EXECUTIVE SUMMARY

This paper presents the results from the survey of research in the Higher Education sector in 1998. The sector is defined as the universities and the institutes of technology, including the Programmes in Advanced Technologies (PATs) and the Technology Centres.

The following are the major findings of the survey :

- Expenditure on research in the higher education sector (HERD) amounted to £160m (EUR203m) in 1998 up from £121m (EUR154m) in 1996 and £73m (EUR93m) in 1992. This is a real increase of 97% over the period 1992 to 1998 or a 12% average per annum increase in that period. HERD in Ireland amounted to 0.27% of GDP in 1998 (0.31% of GNP), compared to the OECD average of 0.37% of GDP.
- Although all fields of science experienced real increases in expenditure in the six-year period to 1998, there were significant developments in the natural sciences and the social sciences. Although expenditure on research in the natural sciences increased in real terms by £24.1m (EUR30.6m) between 1992 and 1998 (an annual average of 9.3%) their share of total expenditure fell from 42% to 36% between 1992 and 1998. In contrast, social sciences research increased by £20.7m (EUR26.3m) over the six-year period (average annual growth of 20.7%) and their share of total HERD rose from 12% in 1992 to 19% in 1998.
- Research in the Institutes of Technology doubled between 1996 and 1998, to £10.6m (EUR13.5m) but still accounts for less than 7% of HERD.
- Basic research has seen its share of total spend decrease from 45% in 1992 to 41% in 1998 (£65.7m)(EUR83.4m) and applied research increased from 40% in 1992 to 45% in 1998 (£72.3m)(EUR91.8m).
- Total number of HE researchers (full-time equivalent) was 2425 in 1998, or 1.5 per thousand of the labour force compared to an EU average figure of 1.8. This compares with a total of 1886 researchers or 1.37 per thousand of labour force in 1992, and 2066 researchers or 1.4 per thousand of labour force in 1996.
- The major source of funding for HE research is from public funding which accounts for 66% of the total funding. This is made up of the research component of the block grant to the colleges for their current and capital expenditure (43% of total) and direct government grants administered by various Government Departments and agencies (23% of total).
- Other major sources of funding are EU programmes (16%), Irish business (7%) and foreign sources (3%). The contribution of Irish business to HE research remains around 7% of total funding. Internationally comparable data indicate that Ireland is slightly above average in this measure.
- This survey comes too early to identify changes associated with major new funding initiatives for Irish research, namely the Programme for Research in Third Level Institutions and the Technology Foresight Fund.

ACKNOWLEDGEMENTS

Forfás acknowledges with gratitude the information supplied by those in the finance and personnel offices of third level colleges who supplied us with the background information on which the analysis was based.

1 Introduction

The production, application and use of new knowledge are accepted as key determinants in achieving and maintaining economic prosperity and international competitiveness. The higher education sector functions in a dual capacity as a trainer of future researchers and skilled personnel and a vehicle to pioneer research into new areas.

The higher education sector is a major component of the national research effort in all developed countries. It complements the research in business sector firms and in public sector institutes, which are usually more applied and developmental in their focus than academic research.

Forfás, as part of its regular surveys of Irish research, conducted (during 1999 and 2000) a survey of higher education research in Ireland; the findings relate to 1998. The sector is defined to include all universities and institutes of technology, including the Programmes in Advanced Technologies (PATs) and the Technology Centres located in the colleges. The survey relates to all fields of knowledge, not just science and technology.

This survey comes too early to identify changes associated with major new funding initiatives for Irish research, namely the Programme for Research in Third Level Institutions and the Technology Foresight Fund.

The methodology and procedures followed in this survey are those recommended by OECD and used by all OECD member states and the results for Ireland should be comparable to those from other OECD countries.

2 General Trends in Expenditure

Table 1 shows the total expenditure on HE research (HERD) and its distribution between the main research performers. Expenditure on research in the higher education sector (HERD) amounted to £160m (EUR203m) in 1998 up from £121m (EUR154m) in 1996 and £73m (EUR93m) in 1992. This is a real increase of 97% over the 1992 level or a 12% average per annum increase in that period. Figure 1 illustrates the trend of expenditure on R&D between 1986 and 1998.

One of the key indicators for international comparisons is the ratio of Higher Education research expenditure to National Gross Domestic Product (GDP). The ratio of HERD/GDP has increased from 0.23% in 1992 to 0.27% in 1998 and, given that Ireland's GDP has increased by over 70% in real terms since 1992, this reflects a considerable level of increased investment by the HE sector in research.

The Universities have increased their share of HE research from 80% in 1992 to 83% in 1998, during which period their research expenditures increased in real terms by 105%. The Programmes in Advanced Technologies (PATs), despite a real increase in expenditure of 46% over this period, had a relative decline from 14% of the total in 1992 to 10% in 1998. The Institutes of Technology doubled their expenditures on research between 1996 and 1998, and now account for 6.6% of HERD.

Figure 1 – Higher Education Expenditure on Research and Development, 1986-1998

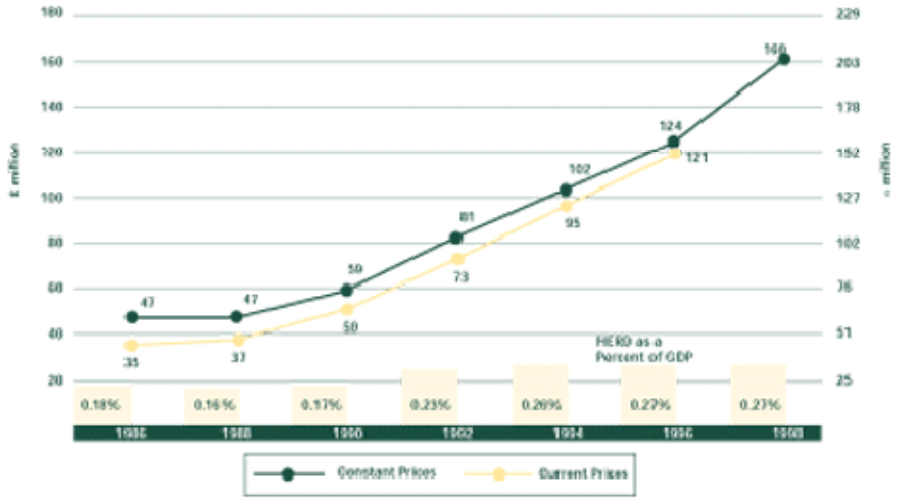


Table 1 - Research Expenditure analysed by Performer

	1992			1994			1996			1998		
	£m	EURm	%	£m	EURm	%	£m	EURm	%	£m	EURm	%
Institutes of Technology	4.6	5.8	6.4	4.5	5.7	4.7	5.1	6.5	4.2	10.6	13.5	6.6
PATS	10.1	12.8	13.9	12.6	15.9	13.2	13.3	16.8	11.0	16.5	20.9	10.3
Universities	58.2	73.9	79.7	78.3	99.4	82.1	102.2	129.8	84.8	133.3	169.3	83.1
Total	72.9	92.6	100	95.4	121.1	100	120.6	153.1	100	160.4	203.7	100

