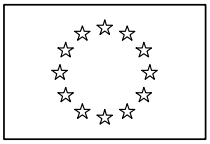

EUROPEAN COMMISSION

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Part 5/41

COMMISSION STAFF WORKING PAPER

Innovation Union Competitiveness report 2011

3. Addressing the gender gap in science and technology

Highlights

Today 45% of all PhD graduates are women. Women, however, are not represented in this proportion in the labour market of science and innovation research. National science and innovation labour markets show vertical and horizontal segregations in terms of participation of women and men.

The highest proportions of women are found in the countries with the lowest R&D expenditure per researcher and the lowest proportions of women are in the sectors with the highest R&D expenditure per researcher.

In order to address the relatively low representation of women in science, the highest innovative European countries have developed very active policy agendas.

The proportion of female grade-A staff has increased from 5.8% to 7.2% in the field of engineering and technology, from 15.6% to 17% for medical sciences (the lowest growth) and an increase from 23.9% to 27% in humanities. However, the most important institutions and areas of decision making in the scientific landscape remain dominantly led and managed by men. There is a strikingly low presence of women in academic decision-making positions in all European countries.

The business and enterprise sector lags behind the public higher-education sector, with only 19% of female researchers compared to 39% of women in the higher education institutions.

3. Addressing the gender gap in science and innovation

The level of gender equity is a result of the combined effect of the R&D innovation systems, the relevance of science for the national economy, the features of the labour market, and the equity policies in place. A wide variety of historical developments and national policy settings that shape and influence the roll-out of policy towards gender equity in science and research can be observed across the EU. Despite many EU initiatives and policy directives, national frameworks of R&D and social policy crucially determine the overall conditions for women in science and research.

The figure below illustrates the gross domestic expenditure on R&D (GERD) per R&D personnel by country. R&D personnel include researchers, technicians/equivalent staff and other supporting staff as defined in the Frascati Manual[58], in all fields. A pattern emerges in the figure, spelling out the fact that the highest proportions of women are found in the countries with the lowest R&D expenditure per R&D personnel and the lowest proportions of women are in the sectors with the highest R&D expenditure per R&D personnel.

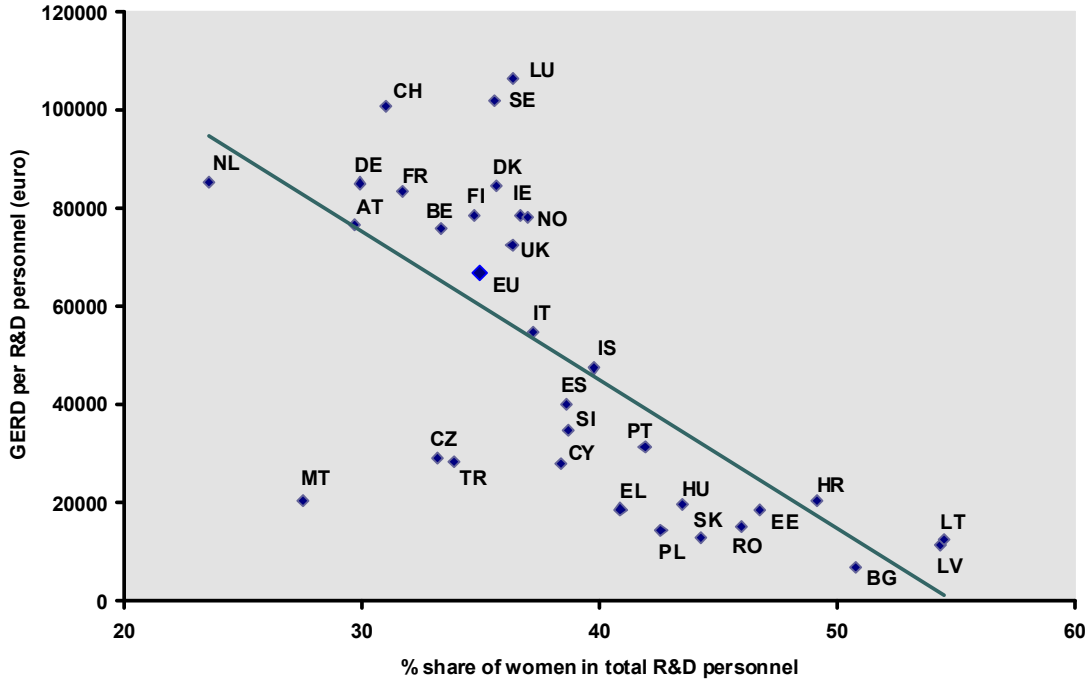
The line of best fit shows a strong negative linkage between a country's expenditure on R&D and their proportion of women in science. The distance of a country from the line of best fit

[58] OECD (2002) *Frascati Manual* 2002 *The Measurement of Scientific and Technological Activities, Proposed Standard Practice for Surveys on Research and Experimental Development*, OECD Publishing.

indicates the loss/gain of access and/or control over R&D expenditure, in the same way that the 'honey pot' indicator did in the ENWISE report[59]. If a country is below the line, it shows that there are fewer women in R&D than the R&D expenditure per R&D personnel would predict in that country.

There are six hypotheses that might be used to explain the negative link between the proportion of women in R&D and the level of development of the country's national system of innovation: lower salaries of women researchers, lower-paid sectors of R&D, 'feminine' sectors of R&D, higher overall levels of employment for women, a male 'brain drain', and combinations of these. Most of the given hypotheses have been proven to cause these imbalances in various contexts. They are also subject to Member States' equity policies.[60]

Figure II.3.1 Share (%) of women in total R&D personnel (1) and R&D expenditure (GERD) per R&D personnel (1), 2007 (2)



Source: DG Research and Innovation
Data: Eurostat
Notes: (1) Head Count
(2) NL: 2003; CH: 2004; EL: 2005; FR, IT: 2006; CZ, SK, IS: 2008

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The most common form of policy towards equity in science and research both in the US and in Europe involves the human resources approach. The key indicator of success here relates to the proportional participation of women in all areas of the science and research system.

[59] European Commission (2003) *Waste of talents: turning private struggles into a public issue;* Women and Science in the ENWISE countries, A report to the European Commission from the ENWISE Expert Group on women scientists in Central and Eastern European countries and in the Baltic States, Luxembourg.
[60] Cf. Benchmarking policy measures for gender equality in science, EC 2008.

Several high-innovative European countries have developed a very active policy agenda in order to address the below-average (EU) representation of women in science.

The Gender Challenge in Research Funding report[61] proposes an instructive classification based on the general gender equality context in each country (*see Table II.3.1*). Thus, countries are roughly divided into proactive ones — which promote and monitor gender equality in research with active policies and measures — versus comparatively inactive countries that display few such measures and initiatives. Within the proactive countries, four important sub-groups are established: the five Nordic countries belong to the 'global gender equality leaders'. These northern welfare states are characterised by early (from the late 1970s to the early 1980s onwards) committed efforts to embed gender equality into science policy and society at large. A second proactive group comprises 'newly active countries with traditionally fewer women in research' such as Germany, the Netherlands, Austria, Belgium, and Switzerland. In recent years, these countries have developed a very active policy agenda in order to address the below-average (EU) representation of women in science. Thirdly, the proactive countries also include 'newly active member states with more women in research' such as Spain, the United Kingdom and Ireland. The last group, quite large and heterogeneous, includes the remaining countries; they can be characterized as relatively inactive when it comes to gender equality in research funding. These countries show little initiative in monitoring gender balance or promoting gender equality in research in general. Some have among the highest proportions of women in HE research in a European comparison, some average and some less than average proportions.

Table II.3.1 The gender challenge in research funding (classification based on EC 2009)

Gender Equality Leaders, small gender gap, more women in HE research (Group 1)	Newly active countries, few women in HE research (Group 2)	Newly active countries, with more women in HE research (Group 3)	Relatively inactive countries, some with more women in HE (Group 4)
Finland Norway Sweden Ireland Denmark	Austria Belgium Germany Netherlands Switzerland	United Kingdom Spain Ireland	Bulgaria Croatia Czech Republic Cyprus Greece Estonia, Italy, Luxembourg Hungary, Malta, Poland Portugal, Romania Turkey, Israel

Source: DG Research and Innovation

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3.1. Is the gender gap in science and technology closing?

Labour markets in all European countries are characterised by horizontal and vertical segregation. Evolution over the last 20 years points towards stagnating if not rising levels of segregation. There is no evidence of a spontaneous movement towards less segregation in the European labour markets.

- Horizontal segregation is understood as under- (over-) representation of a certain group in occupations or sectors not ordered by any criterion.
- Vertical segregation refers to the under- (over-) representation of a clearly identifiable group of workers in occupations or sectors at the top of an ordering based on 'desirable' attributes — income, prestige, job stability etc., independently of the sector

[61] http://ec.europa.eu/research/science-society/document_library/pdf_06/the-gender-challenge-in-research-funding-report_en.pdf

of activity. Under-representation at the top of occupation-specific ladders was subsumed under the heading of 'vertical segregation', whereas it is now more commonly termed 'hierarchical segregation'

The gender gap is slowly closing in the public sector, but major inequalities persist in top academic positions and in the business sector

A revolution has occurred over the last 30 years. The remarkable rise in women's level of education is related to the growth of women's employment in the field of science and research. The share of women in total research employment has been growing at a faster rate than men's in most European countries. However, there are large differences between countries. In higher education, women constitute the majority of bachelor and master students and they even represent 45 % of Ph.D. graduates. If the growth rate in the number of male and female Ph.D. graduates as it was observed in 2000 is sustained, women will catch up with men at this highest level of education as well.

Differences between educational fields still persist even though the percentage of women in all fields has risen. At PhD level, most fields are dominated by women: education, humanities and arts, agricultural and veterinary sciences, health and welfare. Female PhDs represent 47 % in social sciences and law and 41 % in mathematical sciences and computing, but only 20 % in engineering, manufacturing and construction.

On average throughout the EU, only 13 % of institutions in the higher education sector are headed by women in 2007. We can see that this proportion varies from 27 % to 0 %. The countries that show the highest proportion of women are Norway, Sweden, Finland, Italy and Estonia (more than 19 %).

Based on the compound annual growth rate across sectors, a difference can be observed between the higher education sector and the private and business sector. In the first one, the compound annual growth rate in the number of female researchers has been stronger than that of men over the period 2002–2006 in most countries. There seems to be some move towards a more gender-balanced research population in higher education. The government sector presents a very similar pattern. However, for the business enterprise sector, the compound annual growth rate of the number of female researchers has been stronger than that of men in only the half of the countries over the period 2002–2006. This shows that women are catching up with men at a slower pace in the business and enterprise sector than in the higher education and government sectors.

There are also differences in the evolution of the research population according to the field of science. On average throughout the EU, the most positive growth figures have characterised the fields of the medical sciences, the humanities, engineering and technology, and the social sciences. Only in natural sciences has the number of female researchers actually shrunk at a yearly rate of -0.4 % over recent years. The situation varies widely according to the different European countries.

