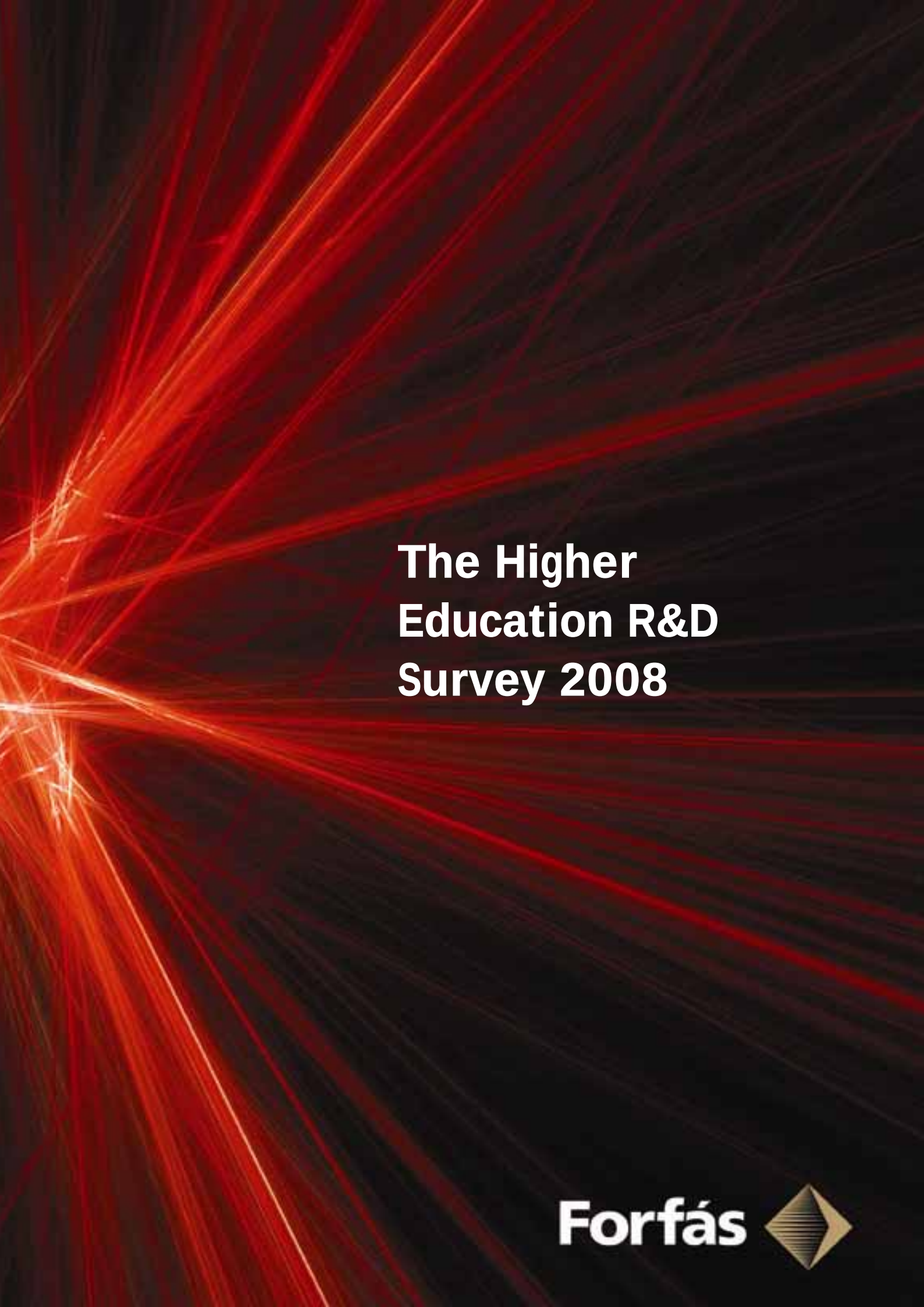
The Higher Education R&D Survey 2008



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Foreword

As Ireland faces the current economic challenges, continued investment in research and development remains of vital importance to enable the economy to recover and grow in the future. The aspiration of the Government's 2006 *Strategy for Science, Technology and Innovation,* and subsequent *Smart Economy Strategy* to develop a knowledge-based economy by providing access to research at all levels, is of more importance than ever. Increased funding in research and development will facilitate the drive towards future economic recovery and growth.

The higher education sector provides a national base of skills and knowledge and complements the research undertaken in business sector firms and public sector institutes, which are usually more applied and developmental in their focus.

Forfás monitors research and development activity, in various sectors of the economy, through regular surveys. Surveys are carried out on the R&D activities of the business sector, the higher education sector and the government sector.

This survey is carried out every two years and the current report focuses on the R&D activities performed within the higher education sector in the 2007/2008 academic year. The lag in publication of these results is to allow for finalisation of the personnel and financial data by the institutions.

Included in this survey are all universities and institutes of technology. The data from this report, and other Forfás R&D reports, feed into wider OECD and Eurostat reports, as well as forming part of Forfás' ongoing policy advice to the government. The methodology and procedures followed in carrying out this survey are as recommended by the OECD in the *Frascati Manual - Proposed Standard Practice for Surveys on Research and Experimental Development.* More detailed methodology is provided in Appendix 1.

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Executive Summary

This report presents the results of a survey of the research and development (R&D) activities of the higher education sector, for the academic year 2007/2008. The results show that up to 2008 Ireland was making progress to increase the amount of R&D undertaken in the higher education sector. Increased public and private investment in R&D in recent years has placed Ireland in a strong position to become a more knowledge driven economy by not only increasing the funding available for research but also by increasing the stock of third-level researchers and research personnel engaged in research work in the country.

Expenditures and human resources devoted to research work in the higher education sector are measured biennially by Forfás in the *Higher Education Research and Development* (HERD) survey. The sector includes universities and institutes of technology engaged in research and development activities.

Ireland's position relative to other OECD countries has improved steadily since 2000 enabling us to close the gap between domestic R&D performance and that of our major competitors internationally.

The main findings of the HERD 2008 survey are as follows:

Table 1 - Summary of Key Results

	2002	2004	2006	2008
Higher education expenditure on R&D (HERD)	€322m	€492m	€601m	€750m
HERD as a % of GNP	0.30%	0.39%	0.39%	0.48%
Ireland's rank among 25 OECD countries	12th	12th	11th	7th
Total researchers (FTE) in HE sector	2,695	4,151	4,689	6,174
Researchers per 1000 labour force - Ireland's rank among 26 OECD countries	9th	10th	13th	9th

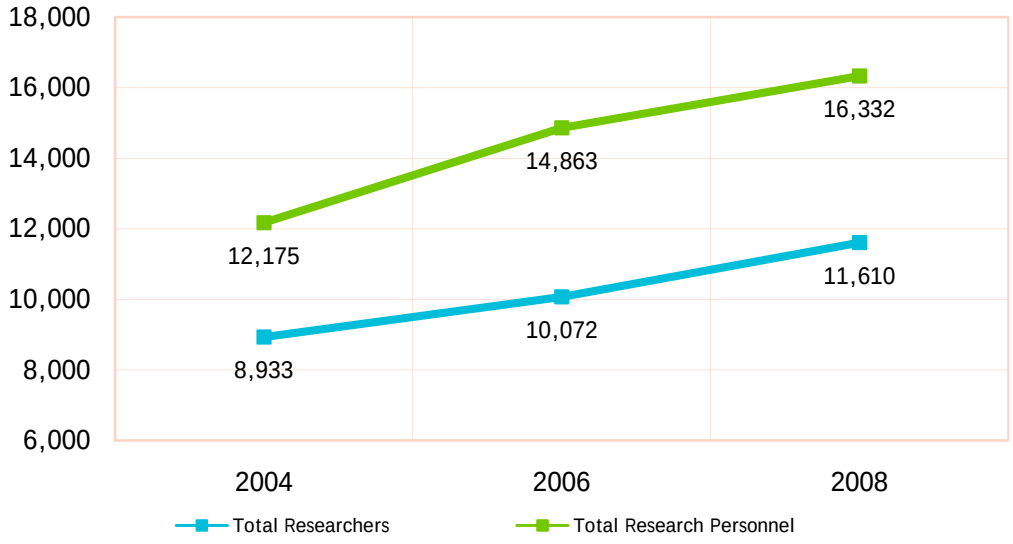
Source: OECD Main Science and Technology Indicators, May 2010 and Forfás data

R&D expenditure:

- In the period 2002-2008 R&D expenditure performed in the higher education sector has more than doubled in nominal terms. In 2008 higher education expenditure on R&D rose to €750 million, an increase of 25% in current terms or 14% in constant prices since 2006.
- Higher education R&D expenditure is forecast to increase by 10.5% in 2009 to reach €829 million.
- While expenditure increased every year, the two-year period between 2002 and 2004 showed the biggest increase. In the 10 year period since 1998 R&D expenditure increased by 268% in nominal terms.

- Universities accounted for 90% of the total HERD spending in 2008, while institutes of technology accounted for the remaining 10% of total R&D spending in the higher education sector.
- Between 2002 and 2004 HERD as a percentage of GNP increased from 0.30% to 0.39%. The ratio stabilised at 0.39% in 2006 and increased to 0.48% in 2008. While R&D expenditure has increased since 2006 the 0.48% increase in 2008 was due largely to the reduction in GNP during the two-year period.
- Ireland's position relative to 25 other OECD countries since 2002 has improved steadily placing us in 7th place in 2008 from 12th in 2002 and 2004 and 11th in 2006 for HERD as a percentage of GDP/GNP.

Figure 1 - Total researchers (headcount) in the higher education sector 2004, 2006, 2008

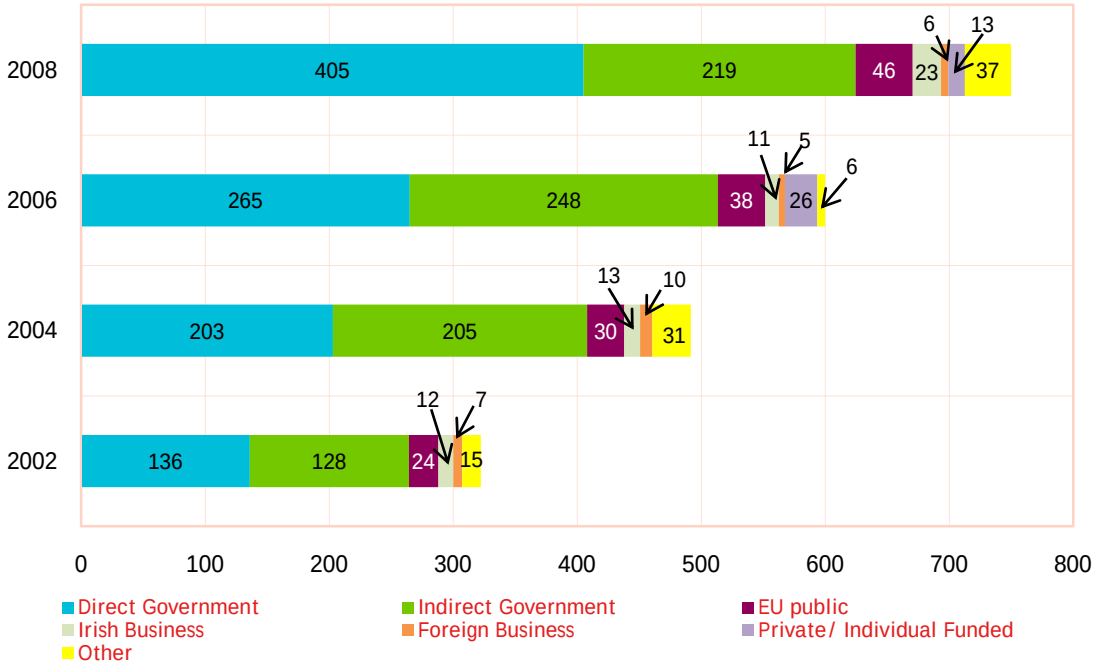


Source: Forfás Data

Human resources dedicated to higher education R&D activities:

- In 2008 the total number of researchers increased from 10,072 in 2006 to 11,610, an increase of 15%. The percentage increase in the number of researchers between 2004 and 2006 was 13%.
- The number of researchers in FTE terms (amount of time spent on research) increased by 32% from 4,689 in 2006 to 6,174 in 2008. This figure has increased steadily since 2002 indicating that the number of hours spent on research by each researcher has increased in addition to an increase in the overall headcount researcher numbers.
- Ireland currently ranks 9th when comparing the number of higher education researchers per 1000 of the labour force against 30 other OECD countries.

