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Indicators on researchers' career and mobility in Europe: a "modelling" approach

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Abstract

This paper presents the "modelling" approach followed by IPTS to construct new and original indicators on researchers' career and mobility. Indeed three main problems have been identified in the existing statistics on researchers: lack of data at the EU level on different issues, lack of comparable and harmonized data between EU countries and long delay in obtaining statistics when they exist. To deal with these problems, the strategy consists in filling the gaps in the EU and national data, building proxies when robust data are not available, carrying out new ad-hoc surveys and estimating and extrapolating the results at the EU level when necessary and feasible. The general methodology of this approach is first presented. Then, three examples are developed to illustrate the interests and benefits of this approach in terms of results, but also the difficulties and problems that may exist. The three examples are the following: i) Nocasting/forecasting the number of researchers. ii) The international mobility of researchers and engineers in the EU25; iii) The career and mobility of doctoral candidates and postdoctorates in life sciences in Europe (and a comparison with the US);

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Table of contents

1 Introduction

The European Research Area (ERA) aims at creating a common science and technology base in the European Union and at strengthening scientific excellence, competitiveness and innovation through the promotion of better co-operation and co-ordination between R&D actors, and in particular between the researchers at the core of the system. Within this context the European Union institutions recognise the need of establishing the framework conditions in order to attract and to retain well-trained and highly-motivated researchers. Creating a real European labour market for researchers is a key element of the ERA strategy.

In this context, the lack of adequate statistics on researchers, and more generally on the human resources available for innovation, science and technology in Europe, is impeding the understanding of the nature and scale of the phenomena of brain circulation across countries, regions, sectors and professions and the implementation of appropriate measures for the implementation of the ERA strategy. In fact, an ideal database encompassing complete, harmonized and comparable data on researchers does not exist in Europe yet.

Therefore, the Institute for Prospective Technological Studies (IPTS) of the European Commission's Joint Research Centre (JRC) is developing an information system on researchers' stocks, mobility and career. It appears that a set of indicators are required to support the design of policies for matching the supply and demand of researchers, their mobility and more generally the development of research careers, at European and Member State levels. The approach followed by IPTS consists in developing specific methods based on estimation and "modelling" techniques to construct such new indicators with the available, although scattered data.

This paper presents the "modelling" approach and develops three examples illustrating the interests and benefits of this approach, but also the difficulties and problems that may exist.

The remaining of this paper is organised as follows.

Section 2 briefly presents the aim and general methodology of the "modelling" approach.

Section 3 presents the first example which provides results on nowcasting/forecasting techniques applied to the number of researchers in the EU, based on Eurostat-OECD-UNESCO data.

Section 4 shows and discusses the results of a study on the international mobility of researchers and engineers in the EU25 (the second example), which is based on results of national Labour Force Surveys of a few countries.

Sections 5 develops the last example related to the career and mobility of doctoral candidates and post-doctorates in life sciences in Europe, which combines statistics from Eurostat and from an ad-hoc survey commissioned by IPTS for Europe, and NSF data for the US.

Finally, Section 6 presents our first provisional conclusions.

2 The "modelling" approach: aim and methods

Three main problems have been identified in the statistics on researchers' mobility and career:

- Lack of data at the EU level on many subjects.
- Lack of comparable and harmonized data between EU countries.
- Long delay in obtaining these data when they exist.

To deal with these problems, a "modelling" approach has been adopted at IPTS that consists in developing specific estimation and modelling techniques to construct new and original indicators on researchers' career and mobility.[1] More precisely, we try to fill the gaps in the EU and national data, to build proxies when robust data are not available, to carry out new ad-hoc surveys when essential and to estimate and extrapolate the results at the EU level when necessary and feasible. Three main steps can be distinguished.

The first step has consisted in identifying existing data sources. It has been based on an inventory and analysis of about 100 data sources in nine European countries. These sources can be classified in five main categories:

- Labour Force Surveys (LFS).
- Registers
- Graduate surveys.
- Other national surveys, studies or research (e.g., on a university, a research centre, a sector, a specific pool of graduates).
- Other national and international data sources and surveys (e.g., R&D surveys, CHEERS survey, Eurostat-OECD CDH survey, US NSF SESTAT system).

The second step consists in collecting new data when data on critical aspects of researchers' career and mobility are not available or to address new specific questions not covered by "official" statistics on HRST. Pilot ad-hoc surveys have been (and will be) carried out. The primary aim is to test the feasibility of new collection methods. However, the provision of new critical results on specific aspects of careers and mobility, on specific populations (e.g., junior/senior researchers, fields) and on a limited scope (e.g., geographical coverage, snapshot) is not negligible.

The "modelling" approach itself constitutes the third step. It is based on the following main elements, even if not all these elements are necessarily valid in each case:

- Harmonization of data.
- Synthesis of information.
- Approximation and estimation.
- Extrapolation at the EU-25 level.
- Now-casting and medium-term forecasting.
- Assessment of the quality, reliability and pertinence of results.

[1] The indicators combine by definition several factors to build an overview, a simplification in one dimension of a complex multidimensional reality.

3 Example I: Nowcasting the number of researchers

The aim of this section is to present results on nowcasting/forecasting the number of researchers for the period 2005-2007, i.e. evaluating the current values and the evolutions of the number of researchers in the near future on the basis of available information, as official data are delayed for a few years.

The method consists in estimating basic econometric models with GDP and/or a trend as explanatory variables. The variable GDP captures the impact of general economic conditions. GDP was chosen as it is forecasted on the next two years and thus can be used to nowcast the number of researchers.[2] The trend variable is intended to capture the exogenous component in the number of researchers.

3.1 Data and estimation techniques

Three models have been estimated:

Model 1: $RES_t = \alpha + \beta GDP_t + u_t \quad u_t \sim N\left(0;\sigma^2\right) \quad t = 1995\ldots2004$

Model 2: $RES_t = \alpha + \beta GDP_t + \delta t + u_t \quad u_t \sim N\left(0;\sigma^2\right) \quad t = 1995\ldots2004$

Model 3: $RES_t = \alpha + \delta t + u_t \quad u_t \sim N\left(0;\sigma^2\right) \quad t = 1995\ldots2004$

where RES is the number of researchers (HC)[3], GDP is the gross domestic product at constant prices (index 1995 = 100), t is the year, u is the error term, α, β and δ are the parameters to estimate.

These models have been applied to the total number of researchers, to the number of researchers in the different sectors taken individually (HE, GOV, PNP, BES) or grouped (total for HE-GOV-PNP).

