the creative recombination process are incommensurable with the radical uncertainty assumption

One empirical study addresses two individual cases and the process of identity and epistemic reconfiguration entailed by geographical mobility. The epistemic effects of mobility are largely unknown.

3 Evidence of return mobility of researchers

The primary focus of this report is to collect and analyse evidence on return mobility of researchers at the country level using data from the MORE2 Survey. This survey specifically targets various aspects of researcher mobility. However, there are other potential data sources on researcher mobility, which may provide further evidence on the return mobility of researchers. Therefore, this section will first offer a deeper analysis based on the MORE2 survey data, and next explore relevant data availability in two other relevant surveys: the regularly conducted EU Labour Force Survey (LFS) and the Careers of Doctorate Holders Survey (CDH), conducted on an ad-hoc basis in collaboration by the UNESCO Institute of Statistics (UIS), OECD and Eurostat.

3.1 International mobility of European researchers: a study of geographical trajectories using the MORE2 Survey

3.1.1 Data, main definitions and basic description of the sample studied

The following analysis of the dynamics of return mobility of European researchers is conducted on the basis of the micro-data from the survey addressed to researchers working in European higher education institutions undertaken within the MORE2 European project on 'Support for Continued Data Collection and Analysis Concerning Mobility of Researchers'. The data allows us to trace to a certain extent the re-allocation of individual researchers across countries. Therefore, as argued earlier, this quantitative study is framed within the allocative approach as described in section 2.1 of this report. The deliverables of the MORE2 project provide extended details on the purposes of the project and the methodology for the design and implementation of this survey (see methodological report, IDEA Consult 2013b), along with a broad range of indicators concerning the population of researchers studied (see indicator report, IDEA Consult 2013b)¹³.

The survey was conducted in 2012 resulting in a database containing information on 10,547 individual researchers working in the EU and Associate and Candidate Countries¹⁴. The MORE2 study, defines researchers according to the Frascati Manual definition (OECD, 2002) and by research career stages according to the European Commission Framework for Research Careers (European Commission, 2011). In addition, the MORE2 survey addresses a variety of types of researcher mobility, which are also described in the corresponding project reports (see for instance Final report, IDEA Consult 2013a pag.61).

This study of the patterns of geographical return mobility of European researchers focuses on the sub-group of PhD holders surveyed within the MORE2 study who provided information on key reference countries. Our choice is justified by the fact that this is the subgroup of researchers surveyed who were also asked to provide information on their post-PhD geographical mobility, which allows us to address geographical outflows from - and inflows to - both their country of origin (citizenship) and the country where they obtained their PhD.

The sub-sample studied adds up a total of 7,469 researchers, including all those reporting a current career stage of R2, R3 and R4¹⁵ and excluding all those missing

¹³ The reports from the MORE2 project are available at:

<http://ec.europa.eu/euraxess/index.cfm/services/researchPoliciesWebsite>

¹⁴ The MORE2 survey includes all 27 EU Member States plus Associated Countries (Switzerland, Norway, Iceland) and Candidate Countries (Turkey, Macedonia (FYROM) and Croatia) (IDEA Consult, 2013a: 55)

¹⁵ See List of abbreviations and definitions on page 60 for a definition of career stages.

information of key importance for our purposes, such as countries of PhD and employment¹⁶:

Table 2 Data cleaning process

	Cleaning	Studied sample
Total MORE2 sample	10,547	10,547
R1 researchers	- 2,190	8,357
R2, R3, R4 missing PhD country	- 887	7,470
R2, R3, R4 missing employment country	- 1	7,469

We address return mobility patterns of PhD holders (R2 researchers) using the following two sets of information provided by the survey:

1. The succession of countries of reference, including country of (first) citizenship, country of PhD, country of residence and country of current employment.
2. The information regarding the international moves undertaken after the PhD and implying work abroad for more than three months, over the previous 10 years before the survey, and including up to a maximum of eight moves (questions 48 to 53 in the survey questionnaire).

Return dynamics can be addressed using either citizenship or country of PhD as main country of reference. The information on mobility described above allows us to distinguish between different types of geographical trajectories. The definitions provided in tables 3 and 4 below cover all of the geographical trajectories that the MORE2 data allows us to address.

¹⁶ We are not applying the country weights included in the MORE2 data file since these are calculated using the panel country as the base country for the whole database. We have focused on other country-related information such as citizenship, PhD and current employment countries. We have also eliminated researchers at career stage R1 from the original dataset in order to centre our analysis on researchers holding a PHD (careers stages R2-R3-R4).

Table 3 Geographical trajectory types according to country of (first) citizenship

Trajectory Type		Description
A	Post-PhD return	The researcher is awarded the PhD in a different country than the country of citizenship, to which he/she returns later in the career. Country of citizenship and country of current employment coincide in these cases.
B	Temporary return	The researcher obtained his/her PhD abroad and is currently employed abroad (different country to citizenship) but registers at least one temporary work visit of more than three months in the country of citizenship.
C	Return following temporary mobility	The researcher obtained his/her PhD in the country of citizenship, where he/she is also currently employed, but registers temporary visits abroad of at least three months of duration (after which he/she returned to the country of origin).
D	Outgoing/incoming mobility	The researcher is currently employed and residing in a different country to the country of citizenship and does not register any temporary returning moves of more than three months.
D. ₁	Pre-PhD mobility	The researcher obtained his/her PhD abroad. He/she is currently employed and residing in a different country to the country of citizenship and does not register any temporary returning moves of more than three months.
D. ₂	Post-PhD mobility	The researcher obtained his/her PhD in the country of citizenship. He/she is currently employed and residing in a different country to the country of citizenship and does not register any temporary returning moves of more than three months.
D*	Partial mobility	The researcher is currently a resident in his/her country of citizenship but is employed elsewhere. Note: Researchers belonging to this group would also be part of either D. ₁ or D. ₂
E	Non-mobility	The researcher obtained his/her PhD in the country of citizenship, where he/she is also currently employed, and does not register temporary visits abroad.

Table 4 Geographical trajectory types according to country of PhD

Trajectory Type		Description
B'	Temporary return	The researcher is currently employed and residing in a different country to the country of PhD but registers at least one temporary work visit of more than three months in the country of PhD.
C'	Return following temporary mobility	The researcher is currently employed in the country where he/she obtained the PhD but registers temporary work visits abroad.
D'	Outgoing/incoming mobility	The researcher is currently employed and residing in a different country to the country of PhD and does not register any temporary returning moves of more than three months (to the country of PhD).
D*	Partial mobility	The researcher is currently a resident in his/her country of PhD but is employed elsewhere. Note: Researchers belonging to this group would also be part of either D. ₁ or D. ₂
E'	Non-mobility	The researcher is currently employed in the country where he/she obtained the PhD, and does not register temporary visits abroad.

The studied sub-sample is classified as shown in the following tables according to gender, career stage and field of research in current employment.

Table 5 Sub-sample by gender and career stage

Career stage	Women	% Women	Men	% Men	Total
R2	899	46.7%	1,026	53.3%	1,925
R3	1,145	38.4%	1,835	61.6%	2,980
R4	759	29.6%	1,805	70.4%	2,564
<i>Total</i>	<i>2,803</i>	<i>37.5%</i>	<i>4,666</i>	<i>62.5%</i>	<i>7,469</i>

Source: MORE2 Survey data, authors' calculations

Table 6 Sub-sample by field of research in current employment

Field of research	Total	%
Agricultural Science	397	5.3%
Engineering and Technology	1,081	14.5%
Humanities	845	11.3%
Medical Science	1,617	21.6%
Natural Science	1,599	21.4%
Social Science	1,930	25.8%
<i>Total</i>	<i>7,469</i>	<i>100.0%</i>

Source: MORE2 Survey data, authors' calculations

3.1.2 Data analysis

3.1.2.1 Geographical trajectories: description and analysis by gender, field of research and current career stage

We may group the geographical trajectory types defined above into three broad categories for a first overview of the data. We group researchers who show some kind of return dynamics (A+B+C taking the country of citizenship as reference and B'+C' using country of PhD); those who are employed abroad and have not experienced return (D,

D'), and those who have not been mobile (E, E': never worked abroad for more than 3 months after their PhD and currently employed in the country of citizenship or PhD).

Table 7 MORE2 PhD holders by broad geographical trajectory type, using citizenship and PhD countries as reference

Type of trajectory		Case 1 (citizenship country)		Case 2 (PhD country)	
		TOTAL	%	TOTAL	%
A+B+C	Return	1,962	26%	1,247	17%
D	Outgoing / Incoming	1,110	15%	1,596	21%
E	Non-mobile	4,397	59%	4,626	62%
	Total	7,469	100%	7,469	100%

Source: MORE2 Survey data, authors' calculations

Out of the 7,469 researchers in our sample, the largest group is formed by 'non-mobile' researchers as defined above, who overall represent 60% of the sample whether we use the country of citizenship (Case 1) or the country of PhD (Case 2) as origin reference. The group of mobile researchers is distributed differently across the two cases, depending on the country of reference. Researchers showing some type of return dynamics to their country of (first) citizenship add up to 26% of the sample, compared to 15% of mobile researchers who left their countries and never returned there to work (for more than three months). In contrast, the returnees to their country of PhD (Case 2) after a period abroad add up to 17% and researchers who left their PhD countries and didn't return equal 21%. It should be noted that the difference between the two cases should mainly be due to researchers who return to their citizenship country after a PhD abroad, who are classified in the return group in the Case 1 column and in the outflow group in Case 2. As shown in Table 8 below these researchers represent a substantial part (31%) of those who are mobile.

Table 7 provides additional details on the subgroup of mobile researchers, which is dominated by those employed in their country of citizenship but registering temporary visits abroad (32%) and, as mentioned, by those returning home after finishing a PhD abroad (31%). Only 1% of mobile researchers register visits to their country of origin while working abroad. The group of outgoing researchers is equally distributed across those who left their country before their PhD and those who left after.

Table 8 MORE2 PhD holders by geographical trajectory type, using citizenship and PhD countries as reference

Type of trajectory		Case 1 (citizenship country)		Case 2 (PhD country)	
		Count	%	Count	%
A	Post-doctoral return	934	30%	n.a.	n.a.
B	Temporary return	43	1%	166	6%
C	Return following temporary mobility	985	32%	1,081	38%
A+B+C	Returnees	1,962	64%	1,247	44%
D. ₁	Outgoing before PhD	527	17%	n.a.	n.a.
D. ₂	Outgoing after PhD	583	19%	1,596	56%
	Total mobile	3,072	100%	2,843	100%
D*	Partial mobility	95	3%	75	2.6%
	Total non- mobile	4,397		4,626	
	TOTAL	7,469		7,469	

Source: MORE2 Survey data, authors' calculations

Table 8 also shows that 56% of mobile researchers are currently working in a different country to the one where they obtained their PhD and 36% of mobile researchers do not work in their countries of citizenship. A small proportion of researchers (3%) reside in their country of citizenship but work elsewhere (D*).

Table 9 MORE2 PhD holders by geographical trajectory type and gender, using citizenship and PhD countries as reference

Type of trajectory		Case 1 (citizenship country)		Case 2 (PhD country)	
		Women	Men	Women	Men
Total Researchers sample					
A	Post-doctoral return	11.2%	13.3%*	n.a.	n.a.
B	Temporary return	0.5%	0.6%	1.9%	2.4%
C	Return following temporary mobility	11.5%	14.2%*	12.7%	15.5%*
A+B+C	Returnees	23.3%	28.1*	12.8%	15.2%*
D. ₁	Outgoing before PhD	6.2%	7.5%*	n.a.	n.a.
D. ₂	Outgoing after PhD	6.1%	8.8%*	18.1%	23.4%*
	Total non- mobile	64.4%*	55.6%	67.3%*	58.7%
	TOTAL	2,803	4,666	2,803	4,666
Mobile Researchers sample					
A	Post-doctoral return	31.6%	29.9%	n.a.	n.a.
B	Temporary return	1.4%	1.4%	5.9%	5.8%
C	Return following temporary mobility	32.4%	31.9%	38.9%	37.6%
A+B+C	Returnees	65.3%	63.2%	44.8%	43.4%
D. ₁	Outgoing before PhD	17.5%	17.0%	n.a.	n.a.
D. ₂	Outgoing after PhD	17.1%	19.9%	55.2%	56.6%
	Mobile	652	1,310	917	1,926

Note: *Significantly higher proportion with 95.44% confidence after performing a test of the difference in proportions of female vs males. *Source:* MORE2 Survey data, authors' calculations.

Table 9 (upper part – Total Researchers) shows how women are significantly more likely to be non-mobile than men, which also implies that the proportion of men is higher than women in the different sub-groups of mobile researchers. The gender difference is statistically significant across all groups of mobile and non-mobile researchers, with the exception of group B, given the small sample of researchers registering temporary returning flows. The lower part of Table 9 reproduces the same calculations as rates over the mobile (instead of total) researcher sample. We observe that the rate of women returnees over the total mobile female population (65%) is higher than that of men (63%). Outgoing mobility before the PhD is also more common among mobile women than mobile men; however mobile women emigrate less after the PhD compared to men. These gender differences do not show up as statistically significant. The results seem consistent with previous findings telling us that women researchers tend to be mobile at earlier stages in their careers, in particular before they complete their PhD (Cañibano et al. 2015).

