

Research and Development in the Business Sector 1993

PREFACE

This report presents the findings of the Forfás 1993 Survey of Technology in the business sector in Ireland. This survey is the latest in a series of such surveys which have been carried out since the mid-1960s.

In the past, results from industrial surveys were presented together with a short commentary on the current and past data. Forfás, as the Policy and Advisory Board for Industrial Development, has in this report adopted a more analytical approach to the presentation of survey findings, while at the same time maintaining the trends of established data series.

This document attempts to identify the main policy issues arising from an analysis of the data - an initiative which it is hoped will serve as a useful contribution to the on-going debate on technological and industrial development in Ireland.

In addition to providing information for national policy analyses, Forfás is continuing to meet its international obligations by supplying data on business sector R&D to international organisations such as the OECD and to Eurostat.

Research and Development in the Business Sector 1993

INTRODUCTION

This report presents an analysis of the level and type of Research and Development (R&D) activity taking place within Irish enterprises. R&D activity is monitored regularly by Forfás as one means of tracking the technological activity of firms in Ireland. It is a key objective of Irish industrial policy to strengthen the technological and innovative capacity of firms with the ultimate goal of increasing Ireland's competitiveness in the world market. The report presents findings from the 1993 Census of R&D Performers and highlights trends that have taken place over the preceding decade, with a particular focus on the five year period 1988 to 1993, coinciding with the first Operational Programme for Industrial Development.

A number of significant policy studies undertaken in recent years have concluded that Ireland's industrial competitiveness and future prosperity is dependent, amongst other things, on a radical increase in the level of innovation in our enterprise sector. The technological capacity of firms in Ireland and their commitment to research and development will have to increase significantly in order for them to maintain a stream of new and improved products that are competitive on the world market. The National Economic and Social Council (NESC) has argued in its report "The Irish Economy in a Comparative Institutional Perspective" that there is a poor system of innovation in place in this country and it is only through an increased emphasis on innovation and product development that industry in Ireland will overcome its inherent weaknesses. Another NESC report "A Strategy for Competitiveness, Growth and Employment" (NESC 1993), refers to the duality in the structure of industry in Ireland. It points to an indigenous element that is predominately concentrated in low technology and traditional sectors and to a foreign-owned element which operates in high technology sectors but whose own ability to add value to products is often constrained by the fact that key functions such as R&D are undertaken outside the country.

The Industrial Policy Review Group which published the Culliton Report in 1992 placed an emphasis on the need to support the adoption of new technologies within firms in order for them to increase their ability to innovate. It argued that the State has a role to play in supporting the adoption of new technologies and in supporting R&D, as the benefits which arise accrue not just to individual firms but to the wider economy. Most recently, the Science, Technology and Innovation Advisory Council (STIAC) argued the need for greater commitment to research and development by business in Ireland within the context of a nationally co-ordinated approach to science, technology and innovation (Tierney Report, 1995).

The councils and committees which authored the different reports quoted above comprised representatives from industry, academia, government and trade unions and they represent a consensus as to the direction which industrial policy needs to take. These reports all acknowledge that solutions to the weaknesses of industry in Ireland will only come about by sustained effort in tackling the relevant issues, not by adopting "quick-fix" solutions or by slavishly copying what has worked successfully in other countries.

It is against this background that Forfás monitors the level of R&D activity taking place in the industrial sector. The main focus of the analysis is on manufacturing industry with the following elements of the service sector also included: software, commercial State-sponsored companies and the construction industry.

Analysis of the level of R&D which is being performed, the industries which are performing R&D, the balance between indigenous and foreign-owned companies in their R&D spend, the financing of business-performed R&D, and the type of R&D work which is being undertaken helps to ensure that policy initiatives in respect of research and development are focused on the areas where they are most required. The census of R&D performers has traditionally concentrated on the hard "facts and figures" of R&D performance rather than attempting to measure the opinions and attitudes of R&D performers. However, some effort was made in the 1993 census to gauge the opinions of industrialists on the role of government in supporting R&D.

Research and Development in the Business Sector 1993

The regular R&D census has always collected information in such a way as to be comparable with other OECD countries, thus giving the opportunity to compare the R&D performance of companies in Ireland with those of our OECD counterparts. The OECD has developed standardised methodologies for the collection of these statistics both because of the importance of research and development activity to industrial competitiveness and also because it is seen as a reliable and measurable indicator of the general technological strength of an economy.

Attempts have been made in recent years in many OECD countries, including Ireland, to collect information on the whole spectrum of activity involved in technological innovation. The first Irish survey of technological innovation (Forfás 1994) showed that research and development accounted for just over one third of the total innovation -related spend of companies which had produced new products or processes in the preceding three years. Further innovation surveys will form a key input into policy decision making. At present however, there is not the same ability to examine results over time and between countries as with the R&D data that form the basis of this report.

Structure of the Report

This report opens with a summary of the main findings from the 1993 census and highlights some of the issues that arise based on these findings. Section 3 of the report provides a broad overview of the level of R&D undertaken by the business sector in Ireland, comparing growth in recent years with that of other countries. Results at the sectoral level are then examined to show the composition of business sector R&D and to determine which sectors of activity account for the highest growth in spend (Section 4). Following this in Section 5 there is an analysis of the type of R&D work which is being undertaken by the business sector in Ireland. Here resources that are allocated to the development of new and improved products versus that given over to process related R&D are examined. Section 6 of the report examines the composition of R&D spend between current and capital expenditure and Section 7 looks at the level of collaborative activity that takes place both among firms, and between firms and higher education institutes. Section 8 examines the funding of private sector R&D work and reports on the perceived role of the Irish government and its agencies in encouraging greater R&D activity.

Research and Development in the Business Sector 1993

MAIN FINDINGS AND ISSUES ARISING

MAIN FINDINGS

The level of R&D performed within industry in Ireland

- Significant growth has taken place in recent years in the level of R&D performed within the business sector. Business-performed R&D amounted to £271m in 1993 and this represents an average growth rate of over 17% per annum in real terms over the preceding five years.
- The increase in business expenditure on R&D (BERD) has far outpaced growth in GDP such that BERD as a percentage of GDP now stands at 0.84% compared with 0.47% in 1988. The change that has taken place in BERD as a percentage of GDP represents one of the most marked increases of all OECD countries. The current rate, however, is still considerably behind the OECD (1.5%) and EU (1.2%) averages but is not dissimilar to the rate found in other small economies such as Denmark and Norway.
- In terms of the proportion of all manufacturing companies undertaking some R&D, Ireland's position does not appear to be significantly different at first glance to a number of other European countries with which a comparison is possible. Further analysis reveals, however, that the majority of R&D performers in Ireland spend less than £100k per annum on R&D with only 300 companies in Ireland spending more than that amount. These bigger-spending companies are divided evenly between Irish and foreign ownership*. They are most likely to have a formal R&D department and are thus considered as the "core" of R&D performers in the country.
- Despite the fact that a similar number of Irish and foreign-owned companies are significant spenders on R&D, the total expenditure on R&D performed by foreign-owned companies far outweighs that of indigenous companies. Whereas there was an even divide in the early and mid-1980s, expenditure by the foreign-owned group of R&D performers is now twice that of their Irish-owned counterparts. While this is consistent with the foreign-owned share of net output in manufacturing industry, it is disproportionate with their 45% share of industrial employment. The high foreign-owned share of business sector R&D reflects the fact that foreign-owned companies are found predominately in higher technology, more R&D-intensive sectors. R&D expenditure in foreign-owned companies has grown at 23% per annum in real terms since 1988 compared with 9% per annum in the indigenous sector.

Sectoral analysis of R&D performers

- Business sector R&D is concentrated in five broad industrial sectors: chemicals & pharmaceuticals (£59m or 22% of BERD in 1993); software (£56m or 21% of BERD); electronics (£45m or 17% of BERD); engineering (£41m or 15% of BERD) and food (£29m or 11% of BERD).
- There have been some interesting changes in the relative importance of the different sectors to total business-performed R&D. The most dramatic increase in share of BERD occurred in the software sector which accounted for 7% of BERD in 1988 and three times that in 1993. This is largely due to companies in the information technology sector which have shifted the emphasis of their work from hardware to software in recent years. This also explains why the R&D share of the electronics/office machinery sector has decreased from 30% in 1988 to 17% in 1993. The chemical/pharmaceutical sector is also one which has shown a dramatic increase in its share of total R&D between 1988 and 1993 (from 12% to 22%). The predominately indigenous food sector has maintained its share of total R&D at 11% indicating that its R&D spend has grown at the same rate of 17% per annum as overall industry since 1988.

