Forfás

Business Expenditure on Research and Development (BERD) Ireland 2003/4

Science and Technology Indicators Unit

Forfás April 2005

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Foreword

This report focuses on analysis of Research and Development (R&D) activities performed across the business sector in Ireland in 2003/04. Data published and analysed in the report has been gathered from a large-scale survey of the business sector asking detailed questions about R&D activity. The report analyses R&D activities of the business sector, and can be used alongside other data gathered from R&D surveys of the Government and Higher Education Sectors, to examine the total R&D performance across the Irish economy.

The survey – 'Business Expenditure on Research & Development' (BERD survey), continues a series of biennial surveys carried out by Forfás over the past two decades. The most recent survey was carried out in the period September to December 2004, with the reference year for data collected being the calendar year 2003.

A more detailed methodological note on operational procedures including sampling, fieldwork procedures, re-weighting and analysis of the data is included in Annex 1 of this report. It should be noted that the data gathered from this survey of business R&D activities, adheres strictly to the international rules and definitions laid down by the OECD and Eurostat, and as published in the 'Frascati Manual'. This ensures that the data and analyses in this Irish survey of business R&D activities, are internationally comparable, and can be used for performance benchmarking purposes.

Forfás would like to thank the many firms across the Irish economy that assisted in the completion of this survey by answering the detailed questionnaires. The strong response rate achieved from businesses to the survey will allow rapid and accurate analysis to take place, paving the way for policymakers to respond to the needs of the business sector regarding the promotion of higher levels of R&D activity over the coming years.

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Introduction

Research and Development (R&D) activities are one of the key drivers of innovation and creativity within an economy. Higher levels of R&D and innovation investment foster higher productivity gains and increased competitiveness across an economy, by creating and transforming new and existing knowledge, technology and processes into higher value-added commercial activities. It is accepted than each additional euro of investment in R&D, can return a multiple of this amount invested in terms of value added.

Across the Irish economy it is clear that long-term economic growth and development will have to depend more and more on achieving higher productivity growth. Over recent years the Irish economy has already begun to reap the benefits of previous R&D investments, and it is hoped that these positive trends can be maintained and accelerated over the coming years. Increasing R&D investment across the economy will be a crucial catalyst to achieving these economic end-goals. The business sector, supported by government, will play the strongest role in the efforts to raise overall R&D performance and to drive productivity gains in the future.

Alongside the performance of the business sector, the Government is committed to supporting and increasing R&D investment through its commitments given in the National Development Plan and also the European-wide Lisbon Agenda project. As well as being a performer of R&D, the Government has also a strong role in supporting businesses to increase their R&D investments. This includes assisting businesses that carry out R&D, supporting R&D infrastructure, promoting international collaboration and promoting R&D across the education and training systems.

This report focuses solely on the R&D performed across the business sector in Ireland. It includes R&D activities performed by multi-national and Irish-owned firms based in Ireland, but excludes the R&D performed by Irish or other firms outside of Ireland. The survey follows the strict definitions and rules laid down by the OECD and Eurostat Frascati Manual.

It should be noted that Business R&D activity is only measured when it is deemed as being Creative work undertaken on a systematic basis in order to create new or improved products, services or other applications'. These R&D activities are therefore distinguishable from other non R&D business activities by the presence of an appreciable element of novelty and by the resolution of problems and uncertainties using scientific or technological means. Activities such as routine software development, routine monitoring and analysis or pre-production preparation which have no novelty or problem resolution are therefore excluded from this survey of R&D activities.

Adherence to these strict international rules and definitions facilitates comparison of global R&D data and allows performance benchmarking to take place. Data and analysis from this report is therefore crucial in measuring the trends and performance in achieving success in several business goals. These include increasing R&D, boosting overall R&D spending and driving forward productivity and economic gains in the future.

Executive Summary

This report examines Research and Development (R&D) activities performed across the business sector in Ireland in 2003. Data published and analysed in the report has been gathered from a large-scale survey of the business sector asking detailed questions about R&D activity. The following is a summary of the key messages appearing in the main business R&D report.

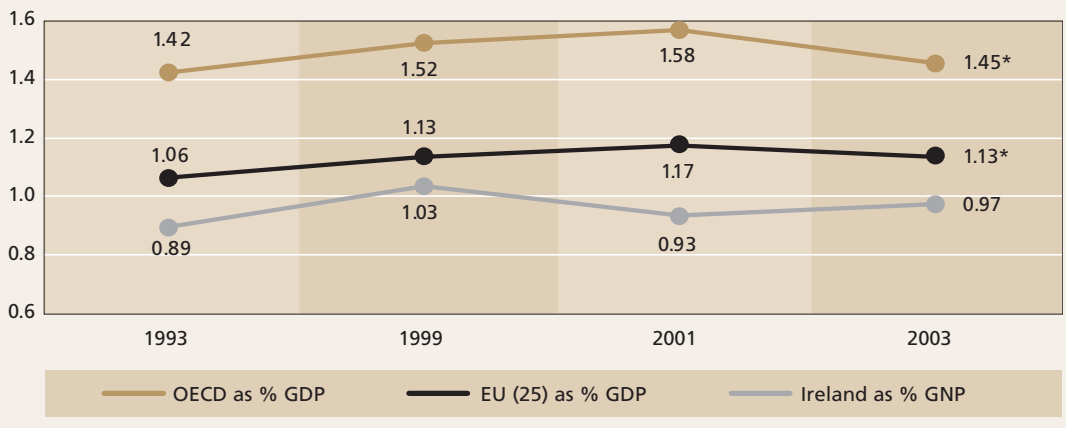
- BERD levels in Ireland stood at €1075.6mn in 2003, representing a nominal growth rate of almost 19.4% over the previous 2 years (9.2% per annum). Looking at previous growth trends from 1993, it is evident that there has been a re-acceleration in the rate of growth of BERD from 2001–2003, following the slowdown in BERD growth from the high growth rates of 1995–1999 when R&D investment was growing from a very low base.
- The strengthening performance in the 2001–2003 period is all the more impressive given the difficult economic conditions at that time which were accompanied by specific sectoral problems in the ICT sector and also by higher investment risks across all other sectors of the economy.
- According to preliminary OECD data, business R&D investment has fallen in nominal terms in the United States and Canada in 2002, and also declined or remained flat in Germany and France in 2003. Against these preliminary results, the 9% per annum growth rate in BERD in Ireland from 2001–2003 is even more satisfactory.

Trends in BERD in Ireland 1993 – 2003 (current prices)

	1993	1995	1997	1999	2001	2003	2004 (estimate)
Business R&D – €mn	343	470	612	784	900.8	**1075.6**	1145
% change (2 yearly)	-	37.0%	30.2%	28.1%	14.9%	**19.4%**	

- The gap between relative R&D performance in Ireland and the EU and OECD has narrowed somewhat between 2001 and 2003.

Trends in BERD (% GDP/GNP) 1993–2003



(=estimate)*

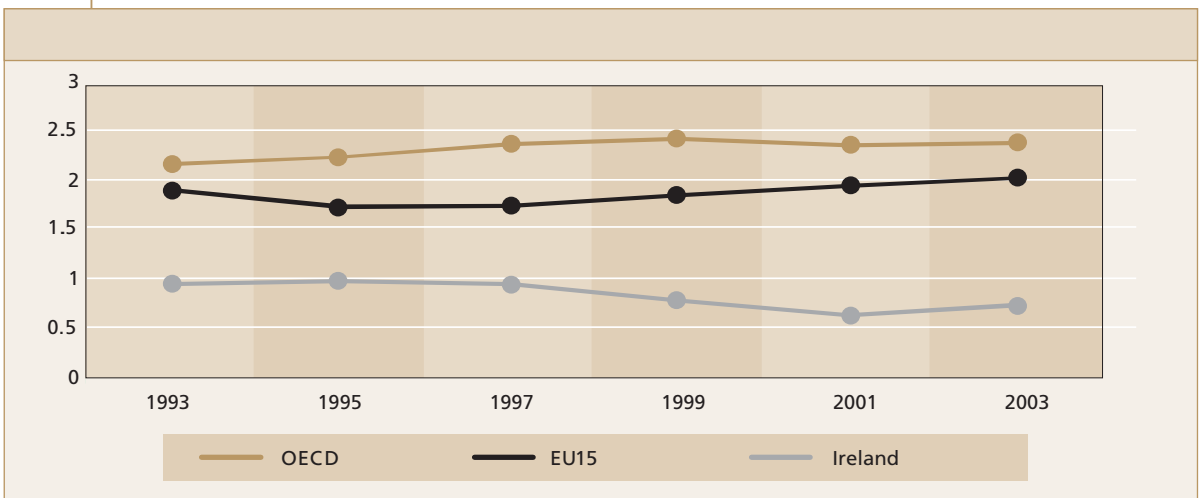
- The Software/Computer sector was responsible for 35% of total BERD in 2003. This was followed by the Electrical/Electronics sector (20%); Pharmaceuticals (18%) and Instruments (11%).
- The relative importance of the Electrical/Electronic Equipment sector to overall BERD fell from 26% in 1993 to 20% in 2003. In contrast, there has been a very substantial growth in the relative share of BERD attributable to the Software & Computer Related sector – from 15% in 1993 to a current level of 35%. The relative role of Food Drink and Tobacco has also fallen back quite substantially accounting for 12% of total expenditure in the early 1990's compared with only 4% in 2003.

Trends in BERD by top sectors, 1993–2003 (€mn)

	1993	1999	2001	2003
Electrical / Electronic Eq.	91.1	206.1	212.4	212.2
Software/Computer Related	49.0	272.6	367.8	378.3
Pharmaceuticals	62.2	82.5	70.7	190.2
Instruments	18.7	38.9	59.3	115.9
Food, Drink & Tobacco	41.7	44.1	50.0	42.3
Overall Total	**339.1**	**780.4**	**900.6**	**1075.6**

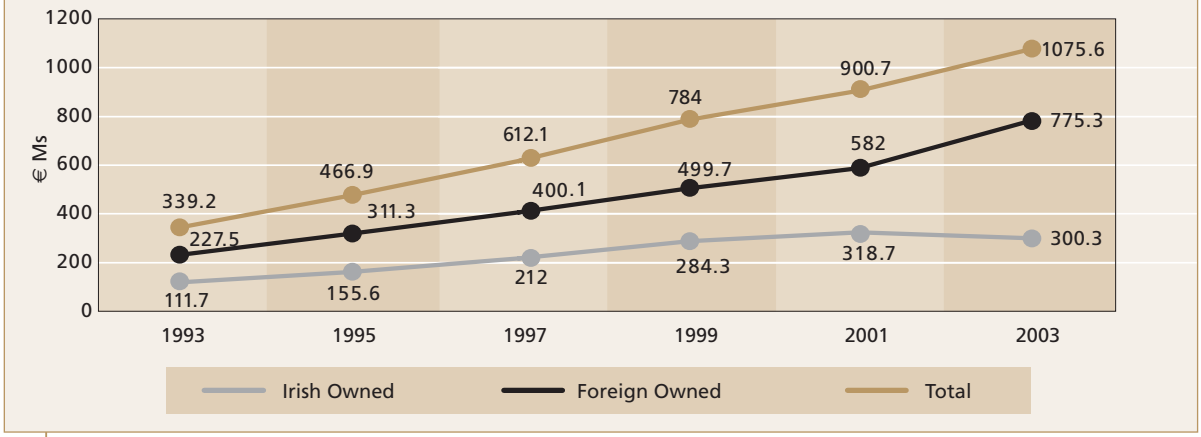
- In terms of contribution to total manufacturing output the report notes that, in aggregate terms, BERD accounts for 0.7% of the value of manufactured output in 2003. At a sectoral level the greatest intensity of R&D expenditure was in the Pharmaceutical sector – where it accounted for 3.8% of the value of measured output. This was followed by Machinery and Equipment (2.4%) and Instruments (2%). Overall R&D intensity continued to lag behind European and OECD averages (2.1% and 2.5% respectively) in 2003.

R&D Intensity (% production) 1993–2003



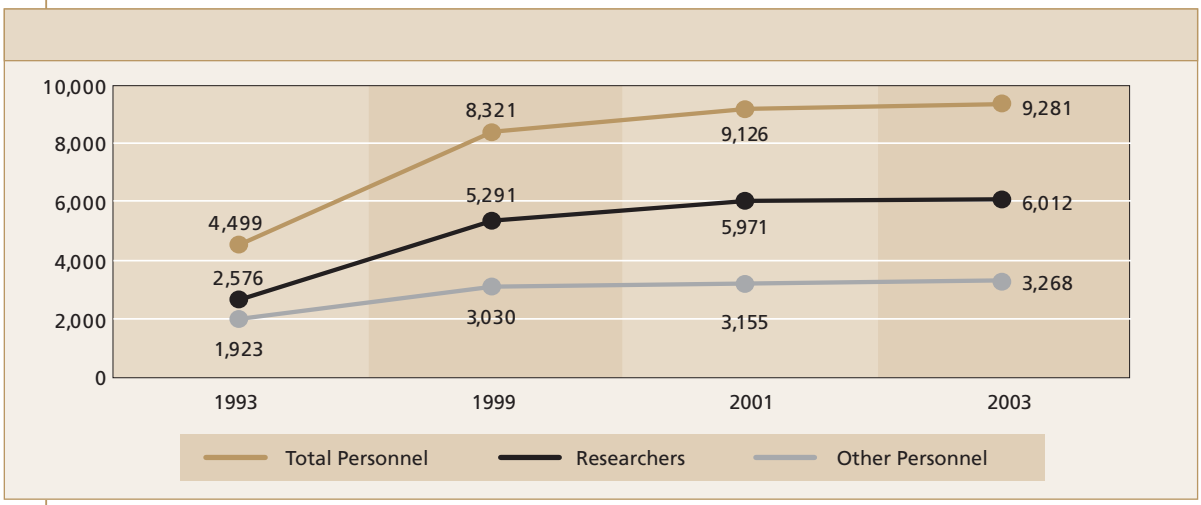
- In broad terms, foreign-owned companies were responsible for just over 72% of total BERD performed in Ireland in 2003, rising from the 65% BERD share recorded in 2001.
- The role of foreign-owned companies is particularly pronounced in some of the high spend sectors such as Pharmaceuticals (foreign companies accounting for 95% of BERD); Instruments (87%) and Electrical & Electronic Equipment (81%).

BERD by Ownership (€ mn) 1993–2003



- In 2003 the number of R&D active firms totalled 1125, an 11% drop in the level of R&D performing firms recorded from the 2001 survey. The number of performing R&D active firms with Irish-ownership fell by 10.7% from 2001 to 2003, with that decline in numbers slightly ahead of the 11.9% fall in companies with foreign ownership in the same period.
- A total of 9,281 full-time equivalent persons were engaged in R&D activity in Ireland in 2003, a slight increase in numbers employed compared with the previous survey. The biennial rate of growth over the last decade has slowed considerably in recent years. R&D personnel are predominantly male (78%).

R&D Employment 1993–2003



Key Indicators 1993–2003

		1993	1999	2001	2003
Resources	1.1 BERD (Current Prices €m)	343	784	900	1,076
€mn and %	1.2 BERD (Constant Prices €m)	463	940	973	1,076
	1.3 BERD (%GNP) Ireland	0.89	1.03	0.93	0.97
	1.4 BERD (%GDP) EU	1.06	1.13	1.17	1.13(e)
	1.5 BERD (%GDP) OECD	1.42	1.52	1.58	1.45(e)
	1.6 BERD (%GDP) Ireland	0.79	0.88	0.78	0.79
Sectoral Data	2.1 Electrical/Electronic Equipment	26%	26%	24%	20%
(% total BERD)	2.2 Software/Computer Related	15%	35%	40%	35%
	2.3 Pharmaceuticals	18%	11%	8%	18%
	2.4 Instruments	5%	5%	7%	11%
Ownership	3.1 Irish Owned	33%	36%	35%	28%
(% of total)	3.2 Foreign Owned	67%	64%	65%	72%
Performing R&D	4.1 Total	820	1153	1264	1125
(number of firms)	4.2 Irish	595	905	978	873
	4.3 Foreign	225	248	286	252
	4.4 Spending >€1.3mn		98	112	108
Human Resources	5.1 Researchers (FTE)	2576	5291	5971	6012
(Number and %)	5.2 Researchers (FTE) per 1000 industrial employment (Ireland)	2.9	4.3	4.5	4.5
	5.3 Researchers (FTE) per 1000 industrial employment (OECD)	5.1	5.7	5.8	5.8
	5.4 Researcher Personnel (FTE)	4499	8321	9126	9281
	5.5 Researcher Personnel (FTE) 1000 industrial employment (Ireland)	4.8	6.8	6.9	7.0
Funding	6.1 Government funding (€m)	13.1	39.8	24.7	32.5
(€mn and %)	6.2 % BERD financed by Government	3.0%	4.0%	2.7%	3.0%
Collaboration (%)	7.1 Total R&D active in collaboration	67%	73%	67%	57%
	7.1 R&D active in business – business collaboration	39%	43%	38%	33%
	7.1 R&D active in business – higher education collaboration	28%	30%	28%	24%
Research	8.1 % spend on basic research	-	-	4.4%	8.9%
(numbers and %)	8.2 Patents applied for	-	-	1698	1464
	8.3 Patents granted	-	-	794	755

1 Aggregate Levels of BERD

1.1 Introduction

This section provides a broad overview of the aggregate level of Business Expenditure on Research and Development (BERD) in Ireland in 2003 along with trends therein over the last decade. In addition, we discuss the relative share of R&D in terms of total economic activity, and also our position in terms of level and intensity of R&D activity relative to other OECD and EU member states. This survey and previous surveys of BERD in Ireland have followed the rules, definitions and methodology laid down in the International Frascati Manual, which governs the gathering of R&D statistics across the European Union and OECD group of countries. Application of these rules therefore allows for meaningful comparisons to be made of Irish R&D performance across the business sector with major competitors on the international stage.

1.2 Aggregate Levels of BERD in Ireland, 1993–2003.

We begin by considering the aggregate level of BERD in Ireland in 2003 in Euro terms along with an examination of growth trends therein over the last decade. Table 1.1 and Figure 1.1 present details on the level of BERD in Ireland over the last decade in nominal and real terms (which allows for inflationary effects to be discounted). The table shows that €1075.6 million was spent on R&D activity performed in Ireland in 2003 by the business sector. This represents a growth in nominal terms of 19.4% in BERD over the period 2001 to 2003, and an average growth rate of 9.2% per annum. In constant 2003 terms we estimate the growth between the 2001 and 2003 surveys to be of the order of 10.6%, and 5.2% average growth per annum.

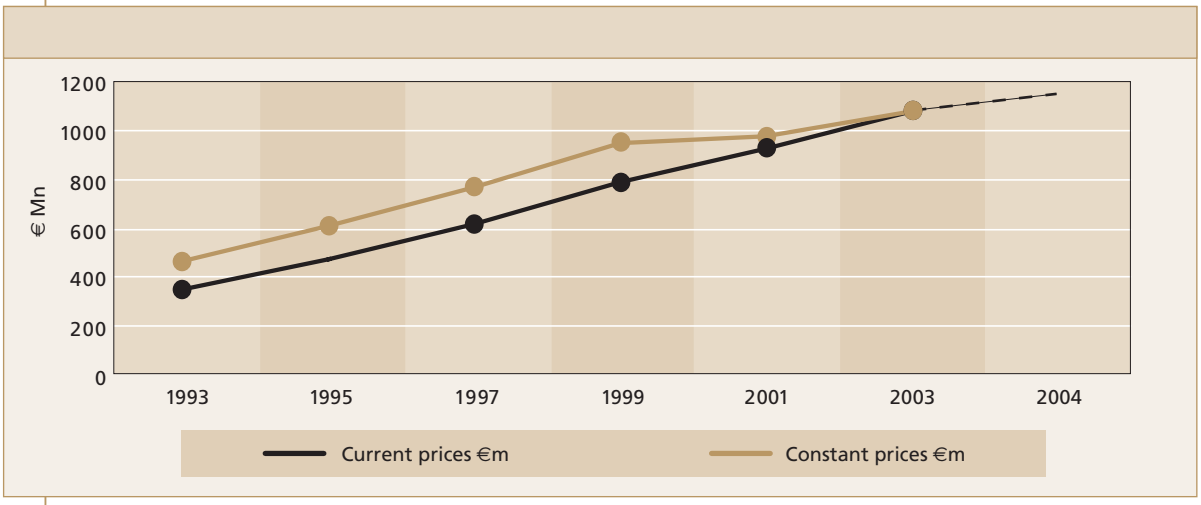
Table 1.1 *Trends in BERD in Ireland 1993–2003 (current and constant prices)*

	1993	1995	1997	1999	2001	2003	2004 (e)
Business R&D – €mn	343	470	612	784	900.8	1075.6	1145
% change (2 yearly)	-	37.0%	30.2%	28.1%	14.9%	19.4%	
Business R&D (constant*) €mn	463	605	764	940	973	1076	
% change (2 yearly)	-	30.6%	26.2%	23.0%	3.5%	10.6%	

* *The CPI deflator was used to bring nominal values to constant 2003 terms in order to remove inflationary effects from the data. Data for 2004 are estimates.*

Looking at previous growth trends from 1993, it is evident that there has been a re-acceleration in the rate of growth of BERD from 2001–2003, following the slowdown in BERD growth from the high growth rates of 1995–1999 when R&D investment was growing from a very low base. The strengthening performance in the 2001–2003 period is all the more impressive given the difficult economic conditions at that time which were accompanied by specific sectoral problems in the ICT sector and also by higher investment risks across all other sectors of the economy. According to preliminary OECD data, business R&D investment has fallen in nominal terms in the United States and Canada in 2002, and also declined or remained flat in Germany and France in 2003. Against these preliminary results, the 9.2% per annum growth rate in BERD in Ireland from 2001–2003 is even more impressive.