Table 10 MORE2 PhD holders by geographical trajectory type and field of research in current employment, using citizenship country as reference ("Case 1")

Type of trajectory		Agri	Eng. Tech.	Hum.	Medical Science	Natural Science	Social Science	Overall
Total researchers sample								
A	Post-doctoral return	10.3%	14.7%	14.2%	10.3% -	10.1% -	14.8%+	12.5%
B	Temporary return	0.5%	0.5%	1.42%+	0.3%	0.5%	0.6%	0.6%
C	Return following temporary mobility	10.3%	12.9%	11.7%	12.0%	16.9%+	12.5%	13.2%
A+B+C	Returnees	21.2% -	28.0%	27.3%	22.6% -	27.5%	27.9%	26.3%
D ₁	Outgoing before PhD	3.8% -	8.8%	7.1%	5.5% -	8.7%+	6.7%	7.1%
D ₂	Outgoing after PhD	2.0% -	7.3%	9.1%	6.7%	12.0%+	6.1% -	7.8%
	Total non- mobile	73.1%+	55.9%	56.5%	65.2%+	51.8% -	59.3%	58.9%
	<i>TOTAL</i>	<i>397</i>	<i>1,081</i>	<i>845</i>	<i>1,617</i>	<i>1,599</i>	<i>1,930</i>	<i>7,469</i>
Mobile researchers sample								
A	Post-doctoral return	38.3%	33.3%	32.6%	29.5%	21.0% -	36.4%+	30.4%
B	Temporary return	1.9%	1.05%	3.3%	0.9%	1.0%	1.4%	1.4%
C	Return following temporary mobility	38.3%	29.14%	26.9% -	34.5%	35.0%	30.8%	32.1%
A+B+C	Returnees	78.5%+	63.52%	62.8%	64.8%	57.1% -	68.6%+	63.9%
D ₁	Outgoing before PhD	14.0%	19.9%	16.3%	15.8%	18.0%	16.4%	17.2%
D ₂	Outgoing after PhD	7.5%	16.6%	20.9%	19.4%	24.9%+	15.0% -	19.0%
	<i>Mobile</i>	<i>107</i>	<i>477</i>	<i>368</i>	<i>563</i>	<i>771</i>	<i>786</i>	<i>3,072</i>

Notes: +/- Significantly higher/lower proportion with 95.44% confidence after performing a test of the difference in proportions of each field vs the overall figures. *Source:* MORE2 Survey data, authors' calculations.

As for the gender analysis, we address trajectories by field of research by calculating the percentage of researchers showing a particular trajectory over the total studied sample (Table 10, upper part) and over the mobile sample (Table 10, lower part). The lower part of Table 10 tells us that mobile researchers in the natural sciences are significantly less likely to return to their citizenship countries than researchers in other disciplines. The opposite applies to mobile researchers in the social and agricultural sciences, who are significantly more likely to return. Consequently, researchers in the social sciences are less likely to emigrate after their doctorates while the opposite applies to researchers in the natural sciences.

This information is completed by Table 10 (upper part), which shows that researchers in the medical and agricultural sciences are significantly more likely to be non-mobile, while those in the natural sciences are significantly more often part of the mobile group. If we take the PhD country as origin reference, very similar patterns are registered according to research fields.

Table 11 MORE2 PhD holders by geographical trajectory type and current career stage, using country of citizenship and country of PhD as reference

Type of trajectory		R2	R3	R4	OVERALL
Reference: Country of Citizenship					
A	Post-doctoral return	7.4% -	13.1%	15.7% +	12.5%
B	Temporary return	0.4%	0.6%	0.7%	0.6%
C	Return following temporary mobility	9.3%-	14.4%	14.7%	13.2%
A+B+C	Returnees	17.0% -	28.0%	31.2% +	26.3%
D. ₁	Outgoing before PhD	11.9% +	6.5%	4.1% -	7.1%
D. ₂	Outgoing after PhD	10.8% +	6.7% -	6.9%	7.8%
	Total non- mobile	60.3%	58.8%	57.8%	58.9%
	TOTAL	1,925	2,980	2,564	7,469
Reference: Country of PhD					
B	Temporary return	1.5% -	2.5%	2.5%	2.2%
C	Return following temporary mobility	11.1% -	15.5%	15.8%	14.5%
B+C	Returnees	12.6% -	18.0%	18.2%	16.7%
D. ₂	Flow after PhD	20.9%	20.7%	22.5%	21.4%
	Total non- mobile	66.5% +	61.3%	59.2% -	61.9%
	TOTAL	1,925	2,980	2,564	7,469

Notes: +/- Significantly higher/lower proportion with 95.44% confidence after performing a test of the difference in proportions of each stage vs the overall figures. *Source:* MORE2 Survey data, authors' calculations.

Research career stage at the time of completing the survey serves as a proxy for career length and seniority¹⁷. Accordingly, Table 11 (upper part, country of citizenship) shows how leading researchers (R4) are less likely to belong to the non-mobile group (although the difference is not statistically significant). They are significantly more likely to have registered post-doctoral return and less likely to have left their countries of citizenship to do a PhD abroad. Younger independent researchers (R2) are significantly more likely to have left their countries of origin either before or after the PhD and significantly less likely to have registered post-PhD return. The probability of return seems to increase for researchers who are currently at R4 stage.

Interestingly, and consistent with this, in a separate ongoing study on mobility and research careers based on the MORE2 data we find a positive and significant association between return mobility and the likelihood of experiencing career progression from R3 to R4 during the instance of return mobility, in particular for researchers who are relatively young (Cañibano et al. 2016)¹⁸. In other words, researchers might be encouraged to return to their country of citizenship by the possibility of career progression at a timely point in their careers. Other studies tell us that the consolidation of careers in foreign countries diminish the probability of return (Andújar et al. 2015, Casey et al. 2001). The combination of both sets of evidence lead us to hypothesize that R4 returnees are likely to have consolidated their careers in leading positions upon (or after) return to their countries of origin. A limitation of the MORE2 data is that it does not allow us to locate career-stage transitions precisely in time. Information regarding instances of mobility (> 3 month duration) can be linked to specific career stages but cannot be linked to a profile

¹⁷ Research career stages are defined following the European Framework for Research Careers (European Commission 2011). Stage R2 refers to Recognised Researchers, R3 to Established researchers and R4 to leading researchers. The corresponding definitions and associated roles and competences are provided in the Framework document (European Commission 2011, 8-11).

¹⁸ This result is based on the analysis of declared international mobility instances longer than 3 months for which researchers were asked to provide the career stage at the beginning and at the end of the mobility. A logistic model is built out of the information of all mobility instances registered along with variables regarding the individuals performing the mobility such as age, gender and research field (Cañibano et al. 2016).

of the career stage progression for the career as a whole. It would be interesting, for future editions of the survey, to capture when each respondent transitioned to a new career stage.

If we consider the country of PhD as origin reference, leading researchers (R4) are significantly less likely to be part of the non-mobile group while independent researchers (R2) are significantly more strongly represented in this group. At the same time, R2 researchers are less likely than the other two groups to register return flows to the country of PhD after leaving.

3.1.2.2 Geographical trajectories by country of origin and destination

In this section we address in detail the dynamics of outgoing, incoming and return mobility of researchers registered by country, according to the available information on geographical trajectories. Tables 12 and 13 provide details regarding the distribution of the studied national samples of researchers by country and type of geographical trajectory. Countries are ordered in the tables according to the rate of registered returnees (trajectories A+B+C).

Table 12 Geographical trajectories of researchers according to their country of citizenship (EU Member States, candidate and associate countries)

Citizenship country	Total citizens	Returnees (A+B+C)	A	B	C	D1.	D2.	MOBILE
Luxembourg	27	88.9%	85.2%	0.0%	3.7%	3.7%	0.0%	92.6%
Iceland	51	88.2%	84.3%	2.0%	2.0%	3.9%	0.0%	92.2%
Cyprus	118	81.4%	78.8%	1.7%	0.8%	10.2%	0.0%	91.5%
Malta	140	77.9%	75.0%	0.0%	2.9%	1.4%	0.7%	80.0%
Greece	331	47.4%	32.3%	1.8%	13.3%	10.6%	5.1%	63.1%
Ireland	236	42.4%	30.5%	0.4%	11.4%	2.1%	1.3%	45.8%
Estonia	178	41.0%	24.2%	0.0%	16.9%	0.0%	0.6%	41.6%
Turkey	168	38.7%	25.0%	0.0%	13.7%	1.2%	1.2%	41.1%
Slovenia	227	33.5%	11.5%	0.0%	22.0%	0.4%	0.0%	33.9%
Norway	186	33.3%	10.2%	0.0%	23.1%	2.2%	0.5%	36.0%
Portugal	265	33.2%	26.8%	0.0%	6.4%	5.3%	1.9%	40.4%
Austria	296	31.8%	5.1%	0.0%	26.7%	2.7%	3.7%	38.2%
Switzerland	139	30.2%	11.5%	0.0%	18.7%	2.9%	5.8%	38.8%
Hungary	117	29.9%	8.5%	0.0%	21.4%	5.1%	3.4%	38.5%
FYRO Macedonia	117	29.9%	19.7%	0.0%	10.3%	1.7%	1.7%	33.3%
Spain	384	27.3%	6.0%	0.3%	21.1%	4.2%	4.4%	35.9%
Finland	182	25.8%	3.8%	0.0%	22.0%	1.6%	4.4%	31.9%
Italy	409	24.4%	3.7%	1.2%	19.6%	13.2%	7.3%	45.0%
Bulgaria	136	23.5%	11.0%	0.0%	12.5%	8.1%	5.1%	36.8%
Slovakia	174	23.0%	8.6%	0.0%	14.4%	2.9%	4.0%	29.9%
Lithuania	266	22.6%	12.8%	0.0%	9.8%	1.9%	0.0%	24.4%
Netherlands	249	22.1%	5.2%	0.4%	16.5%	4.8%	8.8%	35.7%
Romania	266	19.5%	6.4%	0.0%	13.2%	4.9%	1.5%	25.9%
Belgium	217	18.4%	4.6%	0.0%	13.8%	4.1%	8.8%	31.3%
Denmark	183	18.0%	4.4%	0.5%	13.1%	1.6%	5.5%	25.1%
Sweden	169	17.2%	6.5%	0.0%	10.7%	4.7%	11.2%	33.1%
France	313	16.6%	1.3%	0.0%	15.3%	7.7%	12.5%	36.7%
Croatia	216	15.7%	5.1%	0.0%	10.6%	1.4%	0.9%	18.1%
Germany	469	14.3%	2.8%	3.2%	8.3%	14.7%	36.5%	65.5%
Latvia	42	14.3%	11.9%	0.0%	2.4%	4.8%	2.4%	21.4%
United Kingdom	339	13.6%	4.1%	0.6%	8.8%	5.9%	18.3%	37.8%
Czech Republic	210	9.5%	1.0%	0.5%	8.1%	2.9%	1.9%	14.3%
Poland	376	8.5%	2.1%	0.0%	6.4%	1.9%	1.6%	12.0%
Total general	7,196	27.1%	13.0%	0.5%	13.6%	5.1%	6.7%	38.9%
EU-28	6,535	26.0%	12.1%	0.5%	13.4%	5.4%	7.2%	38.7%

Source: MORE2 Survey data, authors' calculations

Interestingly, countries occupying the top of the list and registering very high proportion of return rates (> 80%) are small countries, with relatively small populations of researchers who obtain their PhDs abroad and return. A small proportion of researchers trained abroad do not return (as shown in column D1) to these countries. Post-PhD outgoing mobility (D2) is practically non-existent in the top 4 countries. Countries registering return rates that are around 40% to 50% include Greece (47%), Ireland (42%), Estonia (41%) and Turkey (39%), which also register very small proportions of outgoing mobility (D1+D2). The average return rate for the set of countries studied is 27%. Countries with a return rate above that average are Slovenia, Norway, Portugal, Austria, Switzerland, Hungary, Macedonia and Spain. These countries also show combined outgoing rates (D1+D2) below 10%. They differ substantially in terms of the relative strength of their research and innovation systems. It would be interesting to study the institutional factors underlying or supporting high return rates in these countries.

Among countries registering low rates of return and relatively high rates of outgoing mobility we find Germany (return 14%; outflow 60%), the UK (return 14%; outgoing 24%), France (return 17%; outgoing 20%), and Sweden (return 17%; outgoing 16%). These countries stand out for their competitive and consolidated research systems. The

outgoing flows in these countries take place more frequently after the PhD. Some of these countries however, along with some others showing moderate return rates (i.e. the Netherlands), also register high levels of incoming mobility from other countries as will be shown below.

