Forfás

Survey of Research and Development in the Higher Education Sector 2004

PROMOTING ENTERPRISE, TRADE AND SCIENCE, TECHNOLOGY AND INNOVATION FOR ECONOMIC AND SOCIAL DEVELOPMENT

Survey of Research and Development in the Higher Education Sector 2004

S&T Indicators Unit

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Foreword

Investment in science and technology (S&T), particularly in research and development (R&D) activities, is one of the key pillars of policy under the National Development Plan, which helps drive the Irish economy in its transition to become a more knowledge-driven economy with high value-added activities.

Forfás monitors expenditure and resources employed across the Irish economy in carrying out research and development activities. It regularly surveys all performing R&D sectors of the economy including the business sector, the higher education sector and also the government sector. This report focuses on the R&D activities performed within the **higher education** sector in the 2003/2004 academic year.

The higher education sector provides a national base of skills and knowledge through the more fundamental nature of its R&D and complements the research in business sector firms and public sector institutes which are usually more applied and developmental in their focus. The Governments vision for R&D states that *"by 2010 Ireland will be internationally renowned for the excellence of its research and be at the forefront in generating and using new knowledge for economic and social progress, within an innovation driven culture"*.

The population for this survey includes all universities, institutes of technology and the technology centres located in colleges and covers all fields of knowledge, not just science and technology. These data feed into wider OECD and Eurostat work as well as informing policymakers and practitioners of the state-of-play at a given point in time. The methodology and procedures followed in this survey are those recommended by the OCED in the Frascati Manual. Appendix 1 of this publication provides more methodological details.

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Executive Summary

This report presents the results from the survey of research and development performed in the higher education sector (HERD) in Ireland in 2004. The higher education (HE) sector includes universities, institutes of technology and some other technology centres which perform R&D activities.

Over the past two years Ireland has made considerable progress towards closing the gap between R&D performance in the higher education sector and that of major competitors on the international stage. Ireland's R&D vision states that "*by 2010 Ireland will be internationally renowned for the excellence of its research and be at the forefront in generating and using new knowledge for economic and social progress, within an innovation driven culture*".

The main findings of the survey are as follows:

Trends in expenditure:

- *Higher education R&D expenditure in Ireland climbed to €491.7m in 2004 (academic year 2003/2004), an increase of 52.6% from the previous HERD total recorded in 2002.*
- *There has been a 44% increase in real terms (stripping out inflationary effects), in research expenditure in the higher education sector from 2002 to 2004.*

Research expenditure in the higher education sector, 1998 - 2004 (€m), current and constant prices:

	1998	2000	2002	2004
HERD current prices (€m)	203.7	238.1	322.3	491.7
HERD constant 2004 prices (€m)	253.6	276.3	340.9	491.7

Sources of funds:

- *The strong increases in HERD are due mainly to additional R&D funding through "direct" government spending initiatives such as Science Foundation Ireland and the Programme for Research in Third Level Institutes (PRTLI).*
- *"Direct" government funding increased by 48% between 2002 and 2004, whilst "indirect" government funding (via HEA block grant) increased by 58% in real terms in the same period.*

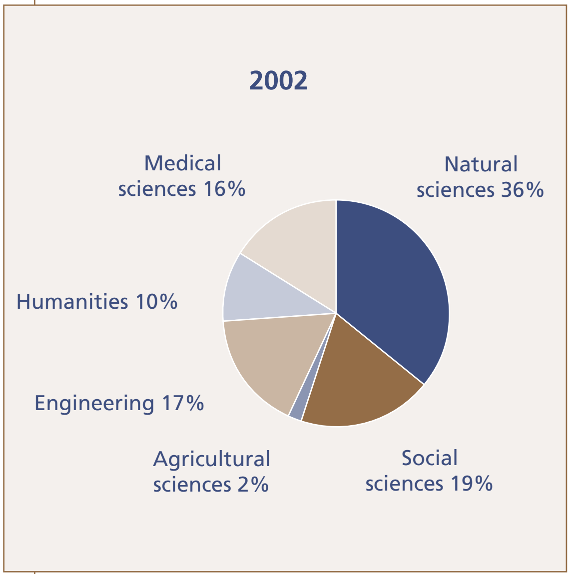
Sources of research funds, 2004 (€m):

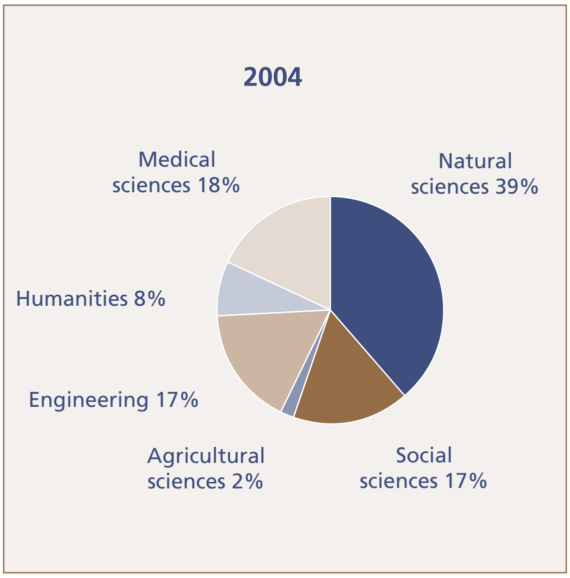
	Direct sources of funds					Indirect government	Total
	Direct government	EU	Foreign sources	Irish business	Other & own		
Total	**202.9**	**30.0**	**10.4**	**12.5**	**30.9**	**204.9**	**491.7**
% of total	41%	6%	2%	3%	6%	42%	100%
% change 98-04	237%	-27%	26%	-25%	58%	91%	94%
% change 02-04	48%	21%	49%	0%	6%	58%	44%

Fields of science:

- *All fields of science saw increases in higher education R&D expenditure between 2002 and 2004.*
- *R&D spending on natural sciences in the higher education sector rose by 56% between 2002 and 2004 to total €191m (39% of total HERD).*
- *Medical sciences R&D expenditure accounted for 18% of total HERD in 2004.*

Share of total higher education R&D expenditure by field of science, 2002 and 2004:

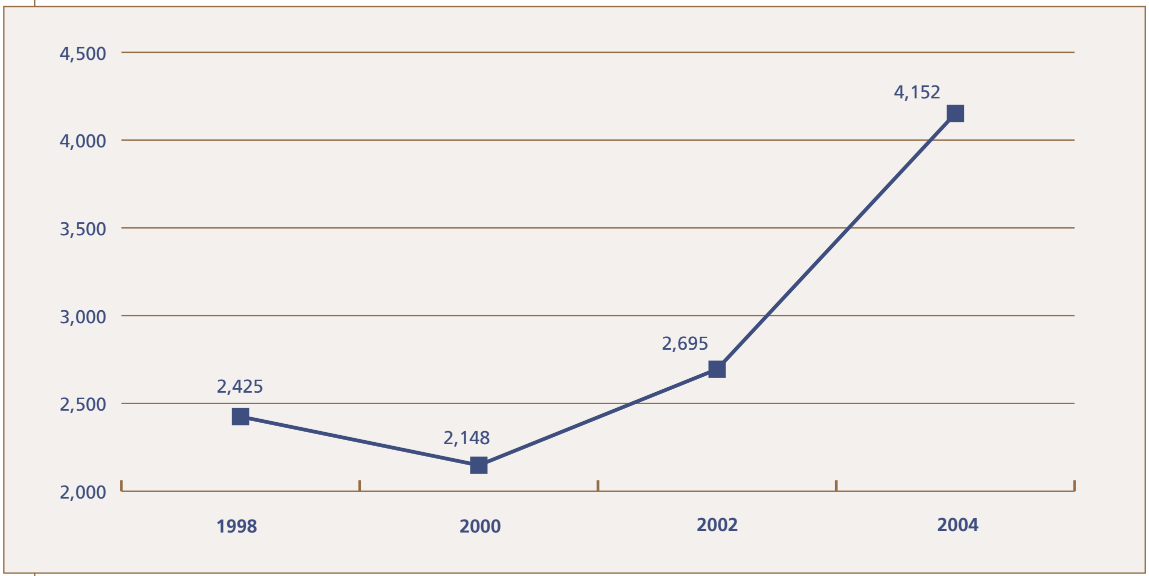




Human resources:

- *The total number of researchers in the higher education sector rose by 51.1% on a full-time equivalence basis (FTE) between 2002 and 2004 to 4,152 FTE's.*

Total researchers in the HE sector (FTE), 1998 – 2004:



- *This increase was driven by a rise in the total headcount of R&D personnel and also by a rise in the time dedicated to research activities by personnel.*

Research personnel (FTE) by category of employment, 2004:

	Academic staff	Post-doctoral fellows	Contract lecturers	Research assistants	Total researchers	Technicians	Admin staff	Other staff	Total research personnel
Total	1695	964	494	998	4152	385	251	53	4841
% Total	35%	20%	10%	21%	86%	8%	5%	1%	100%

Gender comparisons:

- *Males accounted for 59% of total research personnel in 2004, with females accounting for 41% of the total.*
- *Females made up 37% of total researchers in 2004, although this figure is weighed down by the lower ratio of female staff employed as academic staff (29% of the total for this category of employment).*

Research personnel (FTE) by category of employment and gender, 2004:

	Academic staff	Post-doctoral fellows	Contract lecturers	Research assistants	Total researchers	Technicians	Admin staff	Other staff	Total research personnel
% Male	71%	57%	55%	53%	63%	63%	12%	55%	59%
% Female	29%	43%	45%	47%	37%	37%	88%	45%	41%

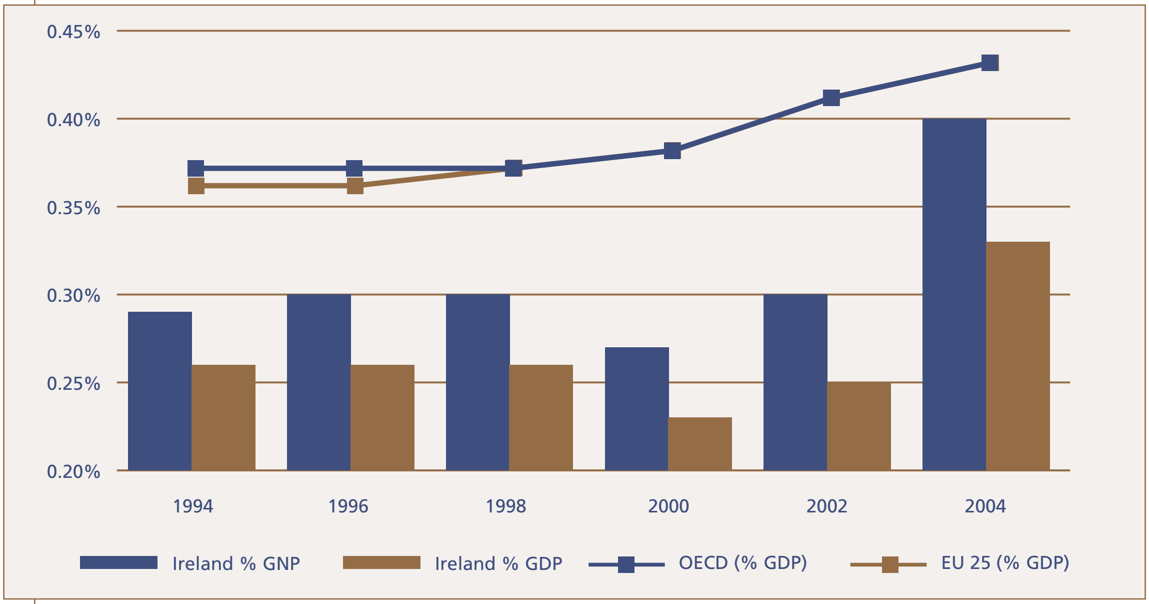
Time-use:

- *The average time spent on research by staff in the employment category 'academic staff' was 31.6% in 2004 (above the 31.1% average time recorded in 2002 and 25.7% recorded in 2000). These percentages are obtained by dividing the full time equivalents calculated (e.g. a single researcher dedicating 40% of their time to research is, 1 x 40%, 0.4 FTE) by the total headcount, giving a weighted average.*
- *The average time spent by total researchers (totalling staff from the categories: 'academic staff', 'contract lecturers', 'PhD fellows' and 'research assistants') on research activities was 46.4% in 2004.*

International comparisons:

- *The strong increases in HERD have allowed the HERD intensity ratio (higher education R&D expenditure divided by economic activity) to climb from 0.27% of GNP in 2000 to 0.40% in 2004.*
- *Significant progress has therefore been made in narrowing the HERD intensity ratio gap between Ireland and the EU25 average (0.43% of GDP).*
- *Ireland's international benchmarking ranking for HERD intensity has risen from 22nd out of 26 OECD countries in 2000 to 16th out of 26 in 2004.*

Higher education expenditure on R&D (% economic activity), 1994 – 2004:



- *There were an estimated 2.2 researchers per thousand people in the Irish labour force in 2004 compared to 1.5 per thousand in 2002.*
- *This strong performance has allowed Ireland's international ranking to rise from 23rd out of 30 OECD countries in 2002 to 14th out of 30 in 2004.*

1. General trends in higher education R&D expenditure

Total expenditure dedicated to research and development activities in the higher education sector (HERD) grew strongly from 2002 to 2004 to total €492 million. This increase in R&D spending was the largest ever recorded in nominal and real terms.