Figure 2 - Sources of higher education research funding in current prices (€millions) 2002-2008

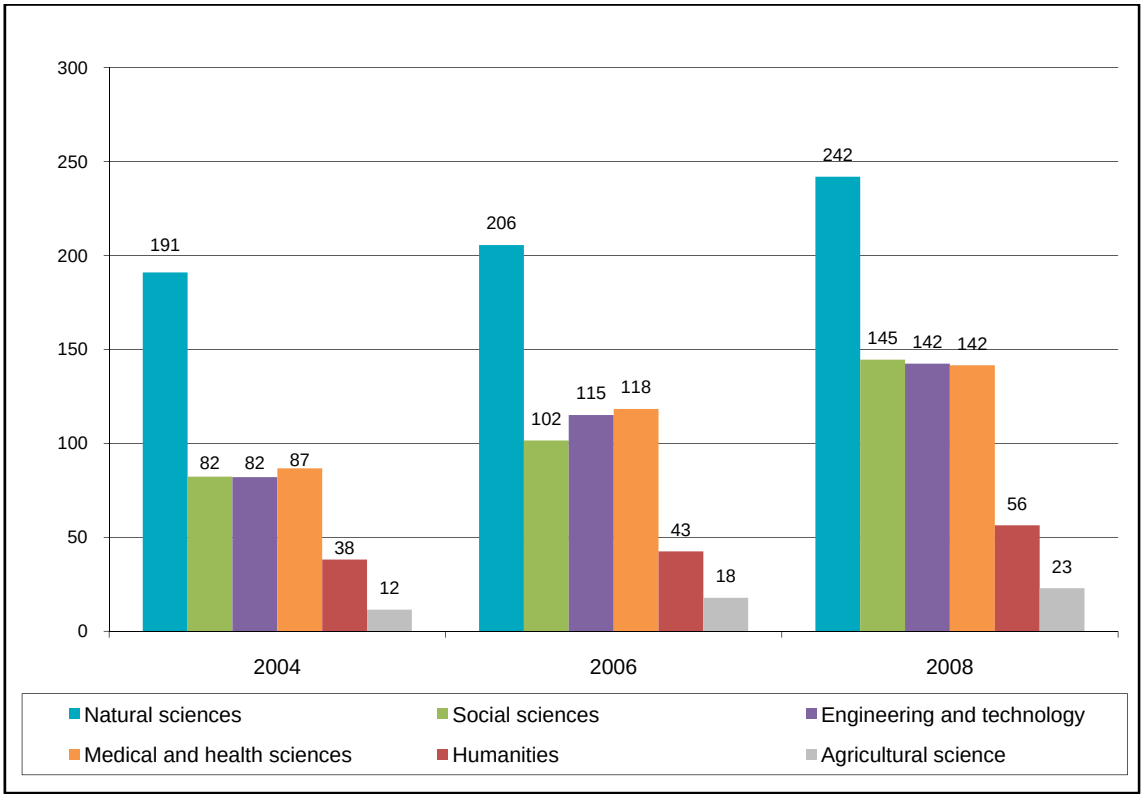


Source: Forfás Data

Sources of funding:

- The main source of research funding in the higher education sector comes directly from government. Direct government funding has tripled since 2002 to total €405 million in 2008, a 53% increase on the amount allocated in 2006.
- The agencies and government departments providing funding include Science Foundation Ireland (38%), the HEA's Programme for Research in Third-Level Education (17%), Enterprise Ireland (13%), the Health Research Board (7%), the Irish Research Council for Science, Engineering & Technology (5%) and the remaining 20% from Teagasc, other HEA funding, IRCHSS and bodies such as the Western Development Commission, National Parks and Wildlife Service, the Marine Institute and various health boards and county councils.
- Indirect government funding comes mainly through the proportion of the Higher Education Authority's (HEA) block grant dedicated to R&D. While indirect government funding marginally outstripped direct funding in 2004, in the two-year period between 2006 and 2008 indirect funding decreased by 12%.
- Total government funding, (both direct and indirect) accounted for 83% of all research income in the higher education sector in 2008. This is a slight decrease on the 86% recorded in 2006.
- Irish and foreign businesses, EU public funding and contributions from private individuals and philanthropists make up the remaining 17% of funding.

Figure 3 - Higher education expenditure on R&D by fields of science (€million, current prices), 2004-2008 current prices



Source: Forfás Data

Higher education R&D activities by field of science:

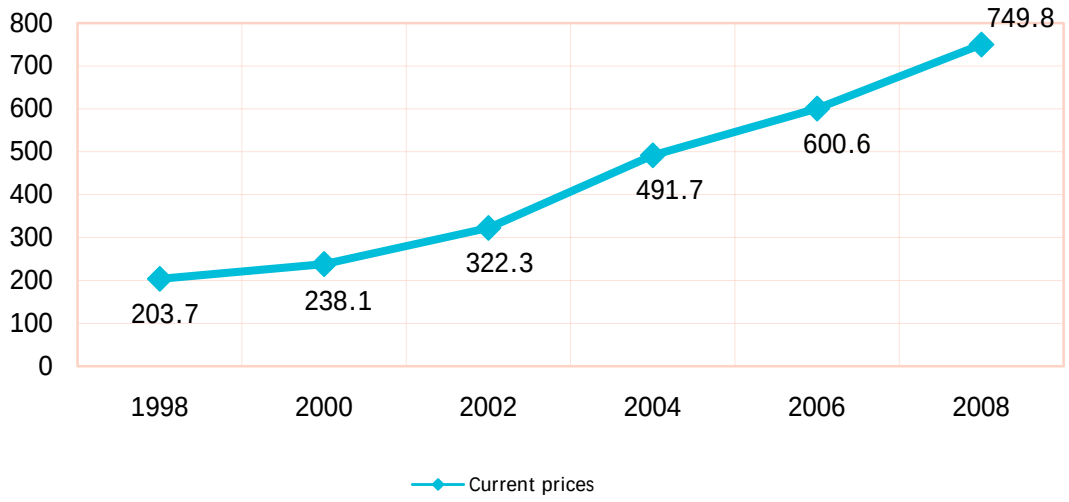
- When HERD expenditure is broken-down by field of science it can be seen, that the largest proportion of R&D spend was in the field of natural sciences in 2004, 2006 and again in 2008. The 2008 figure of €242 million shows an increase of 17% over the 2006 figure.
- R&D expenditure on social sciences increased to €145 million in 2008, a 42% increase over the 2006 figure and a 77% increase over the 2004 figure of €82 million.
- Expenditure in the field of engineering & technology increased over the two-year period between 2006 and 2008 by €27 million, while the increase in the field of medical & health sciences was €24 million.
- Funding for the humanities field of science increased by 30% between 2006 and 2008 and by 13% between 2004 and 2006.
- The agricultural sciences gained an additional €11 million in research funding in the last 4 years which brought the total amount of R&D funding allocated within this field of science to €23 million in 2008.

Chapter 1: General trends in higher education R&D expenditure

The following information on research and development spending by higher education institutions was collected from the accounts and research departments of all higher education institutions engaged in R&D. The survey was carried out under the statistical rules and international definitions as outlined in the OECD Frascati Manual[1].

The period 2006-2008 saw continued rises in expenditure on research and development (R&D) by third level institutes in Ireland. In 2008 higher education expenditure on R&D rose to €750 million, an increase of 25% in current terms. This equates to an increase of 14% in constant prices since 2006.

Figure 1: Trend in HERD expenditure, 1998-2008, in current prices, (€ million)



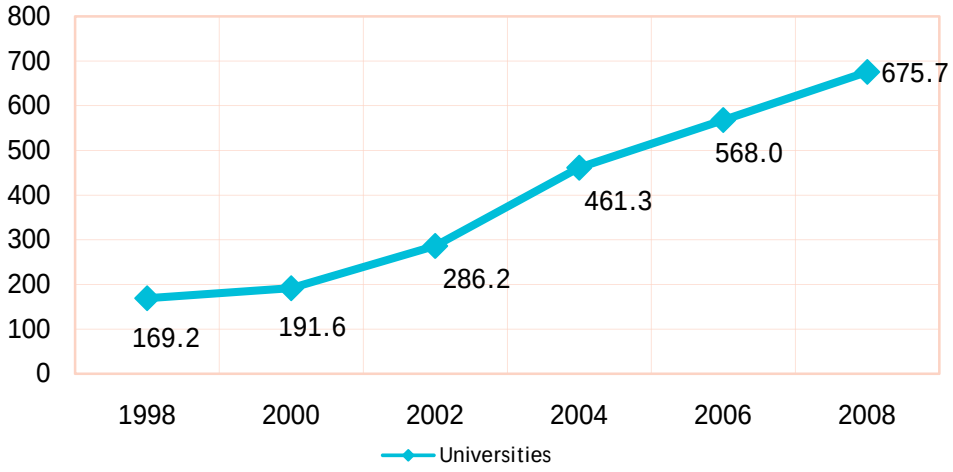
Source: Forfás Data

Higher education expenditure on R&D for the past 10 years is shown in Figures 2a and 2b by type of institute, i.e. universities, institutes of technology and other higher education institutes performing R&D. Appendix 1 contains a full list of the institutions covered in the survey. Higher education R&D expenditure is forecast to increase by 10.5% in 2009 to reach €829 million.

Universities continued to dominate the funding allocated for R&D, in this sector between 2006-2008, accounting for 90% of total expenditure in 2008. In 2008, R&D spending by universities rose to €675.7 million from the €169.2 million recorded ten years ago. (Fig. 2a)

1 Frascati Manual - Proposed Standard Practice for Surveys on Research and Experimental Development - OECD, 2002.

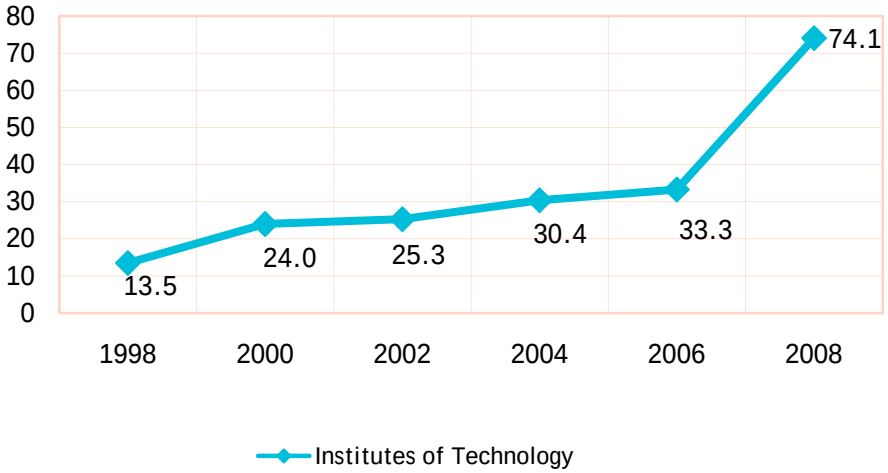
Figure 2a: Research expenditure by the universities 1998-2008 (€ millions), in current prices.



Source: Forfás Data

As can be seen in Figure 2b below, following a 77% increase in the rate of funding growth between 1998 and 2000, R&D spending by the Institutes of Technology (IoTs) levelled off between 2000 and 2006 with only modest increases. However in the two-year period between 2006 and 2008, there was a dramatic rise in R&D spending by IoTs, with expenditure rising from €33.3 million to €74.1 million.

Figure 2b: Research expenditure by the Institutes of Technology 1998-2008 (€ millions), in current prices.



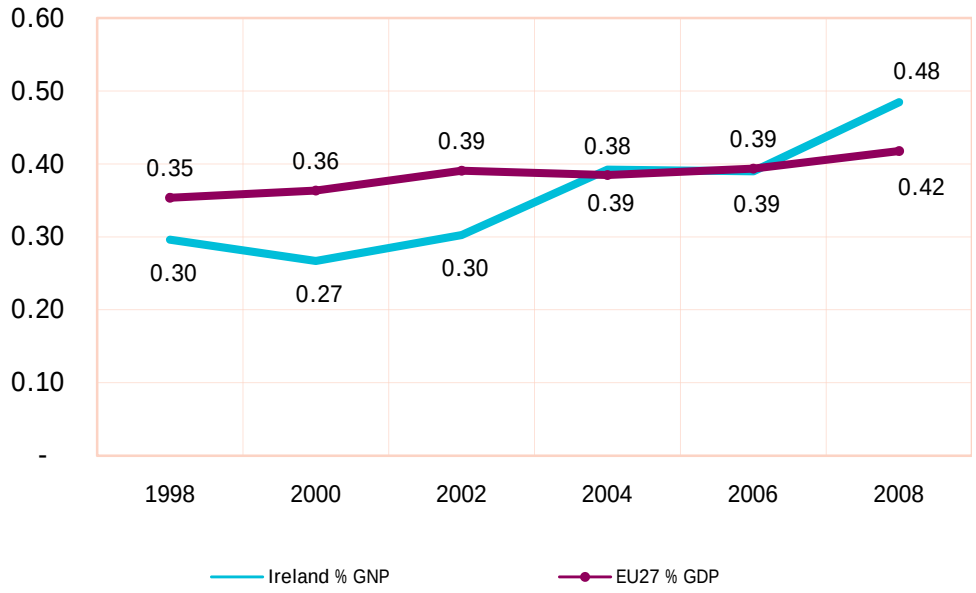
Source: Forfás Data

R&D expenditure by the higher education sector in Ireland, as a percentage of economic activity, is compared in Figure 3 below, with the performance of this sector across the EU27. In Ireland, Gross National Product (GNP) is more commonly used to measure economic activity as opposed to Gross Domestic Product (GDP) which may be overestimated by the profit repatriations of large multinationals based here, and other net foreign income flows. Figure 3 shows HERD as a percentage of economic activity over the 10 year period from 1998 to

2008. Caution should be used when observing these ratios due to the rapid swings in nominal economic activity over the last decade.

