The Higher Education R&D Survey 2006 (HERD)

Detailed findings

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Forfás

Forfás

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Contents

List of Charts

List of Tables

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.

The Strategy for Science, Technology and Innovation outlined a roadmap for these increased S&T investments in the period 2006 to 2013. The vision and challenge of the strategy is that; "Ireland by 2013 will be internationally renowned for the excellence of its research, and will be to the forefront in generating and using new knowledge for economic and social progress, within an innovation driven culture".

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 2005/2006 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 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. This data feeds 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 OECD in the Frascati Manual. Appendix 1 of this publication provides more methodological details.

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Executive Summary

Over recent years Ireland has made considerable progress towards becoming a more knowledge based economy. Latest data and analysis from the survey of research and development (R&D) activities performed in the higher education sector (HERD) confirm these upward trends in the period 2005-2006. Forfas also carries out surveys in both business performed R&D (BERD) and government performed R&D (GOVERD), and these findings have also been positive. The 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. Continued investment in these areas will be crucial if Ireland is to create the vision outlined in the Government's strategy by 2013.

Total expenditure and human resources devoted to research activities performed in the higher education sector is measured on a bi-annual basis by Forfás. The survey methodology is underpinned by the international rules laid out in the OECD's Frascati Manual. This report is a summary of the information gathered in that survey. The higher education R&D sector includes universities, institutes of technology and some other technology centres which perform R&D activities.

The main findings of the HERD 2006 survey are as follows:

R&D expenditure:

- Overall R&D expenditure performed in this sector has almost quadrupled over the period 1996-2006 in current spending terms.
- From 1998 to 2000 the increase was 16.6% and from 2000 onwards the growth trend began to accelerate. During 2000 to 2002 there was a 35% increase. The percentage increase during the period 2002 to 2004 was a substantial 52.8%, underpinned by new funding investments from the public side via Science Foundation Ireland, the Program for Research for Third Level Institutes and others.
- Since 2004 the growth trend has begun to ease, with a still strong 22% upturn in HERD spending since the previous survey in 2004.
- Universities continue to dominate the funding allocated for R&D in this sector, accounting for 94.7% of the total spending in 2006. The R&D expenditure of universities has more than trebled since 1998, from €169 million to €568 million. Between 2004 and 2006 the rate of growth of R&D expenditure in universities was 23.1% (11.1% average per annum increase).
- Following some catch up between 2000 and 2002, the previous intensity gap between Ireland and EU-25 closed rapidly as a result of the significant increases in R&D spending in the Irish higher education sector. 2006 saw the HERD spending intensity ratio for Ireland, continue to stand at 0.40% of GNP, (it currently equals the EU-25 average).

Table 1: Ireland's main HERD indicators, 2000–2006

	2000	2002	2004	2006
Higher education expenditure on R&D, (€ millions)	238	322	492	601.4
HERD as a % of GNP (Ireland)	0.27%	0.31%	0.40%	0.40%
HERD as a % of GDP (EU-25 average)	0.37%	0.40%	0.39%	0.40%
Ireland's rank among 29 OECD countries	22nd	19th	16th	14th
Total researchers in the HE sector (FTE)	2148	2695	4152	4689
HE Researchers per 1000 labour force (Ireland)	1.2	1.5	2.2	2.2
Ireland's rank among 29 OECD countries	24th	23rd	14th	13th

Source: Forfas Data and OECD, Main Science and Technology Indicators, October 2007

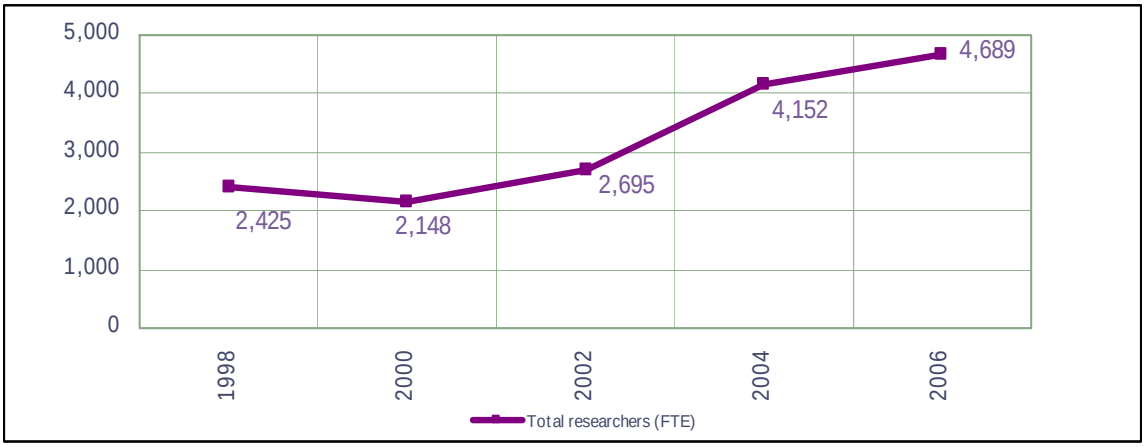
Human resources dedicated to higher education R&D activities:

- The total number engaged in research in the higher education sector increased from 8933 in 2004 to 10072 to 2006. Total research personnel[1] increased from 12175 in 2004 to 14863.
- The total number of HERD full time equivalent (FTE – adjusted for time spent solely on R&D activities)[2] researchers rose from 4152 in 2004 to 4689 in 2006, an increase of 12.9% over the two year period surveyed.
- FTE research numbers have increased rapidly from 2000 onwards in parallel with the increased funding for R&D activities performed in the higher education institutions.
- The ratio of higher education researchers (FTE) per thousand workers in the labour force has risen steadily from 1.2 in 2000 to 2.2 in 2006, placing Ireland in mid-table regarding international performance.
- The overall increase in FTE researcher numbers between 2004 and 2006 was driven by strong increases in the research assistant and PhD fellow grades (post-docs).
- At 1398, the majority of researchers are employed in the field of natural science, with engineering and technology coming in second at 1108, then medical and health sciences.
- FTE researchers in the humanities and social sciences accounted for 26.7% of the total in 2007.

[1] Total research personnel = total researchers + total research support staff

[2] 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 FTE's

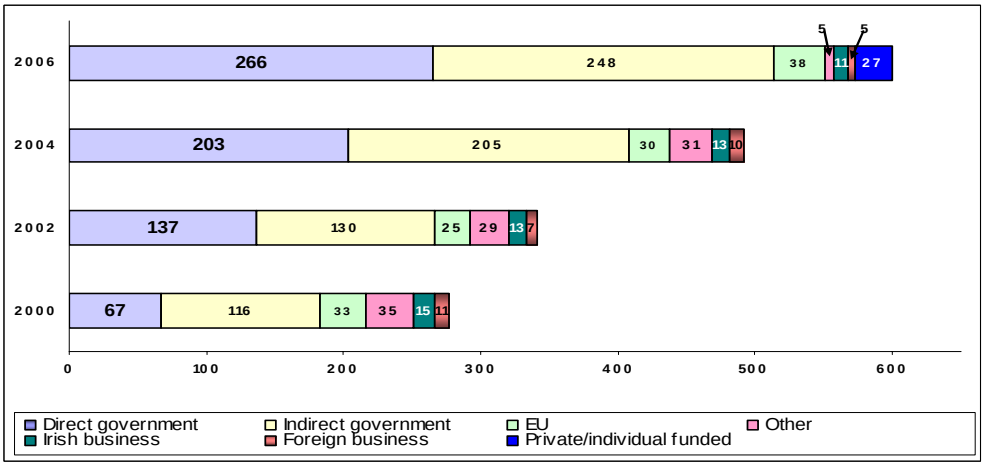
Figure 6: Total researchers employed in the higher education sector, (FTE), 1998-2006



Sources of funding for higher education performed R&D activities:

- At 44% the majority of R&D funding for third level institutes comes from direct government sources. Funding is channelled through agencies such as the Science Foundation of Ireland (SFI), Enterprise Ireland (EI), and the Programme for Research in Third Level Institutes (PRTLI).
- The other main source of funding is the Higher Education Authority (HEA) block grant[3]. This indirect source of funds accounts for 41.2% of HERD funding. The indirect source of government finance is allocated exclusively to the state universities.

Figure 10: Sources of research funding in current prices, (€ millions), 2000 – 2006

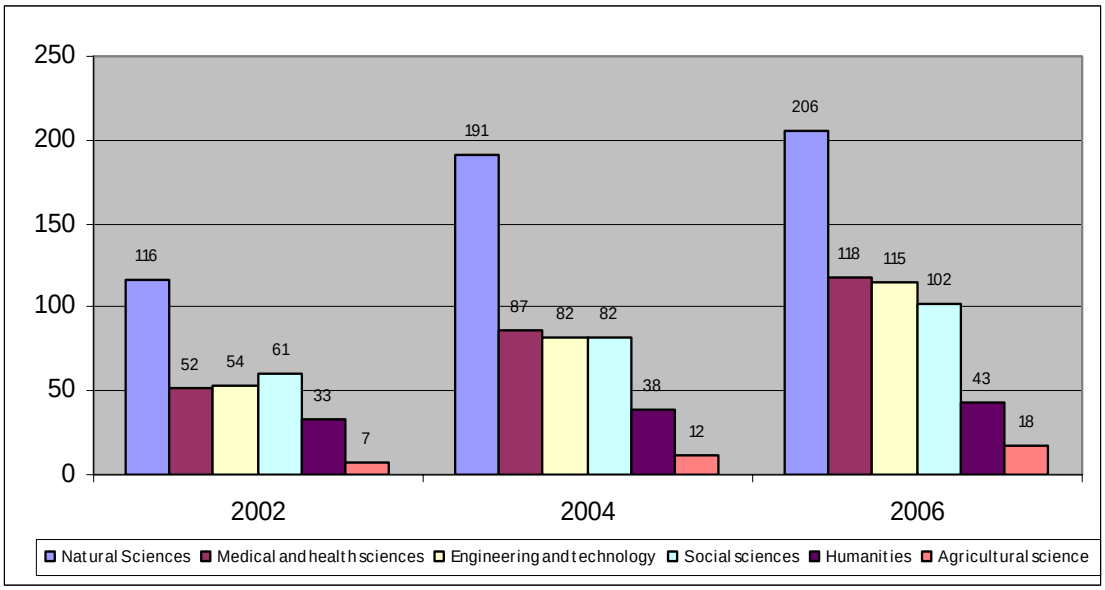


[3] This is funding allocated to the universities on behalf of the Higher Education Authority. The amount attributable to R&D is decided by calculating the amount of research being undertaken at the institute.

Higher education R&D activities by fields of science:

- The natural sciences remain the field which accounts for the largest proportion of the higher education R&D spend. Expenditure in this area has risen from €115.9 million in 2002 to €205.5 million in 2006. This is a 77.3% increase in the funding of natural science research over 6 years.
- The medical and health sciences gained an additional €65.9 million in research funding in the last 6 years which has brought the total amount of R&D funding allocated within this field of science to €118.3 million.
- Engineering and technology departments also continued to grow in importance across the higher education research system, with funding rising from €53.5 million in 2002 to €115.1 million in 2006. There was a 53% increase in R&D performed across these fields of science between 2002 and 2004, while a 40% increase was experienced from 2004 to 2006.
- The remaining fields have all enjoyed modest increases, with the lowest increases being seen in the humanities. In 2002 and 2004 the humanities received €32.5 million and €38.2 million respectively. This figure increased by €4.3 million in 2006 to reach €42.5 million.

