European Commission

Knowledge ecosystems in the new ERA

Talent circulation and intersectoral mobility:

Analytical report with a mapping of talent mobility and causes of brain drain

Research and Innovation

Knowledge Ecosystems in the new ERA: Talent circulation and intersectoral mobility: Analytical report with a mapping of talent mobility and causes of brain drain

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Knowledge Ecosystems in the new ERA

Talent circulation and intersectoral mobility:

Analytical report with a mapping of talent mobility and causes of brain drain

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INTRODUCTION

This analytical report is part of a series of reports on "Talent circulation and intersectoral mobility" of the wide-scoping study "Knowledge Ecosystems in the new ERA". The overarching study addresses the need for a strengthened European Research Area (ERA) by enhancing the Knowledge Ecosystems across Europe and their interconnections.

The report builds upon the work conducted in WP8 "Mapping brain drain and contributing to solutions". It provides detailed findings of a mapping of talent circulation in the European Union and its Member States, a comprehencive account of the the causes of brain drain, and it identifies evidence-based solutions that are sustainable in the long run to increase the attractiveness of research careers in the Member States suffering from brain drain.

PART 1: TALENT CIRCULATION MAP

1. Conceptual framework and indicators

1.1. Conceptual framework of talent circulation

Figure 1 presents the conceptual framework of talent circulation that is applied throughout WP8[1]. It departs from the more general concept of international or geographical mobility. International mobility includes both talent circulation and talent exchange.

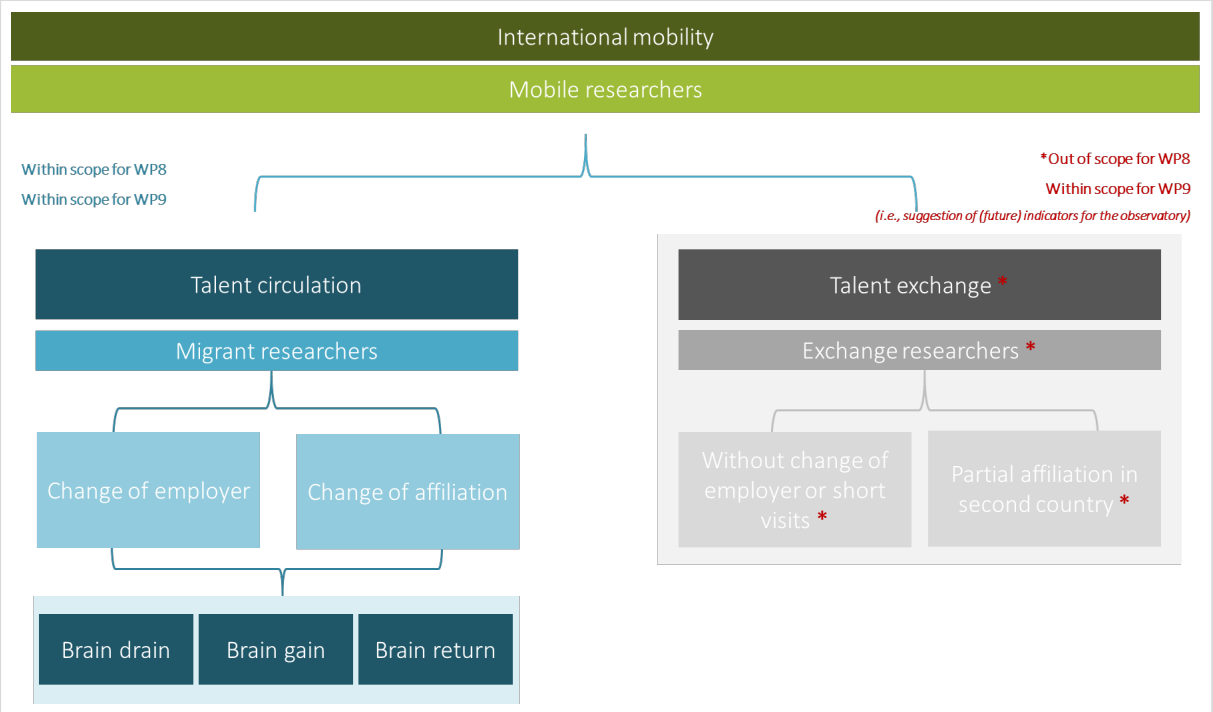
Talent circulation focuses on migration of researchers that start working for an employer in another country. This concept allows to define brain drain, brain gain and brain return. It is therefore the focus of WP8.

Talent exchange, on the other hand, entails all other types of moves without employer change: e.g., study visits, partial affiliations with other institutes than the 'home' institute, etc. These types of moves encourage exchange of knowledge and knowhow, but do not imply a 'loss' to the country of employment of the researcher. Talent exchange is not the focus of WP8, but will be considered for the broader observatory on international mobility developed in WP9.

In the following paragraphs, we define the concepts of the framework. A clear definition will allow applying a common reference framework for the definition of indicators from different sources, in particular the two sources used for the talent circulation map: the MORE survey data and the scientometric approach based on Web of Science (WoS) data. We also define the main units of reference and analysis, namely countries of origin and destination, for these sources.

[1] The framework focuses on circulation of people remaining in research. Those leaving research to work on unrelated activities are not included in the scope.

Figure 1: Conceptual framework of talent circulation



1.1.1. Glossary: definition of concepts

The following paragraphs present the definitions for each of the concepts that sustain the indicators that have been constructed for WP8. In some cases, the characteristics of the underlying methods (survey vs scientometrics) entail that slightly different definitions are derived for each method. When the same definition is used for both approaches, this is indicated with the term 'All'.

- Researcher[2]:
  - General definition (also applied in the MORE surveys): Professionals engaged in the conception or creation of new knowledge, conducting research and improving or developing concepts, theories, models, techniques instrumentation, software or operational methods .(Frascati Manual)
  - Scientometric approach: any publishing author in the WoS, uniquely disambiguated.
- International mobility:
  - All: Extent to which researchers work abroad or are associated to research institutions located in another country.
- Mobile researcher:
  - General definition (also applied in the MORE surveys): Any researcher working in more than one country in a given period of time (not necessarily changing employer).

[2] Note that the scope of the study also includes non-academic researchers and other PhD holders working in R&I-related activities such as research policy advisers, research managers, financial support staff, knowledge transfer officers, business developers, knowledge brokers, innovation managers, data stewards, software engineers, research infrastructure operators, etc. MORE data focus on academic researchers, WoS does not exclude other profiles as long as they are publishing authors. There are however no specific or general data sources that consistently cover these groups, so that they are not sufficiently represented in the indicators and talent circulation map. Other approaches are taken to gain insights on brain drain issues among broader R&I profiles.

- Scientometric approach: any researcher with affiliations to more than one country/unit in the period of analysis (this includes all kinds of affiliations, sequential affiliations, simultaneous affiliations, and multiple affiliations).

- Talent circulation:
  - All: Extent to which researchers move to another country and this move entails a change of employer / of university affiliation.
- Migrant researcher:
  - General: Any researcher who works in a different country than the country of origin (see definition of country of origin below).
  - Scientometric approach: Any researcher with an affiliation in a different country than the country of origin.
- Brain drain:
  - All: Situation when more researchers leave the country than are attracted to the country.
- Brain gain:
  - All: Situation when more researchers are attracted to the country than leave the country.
- Brain return:
  - All: Situation when researchers having left the country return to their country of origin (i.e. they re-establish activity/employment with the country of origin after a period of interruption).
- Talent exchange / Exchange researcher:
  - All: Extent to which researchers are linked to research institutions located in another country. This includes:
    - Moving to another country without changing employer (i.e. keeping the working/affiliation relationship with the research organisation in the country of origin).
    - Being affiliated partially to another research institution in another country without stopping their affiliation with their 'home' country/institution.
    - Short term visits.

1.1.2. Countries as main units of reference

- Country of origin:
  - MORE surveys: Two different units of origin are applied on the MORE data:
    - Country of citizenship: we assume that citizenship is a proxy of the country where the researcher is born.
    - Country in which the highest degree was obtained: we assume that the highest degree is the degree that gives access to the research career (e.g. MsC., PhD).

    For each indicator with reference to origin, the MORE data will thus produce two values, indicated with "(citizenship)" for reference to the country of citizenship and "(degree)" for reference to the country where the researcher obtained his or her highest degree.
  - Scientometric approach:

- Country of origin: Country of the first publication(s) of a researcher in the period of analysis (2008-2019). The assumption is that the first country of a researcher approximates the start of the publishing career of that researcher in the given country, and thus can be considered as the country of *academic citizenship* of the researcher.

- Country of destination:
  - MORE surveys: Country of employment of a researcher at the time of the survey, that is different from the country of origin.
  - Scientometric approach: Country of affiliation of a researcher, that is different from the country of origin. At the end of the period under analysis, it captures the country of current or latest affiliation, i.e., in the last known year of activity of a researcher.

1.2. Indicator framework of talent circulation

Based on the conceptual framework, we define the following main indicators of brain drain, as well as other indicators to contextualise brain drain (Table 1). Together, this set of 8 indicators (and sub-indicators) are the basis of the talent circulation map.

Table 1: Indicator framework of talent circulation

Indicator		Description
Main indicators of brain drain		
I1	**Indicator of stock of incoming researchers**	Share of foreign researchers working in the country (operationalised for the full period and on a yearly basis).
I2	**Indicator of stock of outgoing researchers**	Share of original researchers having left the country (operationalised for the full period and on a yearly basis).
I3	**Indicator of brain drain**	Ratio of stock of outgoing and incoming researchers. If the brain drain ratio is higher than 1, more researchers have left the country than are attracted to the country (operationalised for the full period and on a yearly basis).
Other indicators to contextualise brain drain		
I4	**Indicator of primary brain drain at time t**, based on first move	Share of researchers that fully or partially leave their country of origin for the first time at time t, out of the total active population in the country at time t. This indicator reflects the extent and timing of the brain drain from the country of origin.
I5	**Indicator of attractiveness**	Share of researchers attracted to the country, out of the total active population in the country (operationalised for the full period and on a yearly basis). The full period and yearly attractiveness indicators reflect all moves to the country over time or in a specific year, regardless of whether the attracted researchers are still working in the country at the end of the period. These indicators therefore capture the dynamics behind the stock indicator of incoming researchers.

Indicator		Description
		A third subindicator focuses on the attractiveness at the first move: it reflects the extent to which a country is attractive as first destination country in a situation of brain drain from the country of origin.
I6	**Indicator of propensity to move**	Average number of moves made per researcher of the country of origin (operationalised for the full period). This indicator reflects how likely researchers in a given country are to be mobile.
I7	**Indicator of return mobility**	Share of researchers that returned to their country of origin, out of the total number of researchers of a country of origin that left at some point (operationalised for the full period). This indicator reflects the extent to which countries can counter brain drain via return mobility.
I8	**Indicator of retention in brain drain/gain**	Average number of years (overall) that: - a researcher works in his/her country of origin (regardless of leaving or not). - a researcher works in another country than his/her country of origin. - a researcher with another country of origin works in the country. This indicator reflects how many productive years of the researcher on average: - are spent in the country of origin. - are lost to the country because he/she has left the country. - are gained by the country because he/she was attracted to the country.

2. Data, methodology and operationalisation of indicators

This section outlines how the defined key indicators for the talent circulation map are operationalised based on two sources: the MORE surveys and a scientometric approach based on WoS data (see overview in Table 2).

Table 2: Mix of methods for quantification of talent circulation

MORE EU HE survey	Scientometrics
Based on survey	Based on bibliometric data WoS and affiliations
Time dimension: – Years 2012; 2016; 2019	Time dimension: – Period 2008-2019 (indicators calculated for 2009-2019)
Geographical coverage: – EU MS and 3 AC: Switzerland, Iceland and Norway	Geographical coverage: – Global – Good coverage of publishing researchers

MORE EU HE survey	Scientometrics
– Not exhaustive – Key indicators: representative at country level for all EU MS / Subindicators: not representative at country level – Covering all career stages (including early stage career researchers), fields, gender	– Covering all career stages, fields, gender, but coverage limited by extent of publishing
Sector coverage: – Focused on HE sector	Sector coverage: – Both in and outside HE sector, but only publishing researchers
Indicators: – Stock incoming, stock outgoing, brain drain, propensity to move – Information available on career stage, gender, field	Indicators: – Stock incoming, stock outgoing, brain drain, primary brain drain, attractiveness, propensity to move, return mobility, opportunity cost – Information can be derived on academic age, gender

Other data sources such as OECD or Eurostat were explored, in particular to include a more diverse group of R&I profiles. Yet, these indicators were not withheld for the talent circulation mapping for the following reasons:

- Eurostat data on residence in another country: EU/EFTA citizens of working age who usually reside in another EU/EFTA country by citizenship, age and educational attainment level (ISCED). This indicator was explored to provide context on the general situation of PhD holders residing in another country. Yet, the dimension of educational attainment level reports on the ISCED 5-8 category, and the specific ISCED 8 category cannot be distinguished to zoom in on PhD holders. The indicator is thus not included because the necessary level of detail is not available.

- R&D&I indicators on R&D&I personnel (in HES, GOV or PRIV) in OECD MISTI were explored to see whether they include information on citizenship/nationality (versus country of current employment). This indicator could provide context on the general situation of R&I profiles working in another country. However, this combination of information is not available in the data.

2.1. Data and methodology

2.1.1. MORE surveys

The MORE surveys have been launched three times: 2012, 2016 and 2019. The MORE surveys are based on a two-stage stratified random sampling approach, aiming to produce estimates with a minimum degree of accuracy (5% max error -p value of 5%) at both EU and individual country level. The survey has been administered in 31 European countries: the (then) 28 Member States of the European Union and Iceland, Switzerland and Norway. These surveys are always implemented through a combination of CAWI (Computer-assisted web interviewing) and CATI (Computer-assisted telephone interviewing) techniques. The consecutive MORE surveys collected around 10.000 complete responses each.

Migrant researchers are defined as those researchers that are working in a different country than their country of origin (citizenship or highest degree) at the moment of the survey. For indicators with reference to the country of citizenship, this definition entails that in some countries the number of observations is too low to extract meaningful conclusions.

The dashboard includes all the countries but special attention needs to be paid to the following countries and years as the number of observations is not sufficiently high[3] (i.e., the highest value of outgoing and incoming researchers (respondents) analysed with respect to the country of citizenship is below 15):

- Bulgaria (2016,2019)
- Croatia (2012, 2016, 2019)
- Iceland (2012)
- Latvia (2012, 2016, 2019)
- Lithuania (2012, 2016, 2019)
- Malta (2012, 2016, 2019)
- Slovenia (2012, 2016, 2019)

The indicators are calculated at country level and by dimension at country level: gender, field of science and career stage. For the dimension of field of science, the same three main fields of science applied in the MORE studies are used:

- NATURAL: Field 1 (Natural Sciences) and Field 2 (Engineering and Technology)
- HEALTH: Field 3 (Medical and health sciences) and Field 4 (Agricultural and veterinary sciences)
- SOCIAL: Field 5 (Social Sciences) and Field 6 (Humanities and the Arts)

The career stages are also the same as the ones used in the MORE surveys, which are based on the European Commission's model for career stages[4]:

- 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).

It is important to note that the information on career stages is collected via the survey, through self-selection. The career stage refers only to the career stages of the researcher at the time of the survey, it does not reflect the career stage at the time of migration or exchange.

2.1.2. Scientometric approach based on Web of Science data

The scientometric data used in the project are extracted from the Web of Science database. The main advantage of a scientometric approach to track mobility is that it provides a

[3] The numbers of outgoing and incoming researchers in each country from the perspective of the country of highest degree are higher than those observed when using country of citizenship as reference country. Therefore no special attention needs to be paid to certain countries when analysing the indicators based on the country of highest degree.

[4] The classification describes four broad profiles that apply to all researchers, independent of where they work in the private or public sector: in companies, NGOs, research institutes, research universities or universities of applied sciences. Source: https://euraxess.ec.europa.eu/europe/career-development/training-researchers/research-profiles-descriptors.

common comparative framework to study mobility patterns globally, homogeneously and without the need of imposing any geographical restriction. Another prominent advantage of the scientometric approach is that it helps to unveil other types of mobility not always easy to identify, such as multiple affiliations or partial appointments held by researchers (e.g. by identifying researchers who disclose more than one affiliation in the same publications, or that have shared simultaneous affiliations in more than one country). Moreover, the richness of the data also includes the possibility to estimate the activity that a researcher has developed in a country different of their origin, as well as their gender or academic age, among other variables.

Box 1. Technical specifications – scientometric data

Database: Web of Science (Science Citation Index Expanded - SCIE, Social Science Citation Index - SSCI, Arts & Humanities Citation Index – A&HCI, and Conference Proceedings Citation Index - CPCI). Author name disambiguation algorithm: Caron & van Eck (2014, https://research.tilburguniversity.edu/en/publications/large-scale-author-name-disambiguation-using-rule-based-scoring-a).

Period of analysis: 2008-2019

Overall universe: 22,381,987 publications, 23,264,429 disambiguated researchers. Of these a total of 4,608,494 researchers produced at least 3 publications in at least 2 different years – this is our ***filtered dataset***, which is used as a basis for the talent circulation indicators in order to have a more robust analysis.

Gender identification: extracted from Gender API, Genderize.io, and Gender Guesser. Same methodology as in Leiden Ranking (https://www.leidenranking.com/information/indicators#gender-indicators).

Academic age: based on the year of first publication (YFP), considering the overall production of the researchers in the WoS (i.e. including also production before the period 2008-2019).

Institutional and country harmonization: same used as in the Leiden Ranking to properly identify universities (https://www.leidenranking.com/information/universities), but expanded to include all affiliations of the researchers included in this study.

Box 1 presents the main technical specifications of the data used to calculate the talent circulation indicators. The database used in the study is the Web of Science (WoS), combining its four main indexes (SCIE, SSCI, A&HCI, CPCI). It is important to highlight that by incorporating the conference proceedings database (CPCI) we are substantially enlarging the pool of researchers for whom we can provide mobility statistics.

The period of analysis covers 2008-2019, with 2008 being the first year when WoS started to collect the author-affiliation linkages from scientific publications. This linkage is fundamental to perform mobility studies, since it is the only reliable manner to identify exactly when an individual researcher is affiliated with a given institution and its country.

The most important limitation of the scientometric approach is that it entirely depends on the publishing activities of individual researchers in order to capture talent circulation flows. Thus, if a researcher is mobile but does not produce scientific outputs in the new destination, he/she would not be captured in the data as a mobile researcher. This is especially relevant in the analysis of brain drain occurring among early stage career researchers (for which the MORE studies constitute a strong complementary source of evidence). Moreover, the large presence of younger and lowly productive researchers may also represent a distortion in the estimation of the real research population of countries. For this reason, we have used a "filtered dataset", including only those researchers with a minimum of 3 publications and activity in at least 2 years. By this we ensure that only researchers with some minimal traceable activity are considered, increasing the robustness of the indicators calculated.

2.2. *Operationalisation of indicators*

2.2.1. Indicators based on MORE survey data

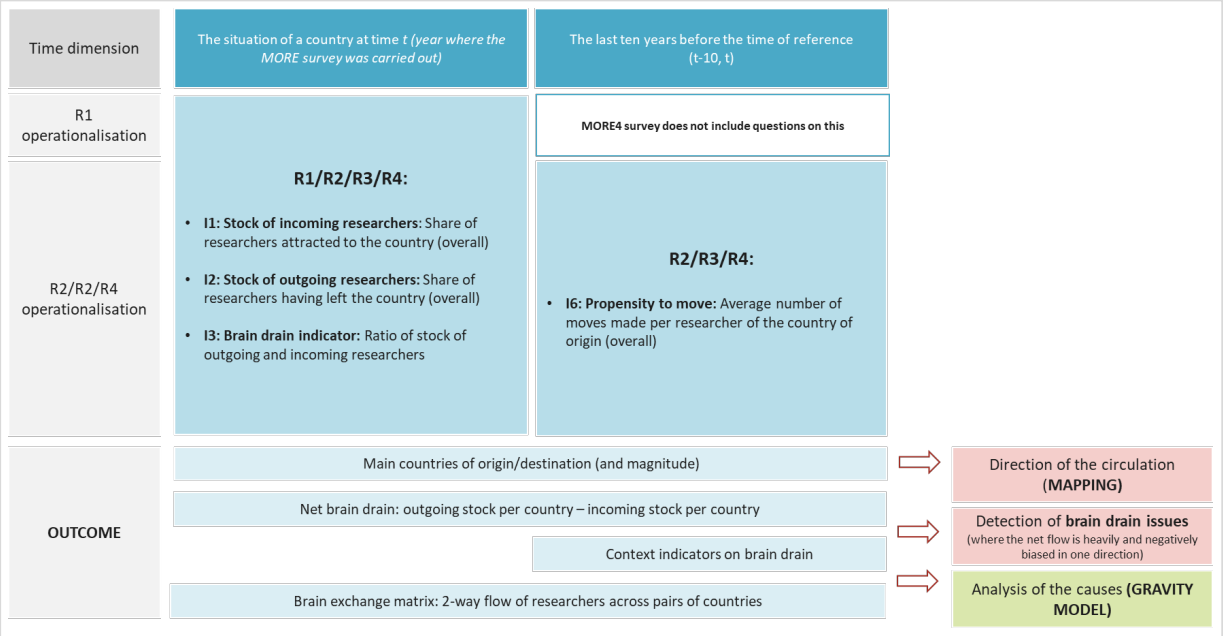
Error! Reference source not found. gives an overview of the indicators that can be calculated based on the MORE survey data.

- The main indicators of stock of incoming and outgoing researchers (I1 and I2) and the brain drain indicator (I3) are measured based on the situation at the time of the survey (2012, 2016 or 2019) and for all four career stages.
- The context indicator of propensity to move (I4) is measured based on the information provided by the researchers on their mobility pattern in the past ten years. This information is not available for R1 researchers.

The indicators will provide insight on the main countries of destination and origin and on the net brain drain as input for the talent circulation map and the detection of brain drain issues.

Moreover, the MORE data are also applied to identify the bilateral flows between countries (including as input for the gravity model to identify the causes of brain drain).

Figure 2: Overview of indicators for talent circulation based on MORE survey data



Error! Reference source not found. below outlines the operationalisation of the indicators based on the MORE survey data.

General points of attention in the operationalisation are:

- No threshold of minimum number of respondents is applied. The results for the indicators based on citizenship for the following countries and years should be interpreted with caution as the highest value of outgoing and incoming researchers is below 15:
  - Bulgaria (2016,2019)
  - Croatia (2012, 2016, 2019)
  - Iceland (2012)

  - Latvia (2012, 2016, 2019)
  - Lithuania (2012, 2016, 2019)
  - Malta (2012, 2016, 2019)
  - Slovenia (2012, 2016, 2019)
- Indicators with reference to the country of highest degree cannot be calculated consistently for 2012 due to changes in the questionnaire (question was asked with a different format).
- All indicators are also calculated for subdimensions of gender, field of science and career stage, except for the indicator of propensity to move.