The evolution of vertical segregation is harder to investigate since data only concern the higher education sector. There is an improvement in women's relative position at the PhD level, but also at the different stages of the academic career in grades A, B and C. This improvement is very slow. A positive factor is that there is a more marked closing of the gender gap among scientists than on the labour market in general. The dissimilarity index has

also decreased between 2004 and 2007 (in some countries it remained stable). These results let us suppose that the career situation is more favourable for the youngest generations of female academics. However, the gender gap is still disproportionately high compared with the increase in the proportion of women amongst students. For the period 2004–2007, the proportion of female grade-A staff increased in the EU-25 from 5.8% to 7.2% in the field of engineering and technology, from 15.6% to 17% for medical sciences (the lowest evolution) and from 23.9% to 27% in humanities. However, the most important institutions and areas of decision-making in the scientific landscape remain dominantly led and managed by men.

3.2. Do women scientists choose the same careers as men?

3.2.1. Women employed in research

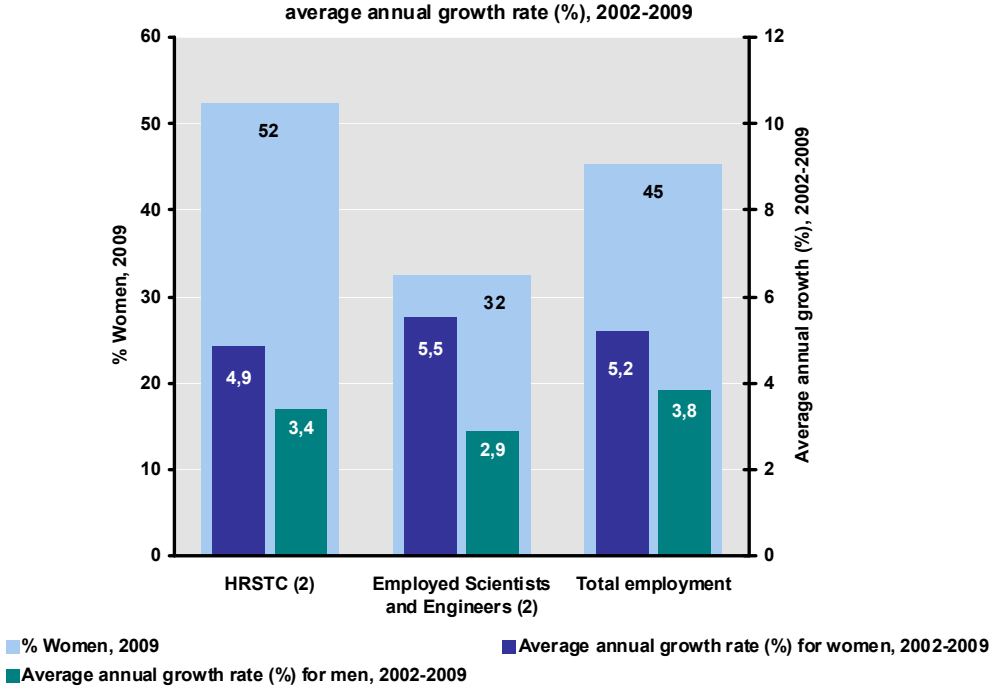
Women are under-represented in science and engineering employment, although the gap is closing

Figure II.3.2 compares the proportion of women in total employment with their share amongst the highly educated employed as professionals or technicians[62] and amongst those working as scientists and engineers [63] for the year 2009. 'The fact that the proportion of women is higher amongst highly educated professionals or technicians (52%) than in total employment (45%) illustrates the fact that tertiary-educated women are more successful than the others in finding a job.

However, their proportion lowers to 32% in the group of employed scientists and engineers which in turn exemplifies the problem of gender segregation in education. Between 2002 and 2009, women have been catching up with men as women's compound annual growth rate has exceeded that of men both in total employment and in the two more precise subgroups. The difference is largest amongst scientists and engineers, where the share of women has annually grown by 5.5% on average between 2002 and 2009, compared with a male growth rate of just 2.9%. These growth rates are respectively 4.9% and 3.4% for highly educated women and men working as professionals or technicians'.[64] This growth rate is thus higher for these categories than for the total employment — where it is limited to 1.8% for women and to 1.1% for men. The same is observed for the compound annual growth rate of the numbers of female and male scientists over the period 2002–2009. Women tend to catch up with men over time. The number of female researchers has increased at a faster rate than the number of male researchers during the period (with the exception of the Czech Republic, Romania, Bulgaria, Hungary, Latvia and France). In the EU on average, the number of female researchers has increased at a rate of 6.2% per year compared with 3.7% for male researchers.

[62] 'Technicians and associate professionals' (ISCO-3) are defined as follows: 'occupations whose main tasks require technical knowledge and experience in one or more fields of physical and life sciences, or social sciences and humanities. The main tasks consist of carrying out technical work connected with the application of concepts and operational methods in the above-mentioned fields, and in teaching at certain educational levels' (p. 127, She Figures, 2009).
[63] The group 'Scientists and Engineers' includes the Physical, mathematical and engineering occupations (ISCO '88 COM code 21) and the Life science and health occupations (ISCO '88 COM code 22).
[64] *She Figures 2009*, p. 20.

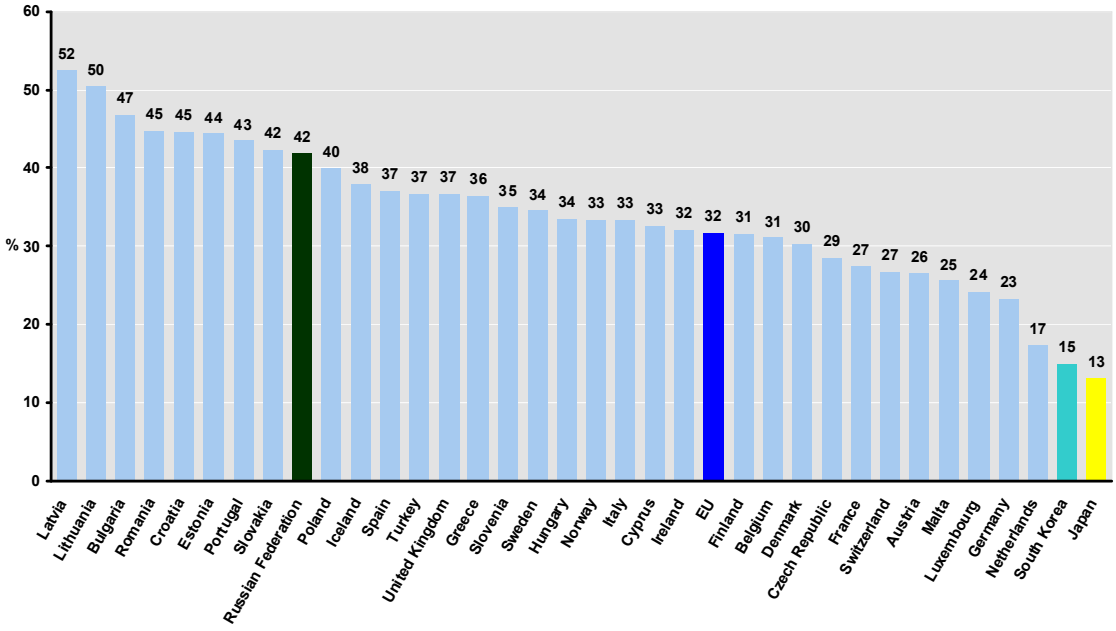
Figure II.3.2 EU - Human Resources in Science and Technology - Core (HRSTC), Scientists and Engineers and total employment [1] - women as % of total, 2009 and average annual growth rate (%), 2002-2009



Source: DG Research and Innovation — Innovation Union Competitiveness Report 2011
Data: Eurostat
Notes: (1) All values refer to age group 25-64.
(2) 2009: EU does not include LU; 2002-2009: EU does not include LU and RO.

Figure II.3.3 presents the proportion of female researchers by country. The average proportion of female researchers in the EU in 2006 is 32%. At the top of the ranking of the proportion of women in research, there is Latvia (52%), followed by Lithuania (50%), Bulgaria (47%), Rumania and Croatia (5%), Estonia (44%) and Portugal (43%). In general, Baltic States and Eastern countries show a very high level of representation of women in research. At the end of the scale, there is the Netherlands with only 18% women researchers.

Figure II.3.3 Female researchers (Head Count) as % of total researchers (Head Count), 2007 (1)



Source: DG Research and Innovation
Data: Eurostat
Note: (1) NL: 2003; CH: 2004; EL: 2005; FR, IT: 2006; CZ, SK, IS, RU: 2008.

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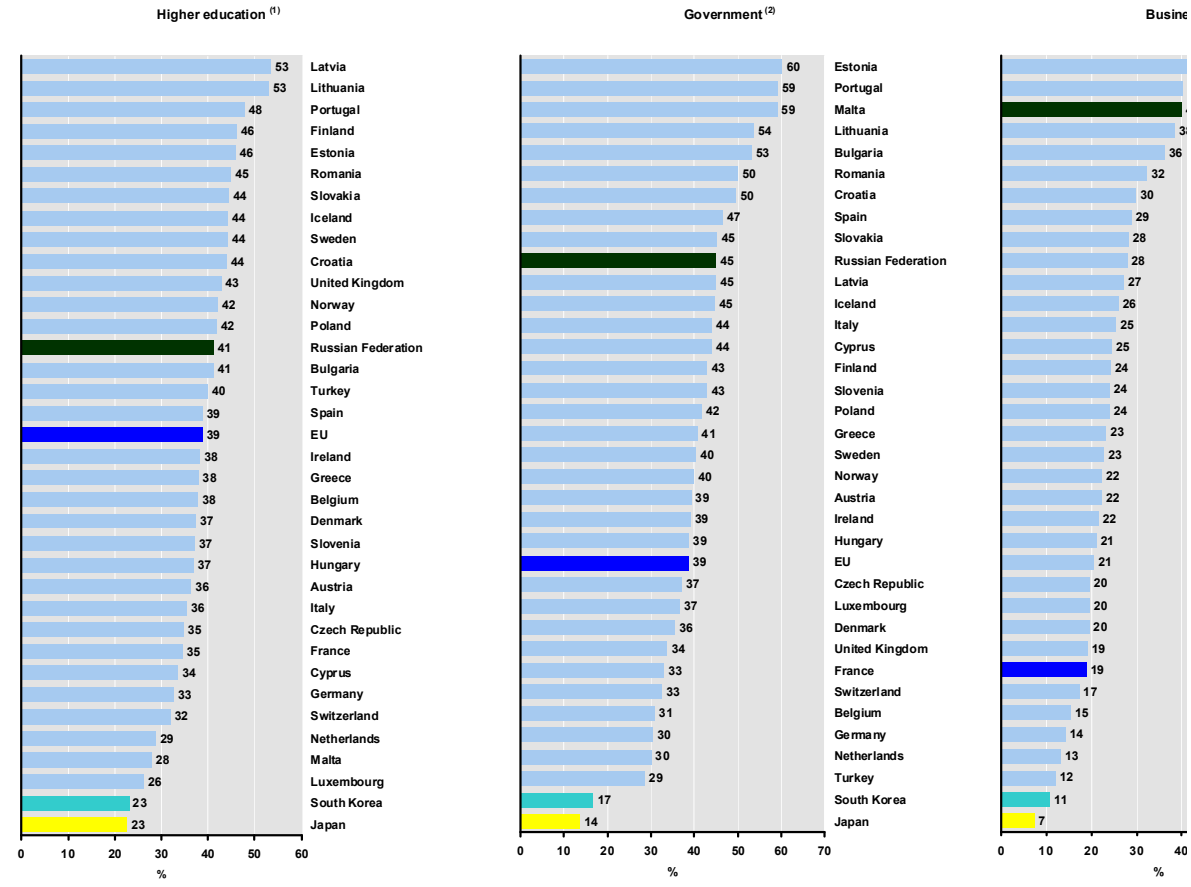
Women represent 39% of researchers in the higher education sector and in the government sector but only 19% in the business and enterprise sector