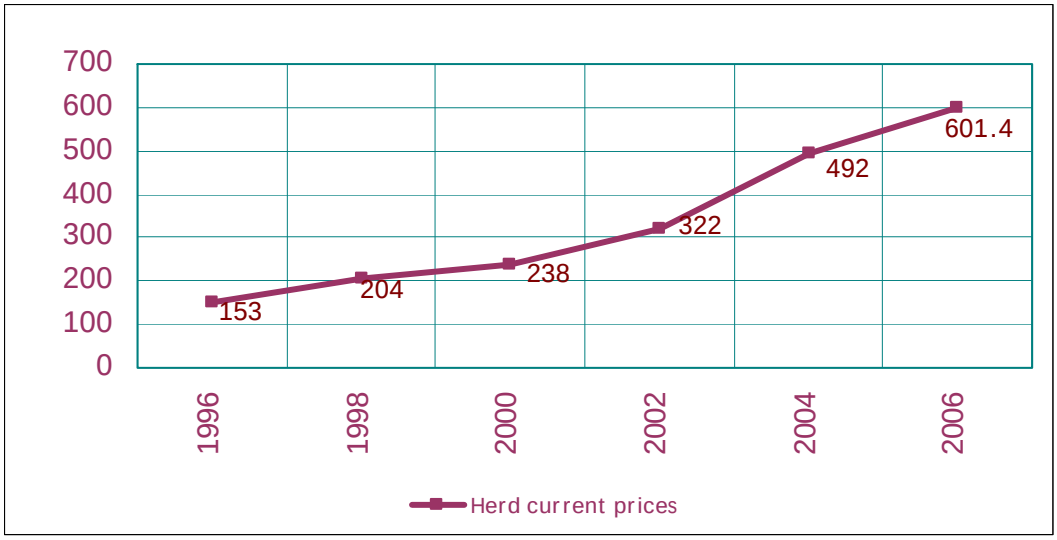
Figure 13: Higher education expenditure on R&D by old field of science in current prices, (€ millions), 2002-2006



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

Total expenditure dedicated to research and development (R&D) activities in Ireland's third level institutes continued to grow strongly during the period 2004 to 2006. In 2006 spending on R&D performed in this sector reached €601.4 million, an increase of 22% in current terms, (18% in constant terms) compared to the previous two years. The graph below shows the trend in higher education R&D since 1996 in current price terms. This R&D spending data was collected using the common international definitions and statistical rules outlined in the OECD Frascati Manual. It was collected from the accounts and research departments of all R&D performing higher education institutions.

Figure 1: Trend in HERD expenditure, 1996 – 2006, in current prices, (€ million)

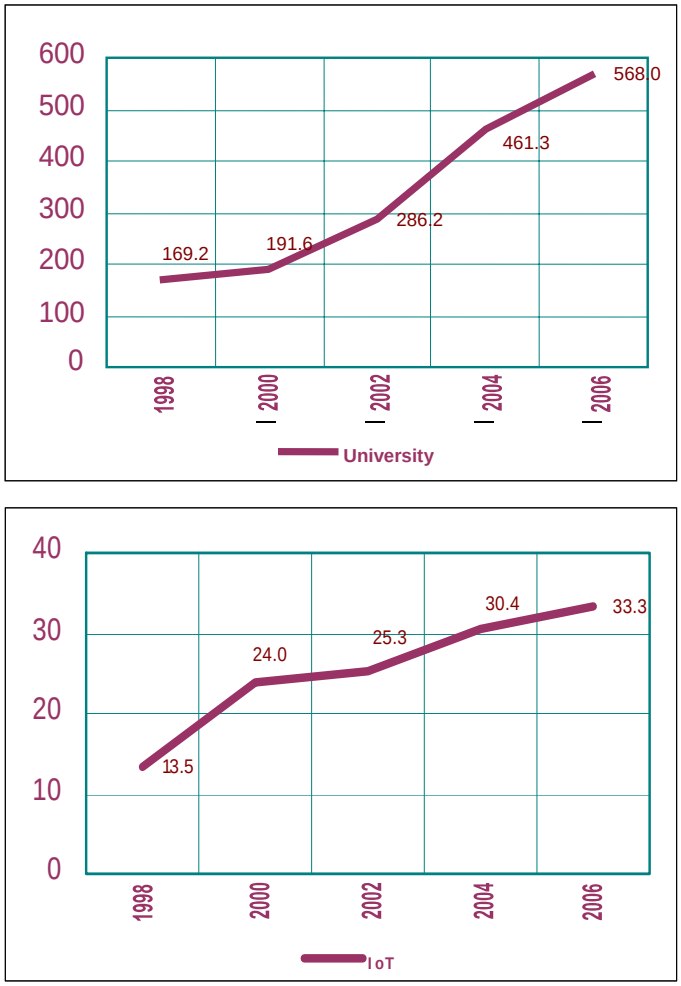


Source: Forfas Data

As can be seen in Figure 1, higher education R&D expenditure has been moving upwards steadily over the past ten years. Overall R&D spending performed in this sector has nearly quadrupled in this period in current spending terms. From 1998 to 2000 the increase was 16.6%, and from 2000 onwards the growth trend began to accelerate. From 2000 to 2002 there was a 35% increase. The percentage increase during the period 2002 to 2004 was 52.8%, underpinned by new funding investments from the public side via the Science Foundation Ireland (SFI), the Programme for Research in Third Level Institutes, (PRTLI) and others. Since 2004 the growth trend has slowed, with a still strong 22% upturn in HERD spending since the previous survey in 2004.

Figure 2 shows expenditure on R&D in the higher education sector broken down by type of institute. Institutes are classified further in the HERD survey into universities, institutes of technology, and other R&D performing institutes. A full list of institutions covered in the survey and their classification is available in Appendix 1. Similar to other countries, universities continue to dominate the funding allocated for R&D in this sector, accounting for 94.7% of the total spending in 2006. The R&D expenditure of universities has more than trebled since 1998, from €169 million to €568 million. Between 2004 and 2006 the rate of growth of R&D expenditure in universities was 23.1% (11.1% average per annum increase).

Figure 2: Research expenditure at universities and IoTs, 1998 – 2006, (€ millions), in current prices, (scales differ on graphs)[4]



Source: Forfas Data

[4] Total HERD from 1998-2002 does not equate to universities plus IoTs as there were additional amounts for the "Programme in Advanced Technology" during this period.

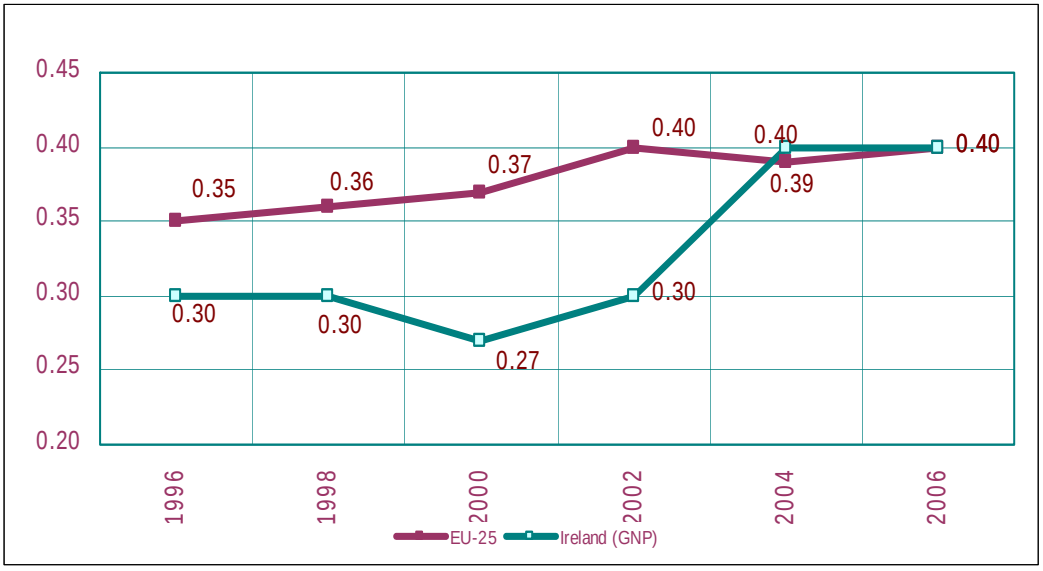
The institutes of technology accounted for 5.5% of total R&D spending in the higher education sector in 2006. Since 1998, R&D spending performed in the IoTs has risen from €13.5 million in 1998 to €33.3 million in 2006. From 1998 to 2000 funding for R&D at IoTs grew by 77.7%. The following two year period saw this trend ease as the rate of funding growth fell to 5.4%. Between 2002 and 2004 the rate of growth in IoT R&D expenditure rose to 20.2%. In 2006 R&D funding for IoTs reached €33.3 million, a 9.5% increase on the amount allocated in 2004.

In order to compare Ireland's overall R&D spending performance in the higher education sector it is necessary to look at it in the context of overall economic activity across a number of countries. The ratio of HERD to economic activity (Gross Domestic Product or Gross National Product) is the common indicator used to carry out this type of international benchmarking analysis. Ireland's Gross Domestic Product (GDP) is almost uniquely inflated due to transfer payments made by large foreign owned multinationals based here. In order to accurately assess levels of economic activity Ireland tends to measure economic activity using the more policy relevant Gross National Product (GNP) figure. In 2006 this figure was 17% less than Ireland's GDP figure during the same period[5].

Figure 3 compares HERD expenditure as a percentage of economic activity in both Ireland and the EU-25. There has been a rapid catch up in the relative performance of HERD spending between 1996 and 2006. From 1996 to 1998, Ireland's spending intensity ratio standing at 0.30% of GNP was below the EU average intensity ratio of 0.36% of GDP. This intensity gap widened in 2000, when Ireland's HERD intensity ratio fell to 0.27% of GNP, below the rising 0.37% of GDP intensity recorded across the EU-25. Following growth between 2000 and 2002, the previous intensity gap between Ireland and the EU-25 closed rapidly as a result of the significant increases in R&D spending in the Irish higher education sector. Between 2004 and 2006 the HERD spending intensity ratio for Ireland, standing at 0.40% of GNP has matched the overall EU-25 average HERD intensity ratio.

[5] www.cso.ie

Figure 3: HERD as a percentage of economic activity, 1996 – 2006, Ireland and the EU



Source: OECD, Main Science and Technology Indicators, October 2007.