Research and Development in the Business Sector 1993

- The increased level of R&D is also manifested in a change in R&D as a percentage of sales in R&D performing companies which has moved from 0.8% in 1988, through 1.1% in 1991 to 1.5% in 1993. The ratio refers only to R&D performing companies and therefore cannot measure the overall sector's commitment to R&D. The rate is higher in foreign-owned industry (2.5%) than in Irish-owned industry (0.8%) and again, this is a reflection of the predominance of foreign-owned industry in high-tech sectors. There is considerable variation in this figure and many Irish-owned companies have a level of R&D as a percentage of sales which is well beyond the average. Irish-owned R&D performers in the software sector, for example, tend to spend approximately 25% of their sales revenue on R&D.

The type of R&D undertaken within Industry

- Despite the unavailability of internationally comparable data the type of research carried out by companies is of interest. In 1993 the bulk of business sector R&D was focused on the development of new or improved products (73%) as opposed to process related R&D (27%). There has been a continuing trend in recent years towards product R&D, in particular the development of new products and this may reflect the changing sectoral composition of BERD. Sectors with a particularly high proportion of resources devoted to product R&D include software and engineering. The food sector, on the other hand, had a much more even divide between product and process R&D.

Research Co-operation

- 38% of R&D performers were involved in R&D co-operation with other firms or with higher education institutes in 1993. International comparisons indicate that such co-operation, while low compared to small economies which actively pursue a "networking" type approach (Denmark, Norway and the Netherlands), is not far below that found in other European countries.

16% of R&D performers were involved in R&D co-operation with other firms in Ireland, with software and food companies having somewhat greater levels of co-operation compared with other sectors.

23% of R&D performers were involved in R&D co-operation with firms outside Ireland and perhaps not surprisingly these were mostly large foreign-owned companies, with a higher than average incidence of co-operation within the chemical/ pharmaceutical and software sectors.

20% of R&D performers were involved in R&D co-operation with higher education establishments in Ireland. Again, large foreign-owned companies in high technology sectors dominated such agreements.

8% of R&D performers were involved in R&D co-operation with higher education establishments outside Ireland.

The funding of business-performed R&D

- The bulk of R&D expenditure is funded by the business sector itself (£234m or 86% of the £271m BERD). However, the government and the European Union also provide direct support to encourage business sector research and development and together, this funding amounted to £34m in 1993, up from £12m in 1991. The £34m was made up of £9m from exchequer sources (up from £6.5m in 1991) provided through State agencies in the form of R&D grants; £19m from a special government initiative, Measure 6, that was funded by the ERDF and £6m in the form of direct support from the European Union under its Framework Programme.

Research and Development in the Business Sector 1993

- The same funding pattern is not evident in all industrial sectors and it appears, for example, that the chemical/pharmaceutical sector as a whole is more “self-sufficient” (93% own funding) than the food sector which financed just over three quarters of its R&D expenditure out of its own resources.
- The 1993 census is the first where companies were invited to express their views on the role of government in supporting business sector R&D. The comments made, demonstrate some diversity of opinion. By far the most frequently cited view was that government must actively support business sector R&D due to the high level of risk involved. The other major themes coming through were: support needs to be focused more on small and medium sized enterprise; greater attention needs to be placed on developmental work rather than pure or basic research; and bureaucracy needs to be minimised in the administration of whatever supports are made available. A very small minority of companies were of the opinion that government should not intervene at all in business sector R&D.

ISSUES ARISING

The results of the latest census of R&D performers and the trends over time prompt a number of significant issues.

Growing the number of R&D performers

While the sharp increase in the value of business-performed R&D is encouraging, there is nevertheless little evidence of a corresponding increase in the total number of R&D performing enterprises undertaking substantial levels of R&D. A core group of around 300 firms account for the bulk of R&D spend, and this number has not increased greatly since the last survey in 1991. There is, however, a growing number of enterprises with some small scale involvement in R&D. Policy mechanisms in this area should aim at deepening the level of this involvement, while at the same time encouraging greater efforts from the large investors and continuing to attract new entrants to the R&D scene.

Setting targets for business sector R&D

Targets for business sector R&D and the level of activity considered necessary to maintain/increase Ireland’s competitiveness on world markets were put forward by STIAC in the Tierney Report. These targets are “global” in nature (e.g. targets for BERD as a percentage of GDP) and it is possible that such targets could be met without raising the R&D commitment of the vast majority of firms or even whole sectors of the economy. The data from the 1993 census indicate that some of the major R&D players in the country are already spending amounts on R&D that are equivalent (as a percentage of sales) to those found in the major R&D performing countries of the OECD. It would seem, therefore, that targets which are set for business sector R&D may not be particularly meaningful at a broad aggregate level and should perhaps be set at a micro level. It is important to recognise that different industrial sectors have different R&D intensities and while all firms should aim to be innovative, not all firms will have the same reliance on R&D to bring about their product and process innovations. Further work needs to be done to explore the possibility of setting specific sectoral targets for R&D performance.

The level of co-operation on R&D

The small size and scale of operation of most indigenous firms is considered to be a major impediment to the performance of R&D. This problem exists in other small countries and a common approach to tackling it is to encourage enterprises to come together in groups which would collaborate in jointly-sponsored co-operative R&D projects. Such a networking programme has been successful in Denmark and has been tried in Spain, Portugal and many other similar economies. The survey shows that the existing level of co-operation on R&D projects with other companies and between companies and higher education institutes is

Research and Development in the Business Sector 1993

amongst the lowest of six European countries examined. When comparing levels in Ireland with those in other small economies (Denmark, Norway, Netherlands etc.) it is important to bear in mind that these countries generally have a larger base of R&D performing companies. Continued efforts are therefore needed to increase the base of R&D performing companies in the country and to increase the level of interaction between them. It is also important that such co-operation take place within all sectors of activity and not be concentrated in a few narrow industrial areas. Traditional sectors can often benefit more from interaction with more technologically advanced researchers in other firms or in the higher education sector.

Role of government in financing business sector R&D

The question of how much, if any, State financial support should be given to business-performed R&D is obviously critical from a policy perspective. The census shows that public funding to encourage R&D has grown dramatically in recent years and there are signs that this support can act as a stimulus for greater involvement in R&D by firms. It should be pointed out that the real growth in public support for business sector R&D has come about by the introduction of EU funded initiatives. There is a policy decision to be made about the level of funding that will be required from national sources when EU funding begins to diminish. While a minority of respondents to this census argue that the State has no place in directly funding business sector R&D, the majority reported that much of the R&D work taking place with government support would not happen otherwise. The question of what form such support should take is important and a number of companies spoke of the desirability of tax incentives and tax credits in the context of minimising the bureaucracy associated with government support for R&D.

Non manufacturing industrial R&D

The 1993 census highlights the growing importance to business-performed R&D in sectors which are outside the boundaries of traditional manufacturing. The huge growth in software R&D demonstrates that research and development work is not confined to the industrial laboratory. This broader context of industrial R&D is an important consideration in the formulation of initiatives to stimulate further industrial R&D activity.

ISSUES FOR FUTURE CONSIDERATION

There are a number of other issues relating to research and development activity that are worthy of in-depth consideration. A lack of time series data or internationally comparable data prevents detailed analysis of these issues in this report. However, it is envisaged that with changes in the international guidelines for collecting R&D statistics and the development of internationally comparable innovation surveys, it will be possible to treat issues such as those listed below in future reports.

- The impact of R&D investment at the level of the firm.
The collection of data on sales, profits, value added, exports at the level of the firm will allow greater analysis of the impact of R&D investment and allow a comparison between the performance of R&D active and inactive companies.
- Analysis of the type of research and development work which is undertaken by firms.
Greater emphasis is being placed internationally on the objectives underlying R&D activity and future surveys should facilitate comparison of the type of R&D work being undertaken by firms in Ireland with that of international competitors.
- Human Resources in Research and Development.
Emphasis is also being placed on monitoring the stocks and flows of human resources dedicated to research and development. This information will be particularly useful to those involved in the education and training of researchers and technicians.

Research and Development in the Business Sector 1993

- Patenting and Licensing activity of firms in Ireland.
Not enough is known of the role of patents and licences in transferring technology between firms. It is envisaged that future reports will give greater insight into the use made of patents and licences by firms in Ireland.
- Impact of government and EU initiatives on R&D activity
Government and EU initiatives to encourage R&D activity within firms, such as the Measure 6 Programme in 1993, can be evaluated by tracking the R&D activity of firms which are assisted under these initiatives. Meaningful analysis is only possible over a number of years and future R&D surveys will allow us to assess the impact which initiatives have had on the firms which were assisted.