An analysis by sector (higher education, government, and business enterprise sectors) shows a very similar presence of women in the public and in the higher education sectors and a considerably lower presence in the private and business sector (Figure II.3.4). On average in the EU, women represent 39% of researchers in the higher education sector and in the government sector but only 19% in the business and enterprise sector. The degree of cross-country disparity is very similar in higher education and public enterprise, but much larger in private enterprise. In all sectors, two countries systematically show low proportions of female researchers — the Netherlands and Japan[65] — whereas Lithuania and Romania always have the highest proportions of women in research. The data presented in She Figures 2003 allows comparison of this evolution of the percentage of women researchers by sector with the EU-15. For the higher education sector, this proportion was 33% in 2000. The evolution was also strong in the government sector where the percentage was 34% in 2000. Finally, the percentage of women researchers in the private sector stood at 18% in 2000.

[65] However, there are other countries in this situation as regards the higher education sector (Malta, Luxembourg and Switzerland) and the government sector (Switzerland, Turkey and Germany).

Figure II.3.4 Researchers (FTE) by sector - female as % of total, 2007



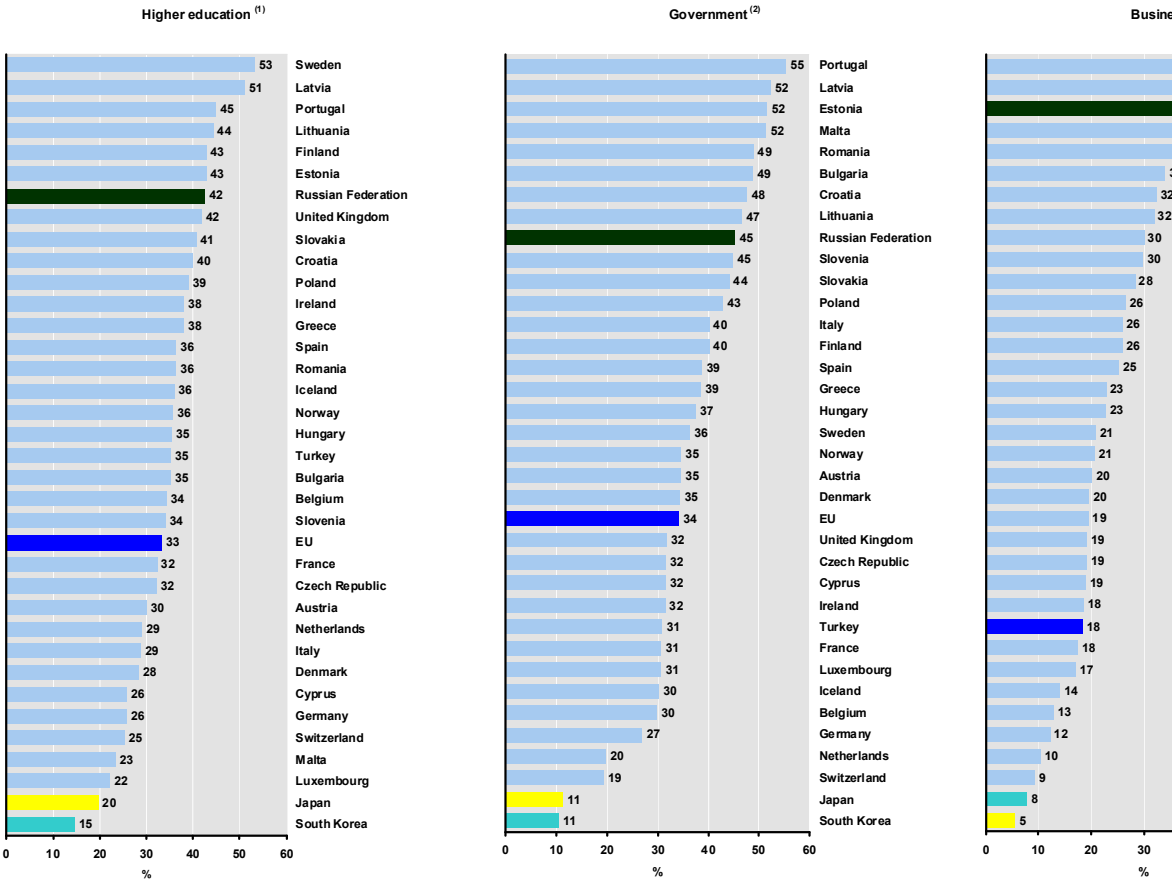
Source: DG Research and Innovation
Data: Eurostat
Notes: (1) NL: 2003; EL: 2005; FR, IT: 2006; CZ, EE, MT, SK, IS, RU: 2008.
(2) EL: 2005; FR, IT: 2006; CZ, EE, MT, SK, IS, CH, RU: 2008.
(3) CH: 2004; EL: 2005; FR, IT: 2006; CZ, SK, IS, RU: 2008.

While the gender imbalance within the public sector has levelled out over recent years, the imbalance between public and private sectors persists

In the higher education sector, which hosts a larger share of female than of male researchers, the compound annual growth rate in the number of female researchers has been stronger than that of men over the period 2002–2006 in most countries (26 out of 31). The inverse holds true in only five countries. These countries are the Czech Republic, Greece, the Netherlands, Latvia, and Sweden. However, the differences in growth rates are extremely modest in the latter three countries. Exceptions aside, in most countries, there seems to be some move towards a more gender-balanced research population in higher education. Throughout the EU on average, the annual growth rate for women has been 4.8% compared with 2.0% for men. The level of the growth rates of both female and male researchers is extremely variable over the different countries. The government sector puts forth a very similar pattern. It has a larger share of female than of male researchers, and women's presence has been strengthening over recent years in the majority of countries. On average in the EU, the number of female researchers has been growing at a pace of 5.4% per year compared with 2.3% for men. There are just four exceptions to this overall pattern. Finally, in the business enterprise sector, where

the proportion of female researchers is generally lower than that of men, the compound annual growth rate of the number of female researchers has been stronger than that of men over the period 2002–2006 in roughly half of the countries (17 out of 33). In these countries, there thus seems to be some move towards greater equality in this sector. There is, nevertheless, a high level of cross-country disparity in the level at which this balancing out is taking place.

Figure II.3.5 Researchers (FTE) by sector - female as % of total, 2000



Source: DG Research and Innovation
Data: Eurostat
Notes: (1) EL, SE, IS, NO: 2001; BE, IE, MT, NL, AT, SK, HR: 2002; DE: 2003; FI: 2004, UK: 2005.
(2) EL, NL, UK, IS, NO, JP: 2001; BE, IE, MT, AT, SK, HR: 2002; DE, SE: 2003; FI: 2004.
(3) DK, DE, IE, EL, ES, NL, IS, NO, JP: 2001; AT, SK, HR: 2002; LU, SE: 2003; MT, FI: 2004; UK: 2005.

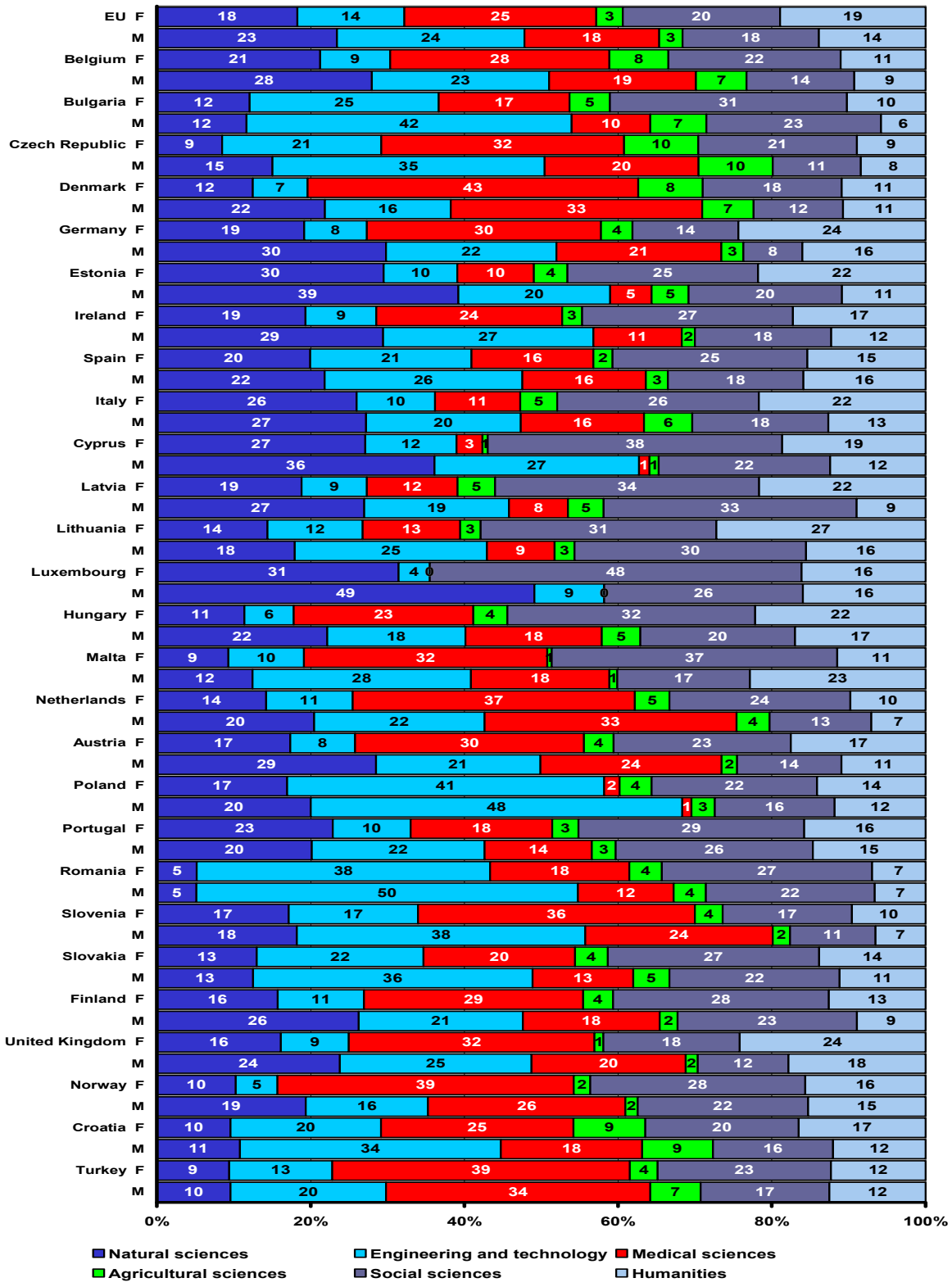
3.2.2 Women employed in research across fields of science