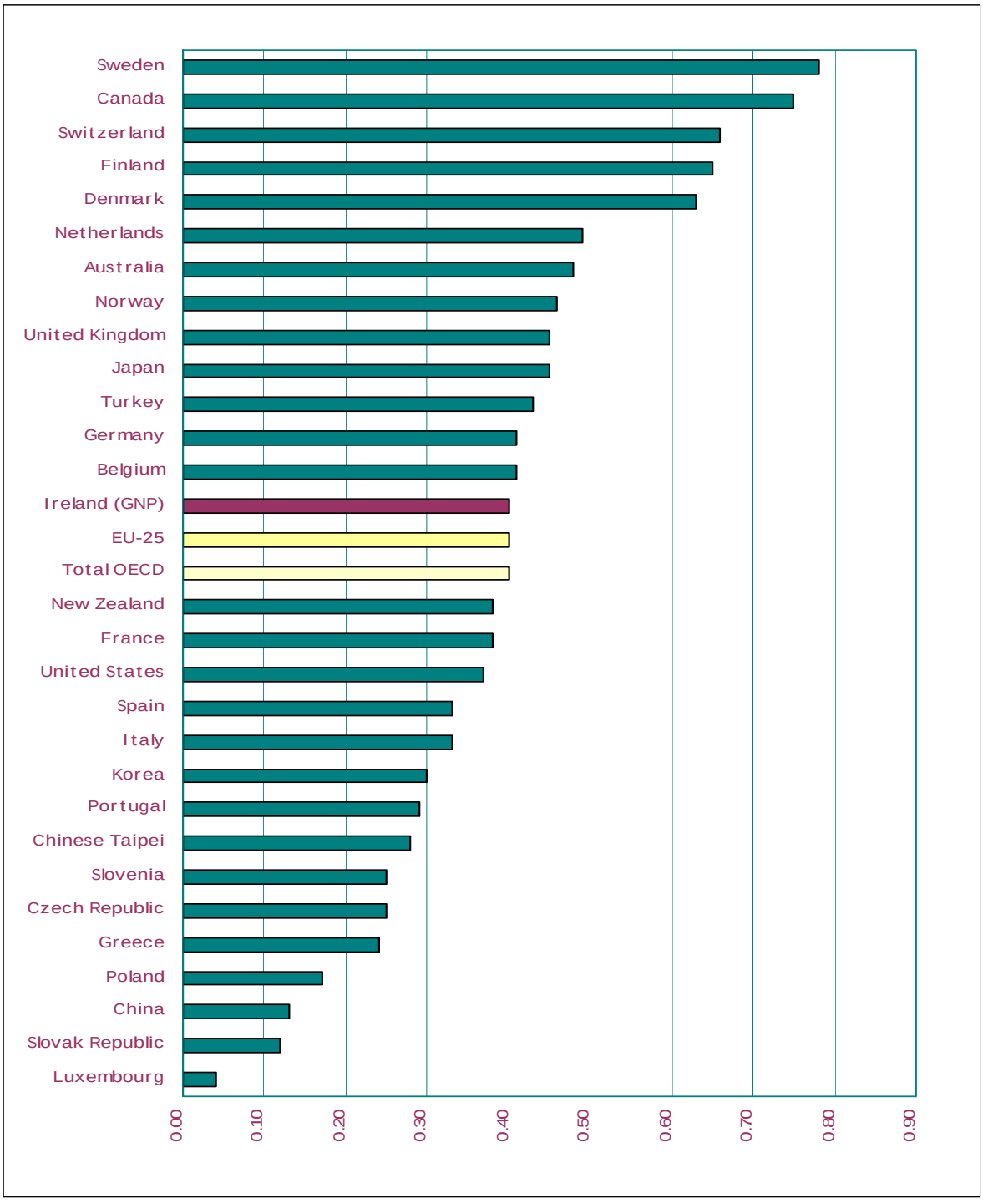
Establishing Ireland's position with respect to other European countries is an integral aspect of the HERD survey. It is important to understand the Irish performance in relation to other developed nations and the level of progress being made in order to meet the objectives set out in the SSTI. By measuring Ireland's performance relative to other OECD states we can gain a clear understanding of Irelands position and progress towards becoming a global centre of research excellence.

Figure 4: Ireland's position on the OECD tables, with respect to HERD as a % of economic activity, 1996-2006

Source: Main Science and Technology Indicators, October 2007.

At present Ireland is ranked 14th of 29 countries benchmarked (Figures 4 and 5) on HERD spending performance. Although there is substantial progress to be made before reaching the top performers such as Sweden, Canada and Switzerland, many gains have been achieved from 2000 onwards in closing the research spending intensity gap. Figure 4 highlights this ranking movement.

Figure 5: HERD as a % of GDP, (2006 or latest available figures)[6]



[6]. Source: OECD, Main Science and Technology Indicators, October 2007. Earliest figures used were recorded by Australia and Switzerland, 2004.

Chapter 2: Human resources allocated to higher education research

The HERD survey as well as gathering data on the cost, expenditures and sources of funding for higher education performed R&D activities, also collects data on the numbers and type of personnel involved in R&D within Ireland's third level institutes. Improving Ireland's stock and flows of knowledge is one of the key challenges in completing the transition to a knowledge economy as envisioned in the recent Science Strategy. In particular Ireland must continue to increase the number of high quality researchers and research personnel employed in the higher education sector, together with the promotion of a strong and relevant learning platform for researchers at student level.

Table 2a shows a break down of the number of researchers by total **headcount**. This includes academic staff, post-doctoral fellows, contract lecturers and research assistants who are judged by responding institutions to be active in research activity. The survey also requested data on research support staff including technicians, administrative/clerical and other support staff, when added to total researchers give the figures for total research personnel. These are examined in Table 2b. Both tables demonstrate a marked increase on the 2004 figures, (with total researchers increasing from 8933 in 2004 to 10072, and total research personnel increasing from 12175 in 2004 to 14863.)

Table 2a: Total researchers analysed by performer, 2006, (total headcount)

	Academic staff	Post-doctoral fellows	Contract lecturers	Research assistants	Total researchers
	A	B	C	D	(A+B+C+D)
IoTs	2421	51	301	153	2926
University	3670	1097	955	1424	7146
Total - 2006	**6091**	**1148**	**1256**	**1577**	**10072**
Total - 2004	**5372**	**995**	**1511**	**1056**	**8933**

Source: Forfas Data

Table 2b: Total research personnel analysed by performer, 2006, (total headcount)

	Total researchers	Technicians	Admin staff	Other staff	Total research personnel
	E	F	G	H	(E+F+G+H)
IoTs	2926	240	520	238	3924
University	7146	854	2174	765	10939
Total - 2006	**10072**	**1094**	**2694**	**1003**	**14863**
Total - 2004	**8933**	**1133**	**1590**	**519**	**12175**

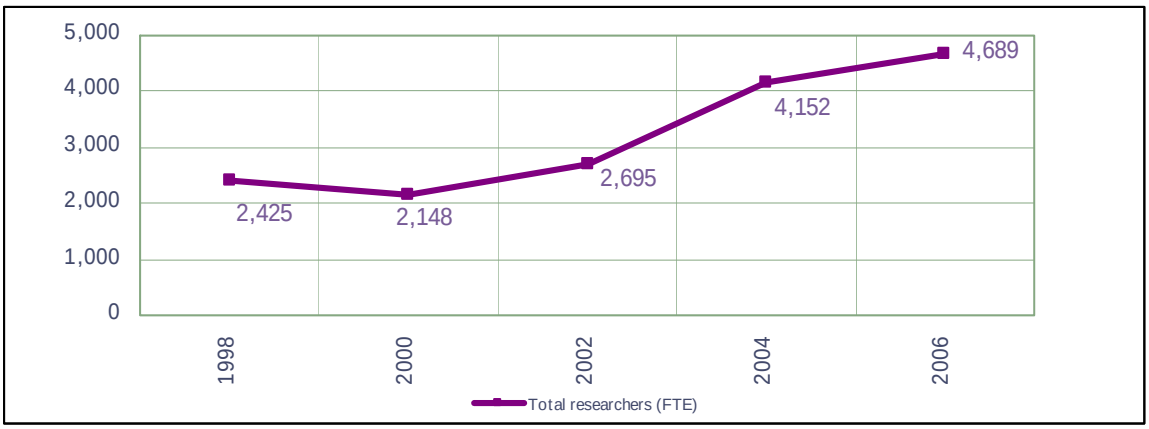
Source: Forfas Data

In addition to obtaining the data on the total number of personnel the 2006 survey also examines the percentage of time spent on research through an analysis of **full-time equivalents (FTEs)**.

Whilst headcount data is an important variable to measure it does not give a full picture of the actual time spent on research by people who have other responsibilities in their jobs as well as their research activities. The HERD questionnaire asks the human resource manager or head of research to estimate the time spent on R&D activities of their research teams, which allows for conversion from headcount to full-time equivalence.

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 FTE's. After an initial decline from 1998 to 2000 the FTE researcher trend has moved rapidly upwards, (see Figure 6). The total number of FTE research personnel increased by 13% from 2004 to 2006. This increase in FTE research personnel numbers is driven both by an increase of researchers in headcount terms and the amount of time each research employee has allotted to purely research related activities.

Figure 6: Total researchers in the higher education sector, 1998 – 2006, (FTE)



Source: Forfas Data

- The total number of HERD FTE researchers rose from 4152 in 2004 to 4689 in 2006.
- This increase was driven by strong rises in FTE researchers in the research assistant and PhD fellow grades between 2004 and 2006.
- At 1398, the majority of researchers are employed in the field of natural science, with engineering and technology coming in second at 1108, followed by the medical and health sciences.
- FTE researchers in the humanities and social sciences accounted for 26.7% of the total in 2006.
- Major changes to the international fields of science classification make year-to-year comparisons difficult. Using old definitions most fields of science saw an increase in FTE researcher numbers between 2004 and 2006.

Table 3a: Researchers by occupation and new field of science in the HE sector, 2006, (FTE's)

	Academic staff	Post-doctoral fellows	Contract lecturers	Research assistants	Total researchers
Field of science	**A**	**B**	**C**	**D**	**(A+B+C+D)**
Natural sciences	449	441	67	441	1398
Engineering and technology	326	290	32	460	1108
Medical and health sciences	265	199	85	271	820
Agricultural sciences	44	26	5	26	101
Social sciences	445	92	92	138	767
Humanities	276	60	39	108	483
Other	6	3	2	1	12
Total - 2006	**1811**	**1111**	**322**	**1445**	**4689**
Total - 2004	**1695**	**964**	**494**	**998**	**4152**

Source: Forfas Data

The total number of FTE research personnel rose from 4841 in 2004 to 5581 in 2006. Alongside the rise in FTE research personnel there has been a parallel increase in FTE support staff. The number of FTE staff in research supporting administrative tasks showed strong increases between 2004 and 2006, with a smaller rise in the numbers of FTE technicians.

Table 3b focuses on FTE research personnel (researchers plus support staff) and shows that the natural sciences account for the majority of research personnel with 1537, (28%) working in this area.

Table 3b: Total research personnel by occupation and new field of science, 2006, (FTEs)

	Total researchers	Technicians	Admin staff	Other	Total research personnel
Field of science	**E**	**F**	**G**	**H**	**(E+F+G+H)**
Natural sciences	1398	96	36	7	1537
Engineering and technology	1108	131	47	2	1288
Medical and health sciences	820	116	66	7	1009
Agricultural sciences	101	40	1	0	142
Social sciences	767	38	73	30	908
Humanities	483	5	26	2	516
Other	12	1	142	26	181
Total - 2006	**4689**	**427**	**391**	**74**	**5581**
Total - 2004	**4152**	**385**	**251**	**53**	**4841**