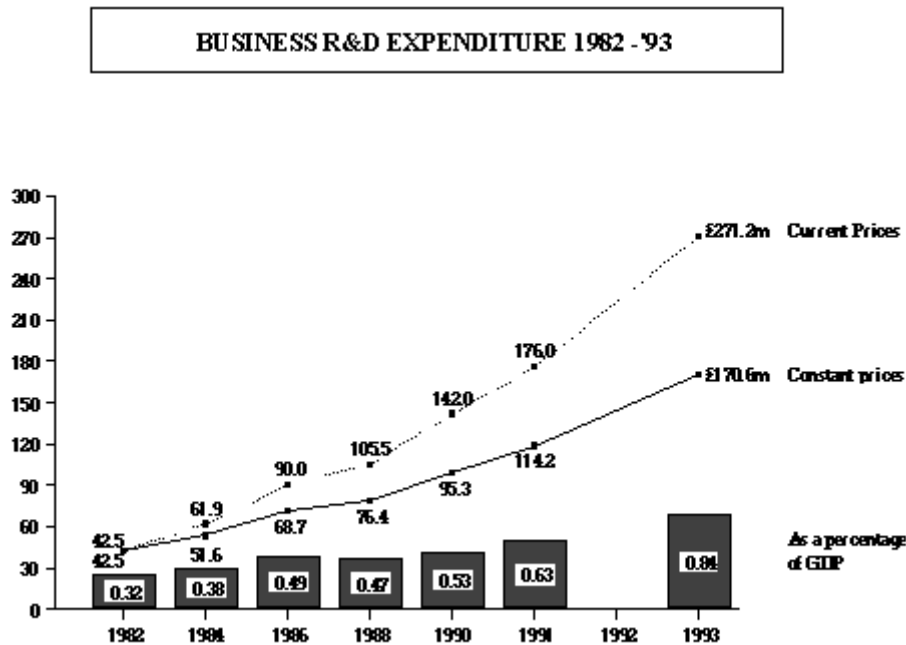
Research and Development in the Business Sector 1993

THE LEVEL OF R&D PERFORMED WITHIN INDUSTRY IN IRELAND

MAIN FINDINGS

There has been a continuation in the strong growth evidenced over recent years in the amount of money spent on R&D performed within the business sector. The rate of growth since 1988 averages over 17% per annum in real terms with just over £271m being spent in 1993.

Figure 1 shows business sector R&D spend for all years for which data has been collected since 1982 and demonstrates that, from a very low base in the early 1980s, business in Ireland is steadily increasing its commitment to R&D.



When presented as a percentage of GDP, Ireland in fact has seen one of the most marked increases since the early 1980s of all OECD countries. The £271m spent in 1993 represents 0.84% of Gross Domestic Product. Table 1 shows Ireland's position relative to a selection of other small economies alongside comparable data for the OECD and EU generally and for the UK.

Research and Development in the Business Sector 1993

Business R&D Expenditure As A Percentage Of GDP, 1982-'93

| | 1982 | 1988 | 1991 | 1993 |
|---------------------|-------------|-------------|-------------|-------------|
| OECD Average | 1.48 | 1.60 | 1.61 | 1.51 |
| EU Average | 1.10 | 1.28 | 1.26 | 1.22 |
| UK | 1.50 | 1.47 | 1.42 | 1.44 |
| Finland | 0.65 | 1.08 | 1.18 | 1.30 |
| Norway | 0.75 | 1.05 | 1.00 | 1.04 |
| Denmark | 0.59 | 0.82 | 1.00 | 1.04 |
| Ireland | 0.32 | 0.47 | 0.62 | 0.84 |
| New Zealand | 0.22 | 0.28 | 0.28 | 0.29 |

Table 1 shows a steady increase for Ireland since 1988 compared to a slower, more stable pattern for other countries. There has been some decline in recent years in business expenditure on R&D within some of the leading world economies thus explaining the decrease in 1993 in the OECD and EU averages. Overall Ireland is beginning to move into line, in relative terms, with the business sector R&D spend of other small economies. This summary statistic of course masks a much more complex picture and it is only through sectoral and ownership analysis of the data that a clearer image emerges as to the key components of R&D growth.

The figure for the United Kingdom masks significant regional diversity and BERD as a percentage of GDP in Ireland is actually as high as, if not higher than, many of the UK regions. Regional analysis of R&D spend has been carried out for the first time in the UK in 1993 and shows, for example, that stg£39m was spent on R&D by firms in Northern Ireland representing 0.3% of regional GDP. The corresponding figures for Wales and Scotland are 0.4% and 0.5% respectively. The high business expenditure on R&D by firms located in the South East of England (at 2.3% of the region's GDP) accounts for most of the UK's overall R&D spend.

Table 2 shows that 820 companies accounted for the £271m in business expenditure on R&D in Ireland in 1993. The majority are Irish-owned but the bulk of the spend comes from the foreign-owned group.

Research and Development in the Business Sector 1993

Distribution of Business R&D Expenditure, 1993

| | Total | | Irish | | Foreign | |
|---|-----------------|--------------|-----------------|-------------|-----------------|--------------|
| | Number of firms | Spend | Number of firms | Spend | Number of firms | Spend |
| Total In-House R&D Expenditure | 820 | £271m | 595 | £91m | 225 | £180m |
| Distribution of Spend | | | | | | |
| • Less than £50k | 375 | £8m | 327 | £7m | 48 | £1m |
| • £50k - £99k | 138 | £9m | 106 | £7m | 32 | £2m |
| • £100k or more | 307 | £254m | 162 | £77m | 145 | £177m |
| Those with formal R&D Department | 332 | £233m | 190 | £62m | 142 | £171m |

The distribution of R&D spend highlights the need for caution when discussing the number or proportion of companies in the country undertaking R&D. Table 2 shows that most of the 820 companies involved in R&D in 1993 spent less than £100,000 on R&D in that year. In fact, just over 300 companies spent almost 95% of total BERD - a group which could be described as the "core" R&D performers* .

There is a fairly even divide in the number of Irish-owned and foreign-owned companies amongst this "core" group but the expenditure on R&D performed by the foreign-owned element far outweighs that of the Irish-owned group. The balance between Irish-owned and foreign-owned companies in terms of R&D spend must be seen in the context of the changing structure of industry in Ireland. It is well documented (Foley and Griffith 1992, NES 1993) that the structure of industry in Ireland, in terms of its sectoral and ownership composition, has changed dramatically since the start of the 1980s with a considerable increase in the share of output and employment accounted for by foreign-owned industry. Table 3 shows the balance of R&D spend between Irish and foreign-owned manufacturing companies alongside some of the key indicators available from the CSO Census of Industrial Production for 1982 and 1990.

Ownership Profile of Irish Manufacturing Industry, 1982, 1990

| | | Share of R&D Spend | Share of Gross Output [^] | Share of Net Output [^] | Share of Industrial Employment [^] | Share of Wages & Salaries [^] |
|------|---------|--------------------|------------------------------------|----------------------------------|---|--|
| 1982 | Irish | 48% | 53% | 41% | 61% | 58% |
| | Foreign | 52% | 47% | 59% | 39% | 42% |
| 1990 | Irish | 35% | 45% | 32% | 55% | 50% |
| | Foreign | 65% | 55% | 68% | 45% | 50% |

* Source: Census of Industrial Production 1982, 1990 (latest available data at time of going to press)

In this context, it is not surprising to see the foreign-owned share of R&D spend increasing although the rate of increase is somewhat greater than that found in the overall output and employment indicators. The balance in R&D spend has moved even further in 1993 with 67%

Research and Development in the Business Sector 1993

of BERD now being accounted for by foreign-owned companies but the CIP data against which to compare this are not yet available. An explanation as to why the foreign-owned group is now dominating R&D performance can only be gained by a sectoral analysis of the data. Most of the growth in R&D spend has been concentrated in a few broad industrial sectors and many of these sectors, which are high-tech in nature are dominated by foreign-owned firms.