From 1998 to 2000, Ireland's spending intensity ratio remained below the EU27 average with a drop to 0.27% of GNP in 2000 compared to the EU27 rate of 0.36% of GDP. Increased spending on R&D by the higher education sector between 2002 and 2004 brought Ireland's ratio to 0.39% of GNP, just marginally above the EU27 rate of 0.38% of GDP. In 2006, HERD as a percentage of economic activity in Ireland and the EU27, were on a par, at 0.39%. In the past two years HERD spending in Ireland has risen to 0.48% of GNP.

Figure 3: HERD as a percentage of economic activity, 1998-2008, Ireland and the EU27

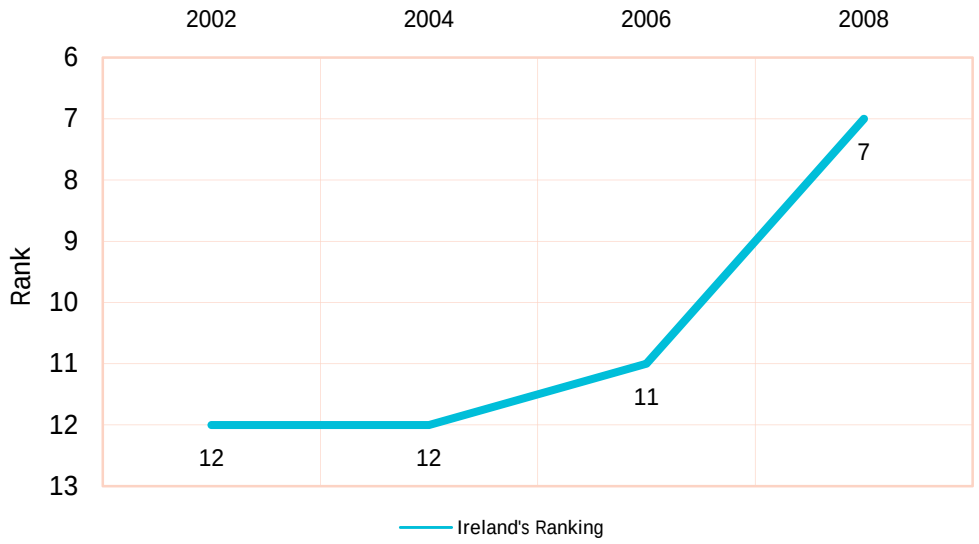


Source: OECD, Main Science and Technology Indicators, Vol. 2010/1

Benchmarking Ireland's performance against other OECD states gives a clear picture of Ireland's progress in becoming a global centre of research excellence. Establishing Ireland's position with respect to other European countries is an important aspect of the HERD survey.

Figures 4 and 5 rank Ireland 7th out of 25 countries, on HERD spending performance. Figure 4 shows clearly that Ireland has been making steady progress to reach its current 7th position from 12th position in 2002 and 2004 and 11th in 2006.

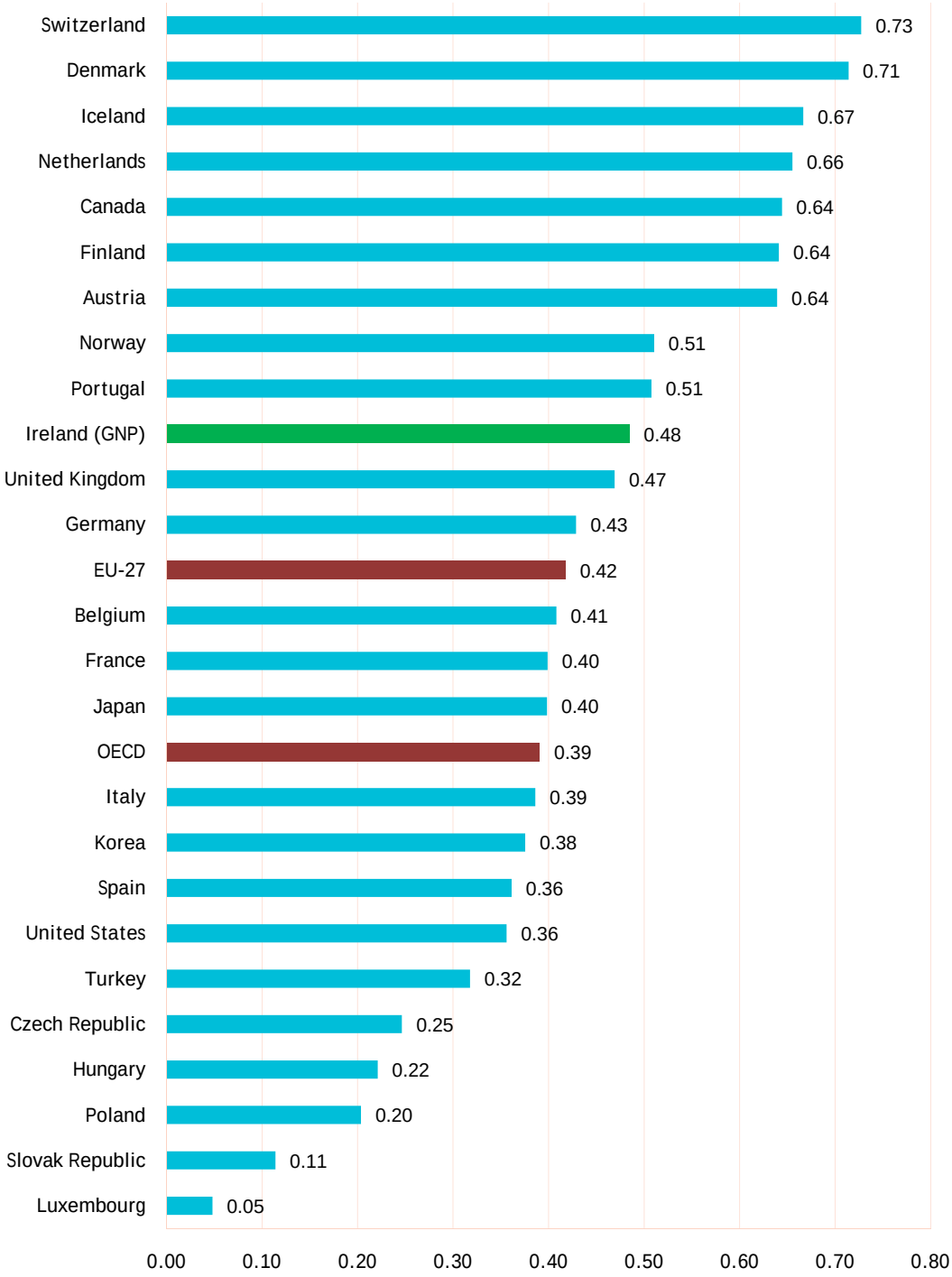
Figure 4: HERD as a % of economic activity - Ireland's position in the OECD, 2002-2008



Source: OECD, Main Science and Technology Indicators, Vol. 2010/1

In 2008, the top performers were Switzerland, Denmark, Iceland and the Netherlands with Canada dropping to 4th place from its 2nd place in 2006 (Figure 5). Although, there is substantial progress to be made before reaching the top performers, many gains have been achieved which have helped Ireland close the research spending intensity gap when compared internationally.

Figure 5: HERD as a percentage of GDP (Ireland GNP) - 2008 or latest available data



Source: OECD, Main Science and Technology Indicators, Vol. 2010/1

Chapter 2: Human resources allocated to higher education research

Improving Ireland's stock and flow of knowledge is one of the key challenges in completing the transition to a true knowledge economy as outlined in the Government's Science Strategy[2] published in 2006. Specifically, there is a need to increase the number of researchers and research personnel employed in the higher education sector, while also promoting the development of a strong and relevant learning platform for researchers at student level. The HERD survey gathers information on the numbers and type of personnel involved in R&D within Ireland's third level sector.

The number of researchers by total headcount is shown in Table 1a below. This includes academic staff, post-doctoral fellows, contract lecturers and contract researchers engaged in R&D. The survey also requested data on research support staff including technicians, administrative/clerical and other research support staff. The total number of researchers (headcount) reported for 2008 has increased by 15% over the 2006 number, rising from 10,072 to 11,610. The headcount of research personnel, including research support staff, has increased by 4% to 15,487 over the 2006 figure of 14,863. Caution should be exercised when comparing 2008 figures by personnel type with previous years due to the introduction of the Principal Investigators category for the 2008 survey. This has resulted in some post-doctoral fellows, contract lecturers or contract researchers being re-allocated to the new category resulting in a reduction in the other categories.

According to analysis conducted by Forfás[3], of the career destinations of doctorate holders in Ireland, using statistics from the 2006 Census, most qualified PhDs are in the education sector, accounting for 46% of the total. However, doctorate holders also find employment across a range of industry sectors such as manufacturing (12%), real estate & business activities (12%), health & social work (11%), public administration (5%) and the remainder in a variety of other sectors. The HEA[4], in their report on graduates in 2008, found that 51% of PhD graduates were employed in the education sector, 13% in manufacturing and 3% in services.

[2] Strategy for Science, Technology and Innovation, 2006-2013.

[3] Analysis of 2006 Census Statistics on Doctorate Holders in Ireland - Forfás 2008.

[4] What do graduates do? The Class of 2008, HEA, March 2010.

Table 1a: Total researchers by performer, 2008 (headcount)

Sector	Academic Staff	Principal Investigators	Post-doctoral Fellows	Contract Lecturers	Contract Researchers	Total Researchers
	A	B	C	D	E	(A+B+C+D+E)
Institutes of Technology	2952	264	103	238	142	3699
Universities	3042	768	2175	1158	769	7912
Total - 2008	**5994**	**1032**	**2278**	**1396**	**911**	**11610**
Total - 2006	6091	-	1148	1256	1577	10072
Total - 2004	5372	-	995	1511	1056	8933

Source: Forfás Data

Table 1b: Total research personnel analysed by performer, 2008 (headcount)

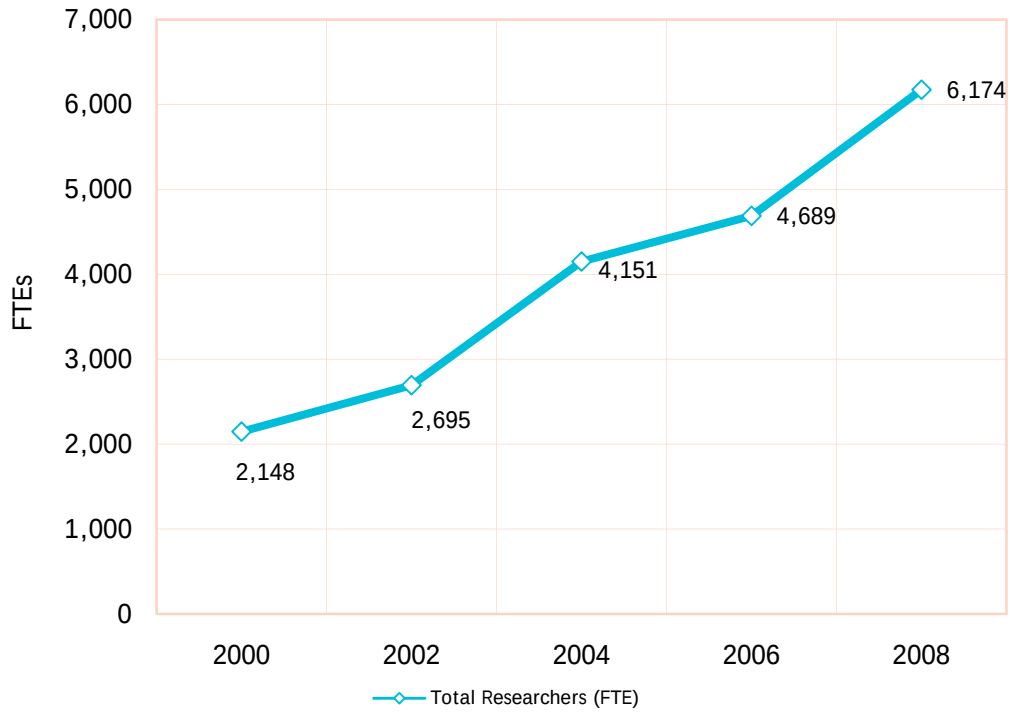
Sector	Total Researchers	Technicians	Admin Staff	Other staff	Total Research Personnel
	F	G	H	I	(F+G+H+I)
Institutes of Technology	3699	211	262	20	4192
Universities	7912	868	1980	536	11296
Total - 2008	**11610**	**1079**	**2242**	**556**	**15487**
Total - 2006	10072	1094	2694	1003	14863
Total - 2004	8933	1133	1590	519	12175

Source: Forfás Data

To obtain a clearer picture of the amount of time devoted to research as opposed to other work the higher education institutes were asked to estimate the actual amount of time spent on research. This estimate enables the headcount figure to be converted to a full-time equivalent figure (FTE) which more accurately describes the time allocated to research in the various institutes. If a single researcher is counted as 1 in headcount terms, and they spend 40% of their total work time on research activities then they are counted as 0.4 FTEs.