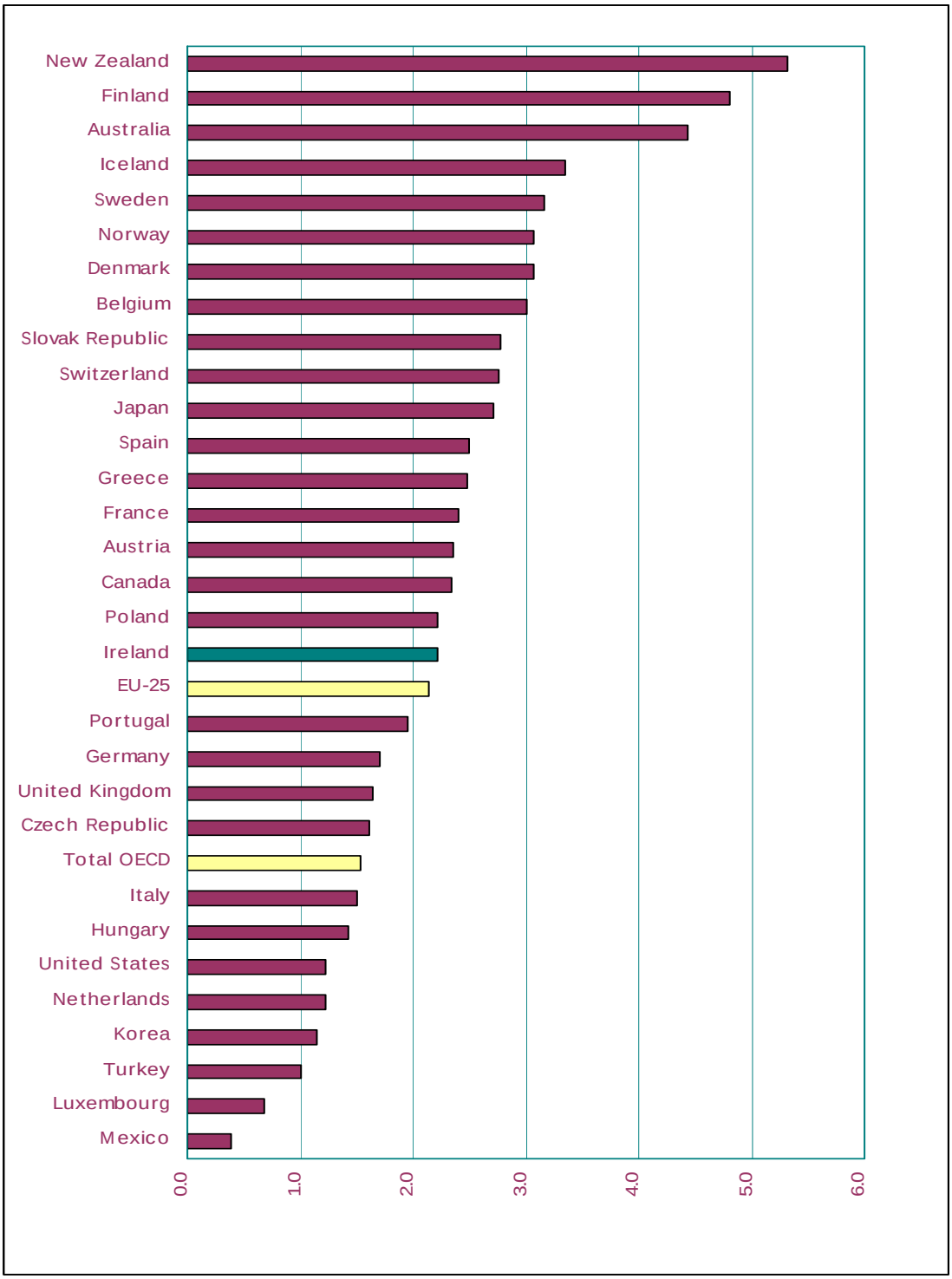
Source: Forfas Data

When compared internationally Ireland performs relatively well. Figure 7 below highlights the increasing numbers of full time researchers working at Ireland's third level institutes since 2000. In 2000 Ireland was ranked 24th of 29 states. By 2006 Ireland has jumped to 13th place. In 2006 it ranked above both the EU 25 and the OECD averages, when researchers per thousand of labour force are examined (Figure 8). The number of female researchers as a percentage of total researchers (Figure 9) ranks Ireland among the highest performing states, 7th of 28.

Figure 7: Ireland's OECD ranking, HE researchers per 1000 of the labour force, (2006 or latest available data)

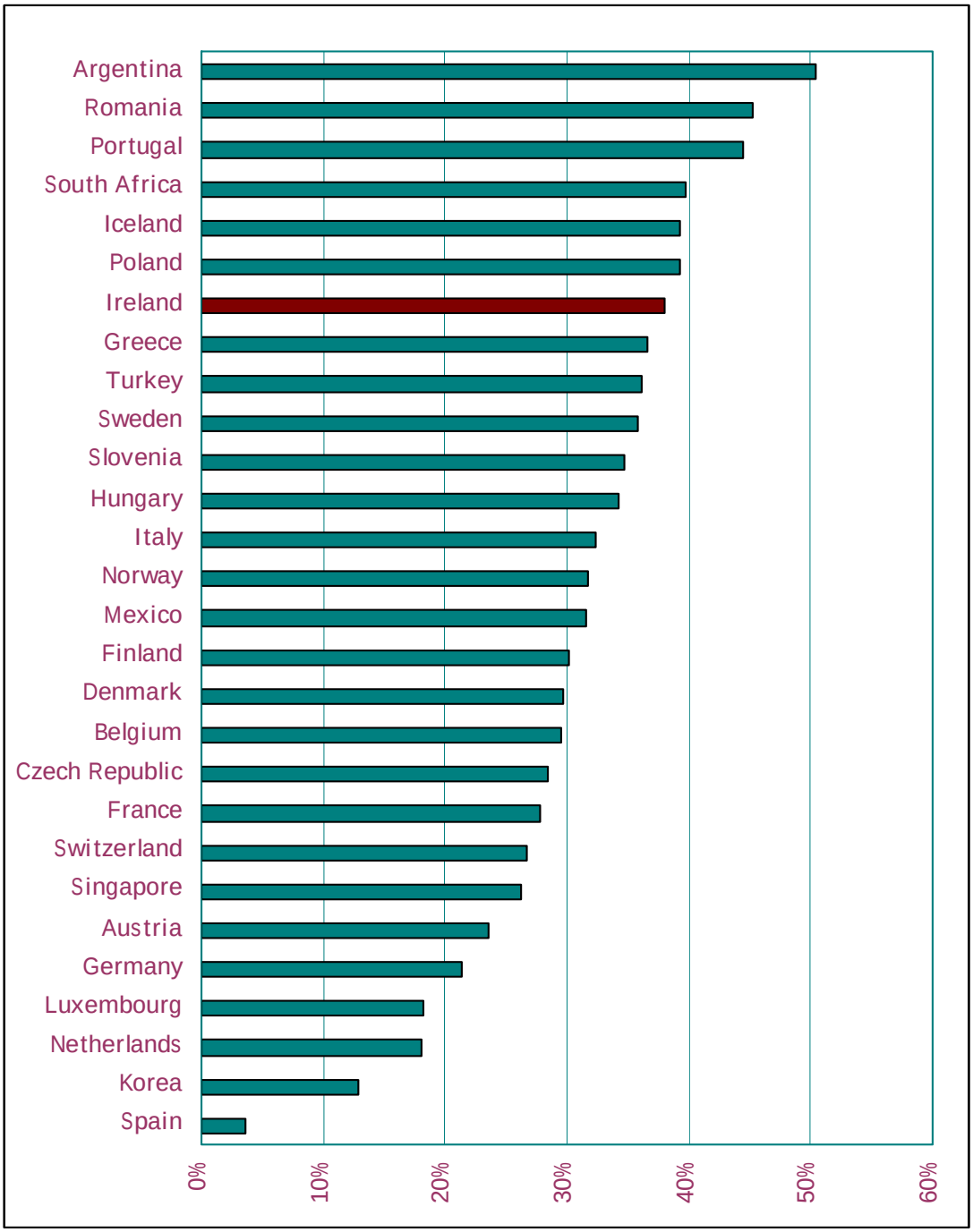
Source: OECD, main Science and Technology Indicators, October 2007

Figure 8: HE researchers per thousand of labour force, (2006 or latest available figures)[7]



[7] Source: OECD, Main science and Technology Indicators, October 2007. Earliest figures used were recorded by New Zealand in 2003.

Figure 9: Female researchers as a % of total researchers, (2006 or latest available figures)[8]

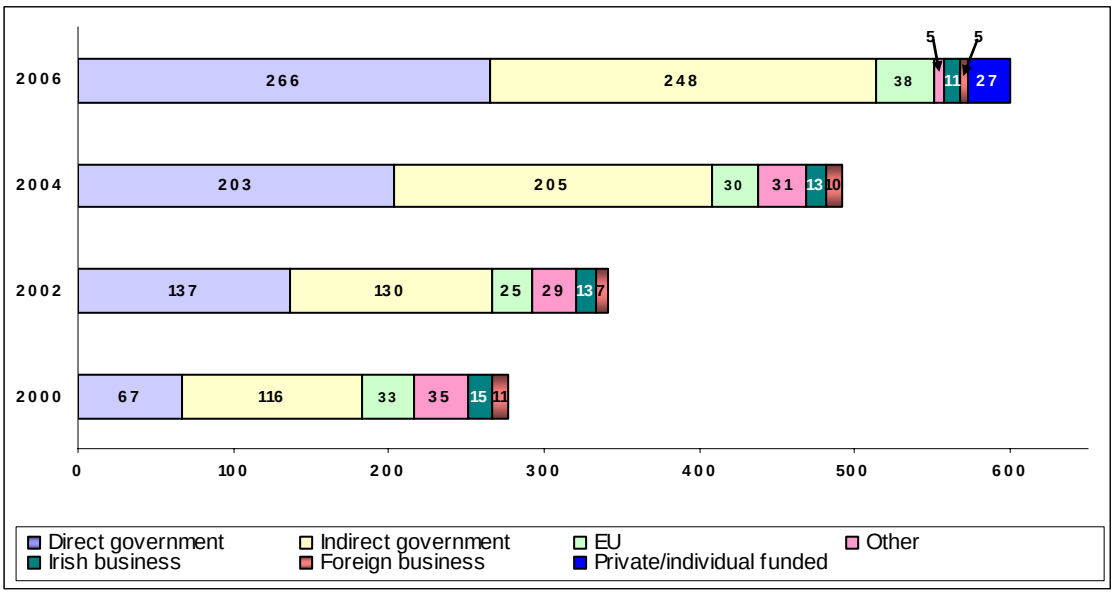


[8] Source: OECD, Main Science and Technology Indicators, October 2007. Earliest figures used were recorded by Mexico in 2003.

Chapter 3: Source of funding of HERD expenditure

It is also important from an analytical and policymaking perspective to examine the main sources of this funding. Research expenditure in the higher education sector is provided from a number of different sources. These sources can be divided under three main headings – direct government funding, indirect government funding (via the Higher Education Authority block grant), and other sources (including funding sourced from businesses in Ireland and abroad, funding for public EU sources including the framework program, and also funding from private individuals.

Figure 10: Sources of research funding, 2000 – 2006, in current prices (€ millions)[9]



Source: Forfas Data

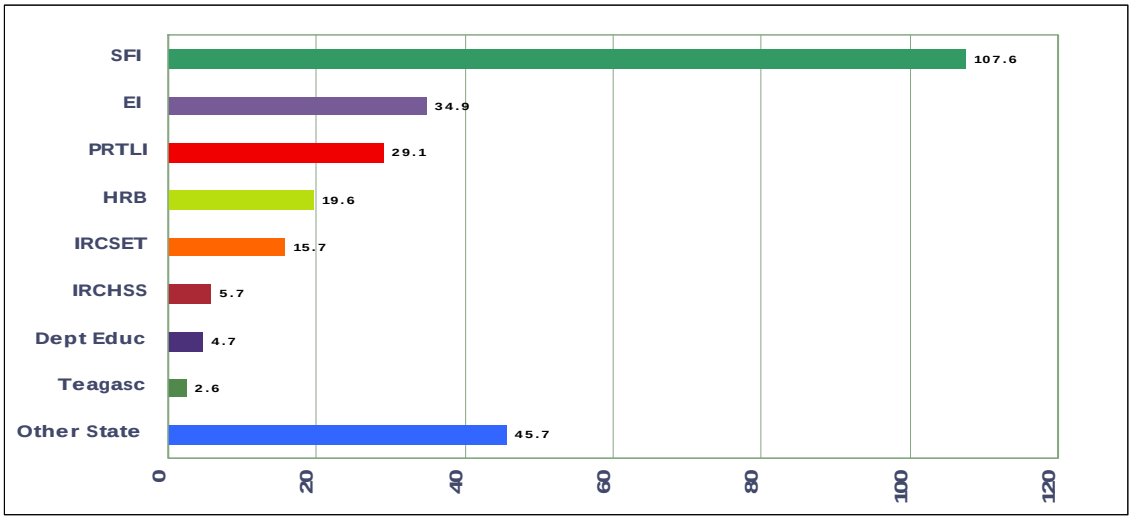
Figure 10 above shows the upward trend in direct and indirect government funding from 2000 until 2006. It can be seen that the main driver of the overall increase in HERD spending from 2000 to 2006 was from the exchequer side – direct and indirect sources. This was supported, but to a lesser extent, by the growing funding sourced from the EU public research programs.

