Researchers in the European Research Area

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SECTION 1: INTRODUCTION

Recent enlargements of the European Union (EU) increased the total population by around 30per cent resulting in a population of over half a billion citizens (Prodi 2001[1]). In 2007 Bulgaria and Romania became the latest countries to join, making a total of 27 Member States (Box 1).

BOX 1: European Union Member States

Pre 1994 - Austria (AT), Belgium (BE), Germany (DE), Denmark (DK), Spain (ES), Greece (EL), France (FR), Finland (FI), Italy (IT), Ireland (IE), Luxembourg (LU), Netherlands (NL), Portugal (PT), Sweden (SE), United Kingdom (UK)

A10 Enlargement May 2004 - Cyprus (CY), Czech Republic (CZ) Estonia (EE), Hungary (HU), Latvia (LV), Lithuania (LT), Malta (MT), Poland (PL), Slovakia (SK), Slovenia (SI)

January 2007 Enlargement- Bulgaria (BG), Romania (RO)

Associate countries - Switzerland (CH), Iceland (IS) Norway (NO)

Candidate countries – Turkey (TR), Croatia (HR) and Macedonia (MK)

The Lisbon European Council (March 2000) established the strategic goal of the European Union '*becoming the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth*'[2]. The development of the European Research Area (ERA) lies at the heart of the European Commission's plan to achieve the Lisbon Strategy and central to this is the commitment to increase the volume, quality and interconnectedness of researchers (Box 2). At the same time there was recognition of wide diversity in science and technology policy: '*It cannot be said that there is today a European policy on research. National research policies and Union policy overlap without forming a coherent whole.*'[3] Efforts to introduce a more joined up approach resulted in the development of a European Research Area. The idea being that greater unification would make Europe more internationally competitive and produce the highest standards of research. Greater centralization and mobilisation of resources are identified as means to achieve this (Box 2).

BOX 2: Aims of the European Research Area

- Networking of existing centres of excellence in Europe and the creation of virtual centres through the use of new interactive communication tools.
- A common approach to the needs and means of financing large research facilities in Europe.
- More coherent implementation of national and European research activities and closer relations between the various organisations of scientific and technological cooperation in Europe.
- Better use of instruments and resources to encourage investment in research and innovation: systems of indirect aid (within the Community rules on State aid),

[1] Prodi R. (2001) "Introductory Speech", Conference Proceedings, *An Enlarged Europe for Researchers*, European Commission, Brussels 27 & 28 June 2001

[2] For discussion of the 'knowledge economy' cf. Cozzens, S and Kallerud, E (2007) 'Science, Technology, and Inequalities in the Global Knowledge Economy: Policy Dimensions' Working Paper, ResIST Project WP1

[3] COM (2000) 6 final, January 2000, 'Towards a European Research Area' Page 7

patents, risk capital.

- Establishment of a common system of scientific and technical reference for the implementation of policies.
- More abundant and more mobile human resources:
- Greater mobility of researchers and introduction of a European dimension to scientific careers.
- More prominence to the place and role of women in research.
- Stimulating young people's taste for research and careers in science.
- Greater European cohesion in research based on the best experiences of knowledge
- Transfer at regional and local levels and on the role of the regions in the European research efforts.
- Bringing together the scientific communities, companies and researchers of Western and Eastern Europe.
- Improving the attraction of Europe for researchers from the rest of the world.
- Promotion of common social and ethical values in scientific and technological matters**.**

Source: COM (2000) 6 final, January 2000

In effect, the ERA has reshaped scientific governance within the EU. European-wide targets have been set to develop the ERA (for example in scientific expenditure and science education) and individual countries performances are judged in relation to these. Whilst this represents an attempt at a European level to influence individual member states in their domestic management, there is little in the way of repercussions for those countries exhibiting a lack of investment (in the broadest sense) in science. By 2002 the Commission noted that most of the barriers in the implementation of ERA policy were '*…due to the low overall level of Member State involvement'*[4] A report by industrialists refers to the failure of the EU to realise some objectives. Identifying the 'lack of investment in centres of excellence' and 'failure to increase the supply of scientists', it suggests that the US continues to 'race ahead through .. its ability to retain the highest calibre researchers .. and its active policy of immigration for the best and brightest' (ERT, 2003, p.3)[5]. In fact the effective utilization of human capital underpins the success of the ERA: '*The share of so-called 'knowledge workers' in a country's total employment and its ability to produce high-tech products and sell them on international markets thus constitute important indications of international economic success.*' (EC, 2003:72)[6] .

With specific reference to the 'brain drain to the US', the Commission Communication, 'A Mobility Strategy for the European Research Area', refers to the need for 'more abundant' human resources and the objective of 'attracting and retaining high quality research talent in Europe.'[7] According to European Commission calculations, an increase in capacity of 700,000 new researchers (in addition to those needed to respond to demographic concerns) is needed in the EU by 2010 to meet the Lisbon objectives[8] In addition, the Communication 'Towards a

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[4] COM (2002),565, October 2002 'The European Research Area : Providing New Momentum, Strengthening - Reorienting - Opening up new perspectives'

[5] European Round Table of Industrialists(2003) The European Challenge

[6] EC (2003) Key Figures 2003-2004 p72

[7] COM (2001) 331, June 2001, para 1.

[8] Council Resolution on the Profession and the Career of Researchers within the European Research Area (ERA) 14636/03 Rech 194 Brussels, 12 November 2003. The Resolution acknowledges the Commission's Communication 'Researchers in the European Research Area: One Profession, Multiple Careers COM(2003) 436 of 18 July 2003.

European Research Area'[9] speaks of the need to develop 'essential critical mass in the major areas of progress in knowledge, in particular to achieve economies of scale, to allocate resources better overall, and to reduce negative externalities due to insufficient mobility'. In another document, the Commission refers directly to the imperative of encouraging labour mobility in response to, '*skills mismatches [which] are often a major cause of imbalances in the supply and demand for labour across sectors and regions.*'[10] .

Mobility is therefore central to the ERA strategy in two respects. Firstly, increasing the *volume* of human capital through policies to retain researchers in and attract researchers into the ERA from third countries and, secondly, shaping the *distribution* of this human capital within the boundaries of the ERA. In many respects these two goals are linked as the development of research concentration and the emergence of specifically European Centres of Excellence play a critical role in maintaining the attractiveness of Europe to those scientists already located within the ERA and acts as a magnet to those from outside.

The concepts of the ERA and knowledge economy are inextricably linked to the utilization of human capital and research capacity. This report maps out key factors in relation to R&D personnel in the EU – firstly, appraising investment in R&D (Section 1), then moving onto the distribution of R&D personnel (Section 2) and lastly, reviewing internationalisation and mobility[11] in the ERA (Section 3).

[9] Communication from the Commission to the Council, The European Parliament, the Economic and Social Committee and the Committee of the Regions, Brussels, para 5

[10] Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions - Commission's Action Plan for skills and mobility [COM/2002/0072 final]

[11] This report deals with the international mobility of research staff *not* intersectoral mobility (for recent publications on this topic cf. EC (2007) Mobility of Researchers between academia and industry, DG Research; EC (2001) The Use of Mobility Schemes in European Innovation Policy' DG Enterprise)

SECTION 2: INVESTMENT IN R&D IN THE EU

In order to comply with the community *aquis* new (and existing) member states have to strengthen their investments in scientific R&D. The Lisbon Strategy set a target of three per cent GDP expenditure on R&D by 2010, in 2005 the EU-25 average was 1.85 per cent (the inclusion of Bulgaria and Romania slightly reduce this – Table 1). Only two countries, Sweden and Finland, had already exceeded this target in 2005. A further four countries spent over two per cent GDP on R&D (Germany, Denmark, Austria and France). Of the 'old' Member States, Greece spent the lowest proportion of GDP on R&D (0.61 per cent in 2005) and Romania invested the least proportionally in the EU-27 (0.39 per cent in 2005).

In terms of actual expenditure, Germany invested the most in R&D, followed by France and the UK. Malta and Cyprus (two of the smallest Member States) invested the least in real terms (Table 1).

The countries with the highest overall proportion of R&D expenditure (Sweden and Finland) also had the highest proportion of business enterprise expenditure on R&D (2.92 per cent and 2.46 per cent respectively), followed by Germany (1.76 per cent) and Denmark (1.67). This indicates a relationship between activity in business enterprise and overall performance in R&D (Table 1).

Table 1 : R&D expenditure in million euro and as a percentage of GDP, all sectors and business enterprise sector, EU-27, EU-25 and selected countries — 2002 to 2005

	Total R&D expenditure								Business enterprise R&D expenditure							
	Millions of Euro				as a % of GDP				Millions of Euro				as a % of GDP			
	2002	2003	2004	2005	2002	2003	2004	2005	2002	2003	2004	2005	2002	2003	2004	2005
EU-27	185 878 s	187 708 s	193 984 s	201 020 s	1.88 s	1.87 s	1.84 s	1.84 s	119 083 s	119 669 s	123 582	128 091 s	1.21 s	1.19 s	1.17 s	1.17 s
EU-25	185 613 s	187 416 s	193 650 s	200 633 s	1.89 s	1.88 s	1.85 s	1.85 s	118 957 s	119 533 s	123 428 s	127 913 s	1.21 s	1.20 s	1.18 s	1.18 s
BE	5 201	5 177	5 350 p	5 428 p	1.94	1.89	1.85 p	1.82 p	3 662	3 608	3 714 p	3 705 p	1.37	1.31	1.28 p	1.24 p
BG	81	89	99	106	0.49	0.50	0.51	0.50	15	18	24	23	0.09	0.10	0.12	0.11
CZ	959	1 013	1 100	1 417	1.20	1.25	1.26	1.42	586	618	701	914	0.73	0.76	0.80	0.92
DK	4 634	4 855	4 899 p	5 097 p	2.51	2.56	2.48 p	2.44 p	3 198	3 355	3 332	3 481 p	1.73	1.77	1.69	1.67 p
DE	53 364	54 539	55 215	56 356 e	2.49	2.52	2.50	2.51 e	36 950	38 029	38 611	39 406 e	1.72	1.76	1.75	1.76 e
EE	56	67	83	104 p	0.72	0.79	0.88	0.94 p	17	23	32	47 p	0.22	0.27	0.34	0.42 p
IE	1 436 e	1 607 e	1 780 p	2 020 ep	1.10 e	1.16 e	1.21 p	1.25 ep	988 e	1 076	1 150 p	1 320 ep	0.76 e	0.77	0.78 p	0.82 ep
EL	:	978	1 021 p	1 112 p	:	0.63	0.61 p	0.61 p	287	313	317 p	326 p	0.20	0.20	0.19 p	0.18 p
ES	7 194	8 213	8 946	10 100 ep	0.99	1.05	1.06	1.12 ep	3 926 b	4 443	4 865	5 491 ep	0.54 b	0.57	0.58	0.61 ep
FR	34 527	34 569	35 534	36 396 p	2.23	2.17	2.14	2.13 p	21 839	21 646	22 210	22 543 p	1.41	1.36	1.34	1.32 p
IT	14 600	14 769	15 253	:	1.13	1.11	1.10	:	7 057	6 979	7 293	7 806 p	0.54	0.52	0.53	0.55 p
CY	34	41	47	54 p	0.30	0.35	0.37	0.40 p	7	9	10	12 p	0.06	0.07	0.08	0.09 p
LV	42	38	47	73	0.42	0.38	0.42	0.57	17	13	21	30	0.17	0.13	0.19	0.23
LT	100	111	137	157	0.66	0.67	0.76	0.76	17	23	29	32	0.11	0.14	0.16	0.16
LU	:	426	448	458 p	:	1.66	1.66	1.56 p	:	379	393	395 p	:	1.48	1.46	1.34 p
HU	706 i	693 i	721 i	838 i	1.00 i	0.93 i	0.88 i	0.94 i	250	255	297	362	0.35	0.34	0.36	0.41
MT	12	11	28 b	27 p	0.26	0.26	0.63 b	0.61 p	3	4	19 b	19 p	0.07	0.08	0.45 b	0.42 p
NL	8 019	8 376	8 723 p	:	1.72	1.76	1.78 p	:	4 543	4 804	5 039	5 148 p	0.98	1.01	1.03	1.02 p
AT	4 684	4 998 e	5 250	5 784 ep	2.12	2.21 e	2.23	2.36 ep	3 131	:	3 556	3 919 ep	1.42	:	1.51	1.60 ep
PL	1 172	1 036	1 139	1 386	0.56	0.54	0.56	0.57	238	284	327	440	0.11	0.15	0.16	0.18
PT	1 029 e	1 020	1 104 ep	1 189 p	0.76 e	0.74	0.77 ep	0.81 p	334 e	338	384 ep	430 p	0.25 e	0.25	0.27 ep	0.29 p
RO	184	203	235	:	0.38	0.39	0.39	:	111	118	130	:	0.23	0.22	0.21	:
SI	360	328	379	338 i	1.52	1.32	1.45	1.22 i	215	209	254	241 p	0.91	0.84	0.97	0.87 p
SK	148	169	174	194	0.57	0.58	0.51	0.51	95	93	86	97	0.37	0.32	0.25	0.25
FI	4 830	5 005	5 253	5 474	3.36	3.43	3.46	3.48	3 375	3 528	3 683	3 877	2.34	2.42	2.42	2.46
SE	:	10 642 i	:	11 109	:	3.95 i	:	3.86	:	7 886 i	:	8 410	:	2.93 i	:	2.92
UK	30 496	28 658	29 956	:	1.83	1.79	1.73	:	19 830	18 319	18 883	:	1.19	1.14	1.09	:
IS	280 e	274	297	:	2.99 e	2.86	2.83	:	160 e	142	167	:	1.71 e	1.48	1.59	:
NO	3 388	3 411	3 317	3 599 p	1.67	1.73	1.62	1.51 p	1 946	1 960	1 821	1 944 p	0.96	0.99	0.89	0.82 p
EEA28	189 281 s	191 101 s	197 259 s	204 574 s	1.89 s	1.88 s	1.85 s	1.84 s	121 063 s	121 635 s	125 404 s	130 034 s	1.21 s	1.20 s	1.18 s	1.17 s
CH	:	:	8 486	:	:	:	2.93	:	:	:	6 257	:	:	:	2.16	:
HR	271	292	345	:	1.11	1.11	1.22	:	115	114	144	:	0.47	0.44	0.51	:
TR	1 280	:	:	:	0.66	:	:	:	367	:	:	:	0.19	:	:	:
CN	16 452	16 444	19 097	24 030	1.07	1.13	1.23	1.34	10 066	10 256	12 761	7 719	0.65	0.71	0.82	0.91
JP	115 676	119 748	133 684	:	3.18	3.20	3.18	:	86 112	89 783	100 519	:	2.36	2.40	2.39	:
RU	4 545	4 899	5 473	6 559	1.25	1.28	1.16	1.07	3 176	3 353	3 780	4 458	0.87	0.88	0.80	0.73
US	292 153 i	258 520 pi	251 254 pi	:	2.65 i	2.68 pi	2.68 pi	:	205 021 i	180 343 pi	176 241 pi	:	1.86 i	1.87 ip	1.88 ip	:

NOTES
EU-27, EU-25 and EEA28: Eurostat estimates
Information note (i):
HU - Total R&D expenditure: Defence is excluded; SE - 2003: underestimated data; SI - 2005 and Total R&D expenditure: underestimated data; US: excludes most or all capital expenditure.

Source: Eurostat/R&D statistics -OECD - MSTI 2006/1

(Source: Gotzfried A., (2007) 'R&D Expenditure and personnel' Statistics in Focus – Science and Technology 2007-23, Eurostat::2)

SECTION 3: DISTRIBUTION OF R&D PERSONNEL

3.1 Number of R&D staff

In 2004 there were more than 51 million people working in science and technology (HRSTO) in the EU-25, equivalent to 27.7% of the total labour force (Götzfried, 2004: 1)[12] of these, around 57 per cent had completed an S&T education (Wilen, 2006:2)[13]. In 2001, Germany had the largest number of researchers working in an EU member states –nearly 260,000. France had the second highest number of researchers – 172,070 and the UK the third highest– 157,662. Cyprus, Iceland, Estonia, Latvia and Slovenia all had fewest researchers. Over half the researchers working in Greece, Spain, Portugal, Poland, Slovakia and Turkey were in higher education (Table 2 and see section 3.2.2)

Table 2: Researchers (FTE) – total numbers and by sector (%), 2001

	In % by sector			Total number of researchers	Average annual growth rates in % 1996-2001 (²)
	Business enterprise	Govern-ment	Higher education		
Belgium	54.5	4.0	40.4	30 219	7.28
Denmark	47.9	20.7	30.2	18 944	4.30
Germany	59.3	14.4	26.3	259 597	2.43
Greece	15.2	13.6	71.0	14 748	11.03
Spain	23.7	16.7	58.6	80 081	9.17
France	47.1	15.2	35.8	172 070	2.67
Ireland	66.1	8.7	25.2	8 516	7.32
Italy	39.5	21.7	38.9	66 110	-3.56
Netherlands	47.6	14.1	37.2	42 085	5.11
Austria	62.6	5.1	31.8	18 715	7.86
Portugal	15.5	21.0	50.3	17 584	6.55
Finland	56.9	12.3	29.8	36 889	8.64
Sweden	60.6	4.9	34.5	45 995	5.68
UK	57.9	9.1	31.1	157 662	4.37
EU-15 (³)	49.7	13.4	34.5	972 448	3.90
Cyprus	:	:	:	333	12.08
Czech Rep.	38.4	32.3	28.4	14 987	2.94
Estonia	:	:	:	2 681	-3.44
Hungary	27.8	31.8	40.5	14 666	7.10
Lithuania	:	:	:	8 075	1.40
Latvia	:	:	:	3 497	4.26
Poland	16.9	18.7	64.3	56 919	1.64
Slovenia	33.6	32.3	30.7	4 498	0.04
Slovakia	23.5	25.4	51.0	9 585	-0.86
EU-25 (³)	47.3	14.5	36.0	1 084 726	3.68
Bulgaria	:	:	:	9 217	-8.98
Romania	57.2	28.4	14.4	19 726	-8.23
Turkey	16.0	10.7	73.2	23 083	6.28
Iceland	45.9	22.8	27.7	1 859	8.52
Norway	55.7	15.6	28.7	19 752	3.09
Switzerland	62.9	1.6	35.5	25 755	4.45
US	80.5	3.8	14.7	1 261 227	4.28
Japan	63.7	5.0	29.6	675 898	1.83

Source: DG Research — Key Figures 2003-2004
Data : OECD, MSTI 2003/Vol.1, for non-OECD members: Eurostat/Member States
Notes: The sectors do not add up to 100% (¹) or latest available year: AT, UK: 1998, BE, DK, EL, US: 1999; FR, IE, IT, NL, EU-15, EU-25, TR, CH: 2000. (²) or nearest available years: AT: 1993-1998, EL: 1995-1999, US: 1997-1999; BE, DK: 1996-1999; FR, IE, IT, NL, EU-15, EU-25, TR, CH: 1996-2000; PT, FI, SE, IS, NO: 1997-2001; CY, EE: 1998-2001. (³) EU-15, EU-25 data are estimated by DG RTD and total numbers do not include LU or MT. EU-25 by sector data exclude LU, CY, EE, LT, LV and MT.

(EC, 2003, Key Figures 2003-2004 Towards a European Research Area Science, Technology and Innovation, DG Research)

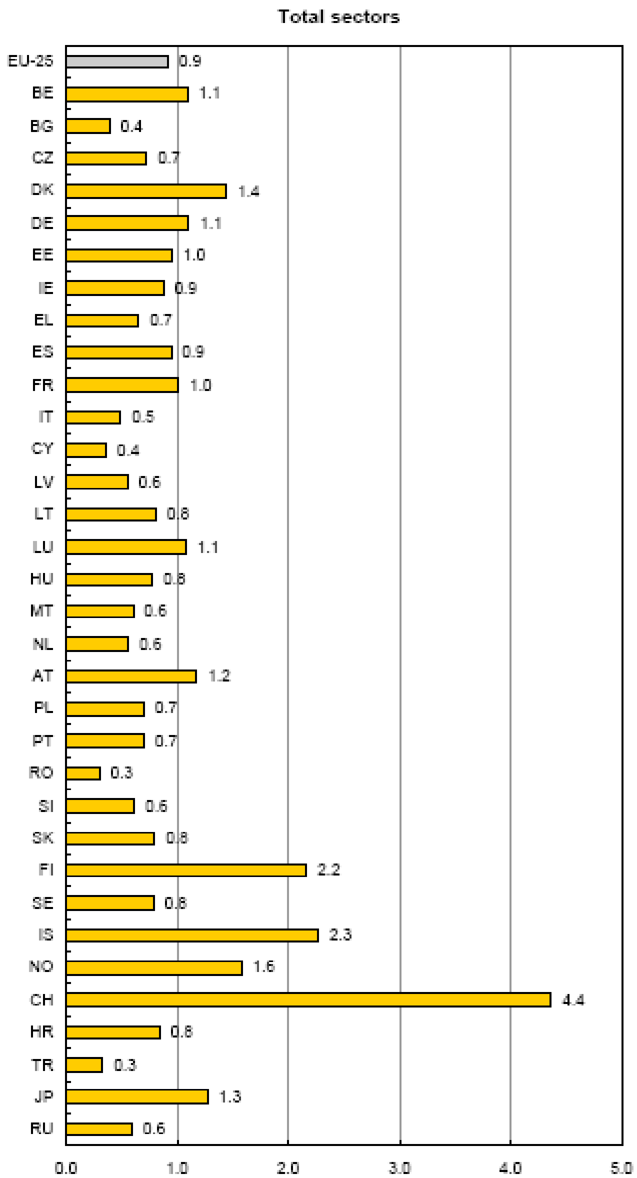
[12] Gotzfried A., (2004) 'Who are Europe's highly qualified human resources and where do they all work?' Statistics in Focus – Science and Technology 2004-11, Eurostat::1

[13] Wilen, H. (2006) 'Which are the characteristics of Europe's highly qualified human resources?' Statistics in Focus – Science and Technology 2006-08, Eurostat

3.1.1 R&D researchers in relation to the general labour force

Looking at the proportion of R&D workers in relation to total employment figures reveals that, in 2004, the EU-25 average (0.9 per cent) lagged behind competitors like Japan (1.3 per cent, Figure 1). On a country by country basis the two highest proportions of researchers in relation to total labour-force occurred in countries associated to the EU - Switzerland (4.4 per cent), and Iceland (2.3 per cent). The highest proportion in the EU was in Finland (2.2 per cent). Austria (1.2 per cent) was slightly higher than its neighbour Germany (1.1per cent). Of the newer Member States, Estonia had the highest proportion (1.0 per cent the same as France) followed by Slovakia, Hungary and Lithuania (0.8per cent – equal to the level in Sweden). The most recent Members of the EU, Bulgaria (0.4 per cent – equal to Cyprus) and Romania (0.3per cent –equal to Turkey) were among those countries with the lowest proportions of researchers to total employment.

Figure 1: R&D researchers as a percentage of total employment (HC), all sectors EU-25 and selected countries — 2004

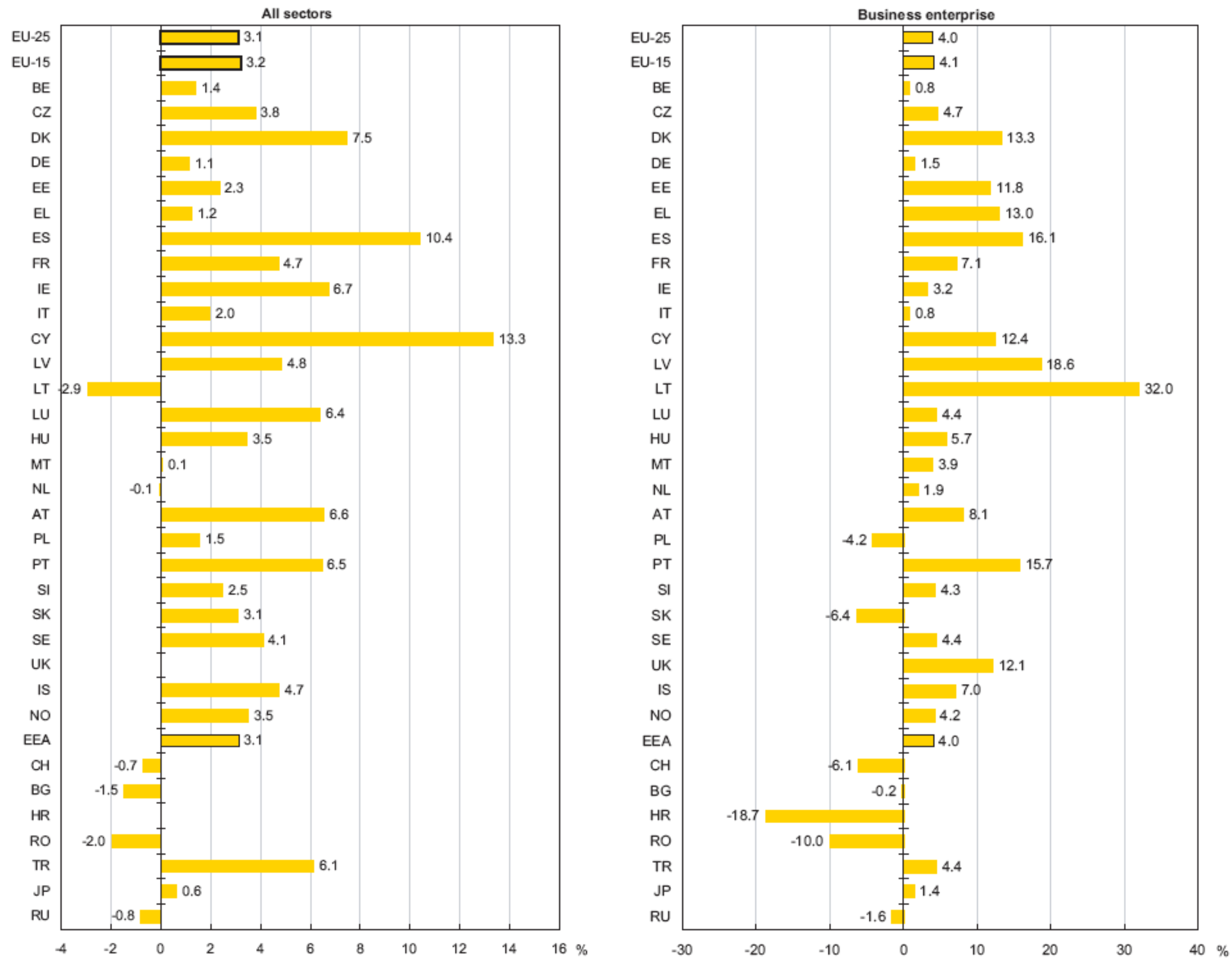


(Source: Gotzfried A., (2007) 'R&D Expenditure and personnel' Statistics in Focus – Science and Technology 2007-23, Eurostat:: 4)

3.1.2 Changes in R&D labour force

Between 2002-2004 there was faster growth in the number of researchers than that of the general R&D workforce in the EU, increasing by 3.5 per cent compared to 1.9 per cent (Gotzfried, 2007, p.6)[14]. The number of full time equivalent researchers in the EU had reached 1.2million by 2004 (an increase of 58,000 researchers from 2002), comparing unfavourably with the figure of 1.3million in the US in 1999 (EC 2006, p.60)[15]. There was much variation in the growth in R&D personnel between countries. In the EU 25, R&D personnel in business enterprise were on average growing faster than across all sectors between 1999-2004 (Figure 2). In this period only Bulgaria and Romania experienced a decline in R&D personnel across all sectors and in the business sector[16].