Figure 1.1: *Trends in Business Expenditure on Research & Development 1993–2003 (constant and current prices $ mn)*



Estimates for 2004 point to expected BERD levels of €1,145 million. Although these expected results must be interpreted with great care, as firms always display caution when attempting to forecast future R&D spending, this would represent a slowdown in expected BERD investment growth to 6.5% annually in the year 2003–2004.

1.3 Relative Importance of BERD

In addition to analysing overall levels of BERD it is also important to assess the overall relative importance of BERD to the national economy. BERD is therefore measured as a percentage of its contribution to overall economic activity as measured by GNP (Gross National Product) and GDP (Gross Domestic Product). Two measures of economic relativity are employed in the Irish case as there is a 21% difference between both measures of economic activity (compared to just an average 1% difference across Europe), with Irish GDP being artificially boosted by the inclusion of the profits of multi national firms, which are excluded in the GNP measure of economic activity.

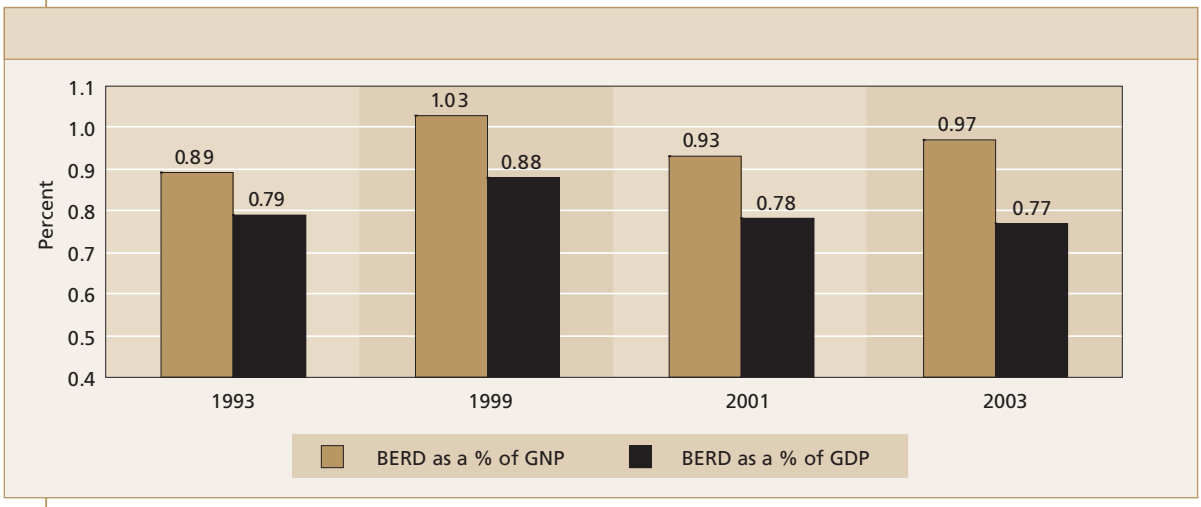
Table 1.2 *Contribution of BERD to GNP and GDP (1993 – 2003)*

	1993	1999	2001	2003
BERD (€mn)	343	784	900.8*	1075.6
% change (two years) BERD	-	-	14.9%	19.2%
% change (two years) GNP	-	-	27.2%	15.0%
% change (two years) GDP	-	-	29.0%	16.8%
BERD as percentage of GNP (%)	**0.89**	**1.03**	**0.93***	**0.96**
BERD as percentage of GDP (%)	0.79	0.88	0.78*	0.79

* *2001 Irish figures have been revised downward from the previous estimate of £917mn to £901mn.*

Table 1.2 and Figure 1.2 show that from 1995–2003 the relative size of BERD to economic activity has remained largely steady around 1.0% of GNP and 0.8% of GDP. Results from the 2003 BERD survey shows that the 18.9% nominal rise in business R&D levels just marginally outpaced the 15% increase in GNP within the same period, allowing the relative BERD/GNP ratio to rise to 0.96% from 0.93%. Therefore, despite strong growth in BERD levels within the period 1995–2003, this performance has been matched by the robust growth of the economy (the strongest in Europe), which has resulted in the relative size of BERD remaining largely the same. Over the coming years as the long term growth of the economy slows to its long term potential (around 6–7% in nominal terms), maintenance of the current BERD rate of growth of 10%+ would allow relative BERD/GNP to rise steadily from the current 1% of GNP toward 1.5% of GNP.

Figure 1.2: *Trends in BERD in Ireland as a percentage of GDP and GNP, 1993, 1999, 2001, 2003*



1.4 International Comparisons

As well as analysing the levels and relative performance of BERD in Ireland, it is also useful to compare this data with other countries in the EU and OECD. As the 2003 BERD survey in Ireland was undertaken using the definitions, rules and methodology required under the international Frascati Manual of R&D, comparison with other major competitors who adopt similar rules is meaningful, particularly when trying to measure progress in achieving one of the key aims of Ireland's R&D Action Plan – 'Business expenditure on R&D should increase to €2.5 billion in 2010 (1.7% of GNP)'.

Table 1.3 and Figure 1.3 provide comparable information in respect of the EU and OECD. It is clear from the table that Ireland has lagged behind both the EU and OECD averages over the 1990s. In 2003 Ireland's BERD/economic activity ratio of 0.97% of GNP compares with an EU (EU–25) BERD/economic activity ratio of an estimated 1.13% of GDP and an estimated OECD ratio of 1.45% of GDP. Final BERD data is not yet available for the EU25 and OECD for 2003 due to survey timeliness issues.

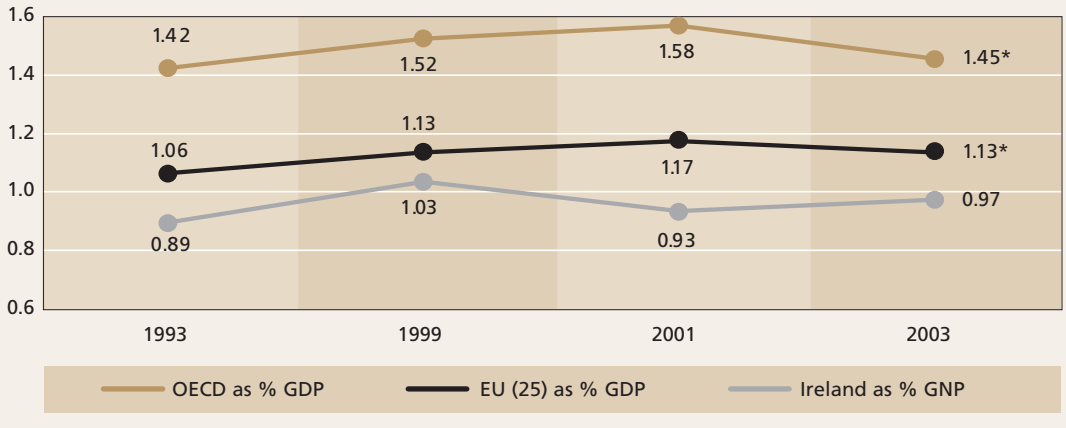
Table 1.3 *BERD as a % GDP, 1993–2003 (GNP Ireland)*

	1993	1999	2001	2003*
Ireland (GNP)	0.89	1.03	0.93	0.97
EU 25 Average	1.06	1.13	1.17	1.13*
OECD Average	1.42	1.52	1.58	1.45*
Rank (OECD 26)	16.0	15	17	15
Sweden	2.21	2.74	3.32	3.30*
Finland	1.26	2.20	2.42	2.40*
France	1.48	1.38	1.41	1.36
United States	1.95	1.98	2.00	1.79
UK	1.36	1.25	1.24	1.26
Canada	0.85	1.07	1.21	1.00
Netherlands	0.95	1.14	1.10	1.02
Denmark	1.02	1.42	1.65	1.75

OECD Main Science & Technology Indicators Volume 2004/2 ** some data for 2003 are estimates*

Despite this, it can be seen that the strong and steady performance of business R&D in Ireland between 2001 and 2003, alongside the R&D slowdown in some other countries, has allowed for a narrowing of the gap between the Irish performance and the EU and OECD average BERD ratios. Ireland's ranking in terms of BERD as a percentage of GDP among 30 EU/OECD countries has also improved from 17th out of the 30 countries benchmarked in 2001, to 15th out of 30 in 2003. (See Appendix Table A3.1 for detailed figures for each of the 30 EU/OECD countries in question). Despite the ranking improvement, relative business R&D activity remains below the leaders in Europe and the OECD. R&D activity in Sweden, which is ranked first among the OECD countries, accounts for 3.32% of GDP; in Finland it accounts for 2.41% of GDP; in the United Kingdom 1.26% of GDP; and in the Netherlands business R&D accounts for 1.02% of GDP.

Figure 1.3: *Trends in BERD (%GDP/GNP) 1993–2003*



* *estimates*

2 BERD by Industrial Sector

2.1 Introduction

In this section we present information on the levels of sectoral R&D activity in Ireland. The sectoral make-up of the overall Irish macro-economy has changed markedly over recent years, as more modern industries gather strength in Ireland and the previous strength and importance of some traditional sectors of the economy begin to ebb away. The levels of R&D performed across the various sectors of the Irish economy continue to undergo rapid change mirroring the fundamental economic changes occurring across the economy.

In addition to asking Irish based firms questions concerning overall levels of current and capital R&D performed and undertaken, the 2003 survey of Business R&D also asked and classified firms relating to their major field of business activity. The main sectoral classifications used in this survey are the standard NACE codes used for analysis by the European Union and by the OECD. Sixteen major sectors were identified in the 2003 BERD analysis, with four sectors identified from that group as major sectoral R&D performers in the Irish economy in 2003, namely Software and Computers, Electrical and Electronic, Pharmaceuticals and Instruments.

Analysing sectoral R&D performance allows identification of important R&D sectors to the overall economy (section 2.2), and also facilitates intensity analysis relative to other indicators such as output and value added (section 2.3). Finally, the sectoral analysis can also be used to benchmark Irish sectoral performance against its European and OECD neighbours.

2.2 Sectoral R&D shares

Figure 2.1 presents summary information on R&D expenditure according to industrial sector. Almost 85% of BERD in 2003 is concentrated in four sectors viz. Electrical & Electronic (19.8%); Software/Computer related activities (35.3%); Pharmaceuticals (17.8%); and Instruments (10.8%). A further 10% is totalled in Food, Drink & Tobacco (3.9%); Machinery & Equipment (3.7%) and Other Services (2.6%).

Figure 2.1: *Sectorial Distribution of BERD in 2003*

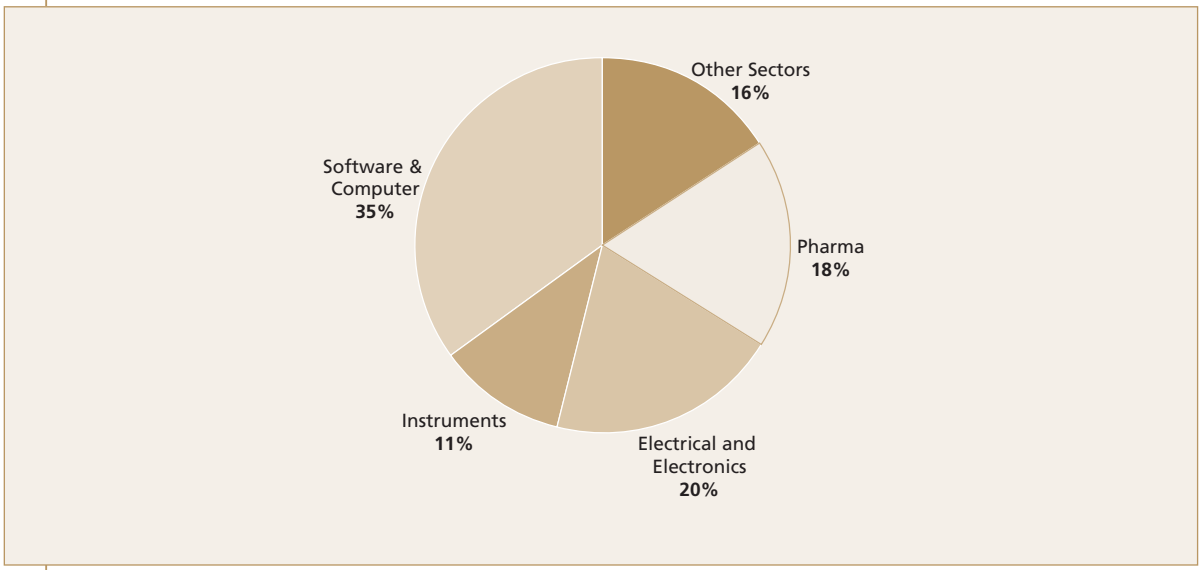


Table 2.1 *Trends in BERD by sector, 1993–2003 (€mn)*

	1993	1999	2001	2003
Software/Computer Related	49.0	272.6	367.8	378.3
Electrical / Electronic Eq.	91.1	206.1	212.4	212.2
Pharmaceuticals	62.2	82.5	70.7	190.2
Instruments	18.7	38.9	59.3	115.9
Food, Drink & Tobacco	41.7	44.1	50.0	42.3
Machinery & Equipment	10.1	22.6	21.7	39.4
Chemicals	16.5	24.1	19.6	17.3
Rubber & Plastics	3.7	11.9	11.8	10.9
Non-Metallic Minerals	6.3	7.0	10.8	8.6
Basic & Fabricated Metals	6.6	9.0	9.4	8.2
Wood Products	0.3	5.7	8.8	8.1
Transport	7.9	12.6	6.5	5.9
Textiles, Clothing, Leather	7.1	4.2	6.0	5.4
Other Manufacturing	1.5	4.9	4.2	6.4
Paper, Print & Publishing	3.7	3.7	3.8	1.3
Uncategorised	12.7	30.5	37.8	25.2
Total	**339.1**	**780.4**	**900.6**	**1075.6**

Tables 2.1 shows the R&D sectoral spend by businesses in Ireland (€mn). Table 2.2 compares these sectoral R&D results as a percentage of total R&D spend in Ireland and with European sectoral R&D averages. This analysis allows comparison to take place across sectors of the economy and to identify those sectors that are more/least important to the Irish economy compared to the European average. The following key R&D facts emerge:

- R&D in the Software/Computer, Pharmaceuticals and Instruments sectors is of more importance to the Irish economy than the EU average.
- R&D in the Transport Equipment sector which is the largest R&D sector across Europe, makes up very little of overall R&D expenditure by Irish-based firms.
- Business R&D spending in the Electrical/Electronic equipment sector is now in line with the EU average sectoral contribution to overall R&D.
- The share of R&D spending in the Irish-based Chemicals and Machinery and Equipment sectors is below the EU average sectoral shares.

Table 2.3 outlines trends in the broad sectoral breakdown of R&D from 1993 to 2003. From the detail of the table one can see that there have been some changes in the relative share of R&D spend by sector over the 1990s and early years of the current decade. There has been a reduction in the relative importance of electrical/electronic equipment in BERD from 26% in 1993 to 20% in 2003. In contrast there has been very substantial growth in the relative share of R&D expenditure attributable to the Software/Computer related sector – from 15% in 1993 to 35% ten years later.

Table 2.2: *BERD Sectoral Share BERD, Ireland and EU*

Sector	Business R&D Ireland – €m	% total R&D Ireland	% total R&D Europe
Software/Computer Related	378.3	35.2	12.4
Electrical/Electronic Equip	212.2	19.7	18.2
Pharmaceuticals	190.2	17.7	12.2
Instruments	115.9	10.8	4.7
Food, Drink & Tobacco	42.3	3.9	1.7
Machinery & Equipment	39.4	3.7	7.5
Chemicals	17.3	1.6	7.8
Other sectors	55.0	5.1	35.5
Uncategorised	25.2	2.3	-
Total	**1,075.6mn**	**100%**	**100%**

Table 2.3 *Trends in BERD by broad sector, 1993–2003*

	1993	1999	2001	2003
	(per cent by sector)			
Electrical & Electronic equipment	26	26	24	20
Software & Computer Related	15	35	40	35
Pharmaceuticals	18	11	8	18
Instruments	5	5	7	11
Food, Drink & Tobacco	12	6	6	4
Other Sectors	24	17	15	12
Total	**100**	**100**	**100**	**100**

The role of Food, Drink & Tobacco in BERD has fallen back quite substantially – from 12% of total in the early 1990s to just 4% by 2003. The trend in the 1990s of a falling share of BERD attributed to the Pharmaceutical sector from a high of 18% in 1993 to 8% in 2001 has now been reversed. The significant increase in Business R&D spending in the Pharmaceutical sector between 2000 and 2003 has now pushed that sector's share of overall R&D spending back up to 18% in 2003. These trends are illustrated in figure 2.2.

2.3 Sectoral R&D intensities

Whilst examining trends in the absolute levels and sectoral shares of BERD is clearly of interest it is possibly of greater importance to consider the contribution of BERD to the output of each sector as well as changes therein over time. Table 2.4 shows that in aggregate terms, BERD accounted for 0.78% of the value of total manufacturing output in 2003, a rise from the 0.65% ratio recorded in 2001, though still below the 0.96% intensity ratio posted ten years previously in 1993. The overall 0.78% Irish R&D manufacturing intensity ratio compared to an EU average BERD/Total manufacturing output ratio of approximately 2.1% (EU15).