Female researchers are more concentrated in medical sciences and less in engineering

The distribution of male and female researchers in the higher education sector across different fields of science in 2008 (Figure II.3.6) indicates that female researchers are concentrated in medical sciences (25% on average in the EU). It is the contrary for agriculture, where they constitute 3% on average in the EU. The widest gender gap is, not surprisingly, observed in engineering. Again there are many cross-country differences in the relative importance of each of the fields of science. 'Whereas just 9% of female researchers are in the natural sciences in Malta, 27% are in Cyprus. In engineering and technology, the low proportions of

female researchers observed in Norway (5%). Austria (8%), Denmark (7%) and Hungary (6%) contrast sharply with the much higher shares of women in Romania (38%), Poland (41%) and Bulgaria (25%). Such contrasting national patterns also characterise the medical sciences, which have particularly high shares of female researchers in Sweden (51%), Malta (32%), and Denmark (43%) and particularly low shares in Estonia (10%), Latvia (12%) and Lithuania(13%). The share of female researchers in the humanities is lowest at 7% inRomania, whereas it peaks at 27% in Lithuania, followed by Germany and UK with 24%. In social sciences there are few cross-country variations in the proportions of researchers.

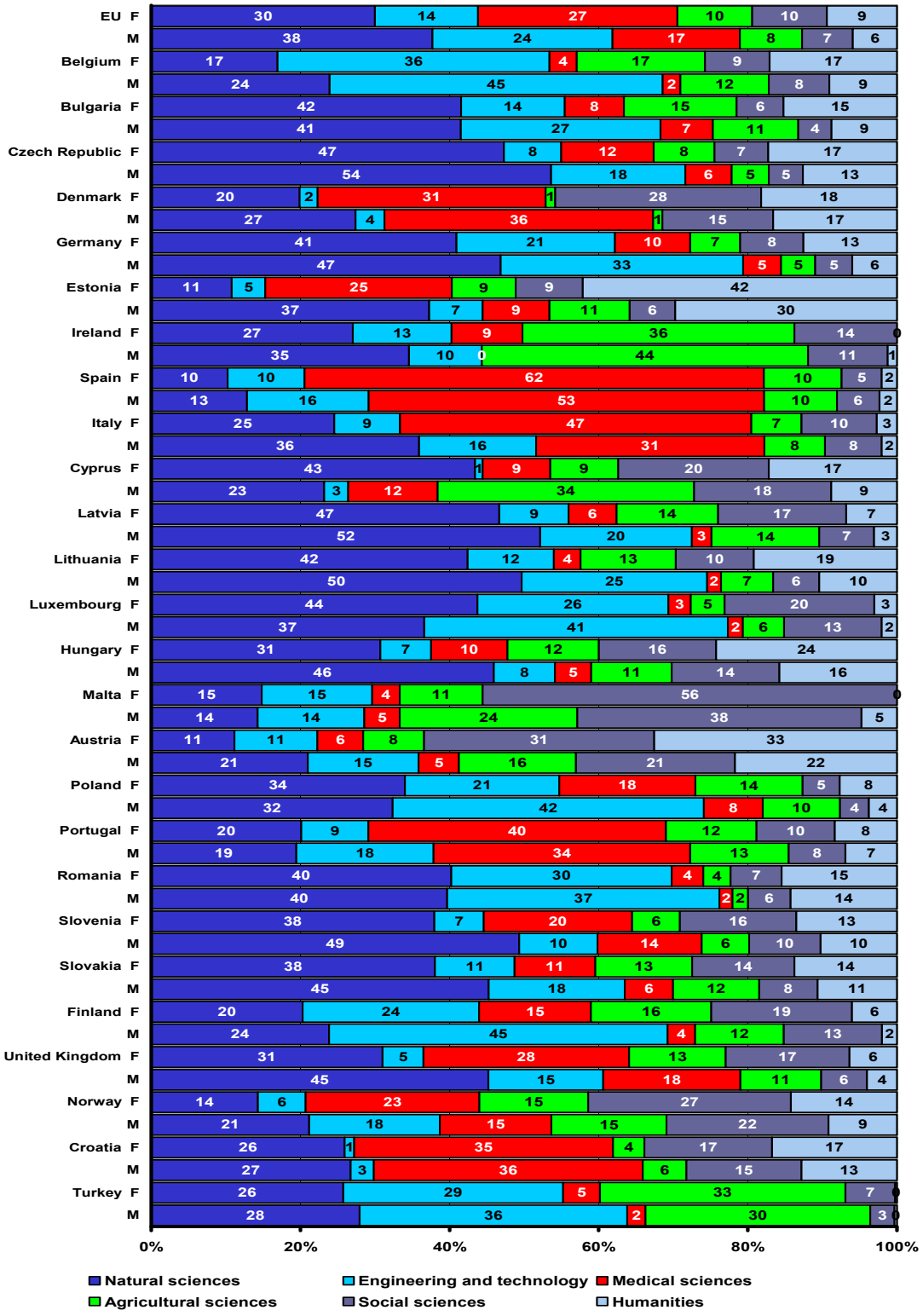
Figure II.3.6 Researchers (Head Count, female and male) in the higher education sector - % distribution by field of science, 2008 (1)



Source: DG Research and Innovation
Data: Eurostat
Notes: (1) EU, BE, DK, NL, AT, FI, UK: 2007; EE, IT, MT, SK, TR: 2009.
(2) EU does not include EL, FR, LU, SE.

Concerning the government sector (Figure II.3.7 below), female researchers are best represented in the medical sciences (as in the higher education sector) and also in the natural sciences (27% and 30% on average in the EU-27). In medicine the share of female researchers is 10 percentage points higher than that of male researchers. In natural sciences, there are a slightly larger proportion of male researchers. Again, a very wide gender gap is observable among the research population in the field of engineering. Engineering hosts only 14% of women researchers (the gap stood at 14% in 2008 throughout the EU). As in higher education, female researchers are least present in agriculture and in the social sciences (10% on average in the EU). Again, cross-country differences are observable: whereas just 10% of researchers in natural sciences in Spain are female, in Latvia the share is 47%. In engineering and technology, the low proportions of female researchers observed in Cyprus (1%), Denmark (2%), UK (54%), and Croatia (1%) contrast sharply with the much higher shares of women in Belgium (36%), Turkey (39%), Luxembourg (26%), and Romania (30%). Such contrasting national patterns also characterise the medical sciences, with particularly high shares of female researchers in medicine in Spain (62%), Italy (47%) and Portugal (40%) and particularly low shares in Lithuania (4%), Belgium (4%), Malta (4%) and Turkey (5%). The share of female researchers in the humanities is lowest at 0% in Ireland and Spain with 2%whereas it peaks at 42% in Estonia and 33% in Austria. Whereas there was the least cross-country variation in the proportions of researchers in the social sciences in the higher education sector, in the government sector, this fails to hold true. Indeed, the proportion of female researchers ranges from 2% in Turkey to 50% in Malta.

Figure II.3.7 Researchers (Head Count, female and male) in the government sector - % distribution by field of science, 2008 (1)



Source: DG Research and Innovation
Data: Eurostat
Notes: (1) EU, BE, DK, IE, LU, AT, FI: 2007; EE, MT, SK, TR: 2009.
(2) EU does not include EL, FR, NL, SE.

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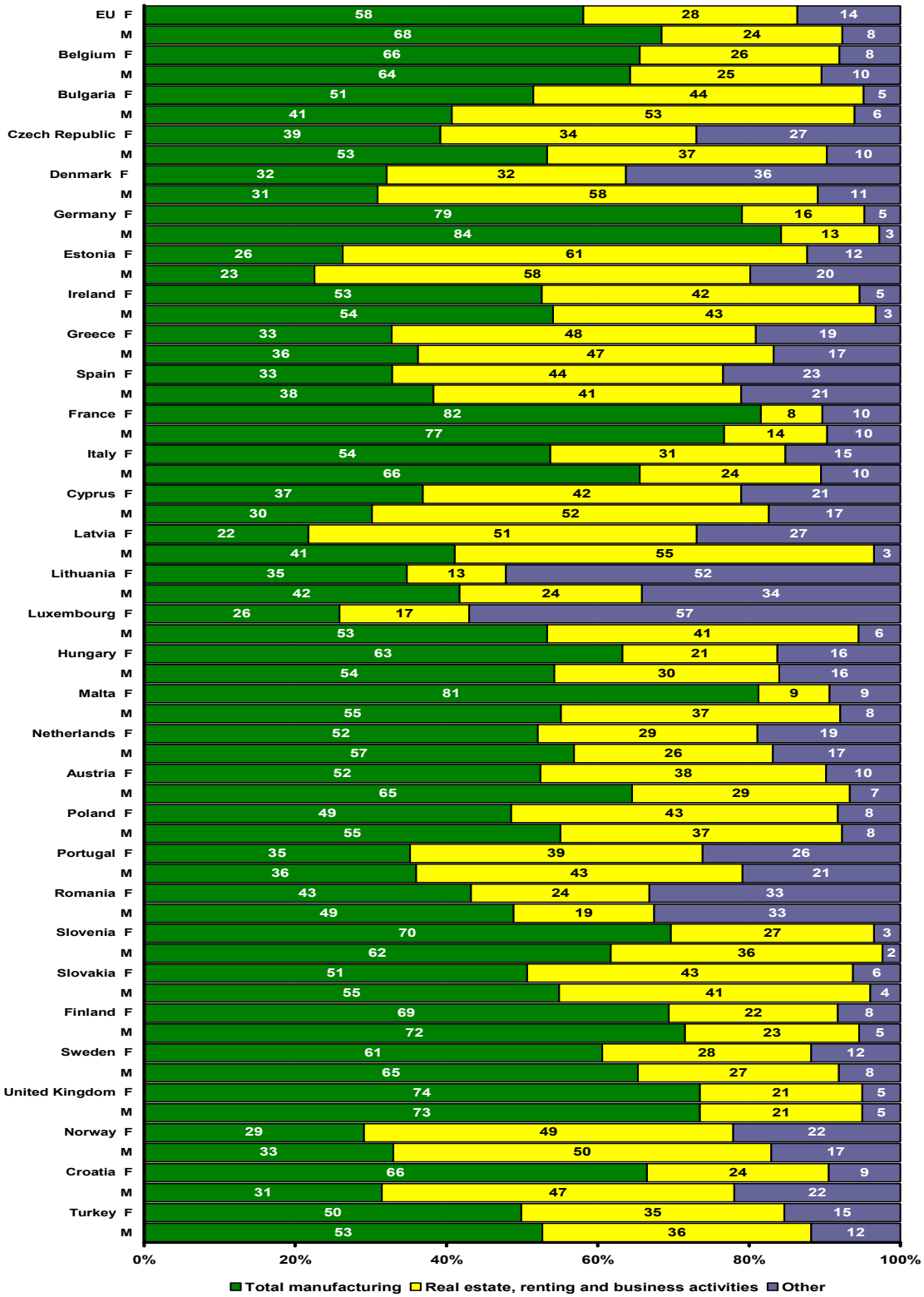
Among the researchers in the business sector, around two thirds of all women do research in the manufacturing sector