Data on the number of researchers come from Eurostat/OECD/UNESCO database.[4]

Model 2 is our "central" model. It is generally preferred to the other models as its quality has proven to be higher, except in some cases when HE, GOV and PNP were considered separately.

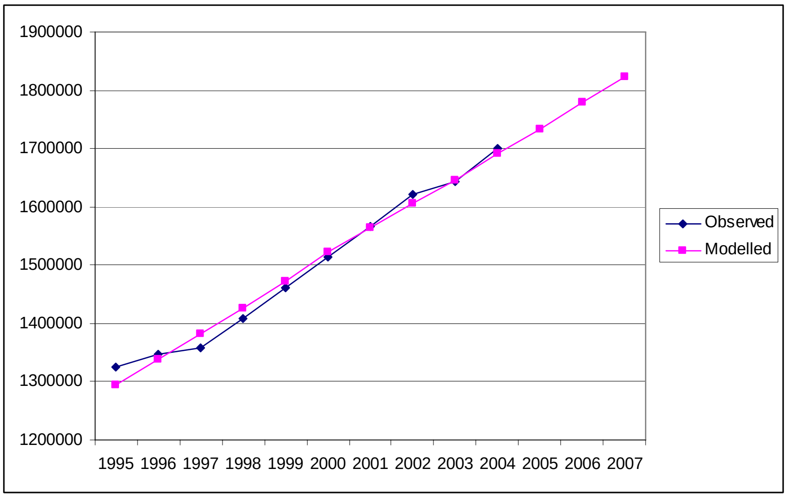
3.2 Some results

3.2.1 The total number of researchers

[2] To the contrary of R&D expenditures for example, which may have been more relevant but are generally not forecasted (and more, they are generally subject to delays as well), and thus can't be used for our purpose.
[3] Other models have been estimated on FTE data. The results are very similar and could be approximated very closely by a multiplying factor.
[4] These data are based on national definitions. Country differences do exist in the population of researchers covered by them, notably as far as doctoral candidates are concerned.

According to our estimations, there will be about 1.82 million researchers HC in the EU25 in 2007. The increase will be about 7% from 2004 to 2007, which corresponds to about 120,000 more researchers.

Figure 1. Total number of researchers (HC) in the EU25, observed and estimated (1995-2007)

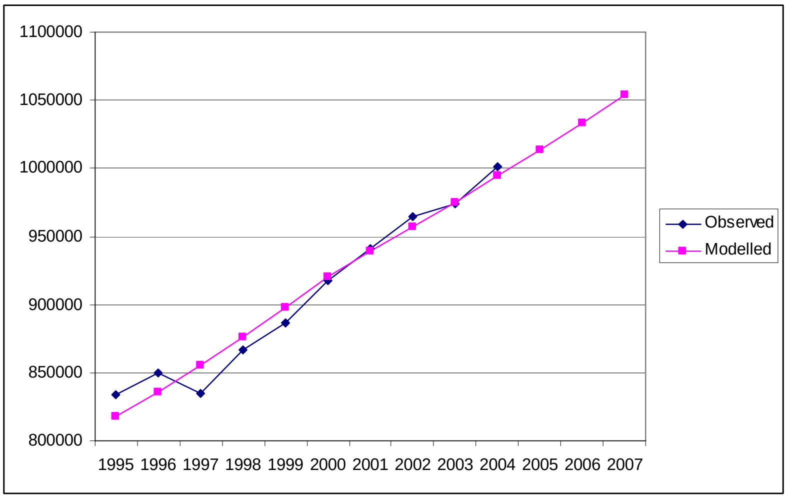


Source: IPTS. Estimations based on the central model.

3.2.2 The number of researchers in HE, GOV and PNP

The number of researchers in higher education, government and not-for-profit sectors is estimated to be about 1 million in 2007, an increase of about 5.2% from 2004 (an increase in the absolute number of researchers of about 50,000 researchers).

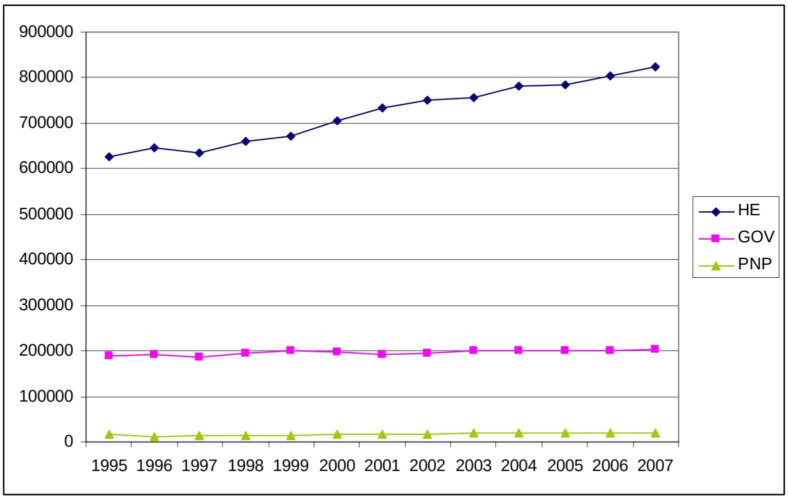
Figure 2. Number of researchers (HC) in HE, GOV and PNP, in the EU25, observed and estimated (1995-2007)



Source: IPTS.

When separated estimations are done for HE, GOV and PNP – the models are less satisfactory however and the nowcasts are more uncertain – we find that nearly all the growth in the number of researchers from 2004 to 2007 would be concentrated in HE sector (this was the case as well on the past) whereas the number of researchers in GOV and PNP would nearly remain constant. From 2004 to 2007, in the EU25, the number of researchers is expected to grow of about 42,000 researchers in HE (+5.4%), 1,000 researchers in GOV (+0.6%) and 1,000 in PNP (+5.8%).[5]

Figure 3. Number of researchers (HC) in each individual sector (HE, GOV and PNP), in the EU25, observed (1995-2004) and estimated (2005-2007)



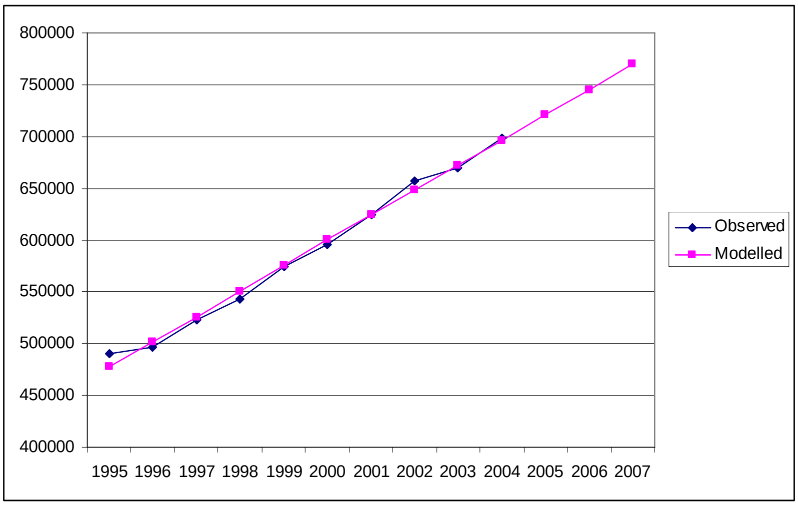
Source: IPTS. From 1995 to 2004, the number of researchers (observed) in each sector is reported. From 2005 to 2007, the forecasts of the number of researchers are presented (estimated with the most appropriate model with GDP only for HE and GOV and trend only for PNP, as explanatory variables).

