Forfás

Survey of Research and Development in the Business Sector 1997

Key findings and tabular data from the Survey of R&D Performing Enterprises in Ireland, 1997

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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 technology 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. The broad functions of Forfás are to:

- advise the Minister on matters relating to the development of industry in the State
- to advise on the development and co-ordination of policy for Enterprise Ireland, IDA Ireland and such other bodies (established by or under statute) as the Minister may by order designate
- encourage the development of industry, technology, 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 and IDA Ireland in relation to their functions.

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Science, Technology and Innovation Division, Forfás
September 1999

FOREWORD

This report presents the findings of a survey of R&D performers in the business sector relating to 1997 and updates a regular series on Business Expenditure on Research and Development (BERD) produced by Forfás. The survey relies on the co-operation of R&D performing enterprises in the country and special thanks is given to all of the enterprises that participated in the most recent survey.

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EXECUTIVE SUMMARY

This report presents an update on indicators of R&D and innovation performance in industry. It is based, for the most part, on the Survey of R&D Performing Enterprises relating to 1997. This survey is undertaken every second year in accordance with OECD guidelines set out in the *Frascati Manual*. The report also makes use of patent statistics and results from the Eurostat *Community Innovation Survey* which was undertaken in Ireland by Forfás.

There are a number of encouraging signs about innovation activity in industry based on the data which are examined:

- Business sector R&D activity has continued to increase, with growth in expenditure (BERD) of 15% per annum since 1995, bringing this measure to £535m (€679m) (1.1% of GDP), in line with the EU average. Indigenous firms account for £192m (€244)(36%) and foreign-owned firms account for £343m (€436m)(64%).
- The R&D intensity of indigenous manufacturing has doubled during the 1990s from 0.5% of gross output in 1991 to an estimated 1.1% based on the most recent survey.
- Growth in R&D activity has been witnessed in each of the main R&D performing sectors (electronics, pharmaceuticals, food & drink, software). The increase in R&D activity has not been confined to one sector.
- R&D accounts for one-third of all innovation expenditure – manufacturing industry spends in total 3.3% of sales on innovation related activities. The share of sales from new or improved products is in line with the EU average.

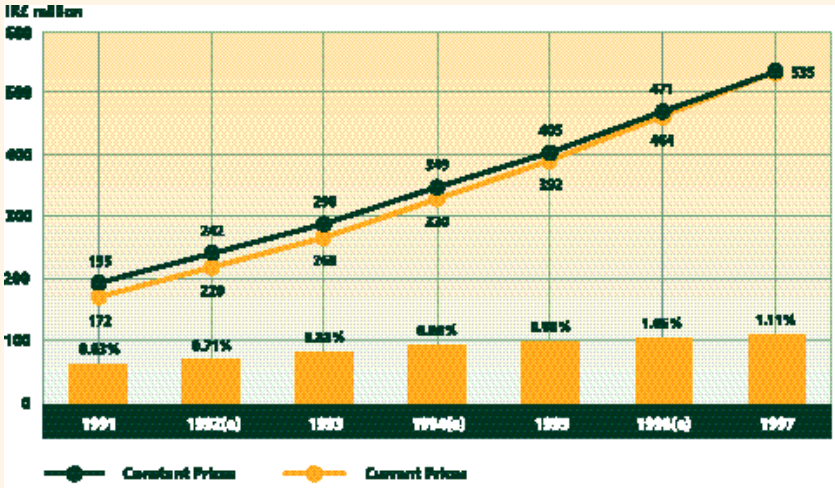
At the same time, there are many areas which give rise to concern and this should help to avoid any complacency about the innovation performance of industry:

- R&D intensities of certain "high-tech" sectors lag far behind those found in other countries. The R&D intensity of the pharmaceutical sector (at 5.1%) is almost one quarter of that found in the lead country, Sweden. The R&D intensity of the electronics sector (at 1.9%) is one fifth of that found in Sweden.
- There are signs of a slowing-down in the growth rates in R&D activity – the growth rate of 15% per annum between 1995 and 1997 is less than the 20% per annum growth witnessed in the early-1990s.
- The aggregate position masks the fact that most firms continue to make little or no investment in R&D. R&D activity is concentrated in a relatively small number of companies and the scale of R&D activity in the "average" R&D performing company is extremely low. The median spend for R&D performers is £67,000 (€85,072).
- Indicators which focus on genuine technical novelty – such as patents granted in the US – paint a far poorer picture of innovative performance and point to little or no change during the 1990s.

A1 Overall Trend in Business Expenditure on Research and Development

In aggregate terms, R&D activity in industry continued to grow between 1995 and 1997. Total business expenditure on R&D in 1997 was £535m (€679m) or 1.1% of GDP. This places Ireland in 11th place out of 26 OECD countries and brings the country on a par with the European average. Aside from some of the larger EU Member States (Germany, UK and France), Ireland still lags behind Sweden, Finland and Denmark on this measure.

Figure 1: Business Expenditure on Research and Development 1991-1997



The above graph relates to the following table. This shows values in Irish pounds and euro equivalents. All conversions to euro were made using the irrevocably fixed conversion rate (1 euro = 0.787564 Irish pounds).

Business Expenditure on Research and Development 1991-1997

	Constant Prices		Current Prices	
	IR £ m	€ m	IR £ m	€ m
1991	195	248	172	218
1992	242	307	220	279
1993	290	368	268	340
1994	349	443	330	419
1995	405	514	392	498
1996	471	598	464	589
1997	535	679	535	679

Figure 2: International Ranking on Business Sector R&D Aggregates 1991-1997

	1991	1993	1995	1997
Business Expenditure on R&D (BERD)	£172m	£268m	£392m	£535m
Business Expenditure on R&D (BERD)	€218m	€340m	€498m	€679m
BERD as % of GDP	0.63	0.82	0.99	1.11
Rank among 26 OECD countries	***17***	***16***	***13***	***11***
Total R&D personnel	3,970	4,500	6,150	8,170
R&D personnel per 1000 labour force	3.0	3.2	4.2	5.3
Rank among 25 OECD countries	***15***	***15***	***14***	***10***
Total researchers in industry	2,128	2,576	3,690	5,098
Researchers per 1000 labour force	1.6	1.8	2.5	3.0
Rank among 26 OECD countries	***16***	***15***	***13***	***9***

See Tables B1, B2 and B3 in the appendices for detailed comparisons

Figure 2 shows that Ireland's overall rank on business expenditure on R&D and R&D personnel in industry has improved steadily during the 1990s. Ireland is quite unique in this regard – no other OECD economy has witnessed such a large relative change in business sector R&D performance.

It should be noted that there are signs of a slowing down in the growth rate of business sector R&D activity. The growth rate in R&D expenditure in real terms between 1995 and 1997 was 15% per annum – lower than that witnessed in the period 1991-1995 (20% per annum). Furthermore, when firms were asked in the survey to make projections for their expenditure in 1999, there is some evidence that growth on average will be lower again. This slowing down in the growth rate is not surprising as growth rates of 20% per annum could not be expected to continue indefinitely.

A2 Industry Share of Gross Expenditure on Research and Development

The growth of business expenditure on R&D has changed the profile of R&D performance in the economy as other R&D performing sectors (higher education and government) have not witnessed the same level of growth during the 1990s. Figure 3 shows that R&D in the higher education sector has increased marginally from 0.22% of GDP in 1991 to an estimated 0.27% in 1997. R&D performed in the State sector has not increased at all as a percentage of GDP.

Figure 3: Gross Expenditure on R&D as a Percentage of GDP 1991-1997

	1991	1993	1995	1997
Business Sector (BERD)	0.61	0.82	0.99	1.11
Higher Education Sector (HERD)	0.22	0.25	0.27	0.27
Government Sector (GOVERD)	0.11	0.12	0.12	0.11
Private non-profit sector (PNP)	0.01	0.01	0.01	0.01
Gross Expenditure on R&D (GERD)	0.95	1.20	1.39	1.50

The effect of this is that industry now accounts for three-quarters of R&D activity in the country compared to two-thirds at the beginning of the 1990s. Figure 4 shows how this structure of R&D performance compares with the EU and OECD averages.

Figure 4: Share of Gross Expenditure on R&D Performed in Industry 1991-1997

	1991	1993	1995	1997
Ireland	64%	68%	71%	74%
EU average	63%	62%	62%	62%
OECD average	68%	67%	68%	68%

See Table B4 in the appendices for detailed comparisons

The data show that the structure of R&D performance in Ireland is different to that found in the EU generally with greater reliance on the private sector in Ireland. Other countries with a high share of industry-performed R&D are Japan (71%), Korea (73%), Sweden (74%), Switzerland (71%) and USA (74%). While there is no right or wrong structure to R&D performance in an economy, it is important that private sector R&D is complemented by a research infrastructure in the public sector that provides a source of knowledge in the technologies important to industry both now and into the future.

A3 Government Funding of Business Sector Research and Development

Government incentive schemes for R&D have played a part in the increase in R&D activity in industry. Figure 5 shows that between 1991 and 1997, a total of £150m (€190m) (in 1997 prices) has been made available to companies to encourage first time R&D performers and to get existing R&D performers to deepen their level of investment.

Figure 5: Government Financing of Industry R&D in Ireland

	BERD	Government grants	Government grants as % BERD	CSF element of grants	CSF element as % of Grants
	Constant 1997 Prices	Constant 1997 Prices	Constant 1997 Prices		
1991-1997 Cumulative	£2,485m	£149.4m	6.0%	£104m	70%
1991-1997 Cumulative	€3,155m	€189.7m	6.0%	€132m	70%

These grants (mostly under EU supported initiatives such as Measure 6, Measure 1 and "RTI") equate to 6% of the cumulative amount spent by industry on R&D over the period 1991 to 1997[1].

Figure 6: Trend in Government Financing of Industry R&D 1991-1997

	1991	1993	1995	1997	1991-1997 cumulative (1997 prices)
Government grants for industry R&D	£9.1m	£32.5m	£23.7m	£28.9m	**£149.4m**
Government grants for industry R&D	€11.6m	€41.3m	€30.1m	€36.7m	**€189.7m**
Government grants for R&D as a % of BERD	5.3%	12.2%	6.0%	5.4%	**6.0%**
Government grants for R&D as a % of all expenditure on enterprise development	2.5%	8.6%	5.4%	5.3%	**4.8%**

See Table B5 in the appendices for international comparisons of government financing of BERD

Figure 6 shows that, with the exception of 1993 (when the Measure 6 initiative was implemented), government financing of industry R&D has been in the region of 5%-6% of BERD. Furthermore, it is estimated that the £150m (€190.46m) provided in R&D grants represents 4.8% of State expenditure on enterprise development for the period 1991 to 1997.