Finally, regarding the business enterprise sector, researchers are distributed across different economic activities (Figure II.3.8). Two sectors of activity are studied: manufacturing; and real estate, renting and business activities. Research activities are mainly conducted within the manufacture and real-estate sectors. These two economic sectors can be compared with all other economic activities taken together. In most countries, the highest shares of both male and female researchers are in manufacturing. The share of women in this sector stood at 58% and that of men at 68% in 2008 (for the EU). However, for Estonia, Greece, Spain, Poland, Slovakia, and Norway, the share of female researchers is highest in real estate, renting and business activities rather than in manufacturing. The share of male researchers is also highest in this sector of economic activity in Denmark, Estonia, Greece, Cyprus, Latvia, Slovakia and Norway. Moreover, if one focuses on pharmaceuticals as a subgroup of the overall manufacturing sector, the share of female researchers at the level of the EU increases to 38.5% from 17.3% in the broad sector of manufacturing. This illustrates that women are relatively better represented in the manufacture of pharmaceuticals than in that of other products. Besides manufacturing, the share of female researchers in real estate, renting and business activities stood at 28% at the level of the EU in 2008. Finally, the other sectors of economic activity host only 14% of female researchers and 8% of male researchers (in the EU on average).

Figure II.3.8 Researchers (Head Count, female and male) in the business enterprise sector - % distribution by economic activity, 2008 (1)



Source: DG Research and Innovation
Data: Eurostat
Notes: (1) FR: 2004; IE, EL, NL: 2005; EU, BE, DK, DE, IT, LU, AT, SE, UK: 2007; SK: 2009.
(2) EU does not include IE, EL, FR, NL.

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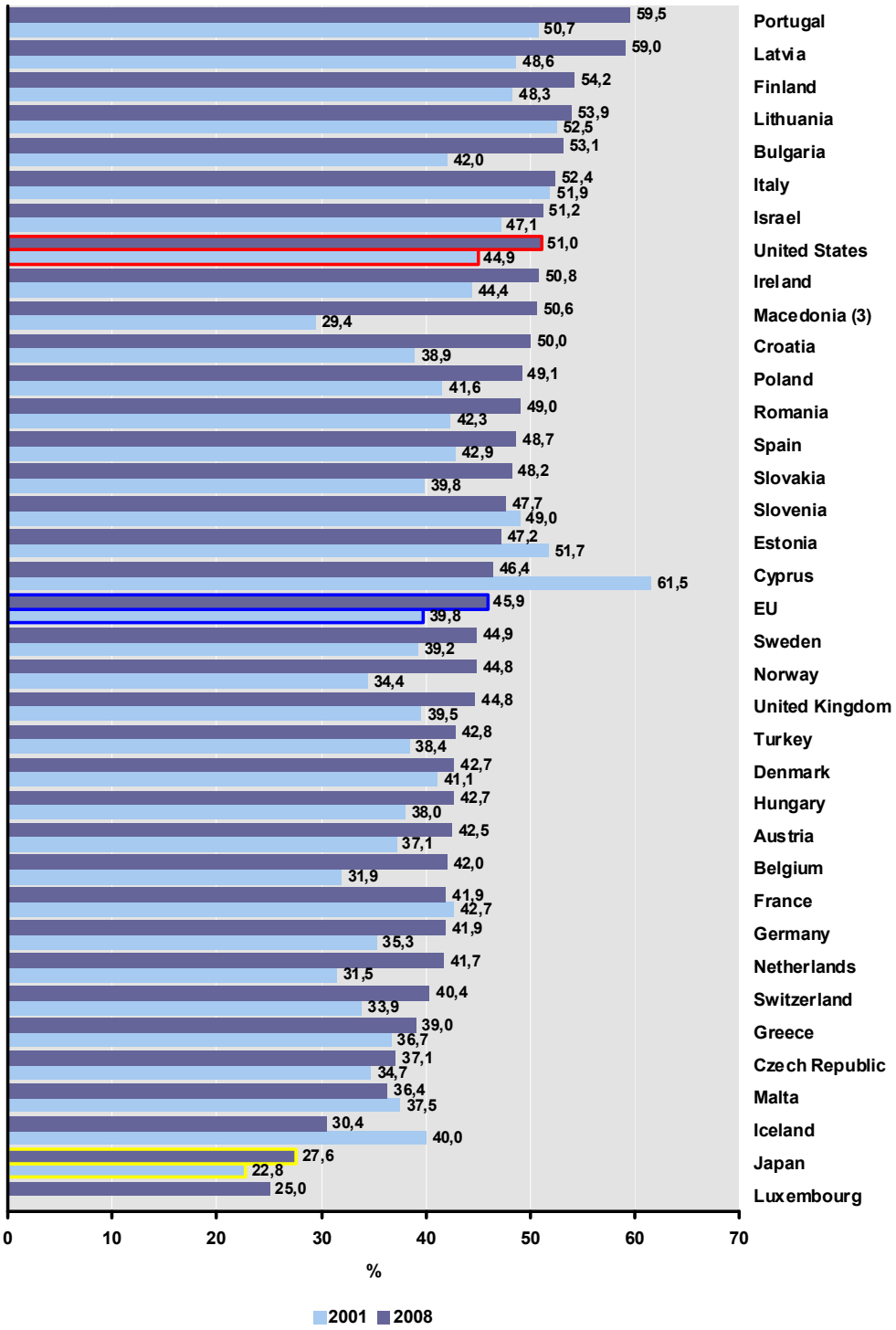
3.2.3 Segregation in higher education

Decisions with respect to the field of study could lead to horizontal segregation between women and men on the labour market.

Forty-five per cent of all PhD graduates are women

Figure II.3.9 shows the proportion of female PhD graduates for 2008; on average in the EU, nearly 46% of all PhD graduates are women. The top-ranked countries are Portugal (60%), Latvia (59%), Finland and Lithuania (54%) and Bulgaria (53%). Ten countries have 50% or more female PhD graduates. At the bottom of the rank, the countries with the lower scores are Luxembourg and Malta, with respectively 25% and 36%. A notable evolution has occurred in the proportion of female PhDs between 2001 and 2008. In general, with the exception of France, Cyprus, Estonia, Slovenia and Malta the percentage of female PhDs has grown in all countries for which data are available between 2001 and 2008. Marked changes are observed in Portugal (from 50% to 59.53%) over the period) as well as Bulgaria (from 42% to 53%) and Latvia (from 48.6% to 59%). The proportion rose from 42.9% to 48.7% in Spain;; from 34,4% to 44.8% in Norway; ; from 31.9% to 42% in Belgium; from 31.5% to 41.7% in the Netherlands;; from 39.8% to 48.2% in Slovakia, and from 35.3% to 41.9% in Germany.

Figure II.3.9 Female PhD (ISCED 6) graduates as % of total PhD (ISCED 6) graduates, 2001 (1) and 2008



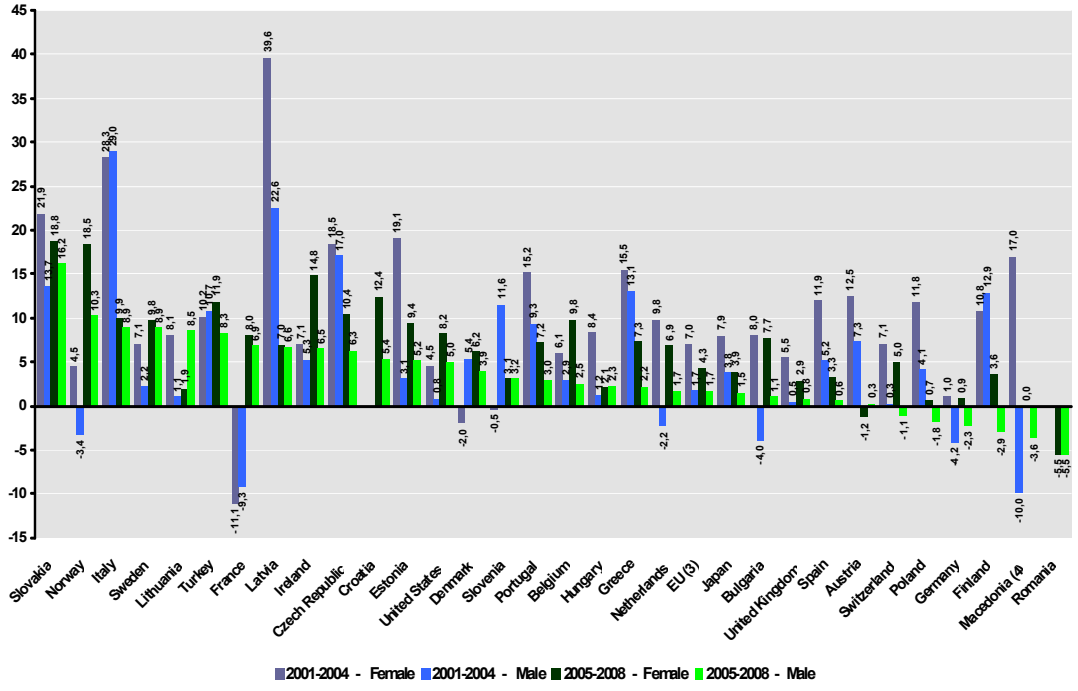
Source: DG Research and Innovation
Data: Eurostat
Innovation Union Competitiveness Report 2011
Notes: (1) MT, IS, CH: 2002; RO, HR: 2003, CY: 2004.
(2) EU: LU and RO are not included in the EU aggregate for 2001.
(3) The Former Yugoslav Republic of Macedonia.

Women's share amongst PhD graduates has been growing in recent years

Figure II.3.10 yields the compound annual growth rate of PhD graduates by sex, and one can observe that with the exception of Italy, France, Norway, Finland, Hungary, Bulgaria and Estonia, the share of women amongst PhD graduates has been growing in recent years. In the majority of countries, the compound annual growth rate of female PhD graduates exceeds that of men over the period. On average in the EU, the number of female PhD graduates increased at a rate of 6.8% per year compared with 3.2% for male PhD graduates. The difference between the female and male rates is greater in Croatia, Portugal, Slovakia, Romania, Denmark and Switzerland. These figures clearly prove that women are catching up with men. This increase of women's educational level will probably result in women being at least equally or even more present than men at the PhD level in the near future.