Table 3: Operationalisation of indicators for talent circulation based on the MORE survey data

Indicator		Name	Operationalisation based on MORE survey data	
Main indicators of brain drain				
I1	**Indicator of stock of incoming researchers** *Share of foreign researchers working in the country*	% of foreign researchers in the country (citizenship)	Share of researchers working in the country at the time of the survey, who have citizenship from another country, out of the total number of researchers working in the country at the time of the survey	- Time dimension: 2012; 2016; 2019 - Country of reference: country of current employment (variable panel country) - Subdimensions: gender, field of science, career stage, year - Weighted by field of science in headcount
		% of foreign researchers in the country (degree)	Share of researchers working in the country at the time of the survey, who have obtained their highest degree in another country, out of the total number of researchers working in the country at the time of the survey	- Time dimension: 2016; 2019 - Country of reference: country of current employment (variable panel country) - Subdimensions: gender, field of science, career stage, year - Weighted by field of science in headcount
I2	**Indicator of stock of outgoing researchers** *Share of original researchers having left the country*	% of original researchers having left the country (citizenship)	Share of researchers with citizenship from the country, who work in another country at the time of the survey, out of the total number of researchers with citizenship from the country	- Time dimension: 2012; 2016; 2019 - Country of reference: country of citizenship - Subdimensions: gender, field of science, career stage, year - Weighted by field of science in headcount
		% of original researchers having left the country (degree)	Share of researchers who obtained their highest degree in the country, who work in another country at the time of the survey, out of the total number of researchers who obtained their highest degree in the country	- Time dimension:2016; 2019 - Country of reference: country of highest degree - Subdimensions: gender, field of science, career stage, year - Weighted by field of science in headcount
I3	**Indicator of brain drain** *Ratio of stock of outgoing and incoming researchers*	Brain drain ratio (citizenship)	Ratio of researchers having left the country (= their country of citizenship) to foreign researchers working in the country (= not their country of citizenship)	- Time dimension: 2012; 2016; 2019 - Country of reference: country of citizenship and country of current employment (variable panel country)Subdimensions: gender, field of science, career stage, year - Weighting not applicable

Indicator		Name	Operationalisation based on MORE survey data	
		Brain drain ratio (degree)	Ratio of researchers having left the country (= their country of highest degree) to foreign researchers working in the country (= not their country of highest degree)	- Time dimension: 2016; 2019 - Country of reference: country of highest degree and country of current employment (variable panel country) - Subdimensions: gender, field of science, career stage, year - Weighting not applicable
Other indicators to contextualise brain drain				
I6	**Indicator of propensity to move** *Average number of moves made per researcher of the country of origin*	Avg. number of distinct moves per researcher	Average number of moves made by a researchers in the period of the last ten years up to the time of the survey	- Time dimension: measured in 2019 for the period 2009-2019; and 2016 for the period 2006-2016 - Country of reference: country of citizenship - Not weighted

2.2.2. Indicators based on the scientometric approach

The operationalisation of mobility and brain drain indicators is a relatively new perspective in scientometric research. Therefore, it was necessary to develop new dedicated approaches in the context of this project that allow to capture different nuances of the mobility flows of scientific researchers in a simplified manner. In Box 2 the main basic notions and activity codes used in the operationalization of mobility events are described. Based on the activity codes described in Box 2, it is possible to further operationalise the so-called mobility footprints, which are the sequence of activity codes that a researcher has accumulated in his/her relationship with a given country. In **Error! Reference source not found.** below we illustrate an example of footprints.

Box 2. Basic notions – scientometric operationalisation of mobility

Activity event codes: the relationship between a researcher and a country, as well as other countries, can be characterised by a set of specific event codes.

We established the following codes:

- (**1**) a researcher is fully (exclusively) publishing with a given country;
- (**b**) indicates a year of activity of a researcher 'before' joining a given country;
- (**f**) indicates activity in a country, but simultaneously with activity with other country (it denotes a 'fractional' relationship with the country);
- (**0**) marks that a researcher is not active with a country, while being active in another country (it denotes a break in the publishing relationship with the country).

Mobility footprints: the codes defined above enable the identification of the 'footprints' of the activity of a researcher with a country or set of countries (see **Error! Reference source not found.**).

Types of footprints: the different footprints can be further classified. Thus, any researcher-country relationship with a '0' indicates a **brain drain**, while any researcher with a 'b' denotes a **brain gain** for that country. Moreover any researcher with '01' or '0f' relationships with a country can be seen as **brain return** cases.

Characterizing footprints: not all brain drain and gain are the same, and we further characterise them as **strict** when the researcher has an exclusive relation with the country (i.e. a '1' in the profile with the country) or **broad**, when the

Table 4: Example of mobility footprints in the scientometric approach

Researcher	Country	t1	t2	t3	t4
Researcher 1	C1	1	0	0	1
Researcher 1	C2	b	1	f	0
Researcher 1	C3	b	b	f	0

The example in **Error! Reference source not found.** captures the footprints for Researcher 1, in his/her relationships with 3 countries (C1, C2, C2) and across four points in time (t1, t2, t3, t4). The example above shows how Researcher 1 has a footprint of '1001' in its relationship with C1, which already indicates that he/she was a case of *brain drain* for C1 (i.e. marked by a '0') at t2. Since the researcher was fully affiliated with C1 at t1, we can also say that is a *strict brain drain* at t2. Moreover, the footprints for C2 and C3 show how R1 has respectively 1 and 2 years of activity before moving to these countries (marked by the 'b' events). Finally, at t4 the researcher has a *return* event to C1.

The operationalisation of the indicators is based on combinations of the mobility footprints of the researchers. We have considered both the strict and broad, as well as the total indicators. In the framework we finally report only the total indicators (including strict and broad) as main indicators. In addition, it is important to highlight that the indicators always take a backward-looking approach. This means that we count the event in the most recent year, although we characterize the accumulated footprint. Indicators can be calculated in two ways:

- For the full period (2009-2019): calculated at the end of the full period and considering the full footprint of a researcher in the country over that time.

- Yearly: calculated for each year, considering the footprint of the researcher in the country up to that year or during that year.

All 8 indicators are calculated for the full period 2008-2019[5]. The indicators that are also operationalised as yearly subindicators are: the stock of incoming and outgoing researchers (I1 and I2), the brain drain ratio (I3), primary brain drain (I4) and attractiveness (I5). In addition, like for the MORE data, the scientometric data are also applied to identify the bilateral flows between countries.

Finally, as mentioned above, gender and academic age have also been considered in the calculation of indicators at the country-level. Regarding the academic age, we have classified researchers in three groups based on when they started to publish, thus we have:

- Researchers who started to publish before 2008 (approximating the R4 career stage);
- Researchers who started to publish between 2008 and 2011 (approximating the R3 career stage);
- Researchers who started to publish between 2012 and 2015 (approximating the R2 career stage);
- Those who started to publish between 2016 and 2019 (approximating the R1 career stage).

Table 5 below outlines the operationalisation of the indicators based on the scientometric approach. General points of attention in the operationalisation are:

- A filter is applied to the dataset so that only researchers with minimum 3 publications and activity in at least 2 years are included in the analysis.
- The database contains data for the full period 2008-2019. However, as the first year is a reference year, indicators can only be calculated for 2009-2019.
- All indicators are also calculated for subdimensions of gender and career stage, except for the indicators of retention.

[5] The year 2008 constitutes the basis for the calculation of indicators for 2009.

Table 5: Operationalisation of indicators for talent circulation based on the scientometric approach

Indicator		Name	Operationalisation based on scientometric approach	
Main indicators of brain drain				
I1	**Indicator of stock of incoming researchers** *Share of foreign researchers working in the country (operationalised for the full period and on a yearly basis)*	% of foreign researchers in the country	Share of researchers working in the country at the end of the period, who have another country of origin, counting all types of affiliation, out of the total number of researchers working in the country	- Time dimension: overall for full period 2009-2019 - Country of reference: country of destination at the end of the period - Subdimensions: gender and career stage (proxy) - Filter applied: only researchers with min. 3 publications and activity in at least 2 years
		% of foreign researchers in the country at time t	Share of researchers working in the country at time t, who have another country of origin, counting all types of affiliation, out of the total number of researchers working in the country at time t	- Time dimension: yearly for period 2009-2019 - Country of reference: country of destination at time t - Subdimensions: gender, career stage (proxy) - Filter applied
I2	**Indicator of stock of outgoing researchers** *Share of original researchers having left the country (operationalised for the full period and on a yearly basis)*	% of original researchers having left the country	Share of researchers having left their country of origin by the end of the period, out of the total number of researchers from country of origin	- Time dimension: overall for full period 2009-2019 - Country of reference: country of origin (first affiliation) - Subdimensions: gender and career stage (proxy) - Filter applied: only researchers with min. 3 publications and activity in at least 2 years
		% of original researchers having left the country by time t	Share of researchers having left their country of origin by time t, counting all types of affiliation, out of the total number of researchers from country of origin	- Time dimension: yearly for period 2009-2019 - Country of reference: country of origin (first affiliation) - Subdimensions: gender and career stage (proxy) - Filter applied: only researchers with min. 3 publications and activity in at least 2 years
I3	**Indicator of brain drain** *Ratio of stock of outgoing and incoming researchers*	Brain drain ratio	Ratio of researchers having left the country (= their country of origin) to foreign researchers working in the country by the end of the period, counting all types of affiliation	- Time dimension: overall for full period 2009-2019 - Country of reference: country of origin (first affiliation) and country of destination at the end of the period - Subdimensions: gender and career stage (proxy)

Indicator		Name	Operationalisation based on scientometric approach	
	(operationalised for the full period and on a yearly basis)			- Filter applied: only researchers with min. 3 publications and activity in at least 2 years
		Brain drain ratio by time t	Ratio of researchers having left the country by time t (= their country of origin) to foreign researchers working in the country at time t, counting all types of affiliation	- Time dimension: yearly for period 2009-2019 - Country of reference: country of origin (first affiliation) and country of destination at time t - Subdimensions: gender and career stage (proxy) - Filter applied: only researchers with min. 3 publications and activity in at least 2 years
Other indicators to contextualise brain drain				
I4	**Indicator of primary brain drain at time t**, based on first move *Share of researchers that fully or partially leave their country of origin for the first time at time t, out of the total active population in the country at time t (per year)*	Primary brain drain at time t	Share of researchers leaving their country of origin at time t out of the total active population in the country at time t	- Time dimension: yearly for period 2009-2019 - Country of reference: country of origin (first affiliation) - Subdimensions: gender and career stage (proxy) - Filter applied: only researchers with min. 3 publications and activity in at least 2 years
I5	**Indicator of attractiveness** *Share of researchers attracted to the country, out of the total active population in the country (operationalised for the full period and on a yearly basis)*	% of researchers attracted to country	Share of researchers attracted to the country, counting all types of affiliation, out of the total active population in the country at the end of the period	- Time dimension: overall for full period 2009-2019 - Country of reference: country of destination (new affiliation) - Subdimensions: gender and career stage (proxy) - Filter applied: only researchers with min. 3 publications and activity in at least 2 years
		% of researchers attracted to country (1st move)	Share of researchers attracted to the country when leaving their country of origin, counting all types of affiliation, out of the total active population in the country at the end of the period	- Time dimension: overall for full period 2009-2019 - Country of reference: country of destination (new affiliation) - Subdimensions: gender and career stage (proxy) - Filter applied: only researchers with min. 3 publications and activity in at least 2 years

Indicator		Name	Operationalisation based on scientometric approach	
		% of researchers attracted to country at time t	Share of researchers attracted to the country at time t, counting all types of affiliation, out of the active population in the country at time t	- Time dimension: yearly for period 2009-2019 - Country of reference: country of destination (new affiliation) - Subdimensions: gender and career stage (proxy) - Filter applied: only researchers with min. 3 publications and activity in at least 2 years
I6	**Indicator of propensity to move** *Average number of moves made per researcher of the country of origin (operationalised for the full period)*	Avg. number of distinct countries researchers move to	Average number of distinct countries that researchers originating from a given country move to, counting all types of affiliation	- Time dimension: overall for full period 2009-2019 - Country of reference: country of origin (first affiliation) - Subdimensions: gender and career stage (proxy) - Filter applied: only researchers with min. 3 publications and activity in at least 2 years
I7	**Indicator of return mobility** *Share of researchers that returned to their country of origin, out of the total number of researchers of a country of origin that left at some point (operationalised for the full period)*	Return ratio of all researchers having left the country	Share of researchers that returned to their country of origin, out of the total number of researchers of a country of origin that left at some point	- Time dimension: overall for full period 2009-2019 - Country of reference: country of origin (first affiliation) - Subdimensions: gender and career stage (proxy) - Filter applied: only researchers with min. 3 publications and activity in at least 2 years
I8	**Indicator of retention in brain drain/gain** *Average number of years (overall) that:* - *a researcher works in his/her country of origin (regardless of leaving or not).* - *a researcher works in another country than his/her country of origin.* - *a researcher with another country of origin works in the country.*	Avg. years per researcher in their country of origin	Average number of years that a researcher works in his/her country of origin (including all original researchers of the country)	- Time dimension: overall for full period 2009-2019 - Country of reference: country of origin (first affiliation) - Filter applied: only researchers with min. 3 publications and activity in at least 2 years
		Avg. years per researcher outside their country of origin	Average number of years that a researcher original from the country works in another country (including all outgoing researchers)	- Time dimension: overall for full period 2009-2019 - Country of reference: country of origin (first affiliation) - Filter applied: only researchers with min. 3 publications and activity in at least 2 years
		Avg. years per researcher in their country of destination	Average number of years that a foreign researcher works in the	- Time dimension: overall for full period 2009-2019

Indicator		Name	Operationalisation based on scientometric approach	
			country (including all incoming researchers)	- Country of reference: country of destination (new affiliation) - Filter applied: only researchers with min. 3 publications and activity in at least 2 years

2.2.3. Bilateral flows

The operationalisation of incoming and outgoing researchers in the MORE surveys and in the scientometric approach is also the basis for the analysis of the bilateral flows between pairs of countries. This information allows to see to which countries original researchers are going (i.e. the direction of brain drain). For this analysis, the flow data is calculated as the share of original researchers working abroad in a specific country divided by the total number of researchers having left the country. This share gives an indication of the distribution of researchers across destination countries and allows to see which destination countries are more common for each country of origin.

The flow data can be analysed from three different dimensions:

- Share of researchers having left the country (citizenship): this dimension analyses the flows with respect to the country of citizenship of researchers. This dimension is calculated on the basis of the MORE4 survey (2019).

- Share of researchers having left the country (degree): this dimension captures the flows with respect to the country of the highest degree. This dimension is calculated on the basis of the MORE4 survey (2019).

- Share of researchers having left the country (SA): this dimension measures the flows with respect to the country of origin (first publication) and the country/ies of destination of the researchers. This dimension is calculated on the basis of the scientometric data and refers to the period 2009-2019.

The dataset only includes those pairs origin-destination with more than 15 researchers/observations. In addition, to facilitate the reading and avoid including in the dataset pairs that are unusual or anecdotical, the dataset only includes those pairs origin-destination with a share higher than 3% per country. Finally, the dataset based on the MORE survey data contains only flows within the EU, the dataset based on the scientometric data also includes global flows.

3. Talent circulation map and general findings related to brain drain

The talent circulation map is a visualisation of the main brain drain indicators, applied in the Microsoft Office App 'PowerBI'[6]. The talent circulation map thus provides a helicopter view of global mobility flows and talent circulation.

In this chapter, we highlight the main findings based on the visualisation and analysis of indicators on the following issues:

- Brain drain defined by citizenship as country of origin
- Brain drain defined by country of highest degree as country of origin
- Brain drain defined by the scientometric approach
- Differences in brain drain across genders, field of science, and career stage
- Context indicators

The selection of countries for further analysis on the causes of brain drain was based on this analysis.

[6] The PowerBI file is provided to the European Commission as a separate deliverable.

3.1. Brain drain defined by citizenship as country of origin

The following figures present an overview of the situation in the 27 Member States, Iceland, Norway, Switzerland and United Kingdom. These findings are based on the analysis of the MORE4 data for 2019 and are based on the following definitions:

- The country of citizenship of the researchers is defined as country of origin. The share of outgoing researchers (original researchers working abroad) is calculated on the basis of this reference country.

- The country of current employment is defined as the country of destination. The share of incoming researchers (foreign researchers working in the country) is calculated on the basis of this reference country.

Error! Reference source not found. shows the relationship between the share of outgoing researchers (original researchers working abroad) and the share of incoming researchers (foreign researchers working in the country).

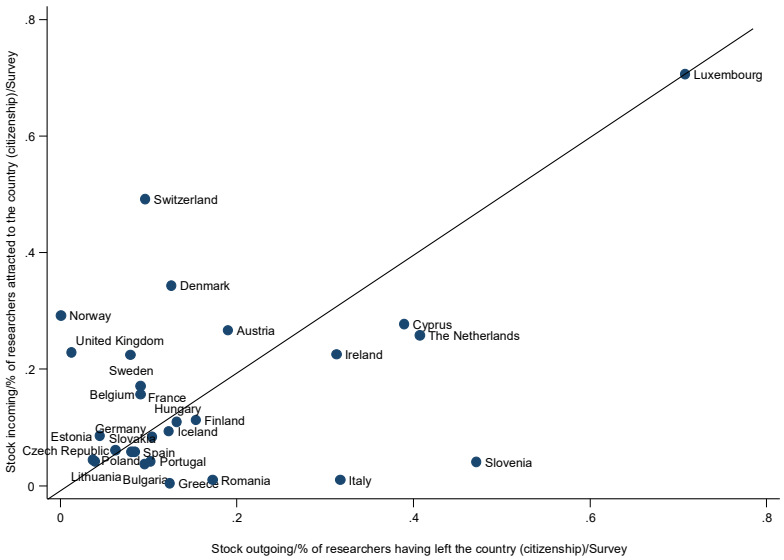
- The countries located in (or close to) the diagonal have a **balanced** situation where a similar share of researchers have left the country (outgoing) and have been attracted to the country (incoming).

- Countries located above the diagonal are those leaning towards a situation of **brain gain**: i.e. a higher share of foreign researchers have come into the country than the share of original researchers having left the country. **This is the case for most Western European countries and Scandinavian countries.**

- Countries located below the diagonal lean towards a situation of **brain drain**: i.e., a higher share of original researchers have left the country than the share of foreign researchers having come into the country. **This situation is most visible in some Southern European countries and some of the Eastern European countries.**

Error! Reference source not found. presents another visualisation of brain drain. It is based on the ratio between the number of (original) outgoing and the number of (foreign) incoming researchers. If the ratio is higher than 1, more researchers have left the country than were attracted to the country (brain drain). If the ratio is lower than 1, the opposite situation occurs (brain gain).

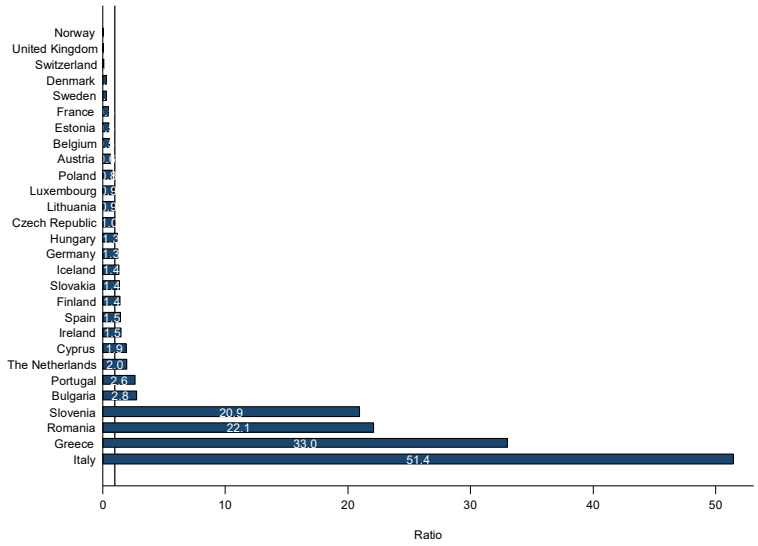
Figure 3: Relationship between stock of outgoing and incoming researchers (based on citizenship, year: 2019)



Source: MORE4 data (2019)
Note:
- *The figure displays proportions (0-1 values)*

- *Stock incoming - Share of foreign researchers working in the country: Share of researchers working in the country at the time of the survey, who have citizenship from another country, out of the total number of researchers working in the country at the time of the survey.*
- *Stock outgoing - Share of original researchers having left the country: Share of researchers with citizenship from the country, who work in another country at the time of the survey, out of the total number of researchers with citizenship from the country .*

Figure 4: Brain drain ratio (based on citizenship, year: 2019)



Source: MORE4 data. (2019)

Note:

- *Brain drain ratio: Ratio of researchers having left the country (= their country of citizenship) to foreign researchers working in the country (= not their country of citizenship)*

3.2. Brain drain defined by country of highest degree as country of origin

The following figures focus on the country of highest degree as country of origin. They present the figures for the 27 Member States, Iceland, Norway, Switzerland, and United Kingdom. These findings are also based on the analysis of the MORE4 data for 2019 and are based on the following definitions:

- The country of where the researcher obtained his/her highest degree is defined as country of origin. The share of outgoing researchers (original researchers working abroad) is calculated on the basis of this reference country.

- The country of current employment is defined as the country of destination. The share of incoming researchers (foreign researchers working in the country) is calculated on the basis of this reference country.

Error! Reference source not found. shows the relationship between the share of outgoing researchers (original researchers working abroad) and the share of incoming researchers (foreign researchers working in the country). The interpretation is similar to the figure shown in the previous page:

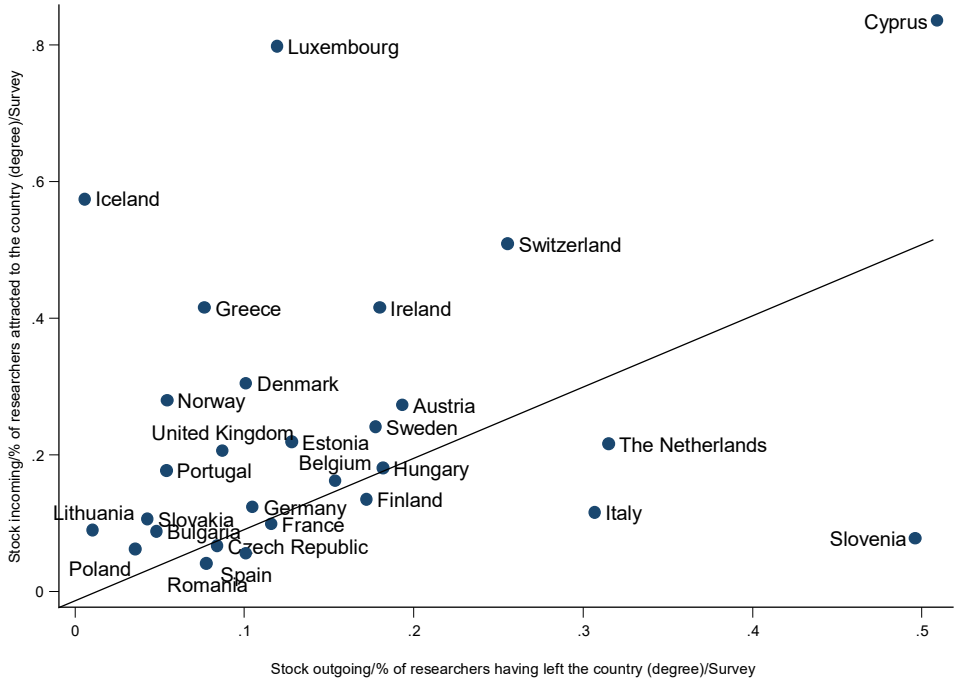
- The countries located in (or close to) the diagonal have a **balanced** situation where a similar share of researchers have left the country (outgoing) and have been attracted to the country (incoming).