Research and Development in the Business Sector 1993

SECTORAL ANALYSIS OF R&D SPEND

An analysis of R&D spend shows that five broad industrial sectors - electronics, software, chemicals and pharmaceuticals, engineering and food - account for the vast bulk of business-performed R&D. In fact, the five years between 1988 and 1993 have brought about an even greater concentration of R&D spend within these industry groups. Table 4 shows the composition of total business-performed R&D for 1988 and for 1993 and highlights a number of points of interest.

| Sectoral Analysis Of Business R&D Expenditure 1988, 1993 | | | | |
|---|---------------|------------------------|---------------|------------------------|
| | 1988 | | 1993 | |
| | SPEND* | As a % of Total | SPEND* | As a % of Total |
| Total BERD | £105m | 100 % | £271m | 100 % |
| Electronics & Software | £38m | 37% | £101m | 38% |
| Electronics | £31m | 30% | £ 45m | 17% |
| Software | £ 7m | 7% | £ 56m | 21% |
| Chemicals & Pharmaceuticals | £13m | 12% | £ 59m | 22% |
| Engineering | £20m | 19% | £ 41m | 15% |
| Food | £12m | 11% | £ 29m | 11% |
| All other sectors | £22m | 21% | £ 41m | 14% |

* Figures are rounded

The table shows some dramatic changes in both the level of R&D being performed in different sectors and in the rank order of the different sectors in terms of their share of total BERD. The most marked increase in relative terms occurs in the software area, which in 1988 accounted for £7m (or 7%) of the £105m BERD. In 1993, this had risen to £56m (or 21%) of the £271m BERD*. This growth can partly be explained by the emergence of new Irish and foreign-owned software development houses spending a significant proportion of their turnover on research and development work. A larger share however, is accounted for by very large foreign-owned firms already undertaking R&D in Ireland which have shifted the emphasis of their work away from hardware and towards software. This explains why the combined share of electronics and software taken together has not changed over the five year period (38% in 1993 versus 37% in 1988).

The chemical and pharmaceutical sector has increased its share of BERD from 12% of the £105m (£13m) in 1988 to 22% of the £271m (£59m) in 1993. As this sector is dominated by very large foreign-owned firms it helps explain the increase in the share of BERD accounted for by the foreign-owned sector. The food sector, which is largely indigenous, has maintained its share of BERD at 11% (£12m in 1988 and £29m in 1993) indicating that the industry's commitment to R&D has been increasing at the same rate as that of overall BERD (17% per annum in real terms).

Table 5 details R&D spend in current year's prices for 1988 and 1993 alongside the per annum real growth rate for all R&D performers and separately for Irish and foreign-owned companies.

Research and Development in the Business Sector 1993

Sectoral Analysis of Growth in Business R&D Expenditure. 1988, 1993

| | Total | | | Irish | | | Foreign | | |
|------------------------|------------|------------|--------------------------------|------------|------------|--------------------------------|------------|------------|--------------------------------|
| | 1988 £m | 1993 £m | Per Annum Real Growth | 1988 £m | 1993 £m | Per Annum Real Growth | 1988 £m | 1993 £m | Per Annum Real Growth |
| All Performers | 105 | 271 | 17% | 50 | 91 | 9% | 55 | 180 | 23% |
| Electronics & Software | 38 | 101 | 18% | 11 | 20 | 10% | 27 | 81 | 21% |
| Electronics | 31 | 45 | 4% | 4 | 5 | 0.5% | 27 | 40 | 5% |
| Software | 7 | 56 | 48% | 7 | 15 | 14% | 0.3 | 41 | 159% |
| Chem./Pharm. | 13 | 59 | 32% | 7 | 5 | -9% | 6 | 54 | 49% |
| Engineering | 20 | 41 | 12% | 10 | 17 | 7% | 10 | 24 | 16% |
| Food | 12 | 29 | 17% | 10 | 25 | 16% | 2 | 4 | 20% |
| All Other Sectors | 22 | 41 | 10% | 12 | 24 | 10% | 10 | 17 | 10% |

This table provides an insight into the origins of growth in overall BERD. The average annual rate of increase in the foreign-owned sector generally at 23% is far greater than the 9% growth rate amongst Irish-owned R&D performers. The significant growth in the foreign-owned element, arises mostly in the software and chemical/pharmaceutical sectors. Amongst the Irish-owned R&D performers, software and food are the sectors with above average growth rates.

Another way of analysing sectoral R&D performance is to relate R&D spend to the sales of the R&D performing companies. This highlights the industrial sectors with the highest R&D intensities and also identifies, when examined over time, if particular sectors are increasing their R&D spend in proportion to increases in sales or whether they are showing a real extra commitment to R&D.

Business R&D Expenditure as a Percentage of Sales in R&D Performing Companies by Sector - 1988, 1993

| | Total | | Irish | | Foreign | |
|-------------------------------|-------|------------|-------|-------------|---------|------------|
| | 1988 | 1993 | 1988 | 1993 | 1988 | 1993 |
| All R&D Performers | 0.8 | 1.5 | 0.6 | 0.8 | 1.2 | 2.5 |
| Electronics | 2.5 | 5.1 | 11.1 | 6.2 | 2.3 | 5.0 |
| Software | 31.7 | 7.1 | 32.0 | 18.4 | 25.8 | 6.0 |
| Chem./Pharm. | 1.8 | 3.7 | 2.8 | 2.2 | 1.1 | 3.8 |
| Engineering | 1.5 | 2.0 | 1.6 | 1.6 | 1.4 | 2.4 |
| Food | 0.3 | 0.5 | 0.3 | 0.5 | 0.2 | 0.6 |
| Other Sectors | 0.5 | 0.6 | 0.4 | 0.5 | 0.5 | 0.6 |

Table 6 shows that increases in R&D spend in most sectors between 1988 and 1993 outpaced the growth in sales of the R&D performing companies. In 1988, R&D performing companies were spending 0.8% of their collective turnover on R&D. This rose to 1.1% in 1991 and rose

Research and Development in the Business Sector 1993

again in 1993 to 1.5%. The Irish-owned and foreign-owned sectors have both experienced an increase in the ratio but the increase in the foreign-owned sector is far more dramatic (from 1.2% in 1988 to 2.5% in 1993). Again, these broad ratios reflect the composition of industry in Ireland with foreign-owned companies being found predominately in the more R&D intensive sectors. The Irish-owned R&D performers which operate in these "high-tech" sectors seem to at least match their foreign counterparts in relative terms as their sectoral R&D intensities are as healthy as they are for the foreign-owned group. The problem of course is that most Irish-owned firms are not based in these sectors but in more traditional industry.

The fact that this ratio is computed on the basis of the sales of R&D performing companies hides the fact that most companies in Ireland do not engage in R&D and, should the ratio be computed on the basis of sales of the whole sector, R&D intensities would be lower* .

Rather than concentrating on a single figure to summarise the R&D intensiveness of different sectors, it is interesting to examine the distribution of R&D spend according to R&D as a percentage of sales (Table 7).

Distribution of Business R&D by Intensity and Sector, 1993

| | All | Electronics | Software | Chem/ Pharm. | Enain- eering | Food |
|-------------------|------|-------------|----------|-----------------|------------------|------|
| Base | 820 | 64 | 61 | 99 | 214 | 87 |
| % of sales on R&D | 100% | 100% | 100% | 100% | 100% | 100% |
| Less than 1% | 28% | 14% | 2% | 27% | 18% | 55% |
| 1 - 5% | 39% | 42% | 7% | 47% | 40% | 35% |
| 5 - 10% | 14% | 20% | 15% | 19% | 21% | 6% |
| 10 - 19% | 9% | 12% | 27% | 3% | 11% | 0% |
| 20% or more | 11% | 12% | 49% | 4% | 10% | 4% |

Table 7 shows that the largest proportion of R&D performers spend in the range of 1% to 5% of turnover on R&D. It is interesting to note the large proportion spending less than 1% and also the significant proportion (1 in 5 R&D performers) spending 10% and more of their sales on R&D. There is a wide variation in the relative R&D spend of different sectors. The software sector, for example, is characterised by a large proportion of R&D performers spending 20% and more on R&D. At the other end of the scale, the majority of R&D performing companies in the food sector spend less than 1% of sales on R&D which is reflected in the fact that R&D performers in this sector as a whole spend just half of one percent of sales on R&D.

The same data are examined across the dimensions of ownership and size (Table 8). In terms of ownership, a greater proportion of Irish-owned R&D performers spend a large proportion of their turnover on R&D. In terms of company size, smaller companies spend proportionately greater amounts on R&D. Many of the very small companies (less than 20 employees) are in their start-up phase and are operating from very low turnover. R&D for these companies accounts for a significant proportion of their turnover and obviously represents a hugely critical investment on their part.