3 Fields of Activity

Figure 2 - Field of science research expenditure in 1998 prices

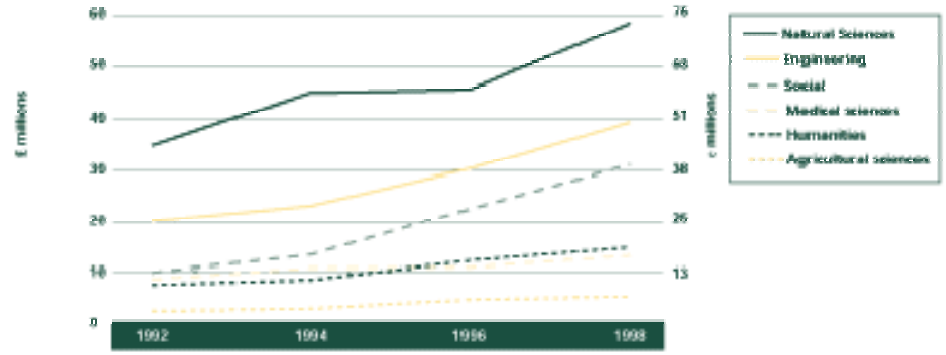
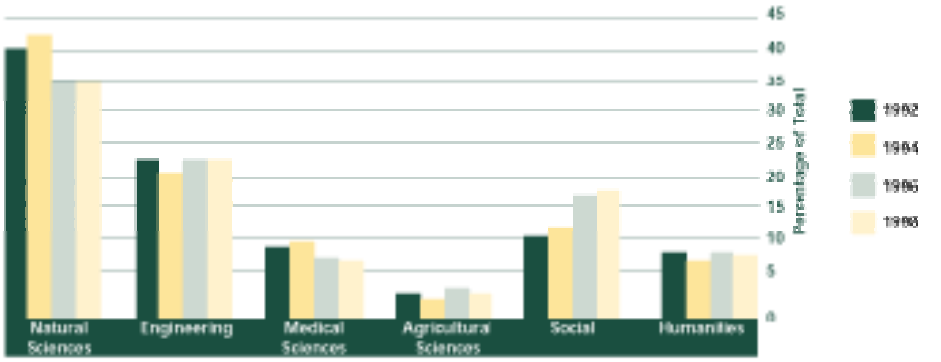


Figure 3 - Field of science share of total research expenditure



In analysing higher education expenditure on R&D the OECD have, in order to maintain comparability across member countries, developed a classification structure in which all HE research is classified into six broad fields. (Appendix 3 describes the field of science classification system used).

While all fields of science experienced real increases in expenditure in the six-year period to 1998, the major changes were in the natural sciences, engineering and social sciences as depicted in Figures 2 and 3. Expenditure on research in the natural sciences increased in real terms by £24.1m (EUR30.6m), or 9.3% per year, between 1992 and 1998; despite this, however, their share of total expenditure fell from 42% in 1992 to 36% in 1998. By contrast, the social sciences increased their expenditure by £20.7m (EUR26.3m) over the same six-year period, or 20.7% per year, and increased their share of total expenditure from 12% in 1992 to 19% in 1998.

4 Sources of Funds

Table 2.1 analyses the sources of funding for HE research in Ireland. The Government is the main provider of funds through direct and indirect sourcing of funds. The indirect source is derived from the annual block grant (recurrent grant) from the Department of Education and Science/HEA, which envisages that staff can and do spend a proportion of their time carrying out research. The co-efficient of time allocated to research in each academic department is applied to the operating costs for the department obtained from the college finance offices to obtain the indirect funding. This is a standard OECD approach to estimating higher education research expenditure in all countries operating a dual system of university funding. For this survey the overall average figure for research time was 25 per cent of the standard working week, a figure obtained from the detailed survey of individual researchers included in the 1996 survey of HE Research. These indirect funds are the single largest funding source for higher education research in Ireland, accounting for 43% of the total, but they do not provide support for incremental costs associated with individual research projects.

Direct funding of research projects comes from Government Departments and their agencies (£38.1m) (EUR48.4m). Enterprise Ireland (£13.4m) (EUR17.0m), Health Research Board (£6.0m) (EUR7.6m), and Teagasc (£0.6m) (EUR0.7m) are the main state agencies involved in providing research funding.

Table 2.1 - Sources of Research Funding by Fields, 1998 £'m

	Direct sources of funds				Indirect		
	Irish Business	Public Funds*	EU	Foreign Sources	Other & own	Government	Total
Natural sciences	3.5	16.5	13.1	2.9	3.9	18.5	58.5
Engineering	4.9	13.0	8.8	0.9	2.4	9.0	39.0
Medical sciences	0.7	2.6	0.6	1.3	2.7	5.3	13.2
Agricultural sciences	0.2	2.3	0.2	0.0	0.0	2.1	4.8
Social science	1.1	2.8	2.7	0.1	3.0	20.8	30.5
Humanities	0.1	0.9	0.8	0.0	0.3	12.3	14.4
Total	10.5	38.1	26.2	5.2	12.4	68.0	160.4
% of total	**7%**	**24%**	**16%**	**3%**	**8%**	**42%**	**100%**
% Real Change 1992-1998	**76%**	**73%**	**87%**	**134%**	**160%**	**111%**	**97%**

*Public funds are exchequer & CSF funds

Table 2.2 - Sources of Research Funding by Fields, 1998 £'m

	Direct Sources of Funds				Indirect		
	Irish Business	Public Funds*	EU	Foreign Sources	Other & own	Government	Total
Natural sciences	4.4	21.0	16.6	3.7	5.0	23.5	74.3
Engineering	6.2	16.5	11.2	1.1	3.0	11.4	49.5
Medical sciences	0.9	3.3	0.8	1.7	3.4	6.7	16.8
Agricultural sciences	0.3	2.9	0.3	0.0	0.0	2.7	6.1
Social science	1.4	3.6	3.4	0.1	3.8	26.4	38.7
Humanities	0.1	1.1	1.0	0.0	0.4	15.6	18.3
Total	**13.3**	**48.4**	**33.3**	**6.6**	**15.7**	**86.3**	**203.7**
% of total	**7%**	**24%**	**16%**	**3%**	**8%**	**42%**	**100%**
% Real Change 1992-1998	**76%**	**73%**	**87%**	**134%**	**160%**	**111%**	**97%**

*Public funds are exchequer & CSF funds

As can be seen from Table 2.1, there is quite a variation in the sources of research income that are received by the different fields of science. In the area of social sciences and humanities, 68% and 85% of their research income respectively comes from the indirect government source. In contrast to this, the natural sciences, engineering and medical sciences are not as dependent on these indirect government funds. These three areas have seen a combined real increase of £23.1m (EUR29.3m) since 1992 from the E.U. and direct Government sources. The monies under direct government sources have a high portion (75% on average) of Community Support Framework funds included in them.

The Irish research community has become very dependent on EU Framework Programme funds. These programmes, which account for 16.3% of the total expenditure, have been a great boost to the academic community and have enabled Irish researchers establish networks into Europe. However, the focus in these programmes is on European research needs and they are not necessarily effective in developing world class capabilities in niche areas of strategic national importance.