- Countries located above the diagonal are those leaning towards a situation of **brain gain**: i.e. a higher share of foreign researchers have come into the country than the share of original researchers having left the country. **This is the case of most Western European countries and Scandinavian countries.**

- Countries located below the diagonal lean towards a situation of **brain drain**: i.e. a higher share of original researchers have left the country than the share of foreign researchers having come into the country. **This situation is most visible in some Southern European countries and some of the Eastern European countries.** Italy and Romania are confirmed as cases with an acute brain drain situation also from this perspective.

Greece and Cyprus are noteworthy cases as the data reflects that the brain drain in these countries is less acute when focusing on the country where the researchers obtained their highest degree. This suggests that brain drain takes place before this stage though more in-depth research into the patterns of talent circulation in these countries would be needed to fully understand these differences.

Figure 5: Relationship between stock of outgoing and incoming researchers (based on country of highest degree, year: 2019)

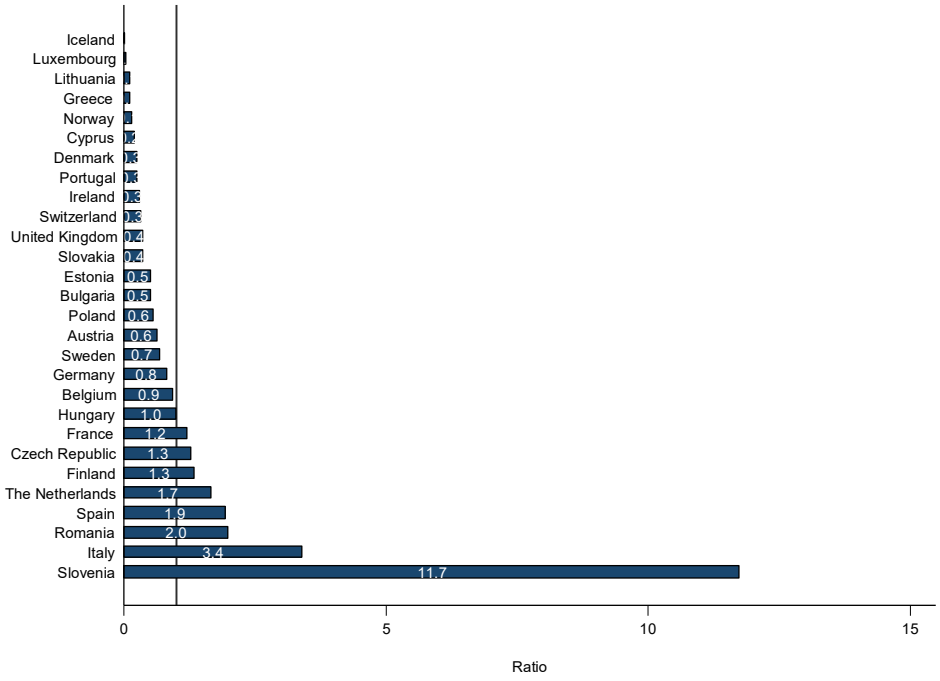


Source: MORE4 data (2019)
Note:

- *The figure displays proportions (0-1 values)*
- *Stock incoming - Share of foreign researchers working in the country: Share of researchers working in the country at the time of the survey, who have obtained their highest degree in another country, out of the total number of researchers working in the country at the time of the survey.*
- *Stock outgoing - Share of original researchers having left the country: Share of researchers who obtained their highest degree in the country, who work in another country at the time of the survey, out of the total number of researchers who obtained their highest degree in the country.*

Figure 6 presents another visualisation of brain drain. It is based on the ratio between the number of (original) outgoing and the number of (foreign) incoming researchers. If the ratio is higher than 1, more researchers have left the country than are attracted to the country (brain drain). If the ratio is lower than 1, the opposite situation occurs (brain gain).

Figure 6: Brain drain ratio (based on country of highest degree, year: 2019)



Source: MORE4 data (2019)
Note:

- *Brain drain ratio: Ratio of researchers having left the country (= their country of highest degree) to foreign researchers working in the country (= not their country of highest degree)*

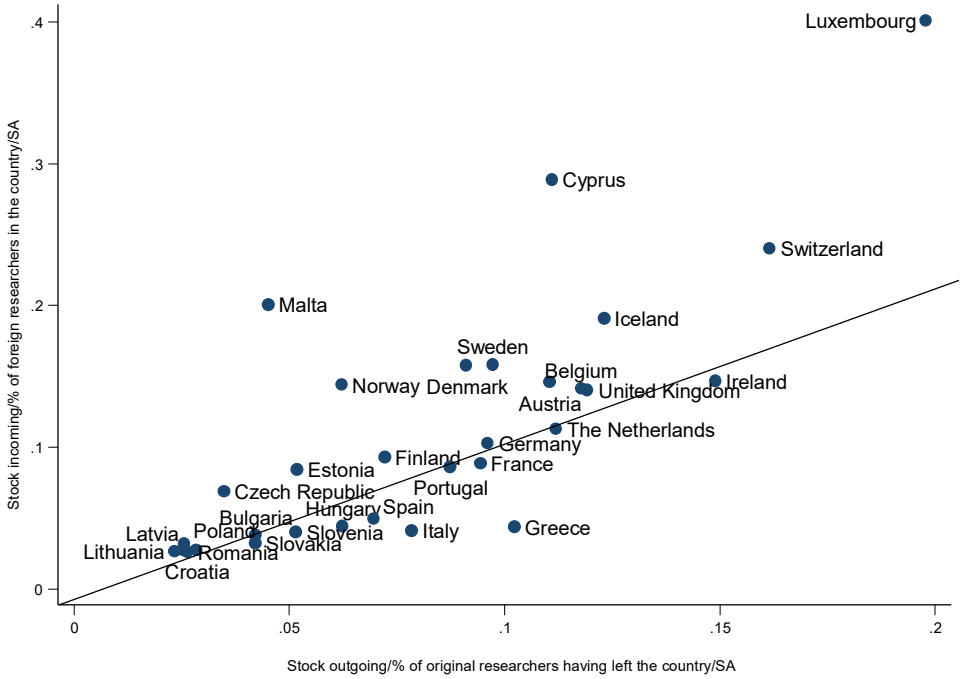
3.3. Brain drain defined by country of affiliation (scientometrics)

The following figures present the analysis derived from the scientometric approach. The countries of origin and destination are hence defined on the basis of affiliation data (country of affiliation). These figures also show the results for the 27 Member States, Iceland, Norway, Switzerland, and United Kingdom and cover the period 2009-2019.

- Countries with the largest brain drain (as per comparison of the share of researchers having left their country of origin and the share of foreigners working in the country) include **Southern European countries** (**Greece, Italy, and Spain), but also some Eastern European countries (Slovakia, Bulgaria, and Hungary)**.

- Regarding the yearly evolution of brain drain, different patterns are identified. There are countries that **switch from gain to drain over time (e.g. Spain or Slovenia)**. Other countries have been increasingly facing brain drain over time, captured by a **broadening gap between outgoing vs. incoming researchers (e.g. Greece or Italy)**.

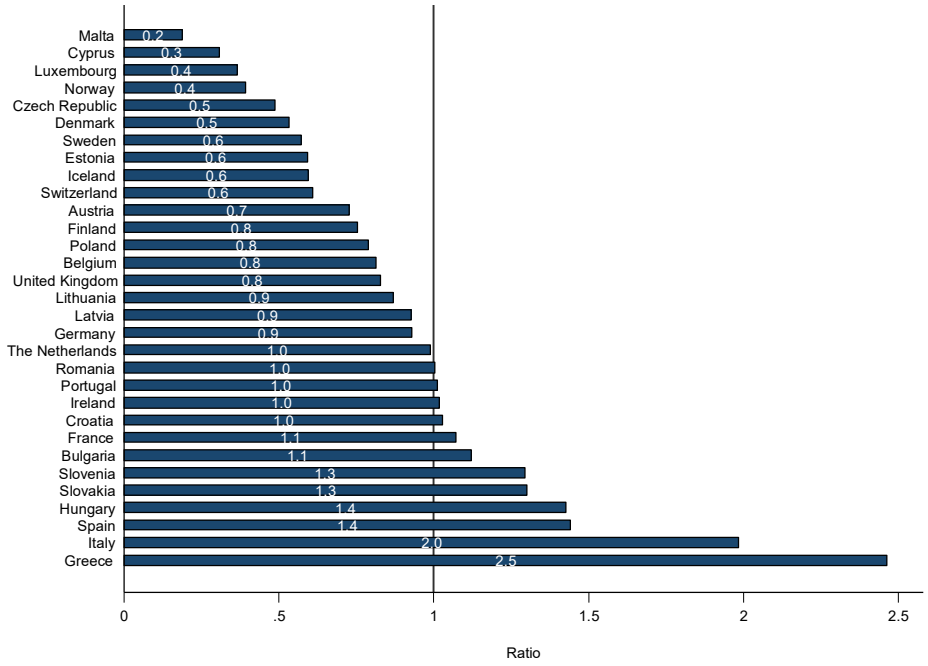
Figure 7: Relationship between stock of outgoing and incoming researchers (based on country of affiliation, 2009-2019)



Source: Scientometric approach (2009-2019)
Note:

- *The figure displays proportions (0-1 values)*
- *Stock incoming - Share of foreign researchers working in the country: Share of researchers working in the country at the end of the period, who have another country of origin, counting all types of affiliation, out of the total number of researchers working in the country.*
- *Stock outgoing - Share of original researchers having left the country: Share of researchers having left their country of origin by the end of the period, out of the total number of researchers from country of origin.*

Figure 8: Brain drain ratio (based on country of affiliation, 2009-2019)



Source: Scientometric approach (2009-2019)
Note:

- *Brain drain ratio: Ratio of researchers having left the country (= their country of origin) to foreign researchers working in the country by the end of the period, counting all types of affiliation.*

3.4. Differences in brain drain across genders, field of science, and career stage

Regarding **gender differences**, the general pattern derived from the scientometric analysis is that male researchers are more prone to be mobile. This suggests that female researchers less often leave their country of origin – with the remarkable exception of Luxembourg, where the percentage of female researchers having left the country is higher than the overall percentage of researchers leaving the country. The survey data, however, shows a more nuanced picture. Female researchers are more likely to be mobile in Luxembourg, Cyprus, Austria, Denmark, Greece, Iceland, and Romania.

With respect to **fields of science**, the analysis based on survey data indicates that on average there are little differences across the three main fields of science considered (Natural, Social and Health[7]). Data at country level for this dimension needs to be interpreted with caution as it is strongly dependent on the number of migrant respondents (unequal across countries and fields of science).

When looking into the differences across **career stages**, the analysis of survey data indicates that R2 researchers (at the time of the survey) are the ones that are more likely to be working in another country than their country of origin. Yet it is important to note that the number of observations is too low for some career stages and/or countries to draw strong conclusions: this evidence needs to be taken with caution. From the perspective of the scientometric approach, we see that academic age (proxy for career stage) is positively related to the number of researchers working in a country other than their country of origin, with the exception of the researchers in the highest career stage (proxy of R4) who tend to be on average slightly less mobile than those researchers in the previous career stage (proxy of R3).

3.5. Context indicators

The following figures present an overview of the context indicators at country level.

Indicator of attractiveness (figure 9): This indicator shows how attractive countries are to foreign researchers by counting all incoming researchers over time (regardless of whether or not they are still working in the country at the end of the period). The indicator takes into account the size of countries. Luxembourg, Cyprus, and Switzerland excel in this dimension.

Indicator of attractiveness - first move (Figure 10): This indicator reflects the attractiveness of countries measured when researchers make their first move from their country of origin. The situation across countries is very similar to the previous figure.

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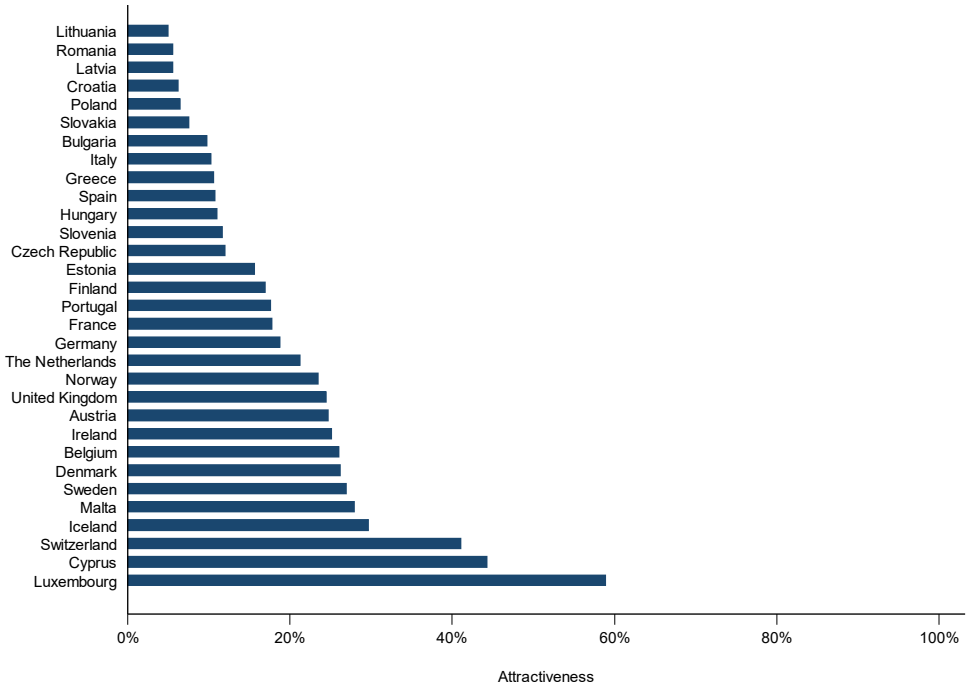
[7] The MORE studies use three aggregated categories for fields of science, based on the Fields of Research and Development (FORD) classifications proposed by the OECD in the 2015 Frascati Manual:
- NATURAL: Field 1 (Natural Sciences) and Field 2 (Engineering and Technology)
- HEALTH: Field 3 (Medical and health sciences) and Field 4 (Agricultural and veterinary sciences)
- SOCIAL: Field 5 (Social Sciences) and Field 6 (Humanities and the Arts)

Figure 9: Indicator of attractiveness (based on country of affiliation, 2009-2019)

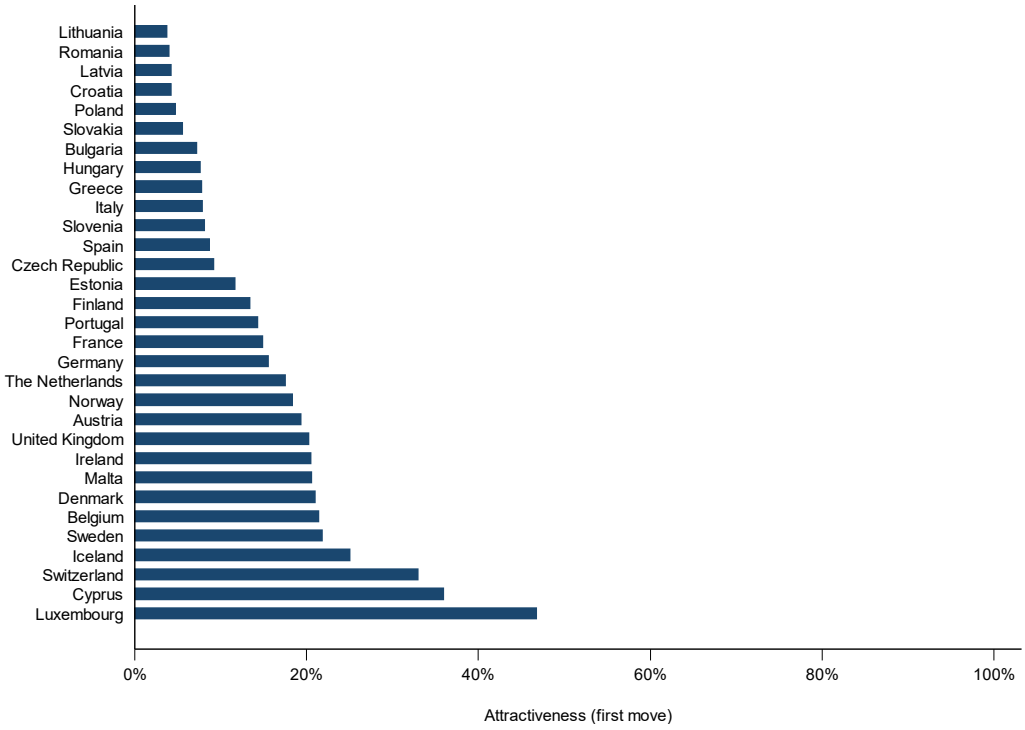


Source: Scientometric approach (2009-2019)

Notes:

- *Share of researchers attracted to the country, counting all types of affiliations, out of the total active population in the country at the end of the period.*

Figure 10: Indicator of attractiveness - first move (based on country of affiliation, 2009-2019)



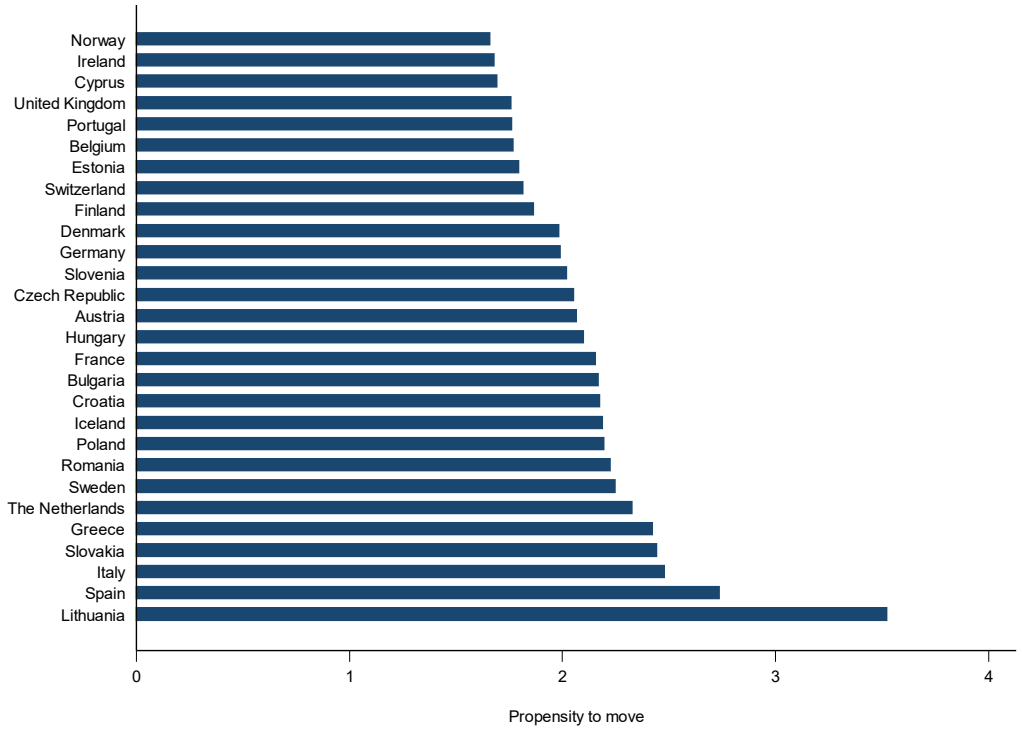
Source: Scientometric approach (2009-2019)

Notes:

- *Share of researchers attracted to the country when leaving their country of origin, counting all types of affiliation, out of the total active population in the country at the end of the period.*

Propensity to move: This indicator reflects how mobile researchers in each country are on average by counting the number of distinct moves per researcher in the last ten years. Lithuania, Spain, Italy and Slovakia stand out as being the countries where researchers have moved more often on average in the period 2009-2019.

Figure 11: Indicator of propensity to move (based on country of citizenship, year: 2019)



Source: MORE4 (2019)

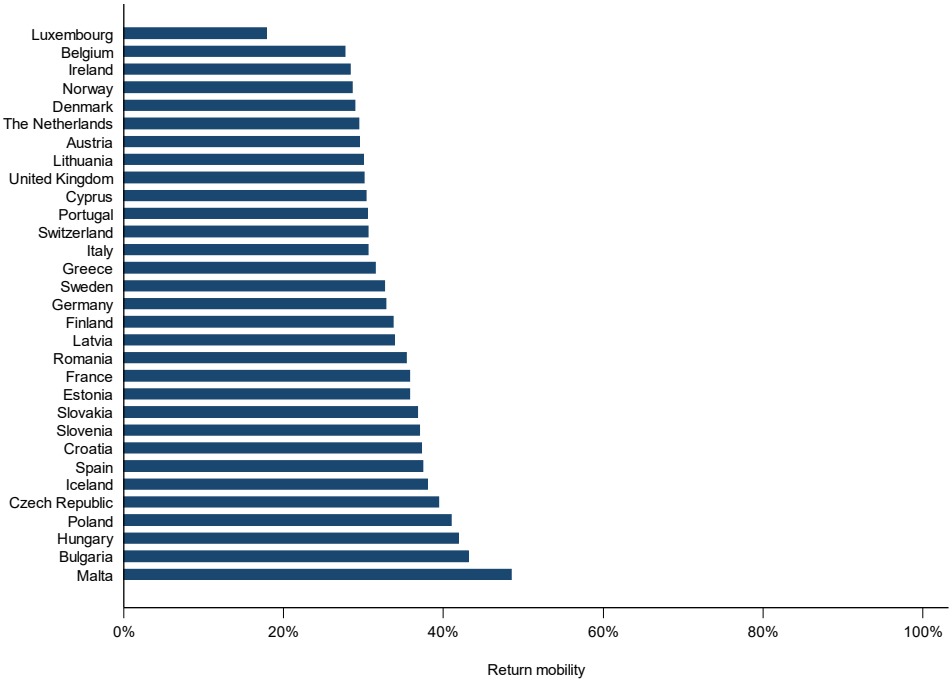
Notes:

- *Average number of moves made by researchers in the period of the last ten years up to the time of the survey.*

Indicator of return mobility (Figure 12): This is an important indicator of the extent to which countries are able to counterbalance the brain drain by attracting their original researchers back to the country. The figure show that there is relatively little variation across countries. Given this, Malta, Bulgaria, Hungary, Poland and Czech Republic are the countries with a higher share of return mobility.

Indicator of retention (Average number of years per researcher in their country of destination) (Figure 13) **:** This indicator shows the extent to which countries are able to retain talent. Some countries, particularly those that are not attracting incoming researchers to a large extent, exhibit a relatively short retention time (e.g. Italy or Greece). On the other hand, countries with a strong capacity to attract researchers are also able to retain them for relatively longer periods (e.g. Luxembourg, Switzerland, Scandinavian countries or Germany).