On the basis of She Figures 2003, we can compare the compound annual growth rate of PhD graduates for the period 1998–2001 to the period 2002–2006. During the first period, the compound annual growth rate was 4.8% for women and 2.4% for men. During the second period these numbers were 6.5% and 2.9% respectively. The compound annual growth rate has significantly risen over time.

Figure II.3.10 Female and male PhD (ISCED 6) graduates - average annual growth (%), 2001-2004 (1) and 2005-2008 (2)



Source: DG Research and Innovation
Data: Eurostat
Notes: (1) FR: 2001-2003; CH: 2002-2004.
(2) FR: 2006-2008.
(3) EU: (i) LU and RO are not included in the EU aggregate for 2001-2004; (ii) LU is not included in the EU aggregate for 2001-2004.
(4) The Former Yugoslav Republic of Macedonia.

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3.2.4 Segregation in education: fields of science

When studying segregation it is necessary to look at the gender distribution of PhD graduates across fields of study. Despite the rise in women's level of education and in their proportion among Ph.D. graduates, there remains a significant degree of segregation in specific fields of study.

On average throughout the EU in 2006, women PhD holders were over-represented in education, health, humanities, agriculture, veterinary while women are under-represented among PhDs in engineering

Women constitute a majority in the fields of health and welfare (54%), of humanities and art (52%), and of agriculture and veterinary (51%). In social sciences, business and law, their proportion is 47%. This proportion falls to 41% for science, mathematics and computing and drops even lower to 25% for engineering, manufacturing and construction. However, this situation strongly varies between countries: the feminisation of the field of education is most pronounced in Portugal, Slovenia and Finland, where only one in four PhD education graduates were a man, and in Estonia, Cyprus and Iceland where 100% of the PhD graduates in education were women. This is probably due to very small sample sizes of PhD graduates in this field in these countries. When comparing the degree of masculinisation of engineering, manufacturing and construction cross-nationally, it appears that less than one in five PhD holders in this field is a woman in Germany (14%), Switzerland (19%) and Japan (11%). On the contrary, in Estonia, engineering appears to be a women's field, and 59% of PhD graduates are female. Estonia is clearly an exceptional case. Nevertheless, the smallest relative degrees of masculinisation of this field (>35% of PhDs being female) are observed in Italy, Portugal, Latvia, Lithuania, Croatia, and Turkey. The proportion of female PhD graduates in engineering, manufacturing, and construction is much lower than the EU-27 average (7.9%) in many countries; the lowest is observed in Germany (2.9%). At the other end of the scale, in Sweden this field boasts up to 20% female PhDs. In contrast with these relatively low shares of female PhDs in engineering, more than 30% of male PhDs are in this field in Sweden, Finland, Denmark, Bulgaria, the Czech Republic, and Slovenia. There is even more cross-country disparity in the proportion of female PhDs in health and welfare. There is usually more gender balance in science, mathematics, and computing and in the social sciences, business and law.

Table II.3.2 compares the proportion of female Ph.D. graduates between 2001 and 2008 in a number of countries. Between these two dates, there are differences in the evolution of the number of female PhD graduates by broad field of study. The most important finding is that women's share among Ph.D. graduates has increased in *all* fields of study. The disciplines where the rise of women has been most marked are education (increase by 12 percentage points between 2001 and 2008), followed by social science, business and law (increase by 9 percentage points). In engineering, manufacturing and construction, their proportion has increased by 6 percentage points as in science, mathematics, and computing.

Table II.3.2 Female PhD (ISCED 6) graduates as % of total PhD (ISCED 6) graduates by field of study, 2001 (1) and 2008 (2)

	Education		Humanities and Arts		Social sciences, business and law		Science, mathematics and computing		Engineering, manufacturing and construction		Agriculture and veterinary		Health and Welfare	
	2001	2008	2001	2008	2001	2008	2001	2008	2001	2008	2001	2008	2001	2008
Belgium	55	39	31	41	35	43	34	38	15	30	31	50	40	55
Bulgaria	44	53	44	70	40	60	46	53	28	35	52	62	52	49
Czech Republic	63	63	50	44	42	43	24	40	27	22	31	48	51	37
Denmark	50	-	52	52	38	49	31	32	24	22	43	56	51	55
Germany	42	56	45	51	32	38	27	36	12	15	53	60	45	54
Estonia	-	80	36	50	50	33	32	45	0	35	50	33	65	67
Ireland	50	73	54	57	49	69	43	47	22	19	37	63	60	59
Greece	52	55	51	56	52	37	32	33	21	25	44	37	65	44
Spain	54	57	45	50	44	51	45	50	23	31	33	48	49	58
France	50	52	57	57	42	47	39	38	27	27	57	28	57	50
Italy	-	71	62	59	48	52	49	51	36	35	56	58	63	62
Cyprus	-	50	0	20	-	-	-	-	-	-	-	-	-	-
Latvia	67	86	50	65	67	62	44	58	29	29	100	100	-	63
Lithuania	:	:	60	55	71	54	45	53	30	37	100	72	44	67
Luxembourg	-	:	-	:	-	:	-	:	-	:	-	:	-	:
Hungary	61	66	42	51	43	42	26	31	24	33	31	47	38	44
Malta	-	-	0	50	-	0	-	50	0	0	0	-	0	33
Netherlands	-	:	32	41	37	47	25	31	14	24	33	47	42	52
Austria	62	73	51	49	39	49	36	38	13	21	51	57	72	56
Poland	-	:	48	55	44	48	45	54	20	28	44	58	47	55
Portugal	66	77	65	67	46	61	50	55	39	39	56	58	67	74
Romania	:	:	49	61	54	50	50	51	30	26	33	44	48	54
Slovenia	81	80	51	66	63	55	43	49	23	24	69	52	58	52
Slovakia	45	61	37	53	47	50	45	49	29	36	38	49	54	54
Finland	66	84	53	56	48	59	37	47	21	28	39	62	65	72
Sweden	66	73	44	52	41	48	33	37	24	29	48	56	53	60
United Kingdom	55	63	46	49	40	55	39	38	19	22	40	57	52	55
EU	55	67	49	54	40	49	36	42	21	26	46	54	49	55
Iceland	-	50	-	-	100	0	-	0	-	0	-	-	100	71
Norway	55	56	47	51	40	52	9	34	14	29	37	43	41	57
Switzerland	25	67	43	49	29	37	26	38	13	22	56	67	47	47
Croatia	0	73	42	71	49	49	40	54	18	24	44	37	49	53
Macedonia (3)	67	45	25	43	10	33	58	64	11	29	-	33	75	68
Turkey	35	42	26	38	34	39	44	43	32	31	39	47	55	61
United States	65	67	45	48	53	58	34	39	17	22	36	39	62	73
Japan	46	49	47	48	33	37	17	21	8	12	23	28	23	31

Source: DG Research and Innovation — Innovation Union Competitiveness Report 2011
Data: Eurostat
Notes: (1) CH: 2002; RO, HR: 2003, EL: 2004.
(2) EU, IT: 2008.
(3) The Former Yugoslav Republic of Macedonia.

3.3. Is Europe utilising the full potential of female researchers?

Europe counts more women than men in its student population, but there are fewer women relative to men as they progress higher up the academic career ladder

Available data on vertical segregation concern mostly the academic sector. The academic career path of women remains strongly marked by the vertical segregation. In general, the proportion of women is clearly declining as they reach higher up the academic ladder. This phenomenon is commonly illustrated by the scissors diagram (Figure II.3.11) that is built on cross-sectional data: the diagram shows the proportion of men and women at each stage of the academic career in a given year and compares them to the proportion that one would expect to find given the numbers of men and women undergraduates in prior years, based on the assumption that men and women were equally likely to stay in the system and to progress through at equal rates.

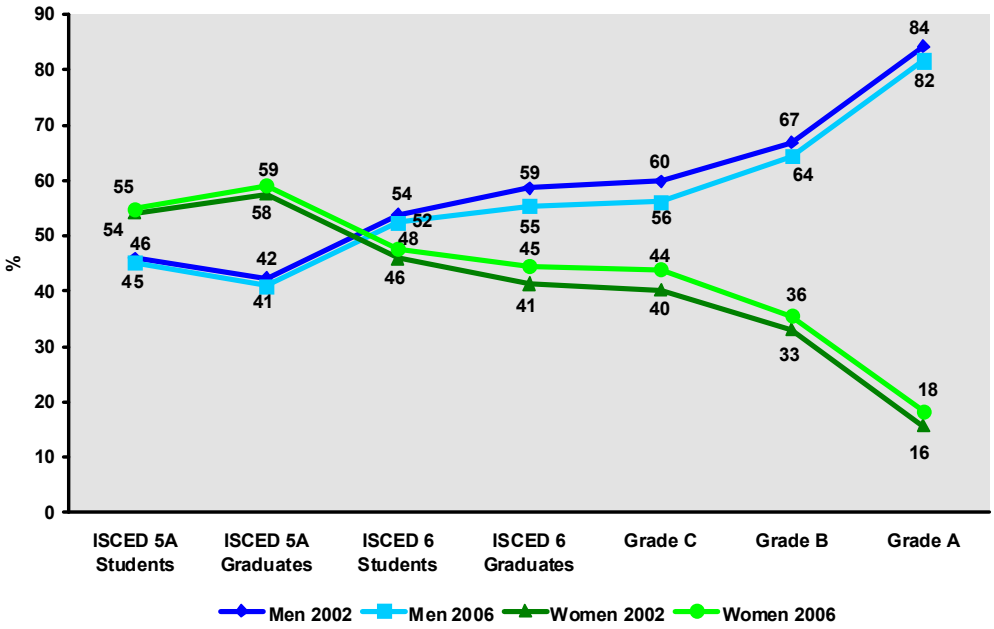
In the first two levels of university education (ISCED 5A students and graduates), the proportion of women outnumbers those of men. Indeed this high proportion of women in the student population is one of the most striking elements of the evolution of the last 30 years in most European countries. The situation changes when reaching the ISCED 6 student level (students in programmes leading to the award of an advanced research qualification — such as the PhD — that are devoted to advanced study and original research) where the proportion of women is 48%. Then the proportion of women drops back to 45% for the PhD graduates and the gender gap widens. The PhD degree often constitutes a necessary level to enter the academic career, so that the attrition of women's numbers at this level will have a knock-on effect on their relative representation at the first stage of the academic career. Furthermore, women represent only 44% of grade-C academic staff, 36% of grade-B academic staff and 18% of grade A academic staff. The grade-C academic staff are the first grade/post to which a newly qualified PhD graduate would normally be recruited. The grade-B academic staff represents researchers working in positions more senior than newly qualified PhD holders, but less senior than those of grade-A staff. Finally, the grade-A academic staff constitutes the single highest grade/post at which research is normally conducted. The figures illustrate the workings of a 'sticky floor', a metaphor to point towards the difficulties graduate women face when trying to slip into the first levels of the academic career. This figure clearly bears witness to the existence of a glass ceiling composed of hard-to-identify obstacles that hold women back from accessing the highest positions in the hierarchy.