3.2.3 The number of researchers in BES

According to the models, the number of researchers (HC) in the business sector in the EU25 will be around 770,000 in 2007. The increase is 10.1% compared to 2004, which corresponds to about 70,000 researchers more.

[5] There are slight differences in the forecasts when adding the forecasts for each individual sector and the forecast for the global HE-GOV-PNP sector. This is explained by the fact that different models have been used for estimating the number of researchers in each sector (the most appropriate has been chosen) and that these models are less satisfactory than the global model.

Figure 4. Number of researchers (HC) in BES in the EU25, observed and estimated (1995-2007)



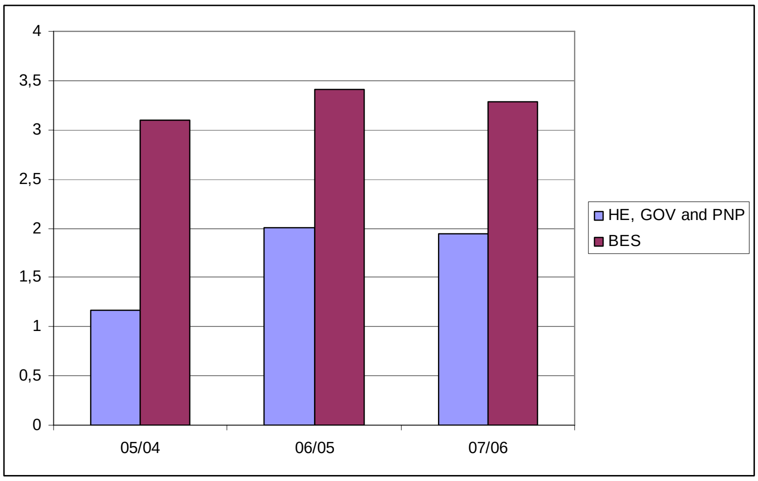
Source: IPTS.

3.2.4 Synthesis of nowcasts for the period 2004-07

On the following graph, we see clearly that the number of researchers in the business sector is expected to increase more rapidly than the number of researchers in HE, GOV and PNP, on the period 2004-07. The table below shows that this is true in relative as well as in absolute terms. We see also clearly that HE is expected to lead the growth among the global sector HE-GOV-PNP.

In total, 61% of the growth in the numbers of researchers is explained by the growth in the business sector, 37% by the higher education sector and 1% each by the GOV and PNP sector.

Figure 5. Nowcasts of annual growth rates of the number of researchers (2004-2007)



Source: IPTS.

Table 1. Number of researchers observed in 2004, nowcasted in 2007, and variations and growth rates between 2004 and 2007

	Number of researchers, 2004 (observed)	Number of researchers, 2007 (nowcasted)	Variations 2007-04	Growth rates 2007/04 (%)	Contributions to growth (%)
HE	782.000	824.000	42.000	5,4	37
GOV	201.000	202.000	1.000	0,6	1
PNP	19.000	20.000	1.000	5,8	1
BES	699.000	769.000	71.000	10,1	61
TOTAL	**1.700.000**	**1.815.000**	**115.000**	**6.8**	**100**

Source: IPTS. The total for 2007 slightly differs from the total presented in the text as estimations have been calculated independently with different models for each sector here.

3.3 Quality and validity

The models are satisfactory in general as around 98-99% of the variance is explained, When HE, GOV and PNP are considered separately, the models perform less well as only about 40 to 50% of the variance is explained.

However, the nowcasts of the number of researchers are dependent upon the quality of the forecasts of GDP. A more general problem remains the impossibility to forecast the exogenous shocks (and notably policy measures).

More complex models could be used but the added value to the quality of the forecasts is uncertain.[6]

4 Example II: The international mobility of researchers and engineers in the EU25

The aim of this section is to estimate the number of (incoming) mobile researchers and engineers (R&E) in the EU-25 and to analyse some of their characteristics using estimates from the national Labour Force Surveys of five EU countries (Germany, France, The United Kingdom, The Netherlands, Poland) and Norway.

4.1 Data and methodology

The results have been computed with the national Labour Force Surveys of six countries (FR, DE, UK, NL, NO and PL). The last available LFS have been used (FR: 2002-Q2, DE: 2004, NL: 2004, NO: 2003-Q3, PL: 2005-Q2, UK: 2005-Q2). Estimates of stocks and incoming

[6] See for example Stapel (2003), Giannone, Reichlin and Small (2005), Lorentz (2005), Moucharta and Rombouts (2005) Eurostat (2006).

mobility of researchers and engineers have been calculated with these surveys and extrapolated at the EU-25 level.

4.1.1 Identification of the population of R&E

The ISCO classification does not have a code to define "researcher". Consequently we do not have a clear-cut definition that enables us to select and distinguish researchers from other types of skilled labour. A broader population has thus been considered here. In the national LFS, the population of R&E has been identified as people who fulfil both the following criteria:

- Possessing tertiary education at or above level ISCED97 level 5.
- Holding an occupation defined by the following codes:
  - ISCO 211 'Physicists, Chemists and Related Professionals'
  - ISCO 212 'Mathematicians, Statisticians and Related Professionals'
  - ISCO 213 'Computing Professionals'
  - ISCO 214 'Architects, Engineers and Related Professionals'
  - ISCO 221 'Life Science Professionals'
  - ISCO 222 'Health Professionals (except nursing)'
  - ISCO 231 'College, University and Higher Education Teaching-Professionals'

4.1.2 "Mobility" criterion

Mobile researchers and engineers have been identified using the nationality of individuals. Mobile R&E are thus individuals who do not hold the nationality of the country in which they work. We have chosen to speak of "mobile" R&E instead of foreign R&E as an EU perspective is adopted.[7]

4.1.3 "Correction" of LFS numbers

The stocks of researchers and engineers from LFS have been corrected for two countries, UK and PL, as they seem to be under-estimated in the case of the UK and over-estimated in the case of PL, compared to the Eurostat category "scientists and engineers". To do so, for each country, we calculated first the ratio of the Eurostat number of scientists and engineers to the Eurostat total number of scientists and engineers in the four countries (the 6 except UK and PL). Second, we apply these ratios for UK and PL to the LFS total number of scientists and engineers. We kept the original numbers for the other countries. The resulting number of R&E are given in the following table for each country.