Figure 12: Indicator of return mobility (based on country of affiliation, 2009-2019)

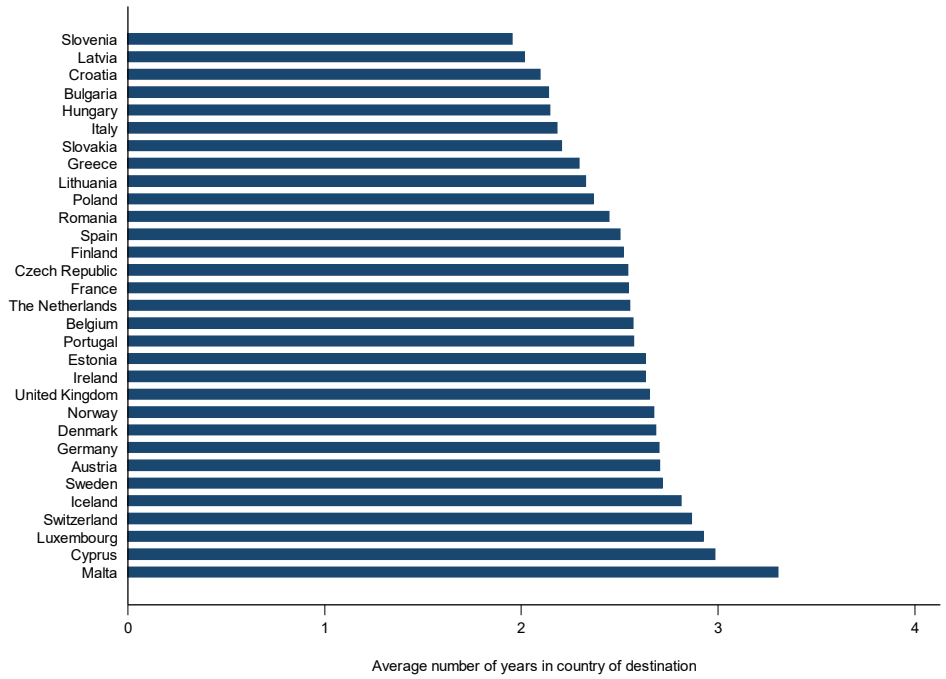


Source: Scientometric approach (2009-2019)

Notes:

- *Share of researchers that returned to their country of origin in the total number of researchers of a country of origin that left at some point*

Figure 13: Indicator of retention (based on country of affiliation, 2009-2019)



Source: Scientometric approach (2009-2019)

Note:

- *Average number of years per researcher in their country of destination.*

3.6. Selection of countries for further analysis

For the selection of countries for further research on causes of brain drain, we have started from the 15 Member States listed as Widening Countries and have complemented this list with other Member States for which we have identified a brain drain issue in this analysis of talent circulation indicators. The selection of countries was thus based on the cross-country comparison of the brain drain indicators. Two main criteria were defined for the selection of countries:

- There is a brain drain situation in each of the three indicators of brain drain defined in this document: by citizenship, country of highest degree and country of affiliation.

- There is a brain drain situation in at least two indicators of brain drain and one of them points at the existence of an acute problem (ratio>1,4).

The Member States listed as Widening Countries are indicated in **Error! Reference source not found.** below in blue in the second column. Six out of these 15 countries fulfil at least one of the two criteria mentioned above, indicating that there is evidence of an important brain drain situation: Bulgaria, Greece, Portugal, Romania, Slovakia, and Slovenia. Slovenia is also one of the countries with higher level of forced mobility according to the MORE4 survey (2019), both explained by lack of opportunities and because it is perceived a requirement to make career progression.

Among the rest of the countries in this group, many have at least one brain drain indicator with a red light, confirming the choice to include this group in the analysis. Moreover, it is important to note that the relatively low figures in the brain drain indicators can conceal the existence of underlying problems that deserve to be looked at in detail. For instance, many countries in this group have lower than average levels of cross-border mobility (i.e. low shares of researchers working outside the country and of foreigners working in the country). Croatia, Czech Republic, Estonia, Latvia, Lithuania are examples of countries facing this situation. Latvia stood out in the MORE4 survey (2019) as one of the countries having higher shares of forced mobility with researchers indicating to have felt forced to move to another country due to a lack of opportunities in their home country).

The countries for which the abovementioned criteria are met and are not listed as Widening Countries, are highlighted in green in the third column of Table 6 and constitute the four additional countries that we included: Ireland, Finland, Italy and Spain. Italy is furthermore one of the countries with a higher level of forced mobility linked to the absence of other options to develop a career in academia according to the MORE surveys of 2016 and 2019. The Netherlands also fulfils the criteria but is not proposed as case for analysis given that the interviews and other secondary sources analysed tend not to consider this country as having a brain drain problem. The full selection of countries is given in Table 7.

Table 6: Brain drain overview

	Widening countries	Additional countries	2019	2019	2009-2019
			Brain drain ratio (citizenship)	Brain drain ratio (degree)	Brain drain ratio (country of affiliation)
Austria			0,645	0,638	0,728
Belgium			0,538	0,941	0,813
Bulgaria			2,769	0,524	1,120
Croatia					1,028
Cyprus			1,907	0,204	0,307
Czech Republic			1,023	1,280	0,486
Denmark			0,286	0,258	0,534
Estonia			0,508	0,522	0,592
Finland			1,428	1,336	0,756
France			0,487	1,202	1,073
Germany			1,265	0,833	0,929
Greece			33,007	0,117	2,464
Hungary			1,252	1,009	1,428
Iceland			1,366	0,004	0,595
Ireland			1,546	0,309	1,017
Italy			51,443	3,404	1,985
Latvia					0,927
Lithuania			0,939	0,108	0,872
Luxembourg			0,924	0,034	0,368
Malta					0,188
Norway			0,001	0,149	0,393
Poland			0,826	0,555	0,788
Portugal			2,650	0,265	1,013
Romania			22,121	1,980	1,004
Slovakia			1,423	0,377	1,301
Slovenia			20,938	11,749	1,295
Spain			1,482	1,930	1,442
Sweden			0,288	0,682	0,573
Switzerland			0,089	0,331	0,609
The Netherlands			1,959	1,668	0,989
United Kingdom			0,042	0,369	0,827

Notes:

The colours indicate the following values:

- *Red: values >1*
- *Yellow: values >0.85 and < 1*
- *Green: values < 0.85*

Table 7: Proposed selection of countries for further analysis on causes of brain drain

Widening countries	Additional countries
– Bulgaria	– Ireland
– Croatia	– Finland
– Cyprus	– Italy
– Czechia	– Spain
– Estonia	
– Hungary	
– Greece	
– Latvia	
– Lithuania	
– Malta	
– Poland	
– Portugal	
– Romania	

Widening countries	Additional countries
– Slovakia – Slovenia	

PART 2: CAUSES OF BRAIN DRAIN OR UNBALANCED TALENT CIRCULATION

The first section in this part of the report (Part 2) presents the theoretical framework for the analysis of the causes of brain drain, based on literature review. This framework is used as the general guideline for the quantitative and qualitative analysis of the causes of brain drain carried out in this study. The following sections present the results of these quantitative and qualitative analyses. These results are used as the basis to identify the policy options at Member State and EU level, presented in the third part of this report (Part 3).

1. Theoretical framework of the causes of brain drain: conditions for a balanced brain circulation

As presented in Part 1 of this report, in this study we understand **brain drain** as a situation where more researchers leave the country than are attracted to the country. The analyses include **all researcher career stages**, although there are specific considerations for early-career researchers. Brain drain of researchers is a phenomenon that cannot be explained by one single factor. The situation is different in each country (historical and geographical background, culture, governance, etc.) and the -for each country unique- **combination of factors** can lead to a more or less intense brain drain.

In this study we focus on the analysis of the **causes of brain drain where public policy action in the domain of RDI[8] can be implemented**. There might be other factors playing a role in brain drain, for which the implementation of a direct policy action goes beyond the scope of this study or might not even be possible: this is the case for instance for countries that have suffered natural disasters (e.g. earthquakes in Croatia), that have felt a stronger impact of the economic crisis (e.g. Greece, Portugal, etc.), that face challenges in the education system (e.g. Romania) or that are characterised by small geographical/population size (e.g. Malta, Cyprus, etc). While the impact of these factors on brain drain is undeniable, the link is indirect or more complex and related to system-level factors beyond the domain of RDI. Policy initiatives that address the overall resilience, recovery, and economic and social strength of countries, are expected to have a positive influence on the strength of the RDI system and on brain drain as well. However, as the relation to brain drain is indirect, we do not explicitly address these in our analysis.

Taking into account the above-mentioned considerations, a list of factors is identified from literature that are expected to play a role in fostering a balanced brain circulation.

presents these different factors, grouped into four main categories:

- System-level factors for R&I;
- Recruitment processes, working conditions and career progression;
- Research environment; and
- Research excellence.

This figure presents the theoretical framework of factors for a balanced brain circulation, that is further applied in the analysis of causes for brain drain. The absence or negative assessment of these factors can lead to more or less acute situations of brain drain.

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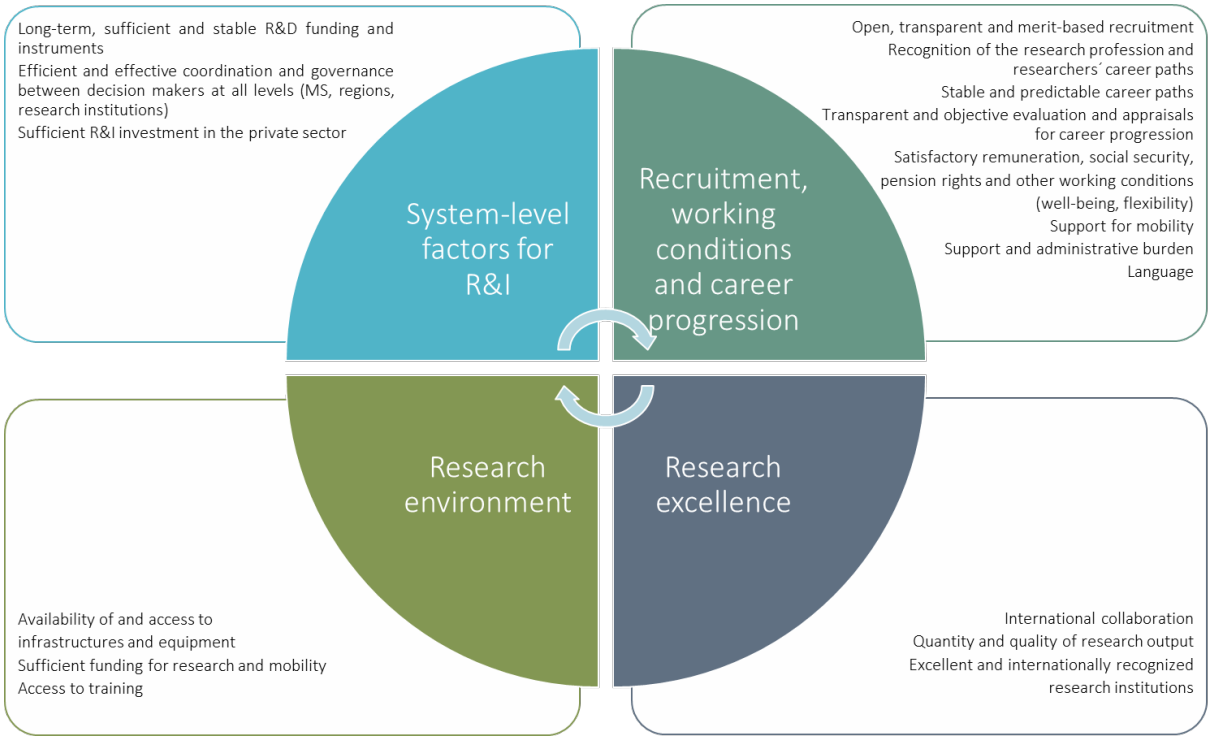
[8] Abbreviation referring to the broader system of research, development and innovation. R&I and R&D are also used as abbreviations in this context.

Figure 14: Conditions for a balanced brain circulation



- **System-level factors for R&I**

This category includes those factors that have an impact at the system level. It refers to the availability of long-term, sufficient and stable funding for R&D coming both from public and private sectors. This funding is the basis for the daily working of the different elements of the system (human resources, infrastructures, equipment, joint initiatives and collaboration efforts, etc.). The availability and stability of this funding is also directly related to the presence of funding instruments for research institutions, individual researchers and companies, that are sufficient, predictable and adapted to the needs of each of the stakeholders in the system. The system-level also relates to the governance of the R&I system: the extent to which there is an effective and efficient coordination between levels of government and with the different stakeholders. This governance dimension is key as it facilitates not only the smooth functioning of the system, it is also important for a committed and stable R&D funding

- **Recruitment processes, working conditions and career progression**

Many countries are seeing how their working conditions for researchers deteriorate over time (see the OECD´s Research Precariat project[9]). The causes for this deterioration are multiple, among which we can cite the stagnation of public funding as well as the imbalance between the number of PhDs awarded and the number of available positions in the system[10]. Unsatisfactory recruitment processes, working conditions and career progression paths are expected to push researchers outside their home countries looking for better conditions. Researchers are expected to look for institutions and jobs that offer **open, transparent and merit-based recruitment processes** as opposed to closed systems where nepotism and/or endogamy are common. The existence of long, unpredictable

9 https://www.oecd.org/sti/science-technology-innovation-outlook/research-precariat/

10 The number of available positions includes also positions in the broader RDI system and is difficult to quantify per country. The lack of sufficient positions is however confirmed through desk research of previous studies and interviews.

and/or unstable career paths is also expected to incentivise researchers to look for opportunities in other countries.

Researchers are intrinsically motivated to do research (see results of MORE4 and of WP7 of this project), yet not all countries offer a context where research and researchers are **recognised** or equally valued. Researchers are expected to move away from countries where research (in general and as a career) is less recognised and valued.

The extent to which researchers are able to perform (good) research is also important. The MORE studies show that science-related factors are key in steering decisions of researchers. Factors such as research autonomy, working with leading scientists, the ability to carry out high risk research, a limited administrative burden, etc. are therefore important in the decision of researchers to stay or move. The presence of support staff for research (e.g. research managers or administrators) is in this sense also important, as they can significantly limit the administrative burden for researchers and they can support in project management and project applications, hence offering more time for researchers to focus on their main job.

Next to the science-related factors, material working conditions are also expected to matter. Remuneration is one of the factors that is most often cited in the interviews carried out in this study as a potentially motivating factor for researchers to move abroad or as factor that makes countries less attractive to researchers working abroad (see the Analytical report of WP7 of this project for a more extensive discussion of the cross-country differences in remuneration). Both the comparability of remuneration with other sectors, or with research positions abroad, is considered to play a role in the decision of researchers to stay or move. Yet, it is important to note that the MORE studies point at a lower importance of this single factor for researchers compared to the science-related factors (cf. above). Other conditions, such as flexibility, well-being, and access to social security rights and pensions are also expected to matter. Unsatisfactory situations in these factors might also fuel brain drain. This is notably the case among early career stage researchers, who in some countries are not eligible for work contracts (i.e. they are considered students) and do not benefit from the same rights as other workers (WP7 provides more insights on the precarious working conditions of early career researchers).

- **Research environment**

This category refers to the conditions that foster or hinder an adequate research activity. It refers, among others, to the availability of appropriate and up-to-date infrastructures and equipment, as well as the availability of appropriate funding for research activities and mobility, understood as having sufficient resources, being accessible to researchers and responding to researchers´ needs. Access to relevant training is also a factor included in this category – although especially relevant for early career stage researchers, it is a factor that is and will be increasingly important in the future across all career stages, notably to foster intersectoral collaboration and diversification of career paths for PhD holders.

- **Research excellence**

As highlighted in previous reports (MORE studies), international mobility of researchers is primarily driven by the desire to develop their international network and to work with leading scientists. This implies that countries with excellent and internationally recognised research institutions, producing high-level quality research output, are more likely to retain and attract researchers. A competitive research environment, with performance-based evaluation procedures of researchers and institutes, is expected to attract ambitious and high-performing researchers. This dimension therefore also interacts with factors in other dimensions, such as the open, transparent, and merit recruitment (OTM-R) and career progression processes, modern HR management and internationalisation, etc. Failure to meet international standards of quality or excellence, jeopardizes the attractiveness of a country´s RDI system and can hence have an important impact on the size of brain drain.

2. Causes of brain drain: overview of findings

2.1. Quantitative analysis: Gravity model

The objective of the quantitative analysis was to investigate the determinants of brain drain in the European Union using a gravity model framework that allows for studying the pull and push factors for researchers in the countries of origin and destination. This method complements the more qualitative desk research and country-specific information in order to validate and structure the potential causes of brain drain and to identify whether patterns in the quantitative information can be found from this perspective. The main data on researchers' mobility comes from the scientometric indicators of brain drain developed in this project. The pull and push factors come from the MORE4 survey and other data sources and are meant to study the factors that impact researchers' mobility (Innovation Scoreboard, Eurostat, etc.). The following sections present a summary of the methodology and the findings (more detail is given in a separate gravity model note).

2.1.1. Methodology

For the quantitative analysis of brain drain, we understand the concept of brain drain as the outflows of researchers having left a country. This differs from the general operationalisation of brain drain applied in other the indicators presented in Section 2.2, where brain drain is understood as the ratio between outflows and inflows of researchers. The operationalisation of brain drain used in this analysis is based on the fact that it adapts better to the econometric model that is applied (gravity model) and that is explained in more detail below. This gravity model relies on the bilateral flows of researchers between pairs of countries.

Regarding the variable of bilateral flows of researchers between pairs of countries (or dyads), the brain drain indicator calculated on the basis of scientometric data is used (see more information in section 2.2). The main argument to use this indicator versus the other indicators based on MORE4 lies on the fact that the scientometric-based indicator has a larger geographical coverage[11].

This quantitative analysis relies on an **empirical gravity model of international flows** to describe and analyse new aggregate and bilateral data on the international mobility of researchers. The gravity model predicts bilateral flows based on the attributes of origin and destination economies for the phenomenon under investigation and measures of the distance between the two economies that can bear upon the costs and incentives for flows to arise.

In the empirical literature, the gravity model is generally estimated by linear regression in which the log of the flow of researchers, RO_{ij}, from a country (i) to country (j) is a function of the characteristics of the country of origin and destination, OX_i and DX_j, respectively, as well as several measures of the link between country of origin (i) and country of destination (j), including proximity measures sharing the common border or speaking the same language, etc. and others bilateral connections Z_{ij}, and taking into account an error term ε_{ij}.

$$\mathrm{Log}\left(RO_{ij}\right) = \alpha_0 + \alpha_1 \log(OX_i) + \alpha_2 \log\left(DX_j\right) + \alpha_3 \log\left(Z_{ij}\right) + \varepsilon_{ij}$$

[11] The first indicator is available for 113 dyads, the second for 130 dyads and the third one for 280 dyads. In the case of the survey-based flows, the dataset only includes those pairs origin-destination with more than 15 researchers/observations. This entails that some countries are not included in the dataset for one of the two survey-based flows (e.g. Switzerland in the case of the flows measured by country of citizenship).

Finally, for the three types of flows, the dataset only includes those pairs origin-destination that constitute a share higher than 3% per country to exclude unusual or anecdotical country pairs.

This empirical framework is used to study the bilateral flows of researchers across the EU Member states and countries outside the EU using the variables described in Annex.

Due to the quite large number of potential indicators, or predictors of brain drain, and the small size of the dataset (i.e. 280 pairs of countries for the bilateral flows of researchers), a number of steps to address multicollinearity and to select the most relevant predictors were applied (see details in Annex).

2.1.2. Main findings

The factors that influence researchers' mobility are grouped into various **models**, each focusing on specific aspects such as human resources, entrepreneurial possibilities, institutional framework, funding and career-related factors, knowledge-intensive economy, R&D investments, openness, working conditions, virtual mobility, institutional factors, and socio-economic factors and gender. The models are estimated by using **linear regression and Random Forest estimation method** that allows for determining the most important drivers of mobility outflows among others (i.e. positive or negative significant relation). The results are summarised in Table 8.

The gravity model analysis shows the factors that influence the mobility inflows to destination countries (pull) and the factors that impact mobility outflows from the country of origin (push). In general, the findings indicate that **cultural and physical proximity** matters in the mobility of researchers in Europe. **Size of the economy** is an increasing factor of mobility inflows and outflows. These indicators of the baseline model are also highlighted as among the most important factors in the results of random forest estimation.

Factors that positively relate to both inflow (pull) and outflow (push), or in other words to stimulating brain circulation both ways, are mainly related to the research base (number of researchers, public R&D expenditures, etc.). Circulation is also put in relation to openness via the indicator on international copublications. In negative terms, a relation is found between circulation and other forms of mobility such as intersectoral (researchers having worked in non-academic sectors) and virtual (researchers who consider this a substitute to physical short- or long- term international mobility) mobility.

Focusing on **factors that influence specifically the outflow from a country of origin**, we find that several elements of economic structure play a role - either positively or negatively (positive to push: innovators or MHT manufacturing, business R&D expenditures, negative to push: entrepreneurial activity or MHT exports). This mixed picture may be caused by the fact that the data sources mainly include academic (publishing) researchers, and/or that the different aspects of a mature research systems may stimulate circulation in both directions. Also attractive research systems are found to increase the mobility of their researchers, possibly in relation to higher circulation overall. Importantly, factors related to remuneration and wealth play a role as negative factors to push researchers outside a country: the share of researchers that consider themselves well-paid or paid a reasonable salary and the average annual GDP growth are negatively related to outflows from a country.

A particular pattern is found regarding the indicator on satistfaction with **recruitment processes** at the home institution. This factor is **both negative to push and positive to pull**, indicating that the OTM-R plays an important role in both the decision to leave a country or to move to a specific country.

Other **factors that are positively related to the inflow in a country**, are freedom of academic exchange and dissemination and degree of satisfaction with different aspects of the current academic position, as well as the existence of top R&D spending enterprises in the economy. Negative to pull researchers into a country are factors related to the share of researchers in private sector, R&D expenditures of the business sector, researchers employed on fixed-term contracts in their current academic position, share of researchers satisfied with their social security rights and benefits in the current academic position and institutional autonomy.

Table 8: Summary of results gravity model

DETERMINANTS OF RESEARCHERS' MOBILITY		PULL & PUSH	PUSH - ORIGIN	PULL - DESTINATION
Model2: Human Resources				
lh1	Researchers (FTE) per thousand employees	positive		
lh3	Number of PhD graduates (ISCED8) per thousand population	positive		
Model3: Entrepreneurial activity				
la7	Ease of starting a business	positive		
li8	Total entrepreneurial activity		negative	
Model4: Attractive research systems				
la1	Satisfaction with recruitment process at home research institution (open. transparent. merit-based) (%)		negative	positive
la6	Attractive research systems		positive	
Model5: Structure of R&D economy				
lm17	Knowledge-intensive services exports	positive		
lm18	Medium and high-tech product exports		negative	
lm22	Product or process innovators		positive	
lm24	Researchers in the private sector in the total number of researchers (%)			negative
lm25	Share High and Medium high-tech manufacturing		positive	
Model6: R&D expenditures/top R&D firms				
lf5	R&D expenditure business sector		positive	negative
lf6	R&D expenditure public sector	positive		
lf7	Top R&D spending enterprises per 10 mln population			positive
Model7: Openness				
la10	International co-publications	positive		
lnew	Researchers having worked in non-academic sectors (%)	negative		
Model8: Satisfaction with different aspects of the current academic position/fixed term contracts				
la3	Degree of satisfaction with different aspects of the current academic position: Composite indicator			positive
la11	Researchers employed on fixed-terms contracts in their current academic position (%)			negative
Model9: satisfaction with remuneration/pension/social security				
la16	Researchers that consider themselves well paid or paid a reasonable salary (%)		negative	
la19	Researchers satisfied with their social security rights and benefits in the current academic position (%)			negative
Model10: Virtual mobility				
lmo1	HEI researchers that consider virtual mobility as substitute for short- or long- term mobility (%)	negative		
Model11: Institutional factors				
v2	Freedom of academic exchange and dissemination			positive
v3	Institutional autonomy			negative
Model12: Wealth and gender				
lm6	Average annual GDP growth (SD)		negative	
lg1	New women doctoral graduates (ISCED 8) per thousand population aged 25- 34		positive	

In sum, the findings of the gravity model confirm that at institutional and individual level, **factors of OTM-R, remuneration and satisfaction in the research position play an important role in mobility decisions**. We find that satisfactory remuneration and academic positions are increasing the attractiveness of a country for mobility inflows whereas fixed-term contracts have a negative impact. We also find that the more satisfied the researchers are with their salary levels the less they choose mobility away from the country of origin. At the same time, **also system-level factors related to GDP growth, public R&D expenditures, etc. have an influence on inflows and outflows within Europe.** The findings on factors on the economy structure and private sector research may be influenced by the source data, which includes mainly academic researchers. In that respect, further research would be needed to refine the insights, and the information from the qualitative analysis will be used to complement the findings. More generally, the qualitative analysis presented in the following section complements and deepens the insights on the underlying mechanisms of brain drain, including more complex relations (e.g. non-linear or multifactorial relations).