[9] It should be noted that the classification of sources of research funds was altered slightly in 2006 to include private/individual funds. This is a new category which includes philanthropic services

Total government funding, (direct and indirect) accounted for 85.4% of all research income in the higher education sector in 2006. This is an increase from 83% in 2004, 79% in 2002. It should be noted that methodological changes to the 2006 HERD survey were introduced to ensure higher quality data on research spending from individuals and philanthropists, which were previously recorded as "other" sources. This data breakdown will be available for analysis from 2006 onwards.

Direct Government Funding: This funding is filtered through the Irish exchequer and various government departments and their agencies in order to fund research projects which are performed in the higher education sector. In 2006 exchequer sourced funding of HERD grew to €266 million. This represented a 31% increase on the amount allocated to higher education sector performed R&D activities in 2004. Science Foundation Ireland (SFI), Enterprise Ireland (EI) and the Higher Education Authority's Programme for Research in Third Level Institutes (PRTLI) funding scheme were the main state agencies involved in allocating research grants in 2006 to the HE sector in Ireland.

Figure 11: Sources of direct government research funding, (€ millions), 2006[10]



Source: Forfas Data

Figure 11 shows the breakdown of direct government funding by its main sources for the academic year 2006. The SFI is the largest state agency responsible for distributing research funds for activities performed in the higher education sector. At €107.6 million, the foundation allocates 40.4% of the total direct government funding research budget. EI allocated €34.8 million for HERD activities in 2006 (13.1% of total direct funding), while the PRTLI was responsible for 11%. The remainder was divided up between a variety of bodies responsible for a number of research areas, such as health, engineering, humanities, social sciences, education and agriculture.

[10] See Appendix 2 for list of acronyms.

Indirect Government Funding: This funding is provided by the Higher Education Authority's annual block grant. The HEA allocates funding to the universities 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 practise in all OECD countries that operate a duel system of higher education funding – direct and indirect (General University Funding). This system follows the guidelines set out by the OECD's Frascati manual. In 2006 the R&D element of the HEA block grant rose to €248 million, increasing from the €205 million contribution recorded in 2004.

Other Sources: This category includes funding from the European Union, foreign businesses, Irish business, private individuals and other internal funds.

EU Funding: After a small decline in 2004, EU funding has once again regained momentum, rising from €30 million in 2004 to €38 million in 2006. This re-initiates the upward trend which began in 2002. Over the coming years it is hoped that the improved targeting of funding from the EU's 7th Framework Program, (FP 7) will increase this source of funding for HERD activities.[11]

Business: Funding from private businesses for higher education performed R&D activities was €16 million in 2006. Because of the changed methodology in capturing separate data on funding sourced from private individuals via philanthropy activities (previously captured under "other" sources of funding), it is difficult to complete a time series comparison in this area. Nevertheless the contribution of business sourced funding for HERD was 2.6% of the total sourced funding. This share is well below the EU and OECD averages of 6.5%, and further below global leaders for relative business funding of total HERD spending, such as Germany (14.1%), Canada (8.3%), United States (4.9%) and the United Kingdom (4.6%), (see Figure 12 for more detail).

Philanthropy: The private or individually funded category allows the survey to capture the amount donated by philanthropists who make donations to higher level institutes for R&D purposes. In 2006 this figure was €27 million.

[11] The Framework Programmes are an EU initiative designed to amalgamate all EU research related activities under a common umbrella. Funding for FP 7 is currently being distributed and it will run from 2007 to 2013.

Overall research funding in the higher education sector can then be broken down by field of science, allowing policy makers to examine how the different areas of academic research are funded. Table 4 below illustrates how heavily dependent the first three fields of science (natural sciences, engineering and technology and medical and health sciences) are on Irish public research funding, while the following three fields, (agricultural sciences, social sciences and humanities) tend to rely more on indirect sources of funding for their R&D programmes.

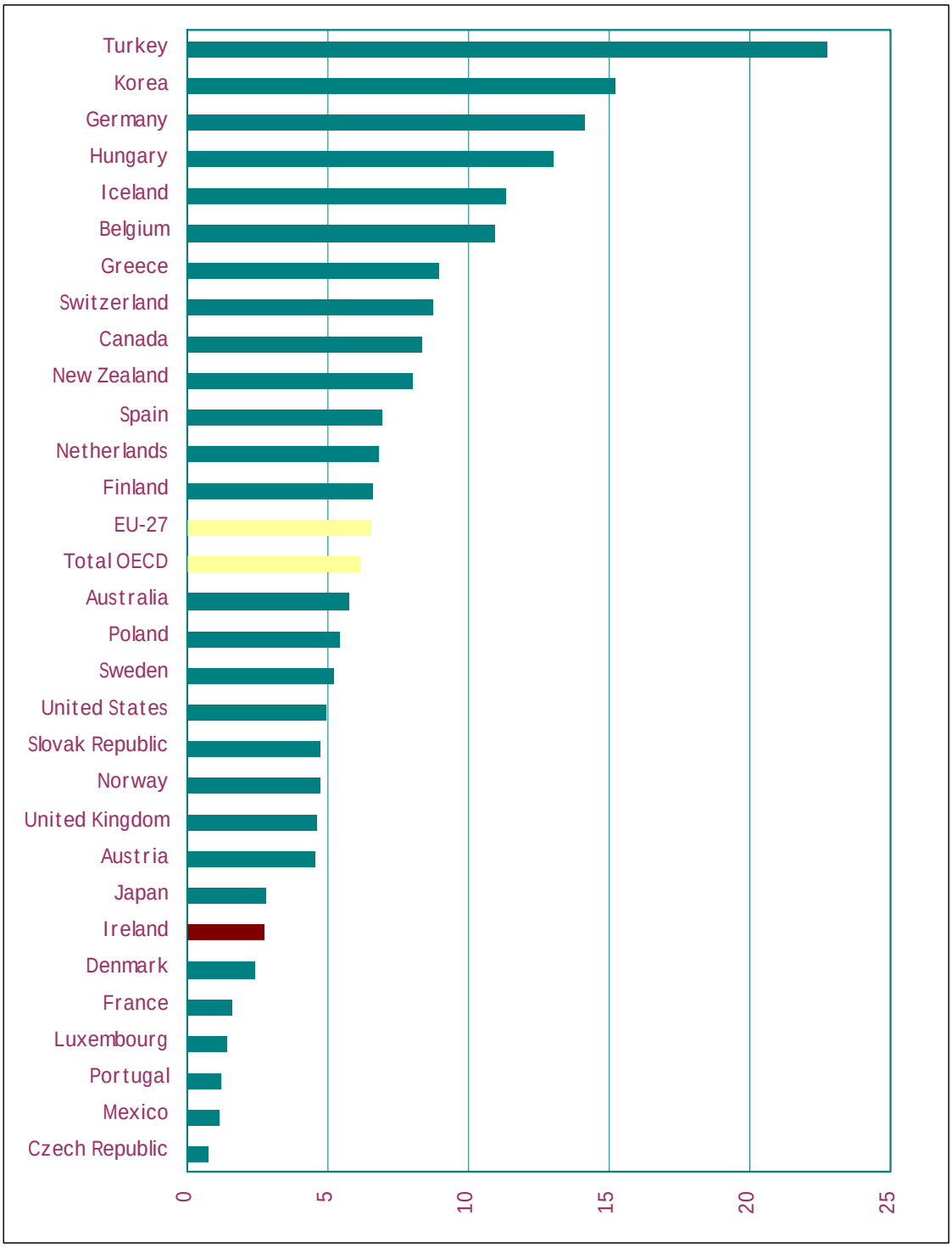
- The natural sciences received 52% of its funding in 2006 from direct government sources. It receives 33.6% from indirect sources and the remainder is divided between EU funding, and other and own.
- Engineering and technology obtains 58.2% of its R%D budget from direct government sources. Only 25.5% is distributed via indirect sources, while 16% comes from EU and other sources of funding.
- The medical and health sciences secure 47.6% of their R&D funding through direct government sources. 38.6% is secured through indirect sources and the remainder is channelled though EU and other sources.
- The agricultural sciences receives 53.4% of its funding from indirect sources. 40.8% comes from direct sources and the remainder is derived through EU and other and own sources of funding.
- The social sciences receive only 22.3% of funding from direct government sources, while 61.7% is allocated via indirect government sources.15.8% is distributed through the two remaining sources.
- The humanities sources 13.9% of its funding through direct government sources and 72.9% through indirect sources. The remaining 13.1% of R&D funding is obtained via other and own and EU direct funding.

Table 4: Sources of research funding by field of science, (€ millions), 2006.

Field of Science	Direct sources of funds			Indirect government	Total
	Irish public research	EU	Other and own		
Natural sciences	85.0	13.8	8.9	54.6	162.4
Engineering and technology	77.4	12.1	9.3	33.9	132.8
Medical health science	51.8	2.6	12.4	42.0	108.8
Agricultural science	6.5	0.6	0.3	8.5	15.9
Social science	20.6	7.6	7.0	56.8	92.0
Humanities	5.5	0.5	4.7	28.8	39.5
Other	18.8	0.9	6.9	23.7	50.2
Total	**265.5**	**38.2**	**49.4**	**248.3**	**601.4**
% of total	**44%**	**6.3%**	**8.19%**	**41.3%**	**100%**

Source: Forfas Data

Figure 12: Percentage of HERD financed by industry, (2006 or latest available data)[12]

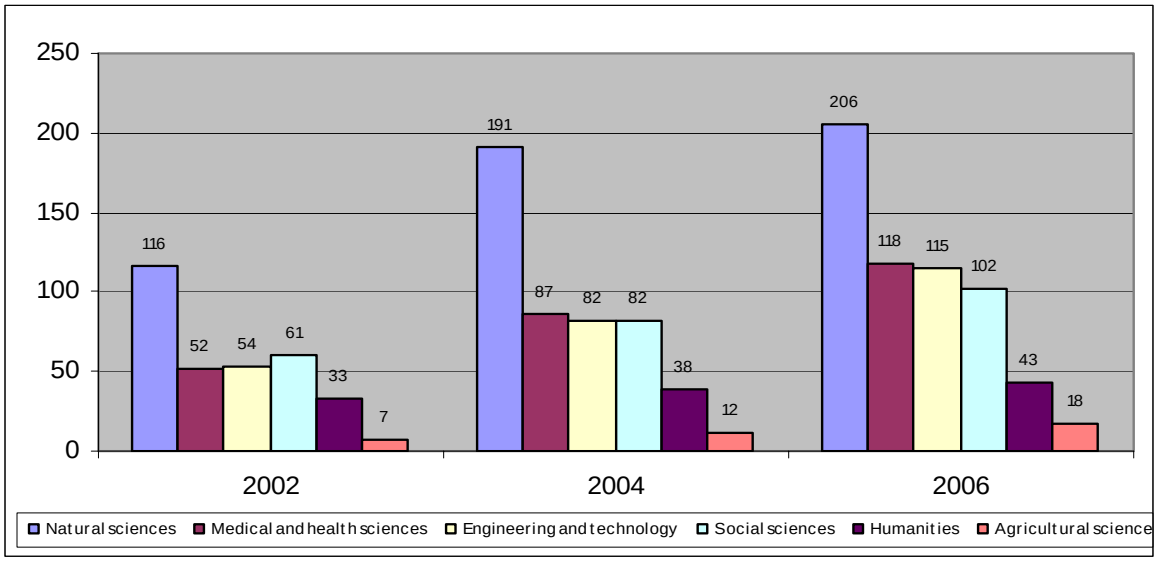


[12] Source: OECD, Main Science and Technology Indicators, October 2007. Earliest data used was recorded by the Netherlands in 2003.