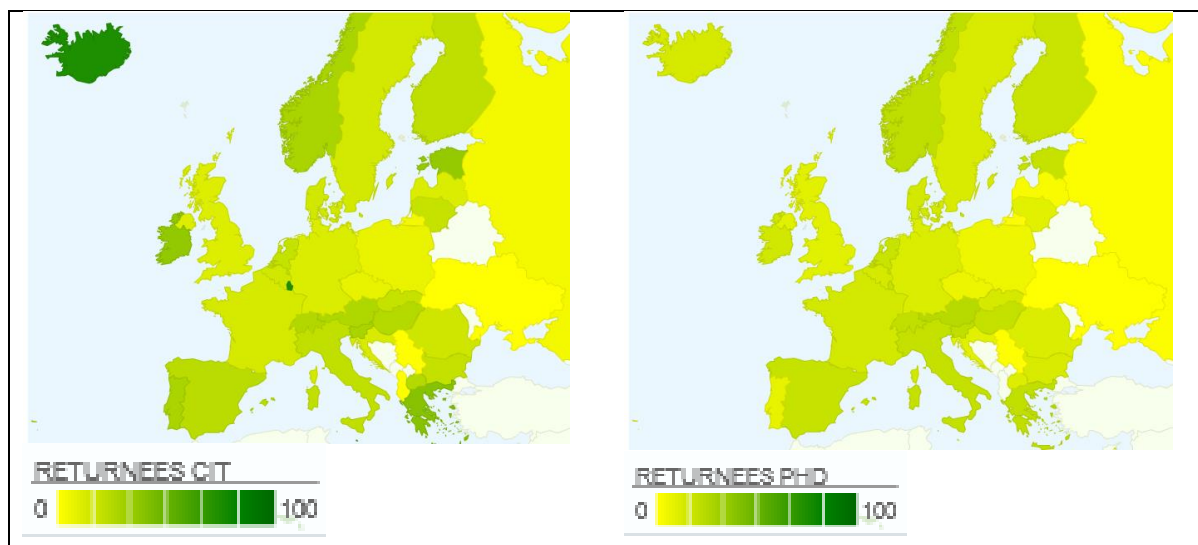
If we use the country of PhD as reference for the calculation of research trajectories, the results obtained by country are shown in table 13. Countries that are good at attracting back their PhDs after a stay abroad occupy the top of the list and include Austria, Norway, Greece, Slovenia, Switzerland and Italy. Among countries that train a large pool of PhDs and that show high rates of post-PhD outgoing mobility (along with low return rates) we find Germany, the UK and France.

Table 13 Geographical trajectories of researchers according to their country of PhD (EU Member States, candidate and associate countries)

PhD Country	Total PhDs	Returnees	B'	C'	D2'	Mobile
Austria	308	28.2%	1.0%	27.3%	8.1%	36.4%
Norway	203	25.1%	1.5%	23.6%	4.9%	30.0%
Greece	197	24.9%	1.5%	23.4%	12.2%	37.1%
Slovenia	208	24.5%	0.0%	24.5%	2.4%	26.9%
Switzerland	181	24.3%	1.1%	23.2%	17.1%	41.4%
Italy	360	23.6%	1.4%	22.2%	13.6%	37.2%
Hungary	112	23.2%	0.0%	23.2%	9.8%	33.0%
Spain	370	23.0%	1.1%	21.9%	9.5%	32.4%
Luxembourg	9	22.2%	0.0%	22.2%	0.0%	22.2%
Estonia	140	22.1%	0.0%	22.1%	2.9%	25.0%
Finland	203	21.7%	0.0%	21.7%	11.8%	33.5%
Netherlands	294	21.4%	3.4%	18.0%	17.0%	38.4%
Turkey	129	18.6%	0.0%	18.6%	3.1%	21.7%
Ireland	187	18.2%	1.1%	17.1%	4.3%	22.5%
Denmark	198	17.7%	1.5%	16.2%	5.1%	22.7%
France	380	17.4%	3.2%	14.2%	28.4%	45.8%
Slovakia	160	16.9%	0.6%	16.3%	5.0%	21.9%
Iceland	6	16.7%	0.0%	16.7%	16.7%	33.3%
Belgium	224	16.1%	1.3%	14.7%	16.5%	32.6%
Cyprus	13	15.4%	0.0%	15.4%	0.0%	15.4%
Sweden	195	15.4%	2.6%	12.8%	19.5%	34.9%
Bulgaria	113	15.0%	0.0%	15.0%	8.8%	23.9%
Germany	472	14.8%	5.7%	9.1%	49.8%	64.6%
Romania	243	14.8%	0.0%	14.8%	3.3%	18.1%
FYRO Macedonia	96	13.5%	0.0%	13.5%	2.1%	15.6%
Malta	33	12.1%	0.0%	12.1%	3.0%	15.2%
Croatia	214	11.2%	0.0%	11.2%	3.7%	15.0%
Lithuania	232	11.2%	0.0%	11.2%	1.3%	12.5%
United Kingdom	671	11.0%	5.2%	5.8%	53.5%	64.5%
Portugal	185	9.2%	0.0%	9.2%	3.2%	12.4%
Czech Republic	217	7.8%	0.0%	7.8%	6.5%	14.3%
Poland	369	6.8%	0.3%	6.5%	2.7%	9.5%
Latvia	39	2.6%	0.0%	2.6%	10.3%	12.8%
Total general	6,961	17.2%	1.7%	15.5%	16.4%	33.6%
EU-28	6,346	16.8%	1.8%	15.0%	17.2%	34.0%

Source: MORE2 Survey data, authors' calculations

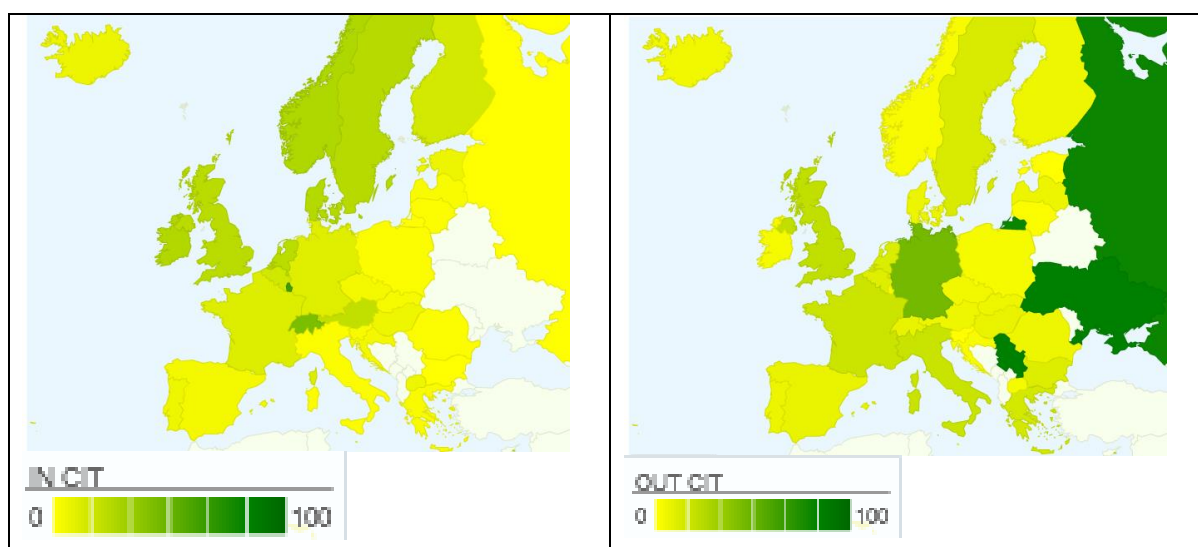
Figure 2 Rates of return by country



Source: MORE2 Survey data, authors' calculations

Figure 2 provides a more graphic view of the distribution of return flows over Europe, based on the data from Table 13. Figures 3 and 4 below represent outgoing and incoming flows using citizenship as country of reference¹⁹.

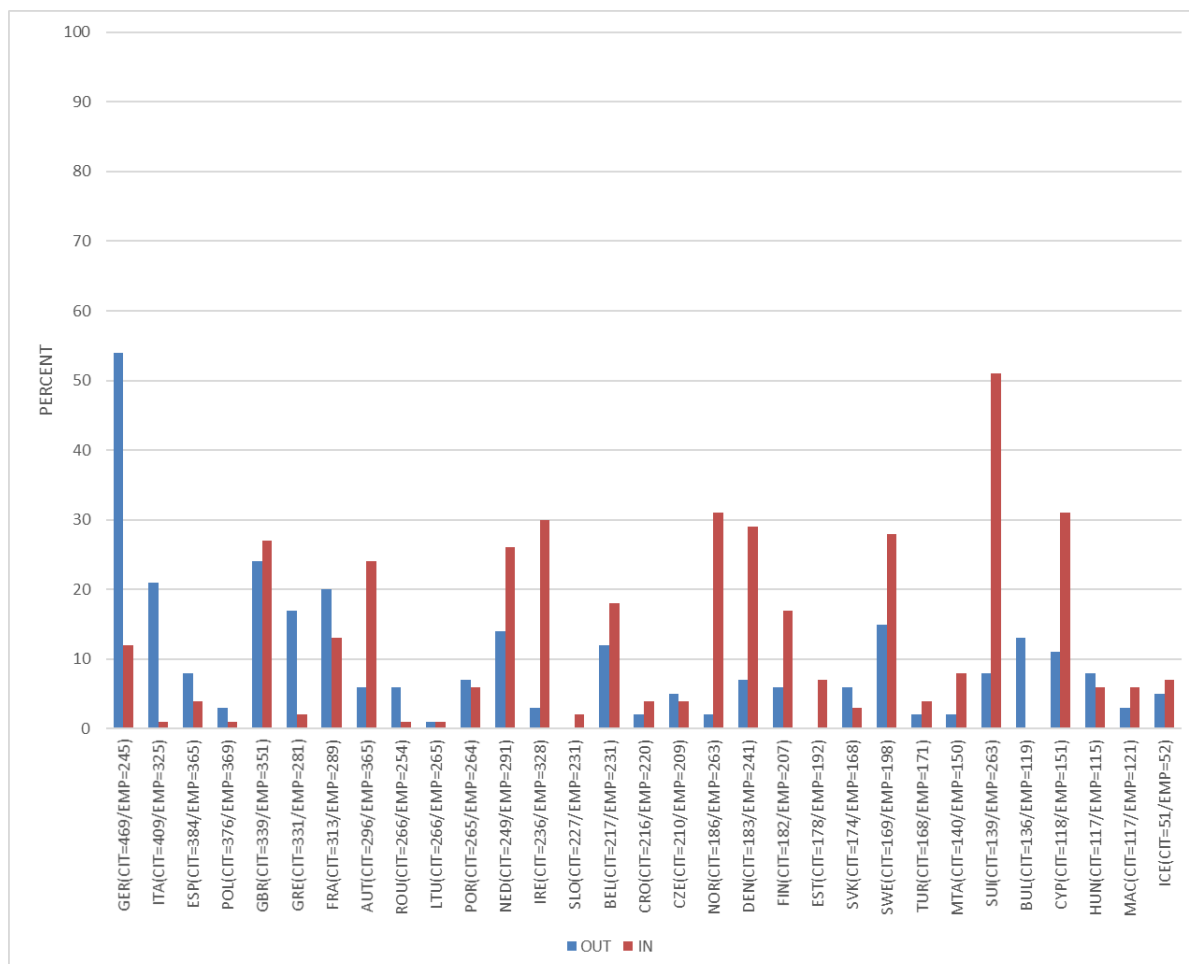
Figure 3 Rates of incoming and outgoing mobility with respect to citizenship country



Source: MORE2 Survey data, authors' calculations

¹⁹ The data on which these figures are based may be found in Appendix 1.

Figure 4 Rates of incoming and outgoing mobility with respect to citizenship country

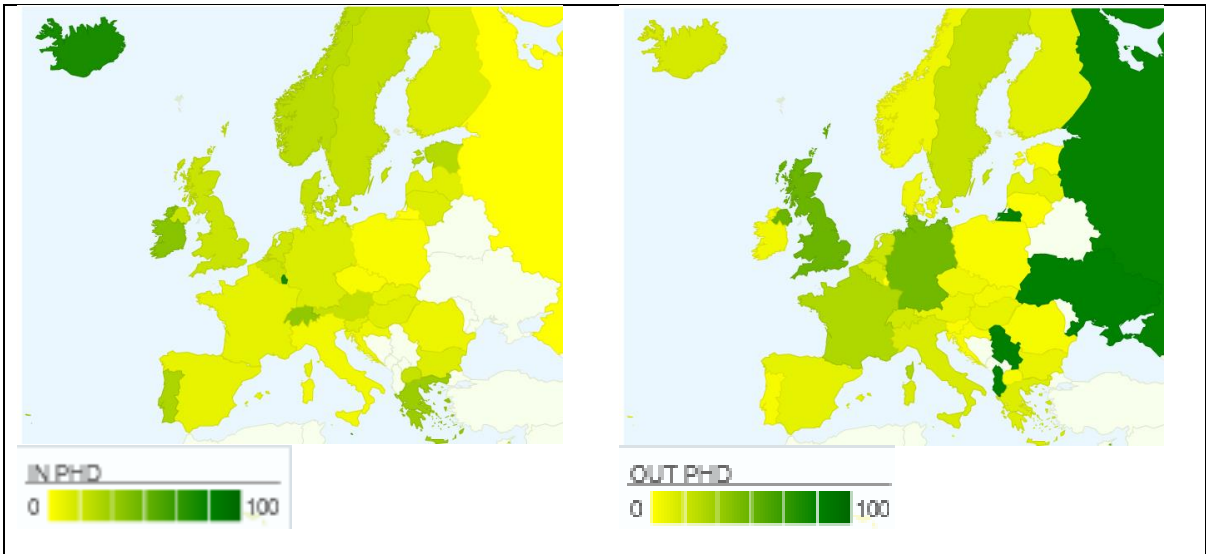


Source: MORE2 Survey data, authors' calculations

Figure 4 shows the percentage of total researchers employed in a particular country that are foreign nationals (incoming, IN-CIT) and the percentage of nationals that are working in other countries (outgoing, OUT-CIT). In Figure 4, the X-axis indicates the initials of a given country along with the size of the national sample of citizens studied and employees (in brackets²⁰). Countries are ordered as a function of sample size. Germany is the country registering by far the highest proportion of outgoing mobility and Switzerland the country registering the highest proportion of incoming flows. In fact Switzerland is a very important destination for German researchers, as will be shown below. Countries registering substantially higher numbers of incoming compared to outgoing mobility also include Norway, Denmark, Ireland, Sweden, the Netherlands, Austria, Finland, Belgium and Cyprus. In contrast, Italy, Spain, France, Greece and Bulgaria are the countries which register higher numbers of outgoing compared to incoming mobility.