2.2. Qualitative analysis

In parallel to the quantitative analysis, a more qualitative in-depth analysis of the situation of brain drain in 19 selected countries has been carried out (cf. section 3.6: the 15 MS eligible as widening countries[12] and 4 non-widening countries[13]). This section describes the methodology and the overarching and country-specific findings.

2.2.1. Methodology

The following methodological approaches were applied for the qualitative analysis of causes of brain drain:

- Desk research of previous studies and reports coming from national and EU sources.
- Desk research of available quantitative indicators coming from various sources (Eurostat, OECD, MORE studies, European Innovation Scoreboard, V-Dem project, Euraxess and Scopus).
- Semi-structured interviews with stakeholders to discuss the situation in each country. To collect different points of view, the interviews were carried out with representatives of the following target groups[14]:
  - At system-level, interviews were carried out with country experts from the European Commission and other country experts (e.g. academic, World Bank, etc.)
  - At country-level, depending on the availability of the invited people and the context in each country, interviews were carried out with representatives of:
    - The permanent representation of the countries to the EU
    - Research councils, research funding organisations, universities and research performing organisations
    - Private sector (e.g. individual companies, cluster associations, trade organisations, etc.)
    - Representatives of researchers.

[12] Bulgaria, Croatia, Cyprus, Czechia, Estonia, Hungary, Greece, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia.

[13] Ireland, Finland, Italy, Spain.

[14] An average of four interviews per country was carried out. Some interviews included the participation of representatives of several organisations/governmental departments.

- The information collected through the different approaches was collected in templates, synthesised in data collection fiches per country, and analysed qualitatively per country and cross-country.

2.2.2. Overarching findings

The cross-case analysis of the information gathered during the elaboration of the qualitative analysis results in several overarching findings:

- The **situation across the countries under analysis is very heterogeneous**, both in terms of the level of brain drain experienced in the countries as well as in terms of the (combination of) causes having an impact on brain drain.

- **There is a widespread problem of lack of data on brain drain/flows** both from the perspective of researchers leaving the country and of researchers coming into the country. This hinders in many cases the development of concrete policy measures to tackle the problem, as well as the monitoring of their impact.

- Brain drain tends to be **more intense among early career stages**, especially R1. In some countries, interviewees indicate that the drain starts to occur already in bachelor and master stages. This is related to the fact that often brain drain occurs in those stages where precarity is also more intense, or where the attractiveness of excellent institutions abroad is perceived to be particularly high, but also points at the importance of general perspectives and attractiveness at the broader system level.

- Brain drain problems at country level tend to be characterised by:

  - **A low capacity to consolidate young researchers in the system**: this is usually related to a mix of factors, with the imbalance between the number of PhDs awarded and the number of positions available in the system being among the factors that is mentioned more frequently. The demographic pyramid of the researchers´ population is also important, especially in those countries whose R&I system grew a lot in the 80s and/or 90s and now concentrate a large part of their open-ended contracts and high-level positions among older researchers, blocking the entry to new generations.
  - **A low capacity to attract and retain foreigners to the system**. This problem is also relatively common. The low attractiveness of the system can be related to a lack of funding and positions overall, a comparatively low quality research environment and output, the predominance of positions only open to those mastering the national language (i.e. related to teaching obligations), recruitment process that are not sufficiently open, advertised and transparent or career progression paths that are ill-adapted to the experience of researchers in other countries.
  - The need to foster **reforms at system-level is common to almost all the countries**. The need to increase R&D funding is a very frequent need. In many cases, interviews indicate that reaching higher levels of public R&D funding has been on the policy agenda for many years, yet the promised increases are not always reached. The levels of private R&D funding remain under the expected levels in many countries and there are still large efforts to be done to reach optimal levels of private R&D funding.

2.2.3. Country-specific findings: Intensity of brain drain

While **Error! Reference source not found.** 1 presented an overview of the indicators of brain drain based on MORE4 data and scientometrics data for each of the countries, a qualitative assessment of the intensity of brain drain in each of the countries under analysis presents a more nuanced picture. Based on 1) the abovementioned indicators; and 2) the insights collected during desk research and interviews, we thus come to a more detailed assessment of the situation per country.

While the correspondence between this qualitative assessment and the MORE or scientometric indicators is evident for some countries (e.g. displaying high levels of brain drain in both, such as Italy or Greece), in other countries the qualitative research has revealed that the problem is less related to the existence of significant brain drain flows than to other problems related to talent circulation and/or talent exchange[15], such as the difficulties to attract or consolidate foreign researchers (FI), the small size of the R&D system leading to a small population of researchers (MT, CY), the low levels of national and international mobility (CZ), a limited number of available positions for researchers (IE), etc. In addition, there is also a historical or time dimension to brain drain. Several Eastern and Southern European countries have faced a strong outflow of researchers in specific periods of time in the past, resulting in a large diaspora population abroad. This entails specific issues as well as pathways for exchange.

Overall, the qualitative assessment points at the highest levels of brain drain in Italy, Greece, Spain, Romania and to some extent Bulgaria. A bit lower, but still substantial levels of brain drain are observed in Portugal, Slovenia, Slovakia, Poland, Croatia, Latvia and Lithuania. In Estonia and Ireland, brain drain is not observed as a strong issue.

2.2.4. Country-specific findings: Impact of the different factors on brain drain

The second step in the analysis is to analyse the factors that have a larger impact on the levels of brain drain of these countries. The situation in each country has been assessed on the basis of desk research and interviews with actors in each country. The first columns of Table 9 present the different factors that are expected to play a role in brain drain (derived from the theoretical framework, see above). Cells in darker colours indicate a stronger role/presence of the factor as cause for brain drain in each country. It is important to understand that this matrix does not present an evaluation or assessment the different systems, but rather shows those factors that are identified as more important causes for brain drain in the country. In this, the matrix does not aim to be exhaustive, but to capture the priority factors that came up during interviews and desk research, i.e. the main causes for brain drain. Consequently, when a country has more cells coloured in darker colours, this does not entail that the country has a more acute problem of brain drain but rather that the brain drain has more multifactorial roots.

[15] As explained in Section 1.1 this study differentiates between talent circulation (where researchers move abroad with a change of employer) and talent exchange (where researchers move abroad without changing employer, for study visits or other research-related activities).

Table 9: Qualitative analysis of brain drain per country

Categories	Subcategories	Causes	Cyprus	Greece	Italy	Malta	Portugal	Spain	Croatia	Czechia	Bulgaria	Hungary	Poland	Romania	Slovakia	Slovenia	Estonia	Latvia	Lithuania	Finland	Ireland
System-level factors for R&I	R&D funding, strategies and instruments	Lack of a long-term R&D strategy															n/a				n/a
		Lack of a long-term, sufficient and stable R&D funding															n/a				n/a
		Instability of instruments: hindering the predictability of career options and awareness															n/a				n/a
	Governance	Lack of efficient and effective coordination between decision making actors at all levels (MS, regions, research institutions)															n/a				n/a
		Governance-related limitations at country level; at HEI/institutional level. Institutional design (multilevel settings with overlapping competences)															n/a				n/a
	Connections with the broader ecosystem	Absence of well-developed ecosystems (presence of different well-connected actors, etc.)															n/a				n/a
	Private sector investment and interest in R&D	R&D investment in the private sector, including SMEs. Extent to which researchers are employed in the private sector															n/a				n/a
Research environment		Limited access to infrastructures and/or equipment															n/a				n/a
		Limited /insufficient funding for research projects and/or research mobility															n/a				n/a
		Limited access to training															n/a				n/a
Recruitment, working conditions & career progression	Recruitment	Lack of open, transparent, clear and merit-based recruitment processes															n/a				n/a
		Language-related limitations															n/a				n/a
	Career progression & working conditions	Lack of recognition of the research profession and															n/a				n/a
		Instable positions and career paths															n/a				n/a
		Lack of transparency and objective evaluation and appraisals for career progression															n/a				n/a
		Insufficient remuneration, access to social security and pension rights and other working conditions (well-being,															n/a				n/a
		Language-related limitations															n/a				n/a
	Support for research	Lack of support staff for research															n/a				n/a
		Administrative burden hampering researchers´ activity															n/a				n/a
Research excellence		Limited international collaboration															n/a				n/a
		Insufficient quantity and/or quality of research output															n/a				n/a
		Limited number of excellent and internationally recognized institutions															n/a				n/a
Other factors		Antimigrants, xenophobic discourses															n/a				n/a
		Resistance to change															n/a				n/a
		Economic crisis															n/a				n/a
		Country size															n/a				n/a

Reading note: Cells in darker colours indicate a stronger role/presence of the factor as cause for brain drain in each country. It is important to understand that this matrix does not present an evaluation or assessment the different systems, but rather shows those factors that are identified as more important causes for brain drain in the country. In this, the matrix does not aim to be exhaustive, but to capture the priority factors that came up during interviews and desk research, i.e. the main causes for brain drain. Consequently, when a country has more cells coloured in darker colours, this does not entail that the country has a more acute problem of brain drain but rather that the brain drain has more multifactorial roots. 'n/a' is used for Ireland and Estonia, where no significant issues of brain drain are identified.

The following paragraphs present the main factors related to brain drain and whether the factor is considered to play a significant role in brain drain in the countries under analysis. The analysis covers the most frequently mentioned factors: this entails that it is important to note that the fact that a country is not associated to a particular factor does not entail that the factor is not present but rather that it is not considered to be among the main causes of brain drain.

System-level factors for R&D

- R&D funding, strategies and instruments
  - Lack of a long-term R&D strategy (IT, EL, ES, PT, SI and to a lesser extent HR, CY, BG)
  - Lack of a long-term, sufficient and stable R&D funding (IT, EL, ES, PT, SLO, MT, FI, HR, CY, BG)
  - Instability of instruments, which hinders the predictability of career options and awareness (ES, SI, CY, PT, EL, IT)
- Governance
  - Lack of efficient and effective coordination between decision-making actors at all levels (MS, regions, research institutions) (ES, BG,PT, SI, IT)
  - Governance-related limitations at country level; at HEI/institutional level. Institutional design (multilevel settings with overlapping competences) (BG, PT, ES, SI, IT, CY, HR)
- Connections with the broader ecosystem
  - Absence of well-developed ecosystems (presence of different well-connected actors, etc.) (PT, SI, BG, ES, IT, EL)
- Private sector investment and interest in R&D
  - Limited R&D investment in the private sector, including SMEs (EL, ES, IT, PT, CY, BG, SI, MT, PT, HR, MT, FI, SK)

Research environment

- Limited access to infrastructures and/or equipment (CY, BG, HR)
- Limited or insufficient funding for research projects and/or research mobility (CY, BG, HR)
- Limited access to training (CY, BG, HR)

Recruitment, working conditions & career progression

- Recruitment
  - Lack of open, transparent, clear and merit-based recruitment processes (EL, PT, ES, BG, IT, HR, CZ, SI)
- Career progression
  - Lack of recognition of the research profession and researchers´ career paths (BG, MT, ES, PT, SI, SK)
  - Instable positions and career paths (IT, ES, FI,EL, PT, SK, HU, CY, BG)
  - Lack of transparency and objective evaluation and appraisals for career progression (CY, BG, IT, EL, ES, PT, SK, PO, HU, CZ, FI, SI)

- Working conditions
  - Insufficient remuneration, access to social security and pension rights and other working conditions (well-being, flexibility) (IT, PL, HU,CZ, SI, SK, CY, BG, HR, PT, EL)
  - Language-related limitations (SI, CZ, EL, BG)
- Support for research
  - Lack of support staff for research (ES, PL, BG, HR, CY)
  - Administrative burden hampering researchers´ activity (SK, PL, ES, EL)

Research excellence

- Limited international collaboration (HR, CY)
- Insufficient quantity and/or quality of research output (SK, PO, HR, HU, BG)
- Limited number of excellent and internationally recognized institutions (BG, CY)

Other (exogeneous) factors

- Antimigrant, xenophobic discourses (SI, PL)
- Resistance to change (HR, BG)
- Economic crisis (EL)
- Country size (MT, CY)

2.3. Synthesis

The quantitative and qualitative analyses suggest the existence of some main trends, i.e. factors that are more frequently associated to brain drain across (almost) all the countries. Some factors identified during interviews or desk research go beyond the scope of this analysis as they refer to the broader system or society, such as the existence of xenophobic, antimigrant discourses in the public debates, issues related to the educational system or to the existence of poverty, etc.

The qualitative analysis indicates that **insufficient public and private R&D funding is associated to fewer job opportunities and/or more precarious ones.** This leads researchers, and particularly the younger ones, to be more prone to leave their home country.

The quantitative and qualitative analyses confirm **the important role of the working conditions** to explain the flows of researchers. In this sense, the gravity model, as well as the preceding literature such as the various MORE studies, shows that one of the most powerful pull factors attracting researchers to a country, is to have good working conditions for researchers, and that the opposite occurs when working conditions are not so good. This is confirmed by the qualitative analysis where low remuneration levels or the instability of research careers are considered to be key factors fostering brain drain.

Related to the previous point, the **difficulty to access stable research positions** is also cited very frequently as a major factor behind brain drain. These difficulties are often a combination of factors, such as:

- The mismatch between the available positions and the number of PhD holders in the system[16]: this is especially pronounced in those countries where the number of PhD holders has grown very much in the last decades, but the number of research positions (in public or private sectors) has not grown with the same pace. Among these are several countries that were severely hit by the 2008-2012 economic crisis which entailed important budgetary cuts and had important effects on recruitment (and remuneration of R&D personnel) (PT, ES, EL)

- Endogamic dynamics at institutional level are also very frequently mentioned as a mechanism explaining high levels of brain drain (especially IT, ES, PT, CZ, EL). The weight and relevance of personal connections in the decision to allocate positions or research grants is considered to have a very strong impact on researchers´ individual decisions. Not only is it difficult to access the system for outsiders (from within or outside the country), endogamic dynamics also hinder international mobility: those who go abroad might face difficulties to come back because of the loss or absence of connections with the individuals taking the decisions at the institutions in the home country. At the same time, those working in their home country will be more reluctant to move abroad if they know that in doing so they will lose their competitive advantage (personal connections). This point emphasises the impact that (the lack of) open, transparent and merit-based recruitment and promotion procedures have on talent circulation and fair conditions.

- In some countries (e.g. SI, IT, ES), the procedures of access to the civil servant system in research institutions is pointed as one of the drivers of brain drain. In some cases, civil servant systems are designed in a way that years of experience are more important than the quality of research or other merits or performance, reducing access to this kind of stable, permanent positions for younger researchers. A more merit-based approach to recruitment is here again a key factor that was mentioned frequently during the interviews.

Insufficient R&D activities developed by industry[17] is also an important factor explaining the likelihood to have higher levels of brain drain. The qualitative analyses provide information about the mechanisms behind this. Some of the most frequently cited mechanisms are:

- Low R&D absorption in industry due to industry structure (IT, PT, IT, ES, EL, CY, HR, BG);

- The lack of valorisation opportunities in spin-offs or entrepreneurship (MT, SN, EL, CY, HR, RO)

- Insufficient support for knowledge transfer to industry (e.g., lack of (experienced) technology transfer offices, or other instruments to support technology development or uptake by industry); or

- Insufficient development of intersectoral collaboration schemes. This includes not only the collaboration on joint-research projects, but also the existence of industrial doctorates or instruments for short or long-term placements of researchers in industry.

- And more generally, insufficiently developed ecosystems for the development and uptake of technologies by industry and other stakeholders in the multiple helix ecosystem (SK, SN, ES, EL, CY).

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16 An analysis on this kind of mismatch is performed in WP7 of this study.

17 In the context of this study, industry is to be interpreted as the broader range of non-academic sectors (and thus not only manufacturing industry).

In addition to this point, we asked interviewees about the role of the **diversification of career paths** in the research system in general and in brain drain more specifically.

- In many cases, the research ecosystem seems to be **lacking bridging services** between research and industry and/or diverse professional career paths for PhD holders. PhD holders tend to focus strongly on academic research careers and there is a low demand for research or knowledge in industry, and thus for researchers in industry or bridge profiles between industry and academia.

- In addition, **diversification of career paths is not considered to impact brain drain issues in the country**. Interviewees do not see these profiles engaging in international mobility, like researchers in academia do, nor do they see opportunities to attract research managers, data scientists, knowledge brokers, etc. from abroad. It does, however, play a role in a different way: the absence of diversification of research profiles entails that there are fewer positions/professions available for PhD holders than there could potentially be in well-developed ecosystems.

- The **need for this kind of profiles** to strengthen the research ecosystem is recognised by interviews. Actions aiming to foster the diversification of careers would need to go hand in hand with the development of a stronger R&D absorption capacity in industry.

Given the complexity and interrelation of factors causing brain drain dynamics, **no clear-cut clustering of countries regarding causes of brain drain emerges from the cross-country analysis**. A number of general trends in geographical areas or countries with historical similarities can be identified, but these are not necessarily found in all countries in the cluster (or to the same extent). In sum:

- **Southern European countries** (PT, ES, IT, EL) tend to be characterised by high levels of brain drain. These were systems that grew a lot during the 80s and 90s and that increased significantly the number of PhD holders produced by the system. The 2000s and 2010s were, however, a period of consolidation that was severely marked by the effects of the 2008-2012 economic crisis. The public sector is the main employer of researchers in these countries and the number of positions available in these systems is not enough to absorb all the researchers. At the same time, these are countries that are in general quite well connected to the international research community, they tend to produce research of high quality and have quite strong infrastructures and research centres. Although researchers are recognised and valued by society in these countries, the working conditions are not always optimal. In spite of the work done in these areas in recent years, there are still some key points of attention, such as the instability and precarity of careers and the endogamic dynamics for recruitment and career progression, found in many institutions.

- **Eastern European countries** (SI, SK, PO, BG, HR, CZ, RO, HU) present a slightly more heterogeneous picture, but there are also some common trends. The historical background has resulted in a strong brain drain as of the 90s, with a large diaspora community as a result. In some countries, RDI is not high on the policy agenda and it is difficult to commit to a stable and sufficient R&D funding. Private R&D funding is low and absorption capacity in industry is limited. In several countries, issues related to a lack of competition and competitiveness in the research system, and the willingness to change at institutional level are mentioned as barriers to improve the system. In particular the remuneration levels are considered to be not-competitive with respect to other EU countries, and this is generally perceived as a factor related to the difficulties 1) to attract foreign researchers and 2) to prevent their national researchers from leaving the system. These countries are more likely to have also quite strong problems related to insufficient international collaboration and mobility. This lack of international connections is considered to harm the attractiveness of the system and, hence, to partially explain brain drain. In this sense, many of the Eastern European countries are putting in place initiatives specifically focusing on nurturing the connections with the diasporas and the collaboration with researchers abroad.

- **The Baltic countries** (EE, LV, LT) face a varying degree of brain drain but similar challenges[18]. In general terms, remuneration levels are considered to be hindering the attractiveness of these systems as they are not able to offer competitive conditions with respect to other EU countries.

- **Smaller countries** (CY, MT) also present some common features related to their country size. Their small size entails that the research institutions (or industry) cannot cover all fields of science nor are able to have good infrastructure or equipment for all of them. Strong scientific specialisation is not possible in all (sub)domains, and forms a reason for specific researchers to move abroad. Like in many countries, the links between research and industry are underexploited due to the limited size and absorptive capacity of industry in those countries.

- **Other countries under analysis** (IE, FI) do not present a significant brain drain problem according to the qualitative analyses (in the same line as Estonia). These countries do face their own challenges in terms of talent circulation and career development and progression[19], such as the difficulties to attract or consolidate foreign researchers (FI) or the limited number of available positions for researchers, partially due to the limited R&D funding (IE), etc.

[18] Estonia is considered to have a situation of balanced brain circulation, Latvia and especially Lithuania display larger levels of brain drain.

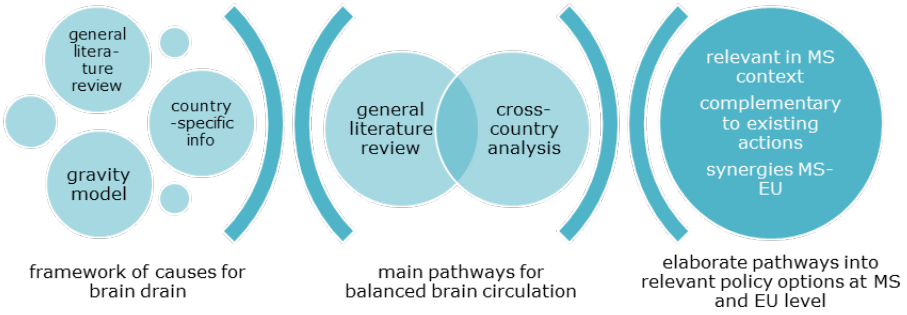
[19] These topics are broader than brain drain and are therefore out of scope of the analysis presented in this report.

PART 3: SOLUTIONS FOR BRAIN DRAIN OR UNBALANCED TALENT CIRCULATION

The analysis of causes of brain drain in the previous part of this report (Part 2) showed that on the one hand, a complex interplay of factors determines the unique situation of each individual country when it comes to explaining brain drain. On the other hand, a number of general and overarching findings point at more common causes across different countries. The cross-case analysis of solutions that were mentioned in the desk research and interviews (cf. data collection fiches), as well as in more general literature, similary point at a number of critical pathways for a more balanced brain circulation, that are valid in many – if not all – cases. However, the degree of applicability and the way to translate these pathways into concrete policies both depend on the national context (regulatory frameworks, industrial and fiscal structure, etc.).

In this part of the report, we first give an overview of actions already taken or planned by Members States to address the different types of causes of brain drain (structured according to the framework in Part 2). Second, for each dimension in the theoretical model, we give an overview of the main pathways at MS level linked to the main causes. In the last section of the Part 3, we identify policy options at EU level and synergies between policy levels as mentioned during the interviews.

Figure 15: Approach for identification of solutions for brain drain or unbalanced talent circulation



1. Actions taken/planned at Member State level

The country reports describe many actions taken or planned (without being exhaustive) to address brain drain directly, or to improve the attractiveness of the research profession or the general RDI environment. Brain drain and the development of human (research) capital are often explicit parts of the national recovery and resilience plans of the Member States.