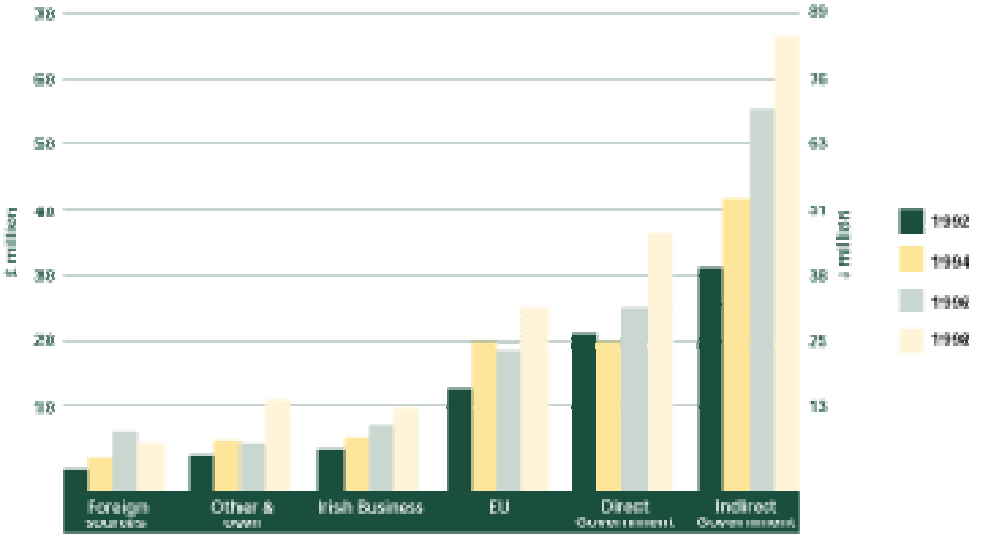
Research co-operation between industry and universities has increased dramatically over the past few decades. Fuelled by the increasing importance of science-based knowledge to the innovation process, university/industry research partnerships have grown markedly in almost all OECD countries. Although industry still accounts for only a small share of university research funding (on average 6 per cent), there has been a

significant change in the traditional framework of interactions between universities, the private sector and governments.

University/industry research partnerships take many forms, ranging from the informal to the institutionalised. Industry has traditionally interacted with universities by giving support for general research activities in the form of endowments and gifts. Recently, there are increasing levels of contract research in universities financed by companies. And now governments are underwriting a variety of co-operative research programmes, ranging from specific collaborative research projects to specialised research centres featuring partnerships among industry, institutes and universities.

Figure 4 details the trends in sources of research income since 1992. Irish business which accounts for 7.3% of total funding, has increased its funding of HE sector research by £4.6m (EUR5.8m) (78%) in real terms since 1992. The engineering sector has benefited the most by receiving £3.1m (EUR3.9m) of this increase.

Figure 4 - Sources of research funds in 1998 prices



5 Human Resources

The personnel data gathered in this survey aim to measure the amount of resources going directly to R&D activities. All persons employed directly on R&D are counted, as well as those providing direct services such as R&D managers, administrators and clerical staff. In the higher education sector there is a wide range of people involved in research from senior academic staff to research assistants, post-doctoral fellows and doctoral students ('postgraduates') to technicians and other support staff. In accordance with an OECD recommendation doctoral students are no longer classified as researchers.

Table 3 shows the number of full-time equivalent (FTE) staff by category in 1998. Compared to 1992 levels, the number of academic staff has increased by 539 FTE (33%), post-doctoral fellows by 21 FTE (8%) while research assistants are down 20 FTE (-5%). Support staff changed only marginally.

Table 3 – Research Personnel by Status of Employment, 1998, FTE

	Academic Staff	Post-Doctoral Fellows	Research Assistants	Technicians	Other Staff	Total
Natural sciences	337	165	396	96	46	1039
Engineering	160	62	232	124	48	626
Medical sciences	79	31	80	41	10	242
Agricultural sciences	26	1	12	20	10	69
Social science	479	5	31	4	18	537
Humanities	312	3	13	3	3	334
Total	**1,394**	**267**	**764**	**288**	**135**	**2,847**
% Total	**49%**	**9%**	**27%**	**10%**	**5%**	**100%**

6 Type of Research

While the HE sector plays a moderate role in the national system of innovation, accounting for less than 20% of national research expenditure, universities fulfil an essential function as the principal performers of basic research. The importance of basic research is shown as economic analysis has demonstrated that basic research has had major long-term social and economic effects, many of which, such as research in fields underlying information technologies, have been profound, fundamental and wholly unanticipated.

In recent years research co-operation between industry and universities has increased ranging from informal to institutionalised partnerships. As their relations with the business sector intensify, universities are increasingly involved in applied and technical tasks. Figure 5 illustrates these trends over time.

Figure 5 - Type of research, 1992-1998 in 1998 prices

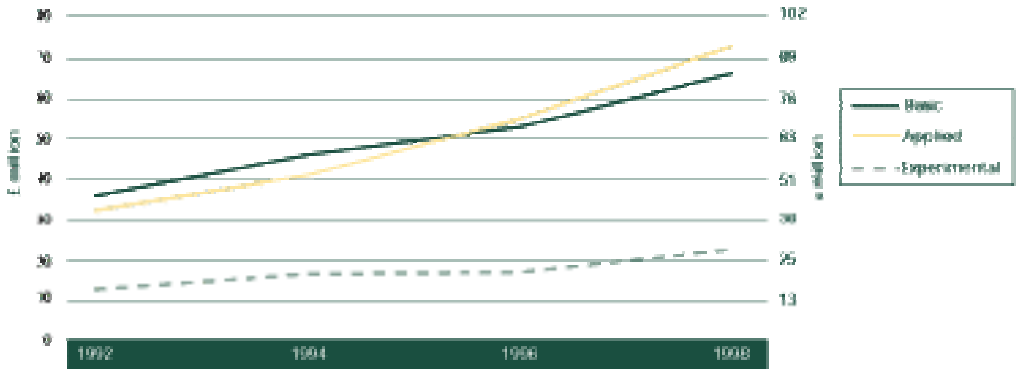


Table 4 shows that applied research has increased by £40.1m (EUR50.9m) (125%) in real term since 1992 and experimental research has also increased by £9.6m (EUR12.1m) in real terms. There is a strong bias in the engineering and agricultural sciences towards the applied/experimental end of the research spectrum, with nearly 80% of research being carried out in this area. Basic research has also increased significantly over this period by £29.3m (EUR37.2m) (81%) in real terms, although its share of the total has decreased from 45% in 1992 to 41% in 1998 and applied research has increased from 40% in 1992 to 45% in 1998.

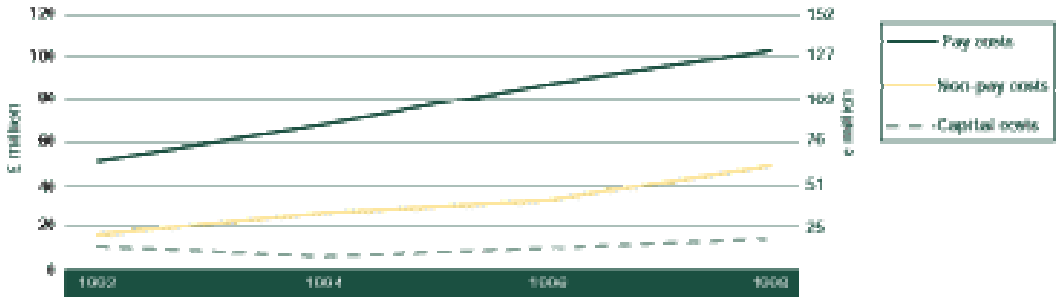
Table 3 – Types of Research 1998

	£m	EUR m	%	£m	EUR m	%	£m	EUR m	%	£m	EUR m	%
Natural sciences	28.1	35.6	48%	24.5	31.1	42%	5.9	7.5	10%	58.5	74.2	100%
Engineering	8.0	10.1	20%	18.5	23.5	47%	12.6	16.0	32%	39.0	49.5	100%
Medical sciences	5.4	6.9	41%	6.5	8.3	49%	1.3	1.6	10%	13.2	16.8	100%
Agricultural												
Sciences	1.0	1.2	20%	3.3	4.2	69%	0.5	0.7	11%	4.8	6.1	100%
Social/												
Economic Science	12.5	15.8	41%	16.2	20.5	53%	1.9	2.4	6%	30.5	38.7	100%
Arts / Humanities	10.8	13.8	75%	3.4	4.3	24%	0.1	0.2	1%	14.4	18.3	100%
Total	**65.7**	**83.5**	**41%**	**72.3**	**91.8**	**45%**	**22.3**	**28.3**	**14%**	**160.4**	**203.7**	100%
Real Change 1992-1998	**29.3**	**37.3**	**81%**	**40.1**	**50.9**	**12.5%**	**9.6**	**12.1**	**75%**	**79.0**	**100.4**	**97%**

7 Types of Cost

There are three main cost components of carrying out research in the higher education colleges – pay, non-pay and capital costs. Figure 6 shows how these have been distributed between 1992 and 1998.