²⁰ A minimum size of 50 citizens and 50 employees is the criteria for inclusion in this figure.

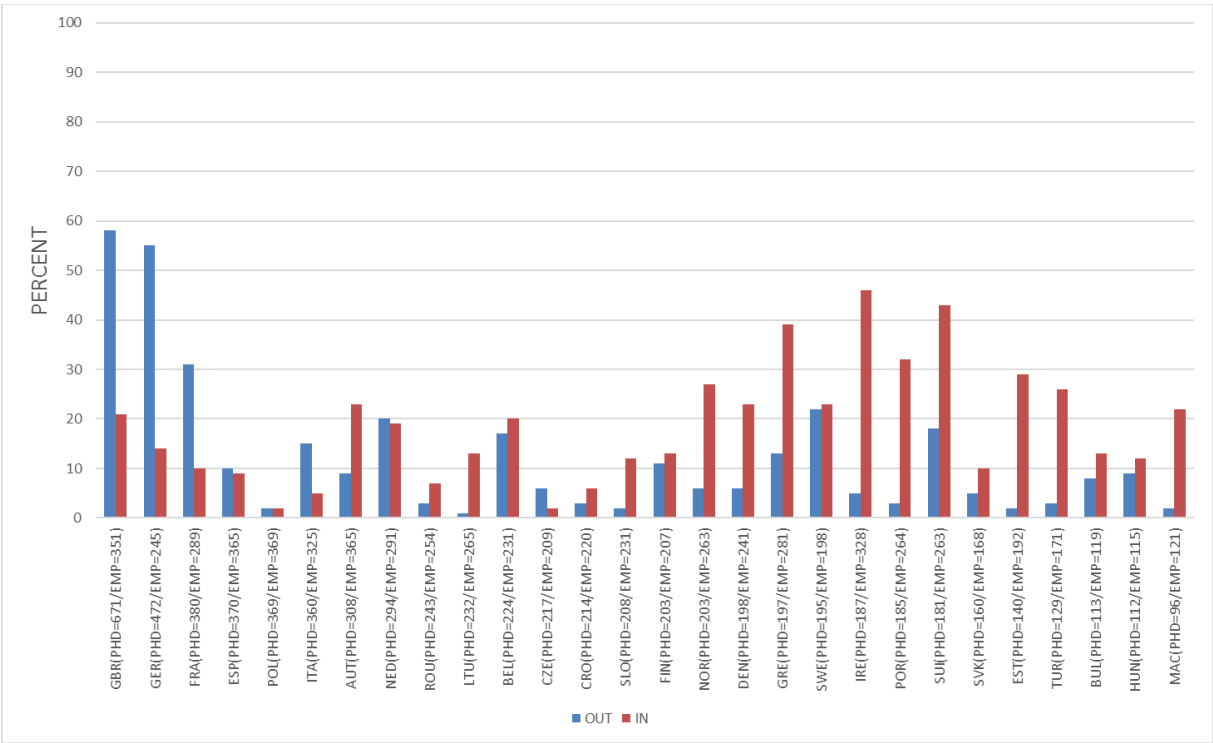
Figure 5 Rates of incoming and outgoing mobility with respect to PhD country



Source: MORE2 Survey data, authors' calculations

Figures 5 and 6²¹ address differences between the country of PhD and the country of current employment, pointing to the UK, Germany and France as the main countries sending their trained PhDs abroad. Luxemburg, Cyprus, Malta, Iceland, Ireland, Switzerland and Greece, along with some Nordic countries like Denmark and Norway, are the main countries employing researchers trained abroad.

Figure 6 Rates of incoming and outgoing mobility with respect to PhD country



Source: MORE2 Survey data, authors' calculations

²¹ The data on which these figures are based may be found in Appendix 1

Table 14 Geographical inflows and outflows using citizenship as origin reference

INFLOWS (CITIZENSHIP)		OUTFLOWS (CITIZENSHIP)	
A. Currently employed	B. Citizenship (>25%)	C. Citizenship	D. currently employed (>25%)
Austria(88)	Germany(46)	Austria(19)	Germany(5)
Belgium(42)		Belgium(28)	Netherlands(7)
Bulgaria(1)	Cyprus(1)	Bulgaria(18)	
Croatia(9)	Bosnia and Herzegovina(3)	Croatia(5)	
Cyprus(47)	Greece(39)	Cyprus(14)	Greece(6)
Czech Republic(10)		Czech Republic(11)	Slovakia(3)
Denmark(72)		Denmark(14)	
Estonia(15)		Estonia(1)	Switzerland(1)
Finland(36)		Finland(11)	Estonia(3)Sweden(3)
France(39)		France(63)	
Germany(31)		Germany(255)	Switzerland(71)
Greece(8)	Cyprus(6)	Greece(58)	Cyprus(39)
Hungary(8)	Italy(2)	Hungary(10)	Austria(4)
Iceland(4)	Germany(2)	Iceland(3)	Denmark(1)France(1)Norway(1)
Ireland(101)		Ireland(9)	United Kingdom(7)
Italy(5)		Italy(89)	
Latvia(1)	Italy(1)	Latvia(3)	Netherlands(1)Poland(1)Sweden(1)
Lithuania(4)	Bulgaria(1)Germany(1)Portugal(1)	Lithuania(5)	
Luxembourg(83)	Germany(34)	Luxembourg(1)	Belgium(1)
Macedonia (FYROM)(8)		Macedonia (FYROM)(4)	France(1)Hungary(1)Italy(1)Norway(1)
Malta(13)	Italy(4)	Malta(3)	Germany(1)Macedonia (FYROM)(1)Slovakia(1)
Netherlands(77)		Netherlands(35)	
Norway(82)		Norway(5)	Denmark(2)Sweden(3)
Poland(6)		Poland(13)	
Portugal(18)		Portugal(19)	
Romania(5)	Hungary(2)	Romania(17)	
Slovakia(6)	Czech Republic(3)	Slovakia(12)	Czech Republic(6)Netherlands(3)
Slovenia(5)		Slovenia(1)	Austria(1)
Spain(15)		Spain(34)	
Sweden(56)		Sweden(27)	Norway(11)
Switzerland(136)	Germany(71)	Switzerland(12)	
Turkey(7)		Turkey(4)	Belgium(1)Netherlands(2)Norway(1)
United Kingdom(96)		United Kingdom(84)	Ireland(42)
United States(7)		United States(53)	
Other(12)		Other(213)	
Total general(1153)		Total general(1153)	

Source: MORE2 Survey data, authors' calculations

Table 14 above provides details regarding the specific number of flows registered by country. The total number of researchers currently working in a foreign country in the sample under study is 1,153. Column A contains information regarding the number of foreign researchers employed in each country. Column B shows the origin countries of the researchers when these account for more than 25% of the population of foreign researchers employed in a particular country. For example, out of the 88 foreign researchers employed in Austria, 46 (52%) are German citizens. Column C refers to citizens of a particular country who are employed abroad (28 from Belgium, 255 from Germany, 84 from the UK, etc.). Column D shows destination countries of researchers working abroad when these are recipients of 25% or more of the total emigrated sub-sample. For example Switzerland employs 28% (n=71) of German researchers working abroad.

Despite the fact that some of the subsamples of flows by country are too small to draw any conclusions, two main results call our attention. First, geographical proximity seems to play an important determining role as shown by the exchange between some neighbor countries: Germany and Austria, Germany and Luxemburg, Belgium and the Netherlands, the UK and Ireland, Cyprus and Greece, Slovakia and the Czech Republic. Second, it confirms that some countries have a clear receiving profile with a substantially higher number of inflows than outflows: Austria, Belgium, Cyprus, Denmark, Finland, Ireland,

Luxembourg, the Netherlands, Norway and Switzerland²². Other countries have a clear sending profile, with a substantial larger number of outflows than inflows: Bulgaria, France, Germany, Greece, Italy, Romania, Slovakia and Spain. The UK stands out for registering important numbers of inflows and outflows which have Ireland as destination to a large extent (50% of emigrated UK researchers work in Ireland).

Third, 23% of the registered outflows (266 researchers) actually correspond to inflows of foreign nationals working in Europe, 20% of which come from the United States. Other important third countries of origin are Canada, China, Russia and India. The data does not allow us to address outflows from Europe to other third countries since the survey targeted researchers working in European higher education institutions.

Table 15 below follows the same structure using the country where researchers obtained their PhD as country of reference. Geographical proximities seem to also play a role but some other apparent trends also stand out. Small Mediterranean countries rely largely on the USA and the UK to train their researchers. In Greece, 58% of researchers who obtained their PhDs abroad were trained in these two countries. The same indicator equals 69% for Maltese researchers trained abroad and 71% of researchers from Cyprus. The UK and the USA in fact provide doctoral training to a large proportion of mobile researchers in this dataset. Together they add up to 37% of researchers who are currently employed in a country which differs to that of their PhD. The UK is the European country registering by far the largest outflow of PhDs (a total of 394), followed by Germany (262) and France (120). Researchers who obtained their PhD in Germany represent more than 25% of the employed population of foreign researchers in Austria, Switzerland and Luxembourg. Researchers who obtained their PhD in the UK represent more than 25% of the employed population of foreign researchers in Cyprus, Greece, Ireland, Malta, Portugal and Turkey. Researchers trained in the USA do not seem to be concentrated in particular European destinations.

²² Non-European countries are not referred in this list even if they appear in the table since the survey targeted researchers working in European institutions. Even if it managed to capture a few researchers also employed outside Europe.

Table 15 Geographical inflows and outflows using country of PhD as origin reference

INFLOWS (PHD)		OUTFLOWS (PHD)	
A. Currently employed	B. PhD (>25%)	C. PhD	D. Currently employed (>25%)
Austria(85)	Germany(39)	Austria(28)	
Belgium(47)		Belgium(40)	Luxembourg(11)
Bulgaria(16)	Russia(6)	Bulgaria(10)	
Croatia(14)		Croatia(8)	Macedonia (FYROM)(6)
Cyprus(138)	United Kingdom(50)United States(49)	Cyprus()	#N/A
Czech Republic(6)	Slovakia(3)	Czech Republic(14)	Slovakia(9)
Denmark(56)		Denmark(13)	
Estonia(56)	Russia(20)	Estonia(4)	Latvia(1)Lithuania(1)Malta(1)Switzerland(1)
Finland(28)		Finland(24)	Estonia(8)
France(29)		France(120)	
Germany(35)		Germany(262)	Switzerland(67)
Greece(111)	United Kingdom(36)United States(29)	Greece(27)	Cyprus(20)
Hungary(14)		Hungary(11)	
Iceland(47)	United States(16)	Iceland(1)	Switzerland(1)
Ireland(151)	United Kingdom(82)	Ireland(10)	United Kingdom(3)
Italy(19)		Italy(54)	
Latvia(5)		Latvia(4)	Estonia(1)Hungary(1)Lithuania(1)Poland(1)
Lithuania(36)	Russia(21)	Lithuania(3)	Estonia(2)Ireland(1)
Luxembourg(100)	Germany(29)	Luxembourg()	#N/A
Macedonia (FYROM)(27)	Serbia and Montenegro(10)	Macedonia (FYROM)(2)	France(1)Italy(1)
Malta(118)	United Kingdom(82)	Malta(1)	Germany(1)
Netherlands(57)		Netherlands(60)	
Norway(73)		Norway(13)	Iceland(8)
Poland(11)	Russia(3)	Poland(11)	
Portugal(85)	United Kingdom(28)	Portugal(6)	
Romania(19)	Moldova(7)	Romania(8)	
Slovakia(17)	Czech Republic(9)	Slovakia(9)	Czech Republic(3)
Slovenia(28)		Slovenia(5)	Croatia(2)Romania(2)
Spain(34)		Spain(39)	Portugal(15)
Sweden(46)		Sweden(43)	
Switzerland(115)	Germany(67)	Switzerland(33)	
Turkey(46)	United Kingdom(14)United States(14)	Turkey(4)	Belgium(1)Estonia(1)Finland(1)Norway(1)
United Kingdom(74)		United Kingdom(394)	
United States(8)	Belgium(2)Germany(2)	United States(252)	
Other(11)		Other(249)	
Total general(1762)		Total general(1762)	

Cultural affinities (including language and historical links) and geographical proximities may also be playing a role in the determination of the flows identified. We know also from previous research that that epistemological practices and research fields play a role in explaining international mobility flows of researchers (Jöns 2007, Cañibano et al. 2011, Blienik and Laudel 2016). In line with this thinking, we analysed the dynamics of inflows and outflows for the different disciplinary sub-fields but did not find results of relevance to this report.