Research and Development in the Business Sector 1993

Distribution of Business R&D by Intensity, Ownership and Size, 1993

| | All | Irish | Foreign | < 20 | 20-49 | 50-99 | 100+ |
|-------------------|-------------|-------|---------|------|-------|-------|------|
| Base | 820 | 595 | 225 | 252 | 243 | 113 | 212 |
| | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| % of sales on R&D | | | | | | | |
| Less than 1% | 28% | 24% | 36% | 9% | 21% | 32% | 49% |
| 1 - 5% | 39% | 39% | 40% | 31% | 51% | 36% | 37% |
| 5 - 10% | 14% | 14% | 13% | 15% | 13% | 17% | 11% |
| 10 - 19% | 9% | 11% | 5% | 18% | 9% | 9% | 1% |
| 20% or more | 11% | 13% | 5% | 28% | 6% | 6% | 2% |

The results in Table 8 do not imply that SMEs outperform large sized companies in their commitment to R&D. The ratios are based only on sales in R&D performing companies and this group forms the minority of firms among SMEs. R&D spend as a percentage of sales for all companies would show a far less favourable picture for SMEs.

The fact that most SMEs do not engage in R&D can be seen from Table 9 which shows the proportion of companies in different size and sector categories that undertook some R&D activity during the three years from 1990 - 92. This data comes from the Innovation Survey undertaken in 1993 and has the benefit of being internationally comparable, although the sectoral classifications used are not directly comparable with those used in the current R&D survey analysis.

Proportion Of Firms Undertaking Some R&D Activity 1990 - '92

| | Ireland | Holland | Norway | Austria | Germany | Denmark |
|----------------------|---------|---------|--------|---------|---------|---------|
| | % | % | % | % | % | % |
| Number of Employees | | | | | | |
| 10-19 | 20 | 10 | 11 | 11 | 27 | NA |
| 20-49 | 21 | 19 | 22 | 25 | 28 | 26 |
| 50-99 | 27 | 38 | 40 | 48 | 24 | 42 |
| 100-199 | 45 | 48 | 45 | 60 | 43 | 53 |
| 200-499 | 52 | 60 | 57 | 72 | 55 | 33 |
| 500+ | NA | 66 | 69 | 80 | 78 | 59 |
| Food/Drink/Tobacco | 16 | 33 | 23 | 30 | 10 | 25 |
| Textiles/Clothing | 27 | 18 | 10 | 30 | 26 | 16 |
| Wood/Paper/Printing | 16 | 11 | 16 | 46 | 7 | 21 |
| Chemical/Pharm. | 37 | 40 | 40 | 69 | 48 | 60 |
| Engineering | 17 | 21 | 14 | 53 | 31 | 36 |
| Electronics | 55 | 42 | 67 | 83 | 71 | 80 |
| Electrical Machinery | 52 | 61 | 39 | 67 | 50 | 44 |
| Instruments | 36 | 47 | 30 | 67 | 63 | 71 |

Source : Community Innovation Surveys 1993

In terms of size of firms, the table shows a reasonable level of consistency between countries insofar as there is a generally increasing incidence of performing R&D according to size of firm in all countries. When examined by sector, there is much greater variation between countries but the data would seem to indicate at first glance that industry in Ireland is as healthy as that

Research and Development in the Business Sector 1993

in some of the other countries in terms of the base of R&D performing firms. However, the table does not give any indication as to the level of R&D which is undertaken within these companies and the 3 year period over which the table presents the data tends to overstate the extent of R&D activity within industry in Ireland.

Drawing together the indicators of R&D performance

A variety of different indicators can be used to describe the R&D performance of different sectors: proportion of companies engaging in R&D, actual level of R&D spend, growth in R&D spend, R&D as a percentage of sales etc. The following summaries draw together the different indicators of R&D performance in five broad sectors.

Electronics :

Approximately half of all companies operating in the electronics industry claim to have been involved in R&D during the three years from 1990 - '92 and this is below the level found in most other European countries (70% - 80%). However, the sector is a major R&D performer in Irish terms and spent £45m (or 17%) on R&D in 1993. Its share of total BERD has dropped in relative terms as a result of a number of major R&D performers previously in the electronics industry, shifting their activities to the software sector. Almost all of the electronics-related R&D work is performed by the foreign-owned companies which dominate the sector. R&D performers in the sector spent just over 5% of their collective turnover on R&D, making this one of the most R&D intensive sectors in the economy; 1 in 4 R&D performers actually spent over 10% of sales on R&D. The Irish-owned companies in this sector which perform R&D, spend proportionately as much of their turnover on R&D as their foreign-owned counterparts.

Software :

Software is the big growth sector in terms of R&D performance. It accounted for £1 of every £5 spent by the business sector on R&D in 1993. In earlier years, R&D was performed mainly by small indigenous companies but the bulk of software R&D is now accounted for by a few very large foreign-owned companies operating in different aspects of the IT industry. Compared to the situation a few years ago, there has actually been a decline in R&D as a percentage of sales in the sector (from 32% in 1988 to 7% in 1993). This is accounted for by the fact that whereas small software houses with low levels of sales used to dominate the sector, large multinationals with very high sales now account for the bulk of R&D.

Chemicals/Pharmaceuticals :

Just over 1 in 3 companies in this sector are in some way involved in R&D and while this appears low for the sector, it reflects the presence of a large number of small companies particularly in the non-pharmaceutical element of the sector. In fact, almost all of the major chemical and pharmaceutical companies undertake some R&D. The sector accounts for the largest portion of BERD, with £59m (or 22%) being spent in 1993. Again, this sector is almost completely dominated by foreign-owned companies which account for more than 90% of the sector's £59m. R&D within the sector has grown at almost twice the annual rate for overall BERD since 1988 and this reflects in part, the attraction of some major multinational chemical/pharmaceutical firms into the country since that date. R&D as a percentage of sales for chemicals and pharmaceuticals together is 3.7% but more detailed analysis points to higher R&D intensities in the pharmaceuticals segment.

Engineering :

The engineering sector accounted for 15% of BERD in 1993 with a total expenditure of £41m. The annual rate of increase at 12% since 1988 is below the overall rate for all industry (17%) but what is striking about this sector is the relatively even divide between Irish and foreign-owned companies in terms of R&D spend. The sector is characterised by a large number of small firms so it is not surprising to find that less than 20% of companies in the sector undertook R&D during the period 1990 - '92. R&D performers in the sector spent 2% of their collective turnover on R&D with a higher intensity in foreign-owned firms (2.4%) compared to the Irish-owned (1.6%). The bulk of companies (58%) spend less than 5% of sales on R&D but the census shows up a group of around 20 companies operating at the high-tech end of the sector and spending upwards of 20% of sales on R&D.

Research and Development in the Business Sector 1993

Food :

The food sector is critically important to the Irish economy and there are encouraging signs of an and medium sized firms and a handful of very large companies. Approximately 1 in 6 firms in the sector undertook some R&D in the period 1990 - '92 and while this is low, it is not unusual when compared with the situation in other European countries. R&D performers in the sector allocate just half of one percent of their collective turnover to R&D but given the size of the sector, this amounted to almost £30m in 1993. On this basis, the food sector accounts for 11% of total BERD, the same share as it had in 1988, indicating that R&D spend in the sector is growing at the same rate as overall BERD.

Research and Development in the Business Sector 1993

THE TYPE OF R&D UNDERTAKEN WITHIN INDUSTRY

Respondents were asked to indicate the proportion of their R&D spend which was devoted to the following activities in 1993 :

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

Studies have indicated that the type of R&D in which a firm engages is very much dependent on the particular circumstances of the firm at a given time. Developing new products and improving them after that consumes most of the R&D budgets of start-up companies whereas process related R&D tends to increase in importance as industries mature and firms seek cost advantages over their competitors through more efficient production systems. Furthermore, there is considerable variation between sectors in the relative importance of product versus process R&D.

Table 10 shows that half of all expenditure on business-performed R&D was allocated to the development of new products, almost one quarter to the improvement of existing products and the remainder allocated to process related R&D.

**Type of R&D Work Undertaken in Different Sectors,
1991,1993**

| | All R&D Performers | | Electronics | | Software | | Chemical /Pharm. | | Engineering | | Food | |
|---|--------------------|------|-------------|------|----------|------|------------------|------|-------------|------|------|------|
| | 93 | 91 | 93 | 91 | 93 | 91 | 93 | 91 | 93 | 91 | 93 | 91 |
| R&D directed towards: | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Developing New Products | 51% | 47% | 56% | 60% | 67% | 60% | 47% | 30% | 57% | 48% | 39% | 39% |
| Improving Existing Products | 22% | 23% | 20% | 18% | 24% | 29% | 24% | 28% | 25% | 22% | 17% | 24% |
| Developing new/ improved processes | 27% | 30% | 24% | 22% | 9% | 11% | 29% | 42% | 18% | 30% | 44% | 37% |

The data show considerable variation between sectors. The software sector, for example, devotes almost all of its R&D expenditures towards the development of new and improved products and the food sector on the other hand has a considerable portion of its R&D spend allocated to process development and improvement.