Table 2. Number of R&E after "corrections"

DE	FR	NL	PL	UK	NO	G6
1 670 000	865 000	333 000	359 000	1 036 000	87 000	4 352 000

Source: calculations based on LFS.

[7] Even if we are perfectly aware that nationality does not perfectly measure international mobility.

On average, the corrected numbers of LFS R&E account for 82% of Eurostat scientists and engineers with some limited country variations.

Table 3. Ratios of LFS R&E corrected to the Eurostat category scientists and engineers

DE	FR	NL	PL	UK	NO	G6
0.87	0.76	0.77	0.82	0.82	0.81	0.82

Source: calculations based on LFS.

4.1.4 EU extrapolation

To extrapolate the results at the EU-25 level, we applied the ratios EU-25/G6 calculated on the population of Eurostat scientists and engineers to the numbers of LFS R&E. The G6 total is the weighted total for the six countries under consideration. In some cases, data are missing for PL. We therefore extrapolate the results for the sample of five countries only. The factor of extrapolation is 1.59 when the 6 countries are considered and 1.73 for 5 countries.

4.2 Some results

4.2.1 The stocks of national and foreign researchers and engineers

6.93 millions of researchers and engineers work in the EU-25. 52% of them work in France, Germany and the UK.

6.8% of EU-25 R&E (about 473,000) are “mobile” (they work in a Member State of which they do not hold the nationality). 105,000 work in the UK, 104,000 in Germany and 42,000 in France.

For the proportion of mobile R&E relative to the total number of R&E, the countries rank like the following: UK (10.2%), Norway (7.0%), Germany (6.2%), France (4.8%), The Netherlands (4.5%) and Poland (0.1%).

Table 4. Stocks of researchers and engineers

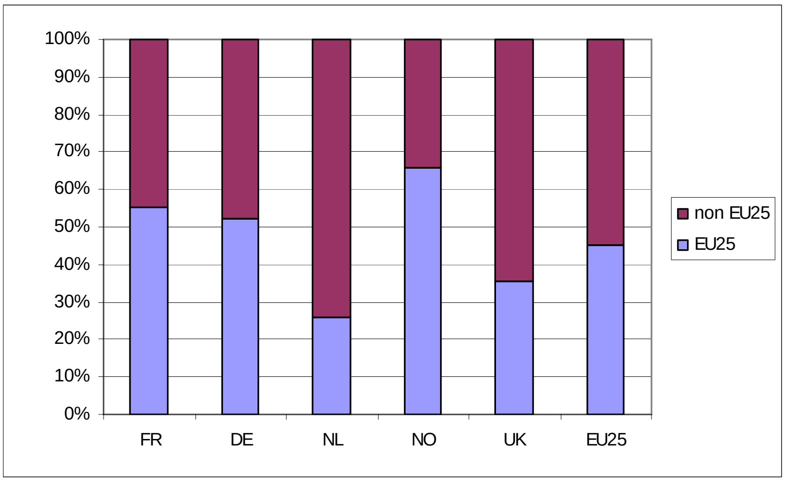
	Non mobile		Mobile		Total	
	Numbers	%	Numbers	%	Numbers	%
FR	823 000	95.2	42 000	4.8	865 00	100
DE	1 566 000	93.8	104 000	6.2	1 670 000	100
NL	318 000	95.5	15 000	4.5	333 000	100
NO	81 000	93.0	6 000	7.0	87 000	100
UK	930 000	89.8	106 000	10.2	1 036 000	100
PL	359 000	99.9	<1 000	0.1	360 000	100
EU-25	**6 456 000**	**93.2**	**473 000**	**6.8**	**6 929 000**	**100**

Source: IPTS. Estimations with national LFS.

4.2.2 Nationality

In the EU-25, 45% of mobile R&E are from another EU-25 country and 55% of them are from third countries. The six countries range like the following for the percentage of mobile R&E who are EU-25 nationals: NL (26%), UK (36%), DE (52%), FR (55%) and NO (66%).

Figure 6. Nationality of mobile researchers and engineers.



Source: IPTS. Estimations with national LFS.

In the EU-25, 3.1% of researchers and engineers are nationals of another EU-25 Member States and 3.7% are nationals of third countries.

In DE and NO, 59% of foreign R&E have been in the country for more than 10 years, and in the UK, 65% of foreign R&E have been in the UK for more than 10 years.[8]

Table 5. Percentage of mobile researchers according to length of stay

	10 years or less	More than 10 years	Total
DE	41	59	100
NO	41	59	100
UK	35	65	100

Source: IPTS. Estimations with national LFS.

Among the foreign R&E who have been in the country for less than 10 years, 59% are of EU-25 origin in DE, 45% in the UK and 53% in NO. Among those who have been there for more than 10 years, 52% are of EU-25 origin in DE, 30% in the UK and 71% in NO.

[8] It has not been possible to calculate this for the other three countries.

Table 6. Origin of mobile researchers and engineers according to length of stay (%)

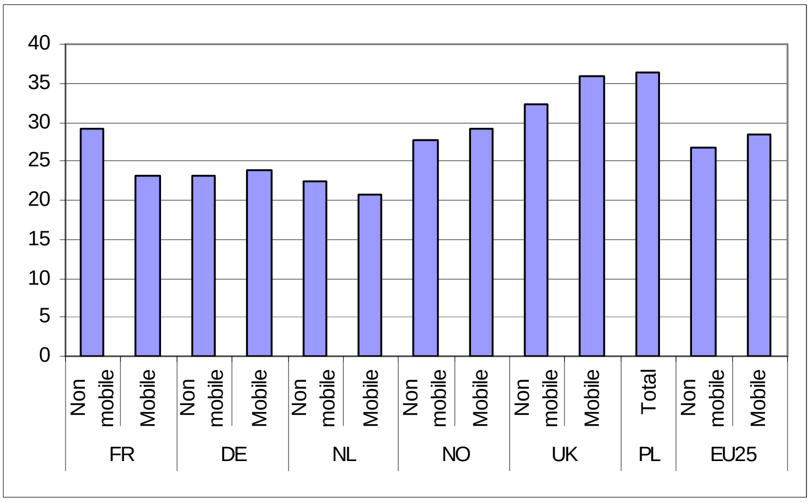
	EU-25 nationals	Non-EU-25 nationals	Total
	Germany		
10 years or less	53	47	100
More than 10 years	52	48	100
	Norway		
10 years or less	59	41	100
More than 10 years	71	29	100
	The United Kingdom		
10 years or less	45	55	100
More than 10 years	30	70	100

Source: IPTS. Estimations with national LFS.