Figure 6 below shows that the number of researchers in FTE terms rose considerably in the two-year period since 2006, growing from 4,689 to 6,174, an increase of 32%. This indicates not only an increase in headcount researchers but also an increase in the amount of time allocated specifically to research by these researchers.

Figure 6: Total researchers in the higher education sector, 2000-2008 (FTE)



Source: Forfás Data

When the FTE numbers of researchers and research support staff for 2008 is examined by field of science, as in Table 2 below, the following can be noted:

- the total number of FTE research personnel rose from 5,581 in 2006 to 7,141 in 2008, with the total number of FTE research support staff increasing over the two-year period between 2006-2008 from 892 to 967.
- the majority of researchers are employed in the field of natural sciences with a FTE figure of 1,941.

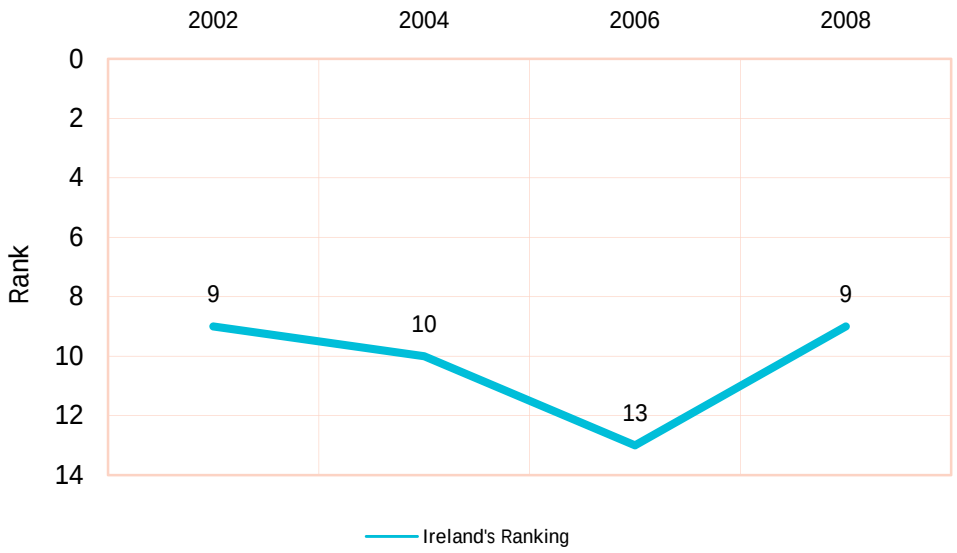
- after natural sciences, researchers spend most of their time on research in the fields of engineering and technology and medical and health sciences.
- FTE researchers in the social sciences, humanities and agricultural sciences accounted for 17%, 10% and 2.7% of total FTE researchers, respectively, in 2008.
- apart from social science, most research support was provided in the fields of medical and health sciences (222 FTE), natural sciences (226 FTE) and the fields of engineering and technology (165 FTE).

Table 2: FTE Researchers by occupation and new Field of Science in the higher education sector, 2008

Sector	Total Researchers	Total Support Staff	Total Research Personnel
Natural Sciences	1941	226	2167
Engineering and Technology	1213	165	1378
Medical and Health Science	1173	222	1395
Agricultural Sciences	167	38	205
Social Sciences	1058	261	1319
Humanities	622	55	677
Total - 2008	**6174**	**967**	**7141**
Total - 2006	4689	892	5581
Total - 2004	4152	689	4841

Source: Forfás Data

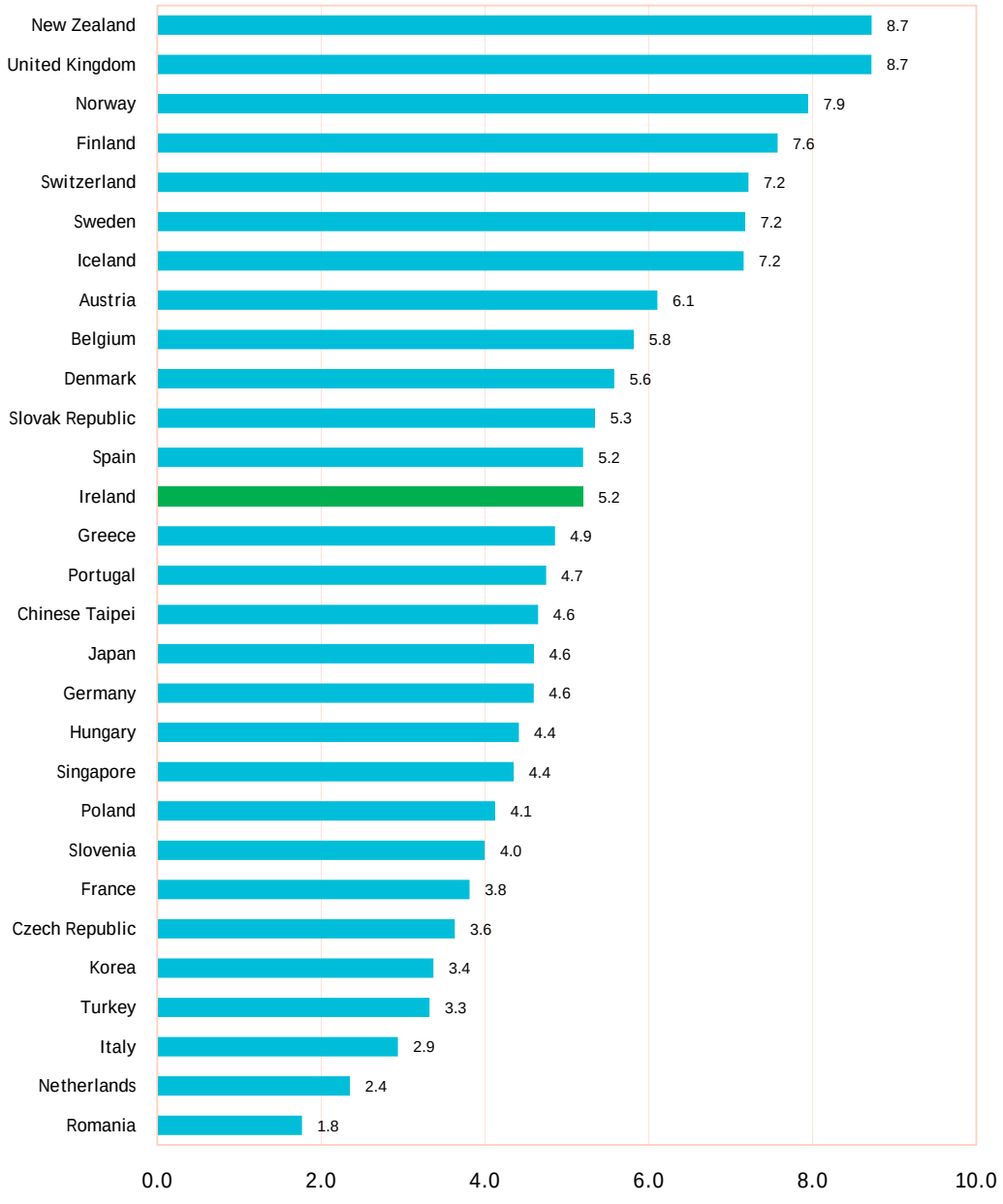
Figure 7: Ireland's OECD ranking, higher education researchers per 1,000 of the labour force (2008 or latest available data)



Source: OECD, Main Science and Technology Indicators, Vol. 2010/1

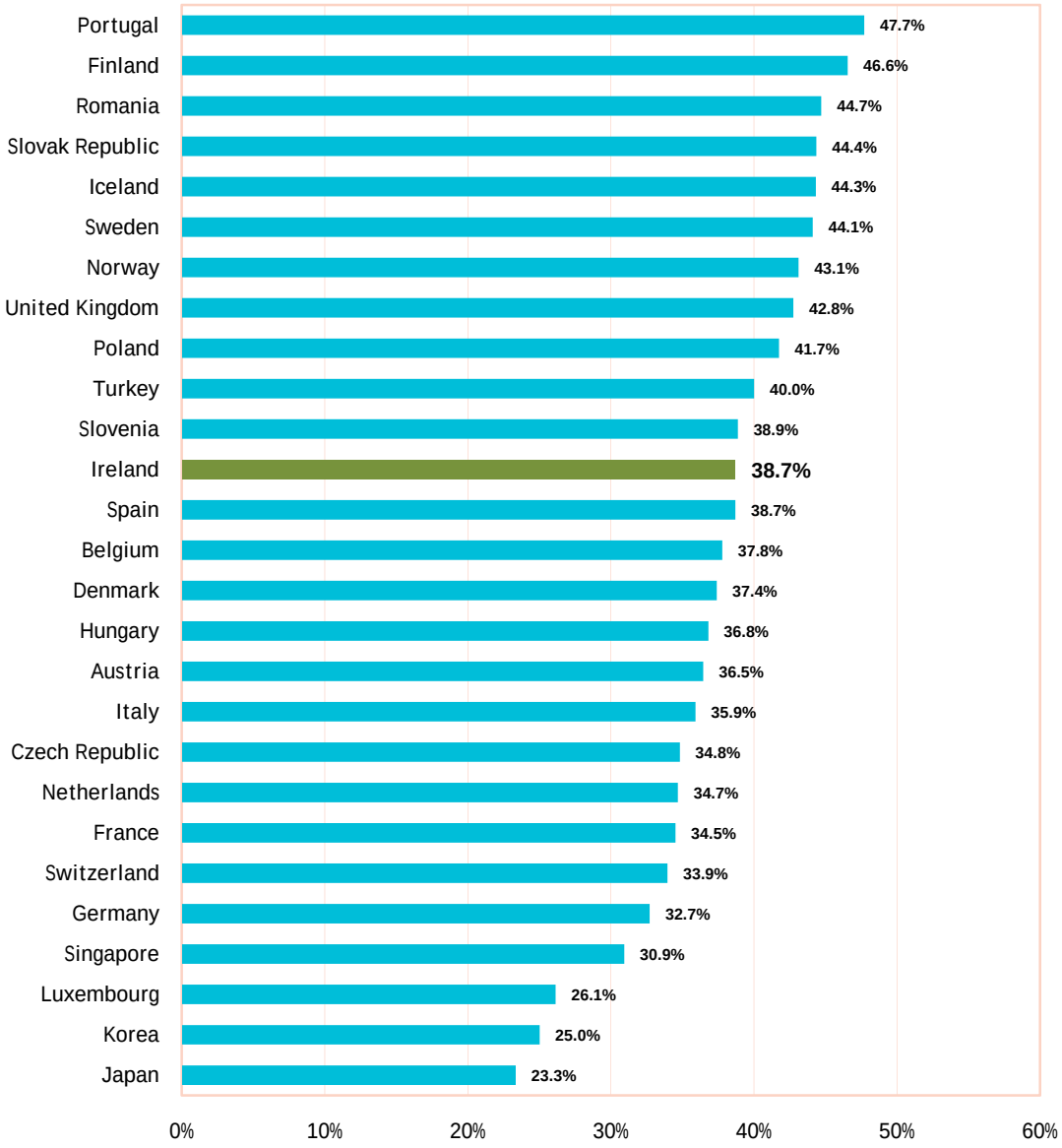
Figure 7 illustrates Ireland's ranking against other OECD countries when comparing the number of higher education researchers per 1000 of the labour force. In 2002 Ireland was ranked 9th of 31 states. In 2004 and 2006 Ireland has moved down to 10th and 13th place respectively. Over the two-year period between 2006 and 2008 Ireland moved up to 9th place again out of 31 OECD countries.

Figure 8: Higher education researchers (FTE) per 1,000 of labour force (2008 or latest available data)



Source: OECD, Main Science and Technology Indicators, Vol. 2010/1

Figure 9: Higher education female researchers as a % of total researchers (2008 or latest available data[5])



Source: OECD, Main Science and Technology Indicators, Vol. 2010/1

When the number of female researchers as a percentage of total researchers is compared internationally (Figure 9), Ireland performs well, ranking 12th out of 27 OECD countries fthis indicator. Portugal and Finland are the current leaders with percentages of 47.7% and 46.6% in 2007 and 2008 respectively.