Chapter 4: HERD Expenditure by Field of Science

As well as measuring overall levels of HERD spending policy makers find it useful to look at the various areas which absorb research funding. While gathering the 2006 data, institutions were asked to divide overall spending into a number of fields of academia which allows the identification of trends within key research areas. In order to maintain comparability across the member countries, the OECD has developed a classification model for all HE research. There are six broad fields, described as "the fields of science" (FOS). These are natural sciences, engineering and technology, medical and health sciences, agricultural sciences and humanities[13]. In June 2006 the classifications were altered in order to reflect the latest developments in science and technology. In the following graph the old FOS classification is used in order to examine meaningful time trends of the expenditure within the different fields of science.

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



Source: Forfas Data

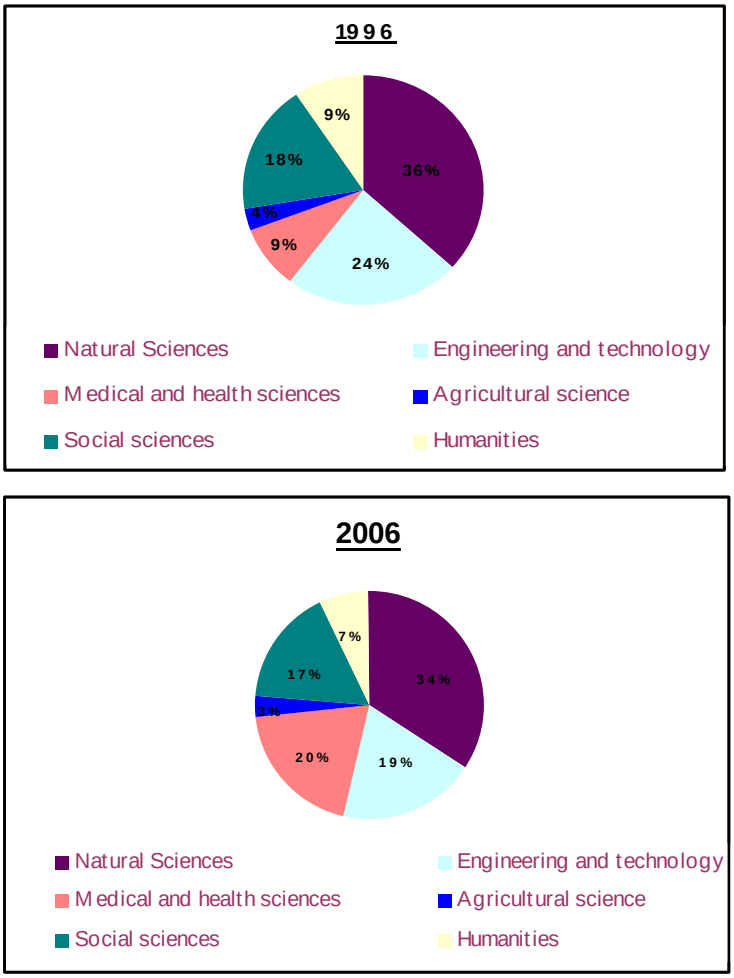
- The natural sciences remain the field which accounts for the largest proportion of the higher education R&D spend. Expenditure in this area has risen from €115.9 million in 2002 to €205.5 million in 2006. This is a 77.3% increase in the funding of natural science research over 6 years.
- The medical and health sciences gained an additional €65.9 million in research funding in the last 6 years which has brought the total amount of R&D funding allocated within this field of science to €118.3 million.

[13] For a more detailed breakdown of the various fields of science see, Table 6, Appendix 3.

- Engineering and technology departments also continued to grow in importance across the higher education research system, with funding rising from €53.5 million in 2002 to €115.1 million in 2006. There was a 53% increase in R&D performed across these fields of science between 2002 and 2004, while a 40% increase was experienced from 2004 to 2006.
- The remaining fields have all enjoyed modest increases. The humanities have seen the least amount of gain out of any of the science fields over the six year period, with only marginal increases in their share of funding. In 2002 and 2004 the humanities received €32.5 million and €38.2 million respectively. This figure increased by €4.3 million in 2006 to €42.5 million.

With all fields of science enjoying an increase in actual funding for R&D activities over the last ten years, it is also useful to examine the share of total R&D activity that each FOS performs. Since 1996 the percentage share enjoyed by the natural sciences (the largest performer of R&D activities in the HE sector) has fallen from a 36% share in 1996 to 34% by 2006. Academic departments classified within the engineering and technologies FOS have also seen their share of total HERD fall from 24% to 19% over the ten year period. Despite increased research funding in this period, the rate of growth has fallen below the exceptional growth seen in medical and health science R&D departments, resulting in a falling share for natural and engineering science performed R&D. The medical and health science category has seen a substantial increase in its share of the expenditure allotment, rising from 9% to 20%, over the ten year period.

Figure 14: Share of total R&D expenditure by old field of science, 1996 and 2006.



Source: Forfas Data

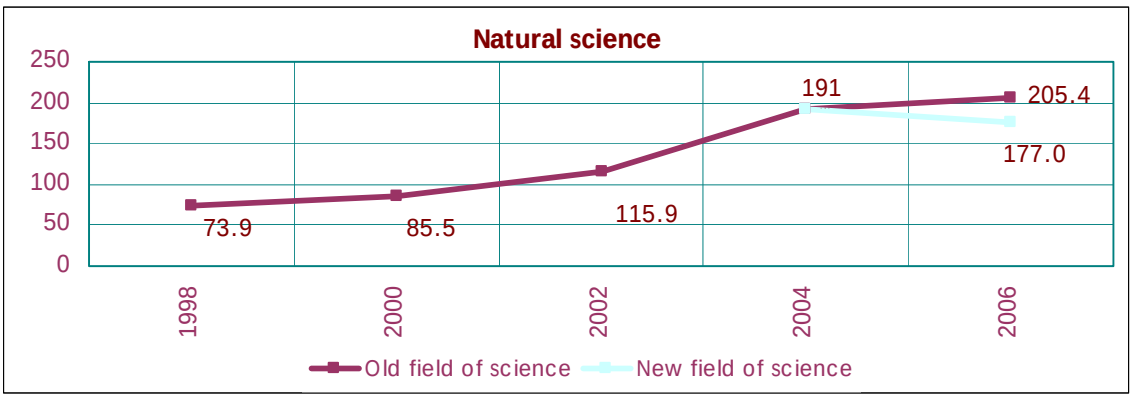
Each field of science is then broken down into smaller sub-categories which allow more detailed examination of HERD spending. These categories and the trend in field of science expenditure are examined in greater detail below looking at sub-fields.

Natural sciences: At 25% the sub-field of biological sciences account for the largest portion of the HERD spend in this category. Physical sciences (20.2%) and computer and information sciences (17.9%) also enjoy quite substantial allocations, while chemical sciences, mathematics and earth and environmental related sciences make up the remainder in almost equal portions.

From the period 1998 until 2004 the trend for R&D expenditure in the natural sciences field has been steadily upwards. The years 2000 and 2002 saw smaller increases, but in 2004 a significant escalation in funding was expanded to this area of study, resulting in a rapid acceleration in R&D performance growth from €115.9 million in 2002 to €191 million by 2004.

Between 2004 and 2006 (using the previous classification system), the growth rate has eased once more to 7.5% to stand at €205.4 million. When examined under the new field of science the total in this revised classification totalled €177 million in 2006 – this was mainly a result of the reclassification of some bio-technology and nanotechnology sub-fields of science into the closely aligned engineering and technology field of science.

Figure 15: HERD expenditure on natural sciences in current prices, (€ millions), 1998-2006

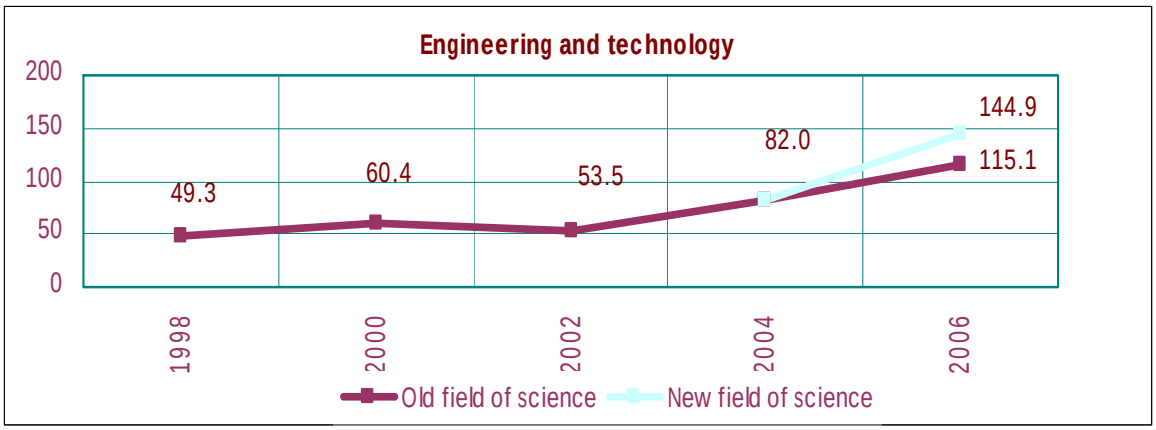


Source: Forfas Data

Engineering and technology: At 24.1% electrical, electronic and information engineering account for the largest portion of this category's spend, with nanotechnology (23.2%) coming a close second. The percentage share given to industrial bio-technology (15%) and mechanical engineering (11.2%) are also significant. The remainder is then distributed among a variety of engineering categories.

After a period of modest growth and decline, (1998 – 2002) spending on engineering and technology performed R&D activities in academic departments began a drive upwards. From 2002 to 2004 there was an increase of 53% in research performance, followed by a slower though still strong 40.3% growth in the period 2004 to 2006 (using the old FOS classification). With the reclassification of some research in the fields of nanotechnology, the total R&D performed in this new FOS classification climbs to an even higher €144.9 million in 2006.