Figure 1 shows this expenditure in both nominal and real terms from 1994 to 2004. In nominal terms HERD increased by 52.8% between 2002 and 2004 (average annual increase of 23.5%).

In real terms HERD climbed by 44.3% between 2002 and 2004 (average annual increase of 20%). This compares to a weaker 23% real rise in the period 2000 to 2002, and an annual increase of 11%. Real or "constant" prices are used throughout this report as they remove inflationary effects from the data.

Figure 1: *Trend in HERD expenditure, 1994 - 2004, in constant and current prices (€m).*

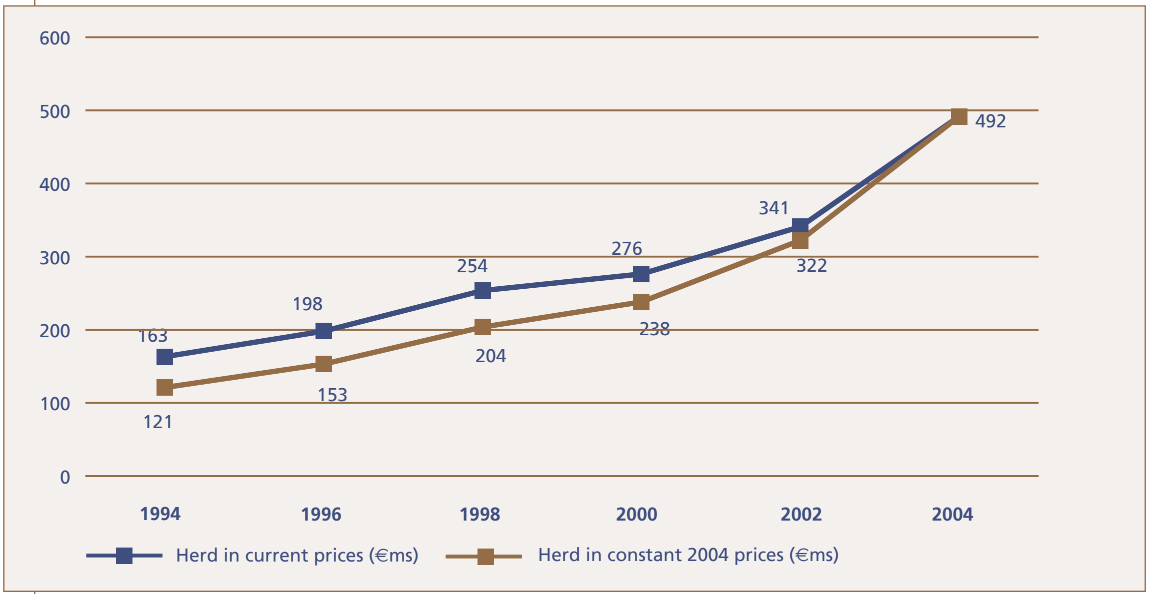
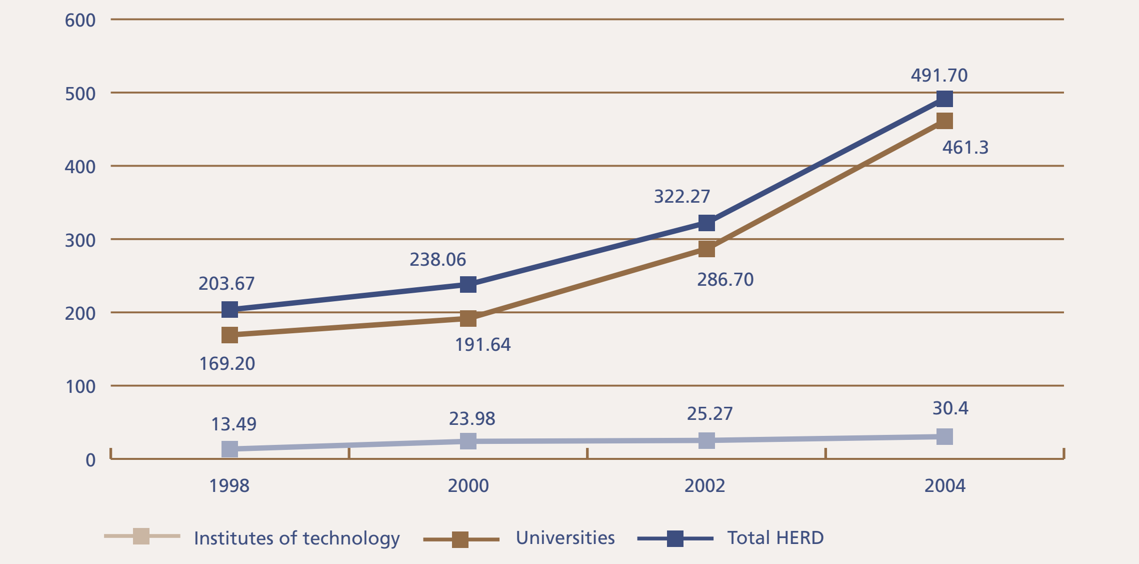


Figure 2 shows expenditure on R&D across the education sector broken down by type of institute. The universities remain the dominant performers of R&D across the higher education sector and continue to account for the majority of HERD. That said, there was a strong increase in the amount of expenditure dedicated to R&D activities across the institutes of technology between 2002 and 2004.

R&D activities performed by universities increased by nearly 61%, between 2002 and 2004, to stand at €461.3m. R&D expenditure in the institutes of technology climbed 20.3% in nominal terms in the same period to total €30.4m.

Figure 2: *Research expenditure analysed by performer, 1998 - 2004, current prices (€m).*

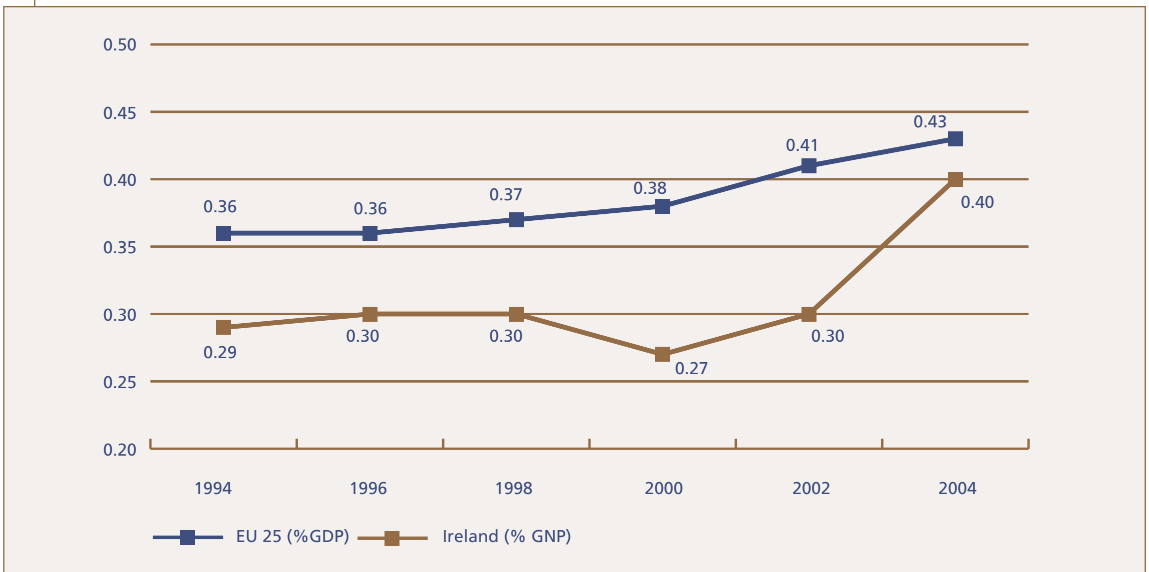


*Total HERD for 1998 to 2002 does not equal universities plus institutes of technology as there were additional amounts for the 'Programme in Advanced Technology' during this period.

The ratio of HERD to economic activity is a key indicator for international comparisons of higher education research activity. In Ireland, Gross Domestic Product (GDP) is greatly inflated because of transfer payments made by large foreign-owned firms here, and so the economic activity measure of Gross National Product (GNP) which excludes net factor flows is preferred when benchmarking international performance.

Figure 3 charts HERD as a percentage of GNP and compares this to the EU average of HERD as a percentage of GDP. The EU average has increased from 0.41% of GDP in 2002 to an estimated 0.43% in 2004 while in Ireland the HERD has increased from 0.30% to 0.40% in the same period. The chart clearly shows the impact of the increased funding through the agencies, particularly from Science Foundation Ireland and the Higher Education Authority, between 2002 and 2004, resulting in major progress towards closing the HERD spending intensity gap between Ireland and the rest of the EU.

Figure 3: *HERD as a percentage of economic activity, 1994 - 2004, Ireland vs EU.*

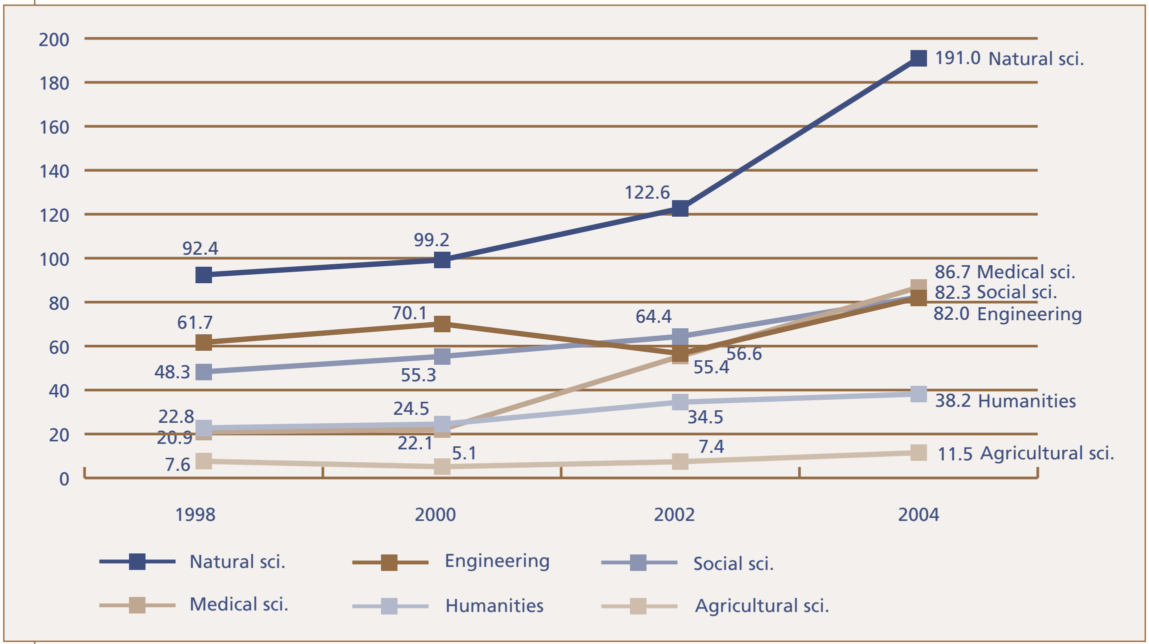


2. HERD expenditure by fields of science

As well as measuring overall levels of higher education spending, it is useful to examine various research areas amongst which funds are divided. Data was gathered in the 2004 HERD survey at department level for each surveyed institute allowing classification of data into the various fields of science. Dividing overall spending into different areas allows closer examination of trends in key areas of research. In order to maintain comparability across member countries, the OECD have developed a classification structure for all HE research. There are six broad fields described as 'Fields of Science'. They are natural sciences, engineering, social sciences, humanities, medical sciences and agricultural sciences.