Figure 2.2: *Trends in BERD 1993, 1999, 2001, 2003*

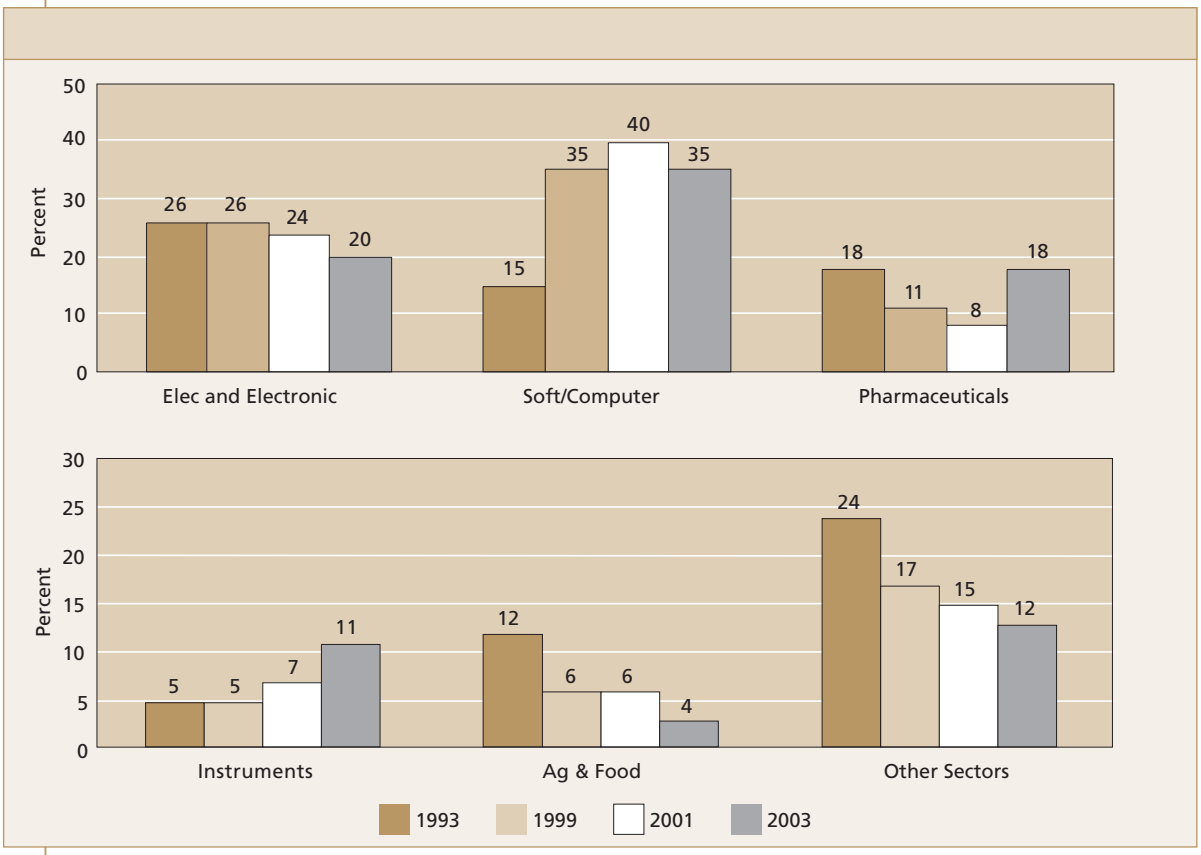


Table 2.4 *R&D Intensity (1993–2003) %*

	1993	2001	2003
Ireland	0.96	0.65	0.78
EU	1.93	2.0	2.1*
OECD	2.2	2.5	2.5*

Irish intensity levels therefore lag behind the EU average pointing to levels of BERD in the manufacturing sector below the potential and optimal value. This weakness in R&D intensity might be magnified somewhat by the distorted levels of output and turnover measured across the economy in the Census of Industrial Production which includes large levels of transfer pricing, particularly among multi-national companies. However, even allowing for these data distortion factors, the intensity data does point to overall weaknesses in R&D intensities in Ireland. Figure 2.3 shows that these intensity weaknesses and gaps between Irish and EU and OECD R&D performance, which had widened from 1993–1999, have remained largely steady in the period 2001–2003.

Figure 2.3: *R&D Intensity (% production)*

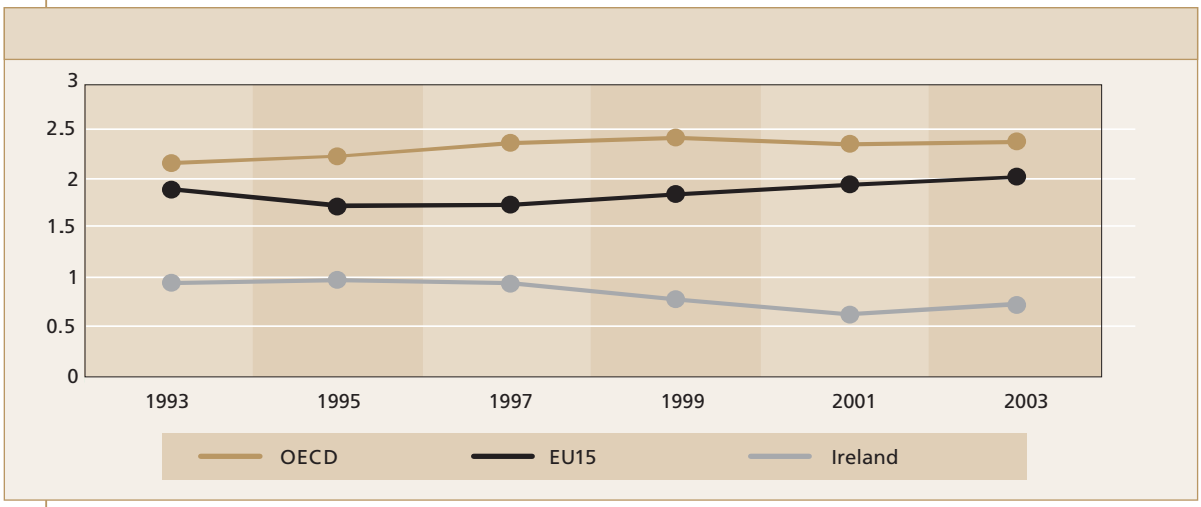


Table 2.5 outlines details on the percentage of output in each manufacturing sector (sectoral R&D intensity) in 2003. The final column of the table provides data on sectoral R&D intensities across Europe. Key points to emerge from the table are:

- The largest intensity of R&D expenditure is in the Pharmaceutical sector (accounting for 3.8 per cent of the value of total output in that sector). This compares with an average EU R&D intensity of 9.9% in this sector. Although the Pharmaceuticals sector is the most intense sector of the Irish economy for R&D expenditure, it still falls well below the EU average. That said, the intensity ratio for this sector has improved dramatically from 2001 when the R&D intensity ratio was as low as 1.3%.
- The second strongest R&D intensity performing group are those firms classified in the Machinery and Equipment sector. The R&D intensity for this manufacturing Irish sector was estimated to be 2.4% in 2003, above the EU average intensity of 1.8% and higher than the intensity ratio of 1.4% measured in 2001.
- The Instruments sector had an R&D intensity ratio of 2.0% in 2003, again below the EU average R&D intensity of 5.1%. The Electrical sector had an R&D intensity ratio of 0.9% in 2003, well below the EU average intensity of 4.5% for this sector.
- In order to improve the overall intensity ratio in Ireland, R&D levels must rise sharply in the key Electrical, Pharmaceutical and Instruments sector which account for almost 50% of total R&D investment. Improvements to the EU average intensity levels in the Pharmaceutical and Instrument sectors toward EU average levels, would push overall R&D intensity up to 1.3%.

Table 2.5: *R&D intensities classified by sector 2003*

Sector	R&D €Mn	% of output Ireland	% of output EU[1]
Electrical/Electronic Equip	212.2	0.9	4.5
Pharmaceuticals	190.2	3.8	9.9
Instruments	115.9	2.0	5.1
Food, Drink & Tobacco	42.3	0.2	0.2
Machinery & Equipment	39.4	2.4	1.8
Chemicals	17.3	0.1	2.3
Rubber & Plastics	10.9	0.9	1.0
Non-Metallic Minerals	8.6	0.6	0.4
Basic & Fabricated Metals	8.2	0.5	0.4
Wood Products	8.1	0.9	-
Transport Equipment	5.9	0.6	4.0
Textiles, Clothing, Leather	5.4	0.7	0.3
Other Manufacturing	6.4	0.4	0.4
Paper, Print & Publishing	1.3	0.0	-
Total Manufacturing	**672.1**	**0.7**	**1.9**
Software/Computer Related	378.3	-	-
Uncategorised[2]	25.2	-	-
Total Business Sector	**1,075.6**		

1 Sectoral output figures were estimated from a combination of the 2002 Census of Industrial Product (CIP); and Industrial Production & Turnover to end December 2003 (CSO Statistical release March 2004).

2 In the context of this survey 'Uncategorised R&D' is a type of residual category designed to capture responses that are infrequent or unanticipated and for which no other appropriate category exists. Caution is urged in interpreting results from survey to survey.

3 Analysis of BERD by Ownership

3.1 Introduction

This section of the report examines variations in BERD according to ownership or the nationality of the company. Ownership and nationality is a designation made by individual survey respondents and refers to whether or not the majority of shares were Irish owned[3] or foreign owned at that particular point in time. Caution should be made in comparing the data over time as a small swing in ownership shareholding can result in volatility in the data from survey to survey. Sections 3.2 and 3.3 examine levels and shares of R&D expenditure by Irish-based firms by nationality of ownership, and also analyses these trends over time. Section 3.4 looks at the intensity of BERD by ownership, and also examines sectoral intensities of Irish-owned and foreign-owned firms and compares them to similar sectors of major competitors.

3.2 Levels of BERD by Ownership

Figure 3.1 provides details on the breakdown of BERD from 1993–2003 according to nationality. Indigenous industry accounted for €300mn of the total €1,075.6mn of business R&D recorded in 2003. This represented a fall of 5.8% in R&D performed in Ireland by Irish-owned firms in the period 2001–2003 (average annual fall of 2.9%). Indigenous R&D performed in Ireland has increased by 169% from 1993.

In contrast to the performance of the indigenous business sector, the levels of R&D performed by foreign-owned firms in Ireland increased by 33.2% in the period 2001–2003 (average annual increase of 15.4%). Foreign-owned R&D has increased by 241% from 1993.

Figure 3.1: *Irish, Foreign and Total BERD 1993–2003*

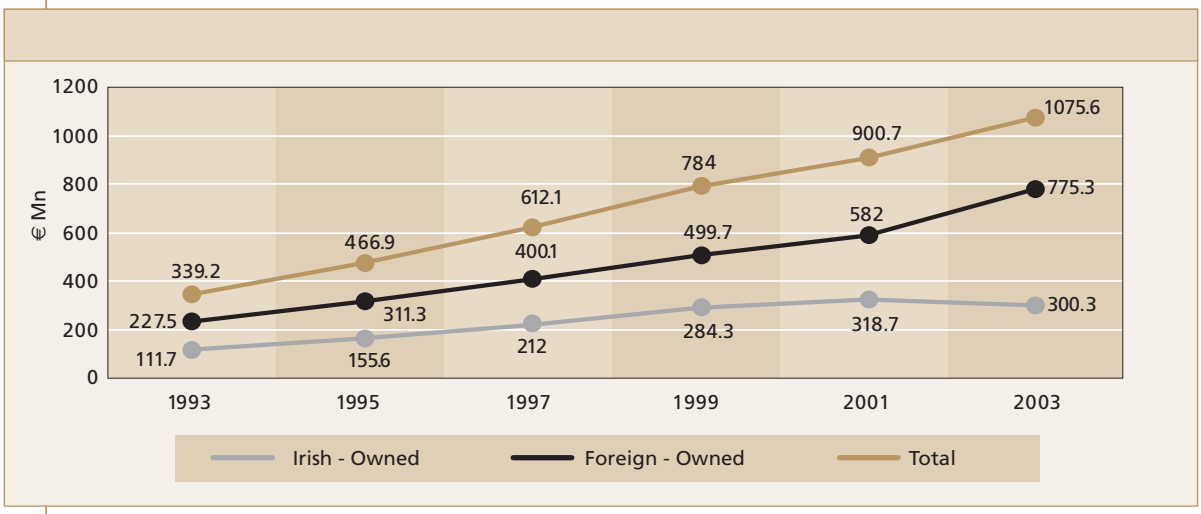
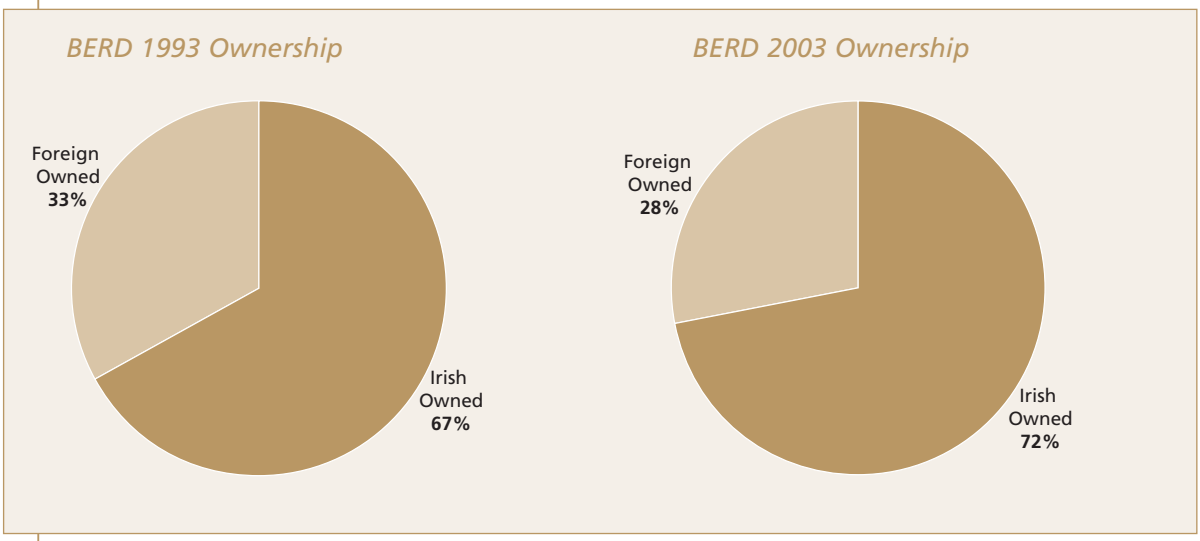


Figure 3.2 shows the changing face of ownership in overall business R&D performed in Ireland from 1993–2003. In 1993, Irish-owned firms accounted for 33% of overall business R&D, with foreign-owned firms accounting for 67% of overall business R&D. In 2003 however these ownership shares had changed dramatically, with Irish-owned firms now accounting for a falling 27.9% of total business R&D investment and foreign-owned firms now making up an increasing 72.1% of overall R&D levels.

3 In the context of the BERD survey, 'Irish-owned' refers to all domestic entities regardless of their size, sector or activity. The designation 'Irish-owned' in the context of the survey is not therefore synonymous with Enterprise Ireland's different client base.

Figure 3.2:



3.3 Sectoral Analysis of BERD by Ownership

Analysis of ownership of firms undertaking R&D activities can be continued further by examining detailed sectoral R&D data by source of ownership. This analysis can be useful in identifying sectoral shifts driving ownership, or ownership shifts driving sectoral R&D levels. Table 3.1 attempts to highlight some of these shifts in R&D investment across the Irish economy. Looking at high spend R&D sectors it is clear that these sectors are dominated largely by foreign owned companies. For example, 95 per cent of R&D expenditure in the Pharmaceutical sector is attributable to foreign owned companies, 87 per cent in the Instruments sector and 81 per cent in the Electrical & Electronic equipment sector.

Table 3.1 *Sectoral BERD by ownership (2003)*

Sector	Value (€m)	Irish-owned % Total	Value (€m)	Foreign-owned % Total
Electrical/Electronic Equipment	39.3	13.1%	172.9	22.3%
Pharmaceuticals	9.8	3.3%	180.4	23.3%
Instruments	14.0	4.7%	101.9	13.1%
Machinery	25.7	8.6%	13.7	1.8%
Food, Drink and Tobacco	26.3	8.8%	16.0	2.1%
Other Sectors	43.0	14.3%	29.2	3.8%
Manufacturing total	**158.1**	**52.7%**	**514.1**	**66.3%**
Software and other services	131.0	43.6%	247.3	31.9%
Uncategorised	11.2	3.7%	13.9	4.6%
Overall Total	**300.3**	**100%**	**775.3**	**100%**

The most important R&D performing manufacturing sectors among Irish-owned firms are the Electrical, Machinery and Food and drink sectors. Irish-owned software firms now account for 43.6% of all performed indigenous R&D. The most important R&D performing manufacturing sectors among foreign-owned firms are the Pharmaceutical, Electrical and Instruments sectors. Foreign-owned software firms accounted for 31.9% of all R&D performed in Ireland by overseas-owned firms.

Figure 3.3 shows the sectoral make-up of R&D performed in Ireland by Irish-owned firms as a share of total Irish-owned R&D in 1993 and 2003 (total €300mn). The most important sectoral trend emerging from this analysis is the rising importance of the software sector in R&D performed by Irish-owned businesses, which rose from a 10% share in 1993 to a 43% share in 2003. Levels of R&D performed by Irish-owned Food and Drink firms has fallen from 1993 to 2003, with that sectors share in overall indigenous R&D levels falling from 30% in 1993 to just 9% in 2003.

Figure 3.3:

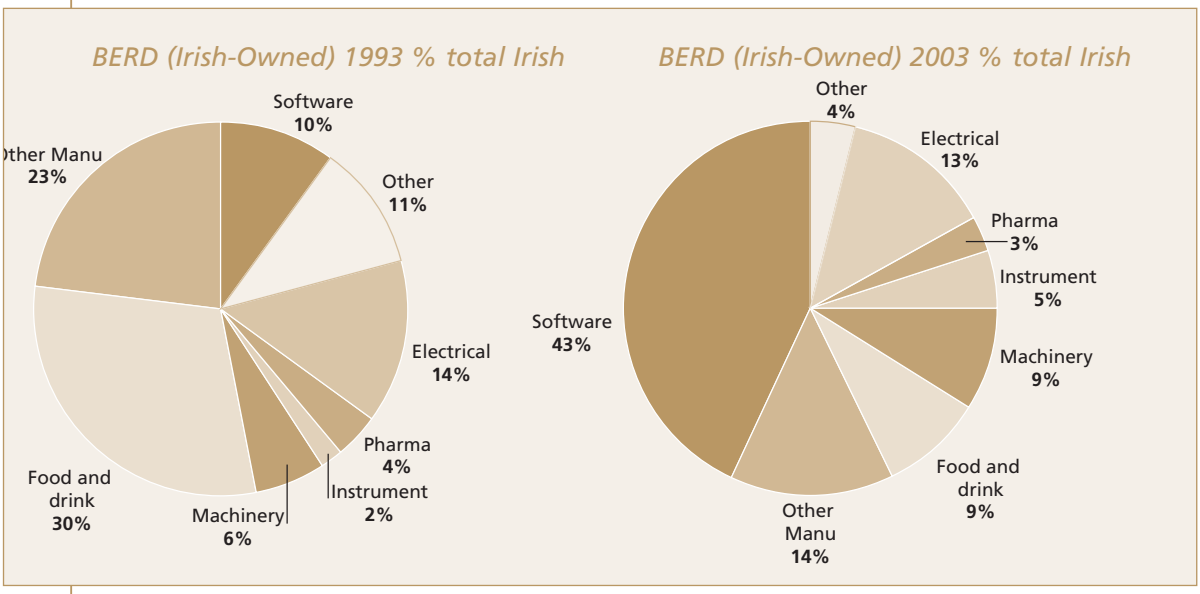


Figure 3.4:

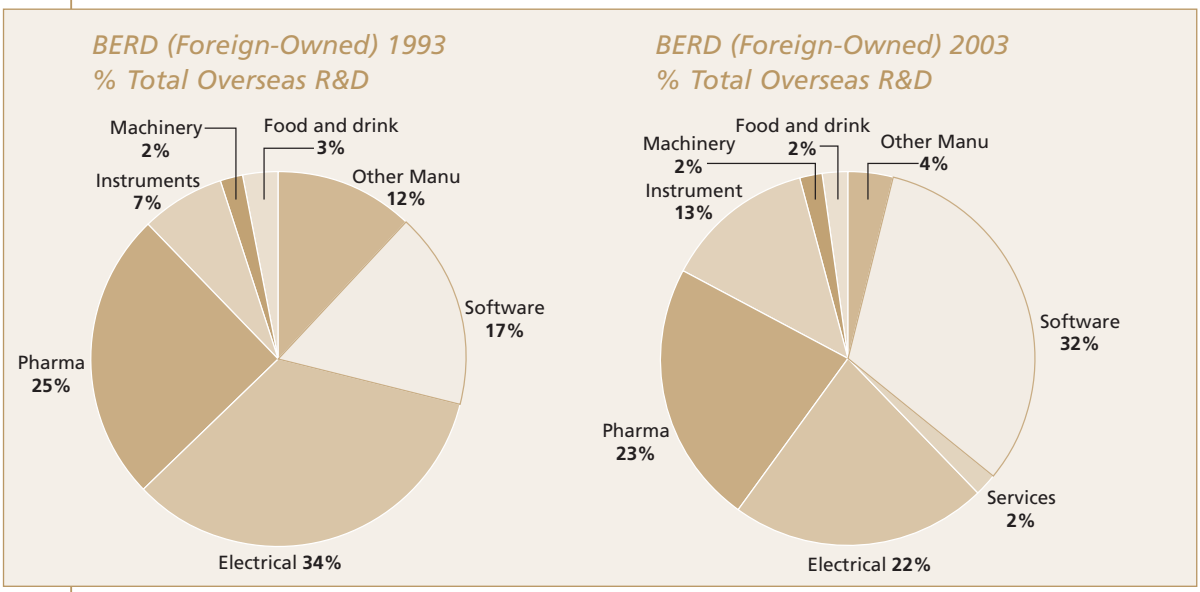


Figure 3.4 shows the sectoral shares of R&D performed in Ireland by foreign-owned firms in 1993 and 2003 as a % of total R&D investment by foreign owned firms (2003 €775mn). The most important issues arising from this analysis is the increase in the sectoral share of R&D performed in the Software sector from 17% of total overseas-owned R&D companies in 1993 to 32% in 2003. In contrast there has been a sharp drop-off in the sectoral share of R&D performed by foreign-owned firms in the Electrical/Electronic equipment sector from 34% of total R&D performed by overseas firms in 1993 to 22% of that total in 2003.