Research and Development in the Business Sector 1993

COSTS OF BUSINESS SECTOR R&D

The composition of R&D spend in terms of current and capital expenditure is examined in Table 11. It shows that the cost composition of BERD does not remain static over time but rather there is a fluctuation from year to year in the proportion of R&D spend which is accounted for by capital expenditure.

Business R&D Expenditure by Type of Cost, 1982-1993

| | 1982 | 1988 | 1991 | 1993 | UK 1993 |
|------------------------------------|------------|------------|------------|------------|--------------|
| | 100% | 100% | 100% | 100% | 100% |
| CURRENT COSTS | 76% | 78% | 85% | 78% | (89%) |
| Labour | 48% | 47% | 48% | 38% | (44%) |
| Other Current Costs | 28% | 31% | 37% | 40% | (45%) |
| CAPITAL COSTS | 24% | 22% | 15% | 22% | (11%) |
| Land and Buildings | 5% | 7% | 3% | 6% | (4%) |
| Instruments & Equipment | 19% | 15% | 12% | 16% | (7%) |

The table shows that the labour component of R&D spend has fallen in relative terms compared with previous years. This is borne out also by other data on human resources dedicated to R&D which have not shown the same level of growth in recent years as that of actual R&D spend. Other current costs, which include materials and supplies and the share of overhead allocated to R&D, have risen gradually in relative terms over the years and are approaching the level found in the UK in 1993. The proportion of R&D spend accounted for by capital expenditure dipped in 1991 but is now in line with the figure in 1988. This indicates that capital expenditure is proportionately much higher in Ireland than in the UK and one might take this as being indicative of a country which is "catching up" on others and whose business sector is building up its R&D capability by investing in buildings and equipment.

The sectoral analysis of this data in Table 12 shows some variation between sectors in their current and capital expenditure. Not surprisingly, the software sector has a particularly high proportion of its R&D spend accounted for by labour costs. The high proportion of capital expenditure in the food sector is also interesting and could be interpreted, as mentioned above, as a sign that the sector is building up its R&D capability and making a commitment to long-term continuous R&D.

Research and Development in the Business Sector 1993

Business R&D Expenditure by Sector and Type of Cost, 1993

| | All R&D Performers | Electronics | Software | Chem / Pharm. | Engineering | Food |
|------------------------------------|--------------------|-------------|------------|---------------|-------------|------------|
| | 100% | 100% | 100% | 100% | 100% | 100% |
| CURRENT COSTS | 78% | 87% | 82% | 76% | 80% | 60% |
| Labour | 38% | 32% | 47% | 29% | 44% | 27% |
| Other Current | 40% | 55% | 35% | 47% | 36% | 33% |
| CAPITAL COSTS | 22% | 13% | 18% | 24% | 20% | 40% |
| Land & Buildings | 6% | 1% | 6% | 14% | 1% | 14% |
| Instruments & Equipment | 16% | 12% | 12% | 10% | 19% | 26% |

The data point to the fact that industry sectors have different levels of "labour intensiveness" when it comes to R&D. Table 13 provides greater detail on this by showing the number of full time equivalent (FTE) personnel engaged in R&D activities in different sectors and their collective cost. Presented also is the proportion of FTEs who are degree holders as opposed to technicians or administrative support personnel.

Table 13

| Personnel Engaged in R&D, 1993 | | | | | | | |
|---|--------------------|-------------|----------|---------------|-------------|---------|---------|
| | All R&D Performers | Electronics | Software | Chem./ Pharm. | Engineering | Food | Other |
| Labour Cost of R&D | £103m | £14m | £27m | £17m | £18m | £8m | £18m |
| As a % of total R&D | 38% | 32% | 47% | 29% | 44% | 27% | 46% |
| No. of FTE personnel | 4500 | 597 | 1013 | 788 | 948 | 398 | 778 |
| % of which are FTE researchers | 57% | 69% | 78% | 55% | 45% | 48% | 44% |
| Average cost of employing FTE person on R&D | £22,946 | £24,131 | £26,407 | £22,697 | £19,277 | £19,749 | £23,888 |

Research and Development in the Business Sector 1993

CO-OPERATION WITH OTHER PARTIES ON R&D

A feature of many economies which have a strong technological capability is the degree of co-operation and collaborative work that takes place on R&D and other innovation-related activities both amongst firms and between firms and higher education institutes. Such co-operation increases the flow of knowledge within the economy and increases the use made of the skills and knowledge bases that exist in other organisations. It is seen as particularly important for small and medium sized companies, which might not necessarily have the skills in-house for all aspects of their R&D work, that they should engage in such collaborative activity.

Table 14 shows the proportion of R&D performing companies which were involved with different parties on collaborative R&D work in 1993.

Table 14

**Level Of Co-Operation On R&D With Other Parties
in 1993 by Sector
(Base: All R&D Performers providing details on co-operation)**

| | All | Electronics | Software | Chem./Pharm. | Engineering | Food | Other |
|---|-----|-------------|----------|--------------|-------------|------|-------|
| % of R&D performers with co-op arrangement with... | | | | | | | |
| ... Any Party | 38% | 38% | 60% | 49% | 33% | 37% | 34% |
| ... Other Firms in Ireland | 16% | 14% | 20% | 11% | 13% | 20% | 17% |
| ... Other Firms outside Ireland | 23% | 20% | 44% | 33% | 19% | 24% | 19% |
| ... Higher Education Sector in Ireland | 20% | 22% | 40% | 32% | 17% | 18% | 15% |
| ... Higher Education Sector outside Ireland | 8% | 12% | 20% | 11% | 5% | 9% | 6% |

The proportion of R&D performers engaging in collaborative R&D has not increased significantly on the levels recorded in 1991 but this period has witnessed an increase in the population of R&D performers so it is encouraging that the incidence of co-operation has at least stayed the same.

The sectoral analysis in Table 14 shows that software and food companies have an above average incidence of co-operation with other firms in Ireland. Software and chemical/pharmaceutical firms are the most likely to engage in R&D collaborative work with other companies outside Ireland and also with the higher education sector in Ireland. The electronics and software sectors appear to be the most likely to engage in collaborative R&D with higher education institutes outside Ireland. In general, therefore, it is the R&D performers operating in high technology sectors which have the greatest incidence of co-operation on R&D projects.

Following on from this, it is not surprising to find in the ownership and size analyses (Table 15) that foreign-owned and large companies (100+ employees) have above average levels of co-operation on R&D with other parties. This is in keeping with the Irish Innovation Survey which found the same broad pattern.

Research and Development in the Business Sector 1993

Table 15

| Level Of Co-Operation On R&D With Other Parties in 1993 by Ownership and Size (Base: All R&D Performers providing details on co-operation) | | | | | | | |
|---|-----|-------|---------|-----|-------|-------|------|
| | All | Irish | Foreign | -20 | 20-49 | 50-99 | 100+ |
| % of R&D performers with co-op arrangement with... | | | | | | | |
| ...Any Party | 38% | 33% | 50% | 41% | 30% | 27% | 47% |
| ...Other Firms in Ireland | 16% | 16% | 14% | 17% | 15% | 7% | 19% |
| ...Other Firms outside Ireland | 23% | 18% | 37% | 22% | 21% | 12% | 32% |
| ...Higher Education Sector in Ireland | 20% | 17% | 26% | 21% | 13% | 18% | 26% |
| ...Higher Education Sector outside Ireland | 8% | 7% | 13% | 10% | 4% | 2% | 13% |

It is not possible to directly compare the Irish data above with other OECD countries but the recent round of EU-sponsored innovation surveys undertaken in a number of countries also dealt with the issue of R&D co-operation. Table 16 presents an analysis of the proportion of R&D performers involved in R&D co-operation with other firms in 1992 categorised by size of company and nature of activity.