Figure 6 - Distribution of types of costs, 1992-1998 in 1998 prices



The funding of pay and non-pay costs has increased in real terms by £45m (EUR57m) and £28m (EUR36m) respectively since 1992. A major cause of concern for academics is the funding of capital costs. Funding to buy new equipment and maintain and upgrade existing equipment is very difficult to obtain. In the 1996 Forfás survey of research in the higher education sector, 23% of respondents cited this as a major issue.

The funding of capital costs, shown in Table 5, has only increased 0.3% (£0.03m)(EUR0.04m) in real terms since 1992. The Government announced, in late 1997, details of a £280m (EUR355m) Science Education Technology Investment Fund which will be used to develop technology education at all levels, ranging from primary schools to advanced research. The funding will be in addition to annual capital allocations and will not replace or reduce existing investment. Funding will be allocated on the basis of priorities developed in consultation with industry and education and will allow for a strong partnership between the State, the institutions and the private sector. The impact of this fund can be seen in the 1998 capital figure which shows a real increase of £2.8m (EUR3.5m) over 1996.

Table 5 – Type of Cost by Fields, 1998 £m

	Basic		Applied		Experimental		Total	
	£m	EUR m	£m	EUR m	£m	EURm	£m	EUR m
Natural sciences	34.9	44.3	20.1	25.5	55.0	69.8	3.5	4.4	58.5	74.2
Engineering	21.1	26.7	13.4	17.0	34.4	43.7	4.6	5.8	39.0	49.5
Medical sciences	7.9	10.1	4.1	5.2	12.0	15.3	1.2	1.5	13.2	16.8
Agricultural sciences	2.8	3.6	1.6	2.0	4.4	5.6	0.4	0.5	4.8	6.1
Social/humanities	34.0	43.1	9.3	11.8	43.2	54.9	1.7	2.1	44.9	57.0
Total	**100.7**	**127.9**	**48.4**	**61.4**	**149.1**	**189.3**	**11.3**	**11.4**	**160.4**	**203.7**
% Total	**63%**		**30%**		**93%**		**7%**		**100 %**	
% Real Change 1992-1998	**96%**		**160 %**		**113 %**		**0.3%**			

8 International Comparisons

It is useful to benchmark Ireland's relative position in comparison to other countries in order to assess our performance to date. It must be mentioned that taking these indicators in isolation may give a false impression of the underlying research scene. Indicators only give a partial view of the reality. In addition, many indicators do not reflect the quality or efficiency of countries in particular areas. For example, a high R&D intensity does not necessarily imply that R&D inputs are efficiently used. Ireland's position in 1998 was in the lower third of OECD countries for indicators of higher education research.

Table 6 – International Ranking of Higher Education Sector R&D 1992-1998

	1992	1994	1996	1998
Higher Education Exp on R&D (HERD)	£73m	£95m	£121m	£160m
	EUR93m	EUR121m	EUR154m	EUR203m
HERD as % of GDP	0.23	0.26	0.27	0.27
Rank among 28 OECD countries	22	20	21	21
Total researchers in HE sector	1,886	1,817	2,066	2,425
Researchers per 1000 labour force	1.4	1.3	1.4	1.5
Rank among 28 OECD countries	17	20	20	20

See Tables A1.7, A1.8 and A1.9 in the appendices for detailed comparisons

Table 6 shows that Ireland's overall rank on HE expenditure on R&D fluctuated slightly between 1992 and 1998. R&D researchers per thousand of the labour force improved somewhat between 1996 and 1998 but nevertheless Ireland has slipped down the rankings. R&D performed by higher education represents on average nearly 0.4% of GDP in OECD countries and exceeds 0.5% in five European countries (Sweden, Switzerland, the Netherlands, Finland, Iceland and Austria), compared to 0.27% in Ireland.

Resources allocated to R&D in the higher education sector (as a percentage of GDP) continued to rise in the early 1990s, but seem to have levelled off subsequently in the main OECD regions. They have declined in a few countries, notably Canada and Hungary, but increased in a number of others such as the Czech Republic, Finland, Korea, Poland and Switzerland.

9 Conclusions

Expenditure on research in the higher education sector (HERD) amounted to £160m (EUR203m) in 1998 up from £121m (EUR154m) in 1996. This continues the upward trend of expenditure since the mid-eighties.

The OECD publishes these data on HERD and HE researchers in their regular update on 'Main Science and Technology Indicators'. The scientific and business communities use this publication in order to assess the scientific capabilities of individual countries.

In projecting future higher education expenditure in 2000 and beyond, there is evidence that growth in Ireland will continue and possibly increase its rate of growth. There have been two major initiatives which will undoubtedly change the Irish research landscape in the higher education sector.

Programme for Research in Third Level Institutions

The Department of Education and Science and the Higher Education Authority (HEA) established the Programme for Research in Third Level Institutions which was launched in May 1998. The £230m (EUR292m) Programme, an unprecedented increase in investment in advanced scientific and technological research in Ireland, is to run over three years.

The funding is being made available to third level institutions on the basis of submissions by them which are evaluated by an expert review process. An international group will carry out the assessment process whose membership reflects the full range of scholarly activity in science, technology and the humanities. Particular emphasis will be put on the contribution which the proposals make to promote the goals and objectives of the research strategy of the institution.

Technology Foresight Fund

There have only been very limited funds (less than £3m (EUR3.8m) per year) made available in Ireland up to now for fundamental (basic) research projects selected by competitive tendering and a rigorous peer review system. In addition, the scale of the projects has been relatively small, less than £25,000 (EUR31,743) per year for three years. This has not been sufficient to enable strong research groups to be developed or to build up a world class research capability.

Other countries have formal mechanisms in place to develop a high quality research environment. The 1999 Technology Foresight report from Irish Council for Science, Technology and Innovation has identified a serious gap at the pinnacle of the research system in Ireland. It has proposed to make Ireland a centre of world class excellence in selected niche areas of biotechnology, information and communications technologies, and in other areas recommended by the Panel reports. One of the key recommendations

of this Report was that the Minister for Enterprise, Trade and Employment should establish a Fund to invest in research in key areas of technology that can best assist in upgrading the future competitiveness of the traded goods and services sector in Ireland.

In response, the Government has approved a Technology Foresight Fund of over £500 (EUR635) million as outlined in the National Development Plan, for commitment in the years 2000-2006. This will support research excellence in strategic technologies, in creating a critical mass of world class basic research in niche areas within ICTs and Biotechnology. A dedicated Research Foundation will administer and manage this Fund, consulting widely with national and international experts in selecting its niche areas.

It is envisaged that the Foundation will have a two pronged approach to funding. Firstly researchers in Third Level Colleges (including the Institutes of Technology) and research institutes will be offered the opportunity to compete for funds through the international peer review process. Secondly the Foundation will have the option to establish its own laboratories if necessary to secure world class performance.