3.1.2.3 Main factors conditioning geographical trajectories

We build a series of logit regression models addressing conjointly the factors that may influence the likelihood of registering a certain geographical trajectory both using citizenship and PhD country as origin references. Geographical trajectory types as earlier defined are thus considered as dependent variables. Independent variables include the following:

- Gender
- Career stage: R2, R3, R4
- Field of research in current employment: dummies for each field except for Engineering and Technology which is used as reference
- Marital merge: dummies for the following variables
 - Single without children (used as reference)
 - Single with children

- In couple without children
- In couple with children
- Country variable 1: Scientific level of citizenship country: percentage of publications in the top 10% most cited averaged over 2010-2012 ²³ (CIT_%Top10_1012)
- Country variable 2: Scientific level of PhD country: percentage of publications in the top 10% most cited averaged over 2010-2012 (PHD_%Top10_1012)

The results of the models indicate the probability of experiencing a particular trajectory type according to specific variables. Table 16 summarizes the results of all models, which may be found in Annex 2. The table indicates the signs of corresponding significant coefficients; + for directly proportional effects and - for inversely proportional effect on the probability of experiencing a particular trajectory type²⁴.

Table 16 Summary of logistic regression results: factors conditioning geographical trajectories

	Country of reference for return: citizenship							Country of reference for return: PhD				
	A. POST-DOCTORAL RETURN	B. TEMPORARY RETURN	C. RETURN FOLLOWING TEMPORARY MOBILITY	D1. FLOW BEFORE PHD	D2. FLOW AFTER PHD	NOT MOBILE	RETURNEES	B. TEMPORARY RETURN	C. RETURN FOLLOWING TEMPORARY MOBILITY	D2. FLOW AFTER PHD	NOT MOBILE	RETURNEES
Female		-	-	-	+	-		-	-	+	-	
Single Parent												
In couple without children												
Couple With Children		-	-	-	+			-	-	+	-	
Career Stage	+	+	-	-	-	+		+	+	-	+	
Agricultural Sciences	-			-	+	-			-	+		
Humanities												
Medical Sciences	-		-		+	-		-	-	+		
Natural Sciences	-	+		+	-			+		-	+	
Social Sciences												
CIT: %TOP10_1012		+	-	+	-	+						
PHD: %TOP10_1012			+					+	-	+	-	+

The results from the models confirm and extend those obtained through the descriptive analyses discussed earlier. In general terms, being a woman increases significantly the likelihood of being non-mobile and therefore reduces the probability of registering mobile trajectories. The same result is found for the variable 'in couple with children'.

²³ Source: Web of Science

²⁴ Cells are shaded in grey in Table 16 when the variable does not apply to a particular model.

Researchers who recorded being 'in a couple with children' are significantly more likely to be part of the non-mobile group and therefore less likely to have left their countries of origin (both citizenship and PhD), and therefore to be 'returnees'. The remaining variables regarding personal and family status do not show as significant in any of the models²⁵.

The models confirm that the probability of return is significantly correlated with career stage. More senior researchers (R4) are more likely to have returned (to both their country of citizenship and their country of PhD) and less likely to register outgoing mobility (without return). The models also confirm a higher likelihood of being non-mobile for researchers in the medical and agricultural sciences and a higher probability of being mobile for those in the natural sciences.

The descriptive analysis regarding countries of origin, destination and return of mobile researchers seemed to indicate that the flows are conditioned by the scientific strength and capacity of national research systems. The variable chosen as proxy for countries' research capacity is their contribution to the top 10% most cited publications averaged over the period 2010-2012. The probability of return to the citizenship country is positively and significantly associated with its scientific capacity. The same goes for the probability of return to the PhD country. In addition, the likelihood of leaving the PhD country (including when it coincides with the citizenship country) is also positively and significantly associated with its scientific capacity. Consequently, researchers either trained or born in countries with strong scientific systems are more likely to be mobile, but less likely to leave before completing their PhDs²⁶. A higher capacity of the PhD country is also positively and significantly associated with a pre-PhD outflow from the citizenship country.

3.1.2.4 Return and job satisfaction

The MORE2 survey contains a question regarding researchers' level of satisfaction (binary: satisfied vs dissatisfied) with their current position in relation to a number of factors (Question 25 in the survey). We thus explore the potential association between return mobility and the level of job satisfaction in researchers' current position. For this, we classify the sample of mobile researchers. Considering the country of citizenship as country of residence, mobile researchers add up to 3,072, of which 1,962 register some kind of return flow. We test for differences regarding satisfaction between the group of returned researchers and the group of mobile but not returned researchers. Table 17 shows the summary of results for the 13 tests comparing the corresponding difference to each of the factors. The complete testing results are available in Appendix 2. Table 17 indicates whether one of the two groups (returnees / non-returnees) chose significantly more than the other the specific answer to the question.

²⁵ To complete the results regarding personal and marital status and the likelihood of return we calculate the rate of the different collectives over the sample of mobile researchers. We find that 69% of researchers in couple with children have returned to their country of citizenship, significantly more than researchers who are single without children, out of which 55% have returned. The rate of return for couples without children is also 55%. The rate of return for single researchers with children is 73%; this subgroup is particularly small in the sample. The table containing these data may be found in Appendix 2.2

²⁶ See Appendix 2.1 for complete details regarding the results of each model.

Table 17 Return and satisfaction with current position (reference country for return = citizenship)

	Satisfied	Dissatisfied	N./A.	Missing
Dynamism		Returnee		
Intellectual challenge				
Level of responsibility				Returnee
Degree of independence				Returnee
Contribution to society				Returnee
Opportunities for advancement		Returnee		
Mobility perspectives	Non-returnee	Returnee	Non-returnee	
Social status	Non-returnee	Returnee	Non-returnee	
Salary		Returnee		
Benefits	Non-returnee	Returnee	Non-returnee	
Job security	Returnee	Non-returnee	Non-returnee	
Job location				
Reputation employer	Non-returnee			

Source: MORE2 Survey data, authors' calculations

Overall, the comparison between returnees and non-returnees shows a consistent inclination towards dissatisfaction among returnees compared to the other group, with the exception of satisfaction regarding job security. More specifically, compared to non-returnees, returnees were significantly more likely to select the dissatisfaction option regarding 'dynamism in the current position', 'opportunities for advancement', 'mobility perspectives', 'salary' and 'benefits'. The only factor for which returnees were significantly more likely to select the satisfaction option was 'job security', regarding which non-returnees showed significantly more dissatisfaction. In addition, non-returnees are significantly more likely to be part of the satisfied group when it comes to 'mobility perspectives', 'social status', 'benefits' and 'employer reputation'.

Reproducing the same exercise using the country of PhD as the reference for return provides quite consistent results, showing a significantly higher degree of satisfaction among non-returnees and dissatisfaction among returnees for the factors 'social status', 'salary' and 'benefits'²⁷.

As argued earlier, in line with other ongoing research, we consider the possibility that that returnees who are at an R4 career stage, might have accessed this stage upon or after return. Therefore, we raise the question of how satisfaction regarding the above factors is distributed across researchers at different career stages.

²⁷ See Appendix 3 for all specific testing results for this section.

Table 18 Return and satisfaction with current position, according to current career stage (reference country for return = citizenship)

	R2			R3			R4		
	n.r.	r.		n.r.	r.		n.r.	r.	
Dynamism	85%	78% *		87%	81% *		88%	83% *	
Intellectual challenge	91%	84% *		91%	89%		91%	92%	
Level of responsibility	86%	86%		89%	86%		93%	92%	
Degree of independence	83%	79%		87%	85%		91%	89%	
Contribution to society	83%	78%		84%	81%		85%	86%	
Opportunities for advancement	58%	51%		57%	53%		74%	65% *	
Mobility perspectives	74%	63% *		65%	60%		72%	66%	
Social status	79%	73%		83%	77% *		87%	81% *	
Salary	73%	48% *		68%	47% *		70%	45% *	
Benefits	71%	50% *		63%	51% *		66%	48% *	
Job security	47%	52%		69%	74%		88%	86%	
Job location	90%	87%		84%	89% *		90%	90%	
Reputation employer	89%	79% *		83%	82%		83%	86%	

Source: MORE2 Survey data, authors' calculations

Table 18 shows the rate of satisfaction regarding the different factors expressed by non-returnees (n.r.) and by returnees (r.) at different career stages. Returnees at R4 career stage show higher levels of satisfaction than do R3s and R2s for all factors except for 'salary' and 'benefits'. The rate of satisfaction of R4s regarding these factors is lower and way below the satisfaction expressed by non-returnees. R4 returnees show similar levels of satisfaction than R4 non-returnees regarding 'dynamism', 'intellectual challenge', 'level of responsibility', 'degree of independence', 'contribution to society' and 'job location'. They are significantly less satisfied than non-returnees regarding 'opportunities for advancement', 'social status', 'salary and benefits'. They show more satisfaction than non-returnees regarding the reputation of their employer. In sum, it might be the case that some returnees are attracted back to their countries of origin by the existence of personal and professional connections and by career progress opportunities. Upon return, senior researchers seem satisfied with the way in which they are performing their research work (independence, challenge), they feel secure regarding their employment and satisfied with their location, but more unsatisfied than younger returnee researchers regarding how their work is financially rewarded.

3.1.2.5 Return and effects of mobility

The MORE2 survey also contains self-reported information regarding the effects of mobility. Researchers were asked to provide information regarding whether a number of possible outcomes had remained unchanged, had decreased (or strongly decreased), or increased (or strongly increased) as a result of their entire mobility experience (Question 58). Table 19 gathers the responses obtained to this question. We may first observe that returnees (60% average response rate) are more likely to provide an answer regarding mobility outcomes than non-returnees (45% response rate). Researchers report that as a result of mobility, research output quantity (publications and patents) and quality (output quality and citation impact) increase rather than decrease, with only small differences between returnees and non-returnees. Differences in appreciations between the two

groups are observable for other effects measured. In particular, returnees declare a higher degree of decrease (and lower increase) in international funding, recognition, job options both outside and inside academia, progress in salary and career progression. Advanced research skills are more likely to be perceived as having increased among returnees than among non-returnees.

Returnees appear therefore to be as productive as non-returnees in terms of research output but perceive a deterioration of work conditions when it comes to important factors such as recognition, salaries and future career options. This result is probably connected with the higher degree of dissatisfaction regarding their current positions compared to the level of satisfaction of non-returnees, as discussed in the previous section.

Table 19 Effects of the entire mobility experience according to the returnee (r.) vs. non-returnee (n.r.) condition, using citizenship as country of reference

	Strongly decreased		Decreased		Remained unchanged		Increased		Strongly increased		Answered		Total	
	n.r.	r	n.r.	r	n.r.	r	n.r.	r	n.r.	r	n.r.	r	n.r.	r.
Output Quality	3%	3%	16%	19%	17%	11%	48%	51%	16%	16%	528	1253	1110	1962
Co-authored pubs.	4%	4%	19%	19%	20%	19%	42%	47%	15%	12%	515	1232	1110	1962
Patents	2%	2%	11%	15%	25%	24%	57%	54%	5%	6%	310	838	1110	1962
Citation Impact	2%	2%	13%	15%	23%	20%	51%	53%	11%	11%	490	1193	1110	1962
Research skills	2%	1%	11%	9%	14%	9%	56%	64%	17%	17%	519	1242	1110	1962
Int Network	3%	2%	11%	17%	7%	7%	55%	51%	25%	23%	527	1253	1110	1962
Nat Network	3%	2%	23%	20%	23%	27%	42%	42%	10%	9%	515	1218	1110	1962
Nat Funding	4%	2%	23%	22%	21%	26%	44%	42%	8%	7%	498	1203	1110	1962
Int Funding	4%	2%	24%	35%	23%	23%	39%	34%	9%	6%	496	1200	1110	1962
Recognition	2%	2%	25%	34%	15%	14%	45%	38%	13%	11%	521	1240	1110	1962
Job options (acad)	3%	3%	31%	39%	19%	24%	37%	27%	10%	7%	513	1209	1110	1962
Job options (non acad)	4%	3%	32%	40%	31%	30%	29%	22%	4%	4%	458	1129	1110	1962
Career progression	2%	2%	17%	25%	15%	13%	53%	50%	14%	11%	521	1239	1110	1962
Progress in salary	4%	3%	31%	35%	32%	44%	21%	15%	11%	4%	519	1217	1110	1962
Quality of life	3%	2%	15%	11%	26%	33%	45%	45%	11%	9%	515	1218	1110	1962

The self-reported nature of these results has many limitations. In any case, the story appears to be that return pays off well to the returnee's host country, since returnees keep producing at high levels of quantity and quality (compared to their non-returnee counterparts and most likely also when compared to the non-mobile ones according with what we know from the literature). However, return does not seem to be paying off directly to researchers themselves in terms of working conditions and career prospects. We also know from the literature, as reviewed in section 2, that the most common reasons for return are personal, family and national identity reasons. Researchers might be facing a trade-off between personal and cultural affinities and the possibility of developing or continuing successful research careers when facing the decision to return. These considerations provide interesting food for thought for the design of national policies in countries registering high rates of return as well as for European research policies.