Although the mention or description of the actions does not necessarily provide information on whether implementation was successful and objectives were reached, an overview can be derived from the qualitative analysis of the main lines of actions taken/planned:

- Commitment to R&D funding and governance:
  - Developing a **long-term perspective** for and investing in R&D, with multiple objectives (incentivising quality and excellence, increasing the number of research positions, improving remuneration levels or precarious conditions for early-stage researchers, etc.). Several countries have recognised the need to invest in R&D and have been steadily increasing public R&D expenditure. In some cases, however, the foreseen increase was not realised as planned.
  - There are a few examples where steps are taken to improve the **governance** of the RDI system, namely by creating a dedicated ministry for research to improve the political commitment and governance (CY) or through the development of comprehensive strategy or programme (PT: framework for researchers' working conditions that aims to strengthen the individual, institutional and system levels and

a comprensive programme for cooperation between higher education, industry and government sectors).

- Development of the national knowledge ecosystem:
  - **Incentivising RDI in the private sector** and improving **interface services** between universities, research organisations and the private sector. In several cases there is mention of support for entrepreneurship and exploitation of research results (e.g. CY, EL, HR, RO), or for collaboration between academia and industry[20] (e.g. BG, EL, HU, PO, PT). Technology transfer offices (TTOs) exist or have been created in several countries (e.g. CY, CZ, HR, HU, IT, MT).
  - Several cases mention the development of **smart specialisation strategies**, flagship initiatives to focus RDI efforts or **centers of excellence** as actions towards stronger and more connected knowledge ecosystems (e.g. BG, CY, EL, PO, RO).
  - In one case (IT) initiative was taken to **raise awareness on opportunities for research careers in the private sector** (e.g. via interaction moments or exchanges).
  - **Infrastructure and training:** Support for research infrastructure and training opportunities are not considered the main factor in this context, but were mentioned in a few cases.
- Support for international mobility:
  - A considerable number of countries mention **return mobility** schemes or support (e.g. BG, CZ, EL, HR, HU, IT, LT, MT, PO, RO, SK, SN) and in particular in countries with a large diaspora from earlier waves of brain drain, targeted actions for return of or exchange with the diaspora are implemented/planned.
  - To further facilitate mobility, one case mentions the creation of a **single point of entry** for foreign researchers and students (PT).
- Improving working conditions for researchers, in particular early career stage researchers:
  - Several countries have dedicated programmes for **early career stage researchers** and a number of specific actions are mentioned to improve the precarious situation of early career stage researchers (e.g. PT: limiting the use of grants/scholarships in postdoc stage; or EL: dedicated support for career development and opportunities). Several countries pay attention to career development and training as well (e.g. LV, PT, SK).
  - More generally, actions are taken to the **modernisation and professionalisation of HR management** in higher education institutions, e.g. by implementing the HRS4R and C&C (e.g. HU, MT, LV, RO). A few actions are mentioned for a more **open, transparent and merit-based recruitment and career progression**, although reluctance to change in the system is a hampering factor for this.
    - Actions to improve the **internationalisation** of the higher education and research system and the development of international collaborative networks were mentioned in several countries (e.g. CZ, MT, LT, PO)
    - In view of improving the **quality of research** and encouraging the retaining/returning of **excellent researchers**, several countries mention synergies with ERC and MSCA grants (e.g. Seal of Excellence principle) (e.g. BG, EL, RO).

[20] In the context of this study, industry is to be interpreted as the broader range of non-academic sectors (and thus not only manufacturing industry).

2. Identification of pathways at Member State level

Based on the desk research and interviews, potential solutions were listed in the data collection fiches per country as they were collected. In this analytical report, this list is structured and analysed across the country cases and held against the causes for brain drain that were found in Part 2 of this report to elaborate further on potential pathways for solutions at MS level. The outcomes of this analysis were validated and refined during a validation workshop with country stakeholders and experts. The outcomes of this workshop are incorporated in this report.

In this section, for each factor that is found to cause brain drain, a vision on change and the main pathways to address the factor are developed. Furthermore, we each time indicate the Members States where this factor and specific pathway are mentioned.

The pathways we outline here, **focus on the RDI system and institutional level, and aspects specifically related to brain drain and circulation**. However, many **links with other policy areas** (education, economy and industry, etc.) are made and in some cases essential reforms are needed in these areas for the mentioned pathways to be effective. Inclusiveness of, participation in and quality of education, for example, need to be sufficiently developed in order to improve participation in higher education and eventually research careers. Issues of inequality, openness towards foreigners, general bureaucracy or corruption are similarly beyond the scope of this study, but need to be taken into account to contextualise the identified pathways at MS level.

2.1. RDI system: funding, governance, ecosystem

Overarching findings

A commitment to increase **R&D funding and a long-term vision on RDI** are the most important solutions to address the heterogeneity across EU Members States, and to foster a more balanced brain circulation. The gravity model confirmed the relation between brain circulation and system-level factors like GDP growth and public R&D expenditures. Funding and long-term vision are mentioned in (almost) all cases. It is a prerequisite without which other pathways and solutions cannot have an effective impact. The discussions during the validation workshop emphasised again that priority needs to be given to structural reforms. A long-term strategy should include incentives for the different parts in the system to inspire everyone to go in the same direction (while respecting autonomy of all stakeholders). Consolidation and evaluation of actions are important in this context to implement improvements and reach a long-term impact.

Awareness and recognition of the importance of RDI for the economy and society among policy makers and the broader society are essential enabling factors for the implementation of a stronger vision and funding strategy by policy makers. Raising more awareness and communicating on the impact of research and innovation (especially to non-research stakeholders) are therefore part of the solution. During the validation workshop, the need was confirmed to engage in a broad discussion with more stakeholders to gain ground for structural reforms.

Actions to improve and make more effective the **governance and coordination** between decision-makers are expected to strengthen the commitment to invest in R&D, improve the stability and predictability of the policies and the funding instruments, and to increase the efficiency and effectiveness of their implementation. During the validation workshop, the importance of breaking down silos at all levels in governance (i.e. between ministries, between countries,…) was strongly emphasised.

Another pathway at system level, is the **development of national/regional knowledge ecosystems**. In many cases there is in practice no strong RDI ecosystem that connects the quadruple helix stakeholders. This can be due to several factors: lack of absorptive capacity/knowledge-intensive companies; lack of recognition of research professionals and their value for public or private sector; lack of interface services; lack of training for professional development and diverse career paths; lack of administrative support (e.g.

for applications, administrative processes, language barriers for foreign researchers, etc.). Addressing these gaps (and the private sector investment and interest in R&D are an integral part of this), is needed to develop complete knowledge ecosystems, as well as the valorisation of research in economy and society. Both outcomes will improve the opportunities and diversification of research careers, and thus the attractiveness of the research profession.

2.1.1. R&D funding, strategies and instruments

System-level factors for R&I

R&D funding, strategies and instruments

- *Lack of a long-term R&D strategy (IT, EL, ES, PT, SI and to a lesser extent HR, CY, BG)*
- *Lack of a long-term, sufficient and stable R&D funding (IT, EL, ES, PT, SLO , MT, FI, HR, CY, BG)*
- *Instability of instruments: hindering the predictability of career options and awareness (ES, SI, CY, PT, EL, IT)*

- *Make the RDI framework stronger and more stable, with more opportunities for RDI and more predictability supporting planning of positions, and thus improve the system's attractiveness*

Pathways:
- Develop a long-term vision/strategy on RDI (EL, RO)
- Increase policy commitment to R&D / Increase stability of R&D funding (ES, PT, EL, HR, RO)
- Increase public R&D funding, according to the R&D strategy (PR, CZ, IT, MT, HU, SK, HR, RO), with sufficiently diversified instruments to address needs of different groups
- Increase public awareness of importance and impact of research for the broader economy and society (MT, RO), e.g. through science communication
- Give a more prominent place to human research capacity in national strategies, e.g. in the context of the NRRP

As mentioned in the overarching findings, **public R&D funding** is a key factor in many aspects that are related to the attractiveness of a research system. By this, it also has an impact on brain drain. Although important in all countries, the above overview lists the countries where these elements were explicitly observed in desk research or interviews. Elements of a pathway to a more balanced brain circulation are: long-term strategy, stability, political commitment, ambitious targets (in line with the EU research funding targets) and efficient and effective deployment of the funding. A policy strategy that emphasises the role of RDI in the broader policy framework, working with multiannual budgeting frameworks for research and leveraging on the EU research funding targets are conditions to reach a stronger commitment and effectively increased public R&D funding. At the same time, consolidation and evaluation of actions taken is important to ensure a long-term impact.

The factor of public R&D funding **relates to almost all other factors** (governance, leveraging private industry funding, funding for training, research projects and mobility, reforming HR practices and providing support services for research, etc.). WP7 of this study, focusing on working conditions of researchers, emphasises for example that stability and predictability are necessary for the planning of open positions and more stable career opportunities.

A strong public awareness of the importance and impact of research for the broader economy and society can leverage the commitment at policy level. Raising more awareness and communicating on the impact of research and innovation are therefore part of the solution. This can be implemented through science communication initiatives, by researchers directly or via support services in the HEIs. Researchers or institutions can be incentivised to invest time into science communication by taking this factor into account in evaluation.

Another leverage factor are the recent **national resilience and recovery plans (NRRPs)**. In many countries, these plans are mentioned when asked about 'actions planned'. Several NRRPs include specific pillars on human research capacity. In some cases, interviewees see the NRRPs as important instruments to give research and human capital development a more prominent place in the national strategies. In this context, consolidation and evaluation of actions are particulary important to avoid the situation of a short-term boost with limited long-term impact.

2.1.2. Governance

System-level factors for R&I

Governance

- *Lack of efficient and effective coordination between decision-making actors at all levels (MS, regions, research institutions) (ES, BG,PT, SI, IT, HU)*
- *Governance-related limitations at country level; at HEI/institutional level. Institutional design (multilevel settings with overlapping competences) (BG, PT, ES, SI, IT, CY, HR, HU, CZ)*

- *Facilitate the participation of different stakeholders in the design of long-term strategies*
- *Define responsibilities and create appropriate incentives for the stakeholders to support the desired policy change*

Pathways:

- Improve management and coordination at governance level (HU, SK, SN, PO, ES, HR, BG, RO) – cf. in some countries fragmented systems, with sometimes high number of HEIs per number of inhabitants (PO, SK, HR) – and develop a comprehensive and consistent framework (LT)
- Reduce resistance to change in HEIs (PT, SK, HR, BG), e.g. incentivise institutions, involve young researchers in HEIs' governance structures
- Reduce bureaucracy e.g. for grant applications, recruitment, recognition of diploma's, buying equipment, etc. (ES, IT, CZ, PO, SK, EL, RO)

- **Improve governance by establishing platforms for policy coordination and discussion**

As mentioned in the previous sections, brain drain is often the result of multifactorial causes. Researchers´ careers are often dependent upon the decisions of several ministries – Labour, Science and Innovation, Education, etc. This entails that different government departments need to be involved in the design of coherent and well-thought strategies to avoid fragmentation and inconsistencies. In many countries, it has become apparent that the lack of coordination between different departments is also the source of many problems of uncertainty in researchers´ careers. **Establishing an interministerial platform** to discuss, develop and coordinate the policies affecting researchers´ careers would be a way to address this lack of coordination.

The success of policy change greatly depends on the extent to which the decisions taken are transparent and have been previously discussed with the main actors in the field. The situation of some countries (e.g. Hungary) suggests that the latest changes on organisational/institutional context is having negative effects on the uncertainty of researchers – not knowing how institutions will look like and what would be expected by them has a negative effect on researchers´ confidence in the future. In other countries, decisions are taken after larger and more open discussions with the stakeholders, but care would need to be made to open the discussions to representatives of all those that would be affected by a potential reform. It is very common to see that universities have a strong role in these discussions (see below, on the resistance to change and the autonomy of these institutions), but other stakeholders, especially those representing individual researchers and those most affected by precarity, are less present in the discussions. **Mechanisms to broaden the participation of different stakeholders** would therefore have a positive impact on the degree of acceptance of the reforms.

- **Address resistance to change through institutional funding incentives**

The **resistance to change** among the actors in the system is mentioned in several countries. In many cases, this refers to the position of universities but also other actors in the systems (funding agencies, etc.) that have vested interests in the current functioning of the system and that feel that changes can jeopardize their position. This resistance to change is also related to the specific character of universities as public entities that have a large autonomy in many cases and that can block the implementation of reforms on the basis of this autonomy.

One of the pathways to address this resistance to change without jeopardizing the autonomy of institutions comes through setting **policies that incentivise** – without forcing – the required policy change. For instance, in some countries institutional public funding is allocated to universities on the basis of the number of students. While this is of course a relevant indicator, it does not account for research efforts and outputs. This entails that institutions devoting more resources to research are not compensated financially for this. **A correct mix of institutional funding accounting both for teaching and research could be a possible solution, adding for instance top-up funding for those institutions that are performing excellent research.** This funding would require to be based on a long-term strategy for institutions (and even departments) to have time to design their own profile in a consistent manner in the long-term – some of them might be more oriented towards teaching, while in others research would play a greater role (vertical stratification based on allocation of research funding to HEIs based on the quality of their research, which can have a positive influence on visibility and attractiveness of research institutions).

Another pathway is to **involve more young researchers in HEIs' governance structures**, thus taking into account their perspective and incentivising a cultural change at institutional level. In several countries, the demographic evolution offers a window of opportunity for this pathway. At the same time, this pathway is one way of diversifying the career opportunities for young researchers.

- **Reduce bureaucracy**

Bureaucracy is often mentioned as a problem **hindering the attractiveness and the performance of R&D systems** in general, and of HEIs in particular. The administrative burden affects many facets of the work of research institutions and researchers. For instance, in Spain the administrative requirements and delays are sometimes perceived as a **barrier for the recruitment of non-EU researchers**: the delays for grant application are not always adapted to the delays for visa application and vice versa. Lighter requirements and procedures for researchers could facilitate this and make it easier for non-EU researchers to come to EU countries.

There are also concerns about the administrative burden **related to the acquisition of research material and equipment**: in some cases, as in Spain the ex ante administrative procedures tend to be time consuming and often at odds with the nature of research activities: buying specific research equipment is not always easy (or quick) under the general public procurement regulations. Having more flexibility in terms of the buying procedures while keeping (or even increasing) ex post control of the expenses would have positive consequences on the daily work at research institutions.

Complex administrative processes for the **recognition of diplomas and accreditation** are also frequently mentioned as major barriers for talent circulation. In Italy, interviewees indicate that Italian (and foreign) researchers who have obtained a PhD qualification abroad face a long, complex and expensive process to have their PhD qualification recognised in Italy: a necessary step to be able to work in Italy as a postdoc researcher. Along similar lines, the system of habilitation ('Abilitazione scientifica nazionale') introduced in 2012 is also considered by some stakeholders as being too complex and not reaching the desired outcomes. Similar concerns regard the accreditation process se tup by the Spanish Agency for Quality Assessment and Accreditation (ANECA) , where requests to facilitate the submission of applications remotely in English and making the accreditation

process more flexible might reduce the barriers to attract (national and foreign) talent from abroad.

The discussion in the validation workshop strongly confirmed this issue in several countries. In some countries, the administrative burden is mentioned to be an important **barrier for return or incoming mobility**, reflecting an issue of trust that the funding is well used. The discussion emphasised the need to break down silos, not only in governance but also with regard to administration and bureaucracy. **Administrative barriers should be evaluated and addressed in an effective manner.** This is a precondition to the pathway of increased support services for researchers (cf. infra). It is indeed advised to increase support services, but this should go hand in hand with a reduction of administrative barriers and not instead result in bureaucracy being maintained.

2.1.3. Connections in the national/regional knowledge ecosystem and private sector investment and interest in R&D

System-level factors for R&I

Connections with the broader ecosystem & and private sector investment and interest in R&D

- *Absence of well-developed ecosystems (presence of different well-connected actors, etc.) (PT, SI, BG, ES, IT, EL)*
- *Limited R&D investment in the private sector, including SMEs (EL, ES, IT, PT, CY, BG, SI, MT, PT, HR, MT, FI, SK)*

- *Strengthen the ecosystems, their competitiveness and innovation capacity*
- *Facilitate the collaboration across sectors and across actors*
- *Facilitate the emergence of connector profiles bridging the different actors in the ecosystem*
- *Facilitate the emergence and consolidation of diversified research careers – more opportunities for PhD holders*

Pathways:

- Develop the RDI ecosystem, among which stronger awareness and R&D (absorption) capacity in industry (ES, PT, RO), support for SMEs (ES, RO), training offer and consolidation of career progression paths for diverse (e.g. 'bridging') profiles
- Encourage collaboration of researchers with the ecosystem, in particular industry (e.g. industrial doctorates (ES, PO, EL, RO), joint research programmes (ES, SK), TTOs and interface services (ES), centers of excellence (PO, SN, FI, BG, RO), networking opportunities, entrepreneurial capacity (RO), etc.) (ES, HR, BG, RO)
- Encourage increased private R&D funding (HR)
- Increase (awareness of) value of PhDs for industry (PT), e.g. through interactions, exchanges, training

In many countries there is a need to reinforce the link between research and industry[21]. The industrial tissue is often composed mainly of SMEs with little absorptive capacity and there are weak (or non-existent) support mechanisms to help SMEs innovate and carry out R&D activities. Strengthening the link between research and industry is likely to have a positive effect in diminishing brain drain as it would offer researchers an interesting (diverse) career pathway beyond the traditional – and often publicly funded - research institutions (HEIs and other research-performing organisations). Also for academic researchers, collaboration with industry can offer attractive perspectives for their research. Overall, reinforcing this link is also likely to have positive consequences on the resilience and competitiveness of regional ecosystems.

Several pathways have been identified in this study to reinforce the link between research and industry. At a more general level, it is key to give a **greater emphasis to intersectoral collaboration in national strategic plans** both from the perspective of R&D policies and from the side of industrial policies. These strategic plans are likely to be more efficient if funding is earmarked for these activities and if this funding has a long-

[21] In the context of this study, industry is to be interpreted as the broader range of non-academic sectors (and thus not only manufacturing industry).

term perspective. These strategic plans could cover different dimensions: 1) fostering the development of the ecosystems; 2) increasing the support mechanisms for the access to and exploitation of these ecosystems.

1. From the perspective of **actions aiming at developing the ecosystems**, we can find the following pathways:

   - **Creation of centres of excellence or regional excellence hubs** bringing together researchers and/or organisations that can work on common topics/areas of interest. These centres of excellence or hubs can be related to the regional Smart Specialisation Strategies, therefore aligning with the broader policy context. In this sense, Cyprus has started a promising path by setting up six centres of excellence as part of the EU flagship scheme of Horizon 2020 and Horizon Europe named Teaming for Excellent Research and Innovation[22]. These public-private centres of excellence are a response for the lack of infrastructure and facilities mentioned earlier. These centres are expected to also enhance international collaboration and develop new knowledge-based economic activity in the country. The centres have initially received funding from the EU and will receive Cypriot public funding in the coming years (around €90m in total for all six). The centres are expected to attract talent from abroad and create more job opportunities for local researchers, and hence to have a large economic impact through R&I.

     By creating **strong excellence hubs**, synergies between organisations can be better exploited, the range of services offered by them can be expanded and the internationalisation of the activities of the members can be facilitated. The Campus of International Excellence Programme initiated by the Spanish Ministry of Education is a good example. The Campus Iberus[23] is one of such campuses bringing together different universities along common topics. Campus Iberus focuses on the areas of Agrifood and Nutrition; Energy, the Environment and Sustainability; Social Innovation and Territorial Development; Technologies for Health and Bioeconomy and the Circular Economy, which are, in turn, the thematic priorities of the Smart Specialisation Strategies (S3) of the four regions where the Campus is located (Navarra, La Rioja, Aragon and Catalonia).

   - From another point of view, focusing on less formal connections, we can cite the establishment of **platforms and/or match-making events** around specific topics, application areas or objectives. These would offer the possibility to the different actors to meet each other and find areas of common interest. There are some interesting platforms being created in EU countries, sometimes even with the aim to connect researchers and companies in and outside their home country. In this sense, we can cite a new pilot project, ReBrain Greece, which aims to counter brain drain and enhance return mobility. The project consists on a public platform whose goal is to match demand and supply of work in Greece and outside (in all sectors), and to create networks not only for jobs but also for specific collaborative projects, resulting in high levels of knowledge transfer.

   - The availability of personnel with the appropriate skills is also an important aspect to take into account. In some cases there is mention of too academic, theoretical training of PhDs, making PhDs not attractive profiles for industry. By creating a stronger interaction during PhD training, research practices and skills can become more transferable to diverse contexts. Initiatives supporting **short and long-term placements of researchers** in industry also have positive results in that regard. However, the success of these initiatives depends on the existence of career progression frameworks for researchers that do not penalise these periods in industry (i.e. due to the reduction in the number of publications, for instance) and on the presence of a relevant industry in the country. Financial support and/or incentives (tax reductions) for companies hiring or hosting researchers are mentioned in some

[22] https://rea.ec.europa.eu/funding-and-grants/horizon-europe-widening-participation-and-spreading-excellence/teaming-excellent_fr

[23] https://www.campusiberus.es/campus-of-international-excellence/?lang=en

cases and can be especially relevant in those contexts where companies are more reluctant to hire researchers (due, for instance, to the perception that researchers´mindset is not well-adapted to work on an industrial or commercial setting').

- Related to this, we can cite **industrial doctorates** as one of the major entry points of researchers in industry. Industrial PhDs are industry-focused: the researchers are employed in a company while performing their PhD. Their PhD is supervised by both their employer and the academic organisation. When these industrial doctorates are well defined, they constitute a good opportunity for companies to hire researchers for the first time, getting to know the advantages and value added of these profiles to their companies. This, in turn, makes the hiring of subsequent researchers more likely. Also here, the feasibility to install this kind of actions co-depends on the presence or development of a relevant industry in the country.
- The availability of personnel to carry out **'bridge' functions with industry** is also required to achieve well-connected ecosystems (e.g. personnel for technology transfer offices, IPR experts, data scientists, research and project management, etc.). The design and offer of **trainings** to prepare researchers for these profiles is likely to have positive effects on individuals (increasing the awareness of career options outside traditional research or academic positions) and on the functioning of the ecosystems themselves. These diverse occupations are emerging and still need to consolidate their place and role in the ecosystems: having their own **career progression paths** can contribute to ensure the stability of these professions and their long-term role in the ecosystems.

2. There is also a wide range of policy options aiming to offer **support for the access to and exploitation of these ecosystems**, such as:

- Fostering, incentivising and creating awareness on **joint research projects** between industry (large companies and SMEs) and research performing organisations - including basic and applied and research. This type of initiatives can allow to increase the competitiveness of SMEs, the emergence and sustainability of start-ups, the creation of trust and connections among stakeholders by working together in common projects. These initiatives can also give researchers the opportunity to work on industry-related projects, fostering their skills on this area.
- Policies supporting **the access of industry and SMEs to R&D activities** are also an option – and an increasingly frequent one. There are good examples of policy efforts, sometimes related to Industry 4.0 initiatives, that aim to foster R&D activities by industry. The use of innovation vouchers[24] combined sometimes with access to assessment tools to evaluate the situation of the SME and its priorities are generally considered as good instruments[25].