Figure 2 : Annual average growth rates (AAGR) of R&D personnel in FTE all sectors and business enterprise sector (BES), EU-25 and selected countries - 1999-2004



Eurostat estimates: EU-25, EU-15 and EEA.
Exceptions to the reference period:
1998-2002: AT,
1999-2003: FR, IT, PT, NO and JP,
1999-2002: TR,
2000-2004: LU,
2002-2004: MT.

Eurostat estimates: EU-25, EU-15 and EEA.
Exceptions to the reference period:
1999-2003: NO and JP.
1999-2002:TR.

(Source: EC (2006) Science, Technology and Innovation in Europe : 70)

[14] Gotzfried A. (2007) 'R&D Expenditure and personnel' Statistics in Focus – Science and Technology 2007-23, Eurostat
[15] EC (2006) Science, Technology and Innovation in Europe
[16] Switzerland and Russia also exhibited a decline in total R&D staff and business R&D staff

3.1.3 Scientists and engineers

Between 2000-and 2003 there was an annual average growth of 2.2 per cent in the number of scientists and engineers working in the EU-25. (Table 3). Within Europe there were big differences – the UK and Germany experienced limited growth at 0.5 and 0.6 per cent respectively. Slovenia (+12per cent), Hungary and Ireland (each +8.3 per cent) had the most rapid growth in scientists and engineers during this period, whereas Bulgaria[17] experienced a substantial decline in numbers (-10.3 per cent) as did Luxembourg (-6.9 per cent) Estonia (-6.1 per cent). Turning attention to the age profile of scientists and engineers, it is evident that some European countries have a limited number of younger workers in these fields. Focusing on scientists and engineers aged 25-34, the EU-25 average as a percentage of the total labour force in that bracket was 5.1 per cent in 2003. However, five countries had less than three per cent of scientists and engineers in this bracket – one 'old' member state Italy, and Slovakia, Latvia, Lithuania, Bulgaria (NB/ figures for Romania unavailable).

Table 3: Scientists and engineers, tertiary educated professionals or technicians (HRSTC) and professionals and technicians (HRSTO) by age, as a % of the respective labour force, 2000-2003

	Scientists & Engineers					HRSTC					HRSTO				
	1000s	As a % of the respective labour force			AAGR (%) 2000-2003	1000s	As a % of the respective labour force			AAGR (%) 2000-2003	1000s	As a % of the respective labour force			AAGR (%) 2000-2003
	25-64	25-34	35-44	45-64	25-64	25-64	25-34	35-44	45-64	25-64	25-64	25-34	35-44	45-64	25-64
EU-25	**8 504**	**5.1**	**4.5**	**4.4**	**2.2**	**28 571**	**17.3**	**15.1**	**14.6**	**2.6**	**50 869**	**28.7**	**27.5**	**27.1**	**2.3**
EU-15	**7 548**	**5.4**	**4.8**	**4.6**	**2.1**	**25 117**	**18.0**	**15.8**	**15.3**	**2.5**	**43 846**	**29.4**	**28.1**	**27.8**	**2.4**
BE	307	10.1	7.4	6.1	3.6	811	25.4	19.1	17.8	0.3	1 145	32.1	27.3	28.0	0.4
CZ	154	3.6	3.4	3.3	-1.5	457	9.9	11.3	9.4	3.1	1 313	29.0	29.8	28.4	2.1
DK	140	5.7	6.5	5.3	1.5	600	25.5	25.1	23.8	6.0	899	36.7	38.5	35.9	1.8
DE	1 928	5.6	5.9	5.1	0.6	5 896	15.7	17.2	17.4	0.9	11 495	33.2	32.8	32.8	1.3
EE	19	3.9 u	4.3 u	2.4 u	-6.1	88	14.7	14.4	16.7	-0.2	131	24.4	23.4	22.4	-0.6
EL	138	3.0	3.4	4.2	-1.1	568	14.9	17.8	12.5	2.1	741	20.7	22.5	15.9	2.0
ES	771	5.6	4.3	4.2	6.7	2 719	19.0	16.6	13.9	6.3	3 573	23.1	22.2	19.9	5.7
FR	1 177	5.3	4.3	5.3	5.4	4 064	23.7	14.9	14.4	2.6	6 820	32.3	26.4	28.4	4.0
IE	124	10.1	7.9	6.7	8.3	256	20.1	16.5	14.5	6.7	363	26.6	23.8	22.3	6.5
IT	601	2.1	2.8	3.4	1.5	2 209	9.3	10.0	11.2	4.5	5 836	24.6	27.5	28.5	3.4
CY	15	5.9	4.6	4.4	4.7	59	26.6	18.1	16.5	9.8	79	30.1	25.4	25.3	8.9
LV	35	2.1 u	3.8	4.5	:	101	11.6	9.5	10.5	:	209	24.0	20.7	21.0	:
LT	48	2.3	3.7	3.6	:	201	14.2	12.9	13.4	:	315	20.5	21.5	21.1	:
LU	7	4.1	4.4	3.5	-6.9	26	16.8	13.9	13.1	-5.0	59	36.1	30.8	32.4	1.0
HU	146	4.0	3.0	4.5	8.3	502	13.6	12.9	13.7	5.8	927	25.0	24.5	25.0	3.3
MT	4	7.0 u	: u	: u	:	12	17.5	7.2 u	6.3	:	29	30.5	20.6	20.9	:
NL	419	7.2	6.2	5.1	2.2	1 308	20.8	18.3	18.0	1.1	2 517	39.0	36.5	34.4	1.4
AT	79	2.7	2.2	2.3	0.2	394	12.2	12.1	11.2	6.6	856	27.6	26.1	23.5	2.1
PL	438	3.6	2.6	2.9	5.8	1 695	14.9	11.2	9.5	4.8	3 210	23.8	22.1	20.9	0.4
PT	109	3.4	2.2	2.0	1.0	382	11.6	8.2	6.6	3.0	644	18.0	13.9	12.4	1.5
SI	39	5.9	4.0	4.1	12.0	128	19.0	13.8	13.1	7.0	246	31.6	29.6	26.8	6.0
SK	58	2.9	2.2	2.8	0.5	212	10.0	8.4	10.0	5.6	563	24.4	24.5	26.4	2.6
FI	159	10.5	6.7	5.3	:	515	26.1	23.7	20.2	:	726	37.2	32.4	28.9	:
SE	252	7.7	6.8	5.3	2.0	900	25.3	21.4	21.7	3.5	1 563	40.1	39.0	38.6	1.7
UK	1 337	7.1	5.0	4.4	0.5	4 469	21.3	17.1	16.0	3.2	6 612	29.9	25.6	24.6	2.6
IS	9	8.8	6.6	5.5	-3.9	25	22.1	21.5	15.5	3.8	42	34.2	34.0	30.3	3.0
NO	109	5.9	5.5	5.0	2.4	490	30.2	23.8	21.4	0.8	733	39.9	36.0	35.1	1.6
CH	258	8.6	8.1	6.5	3.2	668	20.4	20.5	18.3	4.4	1 299	39.6	38.2	36.8	1.1
BG	84	2.2	3.5	2.7	-10.3	462	15.4	15.9	15.5	1.1	653	21.2	22.6	22.2	-0.9
RO	:	:	:	:	:	727	9.7	7.3	8.9	:	1 471	18.1	16.2	18.3	:

Exceptions to the reference year 2003
NL and IS: 2002.

Exceptions to the reference period 2000-2003
NL and IS: 2000-2002;
SE, UK and BG: 2001-2003.

EU-25 and EU-15 are estimated.
:u reliable data not available.
u data should be treated with caution.

(Source: Gotzfried A., (2004) 'Who are Europe's highly qualified human resources and where do they all work?' Statistics in Focus – Science and Technology 2004-11, Eurostat)

[17] For explanation of the decline in Bulgarian personnel cf. Velev, K. (2002) 'Young Scientists in Bulgarian universities and the brain drain problem' Paper to the International Conference in Higher Education management, 'Attracting Young Scientists – Strategies against Brain Drain', Bulgarian Ministry of Education and Science, Sophia (October 18th-20th) and Ackers, H.L. (2007) ESRC Science in Society Project MOBEX project.

3.2 Concentration of Resources

3.2.1 Regional concentration of labour force

The distribution of R&D workers in the ERA is heavily skewed; in 2003, 54 per cent of R&D personnel in the EU-25 were concentrated in Germany, France and the UK[18]. Figure 3 is a map depicting how heavily concentrated professionals and technicians are as a proportion of the labour force. Spain, Greece, Bulgaria, Hungary, Poland and Romania show low concentrations. Scandinavia, Germany, The Netherlands and Switzerland show some of the highest concentrations. In 2004, seven of the top fifteen European regions with the greatest concentrations of scientists and engineers in the labour market were in Germany, two were found in both Belgium and Spain, and one each in France, Finland, the Netherlands and the UK (Table 4). At the same time, Poland had five of the European regions with the least scientists and engineers in the labour force, Portugal had the three lowest concentrations, Greece had three, and Malta, Italy, Slovakia and Hungary each had one.

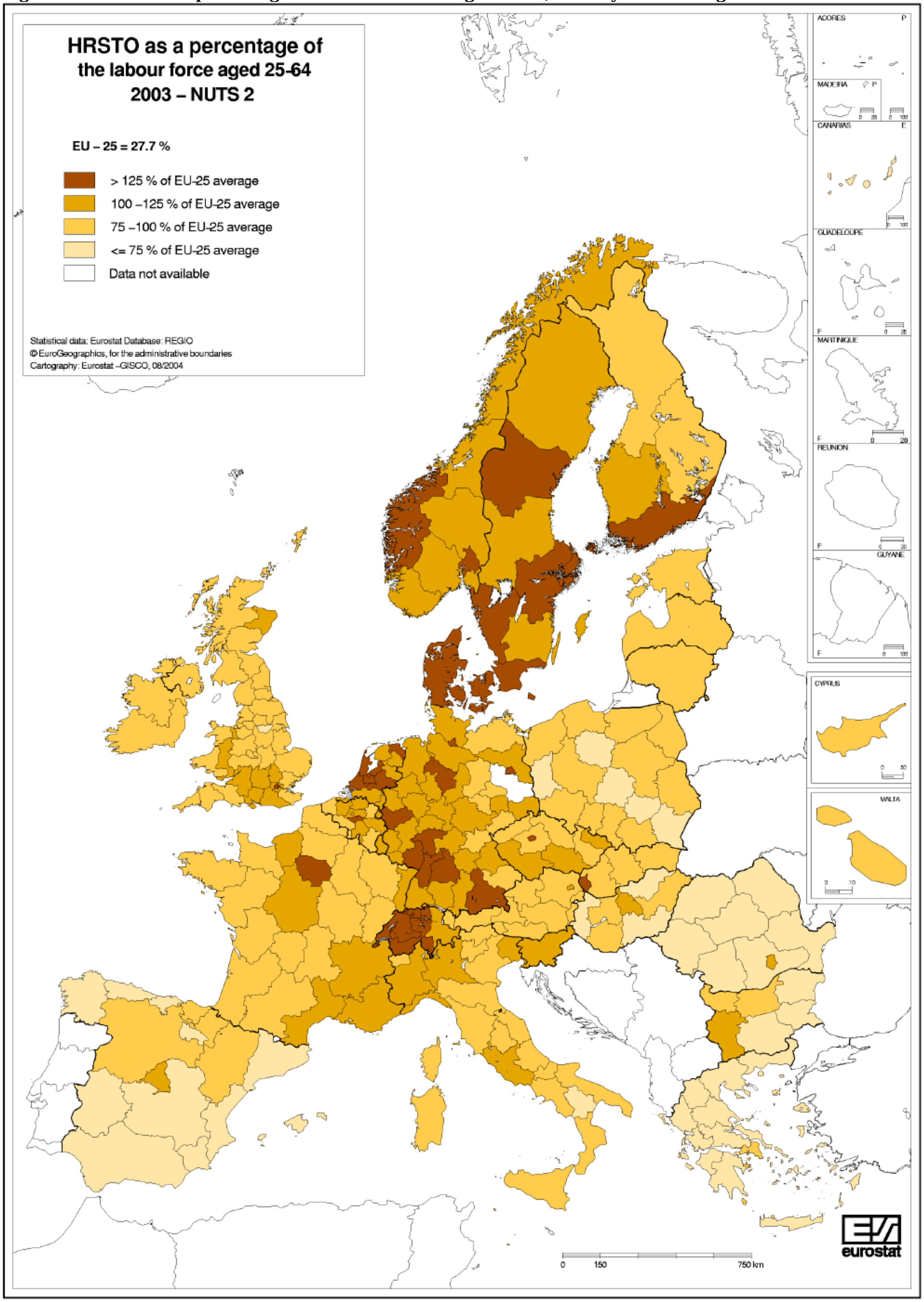
Table 4: Top and bottom regions in EU-25 at NUTS level 1 in terms of S&T labour force as % of the total labour force, share of women, 2004, and annual average growth rate for 1999-2004