3.1.3 Summary of results and general discussion

This empirical study has focused on PhD holders surveyed within the MORE2 project reporting information relevant to the mobility dimension of their research career. The MORE2 survey captures detailed information regarding instances of mobility of more than three months duration (in the previous 10 years), including their countries of citizenship, PhD, current employment and temporary work destinations for more than three months.

Overall, we find that 60% of European researchers do not report any international mobility. They are citizens of the country where they obtained their PhD and currently work, and they do not report any work visits abroad of more than three months duration.

This result needs to be treated with some caution, as there is a high probability that many of these researchers will have been mobile in a way not adequately captured by the survey. Previous research provides evidence of a very high incidence of short-term mobility. For a sample of 10,000 Spanish PhDs, 76% of the international visits conducted by humanities scholars were shorter than three months. The equivalent rate was 71% for the social sciences, 66% for Physics, Chemistry and Mathematics and 60% for Science and Technology of Health (Cañibano et al. 2011). However, applying the three-month threshold may create misleading interpretations regarding overall mobility rates of researchers. This may be particularly the case for some disciplines, in which short-visits are a much more common practice. Developing a more secure baseline understanding of the degree of researcher mobility overall would be assisted by improving the section of the MORE survey regarding short-term mobility (< 3 months) in future editions.

Among the mobile researchers, our analysis finds that 64% have returned to their country of citizenship after being abroad while 36% remain away. Return mobility is thus a common practice among mobile European researchers.

In line with previous analyses performed on this data (Idea Consult 2013, European Commission 2016), we find that women researchers are less likely to be mobile than their male counterparts. In addition, women researchers are slightly more likely to return to their citizenship and their PhD countries. We also find that being part of a couple with children reduces significantly the likelihood of being a mobile researcher, compared to those in other personal and family situations. Mobile researchers with children are more likely to return to their country of citizenship than researchers without children. These results call for a reflection on how policies encouraging mobility may address the gender and family status mobility gap. Some European programs have already taken steps to address this problem. For example, the Marie Skłodowska Curie Fellowship program adapts the level of funding provided during the mobility experience depending on the family status of the research Fellow.

There are differences in the degree of mobility according to scientific field. We find that researchers in the medical and agricultural sciences are less likely to be internationally mobile, which is consistent with previous research results (Cañibano et al. 2011). There is also a large difference observed between the mobility levels of researchers in the medical sciences and in other life sciences. There is an identified gap in the literature regarding the research careers (including mobility) of medical doctors who contribute to research (Woolley et al. 2016). Given that medical doctors as a group contribute in multiple ways to research (clinical, basic, translational), a better understanding of their mobility (and other career characteristics) is highly desirable. Among the group of mobile researchers, we find that researchers in the agricultural and social sciences are more likely to return to their country of citizenship, compared to those in the natural sciences who are more likely to remain abroad. Researchers in the natural sciences are more likely to leave their countries of citizenship after completing their PhDs and less likely to return, compared to the other research fields.

In terms of mobility and career stage, 'leading researchers' are more likely to be mobile and also more likely to have returned to their countries of origin than researchers identified as 'established' or 'independent'. Policies targeted at attracting national researchers back to their 'home' country, including offering career progression opportunities, are likely to be influencing this result. However, senior returnee researchers report lower levels of satisfaction than returnees who make this move at earlier career stages with regard to the current financial arrangements associated with their employment. At the same time these senior researchers seem satisfied with other important dimensions of their current research work, including their degree of research autonomy and independence, their level of job security and their perception of the level of their contribution to society.

The literature tells us that researchers return to their origin countries after being abroad mainly for personal, cultural and identity reasons. According to our overall results, return appears as a trade-off in which researchers give up financial rewards, social status and opportunities for advancement, exchanging these for job security, a satisfactory job location and the possibility to contribute directly to their home societies.

With regard to links between mobility and research performance, according to the self-reported information analyzed, return mobility does not seem to have a negative impact on either research productivity or research quality. However, neither does return mobility appear to have particularly positive influence on either productivity or quality. Given return mobility continues as a high policy priority, there is probably room in the MORE survey to raise specific questions regarding return, in particular the return intentions and motivations of researchers currently working abroad.

Regarding the geographical distribution of researchers' flows across Europe, the results confirm the important training role fulfilled by some of the largest and most competitive research systems in Europe, including France, Germany and the UK. These countries register high rates of outgoing post-PhD mobility, notably among researchers returning to their country of citizenship. Germany also registers a large rate of outgoing national citizen researchers, who are then distributed across many parts of Europe.

Italy, Spain, France and Greece register higher rates of outgoing than incoming mobility, but also relatively high rates of return mobility of their citizens. France is the exception among this group in this latter respect, with a return mobility rate below the European average. Portugal registers much lower rates of outflow than other Mediterranean countries and a rate of return that is above the European average. Among the countries receiving higher numbers of incoming mobility compared to outgoing mobility we find notably Switzerland, Scandinavian countries (Norway, Denmark, Sweden and Finland), the Netherlands, Austria, Belgium and Cyprus. Our models confirm that the more consolidated research systems, with higher weights of publications among the top cited papers, are more likely to attract back their nationals and to attract PhD students. Researchers from these countries are also more likely to be mobile and therefore to leave at some points in their careers, particularly after finishing their PhDs.

A general observation, which holds for the majority of countries, is that a geographical proximity element may also be influencing patterns of mobility. Relatively strong rates of mobility occur between neighbouring or near-neighbouring countries. Linguistic and cultural factors are no doubt a factor in these patterns.

The institutional conditions in different national systems vary considerably (IDEA Consult 2013c), influencing the trends observed in particular ways. Situating the results in more detailed consideration of these institutional conditions will improve their usefulness.

The MORE2 data allows us to study the geographical movement of individual researchers across countries at different points in time but the knowledge effects of the observed trends remain unknown. Knowledge flows and creativity effects deriving from the mobility trends observed require a conceptual model, to enhance the capacity for interpretation and avoid *ad hoc* explanations based on the trends observed. Depending on the conceptual approach developed or adopted, future research steps relevant to these questions would be framed differently.

From an 'allocative' perspective, we would be assuming that knowledge is embodied in researchers and flows in the same direction as them. Countries like Germany, France, the UK and some Mediterranean countries would be suffering a 'brain drain' and the main incoming destinations (Switzerland, Scandinavia) would be seen as winners in the researcher mobility game. We could study the degree to which the foreign born and/or trained researcher population contributes to the research and innovation output of the hosting countries or institutions, as a way to assess the effect of 'brain gain'. However, for a number of reasons it would be misleading to consider these gains to be equivalent to losses suffered by sending countries. These reasons include the lack of knowledge

regarding what the same researchers would have been able to achieve had they not been mobile and the fact that many sending countries register high return rates.

The 'connective' conceptual approach would orient us toward other types of questions. It would be interesting to address how the observed mobility patterns condition the formation of collaboration networks across Europe and how these networks become channels for further knowledge flows. Return flows would be particularly enriching if they allow institutions and countries to remain connected with core foreign scientific hubs. The extent to which the flow of individuals conditions the definition of research agendas in research teams and networks is also an open question. The epistemic effects of mobility remain largely unknown.

From a 'creativity and self-discovery' perspective we could use Lam's terminology and ask ourselves, for example, the extent to which geographical mobility across (and to and from) Europe contributes to a process of identity hybridization (towards more European and less national-based identity feelings for example) and the extent to which this process "facilitates knowledge brokering" (Lam 2016, 3).

In sum, the possibilities for improving our knowledge regarding the role played by researcher mobility within the epistemic and organizational dynamics of the European Research Area are extensive, particularly if we do not only think of mobility as a re/allocative phenomenon. Addressing more complex questions regarding the evolution of research networks calls not only for reflection on the potential for improvement of available survey instruments, but also on the possibility to systematically combine different information sources which can include CV-based information, register data, bibliometrics and qualitative interviews.

3.2 Extracting geographic mobility information from LFS data

The European Union Labour Force Survey (LFS) is conducted in the 28 Member States of the EU, 2 candidate countries and 3 countries of the European Free Trade Association (EFTA).²⁸ The EU LFS microdata²⁹ for scientific purposes contain data for the 28 Member States plus Iceland, Norway and Switzerland. The EU LFS is a large sample household survey providing quarterly results on labour participation of people aged 15 and over as well as on persons outside the labour force. All definitions apply to persons aged 15 years and over living in private households. Harmonized data at European level are available using the same concepts and definitions of the International Labour Organisation guidelines, a common classification recording the same set of characteristics in each country.³⁰

The LFS data may offer relevant information on the mobility of PhD holders, making use of information collected about the highest degree obtained [HATLEVEL] (i.e., PhD in our case), as well as combining the relevant geographical location and time periods, including:

- the country and region (NUTS1 or NUTS2 levels, depending on countries) of residence at the time of the survey [COUNTRY, REGION];
- the country and region (NUTS1 or NUTS2, depending on countries) of residence 1 year before the survey [COUNTR1Y, REGION1Y];
- the country and region (NUTS1 or NUTS2, depending on countries) of the place of work at the time of the survey [COUNTRYW, REGIONW];
- the country of birth [COUNTRYB];
- years of residence in the current country [YEARESID];

²⁸ Legal foundation provided in Council Regulation (EEC) No. 577/98 of 9 March 1998

²⁹ We thank our colleague Sara Flisi for investigating data availability in LFS micro data.

³⁰ For further details, please refer to <http://ec.europa.eu/eurostat/web/microdata/european-union-labour-force-survey>

- year in which person started working for the current employer or as self-employed [YSTARTWK];
- year when the highest educational attainment level was successfully completed [HATYEAR].

The aim of our initial tests is to understand whether EU LFS data may be relevant to provide country-level or regional (NUTS2) statistical information on the geographical mobility of researchers.

To our knowledge, such kind of statistics have not been made available yet. Eurostat provides statistics based on LFS data on the job-to-job mobility of human resources in science and technology (HRST), using information both on when the current job began and the working status of the person in question one year before the survey.³¹ However, such statistics concern a broader population of people who either have successfully completed a tertiary level education, or not formally qualified as above but employed in a science and technology occupation where the above qualifications are normally required. Our aim is to focus on PhD graduates and their international mobility/dispersion.

Based on LFS data, we may, in principle, distinguish recent and “non-recent” return mobility of highly educated people potentially working as researchers (defined, in our case, as PhD holders) to the country of birth: recent return mobility refers to changes in the country or region of work that occurred in the previous year; non-recent return mobility refers to situations in which the country of birth of a researcher differs from their country of work (or residence), or if they have changed country or region since obtaining a PhD.

3.2.1 Return mobility: recent returnees to country of birth

The LFS data allows, in principle, to produce statistics on a rather specific type of return mobility based on the number of persons identified as researchers (i.e. PhD holders according to our definition) who returned to their country of birth within the last year. These researchers would report that their current country of residence (or work) is the same as their country of birth, and that this country is different from the country of residence 1 year before the survey. Clearly, this specification is rather restrictive and imprecise, as we it gives little information on whether the country of residence a year earlier was a country of work, and is it omits return movements taking place before the 1-year time horizon. The indicator may be further refined to show whether the return within the past year was following the attainment of a doctoral degree – but the low number of such recently returning graduates is unlikely to produce sufficient number of observations to have reliable results.

As it turned out, the number of observations for measuring recent return mobility to the country of birth is very low. Figures from single years are insufficient to pass the confidentiality or reliability thresholds for EU Member States. In order to overcome this, we pooled data from 4 survey years: 2011-2014. The share of recent returnees is below the confidentiality threshold for 27 of the 28 Member states, and unreliable for 1 (the Czech Republic). This hardly improves if we consider the current country of work to be the same as the country of birth (while we lose precision given that there is no information on what the country of work was a year earlier). When pooling the EU28 countries’ data for the four years, we find that recently (within 1 year) returned researchers constitute less than 0.5% of the PhD-holder population.

We can safely conclude that LFS survey does not provide sufficient data for a sufficiently large sample to derive reliable statistics on return mobility patterns at the country level on either an annual or multi-annual basis.

³¹ See i.e. http://ec.europa.eu/eurostat/product?code=hrst_fl_mobsex&language=en&mode=view

3.3 Returning Doctorate Holders (CDH data)

The UNESCO Institute for Statistics, OECD and Eurostat jointly launched the Careers of Doctorate Holders (CDH) project in 2004 in order to collect information on the careers of individuals trained at the highest academic level to become researchers. The general purpose of the information collection was to inform research policy makers on whether and how researchers were using their acquired competences in the knowledge economy. The surveys targeted the population of doctorate holders in all institutional sectors of employment. An ad-hoc survey was chosen given the limitations in other information sources, such as standard labour force surveys, population censuses or administrative data.³²

The latest round of the ad-hoc CDH survey was carried out in 2010, for the reference year of 2009 for 13 countries, out of which 11 are (currently) EU Member States. A further investigation of micro-data of this survey was carried out in 2013, but as the survey lost priority, it has only been repeated for a small set of countries (Eurostat did not participate in the third data collection carried out in 2013).