Over the period 1999–2006, the population of women in higher academic positions has slightly improved

Figure II.3.11 allows the evaluation of the evolution of vertical segregation from 1999 to 2006. It shows an improvement in women's relative position. At the level of ISCED 5A graduates, the increase in the proportion of women between 1999 and 2006 was of three percentage points (at these low levels, the proportion of women is higher than that of men). At the level of ISCED 6 students, women's proportion also rose by three percentage points, while for ISCED 6 graduates there was an increase by seven percentage points between 1999 and 2006. The proportion of women at Grade C increased by six points over the period, while there was an increase by only four points at Grade B and five points at Grade A. The increase in the proportion of women was higher among ISCED 6 graduates and Grade C, and it diminishes among higher hierarchical levels. The increase in the proportion of women is

lower at higher hierarchical levels. This illustrates a higher resistance to the integration of women in higher levels (especially Grade A) or it could be due to a time lag on the impact on academia of the positive evolution at PhD level. However, it is also worth noting that these improvements appear to be very slow.

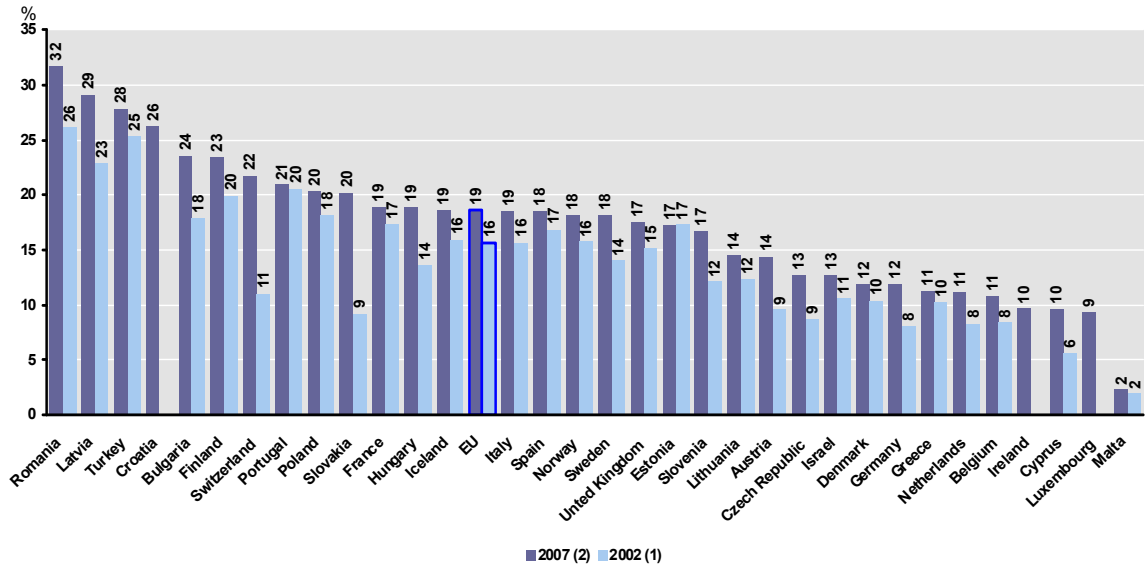
Figure II.3.11 EU - proportions of women and men in a typical academic career - students and academic staff, 2002 and 2006



Source: DG Research and Innovation Innovation Union Competitiveness Report 2011
Data: Eurostat, DG Research and Innovation, Higher Education Authority, Ireland

Figure II.3.12 presents the evolution of the proportion of women in Grade-A academic position by country for the years 2002–2007. Several countries such as Slovakia and Switzerland show very important evolutions of their proportion of women at Grade A. In Portugal, Estonia and Greece, the percentage remains almost stagnant over the period.

Figure II.3.12 Proportion of women in Grade A academic positions, 2002 (1) and 2007 (2)



Source: DG Research and Innovation
Data: DG Research and Innovation, Higher Education Authority, Ireland
Notes: (1) EL: 1999; IL: 2001; AT: 2002; NL, UK, NO: 2003.
(2) EL: 2000; PT: 2003; EE, MT: 2004; DK, FR, CY, LU, AT, IL: 2006; UK: 2006/2007; HR: 2008
(3) The EU average was estimated by DG Research and Innovation.

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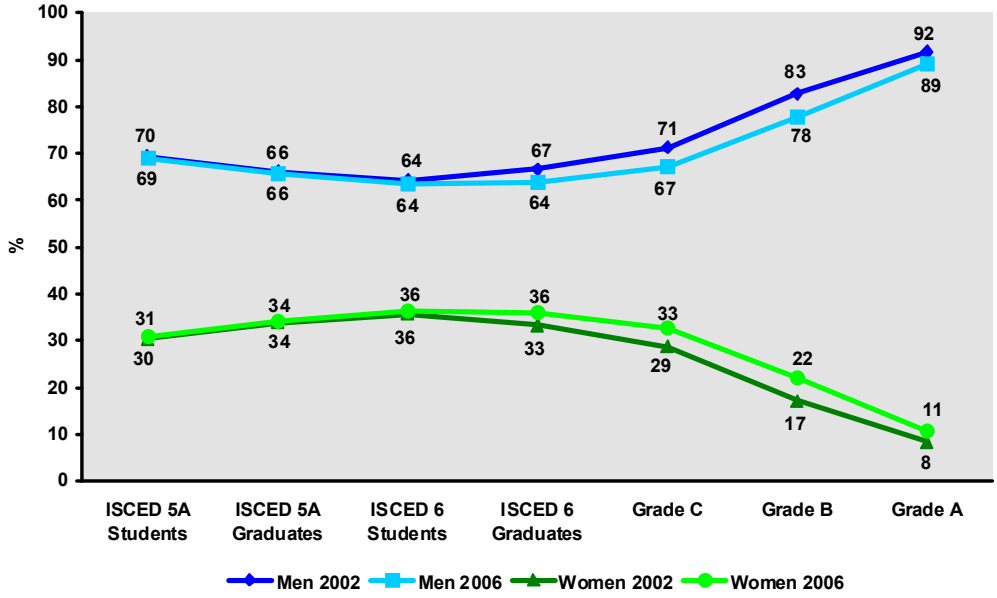
The under-representation of women throughout the academic career is particularly visible in science and engineering

The previous figures documented vertical segregation in the academic world (in the EU). The scissors diagram (Figure II.3.13) concentrates only on the fields of science and engineering. The picture differs considerably and shows a considerably higher degree of women's under-representation. This field lacks attractiveness for women, since only 31% chose this field of science in 2006. However, this is particularly problematic only at the earlier stages of the academic career since the proportion of women increases throughout the first hierarchical echelons to reach 36% at the levels of PhD students and graduates. For the rest, an academic career in science and engineering shows the same pattern as in general over all fields of study. The most notable evolution between 1999 and 2006 concerns the proportion of women at Grade C (increase by seven percentage points over the period). However, for ISCED 5A and at Grade A, women's proportion has increased by just two to three percentage points over the period. The evolution for ISCED 6 (students), ISCED 6 (graduates) and Grade B are respectively four, six and five percentage points.

Figure II.3.13 EU - proportions of women and men in a typical academic career in science and engineering - students and academic staff, 2002 and 2006

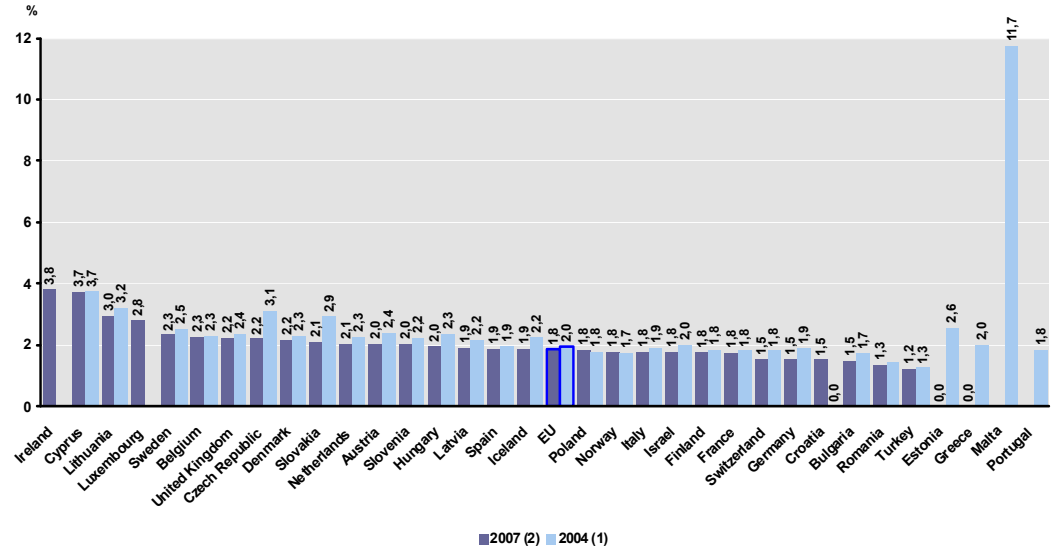


Source: DG Research and Innovation Innovation Union Competitiveness Report 2011
Data: Eurostat, DG Research and Innovation, Higher Education Authority, Ireland

The probability of female researchers reaching a top academic position is lowest in Ireland, Cyprus, Lithuania, Luxemburg, Sweden and Belgium

The glass ceiling index (GCI) illustrates the difficulties women have in getting access to the highest levels of the hierarchy and measures their relative probability, as compared with that of men, of reaching a top position. The GCI compares the proportion of women in grade A positions (equivalent to Full Professors in most countries) to the proportion of women in academia (grade A, B, and C), indicates the opportunity, or lack thereof, for women to move up the hierarchical ladder in their profession. The value runs from zero to infinity. A GCI of 1 indicates that there is no difference between the promotion of women and men. A score of less than 1 means that women are over-represented at grade A level. A GCI score of more than 1 means women are under-represented in grade A positions (glass ceiling effect). In other words, the interpretation of the GCI is that the higher the value, the thicker the glass ceiling and the more difficult it is for women to move into a higher position. On average for the EU-27, the GCI stands at 1.8 (Figure II.3.14). No country presents a GCI equal to or below 1. Its value ranges from 11.7 in Malta to 1.3 in Romania. The index is the highest in Ireland, Cyprus, Lithuania, Luxembourg, Sweden and Belgium. The case of Malta is extreme: it is the only country where so few female academics get into grade A positions. This can at least partly be explained by the fact that there is only one university in Malta. Between 2004 and 2007, the index has decreased or remained stable in all countries.