	Region (NUTS level 1)	S&T labour force (HRST)			
		Total in 1000	% of Women	% of active population	*AAGR 1999-2004*
15 first regions	Bruxelles-Capitale (BE)	277	49.9	64.5	*6.5*
	Île de France (FR)	3 357	50.1	62.4	*6.0*
	Baden-Württemberg (DE)	1 049	50.3	60.4	*4.1*
	Åland (FI)	8	35.7 u	59.5	*8.1*
	West-Nederland (NL)	2 149	47.1	54.6	*7.2*
	Sachsen (DE)	1 171	50.7	53.5	*4.9*
	Comunidad de Madrid (ES)	1 517	49.3	52.3	*9.4*
	Noreste (ES)	1 041	47.6	52.3	*9.5*
	Hessen (DE)	1 510	43.7	51.8	*4.8*
	London (UK)	1 894	46.4	51.5	*5.1*
	Vlaams Gewest (BE)	1 388	48.0	51.3	*5.8*
	Mecklenburg-Vorpommern (DE)	453	51.3	51.1	*5.4*
	Brandenburg (DE)	689	51.8	50.9	*4.5*
	Hamburg (DE)	441	47.8	50.9	*3.8*
	Thüringen (DE)	616	52.1	50.5	*3.7*
15 last regions	Dunantul (HU)	401	56.6	30.7	*5.1*
	Poludniowy (PL)	1 061	59.1	30.6	*4.7*
	Slovenska Republika (SK)	803	57.2	30.4	*5.5*
	Poludniowo-Zachodni (PL)	490	57.8	29.4	*4.3*
	Isole (IT)	717	49.5	29.2	*4.9*
	Malta (MT)	46	39.1	29.1	*:*
	Wschodni (PL)	864	57.7	28.8	*4.7*
	Polnocny (PL)	688	57.0	28.5	*4.7*
	Voreia Ellada (EL)	434	48.3	28.4	*6.6*
	Polnocno-Zachodni (PL)	777	56.7	27.9	*5.1*
	Nisia Aigaiou, Kriti (EL)	127	45.9	26.5	*13.9*
	Kentriki Ellada (EL)	245	45.5	23.8	*12.1*
	Continente (PT)	1 133	51.4	21.6	*10.9*
	Região Autónoma da Madeira (PT)	22	58.5	18.9	*18.8*
	Região Autónoma dos Açores (PT)	17	54.3	15.4	*6.3*

(Source: Wilen, H. (2006) Regional Concentration of Science and Technology Labour Force in the EU, Statistics in Focus – Science and Technology 2006-9, Eurostat

[18] Gotzfried, A. (2005) 'Science, Technology and Innovation in Europe', Statistics in Focus, August 2005

Figure 3: HRSTO as a percentage of the labour force aged 25-64, 2003 by NUTS 2 regions



EU-25 is estimated.

(Source: Gotzfried A., (2004) 'Who are Europe's highly qualified human resources and where do they all work?' Statistics in Focus – Science and Technology 2004-11, Eurostat: 6)

3.2.2 R&D concentration by sectors

Diversity is evident in the sectors in which R&D is being conducted in the EU - partially influenced by the countries practices (where research funding is channeled) and by the presence of, and attractiveness to, business enterprise. In 2003, there were more R&D personnel working in the business enterprise sector than in Government, or Higher Education in the EU-25 (Table 5). The Government sector had the least personnel directly involved in R&D in the EU-25(0.19 per cent). Luxembourg, Finland, Denmark and Sweden had the largest proportion of researchers working in R&D in the business sector compared to total employment in their country. Lithuania had the least R&D personnel in the business sector (0.05 per cent) with a much greater share in HE. Bulgaria had a high proportion of R&D personnel in the Government sector compared to total employment (0.38 per cent) and the second lowest proportion of R&D personnel in the business sector but had the joint lowest proportion in Higher Education too (0.14per cent equal to Romania).

Table 5: R&D personnel (HC) as a percentage of total employment, by sector of performance, EU-25 and selected countries - 2001 to 2003

	All sectors			Business enterprise			Government			Higher education		
	2001	2002	2003	2001	2002	2003	2001	2002	2003	2001	2002	2003
EU-25	1.41 s	1.43 s	1.44 s	0.64 s	0.65 s	0.66 s	0.19 s	0.19 s	0.19 s	0.56 s	0.57 s	0.58 s
EU-15	1.51 s	1.54 s	1.54 s	0.72 s	0.74 s	0.74 s	0.19 s	0.19 s	0.19 s	0.58 s	0.59 s	0.60 s
BE	:	1.81	1.82	1.02	0.93	0.93	:	0.09	0.10	0.67 e	0.78	0.78
CZ	1.04	1.13	1.18	0.42	0.47	0.51	0.27	0.29	0.28	0.34	0.37	0.38
DK	2.20	2.27	2.29	1.26	1.38	1.37	0.37	0.18	0.19	0.56	0.69	0.72
DE	:	:	1.85	:	:	0.93	:	:	0.24	:	:	0.69 p
EE	1.18	1.19	1.29	0.20	0.20	0.26	0.16	0.17	0.19	0.81	0.81	0.82
EL	1.36	:	1.34	0.32	:	0.30	0.21	:	0.21	0.82	:	0.82
ES	1.30	1.40	1.45	0.34	0.44	0.48	0.20	0.19	0.20	0.75	0.76	0.76
FR	:	1.71	1.73	:	0.84	0.85	:	0.21	0.21	:	0.62	0.64
IE	:	1.39	1.43 p	0.72	0.68	0.67	:	0.09	0.09	:	0.62	0.67 p
IT	1.10	1.16	1.13	0.36	0.39	0.37	0.18	0.18	0.19	0.56	0.56	0.55
CY	0.56	0.61	0.64	0.16	0.16	0.17	0.22	0.24	0.22	0.13	0.16	0.18
LV	0.87	0.93	0.80	0.18	0.24	0.12	0.16	0.16	0.15	0.53	0.53	0.53
LT	1.09	0.95	0.99	0.07	0.04	0.05	0.35	0.25	0.22	0.67	0.67	0.71
LU	:	:	2.20	:	:	1.88	0.23	0.25	0.29	0.03	:	0.03
HU	1.18	1.26	1.24	0.22	0.24	0.24	0.27	0.30	0.29	0.69	0.71	0.71
MT	:	:	:	:	:	:	:	0.17	0.02	:	0.53	0.56
NL	:	1.34	1.32	0.76	0.75	0.71	0.17	0.17	0.20 b	:	0.40 e	0.41 e
AT	:	1.79	:	:	0.93	:	:	0.16	:	:	0.68	:
PL	0.87	0.89	0.92	0.16	0.08	0.11	0.14	0.21	0.19	0.57	0.60	0.63
PT	0.77	0.81 e	0.86	0.13	0.16 e	0.19	0.17	0.15 e	0.14	0.37	0.39 e	0.42
SI	1.35	1.34	1.40 e	0.55	0.58	0.63 e	0.32	0.31	0.30 e	0.46	0.44	0.43 e
SK	1.04	1.00	0.97	0.28	0.26	0.21	0.21	0.21	0.21	0.54	0.53	0.55
FI	2.90	3.04	3.11	1.58	1.63	1.67	0.43	0.42	0.41	0.90	0.96	1.00
SE	2.56	:	2.49	1.23	:	1.20	0.12	:	0.13	1.20	:	1.15
UK	:	:	:	:	:	:	:	0.09	0.08	:	:	:
IS	3.32	3.19 e	3.48	1.24	1.16 e	1.40	0.85	0.83 e	1.11	0.96	0.94 e	0.84
NO	2.14	2.23	2.26	0.93	0.98	1.00	0.28	0.29	0.29	0.93	0.96	0.97
EEA	1.42 s	1.44 s	1.45 s	0.64 s	0.65 s	0.66 s	0.19 s	0.19 s	0.20 s	0.56 s	0.57 s	0.58 s
CH	:	:	:	:	:	:	:	0.04	:	:	0.71	
BG	0.60	0.60	0.61	0.07	0.07	0.08	0.40	0.39	0.38	0.13	0.14	0.14
HR	:	1.09	1.12	:	0.17	0.15	:	0.32	0.36	:	0.60	0.62
RO	0.35	0.39	0.43	0.19	0.20	0.18	0.08	0.09	0.10	0.08	0.10	0.14
TR	0.36	0.38	:	0.04	0.04	:	0.04	0.04	:	0.28	0.30	:
JP	1.59	1.58	1.66	0.95	0.93	1.00	0.10	0.11	0.11	0.50	0.51	0.52
RU	1.37	1.32	1.30	0.91	0.86	0.85	0.40	0.39	0.39	0.07	0.07	0.07

(Source: EC (2006) Science, Technology and Innovation in Europe : 63)

3.2.3 Women Researchers

There are more male R&D workers than female in Europe (Table 6). A 'horizontal segregation' of female researchers exists; women tend to congregate in publicly funded research (in governmental research centres or Higher Education) rather than in the industrial sector. In the EU, as a whole, the majority of research & development expenditure is in the industrial sector but women are least likely to research in this sector (Götzfried 2004[19]). In Germany - the country with the largest research base in Europe - only 25 per cent of R&D staff were women in 2003; 37 per cent were women in HE and Government R&D, but in the largest sector of Business enterprise just 19 per cent were women.

Table 6: R&D personnel in FTE and percentage of females, by sector of performance, EU-25 and selected countries - 2003 and 2004

	All sectors			Business enterprise			Government			Higher education		
	2003		2004	2003		2004	2003		2004	2003		2004
	R&D PSL in FTE	% of women	R&D PSL in FTE	R&D PSL in FTE	% of women	R&D PSL in FTE	R&D PSL in FTE	% of women	R&D PSL in FTE	R&D PSL in FTE	% of women	R&D PSL in FTE
EU-25	2 021 395 s	:	2 047 530 sp	1 079 424 s	:	1 093 977 sp	297 688 s	:	292 414 sp	620 696 s	:	636 849 sp
EU-15	1 850 998 s	:	1 872 670 sp	1 036 159 s	:	1 047 544 sp	249 362 s	:	246 948 sp	542 689 s	:	554 700 sp
BE	52 240	30	53 938 e	31 375	22	32 004 e	3 757	33	4 039 e	16 516	44	17 302 e
CZ	27 957	32	28 765	13 711	22	15 064	7 977	43	7 422	5 987	39	6 104
DK	41 616	39	44 279 p	27 230	36	29 747 p	3 448	43	3 070 p	10 697	44	11 204 p
DE	472 533	25	469 100 e	298 072	19	298 100 p	73 867	37	72 000 e	100 594 p	37 p	99 000 e
EE	4 144	49	4 735 p	763	32	1 083 p	829	63	810	2 454	49	2 752
EL	31 822 p	35	31 843 p	11 581 p	19	10 984 p	5 101	42	5 137 p	14 947	44	15 519 p
ES	151 487	36	161 933	65 032	27	71 123	25 760	47	27 166	60 307	41	63 331
FR	346 078	:	:	193 256	:	:	51 372	:	:	95 234	:	:
IE	14 450	29	15 713 e	9 281	22	9 650 e	1 161	37	1 222	4 009	43 p	4 841
IT	161 828	33	:	67 958	18	:	31 463	42	:	59 406	44	:
CY	922	38	940 p	217	34	230 p	370	42	350 p	271	33	295 p
LV	4 858	56	5 103	886	51	881	996	65	1 013	2 976	55	3 208
LT	9 648	54	10 557	664	47	981	3 157	56	3 041	5 827	53	6 535
LU	4 010	22	4 177 e	3 500	20 e	3 556 e	476	35	576 p	34	73	45
HU	23 311 i	:	22 826 pi	7 180	:	6 704 p	7 859 i	:	7 595 pi	8 272	:	8 527 p
MT	413	:	395	93 p	:	94	36	13	17	284	33	284
NL	85 986	:	89 522 p	44 485	:	49 014 p	14 251 b	:	13 479 p	27 209	39	27 000 p
AT	38 893	22	:	26 728	14	:	2 060	41	:	9 879	38	:
PL	77 040	37	78 362	11 378	22	12 978	21 100	38	19 685	44 455	40	45 572
PT	25 529	46	:	6 124	29	6 378	4 917	58	5 149	11 147	49	11 601
SI	8 731 e	37 e	8 830 e	4 722 e	33 e	4 945 e	2 160 e	46 e	2 040 e	1 624 e	38 e	1 586 e
SK	13 354	46	14 329	3 651	37	3 473	3 842 i	55	3 493 i	5 857	45	7 286
FI	57 196	:	58 281	31 861	:	32 612	7 353	:	7 337	17 486	:	17 822
SE	72 978	18	72 459	48 113	25	47 123	3 000	34	3 056	21 495	:	21 910
UK	:	:	:	162 863	:	162 899	20 956	38	20 763 e	:	:	:
IS	2 940	39	3 050	1 352	34	1 422	775	38	794	728	46	746
NO	29 014	:	29 635	16 126	:	16 150	4 970	:	4 985	7 918	:	8 500
EEA	2 053 352 s	:	2 080 407 sp	1 096 904 s	:	1 111 731 sp	303 433 s	:	298 194 sp	629 342 s	:	646 095 sp
CH	:	:	52 250	:	:	33 085	:	:	810	:	:	18 355
BG	15 453	53	15 647	2 091	52	2 158	10 417	57	10 384	2 875	40	3 036
HR	9 148	52	:	2 165	48	1 981	3 275	54	3 458	3 708	53	3 347
RO	33 077	47	33 361	16 942	44	16 368	9 395	53	9 853	6 537	47	6 917
TR	28 964	:	:	5 918	:	:	5 502	:	:	17 544	:	:
RU	973 382	:	951 569	592 625	:	568 173	278 756	:	282 422	99 299	:	99 402