Funding will be awarded to world class researchers in the selected niches on the basis of a competitive international peer review process. Continuation of support for any project funded by the Foundation will be dependant on a continuing research output at world class level.

The Technology Foresight funding is additional and complementary to the existing spend by Government Departments and Agencies. It may supplement existing research activities to enable them to achieve the required standard and scale.

Given these new initiatives, HERD in Ireland may match the performance of the business sector spend on research (BERD) over the nineties, which increased its share of GDP from 0.61% in 1991 to 1.11% in 1997. Dramatic increases in the HERD/GDP ratio are, however, unlikely because of the continuing rapid growth of GDP.

Appendix 1

Table A1.1 – Expenditure by Field of Science

FIELD OF SCIENCE	1974	1975	1978	1981	1984	1986	1988	1990	1992	1994	1996	1998
	IR£'000	IR£'000	IR£'000	IR£'000	IR£'000	IR£'000	IR£'000	IR£'000	IR£'000	IR£'000	IR£'000	IR£'000
Natural sciences	1,640	2,283	3,260	4,654	7,116	11,445	13,127	20,743	30,802	41,586	44,042	58,456
	a2,082	a2,899	a4,139	a5,909	a9,035	a14,532	a16,668	a26,338	a39,110	a52,803	a55,922	a74,224
Engineering	360	525	1,109	2,341	4,327	6,965	8,722	12,656	17,566	21,129	28,947	39,019
	a457	a667	a1,408	a2,972	a5,494	a8,844	a11,075	a16,070	a22,304	a26,828	a36,755	a49,544
Medical Sciences	556	736	1,113	1,682	3,748	6,020	4,187	4,683	7,065	10,004	10,251	13,244
	a706	a935	a1,413	a2,136	a4,759	a7,644	a5,316	a5,946	a8,971	a12,702	a13,016	a16,816
Agricultural Sciences	431	509	855	1,436	1,215	1,960	3,279	2,130	2,038	2,308	4,232	4,783
	a547	a646	a1,086	a1,823	a1,543	a2,489	a4,163	a2,705	a2,588	a2,931	a¤5,374	a6,073
Social / Humanities	461	1,132	1,917	3,245	5,335	8,610	7,758	9,652	15,497	20,327	33,099	44,902
	a585	a1,437	a2,434	a4,120	a6,774	a10,932	a9,851	a12,256	a19,677	2a25,810	a42,027	a57,014
Total	**3,448**	**5,185**	**8,254**	**13,358**	**21,741**	**35,000**	**37,073**	**49,864**	**72,968**	**95,354**	**120,570**	**160,404**
	a4,378	**a6,584**	**a10,480**	**a16,961**	**a27,605**	**a44,441**	**a47,073**	**a63,314**	**a92,650**	**a121,075**	**a153,092**	**a203,671**

Table A1.2 – Expenditure by Type of Cost and Field of Science 1998

FIELD OF SCIENCE	PAY		OTHER CURRENT		TOTAL CURRENT		CAPITAL		TOTAL	
	IR£'000	€'000	IR£'000	€'000	IR£'000	€'000	IR£'000	€'000	IR£'000	€'000
Mathematics & Computer Science	5,783	7,343	3,344	4,246	9,126	11,588	717	910	9,844	12,499
Physical Science	3,983	5,057	2,292	2,910	6,275	7,968	409	519	6,684	8,487
Chemical Science	6,045	7,676	2,321	2,947	8,365	10,621	602	764	8,967	11,386
Environmental Science	1,783	2,264	1,057	1,342	2,839	3,605	202	256	3,041	3,861
Biological Science	17,309	21,978	11,074	14,061	28,383	36,039	1,537	1,952	29,920	37,991
Civil Engineering	2,419	3,071	1,393	1,769	3,813	4,841	331	420	4,144	5,262
Electrical Engineering & Electronics	11,152	14,160	7,516	9,543	18,668	23,703	2,718	3,451	21,386	27,155
Other Engineering Sciences	7,480	9,498	4,463	5,667	11,943	15,164	1,546	1,963	13,489	17,127
Basic Medicine	5,037	6,396	2,357	2,993	7,394	9,388	934	1,186	8,327	10,573
Clinical Medicine	2,076	2,636	1,230	1,562	3,306	4,198	225	286	3,531	4,483
Health Science	833	1,058	510	647	1,343	1,705	43	55	1,386	1,760
Agricultural Science	2,188	2,778	1,321	1,677	3,509	4,455	349	443	3,858	4,899
Veterinary Medicine	642	815	230	292	872	1,107	53	67	925	1,175
Psychology	1,542	1,958	517	656	2,058	2,613	75	95	2,134	2,710
Economics	3,070	3,898	662	841	3,732	4,739	132	168	3,865	4,908
Educational Science	3,662	4,650	1,592	2,021	5,255	6,672	206	262	5,461	6,934
Other Social Science	13,599	17,267	4,615	5,860	18,214	23,127	842	1,069	19,056	24,196
History	3,172	4,028	541	687	3,713	4,714	112	142	3,825	4,857
Languages & Literature	7,187	9,126	1,047	1,329	8,233	10,454	235	298	8,469	10,753
Other Humanities	1,732	2,199	293	372	2,024	2,570	70	89	2,094	2,659
TOTAL	**100,691**	**127,851**	**48,376**	**61,425**	**149,067**	**189,276**	**11,337**	**14,395**	**160,404**	**203,671**
% TOTAL	**62.7%**	**62.7%**	**30.2%**	**30.2%**	**92.9%**	**92.9%**	**7.1%**	**7.1%**	**100%**	**100**

Table A1.3 – Expenditure by Source of Funds and Field of Science 1998

	HEA INDIRECT FUNDS		DIRECT GOVT SOURCES		IRISH BUSINESS SECTOR		EU		FOREIGN SOURCES		OTHER & OWN FUNDS		TOTAL	
	IR£ '000	€ '000	IR£ '000	€ '000	IR£ '000	€ '000	IR£ '000	€ '000	IR£ '000	€ '000	IR£ '000	€ '000	IR£ '000	€ '000
Maths & Computer Science	3,186	4,046	2,716	3,449	723	918	2,836	3,600	99	126	284	361	9,844	12,499
Physical Science	2,273	2,886	1,645	2,089	80	102	2,104	2,671	123	156	460	584	6,684	8,487
Chemical Science	4,487	5,697	2,184	2,773	470	597	1,359	1,725	214	272	253	321	8,967	11,385
Environmental Science	1,149	1,459	745	946	205	260	645	819	185	235	112	142	3,041	3,861
Biological Science	7,405	9,402	9,214	11,699	2,045	2,597	6,128	7,781	2,293	2,912	2,836	3,601	29,920	37,991
Civil Engineering	1,745	2,216	520	660	369	469	1,208	1,534	0	0	301	382	4,144	5,262
Electrical Engineering & Electronics	3,511	4,458	7,712	9,792	3,074	3,903	5,685	7,218	487	618	917	1,164	21,386	27,155
Other Engineering Sciences	3,779	4,798	4,761	6,045	1,482	1,882	1,927	2,447	380	483	1,160	1,473	13,489	17,127
Basic Medicine	3,483	4,422	1,261	1,601	507	644	241	306	894	1,135	1,942	2,466	8,327	10,573
Clinical Medicine	1,332	1,692	767	974	214	272	292	371	422	536	503	639	3,531	4,483
Health Science	472	600	569	722	1	1	50	63	0	0	293	372	1,386	1,760
Agricultural Science	1,527	1,939	1,873	2,378	184	234	231	293	43	55	0	0	3,858	4,899
Veterinary Medicine	538	683	385	489	0	0	3	4	0	0	0	0	925	1,175
Psychology	1,284	1,630	56	71	26	33	215	273	58	74	494	627	2,134	2,710
Economics	3,127	3,971	131	166	88	112	290	368	0	0	228	289	3,865	4,908
Educational Science	3,561	4,522	1,162	1,475	67	85	380	482	10	13	281	357	5,461	6,934