The question raised by these data is whether this represents an adequate re-orientation of supports to industry in favour of research and development, especially given the fact that there are still large gaps in R&D intensity in key sectors in indigenous and foreign-owned industry compared to other countries.

1 Source: Forfás: Financial Support by Government for the Development of Enterprise in Ireland, 1998

A4 Research and Development Expenditure Across Industry Sectors

Drilling deeper to find out more about the nature of R&D activity in the business sector, Figure 7 shows that four key sectors account for most R&D expenditure in industry. The broad electrical and electronics sector accounts for one third of expenditure (£194m) (€246m) with telecommunications related R&D being a particularly notable element. Pharmaceuticals accounts for the next largest share with £77m (€98m) being spent in this area in 1997. Food and drink accounts for £58m (€74m) and software R&D (which excludes routine development) accounts for an increasing share of BERD with £54m (€69m) being spent in this area in 1997. All other sectors combined make up the balance of R&D expenditure.

Figure 7: Business Expenditure on Research and Development by Industry Sector

	1991	1993	1995	1997
Business Expenditure on R&D (BERD)	£176m	£271m	£392m	£535m
Business Expenditure on R&D (BERD)	€223m	€344m	€498m	€679m
Electrical and electronic equipment	37%	36%	36%	36%
Pharmaceuticals	12%	18%	14%	14%
Food, drink and tobacco	12%	13%	12%	11%
Software	7%	6%	5%	10%
All other sectors	32%	27%	33%	29%

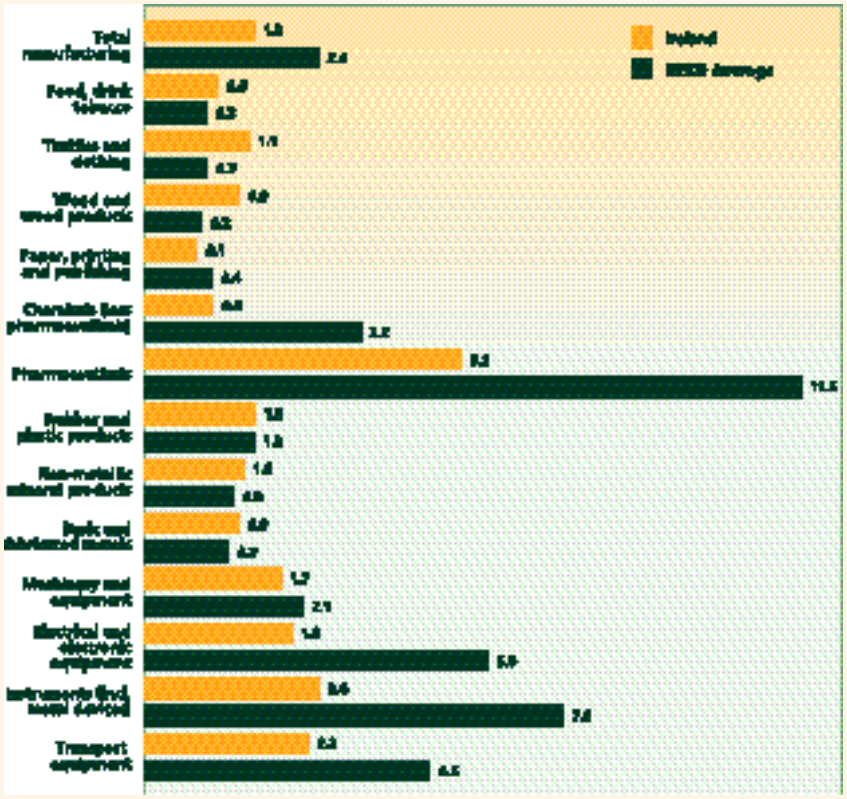
See Table B6 in the appendices for detailed sectoral breakdown

It is interesting to note that there has been a reasonably stable pattern in the sectoral composition of R&D expenditure indicating that growth has not been confined to one or two particular sectors.

The absolute amounts of money provide one perspective on the data and show the relative importance of different sectors. However, in terms of assessing how satisfactory this level of expenditure is, it is more meaningful to look at R&D intensities – R&D expressed as a percentage of the gross output of all firms. This analysis focuses on manufacturing only due to data availability problems for the services sector.

Figure 8 shows that the R&D intensity of manufacturing in Ireland was 1.2% in 1997, half the level found in OECD countries generally.

Figure 8: R&D Expenditure as a Percentage of Gross Output in Manufacturing 1997



The R&D intensity of manufacturing sectors in Ireland relative to the OECD average and to the lead country for each sector are explored further in Figure 9.

The most striking thing about this sectoral analysis is that the main gaps accounting for Ireland's poor overall performance are in the more technologically advanced sectors (pharmaceuticals, instruments, electrical and electronic equipment, chemicals and transport equipment). The other sectors are by nature less R&D intensive so it is not surprising to find low values in Ireland. It is in Ireland's so-called "high-tech" sectors that one sees the largest gaps. In large part, this is accounted for by the reluctance of foreign-owned multinationals to perform R&D in their Irish-based subsidiaries. It is appropriate that policy with regard to multinationals should continue to aim at encouraging this kind of activity, as operations based only on manufacturing are vulnerable to competitive forces from low cost economies.

Figure 9: R&D Expenditure to Gross Output – Ireland Vs International Benchmarks

	R&D intensity in Ireland 1997	OECD average	Lead country	Percentage point gap – Ireland vs. OECD	Percentage point gap – Ireland vs. lead country
All Manufacturing	**1.2**	**2.4**	**3.5**	**1.2**	**2.3**
Pharmaceuticals	5.1	11.5	18.9	6.4	13.8
Instruments (incl. Medical devices)	2.4	7.0	11.7	4.6	9.3
Electrical and electronic equipment	1.9	5.6	11.1	3.7	9.2
Chemicals (less pharmaceuticals)	0.4	3.2	6.0	2.8	5.6
Transport equipment	2.2	4.5	6.3	2.3	4.1
Machinery and equipment	1.7	2.1	3.6	0.4	1.9
Paper, printing and publishing	0.1	0.4	0.7	0.3	0.6
Rubber and plastic products	1.2	1.2	2.3	n/a	1.1
Food, drink, tobacco	0.5	0.3	0.6	n/a	0.1
Non-metallic mineral products	1.0	0.8	1.9	n/a	0.9
Basic and fabricated metals	0.9	0.7	1.2	n/a	0.3
Wood and wood products	0.9	0.2	0.9	n/a	n/a
Textiles & clothing	1.1	0.3	1.1	n/a	n/a

See Table B8 in the appendices for detailed international comparisons

A5 Research and Development Expenditure in Irish and Foreign-owned Industry

The breakdown between indigenous industry and foreign-owned industry needs to be explored in order that the aggregate statistics can be better understood. Obviously, there is a different sectoral composition to indigenous industry compared to that of foreign-owned industry. This difference needs to be taken into account before a proper assessment can be made of the amounts of money being invested in R&D in indigenous industry and in foreign-owned industry.

Figure 10 provides some detail on the composition of R&D expenditure and R&D intensity in indigenous industry and foreign-owned industry.

Figure 10: R&D Expenditure of Irish-owned and Foreign-owned Industry 1997

	Irish-owned		Foreign-owned	
	Share of Expenditure	R&D as a % of gross output	Share of Expenditure	R&D as a % of gross output
Food, drink, tobacco	18%	0.5%	6%	0.5%
Textiles & clothing	4%	1.9%	1%	0.5%
Wood and wood products	1%	0.7%	*	1.4%
Paper, printing and publishing	2%	0.3%	*	0.0%
Chemicals (less pharmaceuticals)	3%	0.8%	5%	0.4%
Pharmaceuticals	2%	4.0%	22%	5.1%
Rubber and plastic products	4%	1.7%	1%	0.8%
Non-metallic mineral products	4%	1.1%	*	0.7%
Basic and fabricated metals	5%	1.3%	*	0.2%
Machinery and equipment	6%	2.4%	3%	1.2%
Electrical and electronic equipment	19%	6.4%	46%	1.7%
Instruments (incl. medical devices)	4%	6.7%	7%	2.0%
Transport equipment	4%	1.8%	2%	2.8%
Other manufacturing	2%	0.5%	*	0.2%
Total manufacturing	**76%**	**1.1%**	**94%**	**1.2%**
Software	18%		5%	
Other services	6%		1%	
Total business sector £	**£192m**		**£343m**	
Total business sector €	**€244m**		**€436m**	

* Less than 1%
See Tables B9 to B12 in the appendices for detailed analysis over time

The table shows that:

- The £192m (€244m) spent by indigenous industry in 1997 is concentrated in electrical and electronic equipment (19%), food and drink (18%) and software (18%). The remaining 45% is spread throughout the other sectors.
- The £343m (€436m) spent by foreign-owned industry is concentrated primarily in electrical and electronic equipment (46%) and in pharmaceuticals (22%). The remaining 32% is spread across the other sectors but mostly in "advanced" sectors such as chemicals, instruments and software.

In aggregate terms, the R&D intensity of indigenous manufacturing is similar to that of foreign-owned manufacturing (1.1% versus 1.2%). However, it is clear from Figure 10 that there is a different sectoral mix behind these aggregates. The R&D intensity of indigenous manufacturing is low by international standards because of the combined effect of R&D being performed in "low-tech" sectors and the R&D intensity of "high-tech" sectors being low by international standards. The R&D intensity of foreign-owned manufacturing is low almost exclusively because of the fact that the "high-tech" sectors in which foreign-owned companies operate (pharmaceuticals, electrical and electronics, instruments etc.) have R&D intensities that are considerably below international averages.

The detailed trends in the sectoral composition and R&D intensity of indigenous industry and foreign-owned industry are presented in the appendices. Figure 11 shows the R&D intensity of indigenous manufacturing has increased from 0.5% in 1991 to an estimated 1.1% in 1997. The R&D intensity of foreign-owned manufacturing has stayed in the range of 1.0% to 1.2% throughout the 1990s.