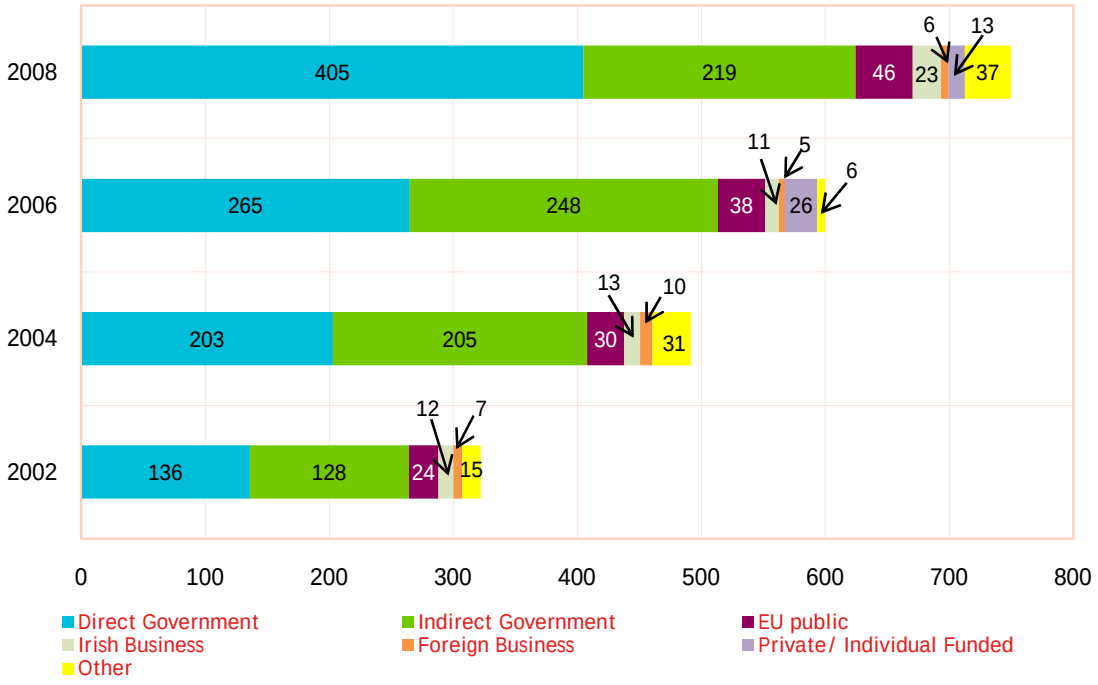
[5] Luxembourg, Germany, Netherlands, Italy, Austria, Denmark, Belgium, Spain, Turkey, United Kingdom, Sweden and Portugal 2007; France 2006; Rest 2008.

Chapter 3: Source of funding of HERD expenditure

This chapter examines the main sources of funding for higher education R&D. Funding for research in higher education institutes is provided by a number of different sources. The main sources of funding come from three distinct areas: direct government, indirect government and other sources such as Irish industry, foreign industry and EU funding programmes, including the framework programme, and also some funding from private individuals.

Direct funding includes funding from the HEA's Programme for Research, Technology and Innovation (PRTLI) fund, Science Foundation Ireland's Research Frontiers Programme, the US-Ireland R&D Partnership Programme, the Principal Investigator Programme and other programmes. Indirect funding sources include funding from the HEA via the annual "block grant" to universities.

Figure 10: Sources of research funding, 2002-2008, in current prices (€ millions)



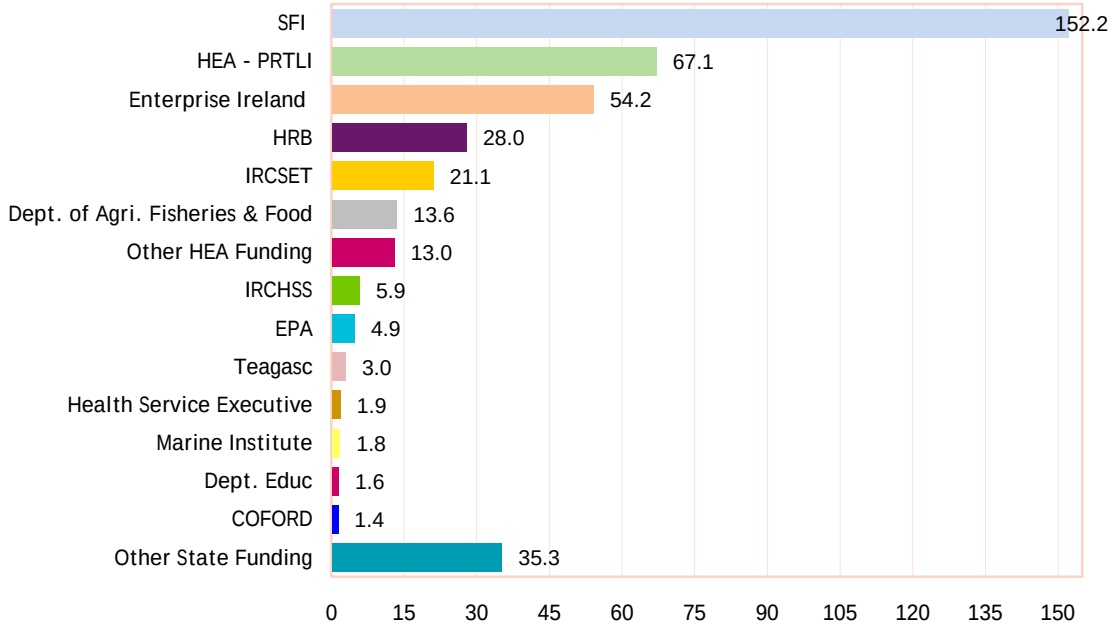
Source: Forfás Data

Figure 10 above illustrates the level of funding provided by government and other sources for 2002, 2004, 2006 and 2008. With the exception of 2004 direct government has been the main source of research funding in the higher education sector. Indirect government funding marginally outstripped direct funding in 2004. While funding directly from government increased substantially between 2006 and 2008, indirect funding decreased by 12% over the same period. Total government funding, (both direct and indirect) accounted for 83.3% of all

research income in the higher education sector in 2008. This is a slight decrease on the 85.6% recorded in 2006.

Direct government funding comes from the Irish exchequer via various government departments and agencies in order to fund research projects which are performed in the higher education sector. In 2008, direct government funding of higher education R&D rose to €405 million, a 53% increase on the amount allocated to research and development activities in the higher education sector in 2006. Government agencies providing funding for research and development activities, in the higher education sector in 2008 included; Science Foundation Ireland (SFI); the HEA, through its Programme for Research in Third Level Institutions (PRTLI); Enterprise Ireland, the Health Research Board, IRCSET and the Dept. of Agriculture, Fisheries & Food etc. A large contribution also came from "Other" sources, which encompasses various government departments, Bord Iascaigh Mhara, National Parks and Wildlife Service, OPW, various Health Boards and County Councils etc.

Figure 11: Sources of direct government research funding (€ millions) 2008



Source: Forfás Data

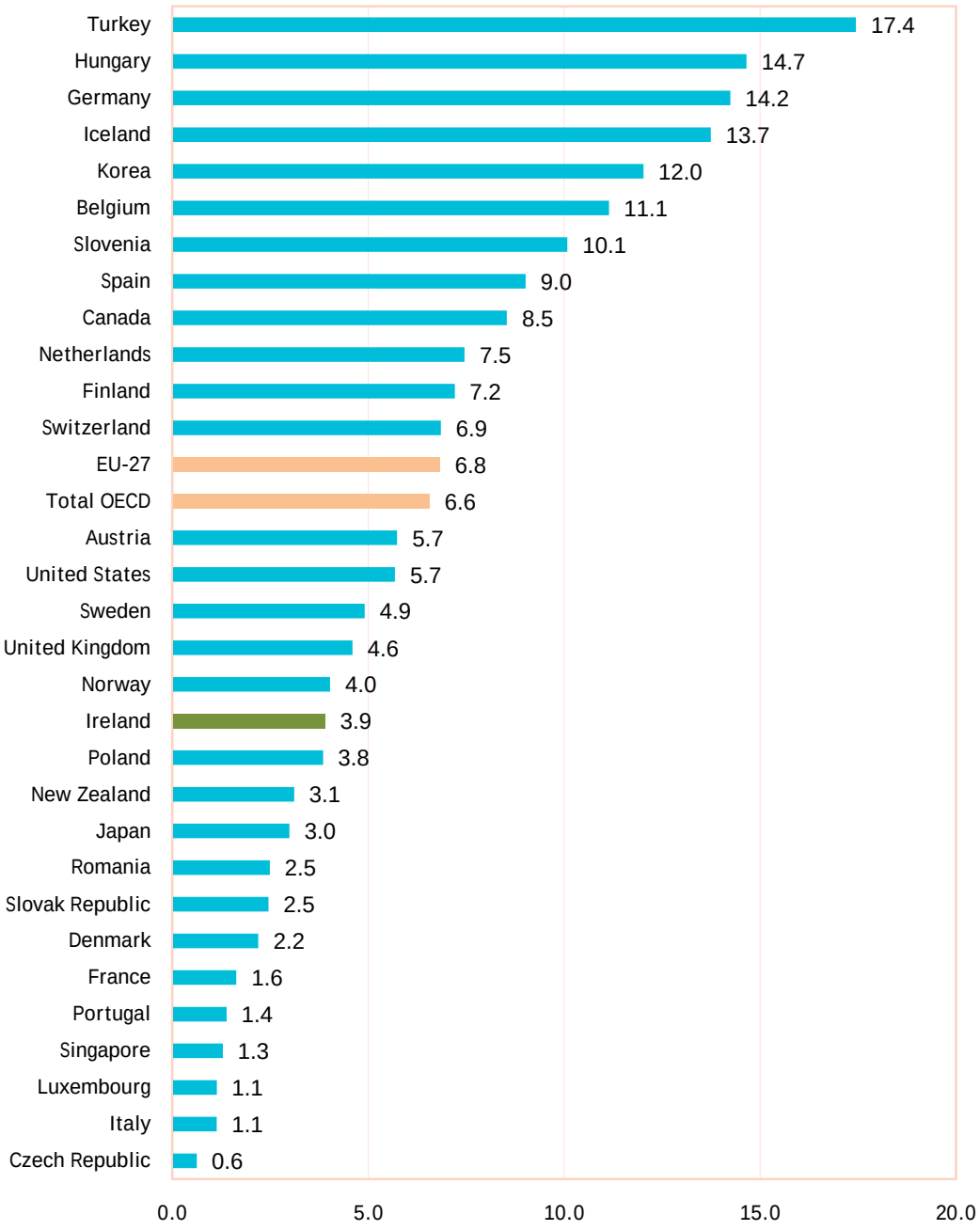
Figure 11 shows the breakdown of direct government funding by its main sources for the academic year 2008. As already mentioned the largest amount of funding for research in the third-level sector comes from SFI. Funding from SFI accounted for 24.3% of the total direct government research funding. PRTLI funding amounted to €67.1 million (11% of the total) and EI's funding in 2008 amounted to €54.2 million (9% of the total). Research in the areas of health, science, engineering and technology, social science and agriculture, account for the remainder of the direct government research funding.

Indirect government funding is distributed by the HEA to the universities in the form of an annual "block grant". The allocation of this funding to the universities is for a variety of purposes on behalf of the Department of Education and Science. The size of the R&D component of the academic part of the block grant is decided upon by measuring the amount of time spent on research at the institution by academic staff, and proportioning that part of overall funding to departmental R&D activities. This is standard practice in all OECD countries that operate a dual system of higher education funding – direct and indirect (General University Funding). This system follows the guidelines set out in the OECD's Frascati manual. In 2008, the R&D element of the HEA block grant fell to €219 million, from the €248 million recorded in 2006.

Since 2002 the EU contribution has almost doubled from €24 million in 2002 to €46 million in 2008, mainly through its Framework Programmes. Irish industry's contribution rose considerably between 2006 and 2008 increasing from €5 million to €23 million. In 2008 industry's share accounted for 3.9% of total funding. Since 2002, funding received from foreign industry has remained relatively stable accounting, in 2008, for 0.8% of total funding. The contribution from private individuals and philanthropists, who donate to higher education institutions to further research, which was measured for the first time in 2006, dropped from €26 million then to only €13 million in 2008 (1.7% of the total).

Figure 12 overleaf, shows the percentage of higher education R&D that is financed by industry in OECD countries. Ireland's contribution of 3.9% ranks well below the leaders Turkey (with a contribution of 17.4%) and Hungry (with a contribution of 14.7%). Ireland is also below the total OECD contribution of 6.6% and the EU-27 contribution of 6.8%, though it should be noted that these figures are for 2007.

Figure 12: Percentage of HERD financed by industry, (2007 or latest available data[6])



Source: OECD, Main Science and Technology Indicators, Vol. 2010/1

[6] Luxembourg, Portugal, New Zealand, Norway, Sweden, Austria, Netherlands, Spain, Belgium, Germany, Total OECD and EU-27 - 2007/ Remainder (incl. Ireland) - 2008/ Canada - 2009

Table 3 below illustrates the breakdown of research funding in the higher education sector by areas of research or fields of science. This breakdown can be used to examine and compare the areas of research receiving most funding and those areas which attract smaller amounts of funding.