Expenditure is also collected by sub-fields within these fields of science categories. A more detailed breakdown of the expenditure by fields of science is available in Appendix 4. All of the broad fields of academic activity experienced real increases in expenditure over the period 1998 to 2004 (figure 4).

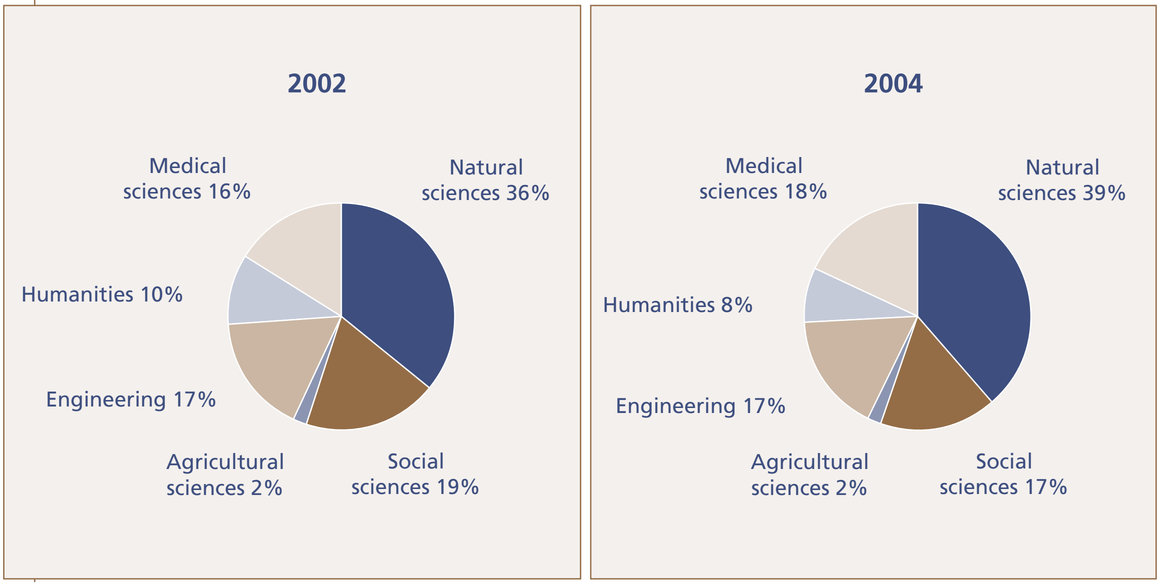
Figure 4: *Higher education expenditure on R&D by field of science, 1998 - 2004, constant 2004 prices (€m).*



- *The natural sciences field remains at the top with the highest R&D expenditure and the highest percentage change. Figure 4 shows a 56% increase to €191m in 2004 from €122.6m in 2002. This compares with a 24% increase in the period 2000 to 2002.*
- *Medical sciences experienced a continuation of their steady increase in R&D expenditure to €86.7m in 2004 from €55.4m in 2002, up by 56% also.*
- *Social sciences also experienced an increase in 2004 to €82.3m, a rise of 28% from 2002.*
- *HERD expenditure rebounded strongly in the engineering field of science in 2004 having dipped in 2002. HERD totalled €82m in this area in 2004.*

In addition to examining the overall changes in expenditure, the fields of science have also been analysed according to their share of total R&D expenditure (figure 5).

Figure 5: *Share of total R&D expenditure by field of science, 2002 and 2004.*



Overall the share of total R&D expenditure across the different fields of academic activity has remained relatively stable. The following are the key changes in the period 2002 to 2004:

- *Natural sciences maintain the largest share and experienced an increase from 36% to 39% of total HERD expenditure.*
- *Medical sciences also increased from a 16% share to 18%.*
- *Both social sciences and engineering hold a 17% share of expenditure in 2004. For the social sciences field this resulted from a drop from 19% in 2002.*
- *Humanities experienced a decrease from 10% to 8% of overall expenditure.*

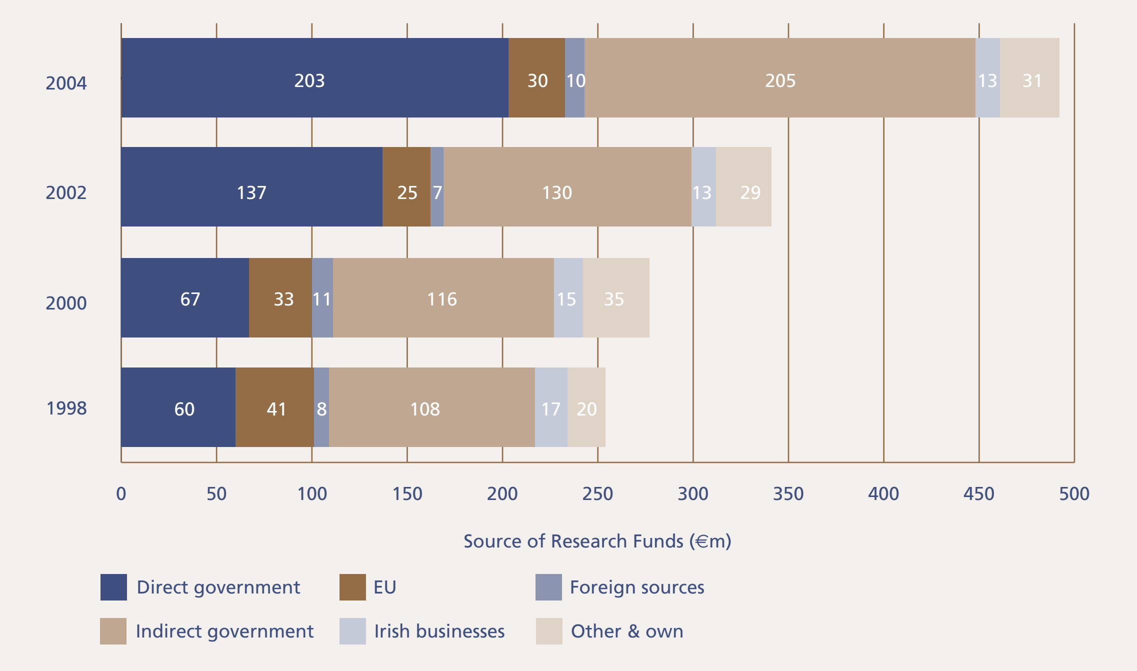
Each field of science is further divided into sub-fields (see Appendix 4). Examining these classifications can give further insight into the changes in HERD expenditure.

- *Natural sciences: Biological sciences represent the largest percentage of HERD accounting for 16% in 2004 having experienced an increase of 73% to €77m in the period 2002 to 2004. Maths and computer sciences doubled to over €42m and earth and related environmental sciences increased by €10.6m to €16.9m. Physical sciences remained quite stable maintaining its 7% share through 2002 to 2004.*
- *Medical sciences: All of the sub-fields of medical sciences saw a real increase. Though basic medicine experienced a decrease in its relative share from 12% in 2002 to 9% in 2004 there was a real increase of over €6m. Clinical medicine almost doubled while health sciences increased fourfold.*
- *Engineering: Expenditure on civil and electrical engineering experienced little change while the 'other' engineering sciences sub-field more than doubled between 2002 and 2004 to €49.7m.*
- *Agricultural sciences: Both sub-fields maintained a 1% share of R&D expenditure from 2002 to 2004 though veterinary medicine doubled in real terms.*
- *Humanities: Expenditure on R&D on the humanities remained relatively stable during the period 2002 to 2004.*

3. Sources of funding of HERD expenditure

Research income in the Higher Education (HE) sector is provided from a number of different sources. These sources fall under the three main headings – direct government funding, indirect government funding (via the Higher Education Authority's block grant) and other sources. Figure 6 shows the trends in sources of research income from 1998 to 2004. Total government funding (including direct and indirect sources) accounted for 83% of all research income in the higher education sector in 2004, increasing its funding share from the 79% recorded in 2002.

Figure 6: *Sources of research funds, 1998 - 2004, in constant 2004 prices (€m).*



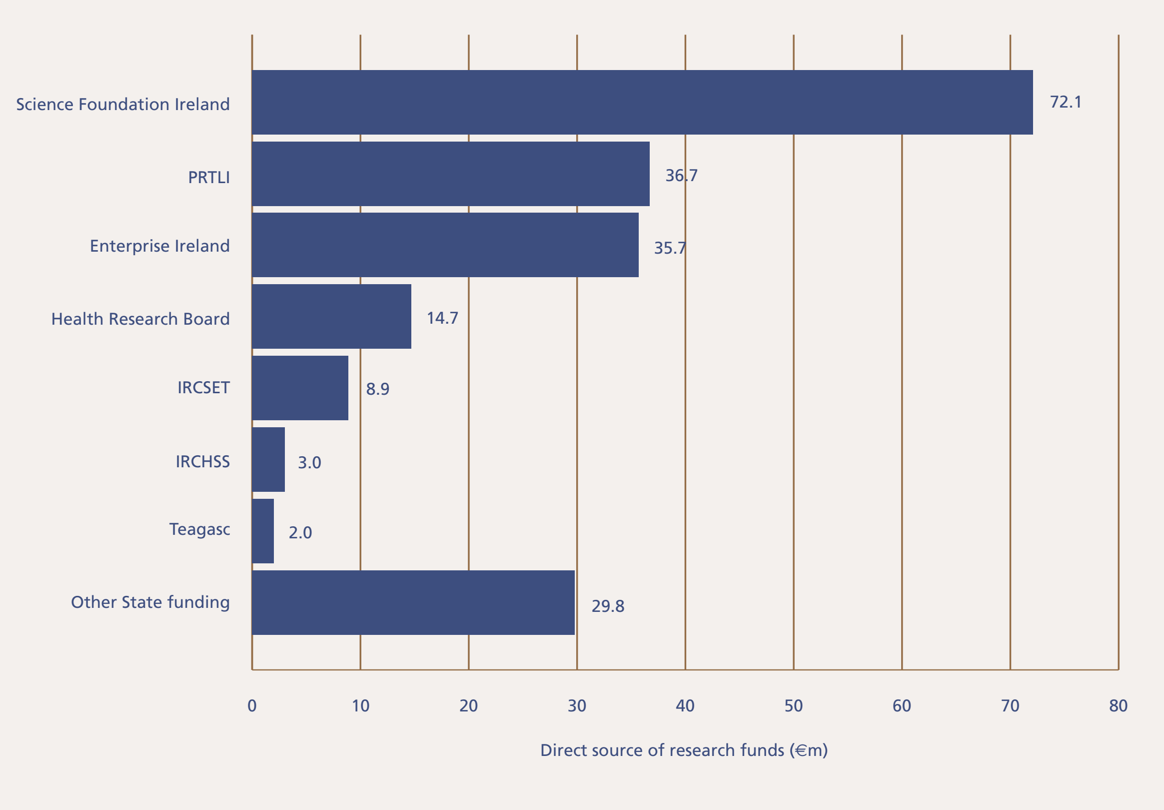
Direct government funding of individual research projects in the higher education sector comes through various government departments and their agencies and totalled €203m in 2004. This represented a 48.2% increase from the survey carried out two years previously. Additional breakdowns of direct funding by government departments are given in figure 7.