Figure 11: R&D Intensity in Irish-owned and Foreign-owned Manufacturing, 1991-1997

	1991	1993	1995	1997(e)
Indigenous Manufacturing				
Expenditure on R&D (£m)	47.8	63.9	123.5	145.8
Expenditure on R&D (€m)	60.7	81.1	156.8	185.1
R&D as % of Gross output	**0.5%**	**0.6%**	**1.1%**	**1.1%**
Foreign-owned Manufacturing				
Expenditure on R&D (£m)	107.0	179.8	241.6	323.3
Expenditure on R&D (€m)	135.9	228.3	306.8	410.5
R&D as % of Gross output	**1.0%**	**1.2%**	**1.1%**	**1.2%**

e = based on estimated gross output
See Tables B10 and B12 in the appendices for detailed sectoral breakdowns

There are a number of issues that need to be considered in interpreting these numbers. With respect to foreign-owned manufacturing, a key point to bear in mind is that its output is likely to be based on very strong research and development – the issue is, however, that the R&D is not being done in Ireland. With respect to the greater increase in R&D intensity of indigenous manufacturing, it must be kept in mind that the indigenous group is coming from a lower base and still accounts for only one-third of total expenditure. Also R&D intensities are affected by changes in gross output for the two groups – the gross output of foreign-owned manufacturing has been rising at a faster rate than that of indigenous manufacturing and this explains in part the larger apparent change in R&D intensity of the indigenous group.

A6 Distribution of R&D Activity Among Irish and Foreign-owned Firms

Moving down to the **level of the firm**, some insight can be gained into the scale of activity of the average Irish-owned R&D performer vis-à-vis its foreign-owned counterpart. In the *Survey of Product and Process Innovation* published in 1997, the point was made that Irish-owned firms were as likely to engage in innovative activity as their foreign-owned counterparts when comparisons are made between firms of similar size, operating in similar sectors. While this conclusion remains valid, the fact is that Irish-owned industry differs from that of foreign-owned industry in terms of its scale and positioning. Figure 12 highlights the nature of R&D activity within the two groups.

Figure 12: Profile of R&D Activity in Irish-owned and Foreign-owned Firms 1997

	Irish		Foreign		Total	
	Number of firms	% of performers	Number of firms	% of performers	Number of firms	% of performers
Estimated number of performers in 1997	**890**	**100%**	**360**	**100%**	**1250**	**100%**
Nature of involvement in R&D						
Engage in R&D on a continuous basis	490	**55**	260	**73**	750	**60**
Engage in R&D on an occasional basis	400	**45**	100	**27**	500	**40**
Have a formal R&D department	280	**32**	240	**67**	522	**41**
Distribution of R&D Spend						
Less than £100,000 (€126,974)	547	**61**	100	**28**	647	**52**
Over £100,000 (€126,974)	340	**39**	260	**72**	600	**48**
Over £1m (€1.3m) per annum	25	**3**	50	**14**	75	**6**
Median Spend (£)	£45,500		£180,000		£67,000	
Median Spend (€)	€57,773		€228,553		€85,072	

In overall terms, it is estimated that there were approximately 1,250 firms with some involvement in research and development in 1997 – 890 of these are Irish-owned and 360 are foreign-owned. However, the scale of R&D activity within these firms is very low in many cases and particularly so for the indigenous group.

45% of the indigenous performers (400 firms) describe their involvement in R&D as "occasional" indicating that their R&D personnel are only involved part-time in R&D activities. Among the foreign-owned R&D performers, a smaller proportion (27% or 100 firms) describe their involvement in R&D as "occasional". This implies that there are approximately 500 Irish-owned companies with a continuous, full-time R&D function as against approximately 260 foreign-owned firms.

Focusing on the firms with a formal R&D department (i.e. R&D set up as a separate cost centre with its own personnel), we see that 32% of indigenous R&D performers (280 firms) claim to come within this definition as against 67% of foreign-owned performers (240 firms).

A similar picture emerges when we examine the distribution of R&D expenditure among R&D performers. Using a cut-off of £100,000 (€126,974), we find that only 39% of indigenous R&D performers are above this level (340 firms) as against 72% of foreign-owned performers (260 firms). This is reflected in the median spend of the R&D performers – in the case of indigenous firms, it is £45,500 (€57,773) and in the case of foreign-owned firms, it is £180,000 (€228,553).

In overall terms, these variables point to the same conclusion – the scale of R&D activity among indigenous firms tends to be a good deal lower than that of foreign-owned firms and really this is a reflection of the structure of the industrial base in Ireland. While it is encouraging that the numbers of R&D performers is rising (from approximately 820 in the 1993 census to approximately 1,250 in 1997), it must be borne in mind that the scale of activity is very low in many cases, particularly among the indigenous cohort.

Continuing the comparison of indigenous and foreign-owned groups, there are some differences in the nature of their R&D activity. Figure 13 shows that the indigenous firms as a group claim that 39% of their R&D is at the "research" end of the spectrum while 61% of expenditure would come under the heading of "experimental development". This suggests there is a proportionately greater element of research in the indigenous R&D compared to the 24% of foreign-owned R&D which is classified under the "research" heading.

Figure 13: Nature of R&D Activity in Irish-owned and Foreign-owned Firms 1997

	Irish-owned	Foreign-owned
Expenditure on R&D	**£192m**	**£343m**
Expenditure on R&D	**€244m**	**€436m**
Nature of R&D Activity		
Basic and applied research	39%	24%
Experimental development	61%	76%
Orientation of R&D work		
Developing new products	54%	51%
Improving existing products	23%	25%
Developing new processes	13%	13%
Improving existing processes	10%	11%

The results suggest that there is greater novelty associated with the R&D of indigenous firms and this might be explained by the suggestion that parent companies tend to give lower end development activity to their foreign subsidiaries while the more novel research resides in the home country.

The orientation of the R&D activity is also assessed in the survey in terms of whether work is focused on products or processes. Contrary to a view sometimes expressed that foreign-owned subsidiaries tend to work mostly on process R&D, the survey suggests that there is a rather similar profile to the R&D activity of indigenous firms and foreign-owned firms. In both cases, approximately three quarters of R&D expenditure is allocated to work on new or improved products.

A7 Examination of Other Indicators of Technological Performance

Finally, it is worth contrasting these R&D statistics with other indicators of technological performance to see if they paint a similar or different picture of innovation in industry. R&D statistics are only one measure of innovative capability and no one set of statistics can fully reflect the very complex nature of the innovation process.

Patent statistics provide another perspective on technological strength and might be considered more discriminatory in some respects in that they focus on genuine novelty as against minor incremental improvements. Three different measures of patenting activity are set out in Figure 14.

Figure 14: Patenting Activity of Irish-based Inventors

	1991	1993	1995	1996
Resident patent applications	786	795	853	805
Resident patent application per 10,000 pop.	2.2	2.2	2.4	2.2
Rank among 28 countries	13	14	13	15
Applications to European Patent Office	64	66	131	
EPO applications per 10,000 pop.	0.2	0.2	0.4	
Rank among 28 countries	18	19	18	
Patents granted in US	55	53	52	
Patents granted in US per 10,000 pop.	0.2	0.1	0.1	
Rank among 23 countries	17	18	18	

See Tables B13, B14 and B15 in the appendices for detailed comparisons

In general, these statistics present a poorer picture of innovative capacity in industry compared to the messages coming from the R&D statistics. They suggest that innovation activity has been rather static over the 1990s and this message is difficult to reconcile with the marked increase in business sector R&D activity.

Resident patent applications per 10,000 population places Ireland in 15th position out of 28 countries, a lower placing than was the case in 1991. Applications to the European Patent Office from Ireland suggest an even poorer ranking (18th out of 28 countries) and Ireland appears even weaker again (18th out of 23 countries) in terms of the number of patents granted in the US to parties resident in Ireland.

Based on a listing of firms taking out patents in the US, it is noticeable that many of the significant foreign-owned R&D performers in the country do not appear to take out patents as Irish residents. This would suggest that either their work is not being patented at all or patents are being taken out by parent enterprises.

Another source of data on innovation performance comes from the Community Innovation Survey (CIS), the Irish element of which is performed by Forfás. The first comparisons of the results from the most recent CIS suggest that, as is the case with R&D, Ireland's performance could be considered as "average" relative to the rest of the EU.

The proportion of firms claiming to have introduced new or improved products is above the EU average but this is a very crude measure of innovation performance. 27% of firms claim to have introduced products that were new not just to the firm but to the market generally and this compares to 20% for the EU average. In terms of innovation expenditure, Ireland is somewhat below the EU average (3.3% of sales as against 3.8% in the EU generally). Given that R&D intensity has been measured at 1.2%, it would appear that R&D accounts for approximately one third of all innovation-related expenditure in industry, a result which is consistent with the first CIS undertaken earlier in the 1990s.

Figure 15: Top-line Results from the Community Innovation Survey 1994-96

	Ireland	EU Average
Proportion of firms with 20+ employees introducing new or improved products between 1994 and 1996	66%	48%
Proportion of firms introducing products completely new to the market between 1994 and 1996	27%	20%
Total expenditure on innovation activities in 1996 as a percentage of sales	3.3%	3.8%
Share of 1996 turnover from new or improved products	32%	31%
Share of 1996 turnover from products completely new to the market	8.5%	6.6%

See Table B16 in the appendices for detailed comparisons

The share of sales coming from products developed or changed in the previous three years is 32% and this is on par with the EU average. 8.5% of sales come from products completely new to the market and not just new to the firm. It is important to keep in mind that the development work for these new or changed products may not have been undertaken in Ireland and the figures could overstate the innovative capacity of industry in Ireland.

The detailed sectoral analysis of these data is presented in Table B16 in the appendices and the data appear to be consistent with R&D statistics in the rank order of different sectors according to their "innovativeness".

R&D statistics, therefore, appear to be broadly consistent with the picture painted of innovation performance by the Community Innovation Survey. In both cases, Ireland appears to be at a "mid-range" position among EU countries. Patent statistics and, in particular, the indicator of patents granted in the US seem to paint a somewhat poorer picture of innovation activity in industry. A range of indicators of innovation performance in industry are now becoming available – it is important that these be used judiciously and focus given to those indicators which can best reflect genuine changes in the innovation performance of industry.