Table 16

| Proportion of R&D Performers Involved in Co-operative Activities With Other Private Sector Firms In Same Country in 1992 | | | | | | |
|---|---------|---------|--------|---------|---------|---------|
| | Ireland | Holland | Norway | Austria | Germany | Denmark |
| | % | % | % | % | % | % |
| 10 - 19 | 26 | 39 | 18 | NA | NA | NA |
| 20 - 49 | 17 | 38 | 32 | 13 | NA | 32 |
| 50 - 99 | 12 | 34 | 39 | 29 | 28 | 45 |
| 100 - 199 | 21 | 40 | 59 | 14 | 20 | 53 |
| 200 - 499 | 30 | 46 | 70 | 23 | 30 | 43 |
| 500+ | 44 | 68 | 72 | 40 | 49 | 63 |
| Food/Drink/Tobacco | 26 | 41 | 28 | 16 | 29 | 45 |
| Textiles/Clothing | 6 | 26 | 3 | 32 | 10 | 37 |
| Wood/Paper | 26 | 57 | 34 | 23 | 43 | 25 |
| Chemical/Pharm. | 20 | 43 | 52 | 25 | 34 | 36 |
| Machinery | 24 | 47 | 54 | 40 | 30 | 42 |
| Electronics | 24 | 43 | 17 | NA | 29 | 61 |
| Electrical Machinery | 30 | 36 | 27 | 17 | 23 | 39 |
| Instruments | 36 | 47 | 46 | 67 | 63 | 71 |

Source : Innovation Surveys 1992

The data indicate that some of these countries (particularly Holland, Norway and Denmark) have very high levels of R&D co-operation between firms. The level of co-operation between

Research and Development in the Business Sector 1993

firms in Ireland is low by comparison but in most cases is not dissimilar to the proportions found in Germany and Austria. However, if Ireland is attempting to model the Danish and Nordic approaches to innovation, it is clear that we have some way to go in terms of encouraging greater co-operation between firms. It must be remembered also that the proportions above are based on R&D performers who in Ireland form the minority rather than the majority.

A similar analysis is presented in Table 17 of the level of co-operation between R&D performers and higher education and other public institutes within the country. This data actually show much greater similarity between Ireland and the other European countries in the analysis. Norway and Austria tend to have the highest proportions of R&D performers co-operating with higher education and research institutes but the data generally show wide variation in terms of size and sector.

Table 17

**Proportion of R&D Performers Involved in Co-operative Activities
With Public Sector Organisations In Same Country in 1992**

| | Ireland | Holland | Norway | Austria | Germany | Denmark |
|-----------------------------|---------|---------|--------|---------|---------|---------|
| | % | % | % | % | % | % |
| 10 - 19 | 17 | 17 | 12 | 46 | NA | NA |
| 20 - 49 | 14 | 17 | 15 | 23 | NA | 25 |
| 50 - 99 | 14 | 27 | 37 | 25 | 14 | 33 |
| 100 - 199 | 23 | 23 | 50 | 39 | 17 | 41 |
| 200 - 499 | 32 | 35 | 63 | 37 | 27 | 36 |
| 500+ | 44 | 56 | 78 | 75 | 45 | 71 |
| Food/Drink/Tobacco | 25 | 24 | 23 | 36 | 44 | 26 |
| Textiles/Clothing | 6 | 12 | 18 | 32 | 3 | 9 |
| Wood/Paper | 17 | 21 | 9 | 28 | 13 | 21 |
| Chemical/Pharm. | 20 | 31 | 50 | 56 | 16 | 43 |
| Machinery | 26 | 26 | 36 | 61 | 30 | 29 |
| Electronics | 32 | 29 | 15 | 60 | 40 | 36 |
| Electrical Machinery | 17 | 19 | 35 | 39 | 22 | 55 |
| Instruments | 26 | 46 | 51 | 46 | 35 | 50 |

Source : Innovation Surveys 1992

Research and Development in the Business Sector 1993

THE FUNDING OF BUSINESS-PERFORMED R&D

The vast bulk of business-performed R&D is financed by the companies themselves with the government and the European Union being two other important sources. Table 18 provides detail on the funding of BERD in recent years.

Table 18

| Source of Business R&D Funds, 1982-'93 | | | | |
|--|--------------|---------------|---------------|---------------|
| | 1982 £43m | 1988 £106m | 1991 £176m | 1993 £271m |
| Own Company | 80% | 84% | 86% | 86% |
| Government Sources | 14% | 9% | 4% | 3% |
| Measure 6 Programme* | N/A | N/A | N/A | 7% |
| Other Irish Sources | 1% | 2% | 4% | 1% |
| EU Framework Programme | 3% | 2% | 3% | 2% |
| Other Foreign Sources | 2% | 3% | 3% | 1% |

Since 1982 there has been a gradual increase in relative terms in the proportion of BERD financed by companies themselves. Given that BERD has been growing rapidly over recent years, this change in relative share demonstrates a real commitment on the part of industry generally. Conversely, the years since 1982 have seen a steady decline in the proportion of BERD financed from exchequer sources channelled through the different government agencies. Companies reported that they received 3% of their R&D funds from this source in 1993 compared with 14% in 1982. The Measure 6 programme* provided an additional source of funding in 1993, with companies spending just over £19m, from this fund.

The European Union also provides funding for business sector R&D directly to firms under its Framework Programme and companies reported having received over £5m (or 2% of the total £271m BERD) from this source. Other Irish and foreign sources mostly relate to private sector funds from other companies but their contribution to BERD in 1993 is less significant than heretofore.

The way in which BERD in Ireland is financed is in line with the OECD and EU averages as can be seen in Table 19.

Research and Development in the Business Sector 1993

Table 19

| Financing of Business R&D Expenditure 1993 or nearest available | | | |
|---|----------|------------|-------|
| | Business | Government | Other |
| OECD Average | 84% | 13% | 3% |
| EU Average | 80% | 12% | 8% |
| UK | 72% | 12% | 16% |
| Finland | 92% | 6% | 2% |
| Norway | 77% | 16% | 7% |
| Denmark | 88% | 8% | 6% |
| Ireland | 86% | 10%* | 4% |
| New Zealand | 89% | 8% | 3% |

Source: Main Science and Technology Indicators OECD, 1995

The funding structure is not uniform throughout industry in Ireland. The sectoral analysis in Table 20 shows some variation, with the chemical/pharmaceutical sector appearing to be more self-reliant than, for example, the food sector which has the lowest proportion of funds coming from the R&D performing companies themselves.

Table 20

| Source of Business R&D Funds by Sector, 1993 | | | | | | | |
|---|--------------------|-------------|----------|------------|-------------|------|-------|
| | All R&D Performers | Electronics | Software | Chem/Pharm | Engineering | Food | Other |
| Own Company | 86% | 88% | 88% | 93% | 81% | 78% | 81% |
| Government Sources | 3% | 3% | 1% | 1% | 6% | 9% | 5% |
| Measure 6 Programme | 7% | 7% | 3% | 6% | 10% | 13% | 7% |
| Other Irish Sources | 1% | ^ | 1% | ^ | ^ | ^ | 1% |
| European Union | 2% | 1% | 4% | ^ | 1% | ^ | 6% |
| Other Foreign Sources | 1% | 1% | 3% | ^ | 2% | ^ | ^ |

* Denotes less than .5%

The impact of the Measure 6 programme is particularly interesting. Its funding was distributed fairly evenly across different sectors but the low R&D spend in some sectors means that it has made a greater relative contribution to some sectors than to others. Table 20 shows that Measure 6 funding amounted to 3% of software R&D spend on the one hand whereas a similar level of funding (in cash terms) accounted for 13% of food sector R&D on the other. The actual monetary amounts of Measure 6 funding spent by companies on R&D performed during 1993 can be found in Table C of Appendix D.

Research and Development in the Business Sector 1993

OPINIONS WITHIN INDUSTRY ON THE ROLE OF GOVERNMENT SUPPORT FOR R&D

Respondents were asked to provide their views on the role of government in supporting R&D activity in the business sector. Distilling the comments of the senior business executives and R&D managers who responded to the question, six major themes are presented below. It is not possible to assess how representative the respondents to this question are of the general population of industrialists. In general, however, respondents have provided very constructive comments as to how they would like to see government policy on R&D being refined. Verbatim comments relating to each of the six themes are presented in Appendix A.

Risk Attached to R&D is so High that Government Must Provide Active Support

The sentiment being expressed here is similar to that found in the Culliton Report where it is argued that benefits accrue to the wider economy when business builds up its technological capacity and therefore the State should take on some of the risk which is involved. The view that government should actively intervene in supporting R&D at the level of the firm is one that appears to be held by a majority of R&D performers and certainly by a far larger number than would prefer government not to intervene.

Incentives are Not Focused Enough on the Sectors That Need to Increase Their R&D Capability

A number of companies feel that the government supports which are available are spread too thinly across all sectors. Small and medium sized Irish-owned companies in particular suggest that more attention should be focused on their needs rather than providing funds to large foreign-owned companies which, as they see it, would be undertaking the R&D in any case. A number of small companies were particularly critical of the Measure 6 initiative which they feel was "wasted" on large companies.