2.2. Research environment: funding for mobility, infrastructure, training

Overarching findings

A specific point of discussion for countries that suffer from brain drain, is the need for mobility grants, and more specifically **return mobility grants**. Return grants are often implemented, but are also subject of criticism. Why privilege researchers who have moved abroad over those who stayed in the country? Will this kind of grants not induce more outward mobility in the short run, when returning to the country after a stay abroad is beneficial compared to remaining? Another way to go about this, is to develop a grant scheme for research in the country based on criteria of excellence, and that is open to not only national researchers, but also returning researchers and even foreign researchers. In combination with other pathways creating a more attractive research environment and

[24] We can cite the examples of the SME Instrument at EU level, the KMO-portefeuille at Flemish level (Belgium)

[25] See, for instance, the ADMA methodology at EU level, or at national level, the HADA tool in Spain.

developing modern institutional practices and support services, a quality-based grant will be attractive also to returning researchers.

For countries with a strong diaspora, this community offers opportunities to strengthen the research base in the home country. Instead of envisaging return mobility of researchers that are long settled in a position abroad, actions to **involve the diaspora** in collaboration, exchange, teaching etc. with the home country are important avenues for strengthening the knowledge and knowhow in the home country.

Although not considered a key factor in causing brain drain, **training** is an element to consider in the pathways towards a more balanced talent circulation, in particular in terms of strengthening the ecosystem and broadening the opportunities for PhD holders.

Researchers typically require funding support for activities that are necessary for an optimal development of their work. This includes the presentation of research findings among peers in national and international settings (conferences, seminars, etc.), resources to do research stays and field work, to get access to research infrastructure, to get access to trainings relevant for their careers, or to carry out cross-sectoral activities. This group of factors was included in our theoretical framework as some of the possible factors that could explain brain drain.

Research environment
• *Limited access to infrastructures and/or equipment (CY, BG, HR)* • *Limited /insufficient funding for research projects and/or research mobility (CY, BG, HR)* • *Limited access to training (CY, BG, HR)*
• *Improve the attractiveness of the system by ensuring a better access to infrastructures, equipment, funding and training*
Pathways: - Invest in/make research infrastructure accessible - Complement return grants or actions with actions to consolidate the researchers in the system - Identify and deploy opportunities offered through the diaspora network for collaboration, accessing international networks and research, and knowledge exchange - Provide training for diverse research careers (transferable skills, entrepreneurship, IPR, tech transfer, etc.) (CZ, FI, SK, ES, HR)

- **Research environment factors tend to be more important to explain low levels of return mobility**

Research carried out in this study reveals that factors of research environment alone cannot explain brain drain, and that in the context of brain drain, they are mainly linked to **low levels of return mobility** by interviewees. The Spanish case is paradigmatic: the Ramón y Cajal programme was set up to promote the incorporation of national and foreign researchers with a distinguished career in R&D centers. The 5-year grants offer remuneration and support to the hosting institution to create a permanent position after the end of the grant. The programme offers 40.000 euros to cover the expenses related to the research activities executed during the five years. Interview information and desk research reveals that one of the major limitations of this grant is the limited resources available to fund the research activities: the 40.000 euros are not sufficient to set up a laboratory or to develop researchers´ own research agenda (which is what researchers with a distinguished careers are expected to do).

- **Return grants: the challenge between attracting researchers vs attracting and consolidating them in the system**

Some countries have **mobility grants to foster the return** of national researchers to their home country and/or the attraction of foreign researchers. This is this case for countries such as Croatia, Spain, Italy and Hungary, and is discussed in several other countries. In Italy, also tax exemptions existed for returning researchers, but there is little evidence of substantial effects.

One of the major drawbacks of this type of grant is that they tend to **focus on attracting talent but not so much on stabilising/consolidating it in the system**. At the end of the grant, researchers do not have a stable position so they need to look for grants or positions in the country or abroad. Researchers applying to the Hungarian "Lendület (Momentum)" scheme for example, find themselves forced to get funds from EU funding at the end of the grant in order to keep their jobs. Stabilising these researchers in the system is even more difficult in systems where there are high levels of endogamy, given that these researchers tend to have little or no connections with researchers in their home country. The Spanish Ramon y Cajal programme mentioned above, although currently under revision, addressed partially this limitation in its last revision: a 100.000 euros subsidy is allocated to the receiving institution in order to create a permanent position after the end of the grant. This shows that complementary measures are needed for these "return" grants to succeed in consolidating the researchers in the system.

Related to this point of consolidation in the system, **HEIs or research organisations need to be involved in the selection of researchers for return schemes** to be able to select 'relevant' researchers to fill specific positions in the institute or system. In some countries, interviewees mentioned a negative impact on their career or a feeling of not being welcomed in the research group after their return. The receiving environment needs to be ready and willing to integrate the researchers in the environment in the long run. In some cases a **cultural change** is needed for this, which needs to be addressed locally, but can be supported at EU level through e.g. promoting institutions that have achieved success in this regard as good practices to inspire change elsewhere.

The topic of return grants was also a topic of debate during the validation workshop, with on the one hand the request to act both at MS and EU level, e.g. by introducing **evaluation criteria** to encourage reserachers to go back home. On the other hand, experts mentioned that the discussion should not be so much on return, but on **creating a stable environment for researchers overall and providing a long-term perspective**, including also personal and family aspects (e.g. childcare, support for finding positions for partners that are also researchers, etc.). The argument is that a one-shot grant would not convince researchers to a country where these conditions are not sufficiently fulfilled. Another argument raised was that instruments should not focus on the diaspora as such, but on **quality criteria** that are equally applied for remaining, returning or incoming researchers in the country. Also in this regard, long-term stable perspectives and consolidation of the researchers in the system are critical factors for the success of these actions.

- **Connection with diaspora through collaboration and knowledge exchange**

For countries with a strong diaspora, this community offers **opportunities to strengthen the research base in the home country** without the explicit focus on physical return mobility. This was a point of discussion during both the interviews and the validation workshop. The ties are mentioned to be strong, and even if researchers established abroad are not inclined to return, they are often open to exchange with the home country. This can take the form of collaborations or exchange actions, but also to offer researchers from their home countries the opportunity for stays or positions in their labs or research groups abroad. The diaspora can thus play a role in the capacity building of the research base in the home country.

Similarly to return mobility actions, actions to foster collaboration with the diaspora could be conceived in a more general manner, focusing on **quality criteria** for relevant collaboration, encouraging the free movement of reseachers and knowledge without limiting this to the national communities. The strong ties with the diaspora will ensure

relevant participation of the diaspora in this kind of actions, without limiting it to this group only.

An example of a successful programme that directly aimed at connecting the scientific research community in the country with the diaspora abroad, and at encouraging international mobility and cooperation more generally, was the Unity through Knowledge Fund (UKF) in Croatia (cf. also section on research excellence).

Another aspect to consider here (although also in a broader context) is the **growing practice of digital meetings and virtual mobility** - also encouraged during the Covid-19 pandemic. This is mentioned in interviews in Finland, as well as Romania, as an opportunity for collaborating and exchanging knowledge and knowhow via new channels. It is a challenge to adapt existing funding instruments and performance criteria to this kind of collaboration or even mobility.

- **Training: The impact of trainings is far-reaching, with positive effects on research, researchers´ careers and the diversification of research careers.**

Trainings are considered important (e.g. LV, SK, PT), especially those referring to the links with the private sector activities as they can play a role in fostering diversified research careers and hence, diminish brain drain.

The Collaborative Laboratories (COLABs) set up in Portugal constitute a promising example: CoLABs are associations or consortia of research units, higher education institutions, enterprises, interface institutions, technological centers, companies, business associations and other relevant partners[26]. They aim at consolidating and promoting research communities, to foster the link with economic development and to create, directly and indirectly, qualified and scientific employment in Portugal through the implementation of research and innovation agendas. In this sense, the offer of specialized, vocational or advanced training programs in close collaboration with social and economic partners is particularly interesting.

Another example is the planned CARLIS-project in Slovakia, where five partner organisations have joined forces with the aim to develop tools, working methods and institutional capacities for the delivery of inter-sectoral career training and preparing PhD students for career paths beyond academia. The programme will explore the gap between skills PhDs have and those requested by employers outside academia (focusing on the life science sector in the region of Bratislava-Vienna), develop a comprehensive training programme helping PhDs to address the existing skills gap and prepare for successful careers beyond academia, test the programme with PhD students at four institutions and evaluate its outcomes, create and facilitate the cross-border community of practice on career development of PhD students engaging researchers, employers and professionals supporting researchers' career development and invest into disseminating lessons learnt to wider community of professionals at higher education institutions in the region.

2.3. Recruitment, working conditions & career progression

Overarching findings

At institutional level, the most important pathways to improve the attractiveness of research careers are the improvement of the precarious position for early-stage researchers, and more generally of the working conditions of researchers, and to make further progress towards open, transparent and merit-based recruitment and career progressions and a modern HR management in HEIs and research organisations. Also the findings of the gravity model highlight the importance of OTM-R practices, satisfying conditions in the research position, academic freedom and remuneration and, therefore,

[26] Such as state laboratories, municipalities, hospitals, museums, archives, or social, national or international institutions.

the importance of mechanisms and conditions that reinforce these factors in order to increase the attractiveness of a country for researchers.

The first pathway at institutional level is to **improve the precarious position of early-stage researchers**, identified in many of the country cases (cf. above for more details), and in some cases the overall **working conditions of researchers**. The level at which this is to be addressed depends on the governance model of HE and research (institutional autonomy versus centralised regulation). We refer to WP7 of this study for more details on working conditions per MS and the recommendations to address imbalances, and thus also the condition-related factors that influence brain drain. The main approach of this WP7 to balance the supply of qualified researchers with the demand for them, as well as to improve working conditions of the existing jobs, which may in turn affect the supply of and demand for researchers: better remuneration, e.g., may attract more people into research, but also decrease demand due to higher cost. Regarding working conditions, the policy options focus on elements of protection against discrimination, protection against negative impact from competition and long working hours, gender equality and remuneration packages.

Recruitment and career progression need to become more open, transparent and merit-based in many EU countries. In several cases there is mention of non-transparent or very bureaucratic procedures, lack of merit-based recruitment and promotion processes, 'inbreeding' or even nepotism. In addition to this, rigid career paths and civil servant positions for later-stage researchers result in a lack of (long-term) perspectives for ambitious young researchers. A more general modernisation of HR management at HEIs and research organisations is important to realise OTM recruitment and career progression.

Related to this, but focussing on incoming mobility, **implicit barriers** exist **for foreign researchers**: language barriers for teaching, administration and national grant applications, insufficient support and welcome services, etc. In a set of countries, also xenophobia is said to play a role. Also here, a modern HR management and support services are pathways to improve this mobility and international exchange in general.

A lack of support for researchers can also be a hampering condition. Administrative support e.g. for applications is in several countries very limited or missing. Especially when this is combined with the prevalence of highly bureaucratic procedures, this results in researchers spending considerable time on administrative tasks and less on research. Increasing this support, but also recognising the importance of this profession in the research system, is important to improve the working conditions of researchers, as well as their participation in national and international programmes.

2.3.1. Recruitment

Recruitment, working conditions & career progression
Recruitment • *Lack of open, transparent, clear and merit-based recruitment processes (EL, PT, ES, BG, IT, HR, CZ, SI)* • *Language-related limitations (SI, CZ, EL, BG)*
• *Create fair recruitment processes that reduce e.g. endogamy/nepotism and encourage a more open research system* • *Foster the role of factors related to research quality in evaluation criteria*
Pathways: - Provide sufficient autonomy/flexibility to HEIs for recruitment (SN, ES, PT) - Encourage internationalisation and modernisation of HR policies (PO, CZ, PT: flexibility, RO) - Reduce barriers (e.g. bureaucratic processes, language barriers,…) and encourage OTM recruitment (also of foreign researchers) (CZ, MT, IT, PO, ES, PT, HR, RO) e.g. through advertisement of vacancies on EURAXESS, fair and barrier-free processes, reflection on parallel or rigid (e.g. civil servants) systems, external evaluation committees, etc. - Provide welcome services for foreign researchers (FI, CZ, SK, RO)

One of the most relevant aspects found across countries to foster brain circulation is the implementation of **open, transparent and merit-based recruitment (OTM-R).** In spite of the efforts done in recent years to promote such kind of procedures at policy and institutional level, the cross-country qualitative analysis reveals that it is a factor that still needs to be developed. The gravity model also showed its importance both as (negative) push factor and (positive) pull factor in flows of brain circulation. Some concrete pathways to address this factor were already addressed in the 2014 Study on the open, transparent, and merit-based recruitment of researchers and the report of the ERA-SGHRM Working Group on this topic[27]. Some pathways that were highlighted by interviewees during this study are:

- **Incentivising the advertisement of job vacancies in Euraxess**. There are still many institutions that do not post their vacancies in Euraxess: access to this information is basic for researchers to know which opportunities are available in Europe and create a real EU labour market for researchers. This is especially important if we take into account researchers working outside Europe (EU nationals or foreign) as Euraxess would be the only platform where they can access this information.

- **Lowering barriers for application.** In some countries, endogamic procedures are still frequent and this often translates into job vacancies not being sufficiently advertised (see point above) or set up high barriers for application (e.g. short delays to submit documentation) as a way to prevent competition for the position and ensure that the local candidate gets the position. Establishing minimum requirements for recruitment processes to guarantee an open recruitment would therefore be an option.

- In many countries, **civil servants** constitute the largest part of the researchers staff. Access to this status is often quite lengthy and complex and varies a lot across countries. Reflections on the extent to which current civil servant schemes are adapted to nowadays research environments would therefore be advisable in many countries (see discussion on this topic in the next subsection on career progression). The **introduction of tenure tracks** in the system as an alternative path is also advisable, especially in those systems where access to civil servants schemes is more closed/restricted. The earlier selection processes into academic careers take place, the less time is spent in

[27] https://euraxess.ec.europa.eu/content/open-transparent-and-merit-based-recruitment-researchers-otm-r

uncertainty and fixed-term contracts. This is expected to have a positive impact on reducing brain drain.

- Introduce **external committees for the evaluation of applications for research grants or positions**, such as the procedures followed at EU level for MSCA and ERC grants. This is already done in a number of countries (in Latvia, for instance), although it often depends on the institutions. In some countries, changes to the governance of HEIs where also highlighted as a possible solution to address endogamic dynamics: for instance, moving away from universal or partial suffrage for the election of rectors and deans, incentivising more open and transparent selection processes and introducing more accountability procedures for these positions based on institutional performance.

2.3.2. Career progression and working conditions

Recruitment, working conditions & career progression

Career progression and working conditions

- *Lack of recognition of the research profession and researchers´ career paths (BG, MT, ES, PT, SI, SK)*
- *Instable positions and career paths (IT, ES, FI,EL, PT, SK, HU, CY, BG)*
- *Lack of transparency and objective evaluation and appraisals for career progression (CY, BG, IT, EL, ES, PT, SK, PO, HU, CZ, FI, SI)*
- *Non-competitive remuneration of researchers (CZ, HU, PO, SK, SN, RO)*

- *Create more stable and predictable career progression models based on transparent and objective criteria*
- *Increase the social recognition of researchers and research-related activities*

Pathways:

- Provide sufficient autonomy/flexibility to HEIs for evaluation (SN, ES, PT)
- Encourage internationalisation and modernisation of HR policies (PO, CZ, PT: flexibility, RO)
- Deployment of the European Competence Framework for Researchers to structure (international) career guidance (PT), including for alternative career paths, and to create awareness both at the demand (employers) and supply side (researchers)
- Reflection on parallel or rigid (e.g. civil servants) career systems
- Provide career guidance (ES, CZ, FI, SK, PT)
- Provide training for diverse research careers (cf. 'research environment')
- Improve precarious working conditions of R1-R2 researchers (cf. WP7; SN, PO, FI, LV, LT, RO)
  - Balance offer and demand in the research labour market (ES, PT)
- Improve remuneration of researchers (CZ, HU, PO, SK, SN, RO)
- Value/Reward international mobility and return (ES, BG, PT, RO)
- Value intersectoral mobility (BG)

- **The controversial role of remuneration in explaining brain drain**

Many countries indicate non-competitive remuneration as an important point in explaining brain drain. While nominal salaries in euros can be quite different, WP7 of this study also finds that accounting for difference in purchasing power reduces thes differences. However, in choosing jobs, researchers may rather compare nominal salaries as flagged in job advertisements than salaries adjusted for dfferences in purchasing power. The MORE studies further illustrate that, all else equal, academic researchers tend to attach more importance to the quality of their research environment and working conditions than to remuneration as such when deciding to become internationally mobile: key is working with leading scientists, clear career prospects and research autonomy. Research funding and the balance between teaching and reserach also play a role.

While a path towards cross-country convergence is desired, the findings of this study point at the fact that, once a minimum acceptable level is reached, remuneration might not be a key factor behind brain drain, at least for academic researchers, if the conditions for research are good. It is a factor that might play a role when trying to attract researchers

based abroad (foreign or national researchers) who might opt for destinations where they have a higher remuneration. For early career-researchers, access to full-time employment contracts, including pension and social security (against precarious conditions) are also important factors in their decision.

To increase salaries of researchers, we refer to WP7 which lists several options. When grants are used to top up salaries, an example given in Hungary in the context of brain drain illustrates the tensions that need to be accounted for when designing measures in this regard. In Hungary, a scheme provides salary top-ups for excellent researchers who won grants. This implies that some of the research grants and e.g. the return mobility scheme have the feature to not just provide, but also top-up salaries for the grantees. This is a cost-effective way of paying at least some researchers higher salaries; however, interviewees also pointed to the tensions at the individual level such schemes can create within research institutions or universities, when some researchers earn considerably more than their colleagues. They may also make governance of institutions harder, when such grants confer a special status to the grantees which insulates them from institution wide policies or reforms.

- **Developing and deploying an EU Competence framework for researchers**

There are three important ongoing trends that suggest the need for a competence framework for researchers. First, the fact that considerations on career assessment are in general moving away from the focus on publishing to include a broader set of elements reflecting the main missions of universities (teaching, service to society) and reflecting better the diversity of career paths: some researchers might create spin-offs, others devote more time to teaching, others put more efforts in science communication, etc. Second, at the same time, the share of PhD holders who manage to stay in academia is very low and they need to be well-prepared for other occupations. Third, research nowadays is becoming increasingly complex and new profiles for researchers are emerging – data scientists, knowledge brokers, etc. The competence framework for researchers would constitute a shared understanding of the skills and competences that researchers need over their career. This framework would potentially:

  - Facilitate the move to other occupations/sectors;
  - Help researchers be more aware of the competences they have and the ones they need to work on;
  - Help institutions to map skills with their researchers in order to offer the necessary skills (e.g. by recruiting specific talent, by increasing the offer of trainings in specific skills, etc.);
  - Be used for inspiration in order to account for other facets of researchers and their performance in evaluation and appraisals for career progression (and hence contribute to move away from the pressure to publish).

The widespread use of such a framework would also facilitate international mobility, as institutions and researchers would have a common inspirational tool (i.e., respecting national competences and institutional autonomy) on which they can base their choices.

- **Introducing more flexibility in the researchers´ career paths in some countries: towards the unification of career paths of researchers and lecturers/professors**

The existence of **parallel career tracks for researchers and lecturers/professors in some countries** is assessed by many stakeholders as a factor hindering the attractiveness and flexibility of the research profession. In these countries, professors and researchers, or researchers in different parallel systems, often do not have equal remuneration, working conditions or legal statuses (SL, ES, LV, RO). In Romania for instance, there is mention of a discrepancy between the salaries of professors and those of the rest of the academic professions, creating a barrier for institutions to promote researchers to a -for them more expensive- professor position. Duplication of tracks with different conditions is to be avoided. Offering the possibility of more flexible careers combining research and lecturing

over a research career tends to be assessed as having a positive effect on making the research career more flexible and predictable at the same time: this option will give the individual researcher (and the institutions) a greater room for manoeuvre to adapt to the positions and their evolution to the needs.

The unification of researchers and lecturers´ career paths would also alleviate the inequality between both groups in some countries. In Slovenia, for instance, researchers employed in public institutions need to secure additional funding from national calls to secure 100% of wages. There is a lumpsum wage for teaching activities that can cover up to 100%, but there is not a similar approach for research. This makes working conditions for researchers less attractive than in other European countries where researchers´ remuneration is not so much dependent upon additional funding for research projects.

Interviewees indicate that addressing this issue would require an important structural reform and large policy efforts at MS-level. At the same time, EU-level initiatives like the Competence Framework for Researchers and the Research Careers Framework provide inspirational frameworks for a more flexible career and competence path with a solid common reference base.

- **Introducing more flexibility in the researchers´ career paths: rethinking the role of civil servant statuses in research**

The use of the civil servant regulation in the research domain in some countries (e.g. SI, IT, ES) is put under question by many interviewees. The rigidity associated to this system is seen as a barrier for the attractiveness of the system, and in particular to reducing precarity in research careers. The OECD paper on reducing the precarity of academic research careers[28] states *"There are concerns about the lack of employer flexibility associated with civil servant status and tenured positions, and dual labour markets are emerging as institutions avoid giving highly protected contracts to younger researchers."*

Access to a civil servant position needs to be granted on the basis of objective merits. Recruitment processes that are common in other settings, such as having an interview with the candidate for a position or the use of peer evaluations are not usually foreseen in the legislation. Several pathways are mentioned to address the rigidity of civil servant statuses:

- Adapting the procedures of access to civil servant statuses in research and introduce more flexibility to account for profiles with different backgrounds (international, intersectoral, etc.). A good practice of the definition of specific procedures for researchers can be found in Belgium: researchers, while remaining subject to civil servant status, are recruited, evaluated, paid and promoted under different rules than civil servants from other sectors[29].
- Abandoning the civil servant scheme for staff employed in universities and research institutions and turning it into open-ended contracts depending on a positive and regular evaluation of performance.
- Introducing parallel systems. In Spain, in parallel to the national civil servant scheme, one can find parallel systems for long-term stable contracts such as those created by the Catalan region (ICREA) or the Basque Country (Ikerbasque).

Changes in institutional organisation can also be a pathway to make research environments and career progression more attractive. In this sense, as it is highlighted by WP7 of this study, moving from highly hierarchical models towards flatter department-style organisational models can be beneficial. This would entail the change from models where there is one permanent professor at the top (chair-based model) to a situation where there

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[28] OECD (2021). *Reducing the precarity of academic research careers*, OECD Science, Technology and Industry Policy Papers May 2021 Nº 113.

[29] ERAC Peer Review of the Spanish Research and Innovation System (2014) https://www.mineco.gob.es/stfls/MICINN/Prensa/FICHEROS/2014/140801_final_report_public_version.pdf

is a higher share of permanent contracts as full professors working in less hierarchical models.

2.3.3. Support for research

Recruitment, working conditions & career progression

Support for research

- *Lack of support staff for research (ES, PL, BG, HR, CY)*
- *Administrative burden hampering researchers´ activity (SK, PL, ES, EL)*

- *Increase the attractiveness of the research profession by limiting the administrative burden and increasing the support for research, thus creating more time for research*

Pathways:
- Strengthen administrative and support services for researchers (IT, PO, RO, CZ, ES, HR, CY (training)) and make sure support services profession is recognised and valued (HR)
- Reduce bureaucracy e.g. for grant applications, recruitment, recognition of diploma's, buying equipment, etc. (cf. 'system-level factors for R&I')

One of the mechanisms through which the research profession can be made more attractive in some countries refers to the **extent to which researchers can devote time to do research**. In many cases, the qualitative analysis indicates that researchers have to dedicate too much time to other tasks that, while necessary for research, would be better developed by staff specialised in them (e.g. research managers or administrators or experts of the HR and financial departments). Tasks like support with administrative procedures and project management, budgets, purchase of research material and even part of personnel management can be carried out by other profiles. As mentioned above, this should go hand in hand with a reduction of administrative barriers to evolve towards an effective and efficient support system.