DETAILED TABULAR DATA

Table B1: Business Expenditure on Research and Development as a percentage of GDP								
	1991		1993		1995		1997	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
No. of countries	**26**		**26**		**26**		**26**	
Australia	0.61%	18	0.73%	17	0.89%	16	0.81%	16
Belgium	1.09%	11	1.01%	11	1.07%	12	1.07%	13
Canada	0.81%	15	0.91%	14	0.97%	14	1.03%	14
Czech Republic	1.41%	9	0.90%	15	0.68%	17	0.73%	17
Denmark	1.00%	13	1.05%	10	1.10%	10	1.26%	9
Finland	1.18%	10	1.29%	9	1.49%	7	1.91%	6
France	1.48%	7	1.51%	7	1.43%	8	1.38%	8
Germany	1.81%	6	1.62%	6	1.53%	6	1.63%	7
Hungary	0.44%	20	0.32%	22	0.33%	21	0.31%	21
Iceland	0.25%	23	0.42%	20	0.49%	19	0.57%	19
Ireland	**0.63%**	**17**	**0.82%**	**16**	**0.99%**	**13**	**1.11%**	**11**
Italy	0.69%	16	0.61%	18	0.54%	18	0.58%	18
Japan	2.13%	1	1.90%	3	1.94%	3	2.01%	3
Korea	1.98%	3	1.98%	2	1.98%	2	2.04%	2
Mexico	0.01%	26	0.02%	26	0.06%	26	0.06%	26
Netherlands	1.02%	12	0.99%	12	1.08%	11	1.10%	12
New Zealand	0.27%	22	0.31%	23	0.26%	23	0.26%	23
Norway	0.90%	14	0.93%	13	0.97%	15	0.97%	15
Poland	0.34%	21	0.34%	21	0.29%	22	0.31%	22
Portugal	0.16%	24	0.14%	24	0.12%	24	0.12%	24
Spain	0.49%	19	0.43%	19	0.41%	20	0.44%	20
Sweden	1.98%	4	2.36%	1	2.67%	1	2.67%	1
Switzerland	1.86%	5	1.86%	4	1.86%	5	1.94%	5
Turkey	0.11%	25	0.10%	25	0.09%	25	0.12%	25
UK	1.42%	8	1.44%	8	1.32%	9	1.26%	10
US	2.05%	2	1.85%	5	1.88%	4	1.96%	4
Total OECD	**1.58%**		**1.46%**		**1.46%**		**1.49%**	
EU	**1.23%**		**1.19%**		**1.14%**		**1.15%**	
Nordic countries	**1.36%**		**1.52%**		**1.69%**		**1.69%**	

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

Table B2: Total Business Sector R&D Personnel per 1000 Labour Force

	1991		1993		1995		1997	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
No. of countries	**25**		**25**		**25**		**25**	
Australia	2.5	18	2.7	17	3.0	16	2.8	16
Belgium	5.3	9	5.2	10	5.3	9	5.3	9
Canada	3.8	14	4.2	14	4.7	12	4.9	12
Czech Republic	10.8	1	5.3	9	2.2	18	2.2	18
Denmark	5.2	10	5.5	8	6.1	7	6.3	7
Finland	5.9	7	6.1	6	7.1	5	8.2	4
France	6.2	6	6.5	5	6.4	6	6.3	6
Germany	8.1	4	7.4	4	7.2	4	7.4	5
Hungary	2.9	16	1.8	19	1.7	20	1.6	21
Iceland	2.0	19	2.8	16	3.7	15	3.9	15
Ireland	**3.0**	**15**	**3.2**	**15**	**4.2**	**14**	**5.3**	**10**
Italy	2.7	17	2.7	18	2.6	17	2.6	17
Japan	8.7	2	8.8	1	8.6	2	8.8	2
Korea	4.7	12	4.7	12	4.7	13	4.2	14
Mexico	0.1	25	0.1	25	0.1	25	0.1	25
Netherlands	4.3	13	4.4	13	5.1	11	5.3	11
New Zealand	1.5	21	1.7	21	1.6	21	1.6	20
Norway	4.7	11	5.0	11	5.5	8	5.5	8
Poland	1.5	22	1.5	22	1.5	22	1.4	22
Portugal	0.4	23	0.4	23	0.4	23	0.4	23
Spain	1.9	20	1.8	20	1.7	19	1.9	19
Sweden	7.5	5	8.2	3	9.6	1	9.6	1
Switzerland	8.6	3	8.6	2	8.6	3	8.7	3
Turkey	0.1	24	0.1	24	0.2	24	0.2	24
UK	5.6	8	5.8	7	5.1	10	4.9	13
US								
Total OECD								
EU	**5.2**		**5.1**		**5.0**		**5.0**	
Nordic countries	**6.1**		**6.5**		**7.5**		**7.5**	

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

Table B3: Business Sector Researchers per 1000 Labour Force

	1991		1993		1995		1997	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
No. of countries	**26**		**26**		**26**		**26**	
Australia	1.5	17	1.6	16	1.7	17	1.6	17
Belgium	2.1	12	2.7	8	2.7	10	2.7	11
Canada	2.1	11	2.5	11	2.9	9	3.0	8
Czech Republic	2.1	10	1.5	18	1.0	19	1.0	19
Denmark	1.8	14	2.0	13	2.4	15	2.4	15
Finland	2.0	13	2.2	12	2.6	11	2.6	13
France	2.4	9	2.6	9	2.6	12	2.7	12
Germany	3.6	3	3.3	5	3.3	5	3.3	5
Hungary	1.2	20	0.8	21	0.7	21	0.8	21
Iceland	1.2	19	1.9	14	2.4	14	2.5	14
Ireland	**1.6**	**16**	**1.8**	**15**	**2.4**	**13**	**3.0**	**9**
Italy	1.2	18	1.2	19	1.2	18	1.2	18
Japan	5.2	2	5.6	2	5.8	2	6.0	1
Korea	3.2	4	3.2	6	3.2	6	3.1	7
Mexico	0.0	26	0.0	26	0.1	26	0.1	26
Netherlands	1.6	15	1.6	17	1.8	16	1.8	16
New Zealand	0.8	21	0.9	20	0.9	20	0.9	20
Norway	3.2	5	3.4	4	3.6	4	3.6	4
Poland	0.6	23	0.6	23	0.6	23	0.6	23
Portugal	0.1	24	0.2	24	0.2	24	0.2	24
Spain	0.8	22	0.7	22	0.7	22	0.7	22
Sweden	2.9	6	3.6	3	4.4	3	4.4	3
Switzerland	2.5	8	2.5	10	3.2	7	3.2	6
Turkey	0.1	25	0.1	25	0.1	25	0.1	25
UK	2.8	7	3.0	7	2.9	8	2.8	10
US	6.1	1	5.8	1	5.9	1	5.9	2
Total OECD	**3.5**		**3.5**		**3.4**		**3.4**	
EU	**2.2**		**2.3**		**2.3**		**2.3**	
Nordic countries	**2.5**		**2.9**		**3.4**		**3.4**	

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

Table B4: Proportion of All R&D Performed in the Business Sector

	1991		1993		1995		1997	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
No. of countries	**26**		**26**		**26**		**26**	
Australia	40%	21	44%	19	47%	19	47%	19
Belgium	66%	9	64%	10	67%	6	67%	9
Canada	53%	17	56%	14	60%	13	63%	11
Czech Republic	69%	5	73%	2	65%	10	63%	12
Denmark	59%	12	58%	13	57%	14	63%	13
Finland	57%	13	58%	12	63%	11	69%	7
France	61%	11	62%	11	61%	12	61%	14
Germany	69%	6	67%	8	66%	7	68%	8
Hungary	41%	19	33%	21	43%	20	42%	20
Iceland	22%	24	31%	22	32%	22	36%	22
Ireland	**64%**	**10**	**68%**	**6**	**71%**	**4**	**74%**	**3**
Italy	56%	15	54%	15	53%	16	55%	16
Japan	71%	3	66%	9	65%	9	71%	5
Korea	74%	1	74%	1	74%	2	73%	4
Mexico	10%	26	10%	26	21%	25	21%	25
Netherlands	50%	18	49%	17	52%	17	53%	17
New Zealand	27%	22	30%	23	27%	23	27%	23
Norway	55%	16	54%	16	57%	15	57%	15
Poland	41%	20	41%	20	39%	21	41%	21
Portugal	26%	23	22%	25	20%	26	20%	26
Spain	56%	14	48%	18	48%	18	49%	18
Sweden	68%	7	70%	5	74%	1	74%	2
Switzerland	70%	4	70%	4	70%	5	71%	6
Turkey	21%	25	23%	24	24%	24	26%	24
UK	67%	8	67%	7	65%	8	65%	10
US	73%	2	71%	3	72%	3	74%	1
Total OECD	**68%**		**67%**		**68%**		**68%**	
EU	**63%**		**62%**		**62%**		**62%**	
Nordic countries	**63%**		**63%**		**67%**		**67%**	

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

Table B5: Proportion of Business Sector R&D Financed by Government

	1991		1993		1995		1997	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
No. of countries	**26**		**26**		**26**		**26**	
Australia	3.0	22	2.4	22	2.4	23	2.6	23
Belgium	7.8	14	7.2	16	4.4	19	4.4	19
Canada	9.8	11	9.8	12	6.9	11	7.0	12
Czech Republic	4.1	19	4.1	20	4.5	17	7.9	10
Denmark	7.9	13	5.8	19	5.4	15	5.1	18
Finland	5.4	18	6.1	18	5.6	14	5.6	14
France	22.3	3	15.3	4	12.7	5	13.1	4
Germany	10.0	10	9.0	14	8.8	10	8.4	9
Hungary	11.4	7	11.4	8	16.2	4	14.7	3
Iceland	9.6	12	14.4	5	3.3	21	3.3	21
Ireland	**3.7**	**20**	**10.6**	**10**	**4.5**	**17**	**5.3**	**16**
Italy	11.8	6	13.4	6	16.7	3	10.0	6
Japan	1.4	24	1.4	24	1.6	26	1.1	26
Korea	3.6	21	3.6	21	3.6	20	4.4	19
Mexico	0.0	25	0.5	25	2.8	22	2.8	22
Netherlands	7.5	15	7.8	15	6.6	13	5.6	14
New Zealand	6.8	16	6.9	17	6.9	11	6.9	13
Norway	15.9	4	16.0	3	11.9	6	11.9	5
Poland	33.9	1	33.9	1	33.8	1	28.2	1
Portugal	6.5	17	9.1	13	5.2	16	5.2	17
Spain	11.3	8	10.6	10	9.2	9	7.9	10
Sweden	10.4	9	10.8	9	9.5	8	9.5	7
Switzerland	1.7	23	1.7	23	2.4	23	2.4	24
Turkey	0.0	25	0.1	26	1.7	25	1.9	25
UK	14.6	5	12.4	7	11.3	7	9.5	7
US	22.5	2	19.4	2	17.8	2	15.0	2
Total OECD	**14.9**		**12.9**		**11.6**		**10.7**	
EU	**13.4**		**11.3**		**10.4**		**9.6**	
Nordic countries	**10.4**		**9.9**		**8.4**		**8.4**	