Other Social Science	12,866	16,337	1,482	1,882	900	1,143	1,785	2,266	15	19	2,007	2,548	19,056	
History	3,106	3,944	568	721	14	18	23	29	0	0	113	143	3,825	4,857
Language & Literature	7,268	9,229	213	270	46	58	768	975	0	0	172	218	8,469	10,753
Other Humanities	1,883	2,391	155	197	14	18	3	4	0	0	39	50	2,094	2,659
TOTAL	**67,985**	**86,323**	**38,119**	**48,401**	**10,509**	**13,344**	**26,172**	**33,232**	**5,224**	**6,633**	**12,395**	**15,738**	**160,404**	**203,671**
% TOTAL	**42%**	**42%**	**24%**	**24%**	**7%**	**7%**	**16%**	**16%**	**3%**	**3%**	**8%**	**8%**	**100%**	**100%**

Table A1.4 – R & D Personnel, Full-Time Equivalent(FTE), by Field of Science 1998

FIELD OF SCIENCE	FULL TIME ACADEMIC STAFF	POST DOCTORAL FELLOWS	RESEARCH ASSISTANTS	TECHNICANS	ADMINISTRATIVE	OTHER STAFF	TOTAL
	FTE	FTE	FTE	FTE	FTE	FTE	FTE
Mathematics & Computer Science	62.1	8.4	78.1	4.14	1.7	6.0	160.4
Physical Science	53.7	21.1	33.6	14.85	2.4	0.0	125.8
Chemical Science	73.3	30.0	35.2	7.97	1.4	0.0	148.0
Environmental Science	16.6	1.0	13.0	10.10	1.4	0.0	42.1
Biological Science	130.9	104.2	235.9	58.78	1.9	31.3	563.0
Civil Engineering	25.6	1.8	10.2	5.50	0.9	0.0	44.0
Electrical Engineering & Electronics	45.6	44.0	114.0	95.72	3.7	35.0	338.1
Other Engineering Sciences	88.5	16.5	108.0	22.60	0.8	7.2	243.6

Agricultural Science	52.4	14.1	44.0	34.41	5.0	0.4	150.3
Veterinary Medicine	19.8	17.0	24.6	6.48	4.0	0.0	71.9
Basic Medicine	7.1	0.0	11.7	0.50	0.7	0.0	20.0
Clinical Medicine	19.8	1.0	8.0	9.20	0.1	5.0	43.3
Health Science	6.6	0.0	3.7	10.44	4.1	0.9	25.8
Psychology	22.3	1.6	10.4	1.21	0.2	0.0	35.7
Economics	78.2	0.0	2.0	0.00	1.6	0.0	81.7
Educational Science	47.7	0.9	2.4	0.90	0.5	0.0	52.4
Other Social Science	331.3	2.4	16.6	1.97	13.9	2.0	367.6
History	70.4	0.0	11.7	0.60	1.5	0.0	84.2
Languages & Literature	196.9	1.0	0.0	1.10	1.4	0.0	200.4
Other Humanities	44.7	1.8	0.8	1.50	0.0	0.0	48.9
TOTAL	**1393.6**	**266.9**	**764.1**	**287.96**	**46.8**	**87.9**	**2847.18**
% TOTAL	**48.95%**	**9.37%**	**26.84%**	**10.11%**	**1.64%**	**3.09%**	**100.00%**

Table A1.5 – Expenditure by Types of R & D Activity by Field of Science 1998

FIELD OF SCIENCE	BASIC RESEARCH			APPLIED RESEARCH			EXPERIMENTAL RESEARCH			TOTAL		
						%			%			%
	IR£ '000	€ '000	% Total	IR£ '000	€ '000	% Total	IR£ '000	€ '000	% Total	IR£ '000	€ '000	% Total
Mathematics & Computer Science	3,574	4,538	36.3%	4,496	5,709	45.7%	1,773	2,251	18.0%	9,844	12,499	100%
Physical Science	3,650	4,635	54.6%	2,238	2,842	33.5%	796	1,011	11.9%	6,684	8,487	100%
Chemical Science	4,877	6,196	54.4%	3,356	4,261	37.4%	734	932	8.2%	8,967	11,385	100%
Environmental Science	1,574	1,999	51.8%	1,202	1,526	39.5%	265	336	8.7%	3,041	3,861	100%
Biological Science	14,375	18,252	48.0%	13,180	16,735	44.0%	2,365	3,003	7.9%	29,920	37,990	100%
Civil Engineering	765	971	18.5%	2,423	3,077	58.5%	955	1,212	23.1%	4,144	5,262	100%
Electrical Engineering & Electronics	4,219	5,357	19.7%	9,177	11,652	42.9%	7,991	10,146	37.4%	21,386	27,155	100%
Other Engineering Sciences	2,993	3,800	22.2%	6,874	8,728	51.0%	3,623	4,600	26.9%	13,489	17,127	100%
Basic Medicine	3,991	5,067	47.9%	3,618	4,594	43.4%	718	912	8.6%	8,327	10,573	100%
Clinical Medicine	1,193	1,515	33.8%	1,807	2,294	51.2%	531	674	15.0%	3,531	4,483	100%
Health Science	256	325	18.5%	1,103	1,401	79.6%	26	33	1.9%	1,386	1,760	100%
Agricultural Science	757	961	19.6%	2,645	3,358	68.6%	456	579	11.8%	3,858	4,899	100%
Veterinary Medicine	216	274	23.4%	652	828	70.4%	57	72	6.2%	925	1,175	100%
Psychology	685	870	32.1%	1,167	1,482	54.7%	282	358	13.2%	2,134	2,710	100%
Economics	963	1,223	24.9%	2,810	3,568	72.7%	92	117	2.4%	3,865	4,908	100%
Educational Science	912	1,158	16.7%	3,862	4,904	70.7%	687	872	12.6%	5,461	6,934	100%
Other Social Science	9,905	12,577	52.0%	8,323	10,568	43.7%	828	1,051	4.3%	19,056	24,196	100%

History	3,459	4,392	90.4%	366	465	9.6%	0	0	0.0%	3,825	4,857	100%
Languages & Literature	5,818	7,387	68.7%	2,516	3,195	29.7%	134	170	1.6%	8,469	10,753	100%
Other Humanities	1,561	1,982	74.5%	523	664	25.0%	10	13	0.5%	2,094	2,659	100%
TOTAL	**65,744**	**83,478**	**41.0%**	**72,336**	**91,848**	**45.1%**	**22,323**	**28,344**	**13.9%**	**160,404**	**203,671**	**100%**

Table A1.6.1 – Expenditure by Areas of R & D Activity by Field of Science (excluding Arts/Humanities) 1998