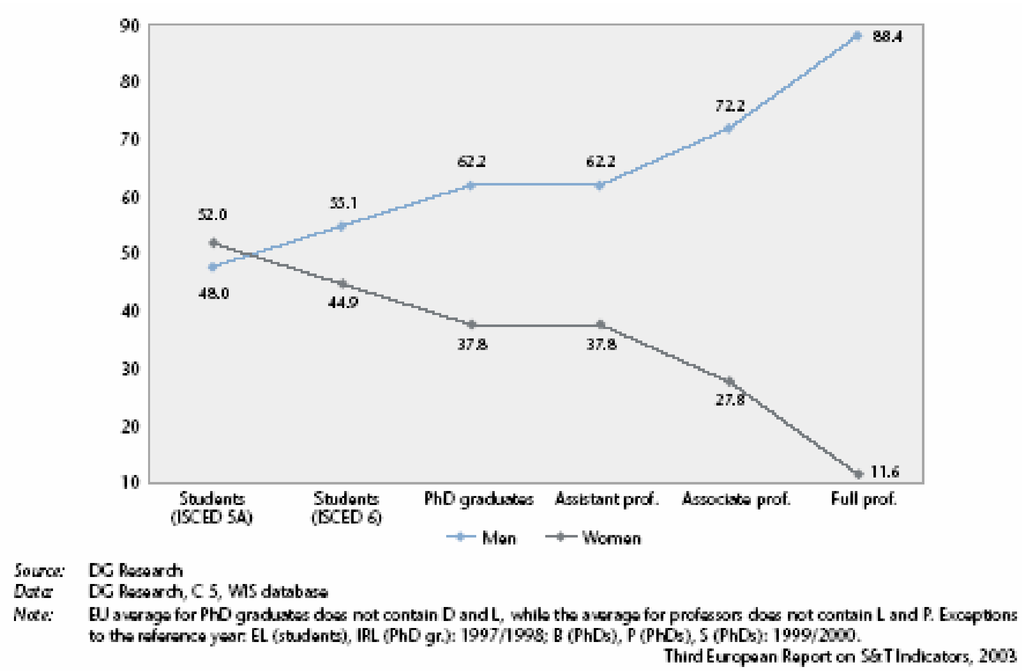
(i) HU, SK: defence excluded (all or mostly).
Exception to the reference year: AT, TR 2002.

(Source: EC (2006) Science, Technology and Innovation in Europe : 65)

[19] For instance, in Austria 64% of R&D expenditure is in the industrial sector yet only 9% of researchers in that sector are women Götzfried, A. (2004) 'Women, science and technology: Measuring recent progress towards gender equality' Statistics in Focus, THEME 9 – 6/2004, Eurostat

Along with horizontal segregation (by sector and field) there is also evidence of vertical segregation. In the EU-15 men are on average 2.9 times more likely than women to end up in a top academic post (ENWISE 2004)[20]. This obvious disparity between men and women's achievement of seniority cannot be explained purely by the lower numbers of women in science. Pictorially, it is possible to show the declining proportion of women in academia within Europe (Figure 4).

Figure 4 Scissor diagram for EU average % by gender, 1998-99



(EC, 2003, Key Figures 2003-2004 Towards a European Research Area Science, Technology and Innovation, DG Research)

Whilst women outnumbered men in the EU for first degrees in 1998/99, they only made up just over a third of PhD students and assistant professorships, dropping to just over a quarter of associate professors and only 12% of full professors were women. Low proportions of women signify not only gender inequality but also a loss of skilled personnel from the science sector, something which the European Commission is keen to rectify. Laafia[21] (2000) points to the "importance of human capital as an engine of growth" and science personnel's contribution to a "knowledge based economy" in which women can play a major role:

> *'A greater involvement of women in research would enrich European science, in terms of its methods, the subjects on which it focuses and the objectives assigned to scientific research. Failure to take advantage of this potential enrichment would harm Europe's interests.' (EC COM(99)76 final)*

Even with greater attention to the problem of progression for female scientists the imbalance in positions of seniority remains steadfast. Women in professorial positions have been increasing by 0.5-1.0% per year in the EU, leading the authors of the ETAN report to conclude that: "*Clearly, **waiting** for a gender balance among the professoriat in European universities is not a particularly effective strategy*." (ETAN 2000: 12)[22].

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[20] ENWISE (2004) Wasted Talents: Turning Private Struggles into a Public Issue: Women and science in the ENWISE countries' European Communities: Luxembourg

[21] Laafia I. (2000) 'Human resources in Science and Technology: A European Perspective' *Statistics in Focus*, Theme 9-1/2000, European Communities: Luxembourg

[22] ETAN (2000) Science Policies in the European Union: Promoting excellence through mainstreaming gender equality, European Communities: Italy

SECTION 4: Internationalisation and mobility of R&D labour forces

4.1 Data issues

Little data is available on the proportion of foreign R&D or science and engineering staff that are working, or visiting, different countries in Europe. Kupiszewski[23] describes some of the key problems frustrating accurate statistical analysis of flows that include: lack of uniform definitions and the inability to distinguish long-term settlement from short-term migration and capture ‘pendulum migrations’. His overview of current data uncovered massive differences between migration figures sourced in the country of origin and host countries (which in some cases vary by a magnitude of thirty-fold). Other experts in the field of highly skilled migration come to similar conclusions. Singleton[24] (1999) provides a review of the limitations of data on international migration collated by Eurostat, arguing that although endeavours have been made to aggregate datasets, problems still remain. For instance, at national level the definitions for international migration are based upon varying lengths of stay abroad, thus, “…many migrants go unrecorded in any system or database”(Singleton 1999:152). For Iglicka[25], official statistics does not allow for a proper analysis of migration as much migration is not officially recorded. On that basis, such data can provide the, ‘starting point for further in-depth analysis’ (2000:.64). The patterns and processes of highly skilled migrations are also problematic to capture. Salt and Ford (1995) argue that relatively small numbers of people are moving that may render them statistically invisible. They note this is particularly an issue for workers moving within multi-national companies where, “no cross-sectional or longitudinal data exist which enable length of stay of corporate relocations, secondments and business travel to be analysed” (1995: 296)[26]

A further practical difficulty is the availability of data. As European workers have the right to work in other EU countries there are few sources that provide data on intra-EU flows (unlike flows to the US where visa information can be used, or registration data held as is the case for students or certain professions). Even where active recruitment is taking place, for example the introduction of the European Scientific Visa[27], the European Commission provides no detail on the number of international researchers in the EU, nor estimations of the scale or destinations the scheme is planned to generate. It is with these caveats in mind that the following sections scope the levels of internationalisation in EU countries and discuss the consequences of further facilitating mobility.

4.2. Internationalisation

4.2.1 Internationalisation in the ‘training’ pool of researchers in Europe

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[23] Kupiszewski, M. (2002) How trustworthy are forecasts of international migration between Poland and the European Union?, in Journal of Ethnic and Migration Studies, 28 (4) pp627-645.

[24] Singleton, A. (1999). ‘Combining quantitative and qualitative research methods in the study of international migration.’ International Journal of Social Research Methodology 2(2): 151-157.

[25] Iglicka, K. (2000) Mechanisms of migration from Poland before and during the transition period’, Journal of Ethnic and Migration Studies, 26 (1), pp.61-73.

[26] Salt J. and Ford R.(1995) “Skilled international migration in Europe: the Shape of Things To Come”? in King R (ed) (1995) Mass Migration in Europe: the legacy and the future, Chichester: Whiley: 293-309

[27] EC Directive 2005/71 on a specific procedure for admitting third-country nationals for the purposes of scientific research The UK and Denmark are the only two EU member states *not* introducing the "scientific visa" package, which aims to streamline the process of entry for international staff. The remainder of EU countries are due to transpose this directive into their national legislation by 12th, October 2007.

Table 7 demonstrates the diversity in the numbers of graduates in different EU countries and the proportion of tertiary graduates in Science, mathematics and computing.

Table 7: Graduation from tertiary education in selected countries–ISCED 5&6- in 2002

	Total Graduates		Science, Mathematics and Computing	
	Total	As a % of population aged 20-29	Total	% of total graduates
DE	293 920	3.3	27 131	9.2
P	459 737	7.8	16 721	3.6
UK	562 374	7.7	94 621	16.8
BG	50 599	4.6	2780	5.5
TR	233 605	:	22 009	9.4
US	2 238 327	:	210 567	9.4

(Source: selected data from Gotzfried A. (2005, p.4)[28]

The last thirty years has seen a massive growth in the number of students studying at tertiary level in a different country from 0.6 million worldwide in 1975 to 2.7 millions in 2004 (OECD, 2006, : 286)[29]. Numerically, the US was the largest host of foreign students in 2004 (22 per cent), followed by the UK (11 per cent), Germany (10 per cent) and France (9 per cent) (OECD, 2006: 288). The number of students undertaking tertiary level studies in the EU continues to increase, and had reached around 895,000 in 2002, an increase of 19% from 1999 (Wilen 2005, p1). Students studying in another EU country accounted for around half of all foreign students[30] The UK and Germany stand out as the two major EU host countries for students, '*The UK, with around 227 000, and Germany, with about 219 000, accounted for 25.4% and 24.5% respectively of all reported foreign students for the EU. In both of these countries, foreign students represented around 10% of all students at the tertiary level, slightly up compared to its 1999 level for Germany, but down for the UK*.' (Wilen, 2005:2.) However, these major 'host' countries are recruiting different pools of students, often influenced by geographic proximity – as Table 8 shows, Germany recruits over half all the Polish and Turkish students who are studying abroad whereas the UK recruits 82.5 per cent of Irish students that are being educated abroad.

[28] Gotzfried A. (2005) 'Science, technology and innovation in Europe' Statistics in Focus – Science and Technology 2005-08, Eurostat

[29] OECD, (2006) Education at a Glance 2006

30 Wilen, H. (2005) 'Increasing numbers of foreign students in the EU, decreasing job-to-job mobility of HRST', Statistics in Focus – Science and Technology 2005-01, Eurostat

Table 8 : Proportion of tertiary level students who are studying abroad from OECD countries of origin, in the UK, Germany and US in 2004

Country of Origin	Country of destination		
	Germany	UK	US
Australia	3.5	16	28.9
Austria	5.6	10.6	7.3
Belgium	9.3	22.1	7.5
Canada	1.4	9.9	**68.8**
Czech Republic	35.1	5.1	14.9
Denmark	10.6	25.2	13.0
Finland	10.6	18.8	6.2
France	11.7	19.7	11.9
Germany	-	19.6	14
Greece	14.8	44.6	4.2
Hungary	38.5	4.6	12.4
Iceland	5.2	9.9	15.3
Ireland	2.7	**82.5**	5.7
Italy	18.1	11.6	7.4
Japan	4.1	10.4	**66.5**
Korea	5.6	3.5	**53.5**
Luxembourg	30.1	12.1	0.7
Mexico	4.0	8.1	**54.4**
Netherlands	15.3	20.1	12.3
New Zealand	1.0	8.3	14.6
Norway	5.1	23.5	9.5
Poland	**50.6**	3.2	9.6
Portugal	15.1	20.8	6.9
Slovak Republic	10.4	1.0	3.7
Spain	21.8	22.1	13.2
Sweden	6.0	24.3	22.4
Switzerland	21.0	14.2	15.1

Turkey	**50.7**	3.6	21
UK	8.4	-	32.8
US	7.3	28.7	-
Total from OECD countries	14.2	16.1	

(Source: selected destination countries from OECD, (2006) Education at a Glance 2006, pp.308-309)

When looking at the number of foreign students in tertiary education in EU countries in 2003, Cyprus has the highest proportion (28.9 per cent but the number of students is relatively low), followed by Austria (13.5 per cent), the UK and Belgium (11.2 per cent each), and Germany (10.7 per cent). Leaving aside Cyprus again, the proportion of foreign students in science and engineering subjects was highest in the UK (15.5 per cent), followed by Denmark (13.2 per cent) then Austria (12.9 per cent) and Germany (11.8 per cent) (EC, 2006:85 – see Figure 5 below).