4.2.3 Gender distribution

About 28% of EU-25 R&E are females. This proportion is 22% in NL, 23% in DE, 28% in NO, 29% in FR, 33% in UK and 36% in PL.

Figure 7. Percentage of females among researchers and engineers



Source: IPTS. Estimations with national LFS.

In the EU-25, females account for 27% of non mobile R&E and 28% of mobile R&E. The proportion of females among those who are mobile is lower than the proportion of females among those who are not mobile in FR (23% against 29%). This percentage is relatively similar in NL (21-22%), DE (23-24%) and NO (28-29%) while the proportion of females among mobiles is higher than the proportion of females among non mobiles in the UK (36% against 32%).

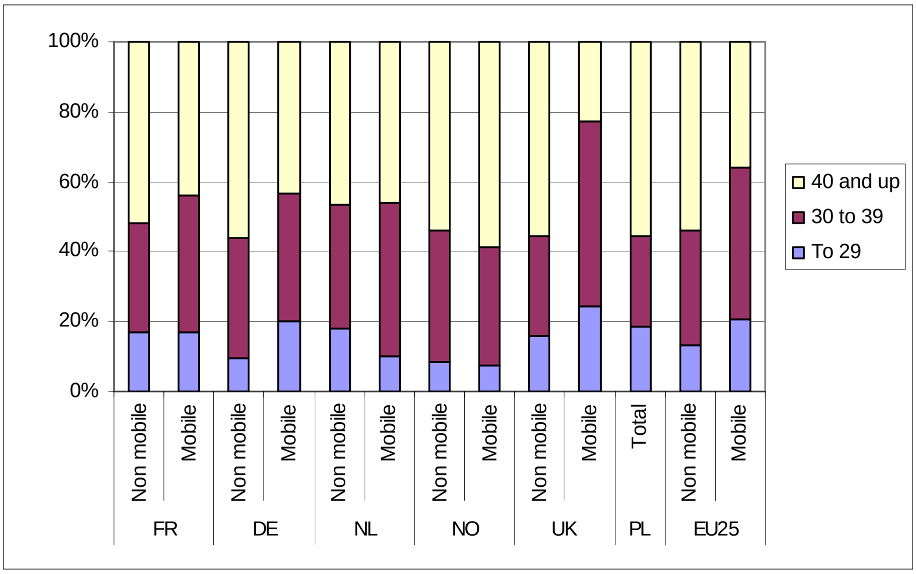
4.2.4 Age distribution

In the EU-25, 14% of R&E are less than 30 years old, 33% are between 30 and 39 years old and 53% are 40 years old or more. The age distribution of R&E is relatively similar in the six countries. Between 10% (in DE) and 19% (in PL) are less than 30 years old, and between 26% (in PL) and 38% (in NO) are between 30 and 39.

In the EU-25, the age distribution of non-mobile R&E is the following: 13% are less than 30, 33% are between 30 and 39 and 54% are older than 40. For mobile R&E the corresponding age distribution is 20%, 44% and 36%.

There are few differences in the age distribution between mobile and non-mobile R&E in most of the countries except in the UK where the R&E less than 40 years old account for 45% among the UK nationals, and 77% among the foreigners (a difference of 32 percentage points).[9] In three other countries[10] the R&E of foreign nationality are also younger on average but the differences are less pronounced (FR: 48% against 56%; DE: 44% against 56%; NL: 53% against 54%). In Norway, it is the contrary (46% against 41%).

Figure 8. Age distribution of researchers and engineers



Source: IPTS. Estimations with national LFS.

4.2.5 Nature of work contract

9% of researchers and engineers have a temporary work contract in the EU-25, 74% work on a permanent work contract and 17% are self-employed.

[9] This may be explained by the broad definition of researchers used here (and notably the impact of the number of graduates).
[10] It has not been possible to calculate this for PL.

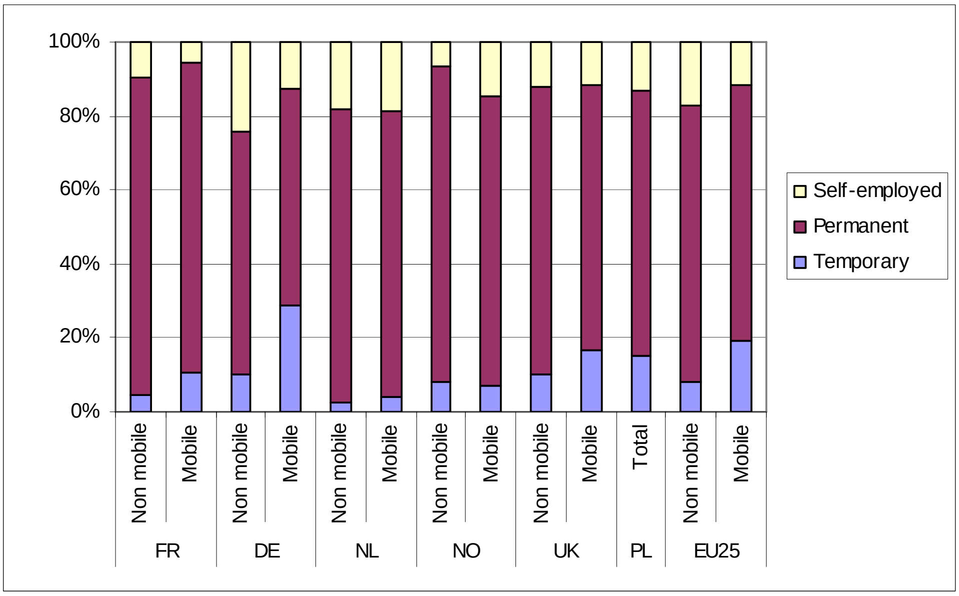
Mobile R&E are more often employed on temporary positions (19%) than those who are non-mobile (8%). This is true for at least three of the countries under study except NO and NL where the percentages are nearly equal (respectively around 8% and 3%).[11]

Table 7. Nature of work contract of researchers and engineers.