- Sixty-four percent of research funding for natural sciences was received through direct government funding. Indirect funding accounted for 21%, while Irish and foreign business and other sources provided 9% and the EU just 6%.
- The engineering and technology research areas received 66% of their HE funding directly from government. Only 18% came from indirect sources, while 16% came via the EU, industry and other sources of funding.
- Direct government funded 53% of research in the medical and health sciences fields of science. Thirty-three percent of funding is provided via the HEA's block grant while the remaining 15% is sourced through business and other sources and the EU respectively.
- The majority of funding for agricultural science research (55%) is provided directly by the government. Thirty-six percent comes from the block grant while the EU funds 5% and the remaining 4% is provided by Irish and foreign business and other sources.
- The social sciences fields of science obtain 39% of their funding from indirect government sources and 37% from direct government sources. Industry and other sources provide 13% while the 10% is funded by EU programmes.
- As with social sciences the majority of funding for the humanities comes from the HEA with the block grant accounting for 55% of funding. By contrast with the other fields of science, direct government funding only accounted for 27% of research funding in the humanities research area. Industry and other sources provided 17% of funding in 2008 and the EU 1%.

Table 3: Sources of research funding by Field of Science (€ millions), 2008

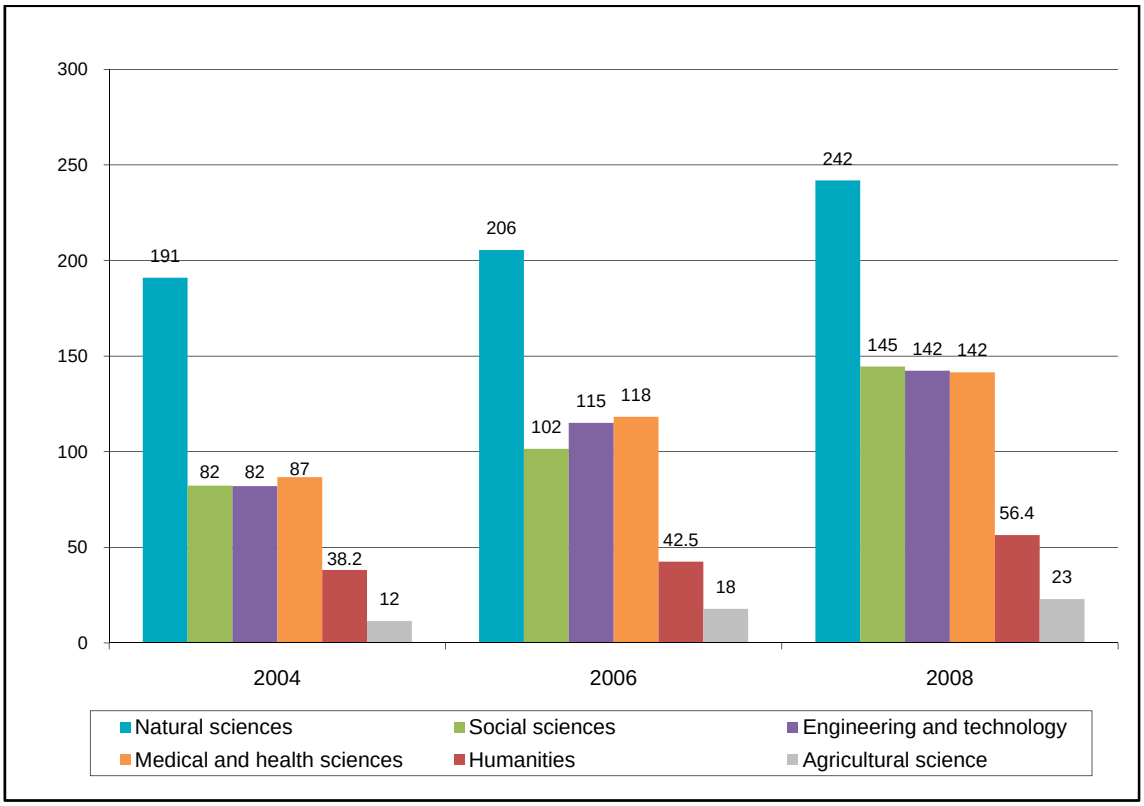
Field of Science	Direct Sources of Funds			Indirect Government	Total
	Irish Public Research	EU	Industry and Other		
Natural Sciences	155.1	13.8	21.8	50.3	240.9
Engineering and Technology	93.9	11.8	11.3	26.3	143.3
Medical and Health Sciences	74.4	3.9	16.8	46.4	141.6
Agricultural Sciences	12.7	1.1	0.8	8.3	22.9
Social Sciences	54.0	14.6	19.0	57.0	144.6
Humanities	15.1	0.9	9.5	30.9	56.4
Total	405.2	46.1	79.2	219.3	749.7

Source: Forfás Data

Chapter 4: HERD Expenditure by Field of Science

This chapter examines R&D expenditure in the higher education sector more closely by breaking the expenditure down by fields of science. Fields of science classifications are produced by the OECD to be used by member countries for international comparison purposes. The major OECD fields of science include: natural sciences; engineering and technology; medical and health sciences; agricultural sciences; social sciences and humanities. The fields of science were revised in 2006 to reflect changes in science and technology such as the emergence of technology fields such as ICT, biotechnology and nanotechnology. While the fields of science allow us to follow trends in key research areas the production of the new classification in 2006 doesn't allow for comparison with previous HERD surveys. Consequently the old field of science classifications are used in this chapter to allow for an examination of meaningful trends over time.

Figure 13: Higher education expenditure on R&D by Field of Science in current prices (€millions), 2002-2006

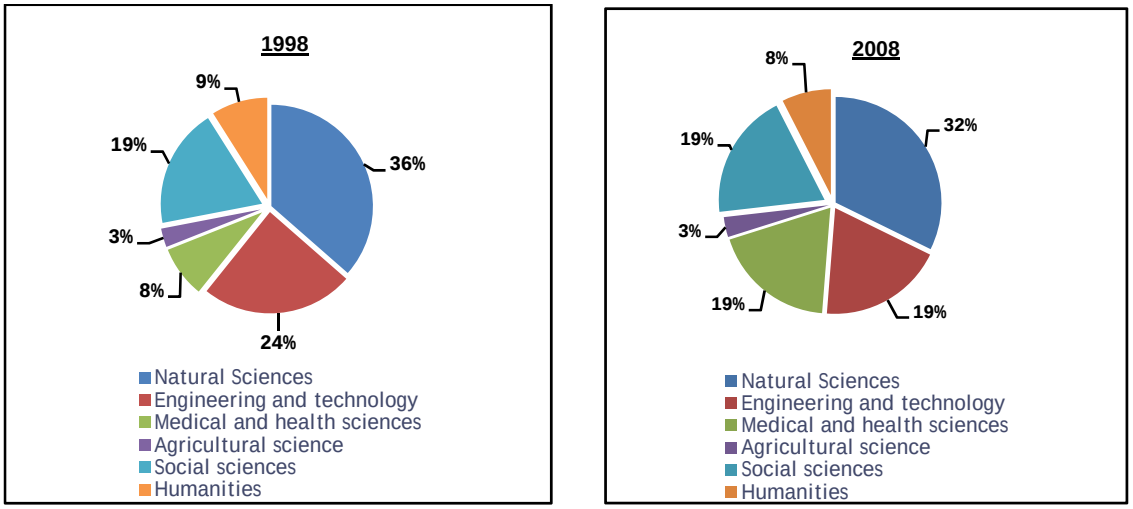


Source: Forfás Data

- Figure 13 shows that the largest proportion of R&D spend was in the field of natural sciences in 2004, 2006 and again in 2008. The 2008 figure of €242 million increased by 17% from the 2006 figure which in turn increased by 8% from the 2004 figure. In 2008 expenditure in the field of natural science was 67% greater than expenditure in the area of social sciences, the field of science with the next largest R&D expenditure.

- In turn R&D expenditure in 2008 on social sciences increased by 42% over the 2006 figure and by 77% increase over the 2004 figure of €82 million.
- Expenditure in the fields of engineering & technology and medical & health sciences amounted to approximately €142 million each in 2008. Engineering and technology increased over the two-year period between 2006 and 2008 by €27 million, while the increase in the field of medical & health sciences was €24 million. Engineering & technology gained additional funding of €60 million over the 4 year period since 2004.
- Funding for the humanities field of science increased by 30% between 2006 and 2008 and by 13% between 2004 and 2006.
- The agricultural sciences gained an additional €11 million in research funding in the last 4 years which brought the total amount of R&D funding allocated within this field of science to €23 million in 2008.

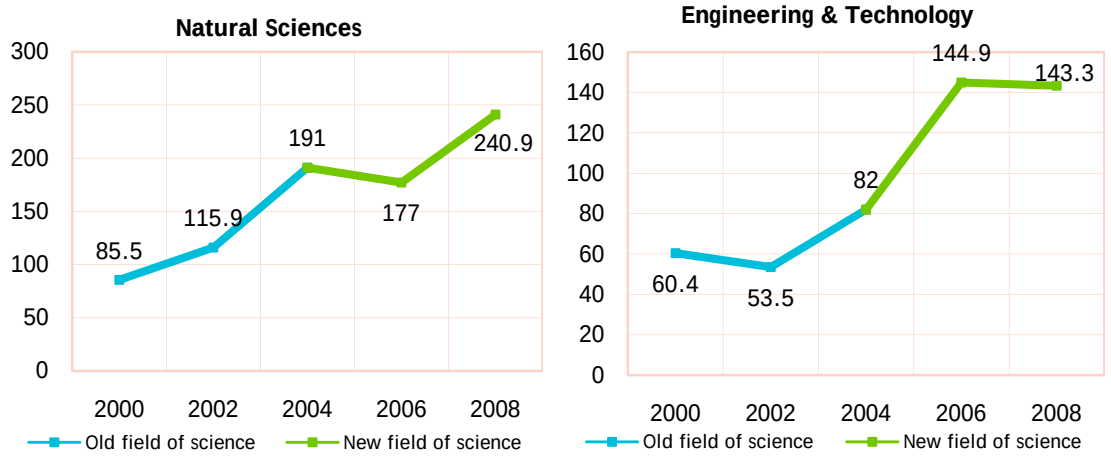
Figure 14: Share of total R&D expenditure by field of science, 1998 and 2008



Source: Forfás Data

Figure 14 above compares the percentage share of total R&D expenditure by the various fields of science in 2008 with the percentage share ten years ago. Generally, most fields of science increased their funding over the last 10 years. However, when compared with 1998 the 2008 percentage shares of the different fields of science have changed somewhat. The natural sciences share has dropped slightly from 37% to 32% in 2008. Engineering & technology academic departments have decreased their share from 24% in 1998 to 19% in 2008. The fields of social science and agricultural science have remained stable while funding for the fields of medical and health sciences has increased as a percentage of the total from just 8% in 1998 to 19% in 2008. Funding ratios for humanities departments decreased slightly in 2008 to 8% from 9% ten years ago.

Figure 15: HERD expenditure on natural sciences and engineering & technology in current prices 2000-2008, (€ millions)



Note: In 2006 the Fields of Science categories were revised by the OECD and new sub-categories added to the original six main fields of science. This resulted in a re-allocation of expenditure between the main fields of science. Consequently, care should be taken when comparing Old and New Fields of Science since 2006.

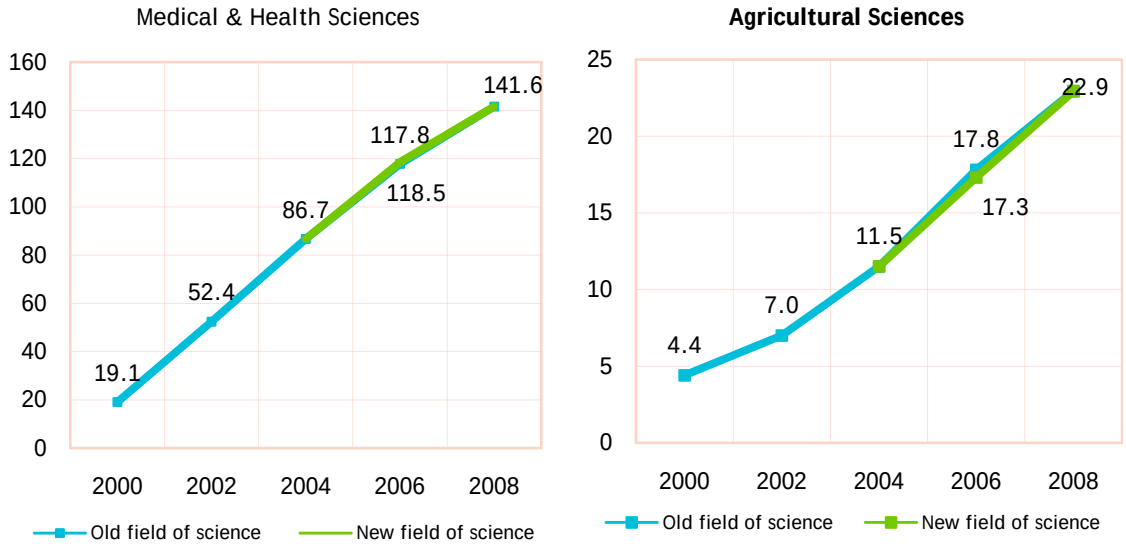
Source: Forfás Data

Natural sciences: The new revised fields of science classifications came into effect in 2006 and the chart above shows the difference in HERD expenditure in the natural sciences area from 2000 to 2008. Expenditure rose from €85.5 million in 2000 to €241 in 2008. The largest increase in expenditure was between 2002 and 2004 when there was an increase of 65% in funding in the area. Using the new field of science classification HERD expenditure in this research area rose by 36% between 2006 and 2008. Breaking down the field of science to the next sub-category (see Appendix 3) shows that the sub-category of biological sciences account for the largest portion of the HERD spend in this category, with 31.4% of total natural sciences funding, in 2008. Computer and information sciences account for 18.2% and mathematics for 11%. Chemical sciences (17%) and earth and related environmental sciences (12.2%) account for substantial portions of funding, with physical sciences and other natural sciences accounting for the remainder.