Indirect sources of R&D funding are derived from the annual 'block grant' from the HEA. The HEA allocates funds to the universities, on behalf of the Department of Education and Science. An amount of this allocation is attributable to R&D and this is determined using estimates of the time spent on research by academic staff. This is standard OECD practice in all countries operating a dual system of higher education funding. These funds do not provide for incremental costs associated with individual projects. Indirect funding rose by 57% between 2002 and 2004. This increase was as a result of nominal increases in the block grant funding and also as a result of a higher research time-use co-efficient estimated by the survey.

Other sources of research income for the higher education sector include funding from the European Union, foreign sources, Irish businesses and other national funding (including internal funds). Other and own funding has risen in real terms by 58% from 1998 to 2002. European funding has fallen by 27% from 1998 to 2004, however, in the period 2002 to 2004 there was a real increase of 21% bringing funding up to €30.1m. There was a substantial drop in funding from Irish businesses of 25% between 1998 and 2002, from €16.6m to €12.5m. The figure of €12.5m was maintained from 2002 to 2004.

Figure 7 shows the breakdown of this funding by the main sources. Science Foundation Ireland (SFI) was the largest state agency providing direct research funds in 2004, totalling €72m and 36% of total public research direct income. The HEA Programme for Research in Third Level Institutes (PRTLI) and Enterprise Ireland provided €37m and €36m in research income, respectively, in 2004. This data represents funding through the higher education institutes for the academic year rather than the calendar year used by the state institutes.

Figure 7: *Sources of direct government research funding, 2004 (€m).*



The overall research funding in the higher education sector provided by all sources can be further broken down by field of science. Table 1 charts this breakdown.

Table 1: *Sources of research funding by fields of science, 2004 (€m).*

Field of science	Direct sources of funds					Indirect government	Total
	Direct government	EU	Foreign sources	Irish business	Other & own		
Agricultural sciences	4.2	0.2	0.1	0.0	0.4	6.6	11.5
Engineering & technology	38.9	10.5	0.8	5.6	3.4	22.8	82.0
Humanities	4.9	0.4	0.0	0.5	3.2	29.1	38.2
Medical sciences	37.5	1.9	4.0	2.0	9.1	32.2	86.7
Natural sciences	102.8	13.2	2.3	3.4	8.4	60.9	191.0
Social sciences	14.4	3.9	3.2	1.0	6.3	53.4	82.3
Total	**202.9**	**30.0**	**10.4**	**12.5**	**30.9**	**204.9**	**491.7**
% of total	41%	6%	2%	3%	6%	42%	100%
% change 98-04	237%	-27%	26%	-25%	58%	91%	94%
% change 02-04	48%	21%	49%	0%	6%	58%	44%

The areas of social sciences, humanities and agricultural sciences are heavily dependent on indirect government funding. They each receive 65%, 76% and 57% of their respective funding from this source. Natural sciences is the most reliant on direct government funding with 54% of its funding coming from this source. While we have seen dramatic increases in direct and indirect government funding in higher education research in the last two years, 48% and 58% respectively, the table also shows a clear increase of 49% in the level of funding received from foreign sources in the period 2002 to 2004.

4. Types of costs

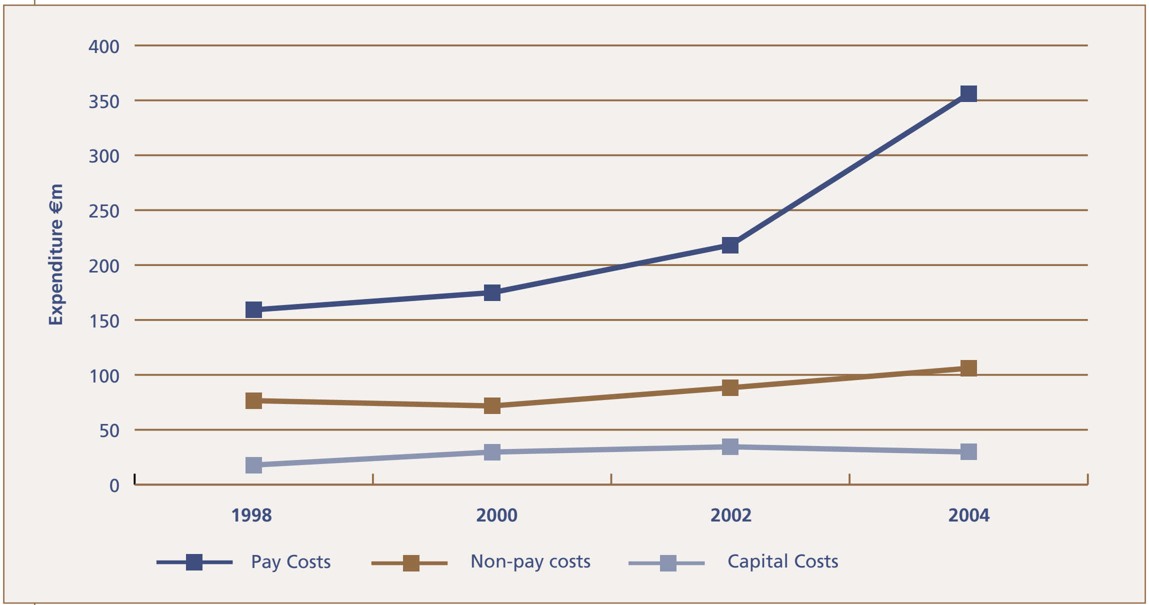
The survey requires the completion by respondents of a detailed breakdown of their R&D expenditure by types of costs. This allows policymakers to analyse the key areas in which funding is taking place. There are three types of research costs identified within the survey – pay costs, non-pay costs and capital costs.

Table 2 and figure 8 show a time series of this distribution over the period 1998 to 2004 in constant prices.

Table 2: *Distribution of types of costs, 1998 – 2004, in constant 2004 prices (€m).*

Type of cost	1998	2000	2002	2004	% of 2004 total	% change 98-04	% change 02-04
Pay costs	159.2	174.9	218.2	355.9	72%	124%	63%
Non-pay costs	76.5	71.7	88.3	106.0	22%	39%	20%
Capital costs	17.9	29.7	34.5	29.8	6%	66%	-14%
Total	**253.6**	**276.3**	**341.0**	**491.7**	**100%**	**94%**	**44%**

Figure 8: *Distribution of types of costs, 1998 – 2004, in constant 2004 prices (€m).*



- *Pay costs continue to represent the majority of total costs with an increase to €356m which accounts for 72% of all costs in 2004 compared to 64% in 2002. This shows the increase in research personnel numbers and the accompanying increase in pay costs resulting from the additional funding. Human resources is dealt with in chapter 7.*
- *Non-pay costs have also increased steadily to €106m in 2004. This shows a 39% increase compared to 1998 though in the period 2002 to 2004 there was a lower increase of 20%.*
- *Capital costs increased to 2002 but then dropped by 14% in the 2002 to 2004 period. However, there has been an overall increase of 66% from 1998 to 2004.*

The costs can be further analysed by field of science, as shown in table 3.

Table 3: *Types of costs by field of science, 2004 (€m).*

HE Sector	Pay costs	% of Total	Non-pay costs	% of Total	Capital costs	% of Total	Total
Agricultural sciences	9.5	81%	2.0	17%	0.2	2%	11.6
Engineering & technology	57.2	70%	21.8	27%	3.1	4%	82.0
Humanities	34.7	89%	2.7	7%	1.4	4%	38.8
Medical sciences	59.2	69%	19.2	22%	7.4	9%	85.8
Natural sciences	127.7	67%	46.8	25%	15.4	8%	189.9
Social sciences	67.6	81%	13.6	16%	2.3	3%	83.5
Total	**355.9**	**72%**	**106.0**	**22%**	**29.8**	**6%**	**491.7**

- *Natural sciences have the highest allocation of pay costs at an amount of €127.7m though this represents 67% of total expenditure in this field (the lowest percentage out of the 6 areas). It has a high percentage of non-pay and capital costs at 25% and 8% respectively.*
- *The humanities have the highest percentage of pay costs as a % of total cost and hence the lowest percentage of non-pay.*
- *Agricultural science has the lowest expenditure on capital at €0.2m, just 2% of its expenditure.*

5. Human resources dedicated to higher education research

In addition to gathering data on the expenditure, costs and sources of funding for higher education R&D, the survey also gathered data on the numbers of personnel involved in R&D. This area of the survey has become increasingly important as Ireland's transition to a knowledge economy will depend heavily on the ability to attract increasing numbers of high quality researchers and research personnel. The Irish R&D action plan estimated that an additional 8,000 researchers would be required over the period 2003 to 2010 if efforts to reach the higher education and public sector expenditure targets of the plan are to be realised.

Table 4a shows a breakdown of the number of researchers by total headcount, which includes academic staff, post-doctoral fellows, contract lecturers and research assistants. Data on research support staff was also requested including technicians, administrative/clerical and other support staff. These are broken down in table 4b.

Table 4a: *Total researchers analysed by performer, 2004, total headcount.*

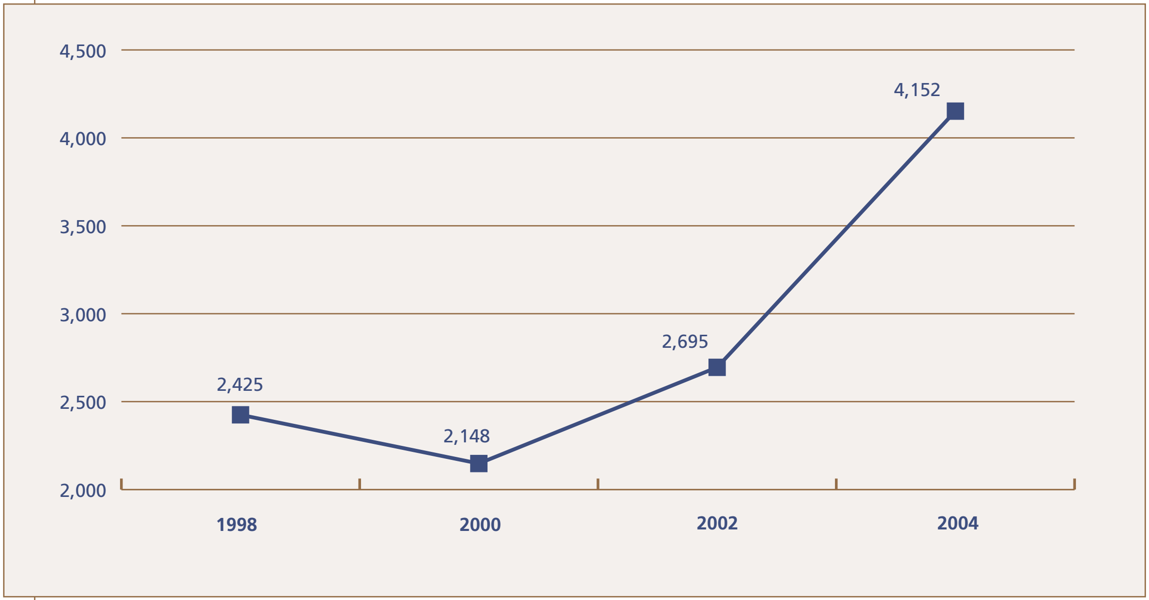
	Academic staff	Post-doctoral fellows	Contract lecturers	Research assistants	Total researchers
	A	B	C	D	(A+B+C+D)
Institutes of technology	1863	36	203	141	2243
Universities	3509	959	1308	915	6691
Total	**5372**	**995**	**1511**	**1056**	**8933**

Table 4b: *Total research personnel analysed by performer, 2004, total headcount.*

	Total researchers	Technicians	Admin staff	Other staff	Total research personnel
	E	F	G	H	(E+F+G+H)
Institutes of technology	2243	248	288	276	3054
Universities	6691	885	1303	243	9121
Grand Total	**8933**	**1133**	**1590**	**519**	**12175**

In addition to obtaining data on total personnel numbers, the 2004 survey also examined the percentage of time spent on research allowing an analysis by full-time equivalents (whilst a single researcher is counted as 1 in headcount terms, if they spend 40% of their total work time on research activities then they are counted as 0.4 FTE's (1 x 40% in terms of full-time equivalence)). The total FTE increased by 54% from 2,695 in 2002 to 4,152 in 2004. Figure 9 shows the upward trend in FTE over the 6 year period from 1998 to 2004.