	FR	DE	NL	NO	UK	PL	*EU-25*
Temporary	4.7	11.2	2.7	8.2	10.6	10.6	***8.9***
Permanent	85.8	65.2	79.1	84.8	77.5	77.5	***74.4***
Self-employed	9.6	23.6	18.3	7.0	11.9	11.9	***16.7***

Source: IPTS. Estimations with national LFS.

Figure 9. Nature of work contract of researchers and engineers



Source: IPTS. Estimations with national LFS.

4.3 Assessment and validity

The results which are presented here are only broad estimations of the stocks and "mobility" of R&E in the EU-25. They only should be considered as such. The reader has to keep in mind that the results are based on LFS (surveys with a limited sample of individuals) and on a sample of 6 countries.

The error margins around the point estimations presented here may be quite large as they are likely to be based on small samples. To illustrate this, the following table presents approximations of lower bounds and higher bounds (at a 95% confidence level) for the number of mobile R&E for five countries (for PL, the number of mobile R&E is very low and can not be used in a satisfactory way).

[11] It has not been possible to estimate this for PL.

Table 8. Error margins around point estimates

	DE	FR	NL	UK	NO
Mobile R&E, LB	96 000	36 000	13 000	90 000	4 000
Mobile R&E, HB	112 000	48 000	17 000	122 000	8 000

Source: calculations based on LFS.

Moreover, the coding of occupations according to the ISCO classification may be problematic when trying to identify specific populations such as researchers and engineers. This leads to a considerable uncertainty, in addition to sample errors, in the occupational breakdowns based on LFS. The "corrections" applied to PL and UK perfectly illustrate this problem.

Finally, nationality is a bad proxy for international mobility.[12]

5 Example III: The career and mobility of doctoral candidates and post-doctorates in life sciences in Europe

This section presents the results of the estimation of the number and characteristics of doctoral candidates/graduates and postdoctorates in life sciences[13] in the EU25. A comparison with the US is carried out as well.

5.1 Data

Three main sources of data have been combined:

- Eurostat provides statistics on the number of ISCED6 graduates in life sciences (the classification field EF42) in the EU-25 countries. They are harmonized and should be comparable between countries. However, there are some breaks and some inconsistencies in the series that makes it impossible or difficult to identify trends on a long period of time.

- The NetReAct survey[14] ("The role of Networking in Research Activities") commissioned by the Institute for Prospective Technological Studies of the European Commission's Joint Research Centre aims at describing and analysing the patterns, dynamics, impacts and strategies of networking in research activities in life sciences. It provides detailed information on the doctoral candidates and post-docs population in 10 European countries (The Czech Republic, France, Germany, Hungary, Italy, Norway, Portugal, Spain, Sweden, and the UK) collected through a questionnaire-based survey addressed to the heads of research teams. The research population identified by the NetReAct project consists of 7,732 teams working in life sciences,

[12] See for example OECD (2001), Lanzendorf and Teichler (2003), Dumont and Lemaître (2005), Kelo, Teichler and Wachter (2006, ed.).
[13] For general discussion and references on the brain drain question at the doctoral and postdoctoral level (in all fields), see Moguerou (2006).
[14] http://www.netreact-eu.org/

from 359 universities. The field of life sciences has been identified using the K.U. Leuven-IRO Subject Classification, considering five main fields: biology, bio-sciences, bio-medicine, neuro-sciences and other disciplines. After sampling and eliminating the not usable responses, the number of usable questionnaire in the sample was 468 teams (6.1% of the population). If these responses are representative of the whole population and if the whole population has been correctly assessed, then, it is possible to estimate the number of doctoral candidates/graduates, the number of postdocs and other staff of the teams, and numerous characteristics of these populations.

- The US National Science Foundation provides statistics in the SESTAT system on the number of Doctorate graduates and post-doctorates in biological sciences in the US.[15] More precisely, data on the number of recent Doctorate graduates come from the Survey of Earned Doctorates (SED) whereas the statistics on postdoctorates mainly are from Survey of Graduate Students and Postdoctorates in Science and Engineering (GSS). The field "biological sciences" is taken into account in this note (the field health has not been included as it is too large to be compared with the field life sciences in Eurostat and NetReAct data).[16]

5.2 Methodology

Three steps can be distinguished:

1. Different characteristics of the doctoral graduates and post-doctorates are extracted from the NetReAct survey (proportion of individuals in different categories) for the 10 countries of the sample;

2. These proportions are applied to the number of graduates from Eurostat database to estimate the size of various populations (doctoral graduates, post-doctorates, origin of doctoral graduates and post-doctorates);

3. The results are extrapolated at the EU-25 level based on an inflation factor.

5.3 Some results

5.3.1 The number and origin of doctorates awarded in the EU25 and the US

8,755 doctorates in life sciences have been granted in EU-25 countries in 2003, according to Eurostat data. From 1999 to 2003, there has been an increase of 39.4% in the EU-25 total number of doctoral graduates in this field.

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[15] See for example Stephan and Levin (2001), Ma and Stephan (2004) and NSF (2004, 2005a, 2005b),

[16] The NSF "biological sciences" field is composed of the following disciplines: Anatomy, Biochemistry, Biology, Biometry/epidemiology, Biophysics, Botany, Cell biology, Ecology, Entomology/parasitology, Genetics, Microbiology, immunology, and virology, Nutrition, Pathology, Pharmacology, Physiology, Zoology, Biosciences, nec.

5,694 doctorates in biological sciences were granted in the United States in 2003 according to NSF data (65% of the total for EU-25 countries).[17] The number of doctoral graduates in this field in the US has been relatively stable for the last five years.

In 2003, among the 5,694 doctorate recipients in biological sciences from US universities, 1,666 were not US citizens (29.3%).[18]

The same year, in the EU-25, we estimate[19] that 1,478 doctorates in life sciences (16.8%) were awarded to non-EU-25 nationals.

Table 9. Doctoral graduates in life sciences in the EU-25 and the US, according to nationality (2003)

	EU-25		US	
	Numbers	**%**	**Numbers**	**%**
Nationals	7 277	83.2	4 028	70.7
Non-nationals	1 478	16.8	1 666	29.3
Total	8 755	100	5 694	100

Source: IPTS. Our estimations with data from Eurostat, NSF and the NetReAct survey. US: sum of non US citizens with permanent visas and temporary visas.

We also estimate that 10.1% of the doctorates granted in life sciences in the EU-25 in 2003 were EU-25 nationals who worked in a Member State of which they did not hold the nationality (intra-EU mobility).