Engineering and technology: Research funding for the engineering & technology areas increased sharply between 2002 and 2008 after a slight drop initially between 2000 and 2002. Funding more than doubled between 2002 and 2004 in this area. However, the new classification of fields of science shows a very considerable rise of 77% between 2004 and 2006 but a slight drop between 2006 and 2008. Under the new classification the engineering and technology research area has been expanded from three to eleven sub-categories, introducing new categories such as mechanical, chemical, materials, medical, and environmental engineering as well as environmental and industrial biotechnology and nanotechnology. This re-classification means that while the sub-set of electrical, electronic and information engineering retains its 28% share, the 65% previously classified as "other engineering sciences" can now be re-classified more precisely under the new headings. Consequently the new classification of nanotechnology now accounts for 27% of the total, with mechanical engineering and industrial biotechnology both receiving approximately 9%.

Environmental technology and civil engineering receive 6% of the total and the rest is distributed between chemical, materials, medical, environmental and other engineering and technology areas.

Figure 16: HERD expenditure on medical and health sciences in current prices 1998 and 2008, (€ millions)

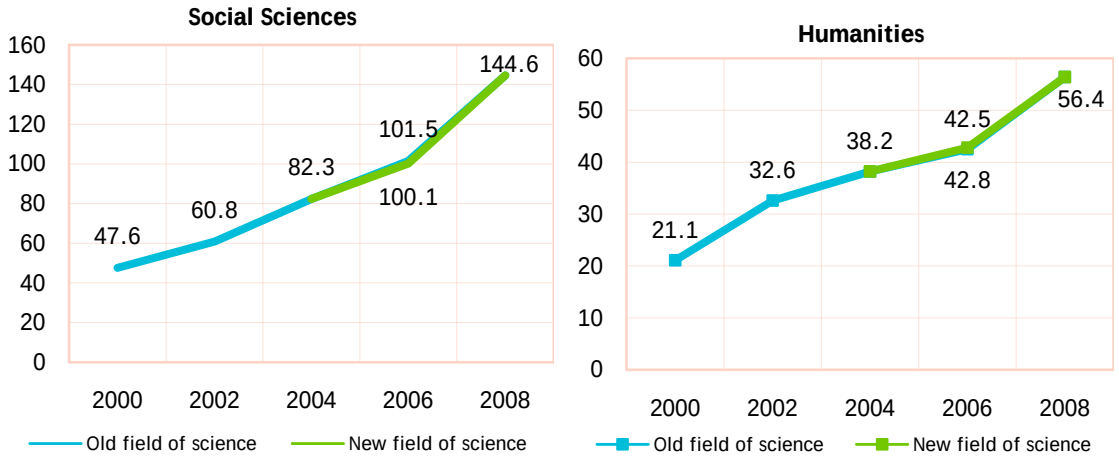


Source: Forfás Data

Medical and health sciences: Funding for the medical and health research areas has increased steadily in the past eight years from €19.1 million in 2000 to €141.6 million in 2008. The sub-categories of health biotechnology and other medical sciences were the only additions in the new field of science re-classification in this area. Consequently, between 2006 and 2008 there was only a very small difference between the old classification and the current one. Funding almost tripled between 2000 and 2002 and continued rising with percentage increases of 65% between 2002 and 2004 and 35% between 2004 and 2006. Almost half of all research funding in the medical sciences area is performed by departments operating within the sub-category of basic medicine. Clinical medicine and health sciences account for 27% and 23% respectively with small amounts divided between health biotechnology and other medical sciences.

Agricultural sciences: Between 2000 and 2002 agricultural science more than doubled its share of HERD funding. This trend continued in the following four years between 2002 and 2006, with funding reaching €17.8 million from €7 million in 2002. In 2008 funding for agricultural science increased by a further 29% to reach €22.9 million by 2008. As with the medical and health sciences, the re-classification of the agricultural sciences sub-categories made little difference to the area. 88% of total funding in this area goes to the sub-category of animal and dairy science, with veterinary science and agriculture, forestry and fisheries accounting for the remaining 12%.

Figure 17: HERD expenditure on social sciences and humanities in current prices 1998 and 2008, (€ millions)



Source: Forfás Data

Social sciences: Expenditure in this field of science has increased steadily since 2000 with the largest increase occurring between 2006 and 2008 when spending in the field increased by 43%. Using the new field of science classifications**,** there was a 45% increase in funding over this period. In the two-year period between 2002 and 2004 funding in the social sciences area increased by 35%**,** while increases between 2000-2002 and 2004-2006 were 28% and 23% respectively. Educational sciences and economics & business together account for over half of the R&D expenditure in the area of social sciences in 2008. The remaining 41% is divided between other social science areas with the largest proportion being spent in the areas of social & economic geography, sociology and psychology.

Humanities: Between 2000 and 2002 R&D spending more than doubled in the humanities field of science. Spending rose only slightly in the following two-year period, while growth in the four years between 2004 and 2008 increased by 44%, with most of that growth (33%) taking place between 2004 and 2008.The languages and literature sub-category of the humanities field of science utilises over 60% of all R&D funding in this area. History and archaeology is the next largest area at 18%, while philosophy, the arts and other humanities make up the remaining 22%.

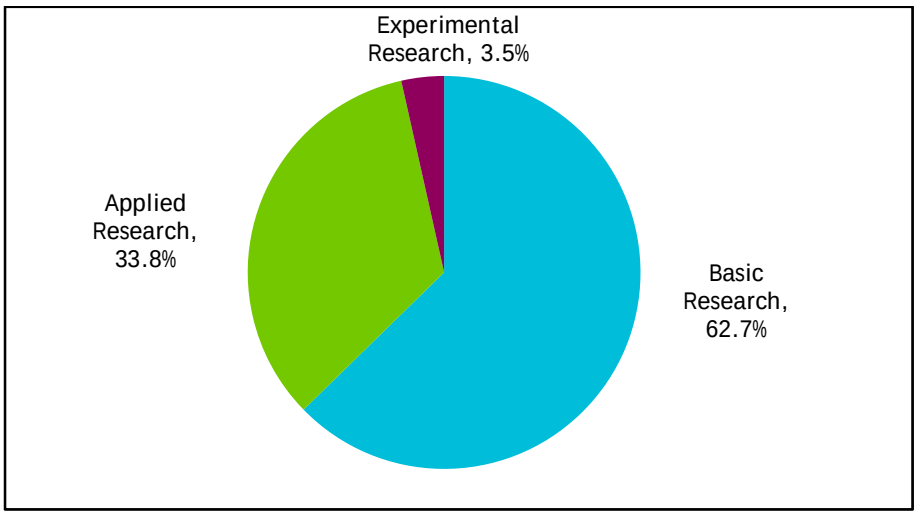
Chapter 5: Types of research

To ascertain the type of research undertaken by the universities and the institutes of technology, participants were asked to classify the type of research they undertake for any particular research programme. The three types of research as defined in the OECD's Frascati Manual are as follows:

- **"Basic research is** experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.
- **Applied research** is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or object.
- **Experimental development** is systematic work, drawing on knowledge gained from research and practical experience that is directed to producing new materials, products and devices; to installing new processes, systems and services; or to improving substantially those already produced or installed."[7]

Figure 18 below divides expenditure on R&D in the higher education sector by research type for 2008. As in previous years the type of research most commonly undertaken in this sector is basic research. Basic research accounted for 62.7% of all research undertaken in 2008 mainly funded via SFI programmes. Universities and institutes of technology spent 33.5% of the total HERD budget on applied research activities while experimental research only accounted for 3.5% of the budget. Basic research increased its percentage share of the total HERD budget in 2008 by 7.6% percent over its share in 2006. The amount of applied research undertaken fell in 2008 by 2.7% while the percentage share for experimental research reduced by 4.9%.

Figure 18: Percentage of total HERD budget by research type, 2008 (Total = €750m)

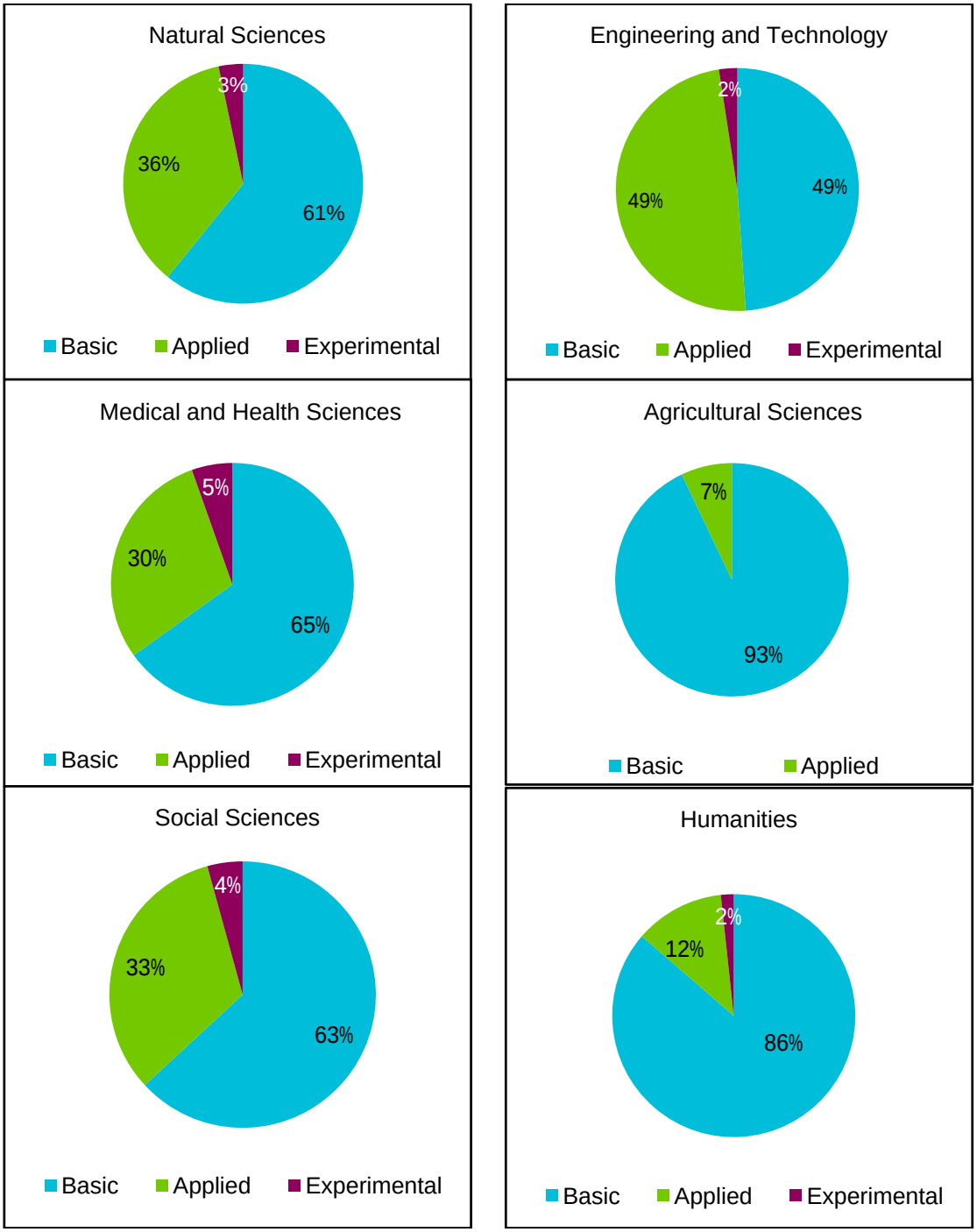


Source: Forfás Data

[7] Frascati Manual - Proposed Standard Practice for Surveys on Research and Experimental Development - OECD, 2002

This is one approach to examining the distribution of R&D expenditure, which is self reported by researchers. Forfás also undertook an analysis[8] based on the classification of funding by research funding agencies and the breakdown of funding for basic research within the Higher Education sector was in the range of 50%-60% and for applied research in the range of 32%-50%.