Beyond the more administrative tasks, researchers can also be offered more **technical support**. The introduction of research support profiles specialised in specific techniques or methods - e.g. data analysts, etc. - that can help several research groups is an interesting way forward to consider.

Finally, there is also the consideration **that researchers´ careers do not necessarily need to be linear** – e.g. from R1 to R4. Researchers might also be interested in working for other researchers: the result would be the availability of highly experienced support staff and an increase in the offer of research support to other researchers. The role of research managers or administrators is found to evolve as research is becoming more complex, and thus to attract more candidates with research-level qualifications and experience (e.g. with knowledge of open sciences, equality, gender, diversity, public management, etc.). Academic training of these profiles further helps to establish good practice and professional standards in this field.[30] These are points that are in turn expected to have a positive impact on the research quality. The investment and promotion of this research support staff is also related to the **diversification of researchers´ careers**. This emerging topic requires, on the one hand, more flexibility in the career options, not only to better respond to researchers´ need but also to the needs of nowadays research. On the other hand, for this diversification to develop optimally more awareness (and training) would be needed to be able to navigate across these options.

[30] As stated in: Research managers are essential to a healthy research culture, Nature 595, 150 (2021), https://www.nature.com/articles/d41586-021-01823-0.

2.4. Research excellence

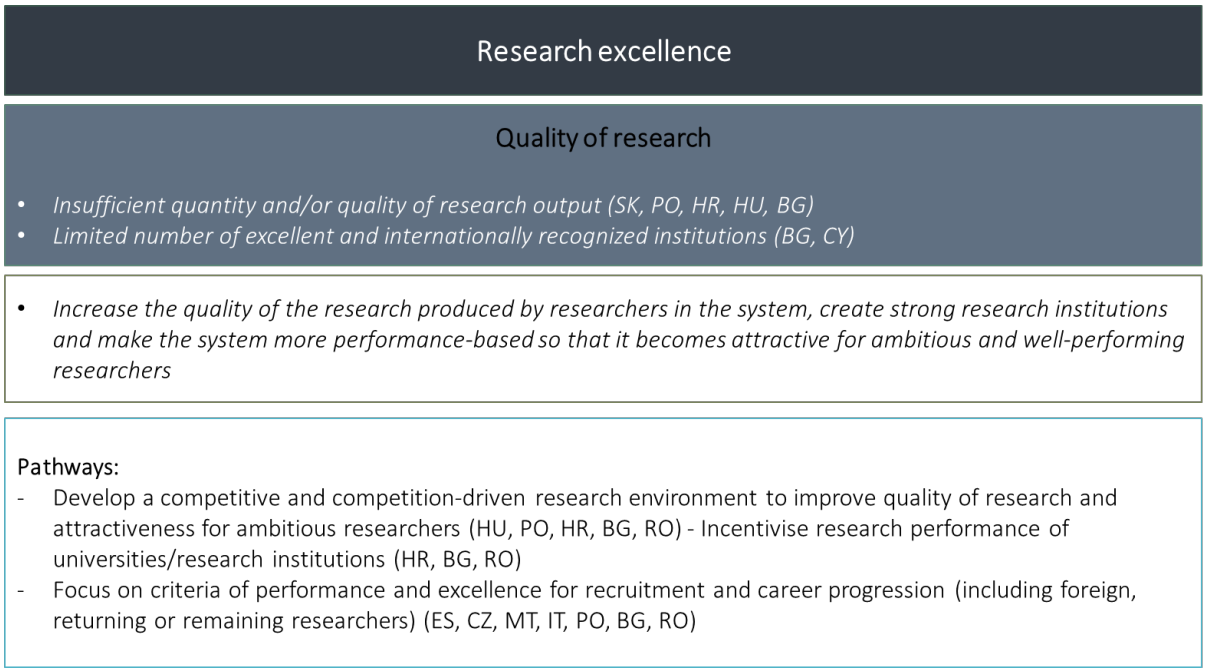
Overarching findings

Several of the pathways described above directly or indirectly encourage research excellence: the development of a complete knowledge ecosystem, recognition of the research profession and modernisation of HR management in HEIs and research organisations, etc.

One pathway to mention here explicitly is the **development of a more competitive research environment.** A few cases mention the lack of a competitive research environment as an important factor explaining why some of the more competitive and ambitious researchers leave the country. A more competition-based practice implies implementing competitive funding and recruitment practices based on criteria of excellence, (international) merit, etc.

Related to this, the development of **international collaborative networks** is a pathway to improve knowledge exchange across Europe, to foster the quality of research and to enhance the access to competitive international funding. In several countries, this pathway plays an important role given the large size of the diaspora of (top) researchers working abroad as a consequence of earlier periods of brain drain. This international dimension and the expected impact on competitiveness and quality of research is expected to contribute positively to the attractiveness of research careers.

2.4.1. Quality of research

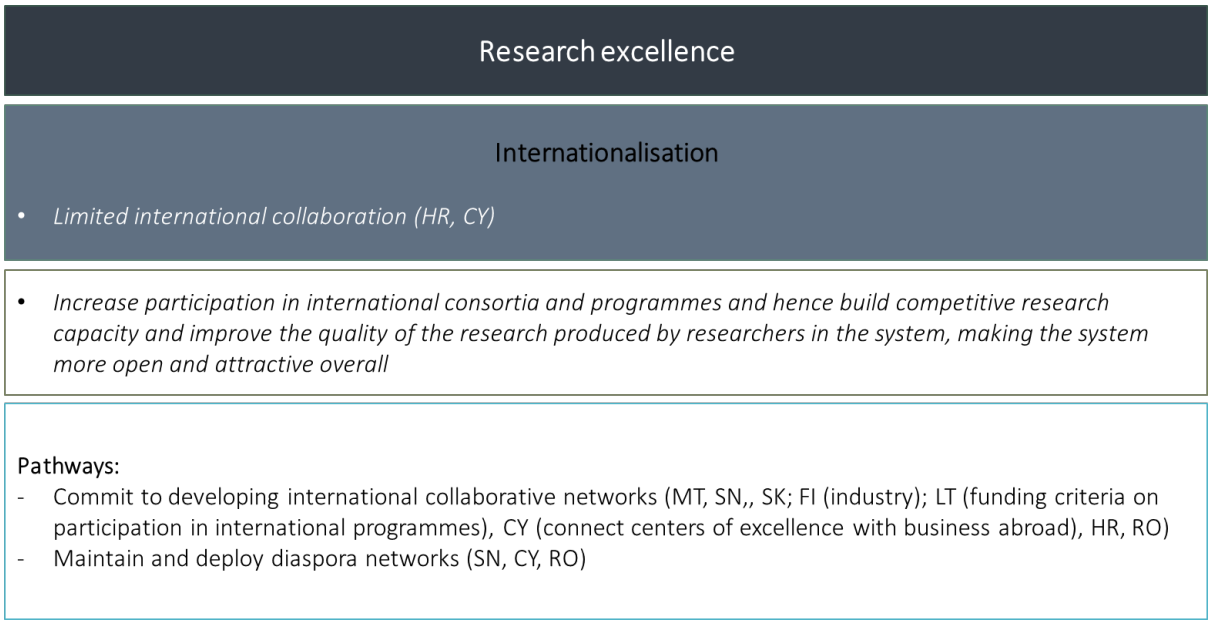


The quality of research is an important factor for the attractiveness of research systems. Several interviewees stressed the need to develop a competitive and competition-driven research environment in order to improve this quality and to retain or attract ambitious and well-performing researchers. Ways to encourage this include introducing performance-based evaluation criteria for individual researchers as well as for universities or research organisations.

Recruitment and evaluation of researchers are touched upon in the section on recruitment, working conditions and career progression. Regarding the institutional level, **performance-based evaluation** goes hand in hand with **allocating part of the institutional funding depending on this research performance**. In many cases, universities receive their public income only/mainly on the basis of the input factors, such as number of students. By adding a component of quality in the institutional funding, excellent research would be promoted. A recent mutual learning exercise (MLE) on

performance-based funding of university research[31] concludes that, depending on the specific needs of the university research system, states should consider adopting a performance-based research funding system (PRFS) or an appropriate alternative if the national university system's research performance is in need of improvement. At the same time, the summary report of this MLE lists a number of risks related to PRFS, that should be taken into account in the policy decisions, design, implementation and regular evaluation of the system. Another way to incentivise performance is by a larger share of project-based funding – an ex ante mechanism, as research proposals are screened for their quality before the research is actually undertaken. Both allocation mechanisms have advantages and disadvantages and need to be implemented carefully, taking account of the wider research environment. This kind of pathways may require structural reforms at national level, in order to create **strong research institutions that promote research excellence**. As mentioned before, in the section on the RDI system, resistance to change is to be taken into account in this kind of reforms.

2.4.2. Internationalisation



The development of **international collaborative networks** is an important pathway to improve international collaboration. Access/commitment to international collaborative networks increases the participation in international programmes and strengthens research capacity. By this, it strengthens the research system and improves relevance and quality of the research output. One way to encourage this, is to include participation in international programmes in **funding criteria**, or to provide **platforms** to connect with actors abroad. Also more generally, investing in **international collaboration and mobility funds** (cf. section on research environment) are expected to stimulate international collaboration. Member States can also explore synergies with EU-level instruments (for instance, the collaborative projects in Horizon Europe requiring international collaboration or the COST scheme encouraging international exchange activities). As described in the section on research environment (return mobility), the deployment of **diaspora networks** also offers opportunities for stronger international networks and collaboration. Internationalisation in general allows to develop a more open research system and gain access to international researchers and knowledge, and by this will contribute to the attractiveness of research careers in a country.

An **example** of a programme **focusing on internationalisation**, was given in Poland. The Ulam NAWA Programme aims to increase the internationalisation of Polish institutions

[31] Performance-Based Funding of University Research: Summary Report. (2018) Mutual Learning Exercise - Horizon 2020 Policy Support Facility. https://op.europa.eu/en/publication-detail/-/publication/ea777219-79b8-11e8-ac6a-01aa75ed71a1

of science and higher education. The Programme will allow both recognised and promising scientists who hold at least a doctoral degree, to visit Poland in order to strengthen the scientific potential of Polish entities and to participate in their scientific activities, primarily research projects and didactics. The Programme will allow to invite scientists regardless of their age, from all around the world and representing all fields of science, including Polish scientists working permanently abroad (they may constitute a maximum of 10% of Fellows in the call). HEIs, scientific and research institutes will have the opportunity to invite specialists from their priority areas to Poland – they will make a significant contribution to the research conducted by a given institution, strengthen didactics or support the institution in applying for prestigious grants. There is no evidence (yet) of the success of the programme.

Another **example** of a programme that aimed to connect the scientific research community in the country with the diaspora abroad, and to encourage international mobility and cooperation more generally, was the Unity through Knowledge Fund (UKF) in Croatia (cf. also section on research environment). This example **demonstrates the impact of a programme aimed at internationalisation on research performance**. The comprehensive programme had three tactic goals: to support research that is competitive and international, that creates new values in Croatian economy and to support projects that help the development of research infrastructure in Croatia. There is evidence of an important impact in terms of participation in competitive research programmes: in the first wave, UKF-accepted projects proved to be more successful in attracting resources from FP7 than other projects in Croatia. Also, scientific output in terms of publications, peer reviewed publications and impact factors of the journals of these publications, was measured and assessed positively. Interviewees mentioned it was recognised as good practice by the World Bank, by the International Labour Organisation and by the Croatian science community, mainly because the programme generated an impact on competitiveness and collaboration with diaspora. Key success factors highlighted by interviewees were its independence, transparency, clear framework, focus on quality and focus on young researchers to address their precarious positions.

3. Identification of pathways at EU level (and other synergies)

During interviews with country experts and stakeholders, a number of synergies or policy options at EU level were identified. Interviewees in different countries point out that achieving a balanced brain circulation is a common challenge in all EU countries, with the need to keep European research on par with other regions. Some interviewees mention that, even though large outflows from East to West exist within Europe, as well as globally e.g. from Europe to the US, there are also opportunities to attract researchers from other regions to Europe, e.g. India. Yet most interviewees agree on the importance of adddressing the heterogeneity across European Member States to develop a more balanced brain circulation within Europe. We focus the discussion in this section on this dimension.

Below, we summarise the main options mentioned during interviews and the validation workshop, including first reflections by the research team. Further elaboration of policy options at EU level will be included in the policy brief.

- **Develop a shared framework for monitoring brain circulation within and from Europe**

  - In almost all cases, there is a mention of the lack of sufficient or sufficiently detailed data to monitor the situation. In some cases, it is even unclear whether, where and to what extent brain drain is an issue. In order to monitor the situation, as well as the impact of the different actions implemented, data registration/collection at MS and EU level (and in some cases regional level) are needed.
  - This data collection would need to be carried out with a certain regularity over time to assess the evolution and the possible impact of policies. Next to the geographical location of employment, the data would need to cover at least the nationality of researchers, career stage, sector of employment and type of position. It is important

to develop a shared framework for monitoring, with common standards and definitions.

- In that regard, including career stages (e.g. as defined in the Research Careers Framework) as dimension in the monitoring would allow to monitor conditions and evolutions at each career stage and collect evidence to feed further research and evidence-based policy on (diverse) career paths and selection points, parallel systems, etc.
- Also better tracking of careers of researchers that work outside of academia (i.e., on their career paths, challenges, working conditions, etc.) is mentioned as an EU-level pathway to better inform the research community and policy makers on these types of research careers.
- Data can be brought together for monitoring and interpretation at EU level. At this level, a comparative analysis of brain circulation flows (both within the EU and towards other regions in the world) is possible and will provide valuable evidence to inform policy makers addressing brain drain issues. This kind of data will also allow to assess the positive as well as negative impacts of EU funding on brain circulation and on the career paths of researchers.

- **Encourage a coherent approach across the EU to develop attractive careers for researchers**

  - Although initiatives are taken, e.g. with the development of the HRS4R and Charter & Code, interviewees see more opportunities for encouraging a coherent approach across Europe, focussing on the attractiveness of the European Research Area in terms of attractive and diverse career paths for researchers.
  - One aspect is the need to make scientific careers more predictable, stable and secure (less precarious). The implementation of open, transparent and merit-based recruitment processes plays an important role in this respect, e.g. to increase the predictability of being able to enter or progress in a research career based on merit-based indicators, keeping the best performers in the system while at the same time offering alternatives to those who do not meet the criteria or have other interests to deploy their competences.
  - Another aspect is the promotion of skills and competences in the career progression of researchers (related to lifelong learning and e.g. moving away from models where merits are evaluated almost exclusively on the number of publications), e.g. through the introduction of the European Competence Framework for Researchers to structure recruitment, career guidance, training offer, etc. This framework can also have a positive impact as well on fostering international or intersectoral mobility and on diverse career paths.
  - Incentivising the advertisement of job vacancies in Euraxess was mentioned as a pathway at MS-level towards the national and regional stakeholders, but can be further encouraged also at EU-level towards the MS. The activities of the EURAXESS network are important to further guide researchers towards the relevant information or services. Access to information on vacancies and career opportunities is essential for researchers to know which opportunities are available in Europe and to create a real EU labour market for researchers. This is especially important if we take into account researchers working outside Europe (EU nationals or foreign) as Euraxess would be the only platform where they can access this information. In relation to monitoring, it would be interesting to link vacancies to career stages as defined in the Research Careers Framework and to competences defined in the Competence Framework for Researchers (currently under development).
  - Another aspect is to promote a better connection between RDI evaluation systems (e.g. funding) and HRM practices at individual level. This request is related to a need for transparent and coherent evaluation criteria on the one hand, and synergies between evaluation at EU and MS level on the other (e.g. like in the Seal of Excellence principle). The inspirational role of frameworks for evaluation (EU-level but also good practices from other countries) is important to inspire policy change and eventually unblock resistance to change.

- We further refer to WP7 for recommendations related to improving working conditions and remuneration of researchers, and in particular those addressing precariousness of research careers for early-career stage researchers.

- **Coordinate the exchange of practices**

  - In some cases, a need was expressed to communicate more on practices and examples, to have open discussions on policy options, etc. (e.g. on examples like entrepreneurial universities). A closer connection, communication and exchange is needed between all actors in the EU ecosystem in order to understand each other and learn from each other, and in particular to encourage the understanding and uptake of coherent approaches as mentioned in the previous point.
  - A specific example was given in the context of return mobility, with researchers facing difficulties in some cases to be accepted and consolidated in the system. Where such cultural change is needed, this should be stimulated locally, but the process can be supported at EU-level through e.g. promoting institutions that have achieved success in this regard as good practices to inspire change elsewhere.

- **Build on the strengths of MSCA/ERC/Horizon Europe and other EU-level funding**

  - First, the EU-level funding for research, in particular the MSCA and ERC grants and the overall Horizon Europe framework programme, are regarded as essential pillars for the functioning and advancement of the ERA. Interviewees find that this type of funding allows to **increase capacity, encourage collaboration and mobility, and foster excellence** across Europe.
  - Second, interviewees also mention the **capacity of these funding programmes to streamline** actions among shared ideas, and to encourage implementation of HR practices. They set a framework for funding modalities and criteria, as well as good practices in terms of evaluation. It can be further researched how to communicate on role models with regard to, for instance, implementation of good HR practices or the promotion of intersectoral mobility.
  - One point raised by several interviewees, was the perception that EU programmes (MSCA-ERC) apply too heterogeneous **remuneration levels** across countries, for MSCA sometimes combined with differences in taxation of the mobility part of the grant. It is important to note that, in the context of brain drain, interviewees are comparing wages across countries and not with other sectors in the home country. As this point came up several times, it is worth further research to assess the role of remuneration (and perception thereof) in this context, taking into account the findings of WP7 of this study, as well as the ongoing MSCA-study on brain drain.
  - It is key to encourage broader participation of research groups in international collaborative networks in this context, in order to spread and further stimulate excellent research across Europe. The integration of less-known research groups in international collaborative networks, based on criteria of quality, is important to develop **broader and stronger capacity across Europe**.

    To foster research excellence as well as a broader participation in international collaborative networks, it is first important to ensure an **objective and bias-free evaluation process** for competitive funding at both national and EU-level, which focuses on capacity and ideas as selection criteria instead of previous project participations or reputation, thus enabling an open and broad participation within the framework of excellence.
  - Second, as support for international mobility in these programmes can have an influence in increasing brain drain (when excellent researchers have more mobility opportunities to move to excellent research institutions), the EU can further support lagging countries to catch up in a more structural way. A lot is done in this respect with the initiatives taken to encourage participation of actors from **Widening countries**, in particular regarding institution building (Teaming), institutional networking (Twinning), developing the context for research excellence (ERA Chairs)

and cross-border scientific network for access to European and international networks (COST)[32]. In Horizon Europe, new initiatives are developed/expected as well under the pillar of Widening participation and strengthening the ERA[33]:

- Hop On Facility to offer institutions from Widening Countries the possibility to join already selected collaborative R&I actions. Main selection criteria are excellence and added value of the new partner performing a relevant additional task in the project;
- European Excellence Initiative to strengthen the capacity for excellence in HEIs and surrounding ecosystems – linked to the European Universities Initiative;
- Excellence Hubs, the innovation component, to strengthen regional innovation excellence in placed based innovation ecosystems by cross-border collaboration on a common strategy and/or alongside value adding chains. The aim is to foster a real placed based innovation culture in widening countries, based on a strategic agenda aligned with regional or national smart specialisation strategies.

As with other instruments, specific attention needs to go to the longer term integration and consolidation of collaborations and networks.

– **Other synergies** for supporting structural change are mentioned by interviewees with ERASMUS+ funds (travel abroad, exchange between professors and researchers,…), ESIF, in particular ESF+ (investing in human capital, both at earlier education level and PhD level,…), Cohesion Funds (make society more green and competitive), the Policy Support Facilities (PSF, provides good practice, independent high-level expertise and guidance at the request of Member States), the Technical Support Instrument (TSI, offering technical support to reforms), etc. This pathway was confirmed during the validation workshop, where the **importance of structural change and reforms** was emphasised in order to reduce heterogeneity between Member States in terms of attractiveness of the research and living environment and, by this, to foster a more balanced talent circulation between countries. Synergies further consist in linking with the Smart Specialisation Strategies and European Regional Development Fund. In the context of the European Universities[34] initiative, efforts could be made to foster the flows of scientific knowledge and personnel across countries and sectors. **Awareness raising on these synergies is important to make them visible and accessible for all**.

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[32] **Teaming** actions help setting up or developing centers of excellence in Widening countries (institution building), linked to a leading scientific institution (https://ec.europa.eu/programmes/horizon2020/en/h2020-section/teaming).

Twinning actions aim to strengthen specific fields of reserach in emerging institutions in Widening countries by linking them to at least two internationally leading counterparts in Europe (institutional networking). These actions support short-term exchange, expert visits, training, workshops, conference attendance, dissemination and outreach (https://ec.europa.eu/programmes/horizon2020/en/h2020-section/twinning).

ERA Chairs projects focus on bringing outstanding academics to universities and research institutions in Widening countries with potential for research excellence. The aim is to attract and maintain high-quality human resources under the direction of this ERA Chair holder as well as to implement structural changes to achieve excellence on a sustainable basis (https://ec.europa.eu/programmes/horizon2020/en/h2020-section/era-chairs).

COST actions help connect research initiatives across Europe and beyond and enable researchers and innovators to grow their ideas in any science and technology field by sharing them with their peers. COST Actions are bottom-up networks with a duration of four years that boost research, innovation and careers (https://www.cost.eu/).

[33] Cf. Horizon Europe Work Programme 2021-2022 - 11. Widening participation and strengthening the European Research Area. European Commission Decision C(2021)4200 of 15 June 2021 (https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2021-2022/wp-11-widening-participation-and-strengthening-the-european-research-area_horizon-2021-2022_en.pdf)

[34] https://ec.europa.eu/education/education-in-the-eu/european-education-area/european-universities-initiative_en

- Several of the above-mentioned grants at EU-level foster intersectoral exchange. In addition, the role of the EIT in terms of human research capacity building can be further communicated (e.g. the **HEI initiative** 'Innovation Capacity building in higher education institutes' aiming to *"increase HEIs' entrepreneurial and innovation capacity whilst integrating them into Europe's largest innovation ecosystem"*[35]).
- Several Member States have implemented or are exploring complementarity of national funding with EU-level funding according to the concept of the **Seal of Excellence**. Positively evaluated applications for e.g. MSCA or ERC grants, that are not funded at EU-level, can automatically receive national funding without new evaluation. This way, Member States can build on the international evaluation practice and fund high-quality research, fostering excellence in the country.

[35] New EIT initiative launched to boost innovation in higher education | EIT (europa.eu)

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This analytical report is part of a series of reports on “Brain circulation and intersectoral mobility” of the wide-scoping study “Knowledge Ecosystems in the new ERA”. The overarching study addresses the need for a strengthened European Research Area (ERA) by enhancing the Knowledge Ecosystems across Europe and their interconnections.

The report builds upon the work conducted in WP8 “Mapping brain drain and contributing to solutions”. It provides detailed findings of a mapping of talent circulation in the European Union and its Member States, a comprehensive account of the causes of brain drain, and it identifies evidence-based solutions that are sustainable in the long run to increase the attractiveness of research careers in the Member States suffering from brain drain.

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