Figure 5: Foreign students in tertiary education, total and S&E, 2003

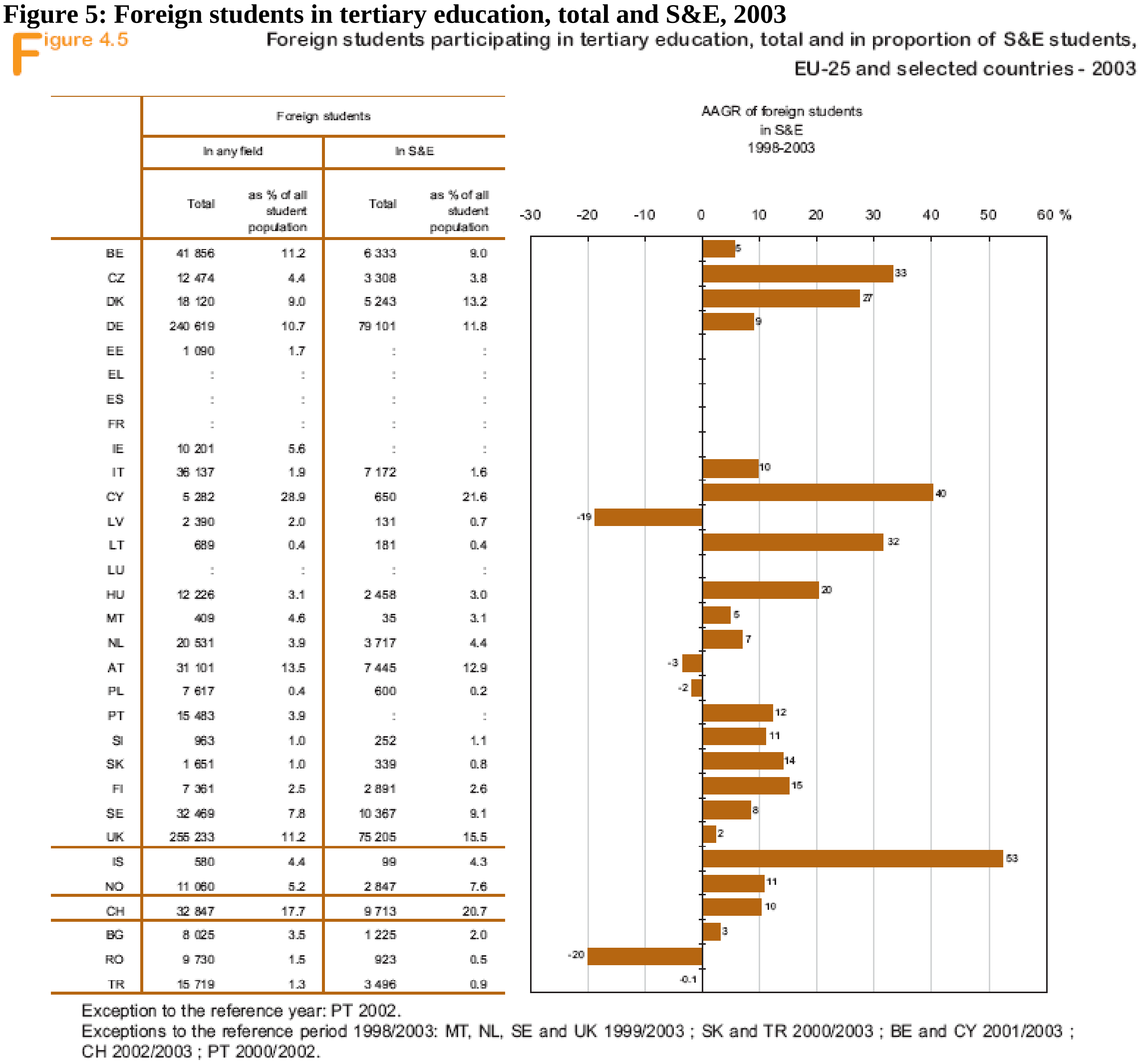


Figure 4.5 Foreign students participating in tertiary education, total and in proportion of S&E students, EU-25 and selected countries - 2003

	Foreign students: In any field – Total	In any field – as % of all student population	In S&E – Total	In S&E – as % of all student population	AAGR of foreign students in S&E 1998-2003 (%)
BE	41 856	11.2	6 333	9.0	5
CZ	12 474	4.4	3 308	3.8	33
DK	18 120	9.0	5 243	13.2	27
DE	240 619	10.7	79 101	11.8	9
EE	1 090	1.7	:	:	
EL	:	:	:	:	
ES	:	:	:	:	
FR	:	:	:	:	
IE	10 201	5.6	:	:	
IT	36 137	1.9	7 172	1.6	10
CY	5 282	28.9	650	21.6	40
LV	2 390	2.0	131	0.7	-19
LT	689	0.4	181	0.4	32
LU	:	:	:	:	
HU	12 226	3.1	2 458	3.0	20
MT	409	4.6	35	3.1	5
NL	20 531	3.9	3 717	4.4	7
AT	31 101	13.5	7 445	12.9	-3
PL	7 617	0.4	600	0.2	-2
PT	15 483	3.9	:	:	12
SI	963	1.0	252	1.1	11
SK	1 651	1.0	339	0.8	14
FI	7 361	2.5	2 891	2.6	15
SE	32 469	7.8	10 367	9.1	8
UK	255 233	11.2	75 205	15.5	2
IS	580	4.4	99	4.3	53
NO	11 060	5.2	2 847	7.6	11
CH	32 847	17.7	9 713	20.7	10
BG	8 025	3.5	1 225	2.0	3
RO	9 730	1.5	923	0.5	-20
TR	15 719	1.3	3 496	0.9	-0.1

Exception to the reference year: PT 2002.
Exceptions to the reference period 1998/2003: MT, NL, SE and UK 1999/2003 ; SK and TR 2000/2003 ; BE and CY 2001/2003 ; CH 2002/2003 ; PT 2000/2002.

(Source: EC 2006: 85)

When taking into account the total participation of foreign students in tertiary education (i.e. including mobility from outside Europe) the UK and Germany are still the major receiving countries (and host about equal numbers of students from outside Europe to the number of European students).

Figure 6 shows the number of all foreign students studying in science and engineering in the EU or candidate countries (for the EU-15 and candidate countries that figures are known for).

Around a third of all foreign students in Finland, Germany and the UK study in science and engineering (although in total S&E students this only accounts for 2 per cent Finland, 10 per cent Germany, 13 per cent UK). Cyprus hosts the most foreign students proportionally to domestic S&E students (foreign students account for 16 per cent of total S&E students) but as the Higher Education system is small this relates to only 331 students. Nearly a quarter of all foreign students in Portugal and Austria were studying S&E this comprised 12 per cent of total S&E students in Austria and only 3 per cent in Portugal. In 2001, the country with the lowest proportion of foreign S&E students compared to domestic S&E students was Italy at just 1 per cent.

Figure 6 Participation of foreign students in tertiary education in 2001 - total share of science and engineering students

	Foreign students in any field	Foreign students in S&E fields		Share of foreigners in total S&E students (%)
	Total	Total	%	
BE	38 150	5 691	17.7	7
DK	12 586	2 930	23.3	7
DE	199 132	61 684	32.6	10
EL	:	:	:	
ES	40 689	:	:	
FR	:	:	:	
IE	8 207	:	:	
IT	29 228	5 433	18.6	1
LU	:	:	:	
NL	16 589	3 073	18.6	4
AT	35 891	8 782	24.5	12
PT	14 202	3 460	24.4	3
FI	6 288	2 378	37.8	2
SE	26 304	8 250	31.4	8
UK	225 722	74 047	32.8	13
CZ	7 750	1 997	25.8	3
EE	863	:	:	
CY	2 472	331	13.4	16
LV	7 917	180	2.3	1
LT	628	94	15.0	0.3
HU	11 242	2 290	20.4	
MT	341	25	7.3	3
PL	6 659	580	8.7	0.2
SI	864	235	27.2	1
SK	1 690	217	12.8	1
BG	8 130	1 205	15.0	2
RO	11 669	961	8.4	1
TR	16 656	3 492	21.0	1
IS	421	53	12.6	
NO	8 857	2 045	25.6	
JP	63 637	11 372	19.9	

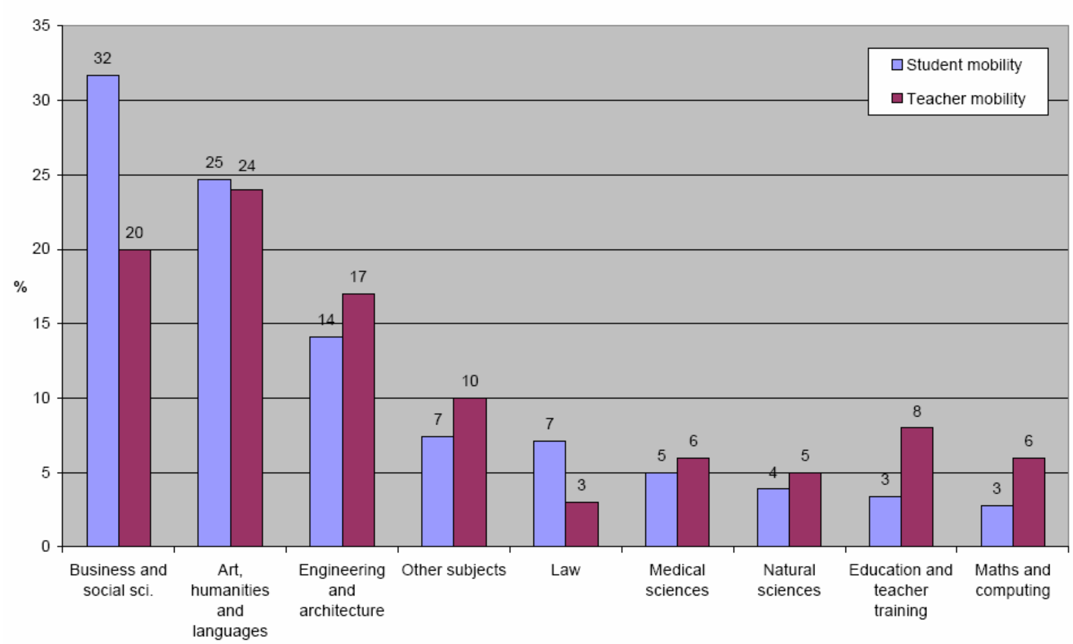
Exceptions to the reference year — ES and AT: 2000.

Source: Eurostat, S&T statistics — UOE questionnaire.

(Source Strack 2003b: 3)

The ERASMUS scheme has been a major route through which intra-European mobility is experienced during a first degree. In 1987/88, there were 3244 mobile students in the Erasmus scheme; this had grown to 123,957 in 2002/03. The natural sciences, maths and computing are among the least mobile fields under the Erasmus programme (See Figure 7). In 1987/88, 157 students in the natural sciences were on the Erasmus scheme, in 2002/03 this had risen to 4,841. However, the growth in mobility has been much more pronounced in other subjects. For instance, in 1987/88 156 social sciences students were on Erasmus but this rose to 12,684 in 2002/02.

Figure 7: Erasmus student and teacher subject areas 2002-03



(Source: http://europa.eu.int/comm/education/programmes/socrates/erasmus/stat_en.html)

4.2.2 Internationalisation in the labour market[31]

Disappointingly, there is very little data that maps the mobility patterns of researchers and academics in Europe, and that which exists is piecemeal and does not all cover gender. Schemes like the Marie Curie Fellowships, DAAD and Wellcome Trust collect demographic details about their fellows which is useful to show patterns of formal mobility. Nevertheless, the 'bigger' picture of research mobility, particularly that outside of fellowship schemes, or the mobility of 'tied movers' (partners working in science) goes largely unrecorded statistically.

A study funded by the World Bank notes skilled workers usually move to industrialized nations (Docquier and Marfouk, 2004:6) [32]. Using census data they found that in the year 2000, the UK had the largest emigration stock of skilled workers in the world (1 542 011), followed by the Phillipines (1 260 879), India (1 021 613), Germany and China (1 016 007), the US was at tenth place (428 078) (Docquier and Marfouk, 2004:32).

An indicator that does show turnover of jobs (but not where recruits come from) is the number of human resources in science and technology who experience job-to-job mobility on a yearly basis. In 2004, 925,000 people experienced job to job mobility in the UK (9.5 per cent of the total employed HRST), followed by Germany with 730,000 individuals (5.1 per cent of the total employed HRST) (EC, 2006, p.108).

Germany hosted the most European S&T workers (from elsewhere in Europe) in its domestic S&T labour force, 84.5 per 1000, this was followed by the UK with 43.4 per 1000 and France with 32.7 per 1000 (Table x). The UK, Germany, France, Belgium, Sweden and Luxemburg all hosted more

[31] Further detail on the international make-up of the research workforce in two of the EU's major 'host' countries the UK and Germany are available as part of the ResIST WP2

[32] Docquier F. and Marfouk, A. (2004) Measuring the international mobility of skilled workers (1990-2000) - Release 1.0, World Bank

European S&T workers than they sent to other countries in Europe. All countries in the EU-15 send more S&T workers to Germany than Germany sends to them.