Figure 19: Type of research carried out by Field of Science, 2008



Source: Forfás Data

8 Categorisation of State Expenditure on R&D according to research type - Forfás

Figure 19 over shows the percentage of the HERD budget by type of research and by field of science for 2008.

Basic research: The largest percentage of the HERD budget allocated to basic research in 2008 was in the field of agricultural science with a 93 percentage share. All the other fields of science allocated considerable percentages of their HERD budget to basic research, with percentage shares ranging from 86% in humanities, to 65% in the medical and health science field, 63% in the fields of social science, 61% in natural science and 49% in engineering and technology.

Applied research: the percentage of the HERD budget allocated to the natural sciences, medical and health sciences and social sciences are similar with percentage shares of 36%, 30% and 33% respectively. The engineering and technology field of science has the largest share of applied science with 49% of the total. Humanities and agricultural science both have a small share with 12% and 7% respectively.

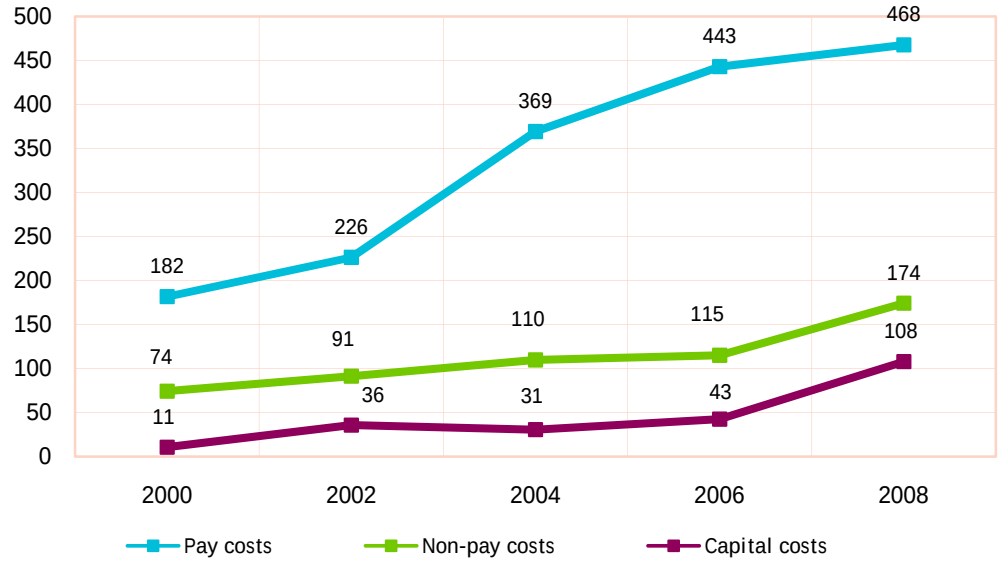
Experimental research: Only small amounts of experimental research were undertaken by the universities and the institutes of technology in all fields of science. The percentage shares range from 5% in the field of medical and health sciences to 2% in engineering and technology and humanities.

Chapter 6: Type of Costs

The type of research costs incurred by the universities and institutes of technology were examined in detail in the HERD survey. These research costs are broken into three types of costs as defined in the Frascati Manual[9] as follows:

- Pay (or labour) costs ".. comprise annual wages and salaries and all associated costs or fringe benefits, such as bonus payments, holiday pay, contributions to pension funds and other social security payments, payroll taxes, etc."
- Non-pay (or other current) costs " ..comprise non-capital purchases of materials, supplies and equipment to support R&D performed by the statistical unit in a given year."
- "Capital expenditures are the annual gross expenditures on fixed assets used in the R&D programmes of statistical units."They are calculated by assessing how much of the capital asset is utilised for research purposes. For example, the institution will assess the percentage of a building's floor space utilised in undertaking research. If 10% of the floor space is used for R&D, then 10% of the building's value will be included in capital costs.

Figure 20: Distribution of research spend by type of costs, 2000-2008 (€ million)



Source: Forfás Data

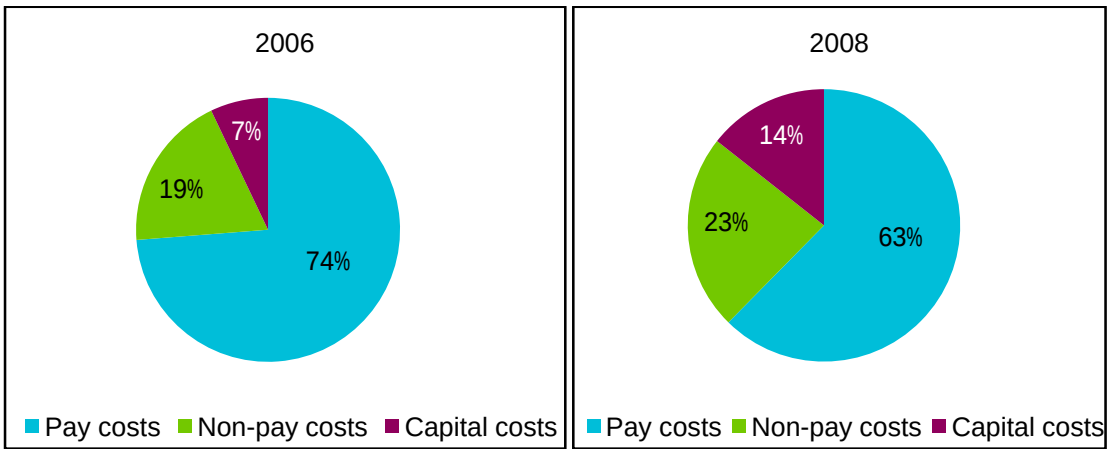
Figure 20 shows most R&D spending goes towards labour costs. In 2008 labour or pay costs amounted to €468 million, an increase of 5.6% over the 2006 figure of €443 million.

[9] Frascati Manual - Proposed Standard Practice for Surveys on Research and Experimental Development - OECD 2002

The largest increase in non-pay costs was between 2006 and 2008 with a 51% increase between the 2006 figure of €115 million and the 2008 expenditure of €174 million. Between 2000-2002 and 2002-2004 there were percentage increases of 23% and 21% respectively, while non-pay costs increased by 5% between 2004 and 2006.

Capital expenditure on R&D is usually focused on the acquisition of land, buildings and equipment. After a large increase in capital expenditure on R&D between 2000 and 2002 from €11 million to €36 million, a small drop of 14% was recorded in the following two-year period between 2002 and 2004 reducing from €36 million to €31 million. Between 2004 and 2006 capital R&D costs increased by 39% and continued rising to reach €174 between 2006 and 2008.

Figure 21: Percentage share of type of costs, 2006 and 2008



Source: Forfás Data

Figure 21 above shows the percentage difference broken down by type of cost for 2006 and 2008. While pay costs account for the largest proportion of R&D expenditure by the universities and institutes of technology in both academic years, the proportions have shifted in the two-year period. Pay costs have reduced from 74% of the total in 2006 to 63% of the total in 2008. Both non-pay and capital costs increased their percentage share from 19% to 23% for non-pay and from 7% in 2006 to 14% in 2008 for capital costs.

Table 4 allows a more detailed examination of the three different types of costs broken down by field of science and showing the percentage of the total for each field of science category.

Table 4: Types of costs by new fields of science, 2008 (€ million)

	Pay Costs €m.	% of Total	Non-pay Costs €m.	% of Total	Capital Costs €m.	% of Total	Total €m.
Natural Sciences	145	59%	56	23%	43	18%	244
Engineering and Technology	83	57%	33	23%	29	20%	145
Medical and Health Sciences	92	60%	39	25%	22	15%	153
Agricultural Sciences	14	61%	9	38%	0	1%	23
Social Sciences	92	68%	32	23%	12	9%	136
Humanities	42	85%	5	11%	2	4%	49
Total	**468**	**63%**	**174**	**23%**	**108**	**14%**	**750**

Source: Forfás Data

As in previous years pay costs account not only for the largest proportion of the R&D costs generally, but within each field of science, without exception, pay costs account for the largest percentage of the total R&D spend with percentages ranging from 85% for humanities to 57% for engineering and technology.

Pay costs in the field of natural sciences account for 59% of total costs, non-pay costs for 23% and capital costs for 18%. The total costs in the field of engineering and technology can be divided between 57% of the total for pay costs, 23% for non-pay costs and 20% for capital costs. Humanities pay costs account for 85% of their total while non-pay costs and capital only account for 11% and 4% respectively of the total.

Agricultural science has the lowest expenditure on both capital and non-pay at €2 million and €5 million respectively, which represent only 4% and 11% of its total expenditure.

The fields of medical and health sciences spend 60% of their total costs on pay, with 25% on non-pay and 15% on capital. Similarly a large proportion of expenditure in the social sciences area is taken up by pay costs (68%), with non-pay costs accounting for 23% of total social science expenditure and capital costs accounting for just 9%.

Appendix 1: Methodology

The survey was carried out following the OECD Frascati Manual (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 2008 academic year (Sep 2007 to Sep 2008).

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

1. An analysis of financial data from each institution;
2. An analysis of personnel data and time-use data based on the amount of research per person employed from each institution.

The coverage included all academic departments in seven universities*, thirteen institutes of technology** and the Royal College of Surgeons 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, Cork IT, Dublin IT, Dundalk IT, Galway-Mayo IT, Letterkenny IT, Limerick IT, Waterford IT, IT Blanchardstown, IT Carlow, IT Sligo IT Tallaght and IT Tralee.*

Questionnaires were sent out at the end of October 2009 to the various colleges and institutes. There was intensive follow-up of non-respondents by telephone from mid November 2009 until mid February 2010 when final outstanding information was received. A full response rate was achieved for the financial and personnel parts of the survey.

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 research academic staff and research support staff. In order to calculate full-time equivalent totals the percentage of time spent on research was also obtained. In addition, the headcounts were split between male and female to allow gender comparisons.

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 as 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:** X
Personal research	Teaching
Team research	General Admin
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 admin and planning	

Appendix 2: Acronyms

EI	Enterprise Ireland
EU	European Union
FOS	Field of Science
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
HRB	Health Research Board
IRCHSS	Irish Research Council for Humanities and Social Sciences
IRCSET	Irish Research Council for Science, Engineering and Technology
OECD	Organisation for Economic Co-operation and Development
PRTLI	Programme for Research in Third Level Institutes
R&D	Research and Development
SFI	Science Foundation Ireland

Appendix 3: Detailed Fields of Science Table

Table 5: Total HERD expenditure by old and new Fields of Science, 2008 (€ millions)

	Old - Fields of Science	€m	New - Fields of Science	€m
Natural Sciences	Mathematics and computer sciences	70.0	Mathematics	26.6
			Computer and information sciences	44.0
	Physical sciences	22.1	Physical sciences	20.5
	Chemical sciences	38.7	Chemical sciences	41.2
	Earth and related environmental sciences	32.0	Earth and related environmental sciences	29.5
	Biological sciences	79.2	Biological sciences	75.6
			Other natural sciences	3.6
		241.9		**240.9**
Engineering and Technology	Civil engineering	8.8	Civil engineering	9.7
	Electrical, electronic and information engineering	40.5	Electrical, electronic and information engineering	40.5
	Other engineering and technologies	93.1	Mechanical engineering	13.6
			Chemical engineering	0.6
			Materials engineering	4.5
			Medical engineering	0.2
			Environmental engineering	2.9
			Environmental biotechnology	9.2
			Industrial biotechnology	13.1
			Nanotechnology	38.9
			Other engineering and technologies	10.0
		142.4		**143.3**
Medical and Health Sciences	Basic medicine	64.5	Basic medicine	64.5
	Clinical medicine	37.8	Clinical medicine	37.8

	Health sciences	39.3	Health sciences	32.9
			Health biotechnology	1.7
			Other medical sciences	4.6
		141.6		**141.6**
Agricultural Sciences	Agriculture, forestry, fisheries and allied sciences	1.0	Agriculture, forestry and fisheries	1.0
	Veterinary medicine	22.0	Animal and dairy science	20.3
			Veterinary science	1.7
			Agricultural biotechnology	0.0
			Other agricultural sciences	0.0
		22.9		22.9
Social Sciences	Psychology	8.8	Psychology	8.8
	Economics and business	41.5	Economics and business	41.3
	Educational sciences	44.2	Educational sciences	44.5
	Other social sciences	50.0	Sociology	12.7
			Law	7.6
			Political science	3.2
			Social and economic geography	13.6
			Media and communications	7.7
			Other social sciences	5.0
		144.6		144.6
Humanities	History	9.9	History and archaeology	9.9
	Languages and literature	33.9	Languages and literature	33.9
	Other humanities	12.6	Philosophy, ethics and religion	3.0
			Art (arts, history of arts, performing arts, music)	4.1
			Other humanities	5.5
		56.4		56.4
	Totals	**749.8**		**749.8**

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