Table 10. Estimation of the number of doctoral graduates in life sciences in the EU-25 according to their country of origin (2003)

	EU		Non EU			Total
	Own country	Other EU country	Other European country (outside EU)	USA or Canada	Other country	
Numbers	6 396	881	220	167	1 090	8 755
%	73.1	10.1	2.5	1.9	12.4	100.0

Source: IPTS. Our estimations from the NetReAct survey and Eurostat data.

EU-25 attracts few doctoral recipients from Canada and the United States (167 according to our estimations) and they are mainly in the United Kingdom (99).

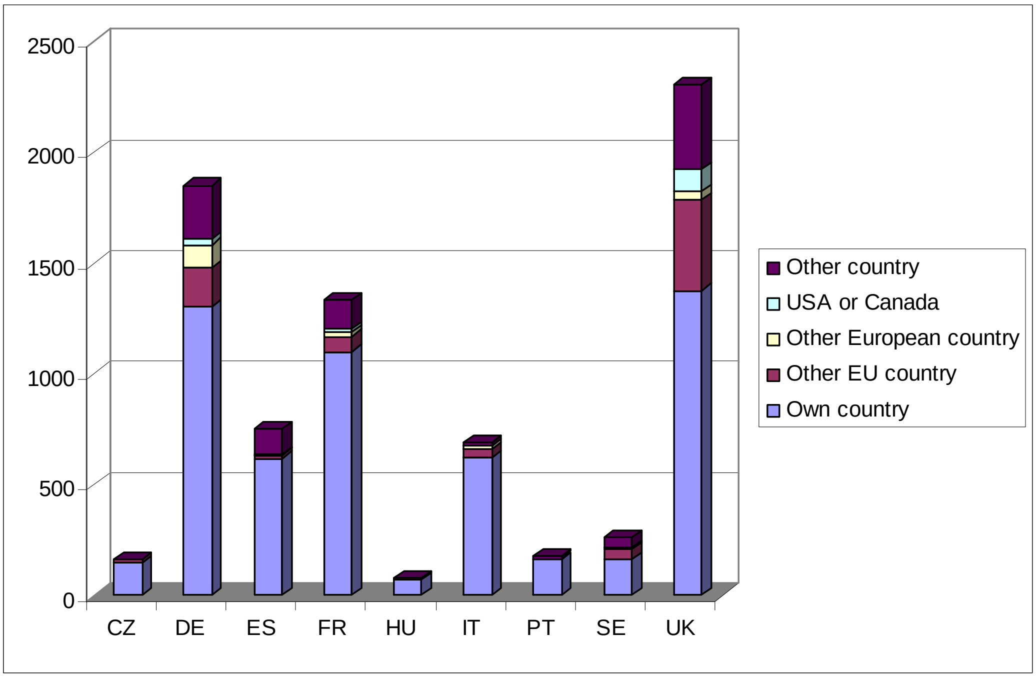
[17] The number of doctorates awarded in the US according to Eurostat data for the field "life sciences" (5,038) slightly differs from the number given by NSF for the field biological sciences (5,694). We work with the NSF numbers so that it can be compared with the number of postdoctorates. Indeed, in the case of postdoctorates, Eurostat does not provide data and we have to work with NSF data.

[18] 265 were non-US citizens with permanent visas and 1,401 were non-US citizens with temporary visas.

[19] In combining NetReAct and Eurostat data.

The UK also attracts many EU-25 doctoral candidates. Indeed, we estimated that 409 individuals from EU-25 countries (other than the UK) were granted a Doctorate in life sciences in this country in 2003.

Figure 10. Estimated number of doctoral graduates in life sciences awarded in nine EU countries, according to their country of origin (2003)



Source: IPTS. Our estimations from the NetReAct survey and Eurostat data.

5.3.2 The number and origin of postdoctorates

The number of postdocs in biological sciences in the US was 17,927 in 2002. It increased by 13.8% from 1998 to 2002.[20]

In the EU-25, we estimated that there were approximately 19,400 postdoctorates in the field of life science in 2003. Most of them (5,700) were working in the UK (29.5% of the EU-25 total).

In 2002, 56.6% of the 17,927 postdocs in biological sciences in the US were temporary visa holders (10,140).

In 2003, it is estimated that 24.7% of postdoctorates in life sciences working in the EU-25 were non-EU-25 nationals (4,800).

[20] There were also 13,163 postdocs in health in 2002 in the US universities.

Table 11. Number of postdoctorates in life sciences in the EU-25 and the US, according to nationality (2003)

	EU-25		US	
	Numbers	%	Numbers	%
Nationals	14 590	75.3	7 787	43.4
Non-nationals	4 787	24.7	10 140	56.6
Total	19 377	100	17 927	100

Source: IPTS. Our estimations with data from Eurostat, NSF and the NetReAct survey.

We also find that 18.7% of postdoctorates were EU-25 nationals workeing in a Member State of which they did not hold the nationality. Nearly 1,000 came from another European country outside EU and another 1,000 came from Canada or the US. Other countries contributed to about 3,000.

Table 12. Estimated number of postdoctorates in the EU-25 according to their country of origin (2003).

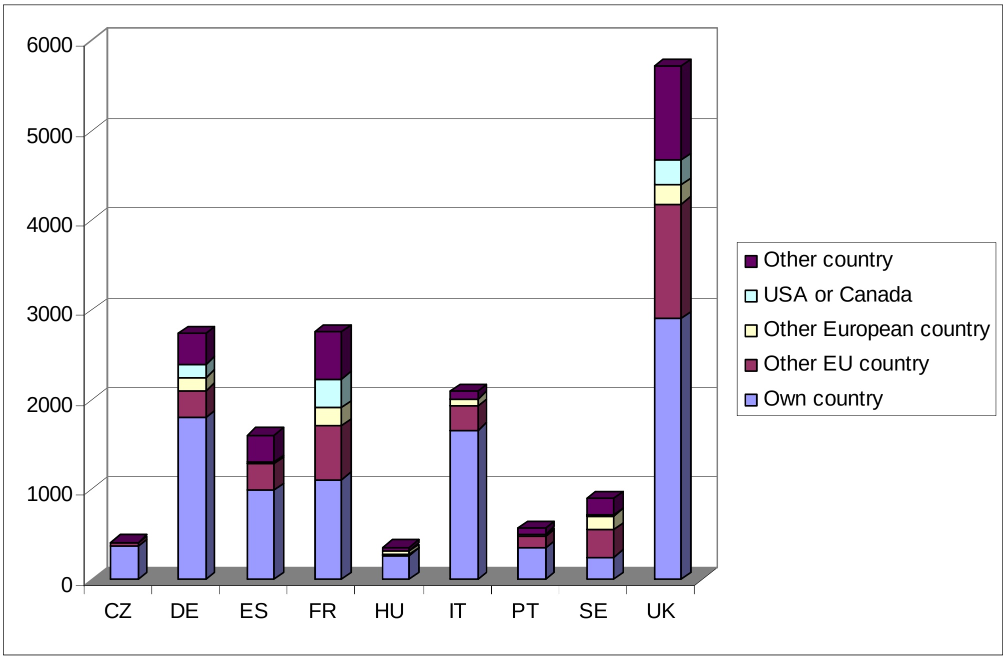
	EU		Non EU			Total
	Own country	Other EU country	Other European country (outside EU)	USA or Canada	Other country	
Numbers	10 971	3 619	960	904	2 923	19 377
%	56.6	18.7	5.0	4.7	15.1	100