FIELD OF SCIENCE	Electronics	Information & Communications Technology	Production Engineering	Bio-technology	Food	Materials Environ-ment		Energy	Instrumentation	Medical Sciences	Natural Resources	Marine Economics & Social Sciences		Other	Total
	£'000	£'000	£'000	£'000	£'000	£'000	£'000	£'000	£'000	£'000	£'000	£'000	£'000	£'000	£'000
Mathematics & Computer Science	41	7,100	186	74	118	26	75	46	14	120	41	80	265	1,659	9,844
Physical Science	239	311	150	126	5	1,717	361	165	1,068	316	44	56	47	2,078	6,684
Chemical Science	126	383	148	416	580	1,208	709	205	338	625	257	70	104	3,799	8,967
Environ-mental Science	20	66	6	69	0	29	633	33	30	4	942	318	17	874	3,041
Biological Science	108	565	98	13,138	871	163	2,172	15	204	5,827	2,161	1,767	144	2,689	29,920

Civil Engineering	24	231	176	8	0	251	1,602	360	165	2	86	11	152	1,077	4,144
Electrical Engineering & Electronics	14,449	4,679	212	19	47	528	22	220	470	158	25	9	11	535	21,386
Other Engineering Sciences	191	806	1,393	215	1,037	4,527	488	1,137	486	940	335	10	52	1,871	13,489
Basic Medicine	30	211	65	283	8	58	39	0	121	7,008	100	1	105	300	8,327
Clinical Medicine	2	44	2	202	255	6	0	0	26	2,752	0	0	165	76	3,531
Health Science	2	20	2	42	153	0	10	0	6	981	0	0	129	42	1,386
Agricultural Science	0	114	0	382	1,014	0	119	0	150	24	1,292	100	333	330	3,858
Veterinary Medicine	1	45	2	86	60	2	6	0	4	168	268	0	0	283	925
Psychology	2	211	6	2	0	3	6	6	110	255	1	0	1,279	252	2,134
Economics	0	47	0	0	233	0	24	0	0	0	80	8	3,474	0	3,865
Educational Science	0	115	0	0	54	0	72	0	8	449	0	0	1,915	2,848	5,461
Other Social Science	9	727	76	34	30	12	822	33	0	223	286	41	12,723	4,039	19,056
TOTAL	15,244	15,673	2,523	15,093	4,466	8,529	7,160	2,221	3,200	19,853	5,916	2,470	20,916	22,754	146,016
% TOTAL	**10.4%**	**10.7%**	**1.7%**	**10.3%**	**3.1%**	**5.8%**	**4.9%**	**1.5%**	**2.2%**	**13.6%**	**4.1%**	**1.7%**	**14.3%**	**15.6%**	**100%**

Table 1.6.2 – Expenditure by Areas of R & D Activity by Field of Science (Excluding Arts/Humanities) 1998

FIELD OF SCIENCE	Electronics	Information & Communications Technology	Production Engineering	Bio-technology	Food, Materials Environment Energy				Instrumentation	Medical Sciences	Natural Resources	Marine	Economics & Social Sciences	Other	Total
	£ '000	£ '000	£ '000	£ '000	£ '000	£ '000	£ '000	£ '000	£ '000	£ '000	£ '000	£ '000	£ '000	£ '000	£ '000
Mathematics & Computer Science	52	9,015	236	94	150	33	95	58	18	152	52	102	336	2,106	12,499
Physical Science	303	395	190	160	6	2,180	458	210	1,356	401	56	71	60	2,639	8,487
Chemical Science	160	486	188	528	736	1,534	900	260	429	794	326	89	132	4,824	11,386
Environ-mental Science	25	84	8	88	0	37	804	42	38	5	1,196	404	22	1,110	3,861
Biological Science	137	717	124	16,682	1,106	207	2,758	19	259	7,399	2,744	2,244	183	3,414	37,991
Civil Engineering	30	293	223	10	0	319	2,034	457	210	3	109	14	193	1,368	5,262
Electrical Engineering & Electronics	18,346	5,941	269	24	60	670	28	279	597	201	32	11	14	679	27,155
Other Engineering Sciences	243	1,023	1,769	273	1,317	5,748	620	1,444	617	1,194	425	13	66	2,376	17,127
Basic Medicine	38	268	83	359	10	74	50	0	154	8,898	127	1	133	381	10,573
Clinical Medicine	3	56	3	256	324	8	0	0	33	3,494	0	0	210	97	4,483
Health Science	3	25	3	53	194	0	13	0	8	1,246	0	0	164	53	1,760
Agricultural Science	0	145	0	485	1,288	0	151	0	190	30	1,641	127	423	419	4,899
Veterinary Medicine	1	57	3	109	76	3	8	0	5	213	340	0	0	359	1,175

Psychology	3	268	8	3	0	4	8	8	140	324	1	0	1,624	320	2,710
Economics	0	60	0	0	296	0	30	0	0	0	102	10	4,411	0	4,908
Educational Science	0	146	0	0	69	0	91	0	10	570	0	0	2,432	3,616	6,934
Other Social Science	11	923	97	43	38	15	1,044	42	0	283	363	52	16,155	5,128	24,196
TOTAL	19,356	19,901	3,204	19,164	5,671	10,830	9,091	2,820	4,063	25,208	7,512	3,136	26,558	28,892	185,402
% TOTAL	**10.4%**	**10.7%**	**1.7%**	**10.3%**	**3.1%**	**5.8%**	**4.9%**	**1.5%**	**2.2%**	**13.6%**	**4.1%**	**1.7%**	**14.3%**	**15.6%**	**100%**

Table A1.7 – Higher Education Expenditure on Research and Development as a percentage of GDP

	1992		1994		1996		1998	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
No. of countries		28		28		28		28
Australia	0.42	10	0.40	10	0.45	7	0.45	8
Austria	0.52	5	0.52	5	0.52	4	0.52	5
Belgium	0.43	8	0.44	8	0.43	8	0.43	9
Canada	0.40	13	0.38	14	0.36	16	0.35	17
Czech Republic	0.02	28	0.05	28	0.09	28	0.12	28
Denmark	0.38	14	0.40	12	0.40	12	0.41	12
Finland	0.48	6	0.44	7	0.47	5	0.56	4
France	0.37	15	0.38	15	0.39	14	0.38	15
Germany	0.43	9	0.43	9	0.42	10	0.41	11
Greece	0.12	26	0.19	26	0.22	24	0.26	24
Hungary	0.23	23	0.24	22	0.16	26	0.17	26
Iceland	0.41	11	0.33	16	0.42	11	0.51	6
Ireland	0.24	22	0.26	20	0.27	21	0.27	21
Italy	0.27	19	0.27	18	0.27	20	0.26	22
Japan	0.55	4	0.57	4	0.42	9	0.42	10
Korea	0.22	24	0.22	24	0.26	22	0.30	18
Mexico	0.12	27	0.14	27	0.12	27	0.14	27
Netherlands	0.60	3	0.59	3	0.60	3	0.58	3
New Zealand	0.31	18	0.29	17	0.30	17	0.41	13
Norway	0.44	7	0.47	6	0.45	6	0.45	7
Poland	0.19	25	0.19	25	0.21	25	0.21	25
Portugal	0.27	20	0.22	23	0.22	23	0.26	23
Spain	0.26	21	0.27	19	0.28	18	0.28	19
Sweden	0.79	1	0.87	1	0.79	1	0.83	1
Switzerland	0.66	2	0.65	2	0.67	2	0.67	2
Turkey	0.33	17	0.24	21	0.28	19	0.28	20
United Kingdom	0.36	16	0.39	13	0.38	15	0.37	16
United States	0.40	12	0.40	11	0.39	13	0.39	14
Total OECD	0.37		0.38		0.37		0.37%	
European Union	0.38		0.39		0.39		0.38%	
Nordic countries	0.55		0.59		0.57		0.56%	

Source: OECD – Main Science and Technology Indicators
(Nearest year used if data not available for a particular year)