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

Table B6: Distribution of R&D Expenditure by Sector – All Firms

	1991		1993		1995		1997	
	£'000	Share of Total	£'000	Share of Total	£'000	Share of Total	£'000	Share of Total
Food, drink, tobacco	21,404	12%	34,985	13%	46,004	12%	57,552	11%
Textiles & clothing	4,802	3%	7,129	3%	14,092	4%	9,509	2%
Wood and wood products	311	0%	262	0%	2,644	1%	3,409	1%
Paper, printing and publishing	1,235	1%	2,671	1%	6,667	2%	3,722	1%
Chemicals (less pharmaceutical)	10,770	6%	10,083	4%	13,274	3%	22,984	4%
Pharmaceuticals	21,239	12%	48,312	18%	54,432	14%	76,906	14%
Rubber and plastic products	2,087	1%	3,715	1%	9,558	2%	10,684	2%
Non-metallic mineral products	3,883	2%	4,146	2%	9,559	2%	8,448	2%
Basic and fabricated metals	4,141	2%	5,342	2%	12,389	3%	10,256	2%
Machinery and equipment	5,094	3%	7,983	3%	13,751	4%	20,603	4%
Electrical and electronic equipment	63,132	37%	96,713	36%	141,029	36%	193,901	36%
Instruments	6,290	4%	15,046	6%	23,668	6%	32,427	6%
Transport equipment	6,946	4%	4,016	2%	6,812	2%	13,911	3%
Other manufacturing	2,789	2%	2,987	1%	10,089	3%	4,414	1%
Total manufacturing	**154,711**	**90%**	**243,708**	**91%**	**365,066**	**93%**	**469,048**	**88%**
Software	12,039	7%	15,138	6%	17,845	5%	51,594	10%
Other services	5,381	3%	8,722	3%	9,414	2%	14,164	3%
Total business sector	**172,132**	**100%**	**267,568**	**100%**	**392,326**	**100%**	**534,806**	**100%**

Source: Forfás Surveys of Research and Development 1991 to 1997

Table B6A: Distribution of R&D Expenditure by Sector – All Firms

	1991		1993		1995		1997	
	€'000	Share of Total	€'000	Share of Total	€'000	Share of Total	€'000	Share of Total
Food, drink, tobacco	27,177	12%	44,422	13%	58,413	12%	73,076	11%
Textiles & clothing	6,097	3%	9,052	3%	17,893	4%	12,074	2%
Wood and wood products	395	0%	333	0%	3,357	1%	4,329	1%
Paper, printing and publishing	1,568	1%	3,391	1%	8,465	2%	4,726	1%
Chemicals (less pharmaceutical)	13,675	6%	12,803	4%	16,855	3%	29,184	4%
Pharmaceuticals	26,968	12%	61,344	18%	69,114	14%	97,650	14%
Rubber and plastic products	2,650	1%	4,717	1%	12,136	2%	13,566	2%
Non-metallic mineral products	4,930	2%	5,264	2%	12,137	2%	10,727	2%
Basic and fabricated metals	5,258	2%	6,783	2%	15,731	3%	13,022	2%
Machinery and equipment	6,468	3%	10,136	3%	17,460	4%	26,160	4%
Electrical and electronic equipment	80,161	37%	122,800	36%	179,070	36%	246,203	36%
Instruments	7,987	4%	19,104	6%	30,052	6%	41,174	6%
Transport equipment	8,820	4%	5,099	2%	8,649	2%	17,663	3%
Other manufacturing	3,541	2%	3,793	1%	12,810	3%	5,605	1%
Total manufacturing	**196,442**	**90%**	**309,445**	**91%**	**463,538**	**93%**	**595,568**	**88%**
Software	15,286	7%	19,221	6%	22,658	5%	65,511	10%
Other services	6,832	3%	11,075	3%	11,953	2%	17,985	3%
Total business sector	**218,563**	**100%**	**339,741**	**100%**	**498,151**	**100%**	**679,064**	**100%**

Source: Forfás Surveys of Research and Development 1991 to 1997

Table B7: R&D Expenditure in Manufacturing to Gross Output – All Firms

	1991		1993		1995		1997	
	£'000	% of output	£'000	% of output	£'000	% of output	£'000	% of output
Food, drink, tobacco	21,404	0.3%	34,985	0.4%	46,004	0.5%	57,552	0.5%
Textiles & clothing	4,802	0.6%	7,129	1.0%	14,092	1.8%	9,509	1.1%
Wood and wood products	311	0.1%	262	0.1%	2,644	0.8%	3,409	0.9%
Paper, printing and publishing	1,235	0.1%	2,671	0.1%	6,667	0.2%	3,722	0.1%
Chemicals (less pharmaceuticals)	10,770	0.5%	10,083	0.3%	13,274	0.3%	22,984	0.4%
Pharmaceuticals	21,239	4.9%	48,312	7.4%	54,432	4.2%	76,906	5.1%
Rubber and plastic products	2,087	0.4%	3,715	0.7%	9,558	1.3%	10,684	1.2%
Non-metallic mineral products	3,883	0.7%	4,146	0.7%	9,559	1.3%	8,448	1.0%
Basic and fabricated metals	4,141	0.5%	5,342	0.6%	12,389	1.2%	10,256	0.9%
Machinery and equipment	5,094	0.7%	7,983	1.0%	13,751	1.3%	20,603	1.7%
Electrical and electronic equipment	63,132	2.0%	96,713	2.2%	141,029	1.7%	193,901	1.9%
Instruments	6,290	1.0%	15,046	1.8%	23,668	2.4%	32,427	2.4%
Transport equipment	6,946	1.7%	4,016	1.0%	6,812	1.3%	13,911	2.2%
Other manufacturing	2,789	0.4%	2,987	0.4%	10,089	1.1%	4,414	0.4%
Total manufacturing	**154,711**	**0.7%**	**243,708**	**1.0%**	**365,066**	**1.1%**	**469,048**	**1.2%**

Source: Forfás Surveys of Research and Development 1991 to 1997 and CSO Census of Industrial Production (estimate for 1997)

Table B7A: R&D Expenditure in Manufacturing to Gross Output – All Firms

	1991		1993		1995		1997	
	€'000	% of output	€'000	% of output	€'000	% of output	€'000	% of output
Food, drink, tobacco	27,177	0.3%	44,422	0.4%	58,413	0.5%	73,076	0.5%
Textiles & clothing	6,097	0.6%	9,052	1.0%	17,893	1.8%	12,074	1.1%
Wood and wood products	395	0.1%	333	0.1%	3,357	0.8%	4,329	0.9%
Paper, printing and publishing	1,568	0.1%	3,391	0.1%	8,465	0.2%	4,726	0.1%
Chemicals (less pharmaceuticals)	13,675	0.5%	12,803	0.3%	16,855	0.3%	29,184	0.4%
Pharmaceuticals	26,968	4.9%	61,344	7.4%	69,114	4.2%	97,650	5.1%
Rubber and plastic products	2,650	0.4%	4,717	0.7%	12,136	1.3%	13,566	1.2%
Non-metallic mineral products	4,930	0.7%	5,264	0.7%	12,137	1.3%	10,727	1.0%
Basic and fabricated metals	5,258	0.5%	6,783	0.6%	15,731	1.2%	13,022	0.9%
Machinery and equipment	6,468	0.7%	10,136	1.0%	17,460	1.3%	26,160	1.7%
Electrical and electronic equipment	80,161	2.0%	122,800	2.2%	179,070	1.7%	246,203	1.9%
Instruments	7,987	1.0%	19,104	1.8%	30,052	2.4%	41,174	2.4%
Transport equipment	8,820	1.7%	5,099	1.0%	8,649	1.3%	17,663	2.2%
Other manufacturing	3,541	0.4%	3,793	0.4%	12,810	1.1%	5,605	0.4%
Total manufacturing	**196,442**	**0.7%**	**309,445**	**1.0%**	**463,538**	**1.1%**	**595,568**	**1.2%**

Source: Forfás Surveys of Research and Development 1991 to 1997 and CSO Census of Industrial Production (estimate for 1997)

Table B8: R&D Expenditure in Manufacturing to Gross Output in Selected Countries

	Irl	Can	Den	Ger	Fin	Fra	Jap	Nth	Nor	Esp	Swe	UK	USA	OECD	EU
Total manufacturing	**1.2**	**1.2**	**1.7**	**2.3**	**1.9**	**2.6**	**2.7**	**1.7**	**1.4**	**0.6**	**3.5**	**1.8**	**2.9**	**2.4**	**1.8**
Food, drink, tobacco	**0.5**	0.2	0.4	0.1	0.5	0.3	0.6	0.5	0.4	0.1	0.4	0.3	0.3	0.3	0.2
Textiles & clothing	**1.1**	0.4	0.1	0.4	0.5	0.3	0.7	0.3	0.7	0.2	0.6	0.1	0.2	0.3	0.2
Wood and wood products	**0.9**	0.1	0.1	0.2	0.2	0.3	0.4	0.0	0.2	0.1	0.1	0.1	0.2	0.2	0.1
Paper, printing and publishing	**0.1**	0.3	0.1	0.1	0.5	0.1	0.3	0.1	0.5	0.1	0.7	0.1	0.5	0.4	0.2
Chemicals (less pharmaceutical)	**0.4**	0.7	1.3	3.9	2.5	3.6	6.0	3.5	3.1	0.5	1.9	2.9	3.0	3.2	2.7
Pharmaceuticals	**5.1**	8.2	13.2	8.2	16.0	8.8	13.1	8.0	13.6	2.5	18.9	16.4	13.1	11.5	9.3
Rubber and plastic products	**1.2**	0.3	0.9	0.8	2.3	1.5	2.1	0.7	0.7	0.5	2.2	0.4	1.2	1.2	0.8
Non-metallic mineral products	**1.0**	0.2	0.3	0.6	1.9	0.9	1.9	0.3	0.5	0.3	0.7	0.4	0.8	0.8	0.4
Basic and fabricated metals	**0.9**	0.6	0.7	0.5	0.8	0.8	1.0	1.2	1.0	0.3	0.8	0.4	0.5	0.7	0.5
Machinery and equipment	**1.7**	0.8	2.8	2.3	3.4	2.4	3.4	0.8	1.0	1.1	3.6	1.9	1.7	2.1	1.9
Electrical and electronic equipt	**1.9**	7.9	4.5	5.5	7.9	8.3	5.1	8.2	8.9	2.5	11.1	4.1	6.0	5.6	5.3
Instruments	**2.4**	2.0	8.0	3.2	6.8	2.3	8.2	1.6	8.3	4.0	11.7	1.5	8.5	7.0	2.5
Transport equipment	**2.2**	1.0	1.1	4.9	1.4	5.6	2.6	2.5	1.1	1.3	6.2	3.6	6.3	4.5	4.2
Other manufacturing	**0.4**	1.9	8.7	0.6	1.6	0.5	0.5	1.3	0.5	0.4	0.4	0.6	1.9	1.0	0.6

Source: OECD STAN Database (data relate to 1994 in most cases)