In terms of sending countries, Italy had the most S&T workers elsewhere in Europe, 34 per 1000, 15.7 per 1000 of which worked in Germany. Conversely, Italy only hosted 3 foreign S&T workers per 1,000 S&T staff. The countries with the least mobility of S&T workers in Europe (outgoing and incoming) were Greece, Finland and Portugal.

Table 9: Intra-European mobility: Foreign S&T employees (per 1000) by country of origin, 2000

country of residence	country of origin															
	EU-15	B	DK	D	EL	E	F	IRL	I	L	NL	A	P	FIN	S	UK
EU-15	230	10.7	5.9	25.4	12	16.9	26	16.2	34.4	1	14.9	17.6	8.9	5.7	2.9	30.9
Belgium	17.7			1.3	0.5	1.1	5.8		5.4	0.2	2.2		0.3			0.9
Denmark	2.6			1.7					0.4						0.4	0.1
Germany	84.5	1.9	1.7		9	6.5	7.6	2.7	15.7	0.7	6.2	16.6	2.2	1		12.6
Greece	0.2															0.2
Spain	3.5	0.1		1.1			0.6		0.7		0.2				0.3	0.5
France	32.7	6.2		4.6		3.7		0.7	5.5		1.1		5.1	0.5	0.7	4.7
Ireland	4.8			0.6			0.9		0.1							3.1
Italy	3.3			1		0.5	1.1				0.6				0.1	
Luxembourg	3.1	0.8		0.4	0		0.7	0.1	0.2		0.1		0.4	0.1	0.0	0.2
Netherlands	14.7	1		2.6		0.3	3.1		1.3			0.3			0.3	5.8
Austria	5.3			3.9				0.6	0.6		0.3					
Portugal	1					1										
Finland	0.9			0.3		0.1						0.1			0.3	
Sweden	11.7		2.4	1.4			1		0.2		0.1			3.8		2.7
UK	43.4	0.5	1.8	6.5	2.5	3.7	5.3	12.2	4.2		4	0.6	0.8	0.5	0.7	

Source: DG Research
Data: Eurostat
Notes: Grey number: country of residence is net receiver, blue number: country of residence is net sender. Blanks: no significant migration streams

Third European Report on S&T Indicators, 2003

(EC, 2003, Key Figures 2003-2004 Towards a European Research Area Science, Technology and Innovation, DG Research)

In 2005 Van de Sande, Ackers and Gill (2005)[33] carried out an impact assessment of the Marie Curie Fellowship Scheme (FP4 and FP5) a condition of the fellowships being that the recipient must study or work in another European country. This revealed an unbalanced flows of fellows within Europe - certain countries received more fellows than went abroad. In proportion to the scientific work force per country, this was notably the case for the UK, Denmark, the Netherlands, and Norway. Other countries could be considered 'sending' countries: more nationals left for a Marie Curie fellowship compared to the researchers that these countries played host to. In proportion to the number of researchers in these countries, this was especially so for the Slovak Republic, Iceland and Hungary.
There were 11,802 beneficiaries of the scheme - southern Europe exports a significant proportion of fellows notably Spain (16 per cent), Italy (14 per cent), Germany and France (13 per cent). The UK

33 Van de Sande, D., Ackers H.L., Gill, B. (2005) Impact assessment of the Marie Curie fellowships under the 4th and 5th Framework Programmes of Research and Technological Development of the EU (1994-2002), Report for DG Research

was the most popular host country (28% of all fellows), followed by France (17%), Germany (12%), the Netherlands (9%) and Spain and Italy (6% each). The latest EU Member States and Candidate countries gradually became eligible to participate to the Marie Curie fellowships during the Fifth Framework Programme; however, their participation was still rather limited in the period 1994-2002. The Marie Curie Fellowship Programme is also responsive to the existence of these 'imbalances' and has developed a series of measures with the objective of, 'promoting scientific and technological cohesion of the Community, particularly with respect to its less favoured regions.'[34]

4.3 Mobility Strategy

The increasing emphasis on the development of the 'knowledge economy' focuses attention on the role of international mobility as the basis for the transfer of knowledge and, in particular, scientific expertise. The broader ERA perspective promotes market liberalization, unfettered individual competition and mobility as the vehicles for the achievement of these goals. The 'free market' is the means by which to recruit and retain the 'brightest and the best' and to 'match' skills and resources optimizing scientific potential. Individual decision-making and the 'matching process' associated with it is central to the European Commission's commitment to meritocratic recruitment, competition and excellence and mobility, an important ' instrument for the transfer of scientific knowledge.' Mobility plays a critical role in the ERA strategy in terms of;

- Raising the scientific excellence of *individual researchers* and furthering the creation of internationally renowned centres of excellence attractive to researchers from all over the world
- Improving the quantity and quality of research training, by offering the best available opportunities *regardless of where this expertise is situated*[35].

The wording of this text underlines the emphasis on individualism in the ERA; the whole thrust is to identify 'excellent' individuals and facilitate their mobility in order to maximize their scientific productivity.

The rationale for the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers[36] is also spelled out in clear economic terms as contributing to the Lisbon objectives of increasing the numbers of researchers in the EU through retention and increasing the attractiveness of the EU to researchers from abroad. In addition to its emphasis on mobility and the institutional integration of researchers, the code focuses on improving approaches to the recruitment, selection and evaluation of individual researchers encouraging greater transparency, openness and equality.

The Council Decision setting out the objectives of the European Commission's flagship mobility scheme (the Marie Curie Fellowship Scheme as mentioned above) places similar emphasis on the need 'to develop the Community's human research potential, making special efforts to ensure equality of access and a better balance between men and women.'[37] Equality of access, in this context, is not 'justified' on social or ethical grounds as such but rather as a means of overcoming

[34] These include a return grant scheme supporting fellows from designated 'less favoured regions' to return. In practice, however, flows within the scheme remain highly skewed in favour of the research rich regions including the UK and Germany

[35] The Communication, 'A Mobility Strategy for the European Research Area' COM (2001) 331, June 2001, para 2.

[36] Commission of the European Communities 11.3.2005 C(2005) 576, para 2.

[37] Excerpt from the Council Decision adopting the specific programe for research, ' Improving the human research potential and the socio-economic knowledge base (1998-2002).

the counterproductive 'underuse of the potential of female scientists'.[38] Although the emphasis here is on the leakage of women from science and the loss of potential this implies, the same argument could be made in relation to scientists working in countries with few opportunities for scientific research who are de-skilled, forced to take up other forms of work instead of or in addition to research or unemployed.

The careful fusion of economic and social goals reflected in recent ERA policy with social objectives essentially underpinning the competitive ethos is perhaps symptomatic of a new approach to the European Social Model. Rather than being presented as some kind of moral imperative with high social costs and potentially draining effects on competitiveness, equality objectives are now tield closely to the latter. The language and approach adopted in many of the ERA policy instruments and the Researchers' Charter and the Marie Curie Fellowship Scheme illustrate what Barnard et al (2001)39 refer to as the 'dynamic tension' that exists between the development of social rights and economic integration. For them, the year 2000 'saw an ever greater stress on the economic dimensions of social policy and in particular its links to the 'knowledge economy.' As evidence of this 'dynamic tension,' Barnard et al identify the emergence of a 'new conceptual language' linking social and economic objectives. In particular, they refer to the use of the concept of 'capabilities' in the Supiot Report which 'opened up a new front in the argument over the role of social policy'.40 They explain the concept of capabilities as follows:
'The relevance of the concept of capabilities for the knowledge economy lies in the idea that mobilizing the economic potential of individuals is not simply a process of providing them with the necessary financial resources to exploit their endowments. Rather the institutional framework of the market has to be examined in order to establish how far it facilitates or constrains the potential of individuals to achieve their desired economic functionings.' (Barnard et al. 2001: 468)
Viewed in this light, European social policy plays a critical role in supporting economic progress and ensuring optimal productivity or as the authors put it, 'European social law and policy can now be firmly regarded as a 'productive factor' which aids competition rather than hindering it (Barnard et al, 2001, p.476). In this context, the promotion of equality and quality (through competition) go hand-in-hand. Although Barnard et al's paper goes on to consider the value of this concept in the context of employment law in general (and situations of maternity leave for example), it offers considerable potential in the current context in terms of understanding the 'balancing of equalities' within the ERA agenda.

4.3.1 Policy Tensions: Individual Equity versus Balanced Growth

The Lisbon objectives (cited above) refer explicitly to the idea of 'sustainable economic growth'. What is unclear, however, is the unit of analysis. If one takes the whole of the ERA as the appropriate level of analysis then one might argue, as many scientists indeed concur, that intra-EU mobility is effectively no different to internal mobility within an individual Member State.[41] On the other hand, if the aggregate effect of individual career and migration decisions, fuelled by policy and

[38] The requirement of mobility generates its own inequalities as migrants are not 'individuals' as such but social actors. Raghuram (2003) refers to the neglect, in the brain drain literature, of attention to family and gender where the unit of analysis is 'inherently individualised'. Our research suggests that the ability to respond to these opportunities may be differential reflecting family status, life-course and gender dynamics (Ackers, 2001:2003).
[39] Catherine Barnard, Simon Deakin, Richard Hobbs, (2001)'Capabilities and rights: An emerging agenda for social policy?', Industrial Relations Journal, 32 (5) pp 464-479
[40] Supiot, A. (ed) (2001) Beyond Employment. Changes in work and the future of labour law in Europe, Oxford: Oxford University Press.
[41] Of course scientific investment and mobility within existing Member States is also highly contentious. The policy of augmenting already resource-rich 'golden triangle' of Oxford/Cambridge/London in the UK is severely criticized as reinforcing territorial injustice and regional inequalities within the UK (Millard 2005)

resource allocation decisions within the ERA, leads to serious imbalances in flows and significant losses to less developed countries then one might question the compatibility of free market economics with sustainability at Member State level.

The European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers[42] explicitly recognizes these inherent policy tensions both in terms of researchers coming into the ERA from third countries and imbalances within the ERA:

*The development of a consistent career and **mobility policy** for researchers to and from the EU should be considered with regard to the situation in developing countries and regions within and outside Europe, so that building capacities within the EU does not occur at the expense of less developed countries or regions. (para 13)*

The Marie Curie Fellowship Programme is also responsive to the existence of these 'imbalances' and has developed a series of measures with the objective of, 'promoting scientific and technological cohesion of the Community, particularly with respect to its less favoured regions.'[43]
More recently, and following specific concerns around the impact of scientific mobility on capacity-building in developing countires (outside of the EU), the European Commission issued an 'EU Strategy for Action on the Crisis in Human Resources for Health in Developing Countries.'[44] Perhaps because of its specific focus on developing third countries outside of the ERA, the document identifies more clearly the 'risks' of highly skilled migration. The symbolic importance of being able to remain within 'ones own country' is rarely if ever seen in debates about EU Member States;

'The long term manageability of international migration hinges on making the option to remain in one's own country a viable one for all people. Sustainable economic growth and equity and development strategies consistent with this aim are a necessary means to that end' (p5)

One of the development strategies under consideration, and building on policies developed in some countires (such as the UK for example) is the potential value of codes of practice governing 'ethical recruitment' which attempt to restrict specific recruitment initiatives in designated areas. The document explicitly recognizes the potential tension that such measures pose in terms of reconciling sustainability with individual equity:

'Regulation as a tool to limit migration, tends to increase the cost of migration to the individual and *may be perceived as discriminatory'* (p6)

The converse argument, that measures to lubricate mobility within the ERA might pose a risk to sustainable development is rarely expressed reflecting the importance attached to the principle of non-discrimination in European and international law.

[42] Commission of the European Communities 11.3.2005 C(2005) 576.
[43] These include a return grant scheme supporting fellows from designated 'less favoured regions' to return. In practice, however, flows within the scheme remain highly skewed in favour of the research rich regions including the UK and Germany
[44] Communication to the Council and the European Parliament 'EU Strategy for Action on the Crisis in Human Resources for Health in Developing Countries' (COM(2005) 642 final dated Brussels 12.12.2005)

The remainder of this article looks first at these 'policy tensions' firstly from the perspective of individual equity and then from the perspective of the 'sending regions'[45].

4.3.2 Non-Discrimination: A General Principle of Community Law and Fundamental Human Right

The emphasis on individual employment and mobility rights in the ERA strategy rests on long-established traditions in European law and policy. According to the European Commission, the 'principles of equal treatment and non-discrimination are at the heart of the European Social Model. They represent a cornerstone of the fundamental rights and values that underpin today's European Union.'[46] The report goes on to identify 'new challenges' arising as a result of EU enlargement and stresses the importance of ensuring that non-discrimination is 'effectively implemented and enforced across the enlarged Union.' (p3) The non-discrimination principle is one element of the 'political criteria' for membership agreed by the Member States and a prerequisite for the opening of accession negotiations.