3.4 Sectoral intensity of BERD by Ownership

Table 3.2 examines R&D investment as a percentage of gross output split by ownership of firm. At an aggregate level BERD among Irish companies accounts for 0.75% of total manufacturing output in 2003. Among foreign owned companies, in aggregate terms BERD accounts for 0.65% of the total manufacturing output in 2003. Both intensity measures were well behind the EU and OECD R&D intensity ratios of 2.1% and 2.5% respectively.

Table 3.2 *R&D Intensity by Irish, Foreign, Total Irish, EU and OECD, 1993–2003*

	1993	1999	2001	2003
Irish	0.70	0.90	0.65	0.75
Foreign	1.20	0.80	0.54	0.65
Total	**0.96**	**0.70**	**0.69**	**0.78**
EU	1.9	1.8	2.0*	2.1*
OECD	2.2	2.5	2.5*	2.5*

** estimates*

Time series analysis shows that overall intensity levels among indigenous-owned firms stood at 0.7% in 1993 rising on a biennial basis to 0.9% in 1999, but falling back somewhat to 0.65% in 2001 before quickening once more between 2001 and 2003 to stand at 0.75%. Trend R&D data for foreign owned firms in Ireland shows that the R&D intensity ratio stood at 1.2% in 1993 and fell back significantly until 2001 (0.54%), before re-accelerating once more between 2001 and 2003 to 0.65%.

Table 3.3 shows that there are large differences in the sectoral R&D intensities of firms depending on whether they are Irish-owned or foreign-owned. The Pharmaceutical sector has the highest level of R&D intensity for Irish-owned firms at 9.9% in 2003, outperforming the average R&D intensity in this same sector for foreign-owned firms of 3.7%. Similarly the R&D intensities for Irish-owned firms in the Electrical and Instruments sectors at 5.3% and 4.0% respectively in 2003 far outpace the sectoral R&D intensity of Foreign-owned firms in those same sectors at 0.7% and 1.9% respectively.

Table 3.3 *BERD Intensities, Irish and Foreign by Sector (2003)*

Sector	Irish-owned R&D % of output	Foreign-owned R&D % of output	EU R&D % of output
Electrical/Electronic	5.3%	0.7%	4.5%
Pharmaceuticals	9.9%	3.7%	9.9%
Instruments	4.0%	1.9%	5.1%
Food, Drink & Tob.	0.2%	0.2%	0.2%
Machinery & Equip.	3.9%	1.4%	1.8%
Other Mfr Sectors	0.5%	0.1%	-
Total Manufacturing	**0.75%**	**0.65%**	**1.9%**
Software/Computer	n/a	n/a	n/a
Other Services	n/a	n/a	n/a
Grand Total	**€300.3mn**	**€775.3mn**	

The greatest long-term changes in intensity levels over the last decade among the indigenous sector were recorded in the Electrical & Electronic equipment and Pharmaceutical sectors. The former sector increased from 3.7% in 1993 to 6.7% in 1999 falling back to 4.2% in 2001 and rising again in 2003 to 5.3%. The trend in intensity among Irish companies in the Pharmaceutical sector indicates slightly longer-term decline throughout the 1990's with a substantial increase over recent years in the proportion of output attributable to R&D expenditure. At the beginning of the decade the figure stood at 6.5%. It fell somewhat to a reasonably constant level of 4.6% throughout the latter half of the last decade before continuing its decline in 2001 to 2.3%. However in 2003 it showed a substantial increase to 9.8 per cent as the effects of R&D projects by Irish-owned firms in the Pharmaceutical sector began to take effect.

As was the case with the indigenous sector R&D spend as a percentage of total output among foreign-owned Pharmaceutical companies has shown a substantial decline over the 1990's falling from 7.6% in 1993 to 1.2% in 2001, recovering somewhat into 2003 to an R&D intensity level of 3.7% of gross pharmaceutical output.

4 R&D Performing Firms

4.1 Introduction

This chapter analyses trends over time of the number of firms responding to the survey who were classified as being R&D active. To be counted as R&D active those firms with R&D expenditure greater than €1,000 were included as being R&D active in the Irish economy. The chapter also examines numbers of R&D active firms classified by size of company and by level of ownership (Foreign or Irish owned). Firms were asked questions concerning all these issues in the 2003 BERD survey concerning R&D activities performed in Ireland, allowing classification and cross-tabulation analysis to be carried out. Levels of R&D where also examined to contrast the percentage of R&D being carried out by the percentage number of firms.

4.2 Number of Active R&D performers by ownership

Table 4.1 shows the number of R&D active firms performing in the business sector of the Irish economy from 1993 to 2003. In 2003 the number of R&D active firms totalled 1125. This represented an 11% drop in the level of R&D performing firms recorded from the 2001 BERD survey. The number of firms performing R&D therefore fell back below 1999 levels as less firms were R&D active. Despite the decline in numbers of firms performing R&D, the value of activities spent in this area has increased, indicating a higher average R&D spend per project in the 2001–2003 period.

Table 4.1 *Total numbers of performing R&D firms*

R&D Active	1993	1999	2001	2003
Irish Owned	595	905	978	873
Foreign Owned	225	248	286	252
Total	**820**	**1153**	**1264**	**1125**

The number of performing R&D active firms with Irish-ownership fell by 10.7% from 2001 to 2003, with that % decline in numbers slightly ahead of the 11.9% fall in R&D active companies with foreign ownership in the same period. Figure 4.1 displays time series analysis of the number of R&D active firms by classified ownership from 1993 to 2003.

4.3 R&D Active Companies, by Size and Ownership

Table 4.2 brings forward the analyses of the previous section and classifies that data further into size of total firm-level R&D investment (€) and also by size of firm (number of employees). The bottom row of the table shows that most firm-level R&D spending performed in the Irish economy is below €500,000 (76.7% of total number of R&D projects). A smaller 16.1% of spending is classified as medium sized project with R&D investment between €500,000 and €2,000,000. Large-scale R&D spending firms (those investing greater than €2,000,000) accounted for 7.2% of all R&D projects in 2003. This represents a rise from the numbers of large-scale spending firms recorded in 2001, which was 5.8% the total.

Looking at the data by size of firms (rows), it is evident that small and medium sized firm (0–100 employees) perform a very low percentage of large scale R&D spending as would be expected, compared to those with large numbers of employees. More firms with over 200 employees have spending levels in the medium range. In order to increase the size of BERD levels in the coming years, it is evident that not only must the number of R&D projects undertaken be increased, but also the average R&D investment undertaken in each project must rise. This means a push for more small and medium sized firms into more mid-sized R&D spending in the €500,000 to €2,000,000 value range, and also a push for larger size firms into the 'big-ticket' R&D spending range with values greater than €2,000,000.

Figure 4.1: *Number of R&D active firms 1993–2003*

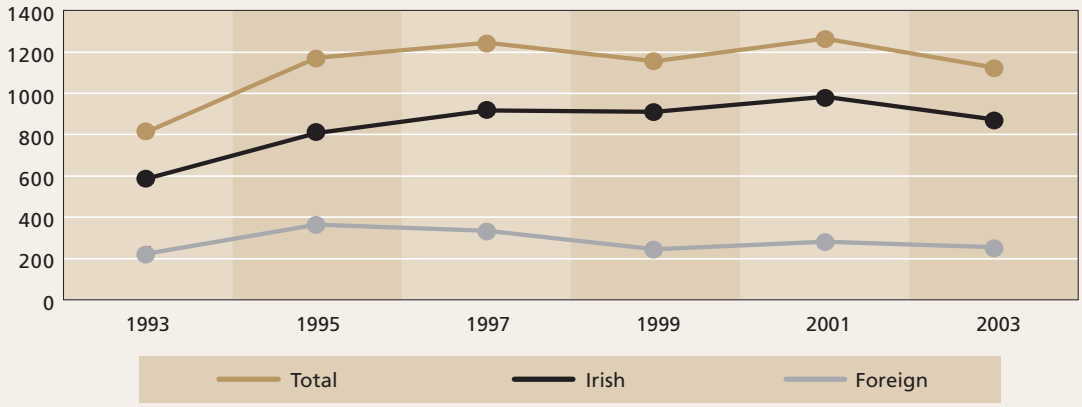


Table 4.2: *% R&D active firms by level of R&D and employees (2003)*

	<€100k	€100k€–500k	€500k–€2mn	€2mn–€5mn	>€5mn
0–10	55.2%	38.5%	5.9%	0.0%	0.5%
11–30	48.7%	34.9%	14.0%	2.0%	0.3%
31–100	37.0%	38.6%	15.8%	4.4%	4.1%
101–200	16.7%	42.7%	28.1%	6.3%	6.3%
>200	6.9%	25.5%	35.3%	11.8%	20.6%
Total	**40.2%**	**36.5%**	**16.1%**	**3.5%**	**3.7%**

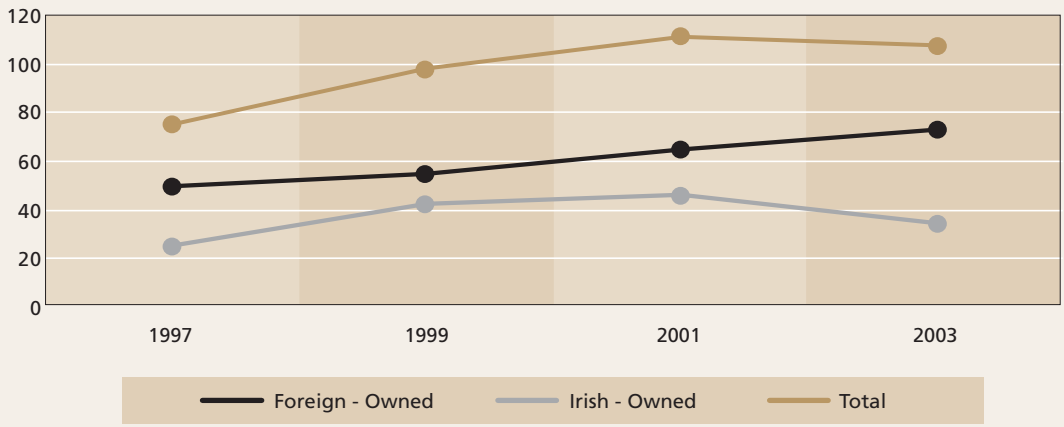
Table 4.3 displays a break down of the percentage of R&D active firms by total firm-level size of R&D investment and also by ownership (Irish owned or foreign-owned). This table shows that for Irish-owned firms performing R&D activities, most projects are concentrated in the small-size categories range (total firm level R&D spending less than €500,000) with a share of 84.8% of the total number of R&D performing firms. This is far ahead of the 48.4% of total performing R&D firms undertaken by foreign owned firms, within these values. Just 2.3% of the total of Irish owned enterprises undertaking R&D activities, invest in large scale R&D spending more than €2,000,000, well below the 23.8% of the total number of R&D active foreign-owned firms undertaking similar sized large-scale R&D investment projects.

Table 4.3 *% R&D active firms by level of R&D and ownership (2003)*

	<€100k	€100k€–500k	€500k–€2mn	€2mn–€5mn	>€5mn
Irish	47.2%	37.6%	12.8%	1.6%	0.7%
Foreign	15.3%	33.1%	27.8%	9.7%	14.1%
Total	**40.2%**	**36.5%**	**16.1%**	**3.5%**	**3.7%**

Figure 4.2 displays the number of R&D performing firms in the Irish economy who have undertaken R&D projects worth more than €1,300,000 from 1993 to 2003. Whilst the total number of firms undertaking large-scale R&D projects rose steadily from 1997 to 2001, this number has fallen slightly in 2003 (108 R&D active firms with projects worth more than €1.3mn). Breaking this number down to factor in ownership of company, it can be seen that the overall drop has been driven by a fall in large-scale R&D projects undertaken by Irish-owned companies, in contrast to the strong performance of foreign-owned firms.

Figure 4.2: *Number of performing R&D firms spending in excess of $ 1.3mn*



4.4 R&D active companies, relative numbers and relative size of investments

Section 4.4 brings the analysis of section 4.3 forward and has additional analysis regarding the share of expenditure attributed to differing sized firms by ownership, benchmarked against the share of R&D performers in those categories. Table 4.4 shows results of this analysis for indigenous-owned firms, with table 4.5 showing comparative analysis for foreign-owned firms.

Table 4.4 *Indigenous distribution of R&D, 2003*

	<100k	100k–500k	500k–2mn	2mn–5mn	>5mn	Total
No. of firms	412	328	112	15	6	873
Share of performers	47.2%	37.6%	12.8%	1.7%	0.7%	100%
Share of expenditure	5.2%	25.5%	32.3%	14.1%	22.8%	100%

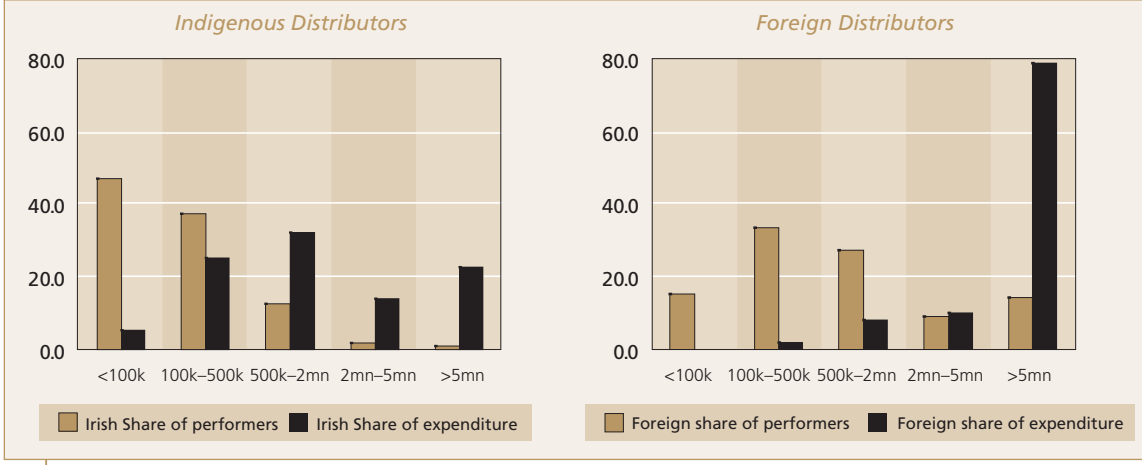
Table 4.5 *Foreign owned distribution of R&D, 2003*

	<100k	100k–500k	500k–2mn	2mn–5mn	>5mn	Total
No. of firms	39	83	69	24	36	252
Share of performers	15.5%	33.1%	27.5%	9.6%	14.3%	100%
Share of expenditure	0.2%	2.5%	8.5%	9.8%	79.0%	100%

The following issues arise:

- Irish-owned firms which are mostly concentrated in smaller R&D spending categories worth less than €500,000 (84.8% of total R&D active), account for 30.7% of total R&D expenditure by Irish-owned firms.
- In contrast foreign-owned firms undertaking similar sized R&D projects (48.6% of total number of R&D active firms are under foreign ownership) account for just 2.7% of the total value of R&D activities by these firms.
- Foreign-owned firms that undertake large-scale R&D projects worth more than €2,000,000 (23.9% of total number of performers), account for 88.8% of the total value of R&D projects undertake by all foreign-owned firms.
- In contrast Irish-owned companies undertaking similar sized R&D projects (2.4% of the total number of R&D active firms which are Irish-owned), account for 36.9% of the total value of R&D projects undertaken by these firms.
- A small number of projects (mostly foreign-owned) contribute greatly to the overall business R&D expenditure in Ireland. 60 foreign-owned firms accounted for 64.3% of the total value of R&D performed by the business sector in Ireland in 2003.

Figure 4.3: *Indigenous distribution*



5 Human Resources

5.1 Introduction

In this section we examine the number of in-house R&D personnel employed during 2003. In the course of the survey of businesses, respondents were asked to record the number of staff involved in in-house R&D classified according to grade and time spent on R&D activities. Respondents were further asked to categorise 'Researchers' into those with and without Doctorates, and 'Research Personnel' into technical and support staff. Finally work was completed to cross reference this data with the key issue of gender.

Given that some staff may share their time between R&D and non-R&D activities respondents were also asked to estimate the average percentage of time spent on R&D. This latter information was used to provide a measure of relevant Full-Time Equivalent (FTE) employment. For example, someone who is recorded as having spent 50 per cent of his/her time engaged on R&D activity is effectively treated as one-half full-time equivalent person. Analysis in this section of the report focuses on the number of full-time equivalent Researchers and Research Personnel, where the equivalisation is based on the percentage of time spent working specifically on R&D activity. Sections 5.2 and 5.3 examine overall employment of Researchers and Research Personnel performing R&D activities in the business sector. Section 5.4 compares these trends with our main international competitors.

5.2 Business R&D employment and gender in 2003

Table 5.1 shows that there were 9281 Full-Time Equivalent Research Personnel employed in the Business Sector in 2003. Of that total, 6012 were classified as Researchers (65%), with 3268 FTE additional Support and Technical staff (35%). 77.7% of all Research Personnel were male, with 22.3% female in 2003. Breaking the data down further:

- 4.3% (396 FTE) of the total Research Personnel in 2003 had PhD's. In this group 82% of these Researchers were male with 18% female, the lowest gender share of all the employment categories.
- 60.5% (5616 FTE) of the total 'Personnel' in R&D employment in 2003 were classified as Non-PhD Researchers, the largest employment group recorded. In that employment category, 20.5% of Non PhD Researchers were female.
- Other Research Personnel staff (Technical and Admin) made up 35% of total employment numbers. Females were represented more in this employment category than the other categories, particularly among support staff with 31.2% of this group being female.

Table 5.1 *Summary employment levels in BERD, 2003 (FTE)*

	PhD Researchers	Non PhD Researchers	Technical	Support Personnel	Total
Number (FTE)	396	5616	1909	1359	9281
% of Total	**4.3%**	**60.5%**	**20.6%**	**14.6%**	**100.0**
% Male	82.0	79.5	77.8	68.8	77.7
% Female	18.0	20.5	22.2	31.2	22.3

5.3 Trends in R&D personnel, 1993–2003

Table 5.1 provides summary details of recent trends in Full-Time Equivalized (FTE) R&D employment in Ireland from 1993 to 2003. From this one can see that there has been a consistent increase in the total number of R&D personnel over the last decade. Levels have risen from 4,499 in 1993 to 9,281 in 2003. Overall numbers rose by 1.7% between 2001 and 2003, though somewhat slower than the 9.7% overall R&D employment rise posted between 1999 and 2001. These trends are highlighted further when examining numbers employed in business R&D activities relative to the size of industrial employment. The sharp rise in Research Personnel between 1999 and 2003 outpaced the increase in industrial employment in that period, pushing the R&D personnel / per 1000 industrial employed ratio up to 7.0 from 6.8.

Table 5.2 *Summary trends in R&D employment in Ireland 1993–2003*

	1993	1999	2001	2003
Total R&D personnel (FTE)	4,499	8,321	9,126	9,281
Total R&D personnel (FTE) per 1000 industrial employment	4.8	6.8	6.9	7.0
Researchers (FTE)	2,576	5,291	5,971	6,012
Researchers (FTE) per 1000 industrial employed	2.9	4.3	4.5	4.5
Other Research Personnel (FTE)	1,923	3,030	3,155	3,268
Other Research Personnel (FTE) per 1000 ind. employment	1.9	2.5	2.4	2.5

The number of Researchers (PhD and non-PhD) has increased from 2576 FTE in 1993 to 6012 FTE in 2003. The numbers of qualified Researchers increased by 0.7% between 2001 and 2003. This was well below the 12.9% employment rise for this category between 1999 and 2001. Specific sectoral employment issues, particularly in the ICT sectors, hampered overall employment growth for qualified researchers between 2001 and 2003. The number of other support staff and admin staff for R&D activities rose by 3.6% between 2001 and 2003. This rise allowed the other R&D staff / industrial employment ratio to remain steady at 4.5. Figure 5.1 displays employment trends for total Research Personnel, alongside employment levels of Researchers (PhD and Non PhD staff), and other Researchers (R&D support and admin staff).