When it comes to statistics relevant to return mobility, the CDH survey offers information on the number and length of stays abroad that lasted for at least 3 months, as well as on the motivations for returning to the home country.³³

The share of doctorate holders who lived or stayed abroad in the past ten years (implicitly, the returnees following foreign stays of various length not less than three months) varies between 3 (Germany) and 30 percent (Malta) across Europe (see Table 20). It is noteworthy that figures on returnees obtained from the CDH and MORE2 surveys are very different – more different than what is likely to be due to the differences in their timing. As an illustration, Table 20 provides statistics for the countries covered in the CDH survey on the share of respondents who lived or stayed abroad in the past ten years (similarly to MORE2), as well as A, B and C categories of return mobility from the CDH survey. While the share of returnees for Belgium is virtually the same according to the two surveys, those for the other countries differ markedly, up to the extreme case of Malta. Notwithstanding the possibility that the wake of the financial crisis caused researchers to return to their home countries in larger numbers, it is difficult to attribute the gap observed between the two sources to this effect, and easier to attribute to differences in the sampling methodology.³⁴

³² For more information on the CDH survey, see Auriol, L. (2007), "Labour Market Characteristics and International Mobility of Doctorate Holders: Results for Seven Countries", OECD Science, Technology and Industry Working Papers, No. 2007/02, OECD Publishing, Paris. DOI: <http://dx.doi.org/10.1787/310254328811>; Auriol, L. (2010), "Careers of Doctorate Holders: Employment and Mobility Patterns", OECD Science, Technology and Industry Working Papers, 2010/04, OECD Publishing, Paris. <http://dx.doi.org/10.1787/5kmh8phxvfvf5-en>; Auriol, L., M. Misu and R. Freeman (2013), "Careers of Doctorate Holders: Analysis of Labour Market and Mobility Indicators", OECD Science, Technology and Industry Working Papers, 2013/04, OECD Publishing, Paris. <http://dx.doi.org/10.1787/5k43nxgs289w-en>; as well as at www.oecd.org/cdh

³³ According to the CDH, an internationally mobile doctorate holder is a doctorate holder who, since the award of his/her advanced research qualification, has stayed or lived in a country other than that of his or her usual residence for a period of at least 3 months, except in cases where the movement to that country was for purposes of recreation, holiday, visits to friends and relatives, medical treatment or religious pilgrimage.

³⁴ As for other measures of external coherence, Eurostat Reference Metadata notes that the CDH 2009 has not been compared with other sources, such as LFS [http://ec.europa.eu/eurostat/cache/metadata/en/cdh_esms.htm].

Table 20 Comparison of CDH and MORE2 return mobility figures (in percentage points)

Country	CDH (2009)	MORE2 (2012)				Difference
	% who lived or stayed abroad in the past ten years	A (Post-PhD return)	B (Temporary return)	C (Return after temporary mobility)	Returnees (A+B+C)	MORE vs. CDH
Malta	29.5	75.0	0.0	2.9	77.9	48.4
Hungary	23.5	8.5	0.0	21.4	29.9	6.4
Spain	21.1	6.0	0.3	21.1	27.3	6.2
Portugal	19.2	26.8	0.0	6.4	33.2	14.0
Netherlands	18.6	5.2	0.4	16.5	22.1	3.5
Belgium	18.3	4.6	0.0	13.8	18.4	0.1
Israel	16.2	n.a.	n.a.	n.a.	n.a.	n.a.
Russian F.	14.6	n.a.	n.a.	n.a.	n.a.	n.a.
Slovenia	14.1	11.5	0.0	22.0	33.5	19.4
Turkey	14.0	25.0	0.0	13.7	38.7	24.7
Croatia	11.5	5.1	0.0	10.6	15.7	4.3
Bulgaria	11.1	11.0	0.0	12.5	23.5	12.5
Romania	8.1	6.4	0.0	13.2	19.5	11.4
Sweden	6.9	6.5	0.0	10.7	17.2	10.3
Lithuania	6.6	12.8	0.0	9.8	22.6	16.0
Latvia	5.6	11.9	0.0	2.4	14.3	8.7
Germany	3.1	2.8	3.2	8.3	14.3	11.2

Source: CDH 2010 and MORE2 surveys (Table 12)

As .

Table 21 shows, there is a variety of motivations for doctorate holders to return to their home countries. In a large number of cases, the key reasons are a combination of academic, economic or personal nature, but there are considerable cross-country differences.

Table 21 Reasons given by national citizens with a doctorate for returning to the home country (CDH 2009)

	Completion of doctorate	End of postdoc or job contract abroad	Other job related or economic factors	Academic factors	Family or personal reasons	Political or other reason	Unspecified	Total
Belgium	5.2	16.6	24.7	19.3	33.6	0.6		100.0
Bulgaria	7.9	0.0	24.1	58.7	6.9	1.7	0.8	100.0
Croatia	20.7	3.6	18.3	26.7	30.7			100.0
Hungary	12.7	2.1	34.4	39.0	9.9	1.0	0.8	100.0
Israel	5.5	1.0	24.3	55.7	12.0	0.0	1.5	100.0
Latvia	8.0	32.8	22.4	11.0	24.7	1.0		100.0
Lithuania	12.7	1.7	40.9	37.0	6.6	1.2		100.0
Malta	34.9	4.6	22.0	5.5	32.1	0.9		100.0
Netherlands	8.1	14.9	28.5	25.7	22.2	0.6		100.0
Portugal	18.0	3.0	24.9	39.1	13.4	1.5		100.0
Romania	23.6	15.8	21.3	14.1	23.4	1.8		100.0
Spain	11.1	15.1	21.8	13.2	27.9	10.9		100.0
Turkey	11.6	10.6	8.8	26.1	14.6	7.5	20.8	100.0

Source: CDH 2009, table 32; Note: percentages based on multiple reasons possible

3.4 Summary on data sources

We observed considerable differences across the various survey-based sources on the return mobility of researchers. The micro-data of the MORE2 survey offered valuable insights about differences in the mobility patterns across gender, discipline, seniority, country of citizenship as well as country of PhD in a way that CDH or other sources could not allow. We noted, however, that a more fine-grained study of individuals using their actual affiliations (universities or research organizations) was not available due to privacy concerns. Similarly, the low number of observations did not allow us to exploit micro-data from the regularly conducted, wide-spread survey, the EU LFS.

Nevertheless, alongside survey data, there are potential alternative sources that may be referred as “big data”. The use of administrative data, bibliometric data, curriculum vitae (CV) data of researchers has a huge potential to be exploited. For instance, calculations by the OECD shown in the Science, Technology and Industry (STI) Scoreboard 2013 show different mobility profiles, using Scopus data for the 1996-2011 period (see Figure 7). Authors with at least two peer-reviewed scientific publications were classified based on how their affiliation changed over the observation period. “Stayers” were defined as those who maintain an affiliation in a given reference country over the period. “Outflows” were defined on the basis of the first affiliation. “New inflows” were defined on the basis of the final affiliation and excluded individuals who “returned” to their original country of affiliation. The latter authors were defined as “returnees” (OECD STI 2013). The data presented in Figure 7 shows a lower share of returnees than what was reflected in the MORE2 and CDH surveys, ranging, in the case of EU Member States, from a mere 4.9% observed for Spain to 8.6% in the case of Austria. The lower figures are not surprising, since it is reasonable to expect that many of the mobility events do not lead to peer-reviewed publications and thus “below the radar” for bibliometric data.

Many of the data sources have their strengths as well as limitations, as shown in Table 22. Bibliometric data, for instance, has its strength in putting a quality filter on mobility: it captures a population of researchers (defined of course in an output-oriented way as those who actually produce research) that would otherwise be difficult to capture in a survey, offering fine-grained information on changing location and collaboration patterns. At the same time, the output orientation is a major limitation, because of the lag between the actual mobility event, the submission and eventual publication of articles. Bibliometric data are also more biased towards natural sciences and may underrepresent arts, humanities and social sciences where monographs and book chapters are more wide-spread, although less frequently produced outputs.

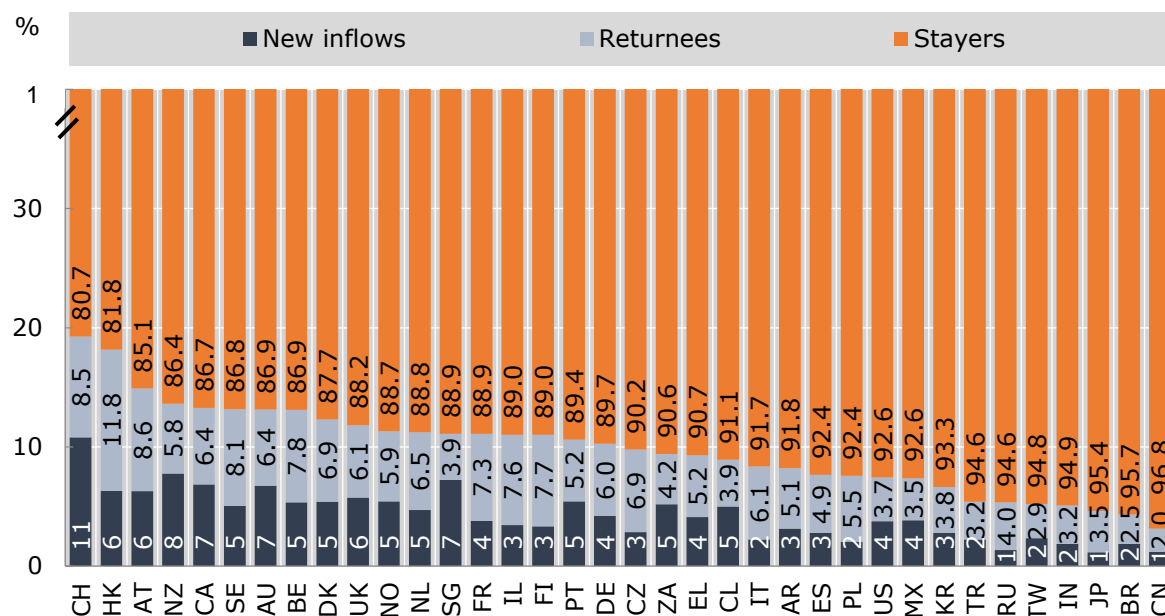
A way to complement bibliometric data may be the use of curriculum vitae (CV) data of researchers, which may offer detailed information on actual dates of research visits or changing affiliations. However, that comes at a price as well: apart from the labor-intensive nature of data collection, coding, cleaning, etc., it may be biased towards the more internationally mobile researchers or those applying and winning grants more often, who are more likely to update their CVs more frequently. Population registers maintained by Scandinavian countries offer a complete collection of CV information, with demographic events, and may be combined with employment information, making it a valuable source to measure researcher mobility.³⁵

Data stored in the Open Researcher and Contributor ID (ORCID) may offer a unique combination of CV and bibliometric information for registered authors, who represent about a quarter of the world’s researcher population. Although not without bias (younger, more productive and mobile researchers are more likely to create and update their ORCID profiles), ORCID collects data on authors including education, employment, publications and (in a less complete way) funding. It not only simplifies the challenge of disambiguating author names, but also offers linkages to various datasets (i.e., clinical

³⁵ An un-exploited source of information are the registers held by foreign offices (consulates, embassies) on the characteristics of nationals residing in foreign countries.

trials, publications, patents) (Haak et al, 2012), thus potentially providing insights on researcher mobility. Similar information is available from ResearchGate, a social networking website for scientists and researchers aimed at sharing papers, ask and answer questions, and find collaborators. Data for researcher profiles that are flagged as public are accessible for research purposes.³⁶

Figure 7 International mobility of scientific authors, 1996-2011, based on bibliometric data



Source: OECD STI 2013 Fig. 3.6.2; calculations based on Scopus Custom Data, Elsevier, version 5.2012, May 2013.

³⁶ See i.e. at <http://datadryad.org/resource/doi:10.5061/dryad.48s16>

Table 22 Overview of the strength and limitations of potential data sources on researcher mobility

Type	Source	Strengths	Limitations
Ad-hoc survey	MORE2 Study on Mobility Patterns and Career Paths of Researchers, 2013	Large-scale survey (N>10,500) with detailed information on the different mobility patterns of researchers for a large set of European and non-European countries	Not available at the regional (NUTS2) or more fine-grained level; time coverage limited;
	Career of Doctorate Holders Survey 2009	Survey with information on mobility patterns and motivations	Country and time coverage limited; cannot be disaggregated to regions
Regular survey	Labour Force Survey	Established, harmonized methodology for the overall population; broad time and country coverage	Sample size too small to produce annual or multi-annual statistics on the mobility patterns of the researcher population;
Administrative or “big” data	Bibliometric data	offers a broad and growing coverage of researchers incomparable to surveys; An output-oriented measure of mobility	Many defining events of mobility do not lead to publications (=output biased), potential biases against some languages, as well as arts and humanities; due to publication lags, little information is available on actual time of mobility
	CV data	Offers in-depth mobility information with actual dates of research stays;	Research-intensive; data availability biased towards more mobile researchers; Privacy concerns
	Author identifier data (ORCID) data	very large sample (currently an estimated ¼ of the world researcher population) and detailed information on education, employment, publication, and funding.	Biased sample mostly representative of the younger and more productive (and mobile) researchers that are more likely to generate and update their ORCID profiles

Source: Authors’ compilation.