The EU's commitment to the principle of non-discrimination is reaffirmed in the Charter of Fundamental Rights (Articles 20-26) which includes specific rights relating to discrimination on grounds of nationality. Furthermore, 'the European Court of Justice (ECJ) has consistently held that fundamental human rights, derived from the international instruments to which all the Member States are signatories, form part of the *general principles of Community law*, the observance of which it ensures. … The principle of non-discrimination on grounds of sex or nationality has been held on numerous occasions by the ECJ to be a fundamental human right under Community law, any exceptions to which must be narrowly interpreted.'(p15)[47]

Interestingly, the next section of the report links the non-discrimination principle to the Lisbon agenda's commitment to economic growth, full employment, social cohesion and sustainable development' and identifies clear policies to 'tackle barriers to prevent members of certain groups from accessing jobs and training' (p15).[48]

Although the above document places significant emphasis on the application of the non-discrimination principle in relation to nationality issues, the implicit emphasis is on within-country forms of discrimination to ensure that all EU nationals are treated fairly *within* their country of residence. However, the right to non-discrimination in employment needs to be read in conjunction with measures under the Free Movement of Persons Provisions (Articles 39-42 EC) which extend access to employment for nationals applying from their home or another Member State (in other words would-be migrants as well as resident migrants). Regulation 1612/68 EC develops the non-discrimination principle in the context of the free movement of workers within the EU. Article 1 provides that 'any national of a Member State, shall, irrespective of his place of residence have the

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[45] Using examples from interviews with scientists from the MOBEX2 project funded by the Science in Society Programme of the UK Economic and Social Research Council (RES-151-25-00) and the Anglo-German Foundation (1468), directed by Professor Ackers.

[46] 'Equality and non-discrimination in an enlarging European Union', European Commission's Employment and Social Affairs Directorate-General, Green Paper, May 2004

[47] The report cites a number of cases to support this contention; namely Case 29/69 *Stauder v City of Ulm*; case 4/73 ECR [1969] 00419, *Nold v Commission*, Case C-600/00 ECR [1974] 00491, Case C-60/2000, *Mary Carpenter v Secretary of State for the Home Department* ECR [2002] 1-006279, Case C-13/94, *P v S and Cornwall County Council ECR* [1996] 1-02143, case C-55/00, *Gottardo* ECR [2002] 1-00413

[48] The document then refers to the recognition of the non-discrimination principle in a whole range of international conventions (p.17-18) including the UN Covenant on Civil and Political Rights, the UN Convention on Economic, Social and Cultural Rights, the UN Convention on the elimination of race discrimination, the ILO Convention No 111 (amongst others). The principle of non-discrimination is reaffirmed in the Cotonou Agreement between the EURO and 78 African, Caribbean and Pacific countries and is one of the subjects covered in the political dialogue underpinning cooperation with these countries. (Article 13 of the ACP EURO Partnership Agreement signed in Cotonou on 23 June 2000.

right to take up an activity as an employed person … with the same priority as nationals of the State'. This Regulation includes measures to prevent employers limiting or deterring applications or 'prescribing special recruitment procedures for foreign nationals', limiting or 'restricting the advertising of vacancies' or 'subjecting eligibility for employment to conditions of registration with employment offices' or '*impeding recruitment of individual workers*' (Article 3). The Regulation places significant emphasis on the safeguarding of *individual rights* to move for the purpose of employment within the European Union.[49]

The principle of non-discrimination on grounds of nationality, particularly where it concerns access to employment and facilitates mobility has clearly taken a very strong foothold in European law and policy. Interviews with scientists indicate a high level of much support for this idea that individual European scientists should not be denied the right to free movement. The following Bulgarian post-doc points to the injustice of allowing some people free movement rights and others not:

They shouldn't stop them leaving, nobody can stop British people leaving Britain and going to the USA [M16]

In the next two cases, the respondents point to the opportunities that mobility presents both in terms of individual career development and in terms of quality of life. Those unable to take advantage of mobility may forgo the advantages of higher salaries and working conditions and find it difficult to work effectively in science. Name argues, in the name of democracy, that scientists should be able to move in order to be able to access the resources they need to work effectively:

I do not think that it is bad when scientists leave Poland and go abroad because - I mean we have democracy so if the people get no scientific funding and scientists cannot work because they have no money for example for equipment and if so then it's the only thing. [D14]

Although [name] admits the potentially negative costs of aggregate decisions to the sending country, he argues that highly skilled people should be permitted to move in order to access better living conditions:

There is some brain squeeze from Poland but c'est la vie. If any scientist in Poland is really well educated and has success in the world it's really difficult to agree to live in the very poor conditions in Poland. It's normal life problems and so it's difficult to live. You can understand why they want to go abroad. [D30]

Echoing the sentiments of the European Commission strategy for developing countries (above - that measures need to ensure that staying in our home country remains a viable option) the next three respondents suggest that the responsibility for the consequences of aggregate migration behaviour rest with the governments of the sending regions and not with individual scientists or employers in receiving countries:

You don't think about the brain drain, you just want to visit; from a certain point of view it's selfish. We travel around the world for our experiments and so I don't think it's really a problem as long as you keep on moving with your experiments, with your knowledge it's no problem. [D22]

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[49] It is important to emphasize that this Regulation applies to existing EU Member States and not the most recent wave of new Member States–which are temporarily governed by the 'transition arrangements' where applied by individual countries.

I think [it is a problem] for the future … but I think the problem is not for the individual but for the politicians. They simply have to create a labour market for scientists in Poland otherwise all the scientists will go abroad and then 70 % or more stay abroad. [D27]

I don't think it's intentional so that someone from Germany or USA is actively looking and pulling people out, it's a kind of passive fact which is rather people from Poland looking around and trying to find something abroad and if they succeed they decide to do it. [D18]

Whether the process is selfish or passive (as opposed to a deliberate recruitment drive on the past of receiving countires or employers) the three respondents all agree that it might have negative impact on the sending countries. The next section addresses these concerns.

4.3.3 The Argument from Sustainable Development and Balanced Growth

We have already referred to the emphasis placed upon the identification and development of Centres of Excellence that lies at the heart of European R&D policy (mirroring that of most Member States) and to the role that mobility plays in 'matching' quality human resources with quality infrastructures. Mobility is the logical corollary of 'clustering' and the redistribution of human capital to support research infrastructures. How does this highly competitive form of capacity-building, which effectively augments existing resource-rich institutions and regions, sit alongside a commitment to building new capacity and maintaining sustainable R&D in less research intensive regions?

European Science and 'Trickle Down'

It could be argued that imbalanced flows of human capital, within the ERA, as a result of aggregate individual behaviour should not in themselves be interpreted as damaging provided that losses to the EU are contained or managed and *European* science, as a whole, is benefiting (and becoming more competitive in the process).

This view is not only evident in policy statements but is 'received wisdom' within the research community. The following Marie Curie supervisor expresses his views on the importance of scientific clustering to the development of European science:

I think it is an essential development that institutes become more specialised in certain areas. So, that it will have its impact in Europe on where certain research will be done. It's essential to create critical mass. If you don't cluster well, it depends on where you want to be. If you want to be among the top in the world, then there's still a lot to do in Europe.

If one takes the view that the meaningful unit of analysis from an economic and political standpoint is the European Union as a whole and not individual Member States as such then imbalanced intra-EU flows, although not unproblematic, might be seen to benefit European science in general. Ultimately the benefits attached to this might 'trickle down' to the constituent sending regions. The following Bulgarian scientist subscribes to this perspective arguing that without mobility European science will lose its cutting edge:

The only chance for people in Europe to survive really is to go to high tech science and then we have to open the borders to allow for the movement inside Europe which is absolutely obvious and I would not consider this as brain drain. I am trying to see this as one country and mobility as circulation. We have to open our borders to extend our work. Europe for me is unified and it can be a long process but if you look from the scientific point of view and the global perspective, if we do *not succeed to make this successful then it will be a catastrophe for all the people in Europe. [MOBEX2.]*

In response to an open question concerned to identify perceptions of the ‘main impacts’ of the Marie Curie Fellowship scheme supervisors (hosts) volunteered responses, without prompting, which indicated a powerful commitment to the value of a co-operative and strategic *European* approach to research policy and training. The comments below are quite typical

To educate a European elite, which is world-leading.
To advance research competitiveness in the EU.
To favour the development of a single European research environment.
Contributing to the training of research students for other European countries.

Certainly many early career researchers in the Marie Curie Scheme share this perspective. According to them, opportunities should be open across the ERA and selection should be based solely on ‘objective’ scientific criteria:

[The scheme] supports equal opportunity for all young researchers in Europe

Fellowships are distributed depending on real scientific issues, not on power hierarchies and personal relationships, which is very rare in Europe.

[The scheme] allows access to top universities to ALL European students

International competition with objective selection criteria strengthens the European concept among citizens of EU nations

The following Dutch supervisor refers to the importance of the openness and flexibility of the Marie Curie scheme in supporting excellence:

Marie Curie I think is the best of the EU funding for life sciences in the sense that it’s not restricted, or it’s not political issues, or it’s not restrictions related to industry … You can build in all kinds of restrictions, but that’s not there. It’s merely quality in fact. Science works best when it’s just selected on quality. The other things come by themselves. [S6422NL]

The importance attached to transparent and fair recruitment was not simply seen in terms of the benefit to individual scientists and their careers but also as a mechanism to maximize *European* scientific output through effective ‘coupling’ up of excellent human capital with prestigious host institutions and supervisors. One Marie Curie fellow describes the situation as follows:

The trick is just to match the person with the right skills to the project. The advantage of the fellowship is precisely that: your search domain is much broader.

Of course optimal ‘matching’ demands both fair recruitment *and* mobility. The following Marie Curie fellow emphasises the importance of mobility:

Individual European countries may have quite small science bases in particular disciplines, leading to a lack of training potential if researchers are not mobile. The fellowships facilitate mobility and maximize human potential in European science.

The following supervisor identifies the autonomy of individual applicants to select their preferred host institution and supervisor (which is an important feature of the Marie Curie post-doctoral fellowship scheme and distinguishes it from most other research fellowships) as critical to this process:

Well, what I said about the quality of science, and that kind of selection. I think that's very good. THEY take the initiative, and, I at least, I am not identifying a person and telling them "if you write this then you can come here". I think it's very good that students can take the initiative and can select themselves. The fact that you judge the post-doc for their quality, , that's one thing. The person who applies is judging the place where he or she goes to. I think it's very unlikely that the person will go to a very mediocre institute. If the initiative is from the fellow, the person makes the decision. They could go anywhere. So that's good. So keep the free choice.

It is clear from the responses discussed above that scientists firmly believe in the importance of individual competition and mobility to the achievement of *European* scientific development. European level policy-makers and individual scientists would appear to share a common perspective that the goal should be to identify and invest in excellent individual scientists through conjoined processes of fair recruitment/progression and free movement. The aggregate effects of these individual processes will deliver a successful and globally competitive *European* economy.

Supporting Balanced Growth in the Context of EU Enlargement

EU enlargement creates a new dynamic in terms of migration flows within the ERA. The Communication, 'A Mobility Strategy for the European Research Area' acknowledges the 'regional dimension to mobility' in the context of EU enlargement. In particular, in designing its mobility strategy for researchers, the Communication seeks to promote forms of 'inter-regional mobility in order to avoid a brain drain from less developed regions'[50].

A recent report refers to '*the insufficient link between policies promoting balanced regional development and policies promoting geographic and occupational mobility'* (CEC 2001: 5)[51] The ERA strategy acknowledges the need to protect candidate countries from the consequences of *'increased competition for highly qualified researchers'* (CEC, 2001:.6). It concludes that, *'special attention should be paid to prevent new forms of 'brain drain' from countries with less developed research capacity'* through the introduction of new funding mechanisms designed to support a *'symbiotic collaboration'* enabling them to build up their own research capacity.[52]

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[50] COM (2001) 331, June 2001, para 1.

[51] EC (2001) High Level Expert Group on Improving Mobility of Researchers:Final Report, DG Research

[52] Specific Marie Curie Actions include new Host Fellowships for the Transfer of Knowledge (TOK) designed to encourage transfer of knowledge into less favoured regions. A compulsory return phase attached to out-going international fellowships encourages return as do 're-integration grants'.

SECTION 5: CONCLUSIONS

This report has provided evidence of the great diversification between members states in expenditure on science, sizes of research communities and the sectors in which research is conducted. Levels of internationalisation, clustering policy and mobility drives towards scientific hotspots may exacerbate these differences. Inherent in the European Research Area strategy lies a fundamental tension between the pursuit of two different dimensions of equality, namely individual equity (and the individual human right not to be discriminated against on grounds of nationality) and sustainable development within the European Union (sometimes referred to as 'balanced growth'). Although they are often not expressed as such, concerns around 'brain drain' within the ERA – and policy responses to it - need to be understood as facets of this wider debate.

Is there a fundamental tension between the commitment to individual equity and agency on the one hand and sustainable economic growth on the other or is the situation more complex and nuanced? Can the concept of capabilities, as Barnard et al propose, help us to understand these processes and gain a more accurate and nuanced understanding of what has become known as 'brain drain'. To give one example, to what extent might the free movement provisions coupled with the non-discrimination principle not only underpin the individual mobility and employment rights of scientists but also support their efficacy enabling them to realize their potential avoiding the risks of 'brain stagnation' or 'brain waste' that is often the consequence of 'staying put'. A number of respondents spoke of how the European Commission funded Marie Curie fellowship gave *'the opportunity to scientists from less-favoured countries to develop a career' or, in another case, 'gave possibilities for Eastern European scientists to carry out high quality research in those areas which have much larger instrumental needs than those provided in the home country'*. Arguably in these cases, the alternative to mobility would be unrealized potential to the detriment of both the individual scientist, the sending and receiving country and European science as a whole.

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