Figure 9: *Trend in total HERD researchers (FTE), 1998 – 2004.*



*2002 data is revised.

This information is further analysed by type of academic post held and also by field of science, as shown in Tables 5a and 5b.

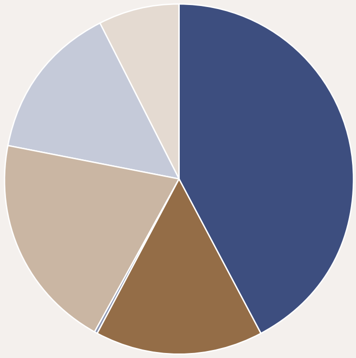
Table 5a: *Researchers by occupation and field of science in the HE sector, 2004 (FTEs).*

	Academic staff A	Post-doctoral fellows B	Contract lecturers C	Research assistants D	Total researchers (A+B+C+D)
Agricultural sciences	35	11	3	29	78
Engineering & technology	291	157	42	215	705
Humanities	283	62	66	33	445
Medical sciences	231	183	95	171	680
Natural sciences	422	466	158	427	1473
Social sciences	433	84	130	124	770
Total	**1695**	**964**	**494**	**998**	**4152**
% of Total (from table 5b)	35%	20%	10%	21%	86%

- *Academic staff accounted for 35% of the total number of higher education researchers (FTE's) in 2004, a drop from the 55% share recorded in the 2002 HERD survey.*
- *The number of FTE post-doctoral fellows has tripled from 310 in 2002 to 964 in 2004.*
- *The majority of researchers are in the field of natural sciences, increasing in number from 1,076 in 2002 to 1,473 in 2004.*
- *The medical sciences have trebled their research personnel from 217 in 2002 to 680 in 2004.*

Information was also gathered on the number of PhD students involved in research. This number has risen significantly from a full-time equivalent of 1,477 in 2002 to 3,644 in 2004. The main area of research is in the natural sciences, figure 10, (1,547 FTE PhD students). This field has more than twice the number of students involved in research than the next major area, engineering and technology.

Figure 10: *PhD students (FTE) by field of science, 2004.*



Total research personnel, including research support staff, have increased by 52% to 4,841 in 2004.

Table 5b: *Total research personnel by occupation and field of science, 2004 (Full-Time Equivalent).*

	Total researchers	Technicians	Admin staff	Other staff	Total research personnel
	E	F	G	H	(E+F+G+H)
Agricultural sciences	78	17	5	1	102
Engineering & technology	705	58	16	5	784
Humanities	445	4	13	6	468
Medical sciences	680	155	96	4	935
Natural sciences	1473	124	50	29	1676
Social sciences	770	26	70	9	876
Total	**4152**	**385**	**251**	**53**	**4841**
% Total	86%	8%	5%	1%	100%

- *Again, the majority of research personnel are in the field of natural science with over 35% of the total personnel working in this area.*
- *A close examination of support staff shows that the majority (over 40%) of research related work by technicians is carried out in medical sciences with natural sciences at over 32%.*

All personnel data received were split between male and female to allow comparisons by gender. Tables 6a and 6b show the breakdown of personnel by occupation and by gender.

Table 6a: *Researchers by gender and occupation in the HE Sector, 2004.*

	Academic staff	Post-doctoral fellows	Contract lecturers	Research assistants	Total researchers
% Male	71%	57%	55%	53%	63%
% Female	29%	43%	45%	47%	37%

Table 6b: *Total research personnel by gender and occupation in the HE sector, 2004.*

	Total researchers	Technicians	Admin staff	Other staff	Total research personnel
% Male	63%	63%	12%	55%	59%
% Female	37%	37%	88%	45%	41%

- *The total research personnel breakdown shows that there are a greater number of men (59%) in research in comparison to women (41%). This represents a drop in the percentage of women in research from 45% in 2002.*
- *By analysing the information by occupation we can see some larger differences between the sexes. The personnel numbers for academic staff and technicians are clearly skewed towards men while the numbers of administrative and clerical staff are skewed towards women.*

6. Time-use of higher education researchers

In the 2004 HERD survey, an additional question was asked for each academic department in each of the higher education institutions surveyed, to identify the amount of time spent on research activities by members of staff. The questionnaire set clear instructions and guidelines allowing heads of academic departments to complete this exercise in an equitable and comparable manner not only across Ireland but also internationally. The time-use variable is a key variable as it not only allows the conversion of personnel data from headcount to full-time equivalence, but it is also used to estimate the proportion of the HEA block grant dedicated to research.

Figure 11: *Excerpt from the survey guidelines for completion of the questionnaire.*

The following activities are deemed as "Research activities" for the purpose of this survey:	The following activities are not deemed as "Research activities" for the purpose of this survey:
✔	✘
Personal research	Teaching
Team research	General administration
Writing research proposals	Supervision of non-PhD students
Writing research reports	Other non-research based activities
Supervision of PhD students	External activities
Other research based activities including administration and planning	

The research time percentage used for calculating full-time equivalents can be examined in greater detail, allowing us to determine which occupations and which fields of science are the most research intensive. The average time spent on research by academic staff alone increased from 31.1% in 2002 to 31.6% in 2004 while the time spent by researchers (academics, post-doctoral fellows, contract lecturers and research assistants) rose from 33.6% to 46.4% over the same period. Figures 12 and 13 examine time spent by academic staff only, across both institutes of technology and universities, by field of science for 2004. Figure 14 gives the breakdown for researchers by occupation and by field of science.

Figure 12: *Average percentage of time spent on research by academic staff across universities by field of science, 2004.*

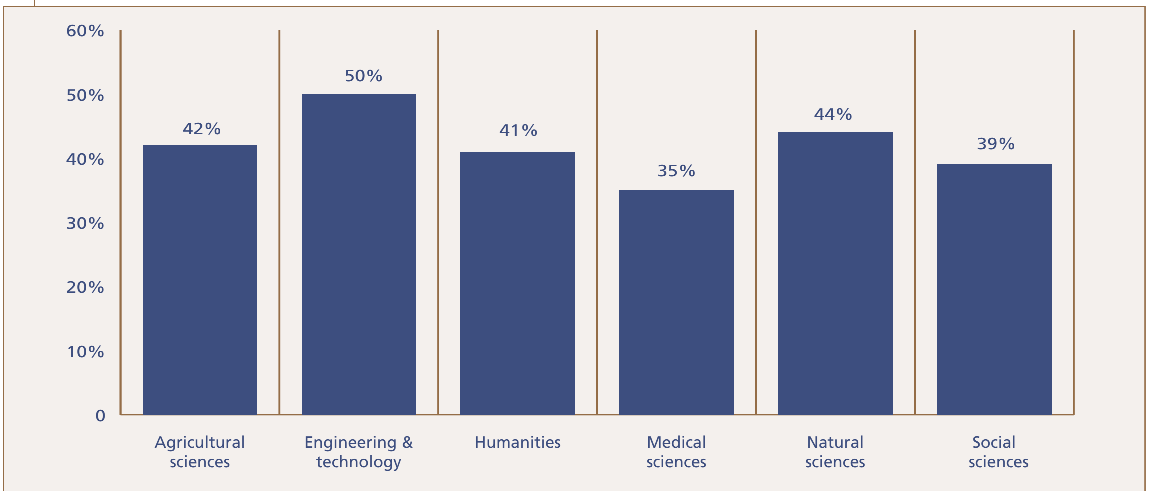
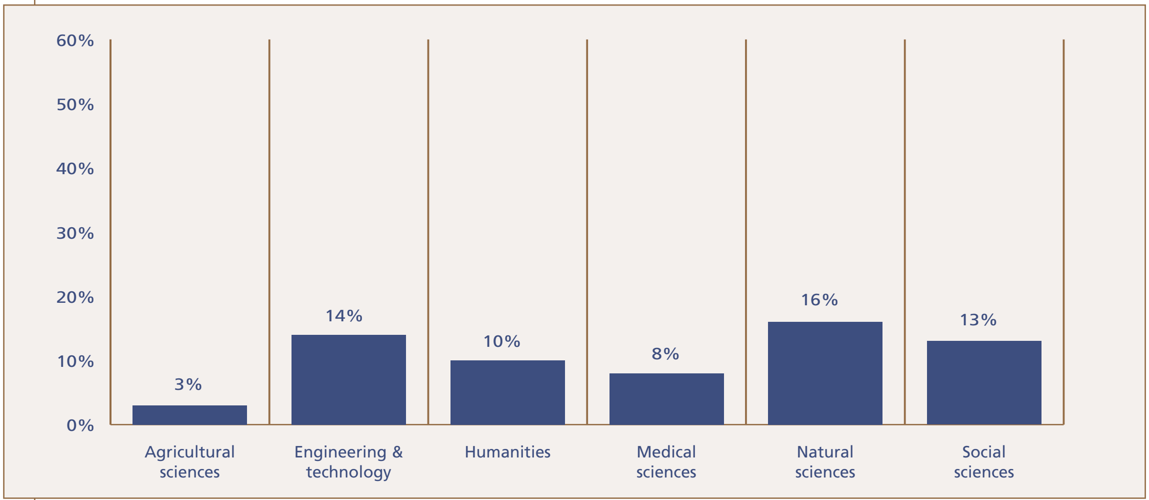
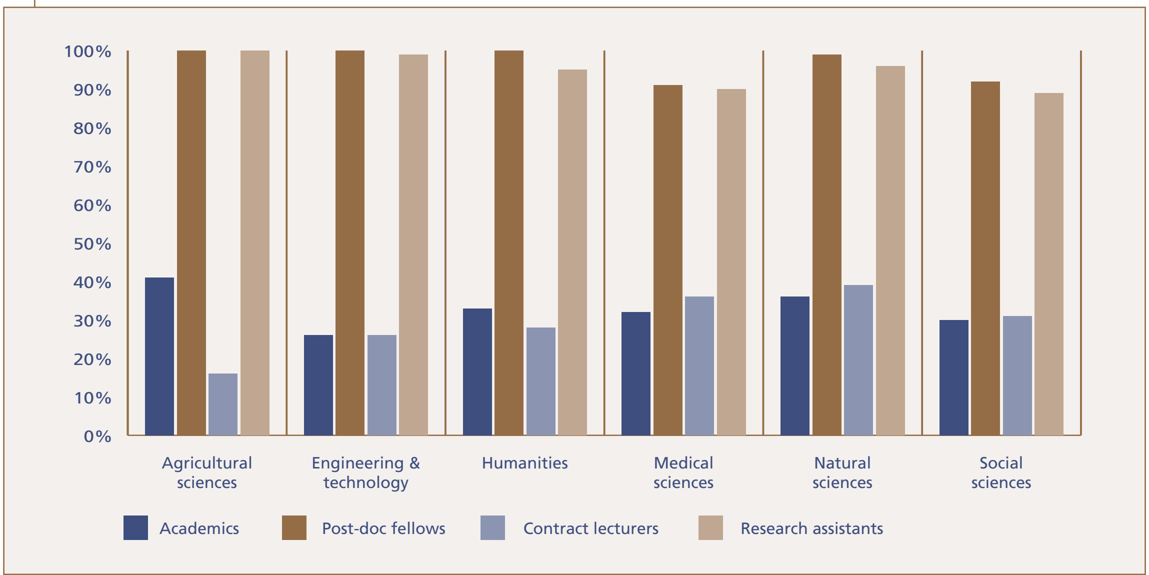


Figure 13: *Average percentage of time spent on research by academic staff across institutes of technology by field of science, 2004.*



The institutes of technology show lower levels of time spent on research in comparison to universities; this is expected as the institutes of technology account for just over 6% of spending on R&D in the higher education sector.