5.4 International comparisons

Table 5.3 shows international comparisons of the number of FTE researchers (PhD and Non PhD) employed in the business sector, as a ratio of numbers in total industrial employment. This is the standard measure used by the EU and OECD to benchmark researcher performance. In 2003 the ratio of FTE Researchers per thousand in 'industrial employment' remained at 4.5 and unchanged from 2001. This ratio was above the average EU25 R&D Researchers employment ratio of 3.8, though below the OECD average ratio of 5.9. Ireland's relative employment ratio for R&D researchers remains well below the leading countries of the OECD, Finland with a ratio of 13.5, and Sweden with a ratio of 10.5. Despite the steady improvement made in relative employment in FTE R&D Researchers, there was a small fall in the international rankings for this measure from 13/25 in 2001 to 14/25 in 2003.

Figure 5.1: *R&D employment 1993–2003*

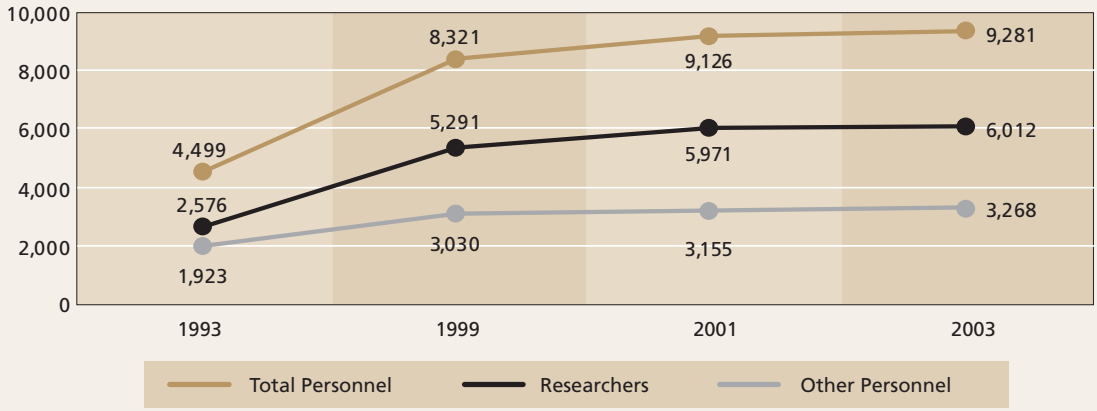


Table 5.3 *International comparisons of business sector researchers 1993–2003*

(FTE Per 1000 Industrial employment)

	1993	1999	2001	2003
Ireland	2.9	4.3	4.5	4.5
EU 25 Average	3.1	3.5	3.8	3.8
OECD Average	5.0	5.7	5.8	5.7
Rank among 25 OECD	15	13	13	14
Sweden	4.8	9.0	10.5	10.5
Finland	3.1	11.4	13.4	13.5
France	3.7	4.9	5.4	5.6
UK	4.1	4.5	4.5	5.0
Netherlands		3.5	3.9	3.6
Denmark	2.9	5.0	5.3	8.0

Table 5.4 shows international comparisons of the number of FTE Researcher Personnel (including admin and support staff) employed in the business sector and completing R&D activities, as a ratio of numbers in total industrial employment. In 2003 the ratio of FTE Researchers per thousand in industrial employment rose to 7.0 from 6.9 in 2001. The ratio was below the average EU25 R&D Researcher Personnel employment ratio of 7.3. Despite the steady improvement made in relative employment in FTE R&D Researchers there has been a small drop in the international rankings for this measure for 13/24 in 2001 to 14/24 in 2003.

Table 5.4 *International comparisons of business sector research personnel 1993–2003* *(FTE Per 1000 Industrial employment)*

	1993	1999	2001	2003
Ireland	4.8	6.8	6.9	7.0
EU 25 Average	6.7	7.1	7.3	7.3
Rank among 24 OECD	13	13	13	14
Sweden	12.0	17.4	18.5	-
Finland	9.5	18.3	19.2	19.2
France	9.9	11.1	11.3	11.6
UK	8.1	7.5	7.3	8.0
Netherlands	6.6	8.2	8.5	8.3
Denmark	9.0	12.1	14.3	15.5

5.5 Sectoral employment of researchers by qualification

Looking at sectoral employment data in 2003 (table 5.5), we can see that the largest sector employing R&D Research Personnel was the Software and Computer related sector, which employed 42.1% of the total FTE number of Researcher Personnel in 2003. The next largest R&D employment sector was the Electrical and Electronic equipment sector which employed 21.8% of the total, followed by the Instruments and Pharmaceutical sectors which employed 8.5% and 6.4% respectively of the total number employed in business R&D activities. These four sectors combined accounted for 78.8% of total numbers employed by business, conducting R&D activities as part of their jobs.

The Instruments sector employed the highest number of PhD qualified researchers in 2003. This sector accounted for 73 FTE PhD Researchers out of the overall 396 FTE PhD Researchers employed in the business sector in 2003 (18.4%). The Electrical, Software and Pharmaceutical sectors had PhD employment ratios just below this number. Non PhD Researchers which totalled 5,616 FTE in 2003 were most commonly employed in the Software sector, which employed 46.1% of the total, and were well ahead of any other sectoral share for Researchers with this set of qualifications.

5.6 R&D spend per head of research personnel

A total of 9,281 persons (FTEs) were engaged in R&D activity in 2003, with 5,777 FTE of these (62%) engaged in R&D activities with firms with foreign-ownership and 3,504 FTE (38%) engaged in R&D with firms with Irish ownership.

Table 5.6 also shows that the average R&D expenditure by Irish based firms per person employed FTE in R&D activities totalled €115,893 in 2003. The average R&D expenditure per person employed was far greater among those firms under foreign-ownership at €134,203, well ahead of the equivalent average for Irish owned firms at €85,702. Sectoral data for these ratios also shows that BERD per capita employed among Irish-owned companies is quite substantially lower in all sectors than among their overseas counterparts.

At a sectoral level per capita spend is highest in the Pharmaceutical sector €322,651 per full-time equivalent person engaged in R&D. One can see that the Software sector is somewhat below the aggregate average with only €96,735 per person engaged (FTE) in R&D.

Table 5.5 *R&D Personnel classified according to industrial sector in 2003*

	PhD		Non PhD		Total Researchers	Total Research Personnel	
	n	%	n	%	n	n	%
Elect. &Electronic	65	16.4	1,609	28.7	1,674	2,025	21.8
Software/Computer	71	17.9	2,589	46.1	2,660	3,911	42.1
Pharmaceuticals	67	16.9	227	4.0	294	590	6.4
Instruments	73	18.4	410	7.3	483	788	8.5
Food, Drink & Tobacco	18	4.5	147	2.6	165	325	3.5
Other Services	20	5.1	189	3.4	209	285	3.1
Mach. &Equipment	29	7.3	205	3.7	234	490	5.3
All Other Sectors	53	13.4	240	4.3	293	867	0.2
TOTAL	**396**	**100.0**	**5,616**	**100.0**	**6,012**	**9,281**	**100**

Table 5.6 *R&D per capita for Irish and foreign companies, 2003*

	Irish Owned Firms	Foreign Owned Firms	All Firms	Ratio Irish/ Foreign
	€ BERD/ FTE	€ BERD/ FTE	€ BERD/ FTE	€ BERD/ FTE
Electrical/Electronics	83,826	111,080	104,771	0.8
Software/Computing	90,476	100,413	96,735	0.9
Pharmaceuticals	98,931	368,019	322,651	0.3
Instruments	73,818	170,367	147,094	0.4
Food, Drink & Tobacco	115,859	164,455	130,154	0.7
Other Sectors	76,687	99,289	84,553	0.8
All Sectors	**85,702**	**134,203**	**115,893**	**0.6**

The final column in the table provides details on the ratio of figures for BERD per capita among Irish and overseas companies. Overall the figure for Irish-owned companies is 60 per cent that of foreign companies. At a sectoral level per capita spend on R&D among Irish-owned companies the Electrical/Electronics and the Software sector is closest to that among their foreign-owned counterparts (80% and 90% respectively). In contrast, in the Pharmaceutical sector per capita spend among Irish-owned companies is only 27% that of foreign-owned companies.

6 Sources of R&D Funding

6.1 Introduction

In this section we first consider the different sources of capital used by firms to fund their R&D expenditure in Ireland. In the course of the interview schedule respondents were presented with 6 possible sources of funding and asked to record which was/were used. The types of capital used were:

- Company's own internal funds
- Funding from other companies in Ireland (for R&D performed on their behalf)
- Funding from Government grants for R&D (including RTI scheme)
- Funding from other Irish sources
- Funding from EU
- Funding from other foreign sources

6.2 Sources of funding for in-house BERD

Table 6.1 presents summary details on sources of funding for in-house R&D in 2003, classified according to ownership. From the final column of the table we can that 87% of funding in 2003 came from companies' own resources or internal funds.

Table 6.1 *Sources of funding for in-house R&D in 2003 by ownership*

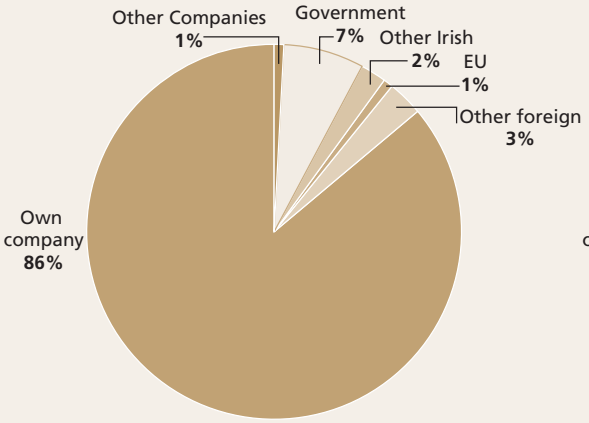
	Irish €Ms	Foreign €Ms	Total €Ms
Own company / internal funds	258.6	678.4	937.0
Payments from other companies in Ireland	1.9	0.4	2.3
Government grants	21.2	11.3	32.5
Other Irish sources	5.0	0.2	5.2
Direct funding from EU	3.5	0.1	3.7
Other foreign sources	10.0	85.0	95.0
Total	**€300.3**	**€775.3**	**€1075.6**

There is very little difference between the foreign companies and the Irish companies in terms of 'own funds' as a capital source (87.5% and 86.1% respectively). Overall, Government grants accounted for 3.0% of the total funding, being substantially greater relative among Irish companies than among foreign owned enterprises. While Irish-owned R&D performing firms recorded 7.0% of their expenditure as coming from 'Government sources' in 2003, the comparable figure in respect of foreign-owned companies is only 1.5%.

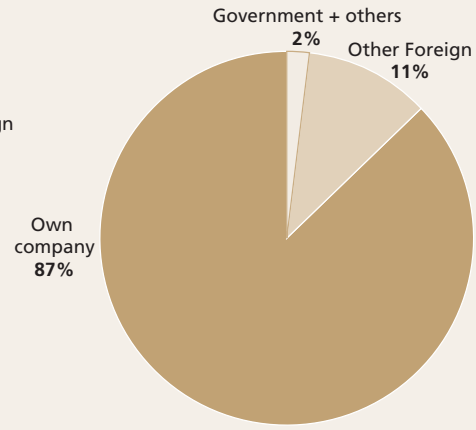
Equally, 'EU' and 'Other Irish' sources are also relatively more important sources of funding for Irish firms. In contrast, as one might expect, 'Other Foreign Sources' play a more significant role for the non-indigenous sector (11.0% compared with 3.3% among Irish companies). Some caution is advised in interpreting these last figures as some foreign-owned companies may have reported transfers from their overseas parent under 'Other Foreign Sources' rather than as being from 'Own Company' sources. This may go some way towards explaining the slightly higher figure for overseas companies in this category. Figure 6.1 summarises these results.

Figure 6.1:

Source of business R&D funding (2003) Irish-Owned



Source of business R&D funding (2003) Foreign-Owned



6.3 Government Funding of business R&D

As can be seen from the previous section, funding of business R&D activities by the Irish Government totalled €32.5mn in 2003. Funding from Government accounted for 3.1% of total BERD investment in 2003, slightly above the 2001 Government funding ratio of 2.7%, though well below the 1997 R&D funding ratio of 6.5%. Funding by the Irish Government for businesses undertaking R&D remains well below EU average government assistance to BERD. In Europe 7.6% of total BERD was financed by Governments in 2003. Ireland was ranked 21st/30 OECD countries.

Table 6.2 *% of business sector R&D financed by government (1997 – 2003)*

	1997		1999		2001		2003(e)	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
Australia	2.4	23	3.2	22	5.1	17	5.1	17
Belgium	5.1	18	6.3	14	5.7	15	5.9	14
Canada	5.0	19	3.5	21	3.2	19	3.2	18
Czech Republic	7.9	13	14.1	3	12.2	4	12.0	3
Denmark	5.3	17	4.1	19	3.1	20	3.1	20
Finland	4.1	22	4.2	18	3.4	18	3.2	18
France	10.4	7	10.0	7	8.4	10	10.3	9
Germany	9.2	10	7.0	13	6.7	12	6.4	12
Hungary	14.6	4	5.7	16	6.1	13	6.4	10
Iceland	5.0	19	2.4	23	1.4	24	1.4	24
Ireland	**6.5**	**15**	**4.0**	**20**	**2.7**	**21**	**3.1**	**21**
Italy	13.1	5	13.0	4	14.9	3	14.4	2
Japan	1.3	25	1.8	25	0.8	25	1.0	25
Korea	4.8	21	5.8	15	8.1	11	5.3	12
Netherlands	5.4	16	5.1	17	5.2	16	5.2	16
New Zealand	8.7	11	9.6	9	8.6	9	8.6	8
Norway	11.0	6	9.7	8	10.3	5	10.3	5
Poland	29.2	1	26.5	1	30.4	1	11.8	4
Portugal	9.4	9	8.1	11	2.1	23	2.1	23
Slovak Republic	16.5	2	24.4	2	20.6	2	22.1	1
Spain	8.7	11	8.6	10	9.5	6	9.5	7
Sweden	7.6	14	7.8	12	5.8	14	5.8	15
Switzerland	2.4	23	2.4	24	2.3	22	2.3	22
United Kingdom	9.6	8	10.2	6	8.9	8	6.7	11
United States	15.2	3	12.3	5	9.4	7	10.0	6
Total OECD	**10.2**		**8.9**		**7.2**		**7.1**	
EU (15)	9.1		8.6		7.9		7.6	

7 Collaboration Activity

7.1 Introduction

In this section we firstly consider the extent to which R&D active companies engage in joint research projects throughout 2003. The 2003 BERD survey asked responding firms to highlight collaboration with other institutions. These institutions included:

Other firms in Ireland, Other firms outside Ireland, Higher education in Ireland, Higher education outside Ireland.

We then move on to examine the extent to which companies out-sourced R&D activity in 2003 to a range of sources including private research laboratories, institutes of higher education, government research facilities etc. These analyses also include data examination of outsourced activities by ownership and also by sector.

7.2 Collaboration

Table 7.1 *Number of firms engaging in joint research projects with other parties inside and outside Ireland by ownership*

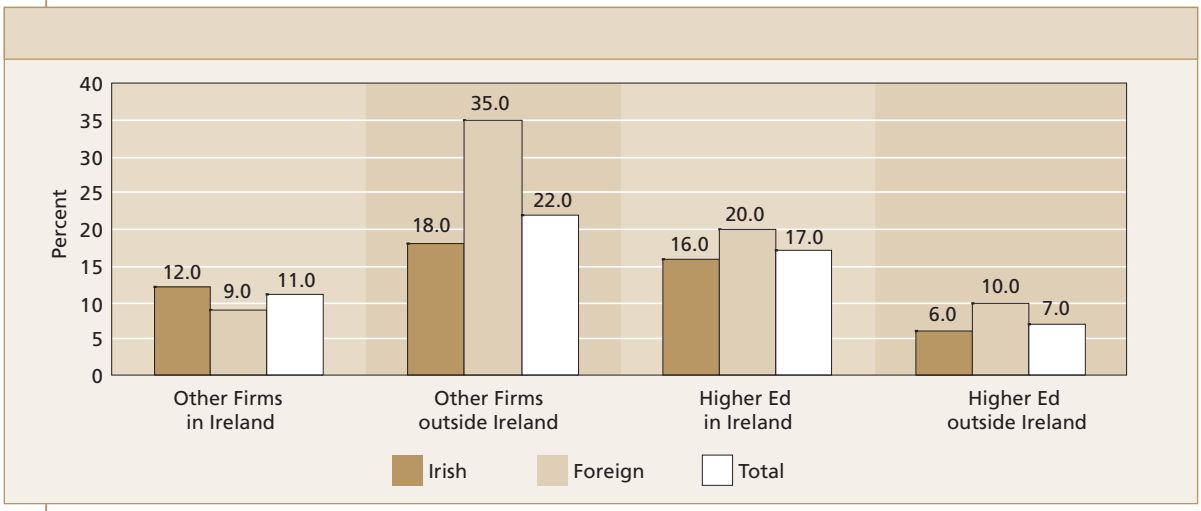
	Other firms Inside Ireland	Other firms Outside Ireland	Higher Ed. Inside Ireland	Higher Ed. Outside Ireland
	Number of firms			
Irish Owned	103	158	143	50
Foreign Owned	23	87	51	25
All	**126**	**245**	**194**	**75**

Table 7.1 outlines details on the number of R&D active firms that were involved in R&D collaborative activities in 2003. It should be noted that this analysis might include those firms who were involved in multi-collaboration activity with a wide range of partnership organisations. A total of 640 R&D collaboration activities were recorded in Ireland in 2003. The largest collaboration was with firms outside of Ireland (38.3% of the total collaborative projects), with collaboration between business R&D firms and higher education institutes in Ireland accounting for 30.3% of all collaborative projects. Collaboration on R&D projects between firms in Ireland accounted for a lower 19.7% of the total number of projects.

One can see that in aggregate terms 56.8% of companies classified as R&D active were involved in a collaborative R&D project performed in Ireland. 11% of R&D active companies had engaged in joint research ventures with other firms inside Ireland and 22% with firms outside Ireland. 17.2% of all R&D active firms were involved in an R&D collaborative project performed in Ireland with Irish higher education institutes and 6.6% of these firms were engaged in collaborative research with foreign higher education institutes.

Analysis can also be undertaken of the extent of collaborative research classified according to nationality of ownership of firm (Fig. 7.1). It is clear that external collaboration is generally much higher among foreign companies. This may, at least in part, be attributable to their link with their overseas parent. It is worth noting in this context, however, that the above average incidence of joint research among foreign R&D active companies is also clearly evident with regard to links with third level education (both inside and outside Ireland).

Figure 7.1: *Percentage of R&D active companies which engaged in collaborative research with other institutions, 2003*



7.3 Trend in collaboration over the years, 1993–2003

Looking at trends in collaboration over the last ten years, it can be seen that the levels of co-operation between firms performing R&D projects in Ireland and other sources has remained largely unchanged. The only exception is for co-operation between firms in Ireland which fell back to 11% of the total number of R&D active companies in 2003 from the 15% total recorded in 2001. This drop was driven mostly by falling co-operation ventures between R&D performing firms in Ireland under foreign ownership and other Irish firms located in Ireland. There was a sharp drop-off between 2001 and 2003 in joint collaboration projects between foreign owned R&D active enterprises in Ireland and higher education institution in Ireland. Collaboration between these two sectors fell from 27% foreign owned R&D active firms in 2001 to 20% in 2003.

Table 7.2 *Percent of firms engaging in joint research projects with other parties inside and outside Ireland classified by ownership, 1993,1999,2001 and 2003*

		Other firms Inside Ireland	Other firms Outside Ireland	Higher Ed. Inside Ireland	Higher Ed. Outside Ireland
		Per cent			
2003	Irish Companies	12%	18%	16%	6%
	Foreign Companies	9%	35%	20%	10%
	All Sectors	**11%**	**22%**	**17%**	**7%**
2001	Irish Companies	15%	18%	17%	8%
	Foreign Companies	16%	38%	27%	13%
	All Sectors	**15%**	**23%**	**19%**	**9%**
1999	Irish Companies	14%	25%	16%	9%
	Foreign Companies	17%	41%	37%	13%
	All Sectors	**15%**	**28%**	**20%**	**10%**
1993	Irish Companies	16%	18%	17%	7%
	Foreign Companies	14%	37%	26%	13%
	All Sectors	**16%**	**23%**	**20%**	**8%**

7.4 Sectoral Distribution

In terms of sectoral variations (Table 7.3) it is clear from the table that R&D active companies in the Instruments sector (16%) had the highest level of collaborative activity among other firms inside Ireland. The Pharmaceutical sector had the lowest levels of joint ventures, with just 6% entering partnerships with other Irish firms in 2003, and well below the overall 11% collaboration level for all sectors. The Electrical/Electronics sector (40%) had the highest level of collaborative activity among other firms outside Ireland. This was closely followed by collaboration with overseas businesses across the Pharmaceutical sector at 36%. Collaboration activities with other businesses irrespective of location was weak in the Software and Computer related sectors.