Figure 16: HERD expenditure on engineering and technology in current prices, (€ millions), 1998 - 2006

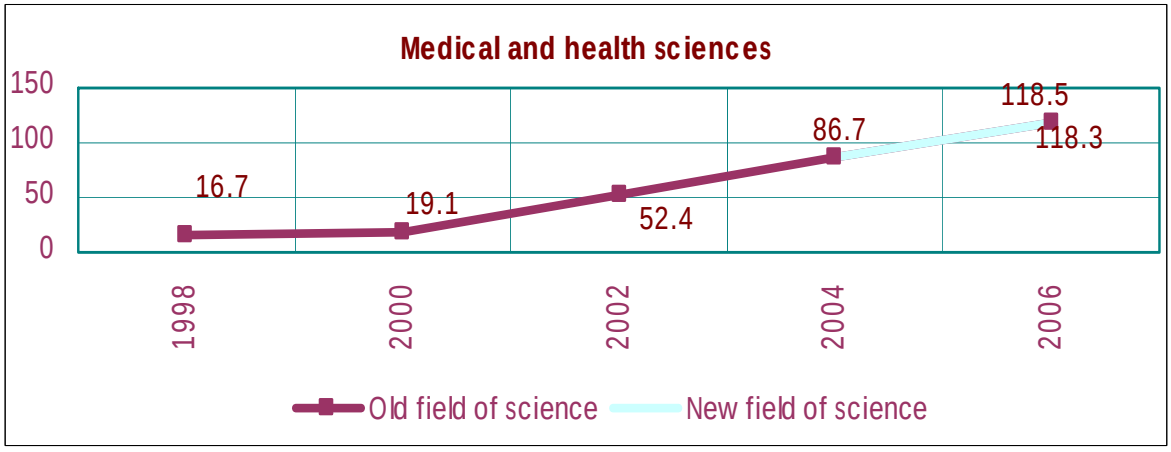


Source: Forfas Data

Medical and health sciences: Just over half of all medical sciences research funding in the higher education sector is performed by departments operating within the sub-category of basic medicine. The remainder is shared between clinical medicine (27.4%) and health sciences (21%).

Between 1998 and 2000 investment in medical R&D started to rise rapidly within the HE sector. The following two year period saw a further quickening in the pace of R&D activity, with spending almost tripling across the medical and health science fields. The period 2002 to 2004 saw a rise of 65.4%, while the latest couple of years in this analysis, (2004 – 2006) show that expenditure on medical and health research posted a 36% rise under both the new and old fields of science. This category was not greatly affected by the change in the field of science classification.

Figure 17: HERD expenditure on medical and health sciences in current prices, (€ millions), 1998 – 2006

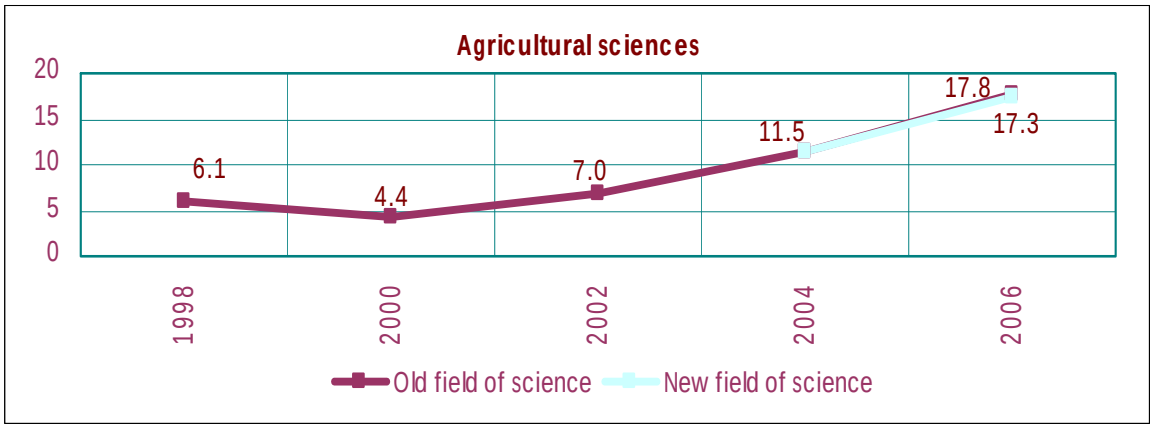


Source: Forfas Data

Agricultural sciences: Animal and dairy science enjoy a 69.1% share of the total HERD spending allocated for this category. Veterinary science utilises 27.9% of research funding, while agriculture, forestry and fisheries account for the remaining 3% of research performance.

After an initial decline of €1.7million, (1998 - 2000) expenditure in this field has risen steadily to stand at €17.8 million, (€17.4 million new FOS) in 2006. The alterations to the field of science classifications have not greatly affected this category.

Figure 18: HERD expenditure on agricultural sciences in current prices, (€ millions), 1998 - 2006

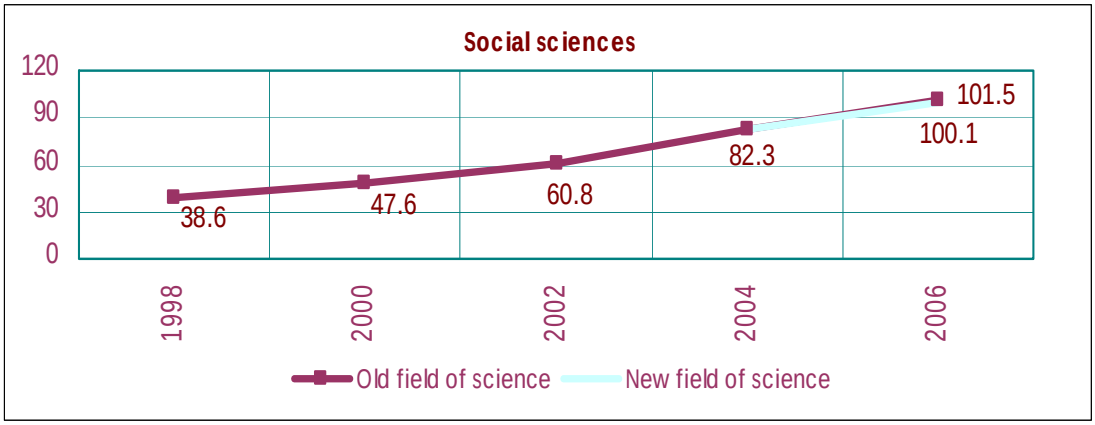


Source: Forfas Data

Social sciences: The vast majority of HERD funding for this category is channelled into the sub-fields of economics and business (30.4%) and the educational sciences (25.2%). Psychology and sociology both account for around 9% of the total figure, and the remaining research funds are distributed for activities performed in a variety of the social science fields.

The overall funding allocation for social science research has steadily increased since 1998. Figure 19 below shows funding rose from €38.6 million in 1998 to reach €82.3 million by 2004. Between 2004 and 2006 spending on social science research performed in the higher education sector rose by 22.1% to stand at €100.5 million (€100.1 million if using the new FOS classification system).

Figure 19: HERD expenditure on social sciences in current prices, (€ millions), 1998 – 2006

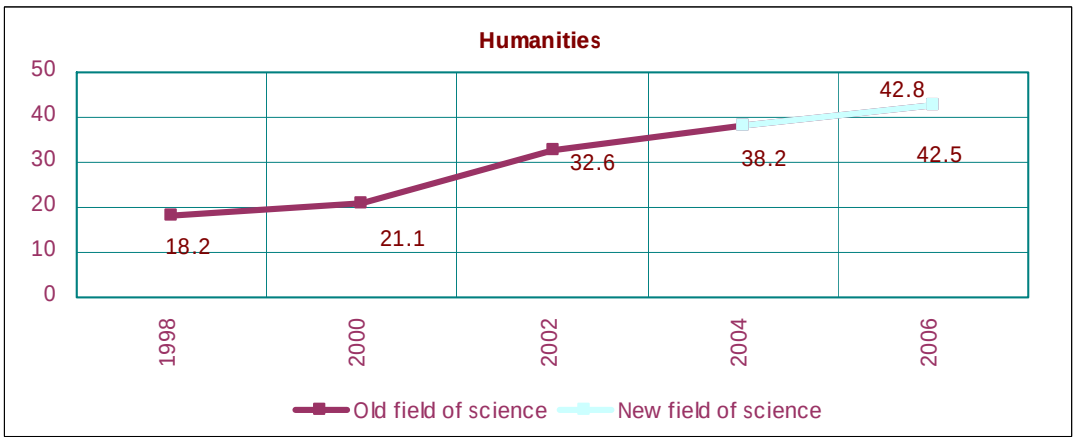


Source: Forfas Data

Humanities: Within this category, language and literature departments are responsible for a large majority of the research spending performance, (62.7%). History and archaeology is the next largest area at 21.7%, while philosophy, the arts and other humanities make up the reminder.

Spending on R&D for research in humanities rose moderately during the period 1998 to 2000. From 2000 to 2004 the field of study saw quite substantial increases in its funding, rising from €21.1 million in 2000 to €38.2 million by 2004. However since 2004 spending growth has eased, increasing by €4.6 million under the old field of science, and €4.3 million under the new field of science.

Figure 20: HERD expenditure on humanities in current prices, (€ millions), 1998 - 2006



Source: Forfas Data

Chapter 5: Types of research

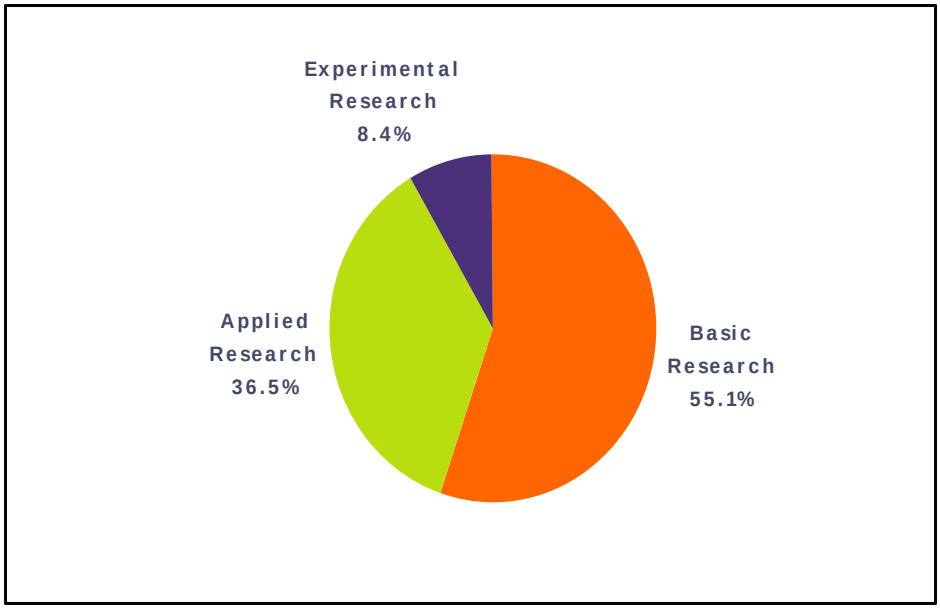
Research activities carried out in the higher level institutes can be broken down into three types of research categories: basic, applied and experimental. The OECD definitions for these types of research are clearly outlined in the Frascati Manual:

Basic research: Experimental or theoretical work undertaken primarily to acquire new knowledge, without any particular application or use in view.

Applied research: Original investigation undertaken in order to acquire new knowledge primarily directed towards a specific practical aim or object.

Experimental research: 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.

Figure 21: Percentage of total HERD budget allocated to the research types, 2006



Source: Forfas Data

As figure 21 above illustrates, total HERD expenditure is distributed between the three research types. At 55.1%, a substantial majority of higher education on R&D is channelled into basic research – mostly funded via the SFI funding programs. Applied research accounts for 36.5% of total HERD expenditure, while experimental research only accounts for 8.4% of total research being carried out at third level institutes.

This is the first year that data concerning the type of HE research being carried out, has been collected. Therefore it is impossible to compare the 2006 figures with any previous years. When we look at the OECD main science and technology indicators (MSTI), basic research was the main activity carried out by the majority of member states within their higher education sectors (72.8% on average), with applied research projects accounting for 21.7%, and experimental development making up the remaining 5.6% of average performance. That said the make-up of research activity performed across institutions on a country basis, varies greatly.