Figure II.3.14 Glass Ceiling Index, 2004 (1) and 2007 (2)



Source: DG Research and Innovation
Data: Eurostat, DG Research and Innovation, Higher Education Authority, Ireland
Notes: (1) EL: 2000; IL: 2001; PT, NO: 2003.
(2) DK, IE (in part), FR, CY, LU, AT, IL: 2006; UK: 2006/2007; HR: 2008
(3) The EU average was estimated by DG Research and Innovation.

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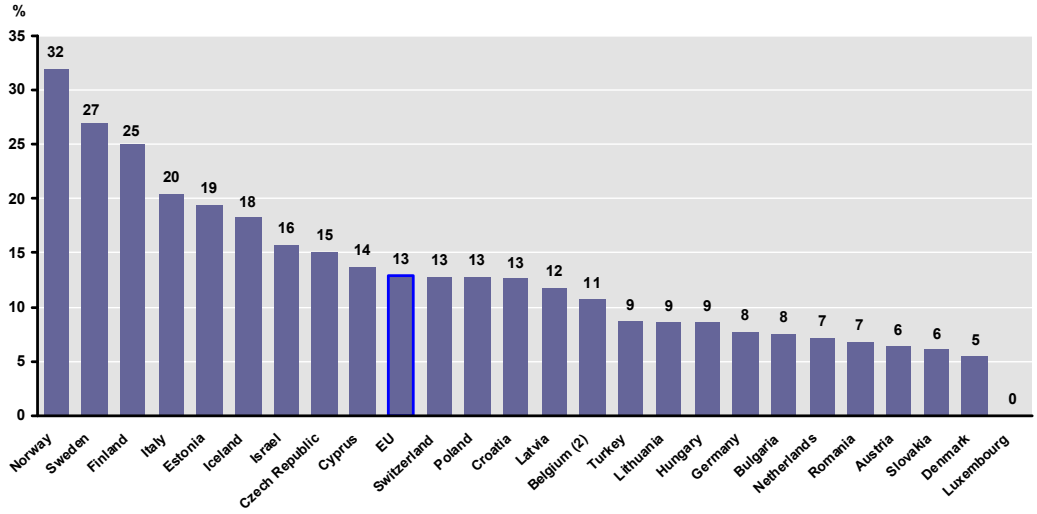
There is a strikingly low presence of women in very high positions such as at the head of universities or other higher education institutions

Women's under-representation in the higher levels of the academic hierarchy is reflected in the composition of the decision-making committees and leadership positions that are mainly composed of men. Consequently, one observes a strikingly low presence of women in very high positions such as at the head of universities or other higher education institutions. Figure II.3.15 illustrates this phenomenon well. On average throughout the EU, only 13% of institutions in the higher education sector were headed by women in 2007. We can see that this proportion varies from 27% to 0%. The countries that show the highest proportion of women are Norway, Sweden, Finland, Italy and Estonia (more than 19%). On the other hand, the countries that show a very low proportion of women in such leading positions are Luxembourg, Denmark and Slovakia (under 7%). When considering only universities and assimilated institutions (institutions that are able to award PhD titles), the proportion is even lower. The EU average shows only 9% of universities with a female head. The highest shares of women rectors are observed in Sweden, Iceland, Norway, Finland, but also in Israel. On the contrary, in Denmark, Cyprus, Lithuania, Luxembourg and Hungary, no single university is headed by a woman. Romania, Austria, Slovakia, Italy, the Netherlands, the Czech Republic, Belgium and Germany also have very low proportions of women rectors (7% at most). When comparing these results with the proportion of women in grade A, it is obvious that the proportion of women continues to fall as they advance on the academic ladder.

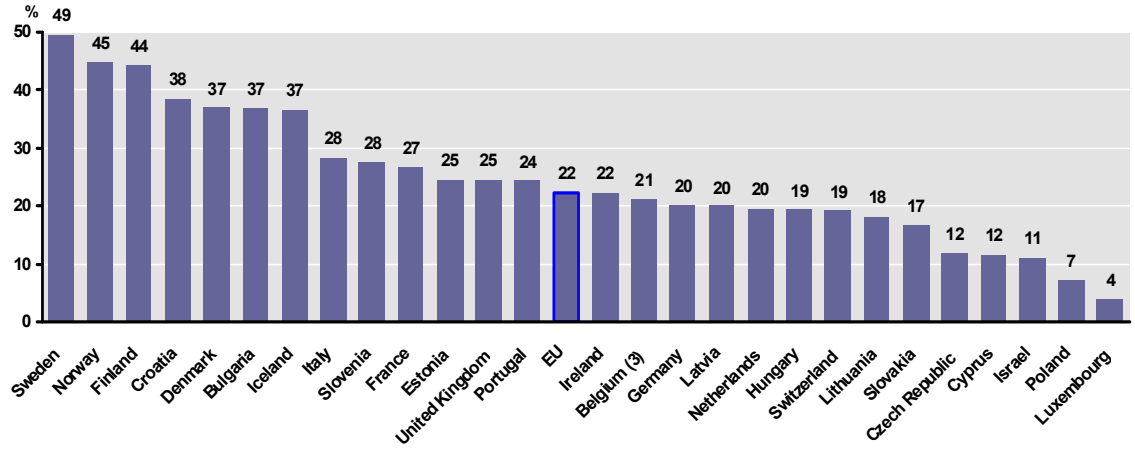
Figure II.3.15 Proportion of female heads of institutions in the Higher Education Sector (HES), 2007 (1)



Source: DG Research and Innovation — Innovation Union Competitiveness Report 2011
Data: DG Research and Innovation
Notes: (1) RO: 2006/2007; DK, CY: 2007/2008; BE (2), DE, EE, HU, AT, PL, SK, FI, SE, HR, CH, IL: 2008; IT: 2009.
(2) Belgium refers to the Dutch-speaking community only.
(3) The EU average was estimated by DG Research and Innovation.

The proportion of women on boards adds interesting information to this overall pattern. Even if the coverage of boards differs across countries, one can state that in general, boards' data cover scientific commissions, R&D commissions, boards, councils, committees and foundations, academy assemblies and councils, and also different field-specific boards, councils and authorities. These all have a crucial power of influence on the orientation of the research. Figure II.3.16 presents data on the proportion of women on boards for the year 2007 — an EU average of 22%. The Nordic countries show particularly high proportions of women on boards. In Sweden, Norway and Finland, the share of female board members exceeds 44%. It is not surprising, as in these countries, there is an obligation to have at least 40% of members of each sex on all national research committees and equivalent bodies. The countries that show the lowest levels of women on boards (less than 20%) are Hungary, Lithuania, Switzerland, Slovakia, the Czech Republic, Cyprus, Israel, Italy, Poland and Luxembourg.

Figure II.3.16 Proportion of women on boards [1], 2007 [2]



Source: DG Research and Innovation — Innovation Union Competitiveness Report 2011
Data: DG Research and Innovation
Notes: (1) There is no common definition of boards. The total number of boards varies considerably between countries.See *She Figures, 2009,* p. 99
(2) FR, PL: 2002; PT: 2003; IE: 2004; CZ, SK, IL: 2008; IT: 2009.
(3) Belgium refers to the French-speaking community only.
(4) The EU average was estimated by DG Research and Innovation.

For all countries and all sectors, the proportion of male researchers is higher than the proportion of female researchers

Data related to vertical segregation in sectors other than the higher education sector do not exist. Data for 2006 are available concerning the gender distribution of R&D staff within different occupations (researchers, technicians and others) for the higher education sector, the government sector, the business and enterprise sector and for all sectors put together. According to the Frascati manual, researchers are 'professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned', while technicians are 'persons whose main tasks require technical knowledge and experience in one or more fields of engineering, physical and life sciences or social sciences and humanities. They participate in R&D by performing scientific and technical tasks involving the application of concepts and operational methods, normally under the supervision of researchers.' Finally, other supporting staff include 'skilled and unskilled craftsmen, secretarial and clerical staff participating in R&D projects or directly associated with such projects.' These definitions allow us to distinguish a certain hierarchy among R&D occupations: researchers are placed at the highest level, followed by technicians and other supporting R&D staff. According to these data, one observes that for all countries and all sectors, the proportion of male researchers is higher than the proportion of female researchers. Among the two other levels (technicians and other), the proportion of women exceeds that of men. Table II.3.3 presents the values of the ID index measuring vertical segregation (across professional categories — ISCO88, 3-digits) for three populations: the total workforce, the population of researchers and the population of the most highly qualified researchers (with a Ph.D. degree) for all Member States of the EU in 2007.

Vertical segregation among researchers should be understood as a different distribution of male and female researchers over the hierarchy of professions. The table shows that vertical segregation in the population of researchers is lowest in Spain, Cyprus, Belgium, Greece,

Luxembourg and the Netherlands, and highest in Italy, Romania and Bulgaria. In 19 countries, the ID index is lower among researchers than on the labour market as a whole, and it drops even further when one compares total researchers with the subsample of the most highly qualified researchers. In a second group including France, Italy, Romania and Bulgaria, the level of dissimilarity in the distribution over professional categories is higher when only researchers are concerned than when the total labour force is analysed. In all of these countries, the ID index, although higher for researchers than for the total workforce, is lower amongst the most highly qualified researchers (ISCED 6) than amongst researchers of all levels of education (ISCED 5A and 5B) and than for the total workforce. In Cyprus, Slovakia, Greece, and to a smaller extent Estonia, professional dissimilarity is highest in the total workforce, lowest in the population of researchers, and falls between these two extremes for the most highly qualified male and female researchers.

Table II.3.3 Vertical segregation (ID-index): researchers compared to total labour force, 2007

	Total labour force	Resaerchers (ISCED 5A, 5B, 6)	Resaerchers with a PhD (ISCED 6)
Spain	0,47	0,24	0,12
Cyprus	0,46	0,25	0,34
Belgium	0,45	0,26	0,14
Greece	0,40	0,26	0,29
Luxembourg	0,45	0,27	0,10
Netherlands	0,46	0,27	0,19
Lithuania	0,53	0,29	0,12
Portugal	0,47	0,29	0,14
Austria	0,49	0,30	0,27
Latvia	0,52	0,31	0,25
Czech Republic	0,52	0,32	0,20
Denmark	0,46	0,33	0,19
France	0,33	0,34	0,16
Poland	0,42	0,34	0,26
Germany	0,47	0,35	0,32
Norway	0,47	0,35	0,09
United Kingdom	0,49	0,35	0,11
Hungary	0,52	0,36	0,27
Estonia	0,57	0,37	0,57
Ireland	0,51	0,37	0,12
Finland	0,55	0,40	0,15
Slovakia	0,54	0,40	0,44
Slovenia	0,42	0,41	0,19
Sweden	0,47	0,45	0,11
Italy	0,39	0,48	0,13
Romania	0,39	0,52	0,24
Bulgaria	0,47	0,55	0,33

Source: DG Research and Innovation Innovation Union Competitiveness Report 2011
Data: LFS 2007, own calculations
Note: (1) The data concerning researchers with a PhD should be interpreted with caution due to small sample size.