Looking at collaboration among R&D active firms in the business sector with higher education reveals some differing trends. The Electrical and Instruments sectors had the highest percentage levels of joint ventures with Irish higher education institutes at 32% and 33% respectively, well ahead of the average 17% collaboration level for all sectors. The Food, Drink and Tobacco sector had most of its collaboration activity with Irish higher education institutes at 29%. The weakest collaborative sector was the Software and Computer related sector, with just 8% of R&D active firms in this sector taking part in joint ventures with Irish higher education institutions. That figure fell to 2% in 2003 when looking at collaboration with academic institutes outside of Ireland.

Table 7.3 *Percentage of R&D active companies engaging in joint research projects with other parties inside and outside Ireland classified by broad industrial groups.*

	Other firms Inside Ireland	Other firms Outside Ireland	Higher Ed. Inside Ireland	Higher Ed. Outside Ireland
	(Per cent of All Companies)			
Electrical/Electronics	14%	40%	32%	15%
Software/Computing	7%	15%	8%	2%
Pharmaceuticals	6%	36%	22%	8%
Instruments	16%	33%	33%	14%
Food, Drink & Tobacco	12%	24%	29%	7%
Other Sectors	12%	17%	12%	5%
All Sectors	**11%**	**22%**	**17%**	**7%**

7.5 Outsourcing of R&D activity

In addition to asking firms questions about R&D performed in Ireland on an 'in-house' basis, firms were also asked to calculate other R&D activities carried out on their behalf by other firms and organisations both inside and outside of Ireland. These organisations included related companies (including parent company, affiliates and subsidiaries), non-related companies, Government research institutes, higher education institutes, private R&D laboratories and other sources. It should be noted that accounting rules state that only R&D activities performed in the Irish territory (irrespective of location of firm ownership) can be aggregated to form the overall internationally comparable BERD measure. R&D activities performed on behalf of Irish-based firms outside of Ireland are not included in these totals. However the analysis of this is useful for out-sourcing and collaboration analysis.

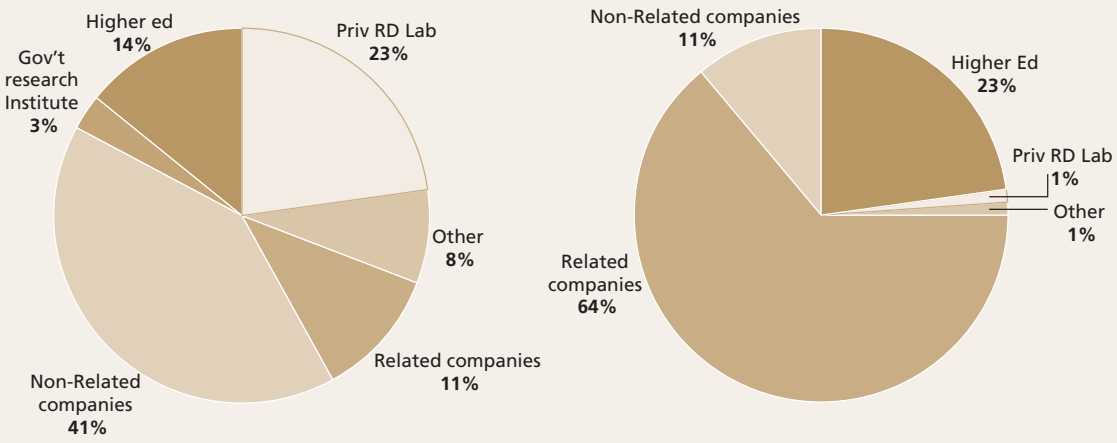
Table 7.4: *Percentage of outsourced R&D activity classified by ownership, 2003.*

Sector	ALL COMPANIES							
	(1) Rel Cos	(2) Non-Rel	(3) Gov Res	(4) Higher Ed	(5) Priv RD Lab	(6) Other	(7) Total	(8) Value €Ms
Irish Companies	11%	42%	3%	14%	23%	8%	100%	18.1
Foreign Companies	64%	11%	0%	23%	1%	1%	100%	138.3
Total	**58%**	**15%**	**1%**	**21%**	**4%**	**1%**	**100%**	**156.4**

The total value of outsourced R&D activity for firms based in Ireland in 2003 amounted to €156.4Ms. A total of €55.3Ms of this was carried out within Ireland (and is included in BERD total), the remaining €101Ms having been located outside the jurisdiction (disqualified from BERD estimates). Outsourcing of R&D activity is clearly dominated by foreign-owned companies which are responsible for €138.3mn (representing 88% of the total).

Outsourced R&D activities of Irish-owned firms was focussed mainly on non-related companies, which accounted for 42% of the total out-sourced R&D activities of Irish-owned firms. Outsourcing to private R&D labs accounted for 23% of that total for Irish-owned firms. Across foreign-owned firms, 64% of the total amount of out-sourced R&D activity was with related companies. 23% of the total amount outsourced was to higher education institutions. Figure 7.2 highlights these differences between the differing importance of the sources for outsourced R&D activities depending on ownership of firm.

Figure 7.2: *Percentage of the value of the total outsourced R&D activity by Irish owned firms in 2003*



Considering outsourcing within sectors one can see that it was mainly concentrated in four sectors viz. Software/Computer related (accounting for 32%); Pharmaceuticals (29%); Instruments (18%) and Electrical/Electronics (12%).

Table 7.5 *Amount of outsourced R&D activity classified by sector, 2003.*

Sector	ALL COMPANIES							
	(1) Rel Cos	(2) Non-Rel	(3) Gov Res	(4) Higher Ed	(5) Priv RD Lab	(6) Other	(7) Total	(8) Value €Ms
Electrical/Electronic	59%	27%	0%	3%	9%	1%	100	18.4
Software/computer	17%	23%	0%	60%	0%	1%	100	50.6
Pharmaceuticals	95%	0%	0%	0%	4%	0%	100	46.0
Instruments	85%	9%	0%	2%	3%	1%	100	28.8
All Other Sectors	20%	30%	5%	21%	11%	13%	100	12.6
Total	**58%**	**15%**	**1%**	**21%**	**4%**	**1%**	**100**	**156.4**

8 Types and Aims of R&D

8.1 Introduction

Section 8 examines a number of aspects of the type, aims and nature of Research & Development activity in Ireland in 2003. This section is broken down into three parts. In Section 8.2 we examine the nature of R&D expenditure in terms of Basic Research, Applied Research and Experimental Development. In Section 8.3 we consider the main product fields targeted by BERD in Ireland. We then analyse the aims of R&D expenditure into developing or improving new products and processes in section 8.4. Finally in section 8.5 we examine the value of contribution of product types to sales turnover.

8.2 Nature of R&D Activity

In this section we examine the nature of R&D activity in 2003. Respondents were asked to assign their R&D expenditure performed in Ireland into three main categories.

- Basic Research – 'involving the experimental or theoretical work undertaken primarily to acquire new knowledge without any particular application or use in view'
- Applied Research – 'the original investigation undertaken to acquire new knowledge primarily directed towards a specific practical aim or objective'
- Experimental development – '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, or to improving substantially those already produced or installed'.

The results are presented in Table 8.1 below. This table shows that a substantial percentage of BERD in Ireland is classified as being experimental in nature (66.4% in 2003). Applied research accounts for 24.7% of expenditure in 2003, with basic research representing 8.9% of total R&D expenditure. If one considers the broad industrial groups one can see that basic activity is relatively more important in the Instruments sector, accounting for 29.1% of activity. Expenditure on applied R&D assumes a roughly equal importance across all sectors.

Table 8.1 *Percentage breakdown of the nature of R&D activity in Ireland, according to ownership*

	Basic	Applied	Experimental
Irish Companies	9.8%	32.8%	58.4%
Foreign Companies	8.5%	22.0%	69.5%
Total	8.9%	24.7%	66.4%

Looking at the type of R&D activity broken down by ownership of firms it can be seen that the percentage levels of basic research carried out between Irish-owned and foreign-owned firms is broadly the same around 9%. However Irish companies have a higher % of activities classified as Applied Research at 32.8%, than foreign-owned companies at 22% of all R&D activities. In contrast foreign-owned firms have a higher percentage of R&D activities classified as experimental development at 70%, compared to Irish-owned firms at 58%.

Table 8.2 breaks down the nature of R&D activity into sectors. The following trends are evident:

- Levels of Basic Research were most important in the Instruments sector (29% of total sectoral R&D), and lowest in the Software/Computer sector at 3.9%.
- Applied research which makes up an average of 24.7% of all activities, was broadly consistent when analysed by sector, with all sectors showing in the 21–26% range.
- Levels of Experimental Research were highest in Electrical and Software sectors.

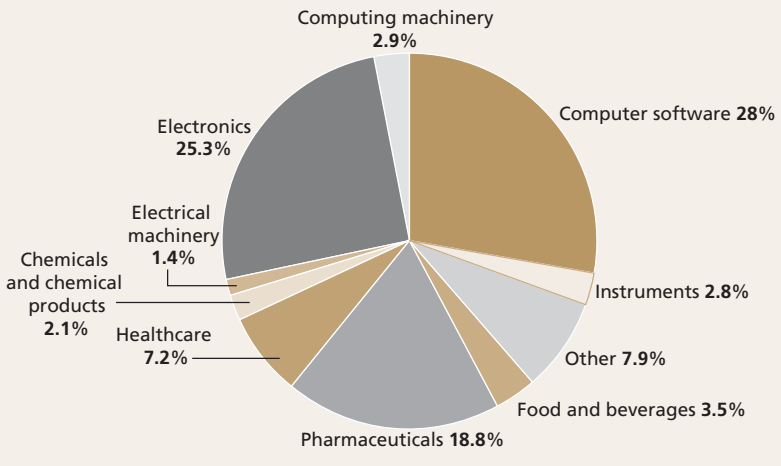
Table 8.2 *Breakdown of the nature of R&D activity in Ireland, according to broad industrial group*

	Basic	Applied	Experimental
Electrical/Electronics	4.2%	22.2%	73.6%
Software/Computing	3.9%	25.1%	71.0%
Pharmaceuticals	11.2%	20.6%	68.3%
Instruments	29.1%	26.5%	44.4%
Food, Drink & Tobacco	10.5%	25.2%	64.3%
Other Sectors	9.1%	31.4%	59.4%
Total	**8.9%**	**24.7%**	**66.4%**

8.3 Product Fields for Business R&D in Ireland

In the course of the survey respondents were asked to record the proportion of their R&D expenditure allocated to each of 9 pre-specified activities or main product fields based on international standard classifications. The nine activities were (1) Food and Beverages; (2) Pharmaceuticals; (3) Medical and Healthcare; (4) Chemical and Chemical Products (less Pharmaceuticals); (5) Electrical Machinery; (6) Electronics (Electronic components, Radio, TV, Communications); (7) Computer Hardware; (8) Computer Software; (9) Instruments (excluding medical devices); and (10) Other. Three main product areas dominate overall R&D investment – Computer Software (accounting for 28%), Electronics (accounting for 25%) and Pharmaceuticals (accounting for 19%). This is shown in Figure 8.1.

Figure 8.1: *Main product fields of BERD activity in Ireland, 2003*



8.4 Aims of R&D Activity

R&D active firms in Ireland were asked to categorise their R&D investment in 2003 by main project aim. The broad aims or objectives of R&D were classified as follows:

- Developing new products / Improving existing products
- Developing new processes / Improving existing processes

Figure 8.2 shows that in aggregate terms, new product development accounts for over half (52.9%) of all BERD. Product improvement or enhancement accounted for another 26% of relevant expenditure in 2003, with process innovations accounting for 20% of total R&D investment. There were little differences in the aims of firms regarding ownership of firm, whether Irish-owned or foreign-owned.

Figure 8.2: *Percentage breakdown of BERD 2003 according to main aims*

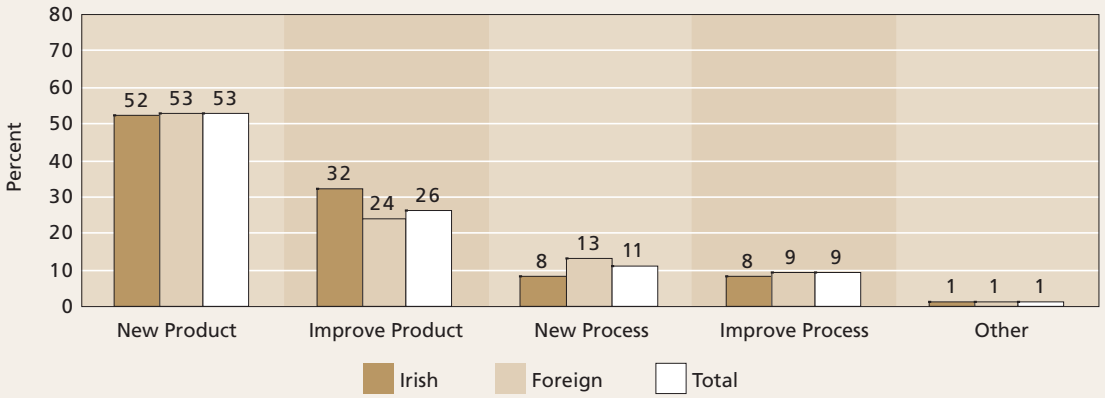


Table 8.3 clearly shows that that new product development is of substantially greater relative importance for sectors such as Electrical/Electronics (63.7%) and Software/Computer (56.4%). Pharmaceuticals on the other hand are more oriented towards process development or improvements in contrast to product development or improvements.

Table 8.3: *Sectoral breakdown of the aims of R&D activity in Ireland in 2003*

	New Product	Improved Product	New Process	Improved Process	Other
Electrical/Electronics	63.7%	28.7%	6.3%	1.4%	0.0%
Software/Computing	56.4%	32.6%	5.7%	5.3%	0.0%
Pharmaceuticals	37.5%	13.0%	26.6%	22.7%	0.2%
Instruments	52.7%	21.8%	14.3%	5.5%	5.7%
Food, Drink & Tobacco	42.2%	26.3%	14.0%	16.7%	0.8%
Other Sectors	51.2%	24.7%	10.3%	13.1%	0.7%
Total	**52.9%**	**26.0%**	**11.3%**	**9.0%**	**0.8%**

8.5 Value of contribution of product types to sales turnover

In this section we look at the total estimated turnover among R&D active companies in 2003 and from there examine the relative contribution from sales of four product types to total sales turnover in 2003. The four product types were as follows:

- Technologically new products introduced between 2001 and 2003 which were new to the respondent's company.
- Technologically new products introduced between 2001 and 2003 which were new to the wider market.
- Technologically improved products introduced between 2001 and 2003
- Products which were technologically unchanged between 2001 and 2003.

The figures in Table 8.4 provide the relevant percentage breakdown of overall turnover of each of the 4 product types in each sector. Looking at the final column of the table it can be seen that the total estimated turnover among R&D active companies in Ireland in 2003 was €50.8bns. The most important sectors were Software/Computer Related (22%); Electrical/Electronic Equipment (21%) and Food, Drink and Tobacco (16%).

Table 8.4: *Percentage contribution to total sales turnover 2003 of 4 product types.*

Sector	New products introduced to Company	New products introduced to Wider Mkt	Improved products introduced to Company	Technologically unchanged Company	Total	Turnover €Ms
Electrical/Electronic	20.3	20.6	24.6	34.5	100.0	10,990.4
Software/Computer	36.9	35.2	4.0	23.9	100.0	11,144.5
Pharmaceuticals	12.9	16.0	13.3	57.8	100.0	5,348.6
Instruments	5.9	4.7	8.0	81.5	100.0	4,778.2
Food, Drink & Tob.	5.1	2.6	9.3	83.0	100.0	8,331.9
Non-Metallic	9.9	9.5	11.6	69.0	100.0	4,029.0
All Other Sectors	8.9	8.2	15.4	67.5	100.0	6,195.1
Total	**17.1**	**16.5**	**12.7**	**53.7**	**100.0**	**50,817.7**

Looking at the contribution of turnover to total sales turnover, Table 8.4 shows that almost 53.7% of turnover in 2003 is estimated by R&D active respondents to have been in the form of products which were 'technologically unchanged' for the company. An estimated 17% of turnover was in respect of products which were 'new to the firm', 16% of the turnover value of products in R&D active companies was 'new to the wider market' and 12.5' of the product was 'improved to the company'.

The sector which appears to be most innovative in terms of introducing products which were 'new to the company or wider market' is the Software/Computer related (37% new to the company and 35 % new to wider market). In contrast the Instruments sector saw just 5% of total turnover coming from new products introduced to the company or wider market. There would appear to be relatively low levels of innovation based in Ireland in the Instruments, Food and Drink and Pharmaceutical sectors.

9 Patents

9.1 Introduction

A patent is '…a legal title of industrial property granting its owner the exclusive right to exploit an invention commercially for a limited area and time. The patent confers on its owner the right to stop others from, among other things, making, using or selling such an invention without authorisation. In return for the exclusive right to exploit it, the technical details of the invention are published. The three criteria that qualify an invention as subject to be patented are its novelty, utility and inventiveness, which are ultimately the grounds for the fundamental hypothesis that a patent represents a codification of inventive activity'.

This section examines the number of patents applied for as well as the number issued to companies who were R&D active in 2003. Section 9.2 examines patent application and section 9.3 deals with patents granted. Respondents were asked to record whether or not applications and awards were made in the Republic of Ireland, the Rest of Europe, the USA or elsewhere.

9.2 Patents Applied for in 2003

A total of 1,464 patents were applied for by R&D active companies in 2003. This represents a 13.8% drop in patent applications from R&D active firms in Ireland compared to 2001 estimates. The number of patents applied for by Irish-owned R&D active firms fell by 19.3% from 2001–2003, with numbers falling by a smaller 6.8% for foreign-owned R&D active firms. 52.2% of total patent applications for R&D active firms in Ireland where therefore from Irish-owned firms in 2003.

Table 9.1 *Trends in patent applications, 1993–2003*

	2001	2003
Irish Owned	948	765
Foreign Owned	750	699
Total	**1698**	**1464**

Figure 9.1 shows the distribution of patents applied for by companies which undertook in-house R&D activity classified by ownership and by location of patent application.

The figures show that approximately one-third of patent applications were made in the USA with a further 28% being made in the Republic of Ireland. Just over one-quarter were made in other European countries outside Ireland while the remaining 13% were made elsewhere. As one would expect, the most striking difference in terms of nationality of company is the much higher percentage among foreign-owned companies applying for patents in the USA. These accounted for 52% of all applications among foreign companies in Ireland. The comparable figure among Irish companies is only 16%. In contrast, patent applications among indigenous companies are characterised to a greater degree as originating within Ireland (41%). The comparable figure among foreign companies is only 14%.

The Software sector and the Electrical & Electronics sector jointly accounted for 43% of the applications (representing 312 and 326 applications respectively). The next most important sectors were the Instruments (19%) and Machinery and Equipment (13%).

At a sectoral level 64% of applications in the Software/ Computer related sector were made to the USA. In the more traditional sectors such as the Food, Drink & Tobacco, Wood Products and Basic & Fabricated Metals a greater proportion of the applications were made in Ireland.