Source: IPTS. Our estimations with data from the NetReAct survey and Eurostat.

The UK attracts many postdoctorates from EU-25 origin. Indeed, we estimate that 1,275 postdoctorates from EU-25 countries (other than the UK) were working in the field of life sciences in UK labs in 2003. France, the second country on the list, attracted only 590 postdoctorates from other EU-25 countries.

Countries attracting the highest number of postdoctorates from North America rank like this: France (324 postdocs from this region), the UK (280) and Germany (148).

Figure 11. Estimated number of postdoctorates in life sciences in nine EU-25 countries, according to their country of origin (2003)



Source: IPTS. Our estimations with the NetReAct survey and Eurostat data.

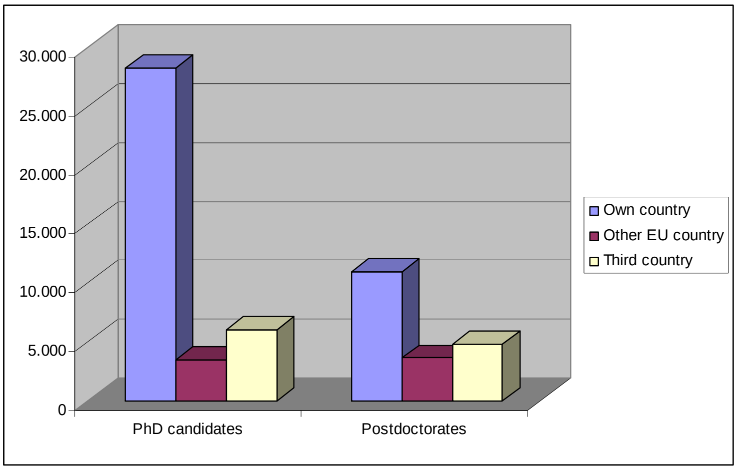
5.3.3 The total number and origin of "junior" researchers in life sciences in the EU25

The number of doctoral candidates in life sciences[21] in the EU25 is estimated to be around 38,000. 28,000 (75%) of them are not "internationally mobile", 4,000 (9%) are from another EU country and 6,000 (16%) are from third countries.

If we sum the number of doctoral candidates and the number of postdoctorates, we find that there are about 58,000 junior researchers in life sciences in the EU25. 39,000 are not "mobile" (69%), 8,000 are from another EU country (12%) and nearly 11,000 are from third countries (19%).

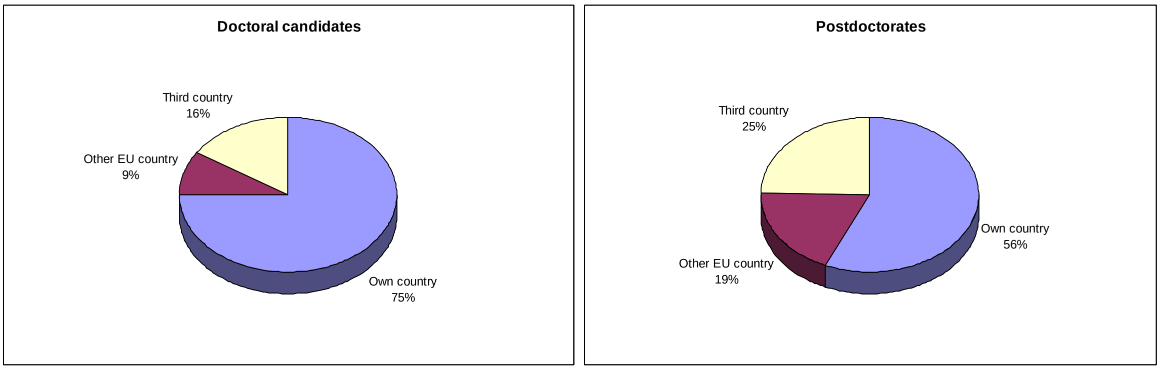
[21] This number has been estimated with Eurostat data, filling some gaps when data were missing and extrapolating the results at the EU level.

Figure 12. Number of junior researchers in life sciences in the EU25, according to nationality



Source: IPTS.

Figure 13. Percentage of junior researchers in life sciences in the EU25, according to nationality



Source: IPTS.

5.4 Assessment and validity

One has to keep in mind that these results are broad estimations of the labour market of young scientists in life sciences. Three questions have been addressed:

- The representativeness of the teams identified in the NetReAct survey: a comparison of various characteristics of the responses with the characteristics of the sample has been done, according to:
  - Inlinks;
  - Staff composition of the teams;
  - Gender of the team head.

  The general conclusion that has emerged is that the representativeness is generally good.

- The representativeness and validity of the results obtained by combining Eurostat and NetReAct data: a comparison of results with some national statistics, such as the number of doctoral candidates and the duration of doctoral studies, has been implemented. It is found for instance that the number of doctoral candidates is correctly estimated for Spain, Italy, Portugal, the UK and France. However for Sweden and Norway the estimation seems to be less satisfactory.

- The extrapolation at the EU level: it seems to be legitimate as the number of doctoral graduates in the 10 countries sample accounts for 87% of the EU25 total provided by Eurostat. However, incertitude remains about the representativeness of the 10 countries when disaggregating by some variables.

6 Conclusion

In this paper the "modelling" approach followed by IPTS to try to construct new and original indicators on researchers' career and mobility has been presented. The results from three studies have been developed to illustrate the interests and limits of the approach. The advantage of this method is indeed to provide new and original results on specific subjects not covered by "official" statistics on HRST. The limits are related to the representativeness of results based on surveys (ad-hoc or of a limited scope) and especially as far as EU extrapolation is concerned.

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