Table B9: Distribution of R&D Expenditure by Sector – Irish-owned Firms

	1991		1993		1995		1997	
	£'000	Share of Total	£'000	Share of Total	£'000	Share of Total	£'000	Share of Total
Food, drink, tobacco	12,487	22%	22,228	27%	31,654	22%	35,310	18%
Textiles & clothing	3,232	6%	1,812	2%	7,534	5%	7,173	4%
Wood and wood products	311	1%	255	0%	1,610	1%	1,970	1%
Paper, printing and publishing	821	1%	2,130	3%	6,167	4%	3,117	2%
Chemicals (less pharmaceutical)	3,459	6%	1,718	2%	2,992	2%	4,910	3%
Pharmaceuticals	1,788	3%	2,814	3%	3,756	3%	3,093	2%
Rubber and plastic products	1,593	3%	2,520	3%	6,526	5%	6,962	4%
Non-metallic mineral products	3,265	6%	3,037	4%	7,482	5%	7,588	4%
Basic and fabricated metals	3,260	6%	4,549	6%	10,555	8%	9,480	5%
Machinery and equipment	3,231	6%	4,931	6%	8,353	6%	11,259	6%
Electrical and electronic equipment	7,440	13%	11,826	14%	19,358	14%	35,969	19%
Instruments	1,851	3%	2,107	3%	4,217	3%	7,768	4%
Transport equipment	2,236	4%	1,512	2%	4,737	3%	7,151	4%
Other manufacturing	2,225	4%	2,146	3%	7,441	5%	3,713	2%
Total manufacturing	**47,756**	**83%**	**63,867**	**78%**	**123,482**	**88%**	**145,787**	**76%**
Software	4,595	8%	9,638	12%	12,511	9%	34,553	18%
Other services	5,381	9%	8,472	10%	4,717	3%	11,631	6%
Total business sector	**57,732**	**100%**	**81,977**	**100%**	**140,710**	**100%**	**191,971**	**100%**

Source: Forfás Surveys of Research and Development 1991 to 1997

Table B9A: Distribution of R&D Expenditure by Sector – Irish-owned Firms

	1991		1993		1995		1997	
	€'000	Share of Total	€'000	Share of Total	€'000	Share of Total	€'000	Share of Total
Food, drink, tobacco	15,855	22%	28,224	27%	40,192	22%	44,834	18%
Textiles & clothing	4,104	6%	2,301	2%	9,566	5%	9,108	4%
Wood and wood products	395	1%	324	0%	2,044	1%	2,501	1%
Paper, printing and publishing	1,042	1%	2,705	3%	7,830	4%	3,958	2%
Chemicals (less pharmaceutical)	4,392	6%	2,181	2%	3,799	2%	6,234	3%
Pharmaceuticals	2,270	3%	3,573	3%	4,769	3%	3,927	2%
Rubber and plastic products	2,023	3%	3,200	3%	8,286	5%	8,840	4%
Non-metallic mineral products	4,146	6%	3,856	4%	9,500	5%	9,635	4%
Basic and fabricated metals	4,139	6%	5,776	6%	13,402	8%	12,037	5%
Machinery and equipment	4,103	6%	6,261	6%	10,606	6%	14,296	6%
Electrical and electronic equipment	9,447	13%	15,016	14%	24,580	14%	45,671	19%
Instruments	2,350	3%	2,675	3%	5,354	3%	9,863	4%
Transport equipment	2,839	4%	1,920	2%	6,015	3%	9,080	4%
Other manufacturing	2,825	4%	2,725	3%	9,448	5%	4,715	2%
Total manufacturing	**60,638**	**83%**	**81,094**	**78%**	**156,790**	**88%**	**185,11**	**76%**
Software	5,834	8%	12,238	12%	15,886	9%	43,873	18%
Other services	6,832	9%	10,757	10%	5,989	3%	14,768	6%
Total business sector	**73,305**	**100%**	**104,089**	**100%**	**178,665**	**100%**	**243,754**	**100%**

Table B10: R&D Expenditure in Manufacturing to Gross Output – Irish-owned Firms

	1991		1993		1995		1997	
	£'000	% of output	£'000	% of output	£'000	% of output	£'000	% of output
Food, drink, tobacco	12,487	0.2%	22,228	0.4%	31,654	0.5%	35,310	0.5%
Textiles & clothing	3,232	1.0%	1,812	0.6%	7,534	2.2%	7,173	1.9%
Wood and wood products	311	0.2%	255	0.1%	1,610	0.7%	1,970	0.7%
Paper, printing and publishing	821	0.1%	2,130	0.2%	6,167	0.6%	3,117	0.3%
Chemicals (less pharmaceutical)	3,459	0.8%	1,718	0.4%	2,992	0.7%	4,910	0.8%
Pharmaceuticals	1,788	3.9%	2,814	5.3%	3,756	5.8%	3,093	4.0%
Rubber and plastic products	1,593	0.7%	2,520	1.1%	6,526	2.1%	6,962	1.7%
Non-metallic mineral products	3,265	0.7%	3,037	0.6%	7,482	1.2%	7,588	1.1%
Basic and fabricated metals	3,260	0.7%	4,549	1.0%	10,555	1.8%	9,480	1.3%
Machinery and equipment	3,231	1.4%	4,931	1.8%	8,353	2.3%	11,259	2.4%
Electrical and electronic equipment	7,440	3.3%	11,826	4.4%	19,358	5.3%	35,969	6.4%
Instruments	1,851	5.8%	2,107	3.6%	4,217	5.6%	7,768	6.7%
Transport equipment	2,236	0.7%	1,512	0.5%	4,737	1.5%	7,151	1.8%
Other manufacturing	2,225	0.4%	2,146	0.4%	7,441	1.3%	3,713	0.5%
Total manufacturing	**47,756**	**0.5%**	**63,867**	**0.6%**	**123,482**	**1.1%**	**145,787**	**1.1%**

Source: Forfás Surveys of Research and Development 1991 to 1997 and CSO Census of Industrial Production (estimate for 1997)

Table B10A: R&D Expenditure in Manufacturing to Gross Output – Irish-owned Firms

	1991		1993		1995		1997	
	€'000	% of output	€'000	% of output	€'000	% of output	€'000	% of output
Food, drink, tobacco	15,855	0.2%	28,224	0.4%	40,192	0.5%	44,834	0.5%
Textiles & clothing	4,104	1.0%	2,301	0.6%	9,566	2.2%	9,108	1.9%
Wood and wood products	395	0.2%	324	0.1%	2,044	0.7%	2,501	0.7%
Paper, printing and publishing	1,042	0.1%	2,705	0.2%	7,830	0.6%	3,958	0.3%
Chemicals (less pharmaceutical)	4,392	0.8%	2,181	0.4%	3,799	0.7%	6,234	0.8%
Pharmaceuticals	2,270	3.9%	3,573	5.3%	4,769	5.8%	3,927	4.0%
Rubber and plastic products	2,023	0.7%	3,200	1.1%	8,286	2.1%	8,840	1.7%
Non-metallic mineral products	4,146	0.7%	3,856	0.6%	9,500	1.2%	9,635	1.1%
Basic and fabricated metals	4,139	0.7%	5,776	1.0%	13,402	1.8%	12,037	1.3%
Machinery and equipment	4,103	1.4%	6,261	1.8%	10,606	2.3%	14,296	2.4%
Electrical and electronic equipment	9,447	3.3%	15,016	4.4%	24,580	5.3%	45,671	6.4%
Instruments	2,350	5.8%	2,675	3.6%	5,354	5.6%	9,863	6.7%
Transport equipment	2,839	0.7%	1,920	0.5%	6,015	1.5%	9,080	1.8%
Other manufacturing	2,825	0.4%	2,725	0.4%	9,448	1.3%	4,715	0.5%
Total manufacturing	**60,638**	**0.5%**	**81,094**	**0.6%**	**156,790**	**1.1%**	**185,11**	**1.1%**

Source: Forfás Surveys of Research and Development 1991 to 1997 and CSO Census of Industrial Production (estimate for 1997)

Table B11: Distribution of R&D Expenditure by Sector – Foreign-owned Firms

	1991		1993		1995		1997	
	£'000	Share of Total	£'000	Share of Total	£'000	Share of Total	£'000	Share of Total
Food, drink, tobacco	8,916	8%	12,758	7%	14,350	6%	22,242	6%
Textiles & clothing	1,570	1%	5,317	3%	6,558	3%	2,336	1%
Wood and wood products	1	0%	7	0%	1,034	0%	1,438	0%
Paper, printing and publishing	414	0%	541	0%	500	0%	605	0%
Chemicals (less pharmaceutical)	7,310	6%	8,365	5%	10,282	4%	18,074	5%
Pharmaceuticals	19,450	17%	45,497	25%	50,676	20%	73,812	22%
Rubber and plastic products	494	0%	1,195	1%	3,032	1%	3,722	1%
Non-metallic mineral products	618	1%	1,109	1%	2,077	1%	859	0%
Basic and fabricated metals	880	1%	793	0%	1,834	1%	775	0%
Machinery and equipment	1,863	2%	3,053	2%	5,397	2%	9,343	3%
Electrical and electronic equipment	55,692	49%	84,887	46%	121,670	48%	157,933	46%
Instruments	4,439	4%	12,939	7%	19,451	8%	24,659	7%
Transport equipment	4,710	4%	2,504	1%	2,075	1%	6,760	2%
Other manufacturing	564	0%	841	0%	2,649	1%	702	0%
Total manufacturing	**106,955**	**93%**	**179,841**	**97%**	**241,584**	**96%**	**323,261**	**94%**
Software	7,445	7%	5,500	3%	5,334	2%	17,041	5%
Other services	1	0%	250	0%	4,697	2%	2,533	1%
Total business sector	**114,400**	**100%**	**185,591**	**100%**	**251,616**	**100%**	**342,835**	**100%**