Figure 9.1: *Patents Applied for in 2003 by R&D Active Companies classified according to country of application*

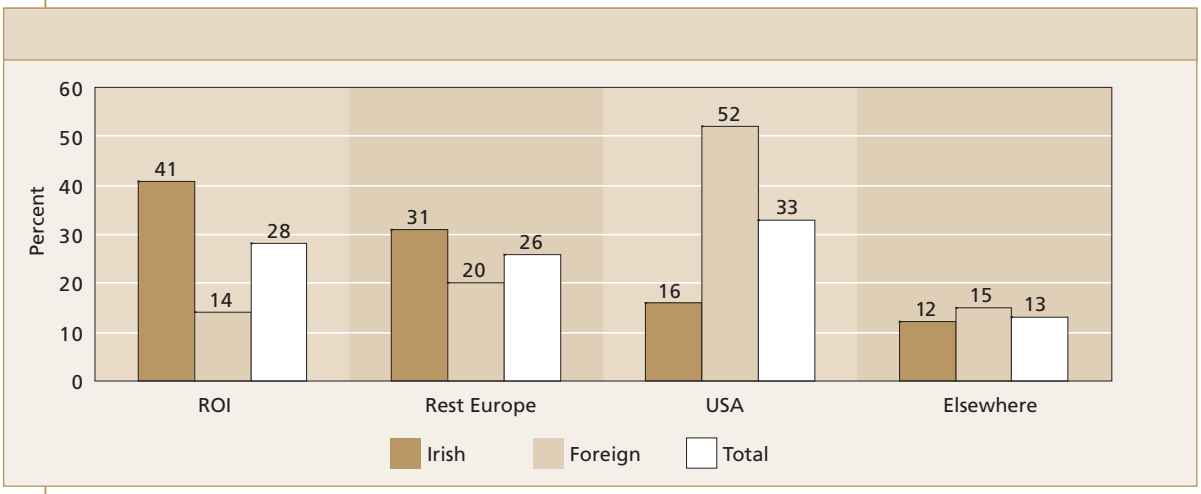


Table 9.2 *Sectoral distribution of patents applied for by companies which undertook in-house R&D activity in 2003*

Sector	All Companies						
	RoI	Rest Europe	USA	Elsewhere	Total	No.	%
Electrical/Electronic Equip	21%	32%	32%	15%	100%	326	22%
Software/computer Related	19%	14%	64%	4%	100%	312	21%
Instruments	23%	25%	35%	17%	100%	285	19%
Machinery & Equipment	44%	29%	14%	14%	100%	191	13%
All other sectors	37%	30%	16%	17%	100%	350	24%
Total	**28%**	**26%**	**33%**	**13%**	**100%**	**1,464**	**100%**

9.3 Patents Granted for in 2003

Table 9.3 provides details on the total number of patents granted to R&D active companies in 2003. One can see that a total of 755 patents were granted in that year, a fall of 4.9% in patents granted to R&D active firms between 2001 and 2003.

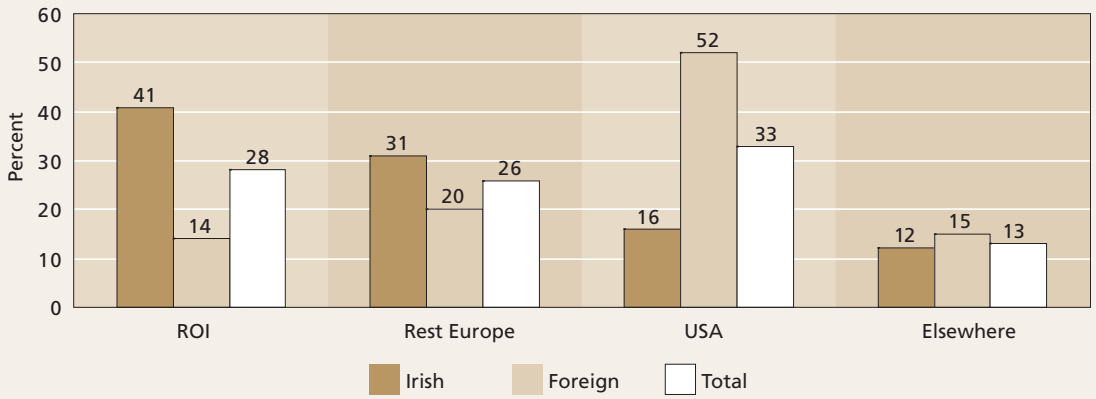
Table 9.3 *Trends in patents granted, 1993–2003*

	2001	2003
Irish Owned	397	394
Foreign Owned	397	361
Total	**794**	**755**

There are clearly difficulties in making a direct comparison between the number of applications made and the number granted as one cannot assume that the 765 patents granted in 2003 were in any way related to the 1,464 applications made in that year given timing issues between applying for patents and getting them conferred. If one accepts, however, that the figures on patents applied for and granted in that year are representative of the usual level of flows in respect of each then it would appear that in the order of 50% of applications are ultimately granted.

Figure 9.2 provides details on the breakdown of patents granted classified by nationality of the company. In aggregate terms, as one would expect, the distribution of source country of patents granted is broadly similar to that of patent applications. Approximately 30% are granted equally from Ireland, the Rest of Europe and from the USA; the remaining 10% from the Rest of the World.

Figure 9.2: *Patents granted in 2003 by R&D active companies classified according to country of application*



The next table examines sectoral variations of patents applied for by R&D active firms in Ireland in 2003, categorised further by source of patent application. It can be seen that the Electrical & Electronics sector accounts for the highest percentage of patents granted in 2003 (32%, representing 239 patents granted). The next highest sectors are Software and Machinery & Equipment, each accounting for 17% respectively.

Table 9.4 *Sectoral distribution of patents granted to R&D active companies in Ireland in 2003*

Sector	All Companies						
	RoI	Rest Europe	USA	Elsewhere	Total	No.	%
Electrical/Electronic Eq	21%	34%	35%	10%	100%	239	32%
Software/computer	23%	17%	56%	4%	100%	131	17%
Instruments	25%	34%	28%	14%	100%	101	13%
Machinery & Equipment	48%	33%	15%	5%	100%	128	17%
All Other sectors	40%	30%	15%	15%	100%	157	21%
Total	**30%**	**30%**	**30%**	**10%**	**100%**	**755**	**100%**

Appendix 1: Methodology

A1.1 Introduction

The Economic and Social Research Institute (ESRI) were commissioned by Forfás to undertake the fieldwork for the 2003 BERD survey. The population to be surveyed consisted of all firms undertaking research and development activities in Ireland identified from various sources including the Forfás database of R&D active firms. The survey design and methodology were determined by Forfás, following the international rules and guidelines set down in the EU and OECD's Frascati Manual which governs the gathering of international R&D statistics. Regular meetings were held between Forfás and ESRI during the data gathering process to monitor the robustness of the survey results. More detailed information is listed below.

A1.2 Sample

A total of 3,095 firms were identified as the target sample from a wide range of sources including firms who:

- Responded to 2002 BERD survey as having R&D (694 firms).
- Responded to the short R&D questionnaire in 2002 as having R&D (359 firms).
- Didn't respond in 2002 but was thought likely to have R&D (324 firms).
- Were identified by Forfás from their own BIS survey as having recorded in the 2001 and 2002 Annual Business Survey that they undertook R&D activity. (862 firms).
- Were large firms drawn from ESRI database in June 2004 from sectors which were assured to have a high level of R&D activity (825 firms)
- Were extra companies that emerged during the course of the fieldwork that might be likely to have R&D (31 companies)

A1.3 Response Rates

Successfully completed questionnaires were returned from 47.2% of firms; 4.5% refused and the remaining 0.8% had 'other' non-completion outcomes. An overall response rate of 47.2% of companies to a survey such as the one in question is very much in line with expectations and is the norm in terms of what can be achieved in surveys of this nature in Ireland today.

Table A1: *Response rates*

	Number of firms	% of totals Sample	% of totals Adjusted Sample
Non-Response	1,285	41.5%	47.4%
Completed	1,280	41.4%	47.2%
Refused	121	3.9%	4.5%
Other	23	0.7%	0.8%
Total Above	**2,709**	**87.5%**	**100.0%**
Out of Business	86	2.8%	
Unknown	120	3.9%	
Included	24	0.8%	
Duplicate	77	2.5%	
No phone for follow-up	79	2.6%	
Total	**3,095**	**100.0%**	

A1.4 Supplementary Short Questionnaire

In October 2004 an abbreviated questionnaire was re-sent to a group of 1,624 companies who had not responded to the main survey. This abbreviated questionnaire recorded details only on whether or not in-house and outsourced R&D activity had been completed; the level of in-house activity; number of employees; description of business activity; ownership and turnover. A total of 480 firms from this group responded and of which 248 recorded having undertaken R&D in 2003 on an in-house basis.

A1.5 Re-weighting the data

In common with all statistical surveys the data were re-weighted or statistically adjusted prior to analysis. The purpose of this is to ensure that they are fully representative of the entire population from which they have been selected. In carrying this out for the current survey the basic weighting metric was number of employees.

The first step in the weighting process was to make an estimate of the probability of the non-respondents to the survey having actually carried out in-house R&D activity in 2003. The information on the abbreviated questionnaires was used in this component of the weighting scheme. From the respondents to the short questionnaire we knew who did and didn't do R&D. From this basis we worked out the probability of the number of employees involved in R&D and applied it to the non-respondents, giving us a total number of employees involved in R&D. This probability was based on a 3-way classification of firms according to industrial sector, employee size and the source of the firms (as discussed in A1.2).

When the population frame of R&D active companies was established, respondents to the abbreviated survey were then statistically adjusted or re-weighted to that population of companies who didn't respond to the main questionnaire. This provided us with a weight for the abbreviated questionnaires.

This second step in the weighting process was to weight the respondents who carried out R&D in the abbreviated questionnaire. In carrying out this part the basic weighting metric was the value of in-house R&D in 2003. A 3-way classification of firms according to industrial sector, employee size (big and small) and the source of the firms was then used to create a population frame of R&D active companies.

Appendix 2: Questionnaire

Survey of Research and Development in Industry 2003/2004

Purpose of collection

This survey provides comprehensive data on Ireland's Business R&D effort. Results from the previous survey formed an important input to the development of Government supports for R&D including the tax credit introduced in the last budget. Forfás is the national agency responsible for the collection of R&D statistics in Ireland. Your co-operation is sought in completing and returning this form.

The questionnaire…

- Measures the R&D activity of companies in the Republic of Ireland in 2003. Please do not include R&D activities of related companies operating elsewhere, unless specified.
- Should be completed by companies who perform R&D or have R&D performed on their behalf by other parties.
- A brief definition of R&D is provided at the top of the next page.

Note for Groups

- If your company is part of a group or if you have more than one plant in the Republic of Ireland, please complete this form in respect of the full group and all outlets or plants within the group.

Data Confidentiality

- The information you provide will be treated in strict confidence and will be used for statistical purposes only. Data will not be published in an identifiable form.

Thank you for your time and co-operation

General classification data

Definition of Research and Experimental Development (R&D) in Industry

R&D is **creative work** undertaken on a **systematic basis** in order to create new or improved products, processes, services or other applications. R&D is distinguishable from other activities by the presence of an appreciable **element of novelty** and by the **resolution of problems and uncertainties** using scientific or technological means.

Routine activities, such as routine software development, routine monitoring/analysis or pre-production preparation, where there is no appreciable novelty or problem resolution, are not considered to be R&D for the purposes of this survey.

Q.1 Given the above definition, did your company perform any in-house R&D in 2003? Yes ☐ No ☐

Q.2 Was any R&D performed on your behalf by other parties in 2003? (i.e. sub-contracted R&D performed by other companies/institutes) Yes ☐ No ☐

Q.3 Does your company have a formal R&D department? (i.e. R&D as a separate cost centre with its own dedicated personnel) Yes ☐ No ☐

Q.4 In what year did your company

A – start operations in Ireland

B – commence R&D in Ireland?

C – first establish a formal R&D department?

Q.5 Estimated Total Sales Turnover (this will be used to compute R&D as a percentage of sales)

2003 € 000's

2004 € 000's

Q.6 Total number of permanent full-time employees at the end of 2003

Q.7 Please describe the nature of your business including products and services provided.

Q.8 Are most of the shares (50% or more) in your company Irish-owned? Yes ☐ No ☐

[If your company did not perform any in-house R&D in 2003 and did not have any R&D performed on your behalf by other parties in 2003 please go to Q21 on page 8]

Resources allocated to in-house performed R&D

The next section aims to measure the human and financial resources allocated by your company to in-house performed R&D. Please use the following general rules to decide on what should be included as R&D and what should be excluded from R&D.

In general terms, if the primary objective of the work is to make technical improvements to products or processes, then the work comes within the definition of R&D. If, on the other hand, the product, process or approach is substantially set and the primary objective is to develop markets, to do pre-production planning or to get a production or control system working smoothly, then the work is not R&D.

Include in R&D	Exclude from R&D
► Development of prototypes for new or improved products or processes	► Patent and licence work which is not related to any R&D project
► Construction and development of pilot plants	► Routine testing, standardisation and pre-production preparation
► Industrial design and drawing directly linked to R&D projects	► After-sales service and trouble-shooting
► Industrial engineering and tooling up directly associated with the development of new or improved products or processes	► General purpose data collection, including market research
► Trial production (if it implies full-scale testing and subsequent further design and engineering)	► Feasibility studies
► Software development with an element of novelty	► Enforcement of standards and regulation
	► Routine software modifications

Expenditure on in-house R&D

Q.9 Please specify your expenditure in 2003 and an estimate of expected expenditure on in-house R&D for 2004 under each of the following headings:

Note: Include only actual expenditure and exclude depreciation charges. R&D performed outside the company should not be included here as this is covered in a later question.

Current Expenditure on in-house R&D	2003 €000's	2004 est. €000's
Labour costs **Wages, salaries and all costs of personnel directly associated with R&D**	€	€
Other current costs **Materials, supplies and equipment, literature and subscriptions, overheads associated with R&D**	€	€
Capital Expenditure directly linked to R&D		
Land and buildings **Sites for laboratories and pilot plants, buildings purchased, constructed and repaired directly for R&D**	€	€
Instruments and equipment (excluding Software) **Major instruments and other capital equipment acquired wholly for R&D purposes**	€	€
Total expenditure on in-house R&D	€	€

Sources of funds for in-house R&D in 2003

Q.10 Please specify the source of funds for in-house R&D undertaken in 2003:

Funding from	€000s
Own company/internal funds	€
Other companies in Ireland **(for R&D performed on their behalf)**	€
Government Grants for R&D **(including RTI Scheme)**	€
Other Irish sources **(Please Specify Briefly)**	€
Direct funding from EU **(e.g. Framework Programme)**	€
Other foreign sources **(specify)**	€
Total funding for in-house performed R&D in 2003 **Please ensure this figure is the same as the total R&D expenditure supplied in Q.9 above**	€

Nature of R&D activity

Q.11 Please indicate the breakdown of total R&D expenditure in terms of the following categories as defined below:

Basic Research	%
Applied Research	%
Experimental Development	%
	100%

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 objective.

Experimental Development

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, or to improving substantially those already produced or installed.

Q.12 Did your company engage in joint research projects with any of the following parties in 2003?

Tick the appropriate box for each category (o)

Other firms in Ireland	Yes ☐	No ☐
Other firms outside Ireland	Yes ☐	No ☐
Higher education or other institutes in Ireland	Yes ☐	No ☐
Higher education or other institutes outside Ireland	Yes ☐	No ☐

In-house R&D personnel

Q.13a Please specify the number of staff (male and female) in each category involved in in-house R&D during 2003.

Q.13b As staff may share their time between R&D and non-R&D activities, please estimate the average percentage of time spent on R&D for each of these categories of staff.

Employed as	Q.13a Number of staff			Q.13b Average % of time spent on R&D
	Male	Female	Total	
1. Researcher Scientists and engineers employed as researchers with a Degree level qualification				
1b – of which qualified to Ph.D level*				
2. Technicians Technically qualified personnel (laboratory technicians, draftspeople)				
3. Support Staff All Other R&D Supporting Staff (Including R&D managers, administrators and clerical staff)				
Total R&D Staff **This is the sum of categories 1, 2 and 3** *Please ensure not to include the figure quoted for Ph.D researchers (category 1b) into the total figure as it is already included in category 1				

Q.14 Please specify how much, if anything, you paid to the following parties for R&D performed on your behalf outside the company in 2003. This expenditure is in addition to the in-house expenditure recorded at Q.10 above.

Payments made to:	Within the Republic of Ireland € 000s	Outside the Republic of Ireland € 000s
Related Companies (Parent, Subsidiary, Other Affiliates)	€	€
Non-Related Companies	€	€
Government Research Institutes	€	€
Higher Education Institutes (Universities/Institutes of Technology)	€	€
Private R&D Institutes/Laboratories	€	€
Other	€	€
Total	€	€

Q.15 Please estimate the proportion of R&D expenditure designated to each of the following categories. The listed product fields are international standard classifications.

Activity / Main Product field	%
Food and Beverages	%
Pharmaceuticals	%
Medical and Healthcare	%
Chemicals and Chemical Products **(less Pharmaceuticals)**	%
Electrical Machinery	%
Electronics **(Electronic components, Radio, TV, Communications)**	%
Computer Hardware	%
Computer Software	%
Instruments **(excluding medical devices)**	%
Other **(Please Specify):**	%
Total	100 %
Please estimate what % of your total R&D relates to Biotechnology	%

Definition of Biotechnology

The application of S&T to living organisms as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services. The (indicative, not exhaustive) list-based definition is:

- DNA (coding): genomics, pharmaco-genetics, gene probes, DNA sequencing/synthesis/amplification, genetic engineering.
- Proteins and molecules (functional blocks): protein/peptide sequencing/synthesis, lipid/protein glyco-engineering, proteomics, hormones and growth factors, cell receptors/signalling/pheromones.
- Cell and tissue culture and engineering: cell/tissue culture, tissue engineering, hybridisation, cellular fusion, vaccine/immune stimulants, embryo manipulation.
- Process biotechnologies: bioreactors, fermentation, bioprocessing, bioleaching, biopulping, biobleaching, biodesulphurisation, bioremediation and biofiltration.
- Sub-cellular organisms: gene therapy, viral vectors.

Q.16 Please estimate the approximate breakdown of total R&D expenditure in 2003 in terms of the following aims. Please also tick or x to indicate whether a particular aim was achieved in 2001–2003 period.

	R&D Expenditure	Aim Achieved
Developing new products or new services	%	Yes ☐ No ☐
Improving existing products or existing services	%	Yes ☐ No ☐
Developing new processes	%	Yes ☐ No ☐
Improving existing processes	%	Yes ☐ No ☐
Other **(please specify briefly)**	%	Yes ☐ No ☐
Total R&D expenditure	**100 %**	

Q.17 Please estimate the relative contribution from sales of the following product types to your total sales turnover in 2003 (as recorded at Q.5 above):

Technologically **new products or new services** introduced between 2001 and 2003 **New to your Company**	%
Technologically **new products or new services** introduced between 2001 and 2003 **New to the wider Market**	%
Technologically **improved products or new services** introduced between 2001 and 2003	%
Products or services which were **technologically unchanged** between 2001 and 2003	%
Total Sales Turnover	**100 %**

A **technologically new product or new service** are those whose technological characteristics or intended uses differ significantly from those of previously produced products.

A **technologically improved product or improved service** are existing products or services whose performance has been significantly enhanced or upgraded. Technologically new or improved products include products that are **new to your enterprise** even if they are not new to the market as a whole.

Q.18 Please state the number of patents applied for and granted to your company (if any) in 2003 in the appropriate box.

	Patents Applied For	Patents Granted
Republic of Ireland		
Rest of Europe **(including European Patent Office)**		
USA		
Elsewhere		

Q.19 A) Are you aware of any of the following schemes which support R&D? B) If yes, did you apply for any of the schemes and C) if so, were you successful? Tick the appropriate box for each category (o)

	A) Aware of		**B) Applied for**		**C) Successful**	
	Yes	No	Yes	No	Yes	No
R&D Grants (Enterprise Ireland, IDA Ireland)						
R&D Capability Scheme (Enterprise Ireland, IDA Ireland)						
EU Framework (EU)						
Marie Curie Scheme **(EU)**						

Q.20 General comment on availability of schemes for R&D support in Ireland.

Company Details

Q.21 Is your company an independent enterprise or part of a wider enterprise group?

Please tick yes as appropriate.

Independent Enterprise	Yes	Survey complete. Thankyou.
Part of a wider group	Yes	

Q.22 If your company is part of a wider group please state in which country is your group headquarters located?

Q.23 If your company is part of a wider group in the Republic of Ireland or has more than one plant within the Republic of Ireland, please specify for which companies/plants this form has been completed.