Figure 14: *Average percentage of time spent on research analysed by occupation and by field of science, 2004.*



7. International comparisons

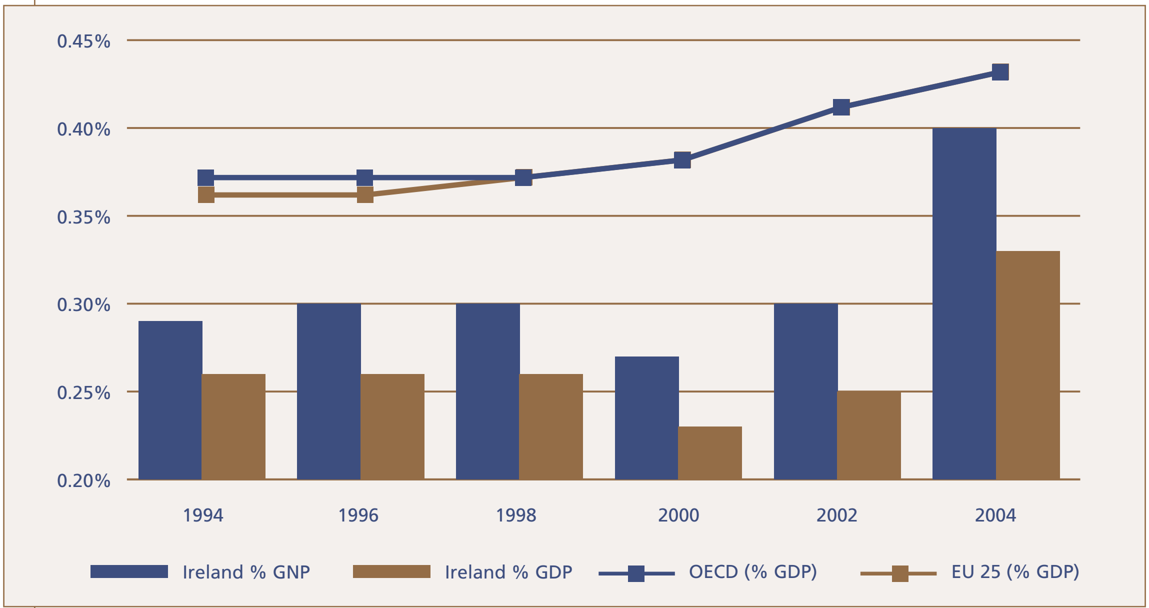
In order to assess Ireland's R&D performance and progress towards meeting the objectives set out in the Lisbon Agenda, it is useful to benchmark Ireland's position compared to other OECD countries. Table 7 shows Ireland's ranking over the period 2000 to 2004.

Table 7: *Placement of Ireland in the international ranking of higher education sector R&D, 2000 - 2004.*

	2000	2002	2004
Higher education expenditure on R&D (HERD)	238.1	322.3	491.7
HERD as a % of GNP	0.27%	0.31%	0.40%
- Ireland's rank among 26 OECD countries	22nd	19th	16th
Total researchers in HE sector	2,148	2,695	4,152
Researchers per 1000 labour force	1.2	1.5	2.2
- Ireland's rank among 30 OECD countries	24th	23rd	14th

- *Ireland's spending on higher education R&D has more than doubled in the period 2000 to 2004 to €492m (0.4% of GNP).*
- *As a result of the increased spending, Ireland's performance of R&D in the higher education sector has significantly improved over the last 4 years, moving from 22nd to 16th position in the ranking of 26 OECD countries.*
- *The total researchers (FTE) in the Irish higher education sector has almost doubled over the same period to 4,152 resulting in a ratio of 2.2 researchers per 1,000 labour force. This positions Ireland 14th out of 30 OECD countries.*

Figure 15: *Higher education expenditure on R&D (% economic activity), 1994 – 2004.*



Figures 16, 17 and 18 outline OECD data on higher education R&D performance across a range of countries.

Figure 16: *HERD as a % of GDP (2004 or latest available data).*

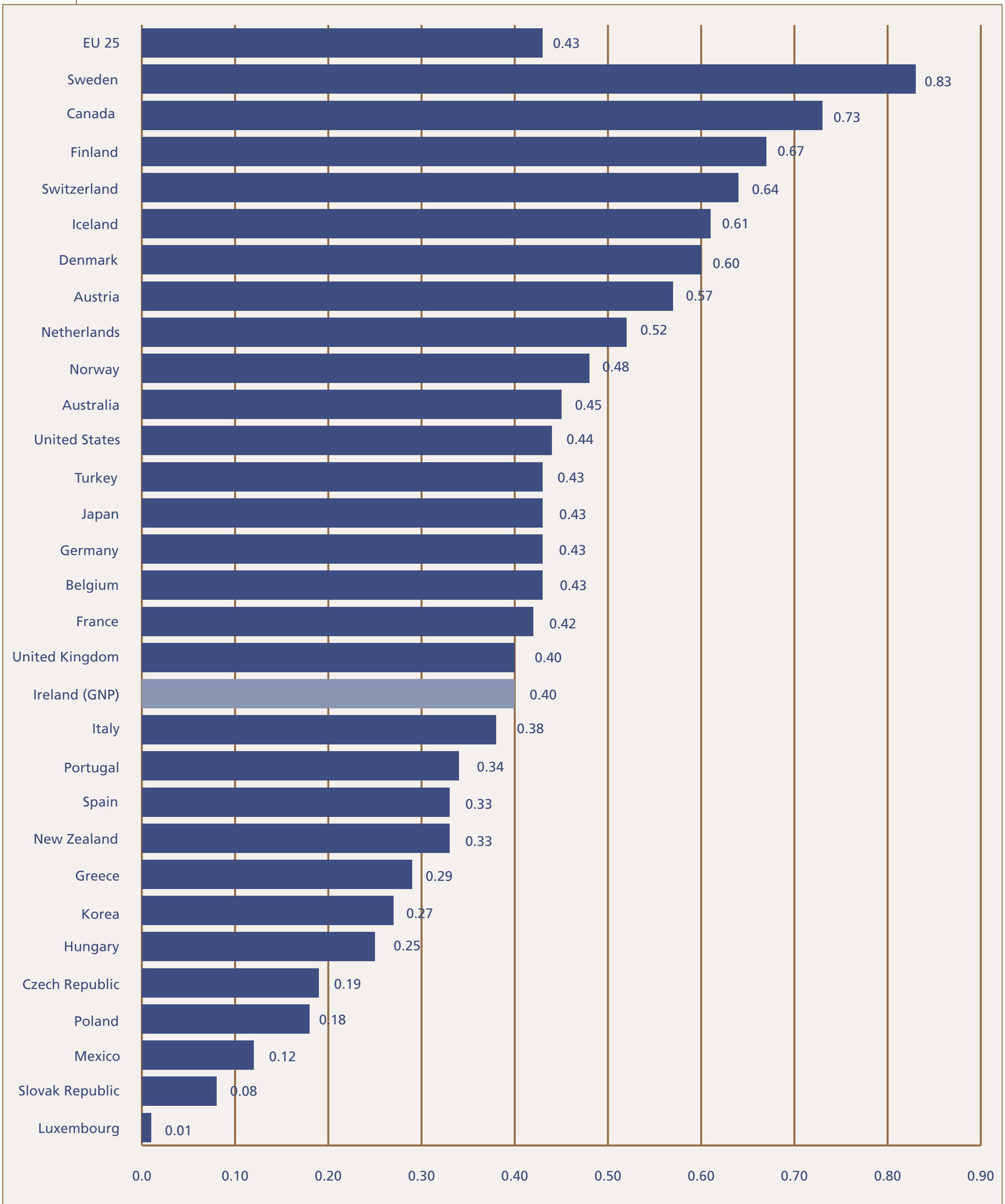


Figure 17: *HE researchers per thousand labour force (2004 or latest available data).*