Figure 22: Type of research carried out in each of the fields of science, 2006

Source: Forfas Data

Basic research: The amount of basic research carried out within the fields of science varies from 44% of humanities research, to 68% of research in the field of agricultural sciences.

Applied research: Over one third of research carried out in the natural sciences, engineering and technology, medical sciences and the social sciences is categorised as applied research. 22% of agricultural research is applied while an ample 50% of research activity performed in the humanities is classified as applied.

Experimental research: The engineering and technology field of science had the strongest contribution to overall R&D projects from experimental research at 12% in 2006. This was ahead of the 10% applied research share recorded in agricultural science R&D projects performed in the HE sector. The other fields of science saw 6-7% of total R&D activity classified as experimental research.

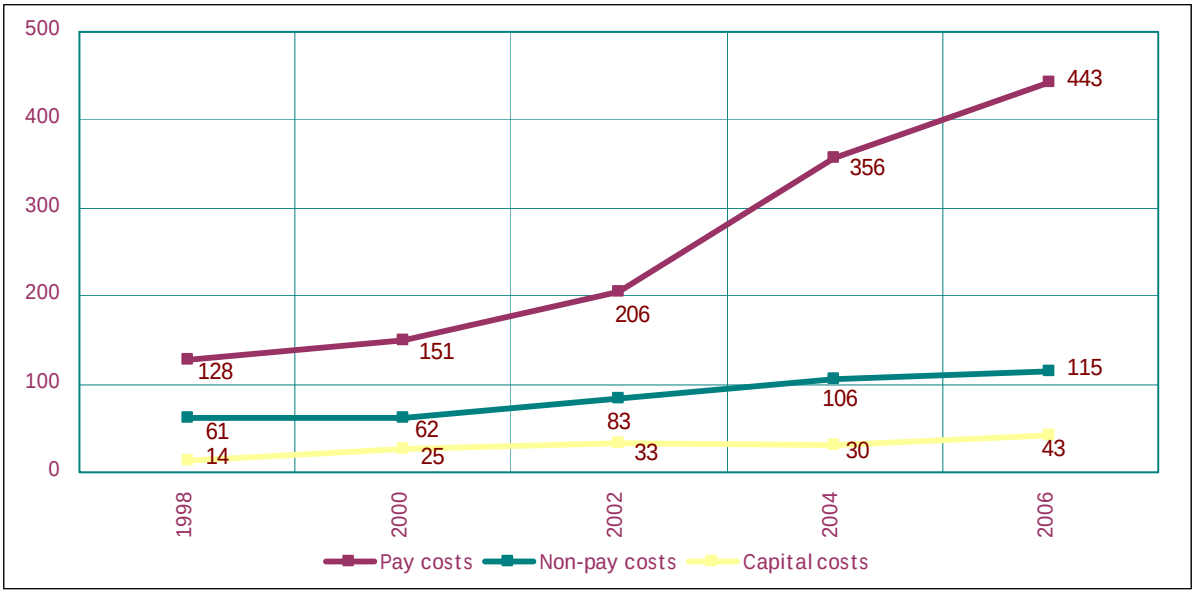
Chapter 6: Type of Costs

The 2006 HERD survey asked the various academic institutes to calculate a detailed breakdown of their R&D expenditure by type of cost. There are three types of research costs examined within the survey – pay cost, non-pay costs and capital costs.

According to the OECD Frascati Manual;

- Pay costs are the annual wages and salaries, and all associated fringe benefits (bonuses, etc.) given to staff.
- Non-pay costs are non capital purchases of materials, supplies and equipment to support R&D performed in a given year.
- Capital costs are annual gross expenditures on fixed assets used in the R&D programme. They are calculated by assessing the amount of the capital asset that is utilised for research purposes. For example, the institute will assess the percentage of a building's floor space employed in research. If 10% of floor space is used for R&D, then 10% of the building's value will be included in capital costs.

Figure 23: Distribution by type of costs, 1998 – 2006 in current prices



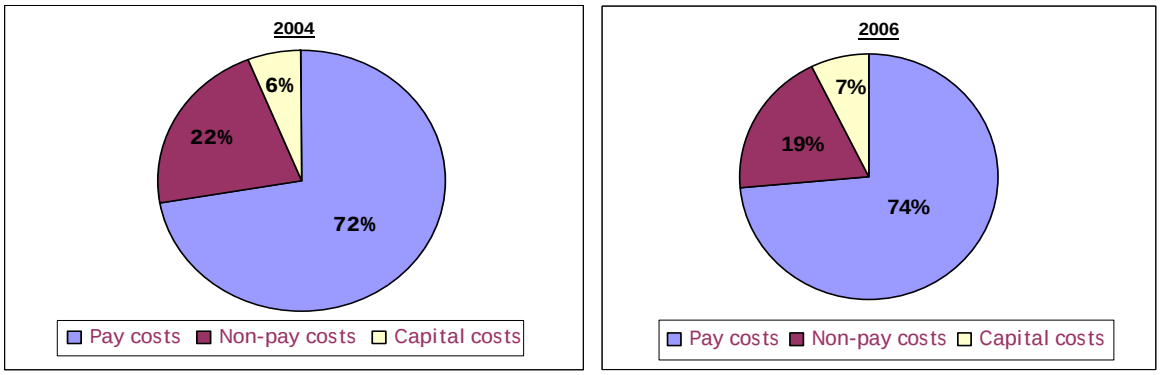
Source: Forfas Data

Pay costs continue to dominate R&D spending. In 2006 R&D costs totalled €443 million, 24.4% ahead of the €356 million posted in 2004. The period 2002 to 2004 saw an increase of 73%, while 2000 to 2002 recorded a pay cost increase of 36.4%.

After a period of stagnation between 1998 and 2000 non-pay costs have been steadily increasing. In 2006 they reached €115 million. This is an increase of 8.5% compared to the total recorded in 2004. The rate of growth therefore slowed from the 27.7% increase in non-pay costs which was calculated between 2002 and 2004.

Following a small reduction between 2002 and 2004, capital investments for R&D in the higher education sector have increased between 2004 and 2006. Capital investment in the form of land, building and equipment for R&D purposes, increased to €43 million in 2006, a rise of 43.3% over the previous two years.

Figure 24: Percentage share of type of costs, 2004 and 2006



Source: Forfas Data

Table 5 examines a further split of costs by type into the various fields of science where R&D is performed.

Table 5: Types of costs by new fields of science, 2006 (€ million)

	Pay costs	% of total	Non-pay costs	% of total	Capital costs	% of total	Total
Natural sciences	120	75%	31.4	20%	8.2	5%	159.7
Engineering and technology	87.5	66%	30.4	23%	15.5	12%	133.5
Medical and health sciences	79.1	72%	25.1	23%	5.8	5%	110.1
Agricultural sciences	13	82%	2.7	18%	0.05	0%	15.8
Social sciences	76.6	84%	14.3	16%	0.7	1%	91.7
Humanities	36.1	92%	2.9	8%	0.2	1%	39.4
Other	30.4	60%	8	16%	11.8	24%	50.2
Total	**443**	**74%**	**115**	**19%**	**42.5**	**7%**	**600.6**

Source: Forfas Data

Within each of the fields of science, pay costs account for the largest percentage of the total R&D spend. There is little variation between the field of science spend on pay costs, with almost all the classifications spending over two thirds of their budget in this area. At 23% engineering and technology and the medical and health sciences are responsible for the majority of the non-pay costs, but once again there is not a huge amount of variation. The humanities are the only exception. At 8% they are well below the 19% average spend on non-pay costs.

The capital cost breakdown into FOS classification shows a lot more diversity than the other two areas. Total capital R&D investment for engineering and technology projects came to 12% of total costs for this field, well ahead of the 1% share for the agricultural sciences. When the 2006 figures are compared to the 2004 figures a slight shift can be seen. The pay costs have increased from 72% of R&D allocation in 2004, to 74% in 2006, while non-pay costs have fallen from 22% to 19%. Capital costs have increased from 6% to 7% over the same two year period.

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 2006 academic year (Sep 2005 to Sep 2006).

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. (the 2006 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[14], thirteen institutes of technology[15], as well as the Dublin Institute of Technology, Royal College of Surgeons, St. Patrick's College Drumcondra and Mary Immaculate College.

Timing of survey and subsequent follow-up

Questionnaires were sent out at the end of April 2007 to the various colleges. There was intensive follow-up of non-respondents by telephone from May 2007 until the end of August 2007. Final outstanding information was received in September 2007. A full response rate was achieved for the financial and personnel parts of the survey.

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.

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

[15] 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, Dun Laoghaire IT, Blanchardstown IT and Waterford IT.

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:
✓	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 field of science tables

Table 6: Total HERD expenditure by old and new fields of science, 2006, (€ millions)

	Old field of science	€000'	New field of science	€000'
Natural sciences	Mathematics and computer science	53	Mathematics	20.6
	Physical sciences	32.2	Computer and information sciences	31.7
	Chemical sciences	27.9	Physical sciences	35.8
	Earth and related environmental sciences	24.7	Chemical sciences	24.3
	Biological sciences	67.1	Earth and related environmental sciences	19.8
			Biological sciences	44.6
			Other natural sciences	0
Engineering and technology	Civil engineering	9.8	Civil engineering	7.8
	Electrical engineering, electronics	32	Electrical, electronic and information engineering	34.9
	Other engineering sciences	72.1	Mechanical engineering	16.2
			Chemical engineering	0.8
			Materials engineering	0.9
			Medical engineering	2.7
			Environmental engineering	4.4
			Environmental biotechnology	12.6
			Industrial biotechnology	21.8
			Nano-technology	33.5
			Other engineering and technology	9.1
Medical and health sciences	Basic medicine	60.9	Basic medicine	61.2
	Clinical medicine	31.9	Clinical medicine	32.4
	Health sciences	31.8	Health sciences	24.8
			Health biotechnology	0
			Other medical sciences	0
Agricultural sciences	Agriculture, forestry, fisheries and allied sciences	2	Agriculture, forestry and fisheries	0.5
	Veterinary medicine	15.3	Animal and dairy science	12
			Veterinary science	4.8
			Agricultural biotechnology	0
			Other agricultural sciences	0

Social sciences	Psychology	9.8	Psychology	9.8
	Economics	21.1	Economics and business	30.5
	Educational sciences	28.4	Educational sciences	25.3
	Other social sciences	40.6	Sociology	9.5
			Law	9.1
			Political science	3.8
			Social and economic geography	2.6
			Media and communications	6.7
			Other social sciences	2.9
Humanities	History	10	History and archaeology	9.3
	Languages and literature	28.8	Languages and literature	26.9
	Other humanities	7.2	Philosophy, ethics and religion	2.9
			Arts, (arts, history of arts, performing arts, music)	3.3
			Other humanities	0.5
	Total	601.4	Total	601.4

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 achomhordú ó thaobh a gcuid feidhmeanna.

Forfás Publications 2007/2008

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Annual Business Survey of Economic Impact (ABSEI)	January 2008
Survey of Selected Multi-National Employers' Perceptions of Certain Graduates from Irish Higher Education Expert Group on Future Skills Needs	December 2007
Review of International Assessments of Ireland's Competitiveness National Competitiveness Council	December 2007
Electricity Benchmarking Analysis and Policy Priorities	December 2007
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Annual Competitiveness Report Volume 2: Ireland's Competitive Challenge National Competitiveness Council	November 2007
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National Skills Bulletin Expert Group on Future Skills Needs	November 2007
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