	Company/Plant Name	Address
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Thank you very much for your co-operation

Appendix 3: International Data

Table A3.1. : *BERD as a percentage of GDP/GNP*

	1993		1999		2001		2003[4]	
Country	**value**	**rank**	**value**	**rank**	**value**	**rank**	**value**	**rank**
Australia	0.70	18	0.66	18	0.78	17	0.78	18
Belgium	1.22	10	1.40	9	1.60	10	1.73	10
Canada	0.90	15	1.07	14	1.21	13	1.00	14
Czech Republic	0.88	17	0.78	17	0.78	18	0.82	17
Denmark	1.02	11	1.42	8	1.65	9	1.75	8
Finland	1.26	9	2.20	2	2.42	2	2.41	2
France	1.48	7	1.38	10	1.41	11	1.36	11
Germany	1.57	6	1.70	7	1.75	8	1.73	9
Greece	0.13	25	0.19	25	0.21	26	0.20	25
Hungary	0.31	22	0.28	24	0.38	23	0.35	23
Iceland	0.42	20	1.11	13	1.80	7	1.77	7
Ireland (GNP)	**0.89**	**16**	**1.03**	**15**	**0.93**	**16**	**0.97**	**15**
Italy	0.60	19	0.51	19	0.55	19	0.55	20
Japan	1.87	2	2.10	3	2.26	3	2.32	3
Korea	1.84	3	1.76	6	1.97	4	2.01	4
Netherlands	0.95	13	1.14	12	1.10	14	1.02	13
New Zealand	0.30	23	0.30	22	0.43	21	0.42	21
Norway	0.92	14	0.92	16	0.96	15	0.96	16
Poland	0.29	24	0.29	23	0.23	25	0.13	26
Portugal	0.12	26	0.17	26	0.27	24	0.32	24
Slovak Republic	0.99	12	0.41	21	0.43	22	0.32	22
Spain	0.42	21	0.46	20	0.50	20	0.56	19
Sweden	2.21	1	2.74	1	3.32	1	3.32	1
Switzerland	1.82	4	1.89	5	1.90	6	1.90	5
United Kingdom	1.36	8	1.25	11	1.24	12	1.26	12
United States	1.78	5	1.98	4	2.00	5	1.79	6
Total OECD	**1.42**		**1.52**		**1.58**		**1.45(e)**	
EU25	1.16		1.13		1.17		1.12(e)	

OECD Main Science & Technology Indicators Volume 2004/2

4 Some data for 2003 are estimates.

Table A3.2: *BERD 'Researchers' per 1000 industrial employment*

Business Researchers per 1000 Industrial Employment[5]

	1993		1999		2001		2003*	
	Value	Rank	Value	Rank	Value	Rank	Value	
Australia	2.3	16	2.4	16	2.5	16	2.5	16
Belgium	3.6	9	6.3	6	6.7	6	7.4	7
Canada	3.2	12	5.4	8	5.9	7	5.9	9
Czech Republic	1.1	20	1.5	20	1.5	20	1.7	19
Denmark	3.0	14	5.0	10	5.3	12	8.8	5
Finland	3.2	12	11.4	1	13.4	1	13.5	1
France	3.8	8	4.9	11	5.4	10	5.8	10
Germany	4.9	4	5.5	7	5.7	8	5.6	11
Greece	0.4	25	0.7	24	1.3	23	1.4	22
Hungary	1.0	22	1.2	22	1.4	22	1.6	20
Ireland	**2.5**	**15**	**4.3**	**13**	**4.5**	**13**	**4.5**	**14**
Italy	1.8	17	1.6	18	1.6	18	1.6	20
Japan	7.5	2	10.0	3	10.2	3	10.5	2
Korea	3.5	10	3.9	14	5.7	8	6.3	8
Netherlands	3.3	11	3.5	15	3.9	15	3.6	15
New Zealand	1.6	18	2.1	17	2.5	16	2.5	16
Norway	5.2	3	6.8	5	7.9	5	7.9	6
Poland	0.8	23	0.8	23	0.8	24	0.5	25
Portugal	0.5	24	0.6	25	0.7	25	0.7	24
Slovak Republic	1.6	18	1.6	18	1.5	20	1.2	23
Spain	1.1	20	1.4	21	1.6	18	2.1	18
Sweden	4.8	5	9.0	4	10.5	2	10.5	2
Switzerland	4.5	6	5.4	8	5.4	10	5.4	12
United Kingdom	4.1	7	4.5	12	4.5	13	5.1	13
United States	9.0	1	10.1	2	10.2	3	10.1	4
EU25	3.1		3.5		3.8		3.8	
OECD	5.0		5.7		5.8		5.9	

OECD Main Science & Technology Indicators Volume 2004/2

5 Data includes PhD and non-PhD researchers but excludes support staff

Table A3.3: *BERD Research Personnel per 1000 ind. employment*

Business Research Personnel per 1000 Industrial Employment[6]

	1993		1999		2001		2003	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
Australia	3.8	17	4.0	15	4.5	15	4.5	16
Belgium	9.1	7	11.9	6	13.2	5	14.5	4
Canada	5.7	12	8.5	10	9.1	10	9.1	10
Czech Republic	3.0	18	3.2	20	3.1	21	3.5	20
Denmark	8.8	8	12.1	4	14.3	3	15.9	3
Finland	9.2	6	18.3	1	19.2	1	19.3	1
France	9.9	5	11.1	8	11.3	7	11.6	7
Germany	11.2	3	11.2	7	11.0	8	11.0	8
Greece	0.8	23	1.5	23	3.7	19	3.8	18
Hungary	1.5	22	2.1	21	2.4	22	2.5	21
Ireland	**4.8**	**13**	**6.8**	**13**	**6.9**	**13**	**7.0**	**14**
Italy	3.9	16	3.6	17	3.8	18	3.8	18
Japan	12.4	1	13.9	3	13.3	4	13.6	5
Korea	4.5	14	5.0	14	6.7	14	7.2	13
Netherlands	6.5	11	8.2	11	8.5	11	8.3	11
New Zealand	2.9	19	3.3	19	4.1	16	4.1	17
Norway	7.6	10	9.2	9	10.4	9	10.2	9
Poland	1.6	21	1.6	22	1.4	23	0.7	24
Portugal	0.6	24	0.9	24	1.1	24	1.2	23
Slovak Republic	4.0	15	3.7	16	3.2	20	2.4	22
Spain	2.8	20	3.5	18	4.0	17	4.8	15
Sweden	12.3	2	17.4	2	18.5	2	18.5	2
Switzerland	11.0	4	12.0	5	12.0	6	12.0	6
United Kingdom	8.1	9	7.5	12	7.3	12	8.1	12
EU25	6.7		7.1		7.3		7.3	

OECD Main Science & Technology Indicators Volume 2004/2

6 Data includes all research staff and also research support staff

Appendix 4: Additional Irish Data

Table A4.1: *Regional BERD data*

Regional distribution of BERD by sector, 2003 (% of total) and value €mn[7]

Sector	Dublin	BMW	Other	Total	€mn
Electrical/Electronic	16.7	13.7	69.6	100.0	212.2
Software/Computer	77.1	5.6	17.3	100.0	378.3
Pharmaceuticals	49.8	4.5	45.7	100.0	190.2
Instruments	12.4	59.6	28.0	100.0	115.9
Food, Drink & Tobacco	40.4	16.6	43.0	100.0	42.3
Machinery & Equipment	24.0	31.8	44.1	100.0	39.4
Chemicals	64.6	8.8	26.6	100.0	17.3
Rubber & Plastics	2.8	23.8	73.4	100.0	10.9
Non-Metallic Minerals	2.0	25.8	72.2	100.0	8.6
Basic & Fabricated Metals	8.6	5.6	85.7	100.0	8.2
Wood Products	0.0	37.0	63.0	100.0	8.1
Transport	0.0	42.7	57.3	100.0	5.9
Textiles, Clothing	30.9	35.1	33.9	100.0	5.4
Other Manufacturing	26.1	52.0	21.9	100.0	6.4
Paper, Print & Publishing	73.9	17.3	8.7	100.0	1.4
Uncategorised	76.4	3.1	20.5	100.0	25.1
Total	**46.5%**	**15.4%**	**38.1%**	**100.0%**	**1075.6**

7 Data includes all research staff and also research support staff

Table A4.2: *BERD by Irish owned companies, 1993–2003.*

	1993		1995		1997		1999		2001		2003	
Sector	**€Ms**	**% output**	**€Ms**	**% output**	**€Ms**	**% output**	**€Ms**	**% output**	**€Ms**	**% output**	**€Ms**	**% output**
Electrical & Electronic	15.4	3.7	27.8	5	44.1	5.1	58.2	6.7	53.6	4.2	39.3	5.3
Pharmaceuticals	4.4	6.5	3.9	4.8	4.8	4.8	5	4.6	8.6	2.3	9.8	9.9
Instruments	1.8	2.4	4.2	4.4	4.9	3.3	13.7	9	8.2	1.8	14.0	4.0
Food, Drink & Tobacco	33.8	0.5	27.5	0.3	26.8	0.3	26.8	0.3	33.7	0.3	26.3	0.2
Machinery & Equipment	6.6	1.9	12.3	2.7	11.5	1.9	15.4	2.3	12.7	1.8	25.7	3.9
Chemicals	2.3	0.5	2.9	0.5	3.5	0.5	3.8	0.5	4.1	0.4	5.2	0.7
Rubber & Plastics	2.6	0.9	8.1	2	7.7	1.5	8.3	1.5	8.7	1.2	4.3	0.6
Non-metallic Minerals	4.4	0.7	7.7	1	7.1	0.8	4.9	0.5	7.3	0.6	8.4	0.7
Basic & Fabricated Metal	5.4	0.9	10.3	1.4	8.6	0.9	7.1	0.7	7.1	0.6	7.5	0.7
Wood Products	0.3	0.2	1.3	0.4	2.8	0.8	4.2	1.1	5.1	1.0	5.2	0.8
Transport	3.1	0.9	3.4	0.8	5.1	1	7.2	1.3	3.0	0.7	2.0	0.5
Textile/Clothing/Leather	3.2	0.8	8.4	1.9	7.9	1.7	3.6	0.7	3.1	0.7	3.4	0.9
Other Manufacturing	1.4	0.2	5.2	0.7	2.5	0.3	3.5	0.4	3.2	0.3	6.4	0.5
Paper & Print	3	0.2	4.5	0.3	4.9	0.3	3.2	0.2	3.4	0.2	0.6	0.0
Total Manufacturing	**87.7**	**0.7**	**127.5**	**0.9**	**142.2**	**0.9**	**164.9**	**0.9**	**161.8**	**0.8**	**158.1**	**0.8**
Software/Computer	11.3	n.a.	18.9	n.a.	53.4	n.a.	92.3	n.a.	123.9	n.a.	131.0	n.a.
Uncategorised	12.7	n.a.	9.2	n.a.	16.4	n.a.	27.1	n.a.	33.0	n.a.	11.2	n.a.
Total Business Sector	**111.7**		**155.6**		**212.0**		**284.3**		**318.7**		**300.3**	

Table A4.3: *BERD by Foreign owned companies, 1993–2003.*

	1993		1995		1997		1999		2001		2003	
Sector	**€Ms**	**% output**	**€Ms**	**% output**	**€Ms**	**% output**	**€Ms**	**% output**	**€Ms**	**% output**	**€Ms**	**% output**
Electrical & Electronic	75.7	1.6	95.3	1.2	161.9	1.5	147.9	1.2	158.8	0.7	172.9	0.7
Pharmaceuticals	57.8	7.6	72.2	4.6	70.1	3.8	77.5	2.6	62.1	1.2	180.4	3.7
Instruments	16.9	1.7	19.9	1.7	23.4	1.5	25.2	1	51.1	1.2	101.9	1.9
Food, Drink & Tobacco	7.9	0.2	18.9	0.4	14.3	0.3	17.3	0.2	16.3	0.2	16.0	0.2
Machinery & Equipment	3.5	0.6	9.2	1	8	0.8	7.2	0.5	9.0	1.0	13.7	1.4
Chemicals	14.2	0.4	16.9	0.4	15.2	0.2	20.3	0.2	15.5	0.1	12.1	0.0
Rubber & Plastics	1.1	0.3	4.3	0.8	3.9	0.7	3.6	0.4	3.1	0.5	6.6	1.4
Non-metallic minerals	1.9	1.4	2.8	1.9	2.9	1.8	2.1	0.8	3.5	1.4	0.2	0.1
Basic & Fabricated Metal	1.2	0.3	2.1	0.4	2.9	0.5	1.9	0.2	2.3	0.3	0.7	0.1
Wood Products	0.0	0	1.3	1.1	1.6	1.2	1.5	0.7	3.7	1.5	2.9	1.2
Transport	4.8	2.7	6.8	2.7	8.9	2.9	5.4	1.1	3.5	0.4	3.9	0.6
Textile/Clothing/Leather	3.9	0.8	6.4	1.2	2.9	0.5	0.6	0.1	2.9	0.7	2.0	0.5
Other Manufacturing	0.0	0	0.3	0.1	0.7	0.1	1.4	0.2	1.0	0.2	0.0	0.0
Paper & Print	0.7	0.1	1.1	0	1.4	0	0.5	0	0.4	0.0	0.7	0.0
Total Manufacturing	**189.8**	**1.2**	**257.6**	**1.1**	**318.0**	**1**	**312.3**	**0.8**	**333.3**	**0.4**	**514.0**	**0.6**
Software/Computer	37.7	n.a.	53.7	n.a.	80.7	n.a.	180.3	n.a.	243.9	n.a.	247.3	n.a.
Uncategorised	0	n.a.	0	n.a.	1.4	n.a.	7.1	n.a.	4.8	n.a.	13.9	n.a.
Total Business Sector	**227.5**		**311.3**		**400.1**		**499.7**		**582.0**		**775.3**	

Table A4.4: *R&D Personnel classified according to industrial sector in 2003*

	PhD		Non PhD		Total Researchers		Total	
Sector	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Elect&Electronic	65	16.4	1,609	28.7	1,674	27.8	2,025	21.8
Soft/Computer	71	18.0	2,589	46.1	2,660	44.2	3,911	42.1
Pharmaceuticals	67	17.0	227	4.0	294	4.9	590	6.4
Instruments	73	18.5	410	7.3	483	8.0	788	8.5
Food, Drink & Tobacco	18	4.5	147	2.6	165	2.7	325	3.5
Uncategorised	20	5.1	189	3.4	209	3.5	285	3.1
Mach&Equipment	29	7.4	205	3.6	234	3.9	490	5.3
Chemicals	39	9.8	47	0.8	86	1.4	155	1.7
Rubber&Plastics	4	1.1	57	1.0	61	1.0	133	1.4
Non-met minerals	3	0.6	38	0.7	41	0.7	97	1.0
Basic&Fab Metal	6	1.4	10	0.2	16	0.3	139	1.5
Wood products	1	0.2	10	0.2	11	0.2	53	0.6
Transport	0	0.0	41	0.7	41	0.7	88	1.0
Textile/Clothing/Leather	0	0.0	14	0.2	14	0.2	84	0.9
Other Manufacturing	0	0.0	20	0.4	20	0.3	99	1.1
Paper & Print & Publishing	0	0.0	2	0.0	2	0.0	19	0.2
TOTAL	**396**	**100.0**	**5,616**	**100.0**	**6,012**	**100.0**	**9,281**	**100.0**

Table A4.5: *Breakdown of R&D expenditure on Biotechnology in 2003 classified by detailed sector*

Sector	(1) Total Expenditure	(2) Expenditure Biotechnology €mn	(3) Per Cent of Biotechnology
Electrical/Electronic Eq	212.2	0.0	0.0
Software/computer	378.3	0.0	0.0
Pharmaceuticals	190.2	0.1	0.3
Instruments	115.9	0.8	12.3
Food, Drink & Tobacco	42.3	3.1	45.0
Machinery & Equipment	39.4	0.4	5.4
Chemicals	17.3	1.9	27.8
Rubber & Plastics	10.9	0.1	1.5
Non-metallic Minerals	8.6	0.0	0.0
Basic & Fabricated Metals	8.2	0.0	0.0
Wood Products	8.1	0.0	0.0
Transport	5.9	0.0	0.0
Textiles, Clothing, Leather	5.4	0.0	0.0
Other Manufacturing	6.4	0.0	0.0
Paper, Print & Publishing	1.3	0.0	0.0
Uncategorised	25.0	0.5	7.6
Total	**1,075.6**	**6.8**	**100.0**

Table A4.6: *Distribution of patents applied for by companies which undertook in-house R&D activity in 2003 classified by industrial sector and nationality.*

Sector	Irish Owned						
	RoI	Rest Europe	USA	Elsewhere	Total	No.	%
Electrical/Electronic Equipment	31	43	6	19	100	171	22
Software/computer Related	36	23	35	5	100	140	18
Pharmaceuticals	36	36	27	0	100	11	1
Instruments	44	27	25	4	100	72	9
Food, Drink & Tobacco	68	25	7	0	100	42	6
Uncategorised	31	14	41	14	100	44	6
Machinery & Equipment	41	27	13	19	100	131	17
Chemicals	41	41	18	0	100	9	1
Rubber & Plastics	72	28	0	0	100	14	2
Non-metallic Minerals	41	46	0	13	100	73	10
Basic & Fabricated Metals	61	0	8	31	100	13	2
Wood Products	100	0	0	0	100	5	1
Transport Equipment	100	0	0	0	100	1	0
Textiles, Clothing, Leather	50	50	0	0	100	11	1
Other Manufacturing	57	30	0	14	100	23	3
Paper, Print & Publishing	33	33	33	0	100	5	1
Total	**41**	**31**	**16**	**12**	**100**	**765**	**100**
Sector	**Foreign Owned**						
Electrical/Electronic Equipment	10	19	60	11	100	154	22
Software/computer Related	5	6	87	3	100	172	25
Pharmaceuticals	25	25	25	25	100	16	2
Instruments	16	24	38	21	100	214	31
Food, Drink & Tobacco	14	43	14	29	100	8	1
Uncategorised	0	30	16	54	100	38	5
Machinery & Equipment	49	31	18	2	100	60	9
Chemicals	0	44	44	11	100	9	1
Rubber & Plastics	0	100	0	0	100	3	0
Non-metallic Minerals	0	0	0	0	0	0	0
Basic & Fabricated Metals	0	0	0	0	0	0	0
Wood Products	0	0	0	0	0	5	1
Transport Equipment	0	0	50	50	100	18	3
Textiles, Clothing, Leather	0	0	0	0	0	0	0
Other Manufacturing	0	0	0	0	0	0	0
Paper, Print & Publishing	0	0	0	0	0	2	0
Total	**14**	**20**	**52**	**15**	**100**	**699**	**100**

Reports Published by Forfás 2004 / 2005

Broadband Telecommunications Benchmarking Study	**January 2004**
Research and Development in Ireland, 2001 – at a glance	**January 2004**
Competitiveness through Innovation *National Competitiveness Council (NCC)*	**February 2004**
International Trade & Investment Report, 2003	**March 2004**
Wireless Communications: An Area of Opportunity for Ireland	**April 2004**
National Code of Practice for Managing Intellectual Property from Publicly Funded Research *Irish Council for Science, Technology & Innovation (ICSTI)*	**April 2004**
Forfás Annual Report	**April 2004**
Report of the Enterprise Strategy Group	**July 2004**
Statement on Nanotechnology *Irish Council for Science, Technology & Innovation (ICSTI)*	**July 2004**
Building Ireland's Knowledge Economy – The Irish Action Plan for Increasing Research and Development to 2010	**September 2004**
Statement on Prices and Costs *National Competitiveness Council (NCC)*	**September 2004**
State Expenditure Priorities for 2005 *Irish Council for Science, Technology & Innovation (ICSTI)*	**September 2004**
Sustainable Development in Ireland *Irish Council for Science, Technology & Innovation (ICSTI)*	**October 2004**
Annual Competitiveness Report 2004 & The Competitiveness Challenge *National Competitiveness Council (NCC)*	**October 2004**
Innovate, Market, Sell – Review of the Sales, Marketing and Innovation Capabilities of Irish Exporting SMEs	**November 2004**
Broadband Telecommunications Benchmarking Study	**December 2004**
Survey of Research and Development in the Higher Education Sector 2002	**December 2004**
State Expenditure on Science & Technology, 2002 and 2003	**December 2004**
From Research to the Marketplace – Patent Registration and Technology Transfer in Ireland (web only)	**March 2005**
Making Technological Knowledge Work – A Study of the Absorptive Capacity of Irish SMEs (web only)	**March 2005**
Strategic Technology Platforms *Irish Council for Science, Technology and Innovation*	**March 2005**
Towards the Seventh EU Framework Programme for Research and Technological Development *Irish Council for Science, Technology and Innovation*	**March 2005**
International Trade & Investment Report, 2004	**April 2005**

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 forbairt teicneolaíochta dílsithe ann. Is é an comhlacht é freisin trína dciomnaítear cumhachtaí ar Fhiontraíocht Éireann le tionscail dúchais a chur chus cinn agus ar ghníomhaireacht Forbartha Tionscail na hÉireann (GFT Éireann) le hinfheistíocht isteach sa tir a chur chun tosaigh. Bunaiodh Fondúireacht Eolaíochta Éireann mar an treas eagraíocht de chuid i Forfás mí iúil 2003. Is iad feighmeanna Fhorfáis :

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

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