Source: Forfás Surveys of Research and Development 1991 to 1997

Table B11A: Distribution of R&D Expenditure by Sector – Foreign-owned Firms

	1991		1993		1995		1997	
	€'000	Share of Total	€'000	Share of Total	€'000	Share of Total	€'000	Share of Total
Food, drink, tobacco	11,321	8%	16,199	7%	18,221	6%	28,242	6%
Textiles & clothing	1,993	1%	6,751	3%	8,327	3%	2,966	1%
Wood and wood products	1	0%	9	0%	1,313	0%	1,826	0%
Paper, printing and publishing	526	0%	687	0%	635	0%	768	0%
Chemicals (less pharmaceutical)	9,282	6%	10,621	5%	13,055	4%	22,949	5%
Pharmaceuticals	24,696	17%	57,769	25%	64,345	20%	93,722	22%
Rubber and plastic products	627	0%	1,517	1%	3,850	1%	4,726	1%
Non-metallic mineral products	785	1%	1,408	1%	2,637	1%	1,091	0%
Basic and fabricated metals	1,117	1%	1,007	0%	2,329	1%	984	0%
Machinery and equipment	2,366	2%	3,877	2%	6,853	2%	11,863	3%
Electrical and electronic equipment	70,714	49%	107,784	46%	154,489	48%	200,534	46%
Instruments	5,636	4%	16,429	7%	24,698	8%	31,323	7%
Transport equipment	5,980	4%	3,179	1%	2,635	1%	8,583	2%
Other manufacturing	716	0%	1,068	0%	3,364	1%	819	0%
Total manufacturing	**135,805**	**93%**	**228,351**	**97%**	**306,748**	**96%**	**410,457**	**94%**
Software	9,453	7%	6,984	3%	6,773	2%	21,638	5%
Other services	1	0%	317	0%	5,964	2%	3,216	1%
Total business sector	**145,258**	**100%**	**235,652**	**100%**	**319,486**	**100%**	**435,311**	**100%**

Source: Forfás Surveys of Research and Development 1991 to 1997

Table B12: R&D Expenditure in Manufacturing to Gross Output – Foreign-owned Firms

	1991		1993		1995		1997	
	£'000	% of output	£'000	% of output	£'000	% of output	£'000	% of output
Food, drink, tobacco	8,916	0.4%	12,758	0.4%	14,350	0.4%	22,242	0.5%
Textiles & clothing	1,570	0.4%	5,317	1.3%	6,558	1.5%	2,336	0.5%
Wood and wood products	1	0.0%	7	0.0%	1,034	1.1%	1,438	1.4%
Paper, printing and publishing	414	0.0%	541	0.0%	500	0.0%	605	0.0%
Chemicals (less pharmaceutical)	7,310	0.4%	8,365	0.3%	10,282	0.3%	18,074	0.4%
Pharmaceuticals	19,450	5.0%	45,497	7.6%	50,676	4.1%	73,812	5.1%
Rubber and plastic products	494	0.2%	1,195	0.4%	3,032	0.7%	3,722	0.8%
Non-metallic mineral products	618	0.5%	1,109	1.1%	2,077	1.8%	859	0.7%
Basic and fabricated metals	880	0.2%	793	0.2%	1,834	0.5%	775	0.2%
Machinery and equipment	1,863	0.4%	3,053	0.6%	5,397	0.8%	9,343	1.2%
Electrical and electronic equipment	55,692	1.9%	84,887	2.0%	121,670	1.6%	157,933	1.7%
Instruments	4,439	0.7%	12,939	1.7%	19,451	2.1%	24,659	2.0%
Transport equipment	4,710	5.1%	2,504	1.8%	2,075	1.0%	6,760	2.8%
Other manufacturing	564	0.2%	841	0.3%	2,649	0.8%	702	0.2%
Total manufacturing	**106,955**	**1.0%**	**179,841**	**1.2%**	**241,584**	**1.1%**	**323,261**	**1.2%**

Source: Forfás Surveys of Research and Development 1991 to 1997 and CSO Census of Industrial Production (estimate for 1997)

Table B12A: R&D Expenditure in Manufacturing to Gross Output – Foreign-owned Firms

	1991		1993		1995		1997	
	€'000	% of output	€'000	% of output	€'000	% of output	€'000	% of output
Food, drink, tobacco	11,321	0.4%	16,199	0.4%	18,221	0.4%	28,242	0.5%
Textiles & clothing	1,993	0.4%	6,751	1.3%	8,327	1.5%	2,966	0.5%
Wood and wood products	1	0.0%	9	0.0%	1,313	1.1%	1,826	1.4%
Paper, printing and publishing	526	0.0%	687	0.0%	635	0.0%	768	0.0%
Chemicals (less pharmaceutical)	9,282	0.4%	10,621	0.3%	13,055	0.3%	22,949	0.4%
Pharmaceuticals	24,696	5.0%	57,769	7.6%	64,345	4.1%	93,722	5.1%
Rubber and plastic products	627	0.2%	1,517	0.4%	3,850	0.7%	4,726	0.8%
Non-metallic mineral products	785	0.5%	1,408	1.1%	2,637	1.8%	1,091	0.7%
Basic and fabricated metals	1,117	0.2%	1,007	0.2%	2,329	0.5%	984	0.2%
Machinery and equipment	2,366	0.4%	3,877	0.6%	6,853	0.8%	11,863	1.2%
Electrical and electronic equipment	70,714	1.9%	107,784	2.0%	154,489	1.6%	200,534	1.7%
Instruments	5,636	0.7%	16,429	1.7%	24,698	2.1%	31,323	2.0%
Transport equipment	5,980	5.1%	3,179	1.8%	2,635	1.0%	8,583	2.8%
Other manufacturing	716	0.2%	1,068	0.3%	3,364	0.8%	819	0.2%
Total manufacturing	**135,805**	**1.0%**	**228,351**	**1.2%**	**306,748**	**1.1%**	**410,457**	**1.2%**

Source: Forfás Surveys of Research and Development 1991 to 1997 and CSO Census of Industrial Production (estimate for 1997)

Table B13: Resident patent applications per 10,000 population

	1991		1993		1995		1996	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
No. of countries	**28**		**28**		**28**		**28**	
Australia	4.5	3	4.6	4	4.8	3	4.6	5
Austria	2.7	11	2.8	11	2.2	14	2.3	13
Belgium	0.7	22	1.0	21	0.8	20	0.9	18
Canada	0.8	21	1.3	18	0.8	19	0.9	19
Czech Republic	2.1	15	0.9	22	0.6	23	0.6	22
Denmark	2.1	16	2.3	13	2.4	12	2.5	12
Finland	4.3	4	4.3	7	4.1	8	4.3	6
France	2.2	12	2.2	15	2.2	15	2.2	14
Germany	4.1	5	4.3	6	4.7	4	5.2	3
Greece	0.4	25	0.4	25	0.4	25	0.4	25
Hungary	1.5	17	1.1	20	1.1	18	0.8	20
Iceland	1.3	19	1.3	17	0.7	21	0.6	23
Ireland	**2.2**	**13**	**2.2**	**14**	**2.4**	**13**	**2.2**	**15**
Italy	1.4	18	1.4	16	1.4	17	1.2	17
Japan	27.1	1	26.6	1	26.6	1	26.9	1
Korea	3.7	7	4.9	2	13.1	2	15.0	2
Mexico	0.1	27	0.1	27	0.0	27	0.0	28
Netherlands	1.1	20	1.2	19	1.4	16	1.6	16
New Zealand	2.9	10	3.6	9	3.6	9	3.6	9
Norway	2.2	14	2.3	12	2.5	11	3.0	11
Poland	0.7	23	0.7	23	0.7	22	0.6	21
Portugal	0.1	26	0.1	26	0.1	26	0.1	26
Spain	0.6	24	0.6	24	0.5	24	0.6	24
Sweden	3.7	6	4.4	5	4.5	6	4.7	4
Switzerland	4.5	2	4.7	3	4.4	7	3.8	8
Turkey	0.0	28	0.0	28	0.0	28	0.1	27
UK	3.3	9	3.2	10	3.2	10	3.1	10
US	3.5	8	3.9	8	4.7	5	4.0	7
Total OECD	**5.5**		**5.6**		**5.8**		**5.8**	
EU	**2.2**		**2.4**		**2.3**		**2.6**	
Nordic countries	**3.2**		**3.5**		**3.6**		**3.8**	

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

Table B14: EPO patent applications per 10,000 population

	1991		1993		1995		1997	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
No. of countries	**28**		**28**		**28**		**28**	
Australia	0.4	15	0.4	15	0.6	14		
Austria	0.9	8	0.8	10	1.1	8		
Belgium	0.5	12	0.6	12	1.0	11		
Canada	0.2	17	0.3	16	0.4	17		
Czech Republic	0.0	22	0.0	24	0.1	23		
Denmark	0.7	9	0.9	6	1.6	5		
Finland	1.0	6	1.2	4	2.2	3		
France	0.9	7	0.9	8	1.0	9		
Germany	1.5	2	1.4	2	1.8	4		
Greece	0.0	23	0.0	23	0.0	24		
Hungary	0.1	19	0.1	21	0.1	20		
Iceland	0.3	16	0.2	18	0.3	19		
Ireland	**0.2**	**18**	**0.2**	**19**	**0.4**	**18**		
Italy	0.4	14	0.4	14	0.5	16		
Japan	1.0	4	0.9	7	0.9	12		
Korea	0.0	24	0.0	22	0.1	22		
Mexico	0.0	27	0.0	27	0.0	27		
Netherlands	1.0	5	1.0	5	1.2	6		
New Zealand	0.1	20	0.2	17	0.6	15		
Norway	0.5	13	0.6	13	0.8	13		
Poland	0.0	26	0.0	26	0.0	26		
Portugal	0.0	25	0.0	25	0.0	25		
Spain	0.1	21	0.1	20	0.1	21		
Sweden	1.3	3	1.3	3	2.4	2		
Switzerland	2.6	1	2.4	1	2.8	1		
Turkey	0.0	28	0.0	28	0.0	28		
UK	0.7	11	0.7	11	1.0	10		
US	0.7	10	0.8	9	1.1	7		
Total OECD	**0.7**		**0.7**		**0.8**			
EU	**4.6**		**4.6**		**4.6**			
Nordic countries	**1.0**		**1.0**		**1.9**			

Source: Second European Report on S&T Indicators, 1997

Table B15: Patents granted by US Patent and Trademark Office per 10,000 population

	1991		1993		1995		1997	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
No. of countries	**23**		**23**		**23**			
Australia	0.3	14	0.2	16	0.3	16		
Austria	0.5	11	0.4	11	0.4	11		
Belgium	0.4	13	0.4	13	0.4	12		
Canada	0.7	6	0.7	6	0.7	6		
Czech Republic								
Denmark	0.4	12	0.4	12	0.4	13		
Finland	0.7	8	0.6	7	0.7	7		
France	0.5	9	0.5	9	0.5	9		
Germany	1.0	4	0.8	4	0.8	5		
Greece								
Hungary	0.1	20	0.1	20	0.0	20		
Iceland								
Ireland	**0.2**	**17**	**0.1**	**18**	**0.1**	**18**		
Italy	0.2	16	0.2	15	0.2	17		
Japan	1.7	3	1.8	2	1.7	2		
Korea	0.1	19	0.2	17	0.3	15		
Mexico	0.0	22	0.0	22	0.0	22		
Netherlands	0.7	7	0.5	8	0.5	8		
New Zealand	0.1	18	0.1	19	0.1	19		
Norway	0.3	15	0.3	14	0.3	14		
Poland	0.0	23	0.0	23	0.0	23		
Portugal								
Spain	0.0	21	0.0	21	0.0	21		
Sweden	0.8	5	0.7	5	0.9	4		
Switzerland	2.0	2	1.6	3	1.5	3		
Turkey								
UK	0.5	10	0.4	10	0.4	10		
US	2.0	1	2.1	1	2.1	1		
Total OECD								
EU	**4.6**		**4.6**		**4.6**			
Nordic countries	**0.6**		**0.5**		**0.6**			