3.5 Association of return mobility with research excellence

Under the assumptions of the “allocative approach” described in section 2.2, researchers returning to their countries of origin with experience gained abroad can be seen to strengthen the research system of their home countries by increasing the local knowledge stock. As a final step, we analyze, at the country level, associations between the share of returnees with the research excellence of the respective country. How exactly returnees strengthen the excellence of their home countries’ research system or how the research systems attract returning researchers is outside the scope of this study. The purpose of the paragraphs below is to offer a broad overview of country performance in the two dimensions.

In the left panel of Figure 8, we contrasted the Adjusted Research Excellence Index (REI) scores of 2013³⁷ with the share of returnees by countries of citizenship. We observe a

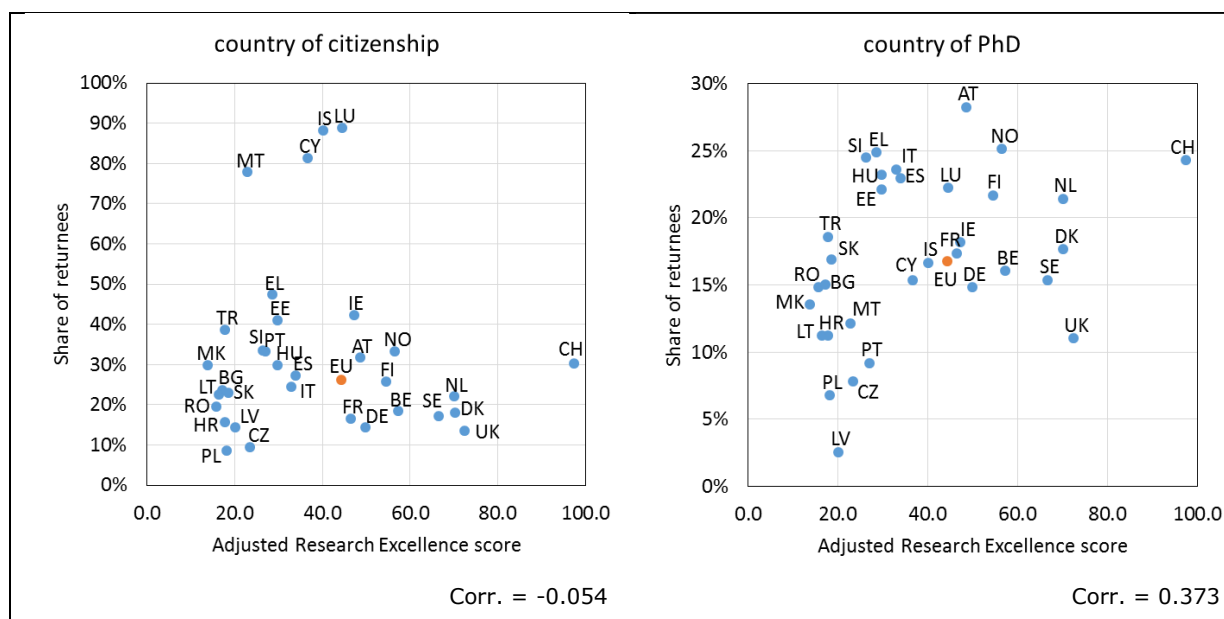
³⁷ This measure is used to track European Research Area priority 1: effective national research system. It is a composite indicator measuring share of top 10 % most highly cited publications per

lack of observed association between the share of returnees and REI scores. For instance, while the rate of returnees is about the same for Slovenia, Portugal and Hungary as well as Switzerland, the 3 former and the latter countries differ substantially in their research excellence performance.

Apart from the cluster of small countries, we find Greece, Turkey, and Estonia as locations with above-average returnee rates, and below-average excellence scores. There may be a more optimistic, and a more pessimistic reading of the diversity of this picture. It may signal a potential movement by which returnees will increase the excellence of lower ranking research systems, using the experience gained in stronger performing countries. Or, it may also signal the opposite, if returnees are researchers that failed to meet the relatively higher expectations of the more excellent research systems. In any case, the realization of the potential impact of mobility is conditioned by the institutional framework of the countries.

The share of returnees back to the country of PhD expresses a different picture (right panel of Figure 8). The positive correlation between the share of returnees and country-level excellence is driven by the fact that excellent research systems had already been attractive for researchers choosing a location to pursue their PhDs.

Figure 8 Research excellence and the share of returnees by country of citizenship and PhD



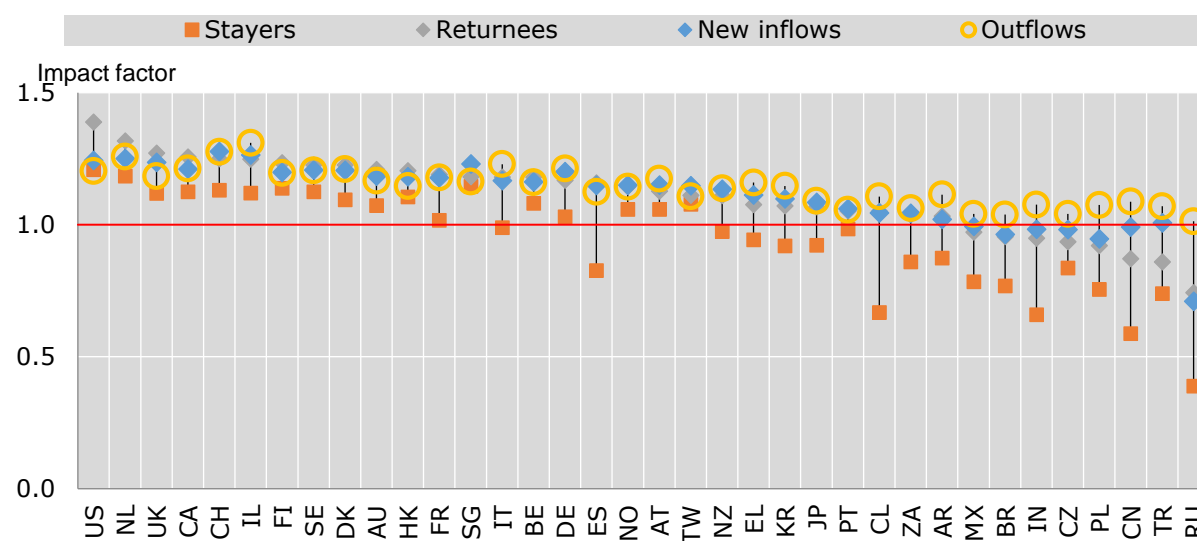
Source: MORE2 survey, authors' calculations; European Commission (2017)

Differently from a survey-based approach, there have been attempts to use bibliometric data to describe the “excellence” of mobile researchers, including returnees. The above-mentioned OECD Science, Technology and Industry (STI) Scoreboard 2013 also published the results of computations of scientific impact for four different mobility profiles. (Figure 9). A proxy measure of scientific impact was estimated for researchers with different mobility patterns by calculating, for each author and mobility profile, the median across the respective journals’ Source-Normalized Impact per Paper (SNIP) over the entire period of observation. A SNIP impact value that is higher than one means that

total publications (data source: CWTS); PCT patent applications per population (OECD); ERC grants per public R&D (DG-RTD, Eurostat, OECD) and participation in Marie Skłodowska-Curie fellowships (DGEAC). Dates refer to 2013. For further details, see European Commission (2017).

the median attributed SNIP for authors of that country/category is above average. Two key observations from Figure 9 are the overall high correlation between the median impact scores found for the “returnees” and “stayers”, and the changing distance between the median impact of “returnees” and “stayers” as scores decrease. Furthermore, while returnees show above-average impact in most countries even if stayers perform below average (scores below 1), there are exceptions in EU Member States including the Czech Republic and Poland. Spain, on the other hand, is an outlier among peers in terms of returnees, because of its relatively low impact observed for the “stayers”. We need to highlight that these data are of experimental nature and should be read keeping in mind the limitations discussed in the previous sub-section (see Table 22).

Figure 9 Impact of scientific authors, by category of mobility, 1996-2011 based on bibliometric data



Source: OECD, STI Scoreboard 2013, Fig. 3.6.3; OECD calculations based on Scopus Custom Data, Elsevier, version 5.2012, and SNIP2 Database, www.journalmetrics.com, Elsevier, Scimago and University of Leiden, May 2013.

4 Outlook for future research

The main finding of this report is that apart from the widely diffused, neo-classical economics, general equilibrium-based “allocative approach” to conceptualize researcher mobility (which assumes that human capital, embodied in rational agents, is efficiently allocated and used by the “general” productive system), other approaches exist and can be further developed. These approaches may be more aligned with how scientific research activity is carried out and how it is embedded in the socio-economic system. An eventual shift of focus from the “allocative” to a “connective” approach (which, based on an economic evolutionary conception of human capital as inherently networked, in a complex, evolving system) would point in the direction of changing the object of study. Rather than on the changing stock of researchers, it would focus on the heterogeneity of research actors and networks, the impact of reconfigurations of scientific, technological and social networks in which researchers’ work is embedded. As one of the case studies reviewed shows, a research system of a given country can substantially benefit from the establishment of new academic and social network connections due to a temporary mobility event even if the mobile research in question has physically “emigrated” from the country of origin. Alternatively, a focus on the “creative” approach (which considers changes of contexts as inherent to creating the conditions for knowledge recombination) would lead to putting greater emphasis on the study of the evolution of ideas, research agendas and research careers. The possibilities for improving our knowledge regarding the role played by researcher mobility within the epistemic and organizational dynamics of the European Research Area are extensive, particularly if we do not only think of mobility as a re/allocative phenomenon. Addressing more complex questions regarding the evolution of research networks calls not only for reflection on the potential for improvement of available survey instruments, but also on the possibility to systematically combine different information sources that should include CV-based information, register data, bibliometrics and qualitative interviews. In many ways, this is moving in the direction of what is referred to as exploiting “big data” sources: contrary to surveys, the original purpose for the conception of bibliometric and CV data was not to provide information on researcher mobility patterns. However, these sources offer evidence that is unparalleled to surveys. Sources that combine CV and bibliometric data at the author level, such as ORCID, offers highly valuable information for future studies. Key concerns are on the one hand, ensuring that the correct signals are picked up from data collected for different purposes, and on the other hand, respecting privacy of individual researchers.

This report is merely a first step in arguing for the need to open the horizon. The quantitative evidence reported – computed according to the “allocative” approach – merely highlights country-level patterns and correlations. We also propose recommendations on the limits regarding the MORE surveys, based on the finding that some results need to be treated with some caution, given the high probability that mobility events (i.e. those shorter than 3 months) were not adequately captured by the survey, particularly in the case of disciplines in which short-visits are a relatively common practice. We finally notice that the association between country-level rates of return mobility and research excellence is rather low (regardless of the measurement methods). As this evidence may be a source optimism indicating that future excellence is in the making, it further highlights the need for revising the assumed conceptual approaches.

We find the words from Scott (2015) regarding academic mobility to be particularly inspirational and relevant for the closure of this report.

"The possibility should at least be considered that the terms and categories currently used to discuss academic mobility [brain drain/gain/circulation] are out of date. It is possible to argue that under 21st century conditions the distinction between academics who make their careers at home and those who move to other countries may no longer be so sharp and meaningful as it was in the 20th century. In the contemporary environment in which academic mobility can be regarded as just one element in global

mobility, especially of elites, and also in which 'virtual' and 'physical' mobility are combined in curious and volatile mixtures, this binary distinction may have a reduced explanatory value. Maybe a better way to think about academic mobility is as a spectrum, from the deeply rooted to the highly mobile academic, with most strung somewhere along the middle of that spectrum. Nor should the less mobile academic be stigmatised as inferior, the implication of the weightings and criteria used in the construction of many global university league tables. It should always be remembered that Immanuel Kant never travelled far from his home in Königsberg (now Kaliningrad), just as it should also be recognised that the triviality of the jet-setting academic familiar in satiric 'campus' novels, always skating across the surface of academic life, is not always a caricature. In a very real sense all academics are now both 'local' and 'global'. To accept such a conclusion, of course, may undermine many of the studies of academic mobility, empirical or speculative, that rely on holding fast to these distinctions. But it also leans towards 'fluid globalisation' rather than 'hegemonic internationalisation' as a better framework in which to consider the future of academic mobility – and, as such, to regard such mobility in terms of hope rather than of threat.” (Scott 2015, S68).

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List of abbreviations and definitions

CDH	Career of Doctorate Holders Survey
EFTA	European Free Trade Association
ICT	Information and Communication Technologies
LFS	Labour Force Survey
MORE	Survey on the Mobility of Researchers in Europe
EU28	European Union of 28 Member States
HRST	Human resources in science and technology
NUTS	Nomenclature of territorial units for statistics
OECD	Organisation for Economic Co-operation and Development
ORCID	Open Researcher and Contributor ID
PhD	Doctor of Philosophy
R1	First Stage Researcher (Up to the point of PhD)
R2	Recognised Researcher (PhD holders or equivalent who are not yet fully independent)
R3	Established Researcher (Researchers who have developed a level of independence)
R4	Leading Researcher (Researchers leading their research area or field)
R&D	Research and development

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