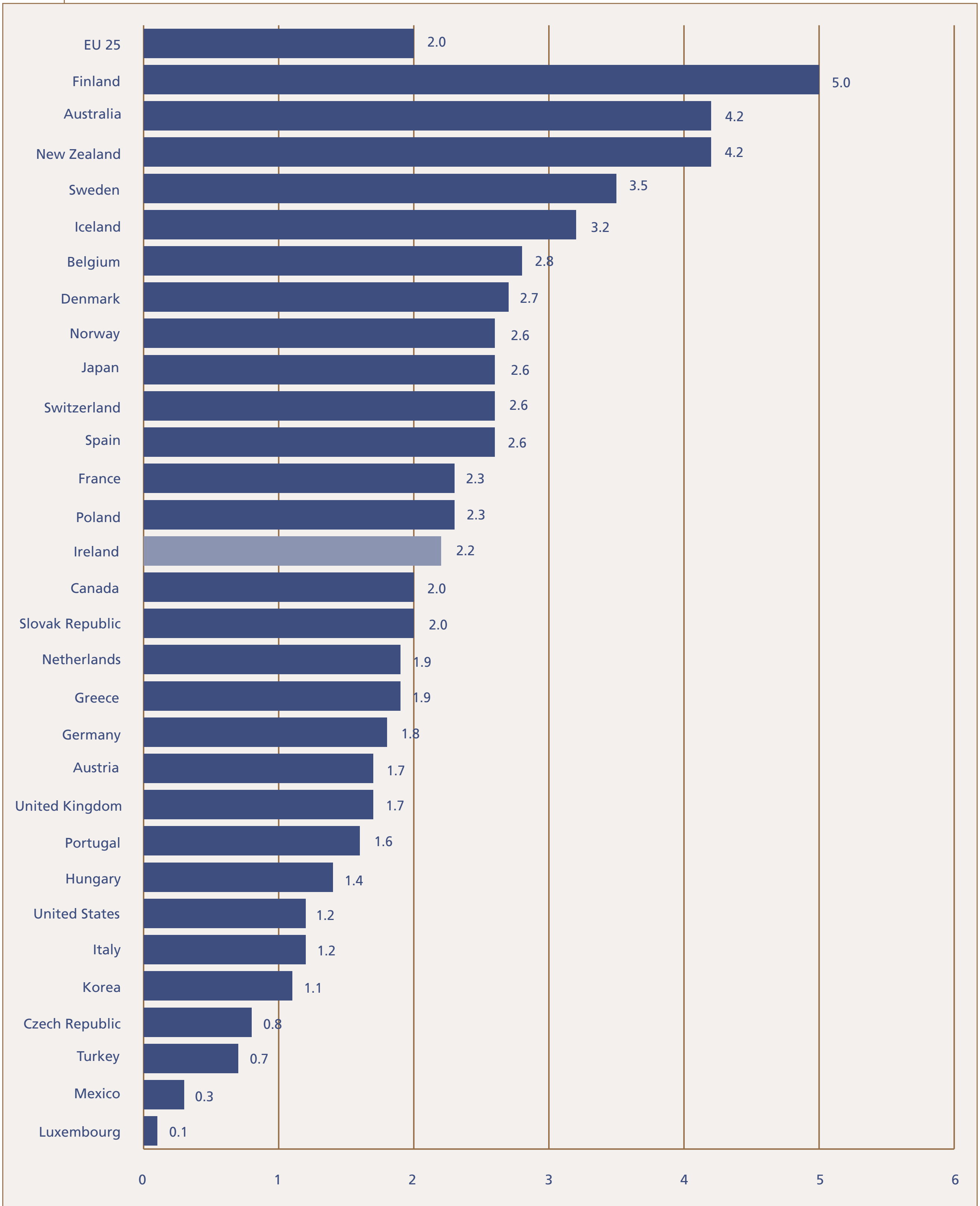
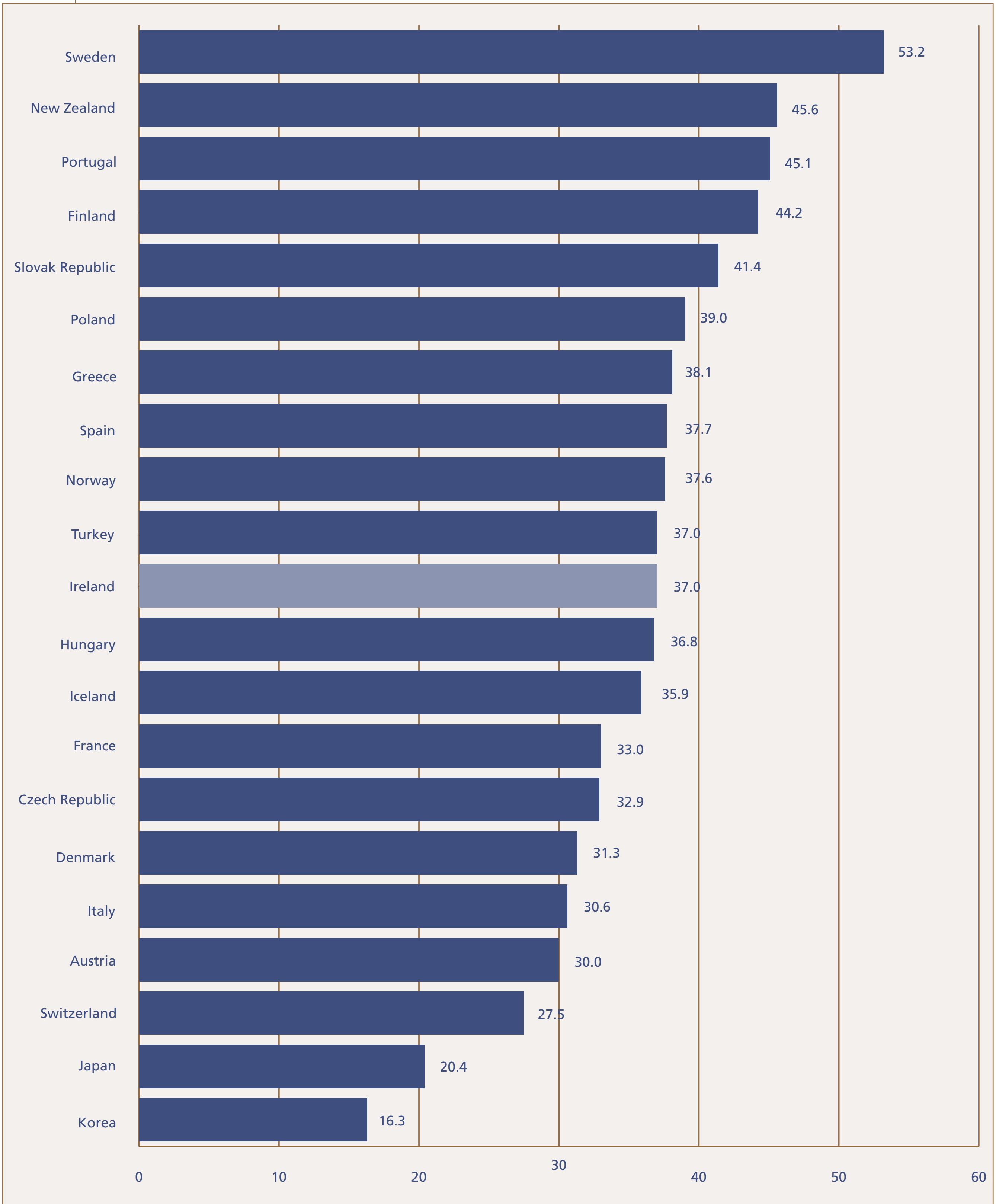


Figure 18: *Higher education sector: Women researchers as a percentage of total researchers (headcount).*



Appendix 1: Methodology

Introduction

The survey was carried out following OECD/Frascati Manual (1993, 2002) guidelines for estimating levels of research and development in the higher education sector and the results for Ireland are comparable to those from other OECD countries. Data captured in the survey relates to the 2004 academic year (September 2003 to September 2004).

There were two elements to this survey of research and development in higher education colleges:

- *An analysis of financial data received from each institution;*
- *An analysis of personnel data received from each institution. In addition, the 2004 HERD survey also asked each academic department to estimate the time spent on research per person employed.*

Coverage

The coverage included all academic departments, in the seven universities*, eleven institutes of technology**, as well as the Dublin Institute of Technology, Royal College of Surgeons, St. Patrick's College, Drumcondra and Mary Immaculate College.

*Universities: Dublin City University, NUI Galway, NUI Maynooth, University College Cork, University College Dublin, University of Dublin (Trinity College) and University of Limerick.

** Institutes of Technology (IT): Athlone IT, Carlow IT, Cork IT, Dundalk IT, Galway-Mayo IT, Letterkenny IT, Limerick IT, Sligo IT, Tallaght IT, Tralee IT and Waterford IT.

Timing of survey and subsequent follow-up

Questionnaires were sent out at the end of April 2005 to the various colleges. There was intensive follow-up of non-respondents by telephone from May 2005 until the end of August 2005. Final outstanding information was received in September 2005.

A full response rate was achieved for the financial and personnel parts of the survey. For the time use element of the survey all but one institute were able to complete the survey request and data was estimated and inputted for this institution by Forfás.

Financial data

Detailed departmental income and expenditure was obtained from the finance office in each university. Industrial liaison offices provided similar information for the institutes of technology.

This information comprised total capital and current expenditure from the colleges' block grant for all departments, from which a research proportion was derived, based on the amount of research-time reported by the respondents.

Research income for each department was provided by source of funds and types of costs.

Personnel data

Detailed departmental headcounts were obtained from the personnel offices, categorised by academic staff, contract lecturers, post-doctoral fellows, research assistants, technicians, administrative and other staff. In order to calculate full-time equivalent totals for each category, the percentage of time spent on research was also obtained. In addition, the headcounts were split between male and female to allow gender comparisons.

Time-use data

Each academic department was also asked to estimate the time spent on research activities by each member of staff in his/her department. Strict guidelines and instructions were sent to each head of department outlining a single agreed methodology which identified comparable time spent on research activities. This methodology is the one recommended by the international OECD Frascati Manual.

The following matrix was used to determine the percentage of time spent on research activities by people employed in the higher education sector:

The following activities are deemed as "Research activities" for the purpose of this survey:	**The following activities are not deemed as "Research activities" for the purpose of this survey:**
✔	✘
Personal research	Teaching
Team research	General administration
Writing research proposals	Supervision of non-PhD students
Writing research reports	Other non-research based activities
Supervision of PhD students	External activities
Other research based activities including administration and planning	

Appendix 2: Fields of science & technology

1. Natural sciences

1.1 Mathematics and computer sciences
[Mathematics and other allied fields: computer sciences and other allied subjects (software development only; hardware development should be classified with the engineering fields)]

1.2 Physical sciences
(Astronomy and space sciences, physics, other allied subjects)

1.3 Chemical sciences
(Chemistry, other allied subjects)

1.4 Earth and related environmental sciences
(Geology, geophysics, mineralogy, physical geography and other geosciences, meteorology and other atmospheric sciences including climatic research, oceanography, vulcanology, palaeoecology, other allied sciences)

1.5 Biological sciences
(Biology, botany, bacteriology, microbiology, zoology, entomology, genetics, biochemistry, biophysics, other allied sciences excluding clinical and veterinary sciences)

2. Engineering and technology

2.1 Civil engineering
(Architecture engineering, building science and engineering, construction engineering, municipal and structural engineering and other allied subjects)

2.2 Electrical engineering, electronics
[Electrical engineering, electronics, communication engineering and systems, computer engineering (hardware only) and other allied subjects]

2.3 Other engineering sciences
(Such as chemical, aeronautical and space, mechanical, metallurgical and materials engineering, and their specialised subdivisions; forest products; applied sciences such as geodesy, industrial chemistry, etc.; the science and technology of food production; specialised technologies of interdisciplinary fields, e.g. systems analysis, metallurgy, mining, textile technology and other allied subjects)

3. Medical sciences

3.1 Basic medicine
(Anatomy, cytology, physiology, genetics, pharmacy, pharmacology, toxicology, immunology and immunohaematology, clinical chemistry, clinical microbiology, pathology)

3.2 Clinical medicine
(Anaesthesiology, paediatrics, obstetrics and gynaecology, internal medicine, surgery, dentistry, neurology, psychiatry, radiology, therapeutics, otorhinolaryngology, ophthalmology)

3.3 Health sciences
(Public health services, social medicine, hygiene, nursing, epidemiology)

4. Agricultural sciences

4.1 Agriculture, forestry, fisheries and allied sciences

(Agronomy, animal husbandry, fisheries, forestry, horticulture, other allied subjects)

4.2 Veterinary medicine

5. Social sciences

5.1 Psychology

5.2 Economics

5.3 Educational sciences

(Education and training and other allied subjects)

5.4 Other social sciences

[Anthropology (social and cultural) and ethnology, demography, geography (human, economic and social), town and country planning, management, law, linguistics, political sciences, sociology, organisation and methods, miscellaneous social sciences and interdisciplinary, methodological and historical S&T activities relating to subjects in this group. Physical anthropology, physical geography and psychophysiology should normally be classified with the natural sciences]

6. Humanities

6.1 History

(History, prehistory and history, together with auxiliary historical disciplines such as archaeology, numismatics, palaeography, genealogy, etc.)

6.2 Languages and literature

(Ancient and modern)

6.3 Other humanities

[Philosophy (including the history of science and technology), arts, history of art, art criticism, painting, sculpture, musicology, dramatic art excluding artistic "research" of any kind, religion, theology, other fields and subjects pertaining to the humanities, methodological, historical and other S&T activities relating to the subjects in this group]

Source: Proposed Standard Practice for Surveys on Research and Experimental Development, OECD (Frascati Manual 1993, 2002)

Appendix 3: Acronyms

EU	European Union
FTE	Full-time equivalent (1 FTE = R&D 40 hours per week)
GDP	Gross Domestic Product
GNP	Gross National Product
HE	Higher Education
HEA	Higher Education Authority
HERD	Higher Education Expenditure on R&D
OECD	Organisation for Economic Co-operation and Development
R&D	Research and Development
PRTLI	Programme for Research in Third Level Institutes

Appendix 4: Detailed Irish tables

Table A4.1: *Expenditure by field of science, current prices.*

Field of science	1994	1996	1998	2000	2002	2004
Natural sciences	52.8	55.9	74.2	85.5	115.9	191.0
Engineering	26.8	36.8	49.5	60.4	53.5	82.0
Medical sciences	12.7	13.0	16.8	19.1	52.4	86.7
Agricultural sciences	2.9	5.4	6.1	4.4	7.0	11.5
Social sciences	16.0	27.7	38.7	47.6	60.8	82.3
Humanities	9.8	14.3	18.3	21.1	32.6	38.2
Total	**121.1**	**153.1**	**203.7**	**238.1**	**322.3**	**491.7**

Table A4.2: *Expenditure by field of science, constant 2004 prices.*

Field of science	1994	1996	1998	2000	2002	2004
Natural sciences	71.2	72.4	92.4	99.2	122.6	191.0
Engineering	36.2	47.6	61.7	70.1	56.6	82.0
Medical sciences	17.1	16.8	20.9	22.1	55.4	86.7
Agricultural sciences	4.0	7.0	7.6	5.1	7.4	11.5
Social sciences	21.6	35.9	48.3	55.3	64.4	82.3
Humanities	13.2	18.5	22.8	24.5	34.5	38.2
Total	**163.2**	**198.1**	**253.6**	**276.3**	**340.9**	**491.7**