Source: Second European Report on S&T Indicators, 1997

Table B16: Top-line Results from the Community Innovation Survey 1994-1996

	Proportion of firms with 20+ employees introducing new or improved products		Proportion of firms introducing products completely new to the market		Total sales expenditure on innovation activities as a percentage of sales		Share of 1996 turnover from new or improved products		Share of 1996 turnover from products completely new to the market	
	Irl	EU	Irl	EU	Irl	EU	Irl	EU	Irl	EU
Total Manufacturing	**66**	**48**	**27**	**20**	**3.3**	**3.8**	**32.2**	**30.6**	**8.5**	**6.6**
20-49	61	39	23	14	2.8	2.3	21.4	15.1	11.0	3.0
50-249	70	54	28	21	3.2	2.4	25.6	21.9	7.0	3.4
250 +	78	76	50	43	3.7	4.4	42.9	35.1	8.8	8.0
Food products; beverages and tobacco	60	44	29	15	1.1	1.5	10.2	16.8	2.6	3.6
Textiles and leather	54	35	11	16	3.2	1.7	34.1	20.2	4.8	4.2
Wood; pulp and paper; publishing	49	34	18	8	2.2	2.5	19.5	14.9	4.7	2.3
Chemical and pharmaceutical products	77	69	23	34	5.3	4.4	22.1	24.4	10.2	7.1
Rubber and plastic; non-metallic mineral prod.	63	50	25	21	2.9	2.7	27.7	28.5	12.8	6.3
Basic metals and fabricated metal products	59	40	28	14	4.6	1.9	25.8	19.9	8.4	3.1
Machinery and equipment NEC	84	68	34	31	3.9	3.7	40.1	38.5	4.1	6.6
Electrical and optical equipment	85	68	48	36	5.0	8.1	71.2	55.7	14.7	12.7
Transport equipment	76	54	21	25	5.8	4.9	19.6	40.8	3.4	9.1
Manufacturing NEC	64	42	14	16	3.9	2.2	26.6	30.0	1.9	4.2

Source: Preliminary data from Eurostat based on CIS undertaken in EU Member States

APPENDIX A – SURVEY METHODOLOGY

The fieldwork for the Survey of R&D Performing Enterprises was conducted in 1998 relating to the R&D activity of firms in 1997.

The survey is based on a questionnaire sent to all known R&D performing enterprises or any enterprise with a possibility of having performed in-house R&D in the reference year. The main listing used is derived from the Forfás Business Information System which contains information on all firms known to the development agencies (Enterprise Ireland, IDA Ireland, Shannon Development and Údarás na Gaeltachta). This listing is supplemented with other information based on previous surveys, recipients of government grants and participants in various programmes (EU Framework Programme etc.).

A wide trawl of companies was undertaken for the survey with 2,400 questionnaires being sent to enterprises in July 1998. All enterprises were followed up by telephone following receipt of the questionnaire. In the case of 1,150 enterprises, the questionnaire was found to be not applicable or the enterprise had received the questionnaire under a different name. The remaining 1,250 enterprises form the population of R&D performers. Completed questionnaires were returned by 655 enterprises, a response rate of 52%. However, particular emphasis was placed on ensuring that a response was received from as many of the largest R&D spenders as possible (i.e. those spending over £0.5m (€0.6m) in previous surveys). The response rate for the priority group was 74%.

In grossing up the data, individual estimates were made for the non-respondents in the priority group based on their R&D spend in previous years. For the other non-respondents, a median expenditure figure was applied based on the respondents to the survey controlling for size of firm, industry sector and nationality of ownership (indigenous versus foreign-owned).

The survey fieldwork took place between July and December 1998. Data cleaning, validation and analysis was undertaken in first quarter of 1999 and preliminary results from the survey were made available in May 1999.

Survey of Research and Development in Industry 1997

Please check the following details and amend if necessary

This survey is concerned with measuring the research and development (R&D) activity of companies in the Republic of Ireland in 1997. The questionnaire should be completed by companies engaging in R&D or having R&D performed on their behalf by other parties.

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

What is research and development (R&D)?

Research and development (R&D) in industry is defined as **creative work** which is 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 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.

Q1 Using this definition, how would you describe your company's involvement in R&D?

	Tick the box that applies (✔)	
R&D is performed by your company at this location **and** at other locations in the Republic of Ireland.	☐	Go to Q2
R&D is performed by your company at this location **but not** at any other locations in the Republic of Ireland.	☐	Go to Q4
R&D is **not** performed at this location **but is** performed by related companies in the Republic of Ireland (parent or subsidiary).	☐	Go to Q3
R&D is **not** performed by your company at this location **or at any other** location in the Republic of Ireland.	☐	*Please return the questionnaire in the reply paid envelope*

Q2 If your company is part of a wider enterprise group in the Republic of Ireland, please specify for which companies this form is being completed:

	Tick the box that applies (✔)
• Irish headquarters and all Irish subsidiaries	☐
• Irish headquarters only	☐
• Your subsidiary only	☐
• Other arrangement (please specify)	☐

Q3 If this form should be completed by another part of the enterprise group in the Republic of Ireland, please fill in the contact details for the appropriate respondent and return the questionnaire in the reply paid envelope.

This questionnaire should be re-directed to:

Mr/Ms/Dr

Title

Company name

Address

General description of R&D activity in 1997

Q4 Which of the following activities did your company undertake during 1997?

	Tick the appropriate box for each question (✔) Yes	No
• Performed in-house R&D on a **continuous** basis during 1997 (i.e. programme of R&D work)	☐	☐
• Performed in-house R&D on an **occasional** basis during 1997 (i.e. isolated R&D projects)	☐	☐
• Had R&D undertaken on your behalf by others during 1997 (i.e. subcontracted R&D)	☐	☐

Q5 Does your company have a **formal R&D department**, that is R&D as a separate cost centre with its own dedicated personnel?

	Tick the appropriate box for each question (✔) Yes	No
• Have a formal R&D Department	☐	☐

Q6 In what year did your company first become involved in R&D in Ireland?

	Year
• Commenced R&D Activity on any basis	
• Established a formal R&D Department (if applicable)	

Q7 Did your company engage in **collaborative R&D** with any of the following parties in 1997?

	Tick the appropriate box for each category (✔) Yes	No
• Other firms in Ireland	☐	☐
• Other firms outside Ireland	☐	☐
• Higher education or other institutes in Ireland	☐	☐
• Higher education or other institutes outside Ireland	☐	☐

Resources allocated to in-house performed R&D in 1997

This section of the questionnaire 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.

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
	• Enforcement of standards and regulation

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 no longer R&D.

In-house R&D personnel

Q8a Please specify the number of staff in each category who were involved in in-house R&D in 1997

Q8b As staff may share their time between R&D and non-R&D activities, please specify also the average percentage of their time which was spent on R&D

	Q8A Number of staff	Q8B Average % of time spent on R&D
PhD researchers Scientists and engineers with a PhD qualification		
Non-PhD researchers Scientists and engineers with other degree level qualifications		
Technicians Technically qualified personnel (laboratory technicians, draftspeople)		
Managerial, administrative and clerical staff Managers, accountants, and clerical staff supporting R&D		
Other R&D Staff Skilled and unskilled labour (machinists and electricians etc.)		
Total		

Expenditure on in-house R&D

Q9 Please specify your expenditure on R&D performed within your company in 1997 under each of the following items:

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.

	000s
Labour costs Wages, salaries and all associated costs of personnel directly associated with R&D	£
Other current expenditure Materials, supplies and equipment, literature and subscriptions, overheads associated with R&D	£
Land and buildings Sites for laboratories and pilot plants, buildings purchased, constructed and repaired directly for R&D	£
Instruments and equipment Major instruments and other capital equipment acquired wholly for R&D purposes	£
Total expenditure on in-house R&D	£
Turnover in 1997 (used to compute R&D as a percentage of sales)	£

Q10 In approximate terms, what was your company's total expenditure on in-house performed R&D and turnover *in 1995*?

Approximate R&D spend in 1995 000s	Approximate turnover in 1995 000s
£	£

Q11 In approximate terms, what target or expectations do you have for expenditure on in-house performed R&D and turnover *in 1999*?

Target/expected R&D spend in 1999 000s	Target/expected turnover in 1999 000s
£	£

Sources of funds for in-house R&D in 1997

Q12 Please specify the source of funds for the in-house R&D undertaken in 1997:

		000s
Own company/internal funds	£	
Payments from other companies in Ireland for sub-contract R&D	£	
Government grants:		
• "Measure 1" grants/RTI Scheme	£	
• Other grants for R&D received from state agencies	£	
Other Irish sources (specify)	£	
Direct funding from EU (e.g. Framework Programme)	£	
Other foreign sources (specify)	£	
Total funding for in-house performed R&D in 1997	**£**	

Nature of R&D activity

Q13 Please indicate the breakdown of total R&D expenditure in terms of the following categories:

• Fundamental Research	%
• Applied Research	%
• Experimental Development	%
	100%

Fundamental 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.

Q14 Please indicate the breakdown of total R&D expenditure in terms of the following aims:

• Developing new products	%
• Improving existing products	%
• Developing new processes	%
• Improving existing processes	%
• Other (please specify)	%
	100%

Q15 Please estimate how your turnover in 1997 was distributed between the following products:

Technologically **new products** introduced between 1995 and 1997	%
Technologically **improved products** introduced between 1995 and 1997	%
Products which were **technologically unchanged** between 1995 and 1997	%
	100%

A **technologically new product** is a product whose technological characteristics or intended uses differ significantly from those of previously produced products. A **technologically improved product** is an existing product 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.

R&D performed outside the company

Q16 Please specify how much, if anything, you paid to the following parties for R&D performed on your behalf outside the company

Payments made to:	**Within the Republic of Ireland** 000s	**Outside the Republic of Ireland** 000s
Parent company	£	£
Subsidiary companies	£	£
Joint venture companies	£	£
Other affiliated/associated companies	£	£
Non-affiliated companies	£	£
Private R&D institutes/laboratories	£	£
Higher education institutes/universities	£	£
Government research institutes	£	£
Other	£	£
Total	**£**	**£**

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