Table A1.8 – Higher Education Sector Researchers per 1000 Labour Force

	1992		1994		1996		1998	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
No. of countries		28		28		28		28
Australia	3.2	2	3.7	1	3.9	1	3.9	1
Austria	1.3	19	1.3	19	1.3	21	1.3	22
Belgium	2.0	6	2.3	5	2.3	6	2.3	7
Canada	2.1	5	2.1	7	2.1	11	2.1	12
Czech Republic	0.2	28	0.3	27	0.7	26	0.5	27
Denmark	1.5	15	1.6	14	2.1	10	2.2	10
Finland	2.1	4	2.4	4	2.6	3	3.3	2
France	1.9	8	2.1	8	2.1	9	2.1	11
Germany	1.6	12	1.6	13	1.7	15	1.6	15
Greece	0.8	25	1.2	22	1.4	19	1.6	16
Hungary	1.1	22	1.1	23	1.0	24	1.0	23
Iceland	1.6	13	1.5	18	2.6	4	3.1	4
Ireland	1.4	17	1.3	20	1.4	20	1.5	20
Italy	1.3	18	1.5	17	1.5	18	1.5	21
Japan	3.4	1	3.5	2	2.5	5	2.6	6
Korea	0.9	23	0.9	25	0.9	25	0.9	25
Mexico	0.2	27	0.3	28	0.3	28	0.3	28
Netherlands	1.8	11	1.8	12	1.6	16	1.6	18
New Zealand	1.8	10	1.8	11	1.7	14	2.6	5
Norway	2.0	7	2.2	6	2.3	7	2.2	8
Poland	1.5	14	1.5	15	1.8	13	1.9	13
Portugal	1.1	20	1.2	21	1.2	22	1.5	19
Spain	1.4	16	1.8	10	1.9	12	1.9	14
Sweden	2.5	3	2.6	3	2.7	2	3.2	3
Switzerland	1.8	9	1.9	9	2.2	8	2.2	9
Turkey	0.4	26	0.5	26	0.6	27	0.6	26
United Kingdom	1.1	21	1.5	16	1.6	17	1.6	17
United States	0.9	24	1.0	24	1.0	23	1.0	24
Total OECD	1.3				1.4		1.4	
European Union	1.5				1.8		1.8	
Nordic countries	2.3				2.4		2.8	

Source: OECD – Main Science and Technology Indicators
(Nearest year used if data not available for a particular year

Table A1.9 – Proportion of All R&D Performed in the Higher Education Sector

	1991		1993		1995		1997	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
No. of countries		26		26		26		26
Australia	26%	13	25%	14	26%	13	26%	12
Austria	35%	4	35%	5	35%	5	35%	6
Belgium	26%	12	28%	9	27%	11	27%	10
Canada	26%	14	24%	17	22%	17	22%	17
Czech Republic	1%	28	5%	28	9%	28	10%	28
Denmark	23%	17	23%	19	22%	19	21%	19
Finland	22%	20	19%	22	18%	23	19%	21
France	15%	25	16%	25	17%	24	17%	24
Germany	17%	23	19%	23	19%	22	18%	23
Greece	34%	5	41%	3	46%	2	52%	2
Hungary	21%	21	26%	11	25%	15	25%	13
Iceland	31%	7	24%	16	28%	10	25%	15
Ireland	22%	18	20%	21	19%	21	19%	22
Italy	22%	19	26%	12	27%	12	25%	14
Japan	19%	22	20%	20	15%	25	14%	25
Korea	8%	27	8%	27	9%	27	10%	27
Mexico	54%	2	47%	2	38%	3	40%	4
Netherlands	30%	8	29%	7	29%	8	27%	9
New Zealand	31%	6	28%	8	31%	7	36%	5
Norway	27%	11	27%	10	26%	14	27%	11
Poland	24%	16	24%	18	28%	9	28%	8
Portugal	43%	3	37%	4	37%	4	40%	3
Spain	29%	9	32%	6	32%	6	32%	7
Sweden	27%	10	26%	13	22%	18	22%	18
Switzerland	25%	15	24%	15	24%	16	24%	16
Turkey	68%	1	67%	1	62%	1	57%	1
United Kingdom	17%	24	19%	24	19%	20	20%	20
United States	15%	26	16%	26	15%	26	14%	26
Total OECD	17%		18%		17%		17%	
European Union	20%		21%		21%		21%	
Nordic countries	26%		25%		23%		21%	

Source: OECD – Main Science and Technology Indicators
(Nearest year used if data not available for a particular year)

Appendix 2

Methodology

1. Introduction

The survey was carried out in conformance with OECD/Eurostat guidelines for estimating levels of research in the higher education sector and the results for Ireland should be comparable to those from other OECD countries.

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

• analysis of financial data received from administrative staff in each college;

• analysis of personnel data received from administrative staff in each college.

2.1 Coverage

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

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

** Institutes of Technology (IT) Athlone IT, Carlow IT, Cork IT, Dundalk IT, Galway IT, Letterkenny IT, Limerick IT, Sligo IT, Tallaght IT, Tralee IT and Waterford IT (Since the survey the number of ITs has increased to 13).

2.2 Timing of survey and subsequent follow-up

Questionnaires were sent out in mid November 1999 to the various colleges. There was intensive follow-up of non-respondents by telephone from February 2000 until the end of April 2000

3 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 respondents in the 1996 survey. Furthermore, research income for each department was provided with source of funds and type of cost specified.

4 Personnel Data

Detailed departmental headcounts were obtained from the personnel offices, categorised by academic staff, post-doctoral fellows, research assistants, technicians, administrative and other staff. In order to calculate fulltime equivalent totals for each category, the co-efficients of total research time derived from the 1996 survey were applied accordingly.

Appendix 3

Definitions of Fields of Science and of Types

Fields of Science and Technology

1. Natural Sciences

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

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

1.3 Chemical sciences (Chemistry, other allied subjects)

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

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

2. Engineering and Technology

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

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

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

3. Agricultural Sciences

3.1 Agriculture, forestry, fisheries and allied sciences (Agronomy, animal husbandry, fisheries, forestry, horticulture, other allied subjects)

3.2 Veterinary medicine

4. Medical Sciences

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

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

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

5. Social Sciences

5.1 Psychology

5.2 Economics

5.3 Educational sciences (Education and training and other allied subjects)

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

6. Humanities

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

6.2 Languages and literature (Ancient and modern languages and literature)

6.3 Other humanities (Philosophy (including the history of science and technology), arts, history of art, art criticism, painting, sculpture, musicology, dramatic art excluding artistic “research” of any kind, religion, theology, other fields and subjects pertaining to the humanities, methodological, historical and other S&T activities relating to the subjects in this group) Source: Proposed Standard Practice for Surveys of Research and Experimental Development, OECD (Frascati Manual 1993)

Type of Research Definitions

Basic research

Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations or phenomena and observable facts, without any particular application or use in view.

Applied research

Applied research is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.

Experimental development

Experimental development is systematic work, drawing on existing knowledge gained from research and practical experience, that is directed to producing new materials, products and devices, to installing new processes, systems and services, and to improving substantially those already produced or installed.

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

Appendix 4

Acronyms

CHIU – Committee of the Heads of Irish Universities

EU – European Union

FTE – Full-time equivalent (1 FTE = R&D 40h per week)

GDP – Gross Domestic Product

GNP – Gross National Product

HE – Higher Education

HEA – Higher Education Authority

HERD – Higher Education expenditure on R&D

OECD – Organisation for Economic Co-operation and Development

PAT – Programme in Advanced Technology R&D – Research and Development