Table A4.3: *Expenditure by source of funds and field of science, 2004.*

Field of science	HEA indirect funds €'000	Direct gov €'000	European Union €'000	Other foreign sources €'000	Irish industry funded €'000	Other & own €'000	Total €'000
Mathematics and computer sciences	15,942	21,320	1,666	163	660	2,476	42,226
Physical sciences	6,980	21,491	4,631	312	292	590	34,295
Chemical sciences	8,237	9,425	932	76	912	782	20,364
Earth and related environmental sciences	3,874	9,501	1,768	354	267	1,159	16,923
Biological sciences	25,835	41,089	4,220	1,418	1,243	3,410	77,215
Civil engineering	4,113	2,500	1,043	7	750	415	8,828
Electrical engineering, electronics	7,601	11,575	3,095	50	509	664	23,494
Other engineering sciences	11,099	24,875	6,343	730	4,338	2,310	49,694
Basic medicine	15,542	24,666	914	2,305	1,351	1,753	46,531
Clinical medicine	7,981	8,446	828	1,603	199	3,234	22,292
Health sciences	8,630	4,420	155	49	498	4,123	17,875
Agriculture, forestry, fisheries and allied sciences	2,923	2,310	138	9		176	5,555
Veterinary medicine	3,636	1,884	39	102		238	5,899
Psychology	6,986	1,412	1,055	59	49	729	10,291
Economics	4,649	311	37		64	212	5,273
Educational sciences	9,652	3,523	749		77	2,082	16,084
Other social sciences	32,158	9,164	2,020	3,181	853	3,306	50,681
History	5,487	1,158	124			943	7,712
Languages and literature	17,272	1,192	199	13	322	2,047	21,046
Other humanities	6,336	2,600	89		151	244	9,420
Total	**204,932**	**202,862**	**30,045**	**10,430**	**12,533**	**30,895**	**491,697**

Table A4.4: *Expenditure by type of costs and field of science, 2004.*

Field of science	Pay €'000	Non-pay current €'000	Capital expenditure €'000	Total €'000
Mathematics and computer sciences	30,747	8,147	975	39,869
Physical sciences	19,868	9,967	4,164	33,998
Chemical sciences	14,904	3,929	1,259	20,093
Earth and related environmental sciences	10,832	4,266	2,349	17,447
Biological sciences	50,747	19,012	6,569	76,328
Civil engineering	5,523	1,449	32	7,005
Electrical engineering, electronics	16,608	4,060	915	21,583
Other engineering sciences	32,967	15,903	2,077	50,947
Basic medicine	29,681	11,474	5,983	47,138
Clinical medicine	14,132	4,561	1,168	19,861
Health sciences	13,782	3,198	243	17,223
Agriculture, forestry, fisheries and allied sciences	4,306	819	96	5,221
Veterinary medicine	4,714	1,129	99	5,942
Psychology	9,079	1,129	72	10,280
Economics	5,408	283	35	5,726
Educational sciences	12,378	3,280	87	15,745
Other social sciences	38,961	8,202	1,844	49,007
History	7,194	735	18	7,947
Languages and literature	20,044	1,279	111	21,434
Other humanities	7,155	421	18	7,594
Other	6,841	2,760	1,708	11,310
Total	355,872	106,004	29,822	491,698

Table A4.5: *R&D personnel (full-time equivalent) by field of science, 2004.*

Field of science	Academic staff	Post-doctoral fellows	Contract lecturers	Research assistants	Technicians	Admin staff	Other staff	Total FTE
Mathematics and computer sciences	162	78	68	69	8	10	4	398
Physical sciences	64	75	27	89	21	11	2	288
Chemical sciences	62	80	12	37	19	5	2	217
Earth and related environmental sciences	28	30	5	20	8	4	4	99
Biological sciences	106	204	47	211	68	17	17	671
Civil engineering	36	8	10	16	8	2	1	80
Electrical engineering, electronics	69	39	7	40	13	2	3	172
Other engineering sciences	185	111	25	155	38	8	2	523
Basic medicine	67	100	21	39	97	24	3	350
Clinical medicine	71	55	34	47	13	16	1	237
Health sciences	87	8	28	44	5	30	1	203
Agriculture, forestry, fisheries and allied sciences	21	6	0	9	7	1	0	44
Veterinary medicine	15	5	3	20	10	1	0	54
Psychology	27	17	10	17	3	4	0	78
Economics	41	7	18	10	0	1	0	77
Educational sciences	71	3	9	14	21	15	3	137
Other social sciences	292	57	93	83	2	36	4	565
History	53	21	9	15	1	3	0	103
Languages and literature	162	23	44	7	3	7	2	247
Other humanities	67	18	13	11	0	2	3	115
Other	11	20	11	47	41	51	3	183
Total	1695	964	494	998	385	251	53	4841

Appendix 5: Detailed international tables

Table A5.1: *HERD as a percentage of GDP, 2000 – 2004.*

	2000		2002		2004 (or latest available data)	
	Value (%)	Rank	Value (%)	Rank	Value (%)	Rank
Australia	0.42	10	0.45	9	0.45	9
Belgium	0.41	12	0.43	13	0.43	13
Canada	0.55	4	0.65	3	0.73	2
Czech Republic	0.18	25	0.19	25	0.19	24
Denmark	0.45	8	0.58	5	0.6	6
Finland	0.61	2	0.66	2	0.67	3
France	0.41	12	0.43	13	0.42	14
Germany	0.4	13	0.43	13	0.43	13
Greece	0.33	18	0.29	21	0.29	21
Hungary	0.19	24	0.26	23	0.25	23
Iceland	0.45	8	0.5	7	0.61	5
Ireland (GNP)	0.27	22	0.31	19	0.4	16
Italy	0.33	18	0.38	16	0.38	17
Japan	0.43	9	0.43	13	0.43	13
Korea	0.27	21	0.26	23	0.27	22
Netherlands	0.53	5	0.52	6	0.52	7
New Zealand	0.35	16	0.35	17	0.33	20
Norway	0.47	6	0.45	9	0.48	8
Poland	0.21	23	0.2	24	0.18	25
Portugal	0.3	19	0.34	18	0.34	18
Slovak Republic	0.06	26	0.05	26	0.08	26
Spain	0.28	20	0.31	20	0.33	20
Sweden	0.81	1	0.83	1	0.83	1
Switzerland	0.59	3	0.64	4	0.64	4
United Kingdom	0.38	14	0.42	15	0.4	16
United States	0.37	15	0.42	15	0.44	10
EU 25 Average	*0.38*	-	*0.41*	-	*0.43**	
OECD Average	*0.38*	-	*0.41*	-	*0.43***	

*Forfás estimates used as latest available data for EU 25 was 0.41% for 2002.

**Forfás estimates used as latest available data for OECD was 0.42% for 2003.

Table A5.2: *HE researchers per thousand labour force, 2000 – 2004.*

	2000		2002		2004	
	Value	Rank	Value	Rank	Value	Rank
Australia	4.1	2	4.3	3	4.2	3
Austria	1.5	21	1.8	19	1.7	21
Belgium	2.7	5	2.8	6	2.8	6
Canada	2.1	13	2.1	14	2.0	16
Czech Republic	0.7	28	0.8	27	0.8	27
Denmark	2.0	15	2.6	8	2.7	7
Finland	4.2	1	4.7	1	5.0	1
France	2.3	11	2.4	12	2.3	13
Germany	1.7	19	1.8	19	1.8	19
Greece	2.3	11	1.9	16	1.9	18
Hungary	1.4	22	1.5	23	1.4	23
Iceland	3.0	4	3.2	5	3.2	5
Ireland	1.2	24	1.5	23	2.2	14
Italy	1.1	26	1.2	25	1.2	25
Japan	2.6	7	2.5	10	2.6	11
Korea	1.1	26	1.1	26	1.1	26
Luxembourg	0.1	30	0.1	30	0.1	30
Mexico	0.3	29	0.3	29	0.3	29
Netherlands	1.9	17	1.9	16	1.9	18
New Zealand	2.6	7	4.4	2	4.2	3
Norway	2.3	11	2.4	12	2.6	11
Poland	2.0	15	2.2	13	2.3	13
Portugal	1.6	20	1.7	20	1.6	22
Slovak Republic	1.9	17	1.8	19	2.0	16
Spain	2.3	11	2.5	10	2.6	11
Sweden	3.3	3	3.5	4	3.5	4
Switzerland	2.2	12	2.6	8	2.6	11
Turkey	0.7	28	0.7	28	0.7	28
United Kingdom	1.7	19	1.6	21	1.7	21
United States	1.3	23	1.3	24	1.2	25
Total OECD	*1.6*	-	*1.6*	-	*1.6*	-
EU 25	*1.9*	-	*2.0*	-	*2.0*	-

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Functions of Forfás

Forfás is the national policy and advisory board for enterprise, trade, science, technology and innovation. It is the body in which the State's legal powers for industrial promotion and technological development have been vested. It is also the body through which powers are delegated to Enterprise Ireland for the promotion of indigenous industry and to IDA Ireland for the promotion of inward investment.Science Foundation Ireland was established as a third agency of Forfás in July 2003. The broad functions of Forfás are to:

- *advise the Minister on matters relating to the development of industry in the State*
- *advise on the development and co-ordination of policy for Enterprise Ireland, IDA Ireland, Science Foundation Ireland and such other bodies (established or under statute) as the Minister may by order designate*
- *encourage the development of industry, science and technology, innovation, marketing and human resources in the State*
- *encourage the establishment and development in the State of industrial undertakings from outside the State, and*
- *advise and co-ordinate Enterprise Ireland, IDA Ireland and Science Foundation Ireland in relation to their functions.*

Is é Forfás an bord náisiúnta um polasaí agus comhairle le haghaidh fiontraíochta, trádála, eolaíochta, teicneolaíochta agus nuála. Is é an comhlacht é a bhfuil comhactaí dlíthiúla an stáit maidir le cur-chun cinn tionscail agus forbairtteicneolaíochta dílsithe ann. Is é an comhlacht é freisin trína dtiomnaítear cumhachtaí ar Fhiontraíocht Éireann le tionscail dúchais a chur chun cinn agus ar ghníomhaireacht Forbartha Tionscail na hÉireann (GFT Éireann) le hinfheistíocht isteach sa tir a chur chun tosaigh. Bunaíodh Fondúireacht Eolaíochta Éireann mar an treas eagraíocht de chuid i Forfás mí Iúil 2003.
Is iad feighmeanna Fhorfáis:

- *comhairle a chur ar an Aire ó thaobh cúrsaí a bhaineann le forbairt tionscail sa Stát*
- *comhairle maidir le forbairt agus comhordú polasaithe a chur ar fáil d'Fhiontraíocht Éireann, d'GFT Éireann, Fondúireacht Eolaíochta Éireann agus d'aon fhoras eile dá leithéid (a bunaíodh go reachtúil) a d'fhéadfadh an tAire a ainmniú trí ordú*
- *forbairt na tionsclaíochta, na teicneolaíochta, na margaíochta agus acmhainní daonna a spreagadh sa Stát*
- *bunú agus forbairt gnóthas tionsclaíoch ón iasacht a spreagadh sa Stát, agus*
- *Fiontraíocht Éireann, GFT Éireann agus Fondúireacht Eolaíochta Éireann a chomhairliú agus a chomhordú ó thaobh a gcuid feidhmeanna.*

Board Members

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Managing Director, Aderra

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Chief Executive, Forfás

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Chief Executive, IDA Ireland

Sean Gorman
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Dr William Harris
Director General, Science Foundation Ireland

Prof. Michael Hillery
Emeritus Professor of Engineering, University of Limerick

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