Too Much Bureaucracy Attached to the Different Schemes and Initiatives

A large number of respondents voiced concern about difficulties in finding out what government and EU supports are available for R&D. They complain also about the excessive bureaucracy that is involved once a company decides to participate in a particular programme. Several companies suggested that it is often not worth the management and administrative time that is involved in trying to source grant-aid for R&D projects.

Government lacks Understanding of the Importance of R&D

A view was expressed by a small group that notwithstanding the resources that are being put into R&D schemes and initiatives, the government does not have a clear understanding of the role and nature of R&D activity. Consequently there is no strategic perspective on R&D funding.

Focus of Government Support for R&D is Biased in Favour of Research Rather Than Development

A number of respondents argued that projects with an emphasis on pure and basic research tend to get favoured more than development projects which are of more direct and immediate benefit to industry. The reason for this, according to some, is the influence which the higher education sector exerts when funding becomes available.

Government should not intervene in Business Sector R&D.

Contrary to the first theme explored above, a minority of respondents feel that government should not intervene in business sector R&D. Government should concern itself more with reducing taxation and providing the environment that will encourage greater private sector investment.

Research and Development in the Business Sector 1993

Appendix A

Selection of verbatim quotes on the role of government in supporting R&D

RISK ATTACHED TO R&D IS SO HIGH THAT GOVERNMENT MUST PROVIDE ACTIVE SUPPORT.

- "R&D can be very costly initially. The availability of government assistance can very often be the spur to get a company to progress product development and make further investment."
Irish-owned food company employing 100+ persons
- "R&D can involve long-term projects which may not be of immediate commercial value, and so can be difficult to sustain financially. More government funding would enable such research to go ahead which may be of benefit to the industry in general."
Foreign-owned food company employing 100+persons
- "Innovation and product development are essential to the viability/success of any profitable business. Irish companies by and large fall into the category of SME, and lack the resources within to sustain a high level of new product development. Therefore support from the State is vital and will be well rewarded."
Irish-owned food company employing 100+persons.
- "We can see that if we could fund our development ideas we could make the best software in the world in our area. The level we can afford makes us move slowly and the country does not experience the possible economic spin-offs. State money would be desirable and well spent."
Irish-owned software company employing less than 50 persons.
- "Imperative that government supports R&D in industry as normally it is at its most applied when undertaken by industry. Irish companies must compete with countries offering much greater funding and support services."
Irish-owned engineering company employing less than 50 persons.
- "Grant-aid does help attract R&D projects to companies like ours where it might otherwise have been carried out elsewhere. We received grant approval for R&D expenditure in 1990 that underpinned several projects up to this date. We are now investing in a full CAD/CAM system to accommodate increased R&D activity."
Foreign-owned engineering company employing less than 50 persons.
- "Supporting the growth of R&D helps increase the technology base making it attractive for multinationals to invest in Ireland. Furthermore it has the effect of creating an environment whereby our highly qualified young professionals can gain meaningful employment without going abroad or alternatively attracting those that have left back home."
Foreign-owned electronics company employing 100+ persons.
- "From an overall business perspective, the role of the government is critical. Given our area of operation, it is crucial that we stay at the forefront of technology in order to retain our competitive edge. As a developing company, the funds available solely from the company to finance R&D activity are of necessity very limited. We were not in a position to maintain R&D levels in 1994 for example."
Irish-owned software company employing less than 50 persons.
- "Without government support we would be unable to attempt R&D to the degree necessary to supply machines on the home market and the export market. We must keep ahead of competition from abroad and R&D is of utmost importance and government support on an ongoing basis is very necessary."
Irish-owned engineering company employing less than 50 persons.

Research and Development in the Business Sector 1993

- "R&D generally provides profit in the long term. In the short term the company must bear the risk that the R&D will be fruitful. In many cases the risk is too great for companies to bear and it is only by financial incentives from government that companies can be induced to establish an R&D department."
Irish-owned ceramics company employing 50-99 persons.
- "Government must support R&D financially. With the streamlining that has taken place, all State agencies are now co-ordinating their efforts to help companies in R&D. My experience to date suggests optimism for the future in this regard."
Foreign-owned food company employing 100 + persons.
- "From these small beginnings we have been pushing for a growing involvement in group R&D activities. We consider it to be a very positive reflection of our achievements to date that our Group is giving serious consideration to our growing involvement in these activities. It is very important, therefore, in the face of competition from other regions that the government encourages the development of R&D facilities in Ireland by way of financial inducements. Longer-term, Irish companies may not be able to compete with low labour cost countries. Our ability to handle high tech projects will provide future job security and growth."
Foreign-owned engineering company employing 100+ persons.

INCENTIVES ARE NOT FOCUSED ENOUGH ON THE SECTORS THAT NEED TO INCREASE THEIR R&D CAPABILITY.

- "There is not very much awareness of the amount of R&D that goes on in the clothing sector. Assistance is needed to support the high level of R&D which is ongoing.
Irish-owned clothing company employing less than 50 persons.
- "The R&D difficulties of smaller industries are not being addressed. Educational bodies should be further encouraged to participate in development work with the smaller established firms."
Foreign-owned food company employing less than 50 persons.
- "For our company the help received from Forbairt has made it possible for us to develop equipment whose impact will only start to show in the next few years. The trend of reducing funding from government bodies towards R&D is worrying since small companies often do not have adequate resources for R&D but do need R&D for their growth and survival."
Irish-owned engineering company employing less than 50 persons.
- "Focus should be on financing small companies with potential. Large companies have other sources of finance. Industry R&D initiative was wasted on multinationals."
Irish-owned electronics company employing less than 50 persons.
- "Totally inadequate as far as we are concerned. IDA/Shannon Development schemes 'switch off' before research is completed. EU finance for R&D seems to be specially structured to prevent small indigenous firms such as ours from any access to their punts (Measure 6 - CRAFT etc.)."
Irish-owned engineering company employing less than 50 persons.
- "I believe that government support is absolutely essential to smaller industries supporting 10-50 employees. When companies become profitable funds given by government agencies should be returned. Large profitable organisations should get limited funding if any. It is important to remember that the government provides excellent facilities to companies requiring R&D and testing through Forbairt and the academic institutions."
Irish-owned construction company employing 100 + persons.

Research and Development in the Business Sector 1993

- "The government has paid lip-service to R&D. The administrators of the R&D initiative had a poor understanding of the projects submitted and were influenced by the larger-scale projects."
Foreign-owned chemicals company employing less than 50 persons.
- "Small companies cannot get products to market sufficiently rapidly without assistance. Specific companies in specific subsectors only should be supported. At present time there is no government policy in place supported by funds. Industry R&D initiative was poorly administered - relatively incompetent personnel."
Irish-owned engineering company employing less than 50 persons.
- "R&D expenditure is an essential part of any electronics business just to stay alive. Growth requires additional funding for experimentation with new innovations which by definition are high risk. If indigenous industry is to grow significantly and provide jobs this high risk R&D investment will have to be given close to 100% R&D support. Companies cannot risk even the 50% contribution to such projects. They must still improve existing products to exist. Note the allocation of Measure 6 funds to multinational and large companies are ridiculous in the above context."
Irish-owned electronics company employing less than 50 persons.

TOO MUCH BUREAUCRACY ATTACHED TO THE DIFFERENT SCHEMES AND INITIATIVES.

- "It has negligible impact. Grants are more trouble than they are worth."
Irish-owned engineering company employing 100+ persons.
- Government grant system too cumbersome. For companies once a project is approved funding should come by retaining a percentage of PAYE/PRSI to be paid."
Irish-owned software company employing less than 50 persons.
- "There should be a "level playing field" and bureaucracy should be at a minimum. To date our company has not received any R&D grant assistance - the prior approval bureaucracy is a waste of management time - the system is geared to the "grant holics", not to those who genuinely use R&D as an essential tool to survive and grow."
Irish-owned engineering company employing 100+ persons.
- "Government bodies adopt a very safe/cautious stance regarding assistance with R&D activities; attitude seems to be to act as a damper on proposed research in order to avoid having to fund any project that does not show an almost guaranteed success probability."
Irish-owned engineering company employing 50-99 persons.
- "Very poor. Measure 6 improved matters. Most effective solution may be allowance of tax credits against R&D expenditures as proposed by IBEC. Otherwise, we are at a serious disadvantage vs other European locations where we have major markets."
Foreign-owned chemicals company employing 100 + persons.
- "In most jobs requiring R&D the administration work required for grants is not worth the time because of the particularly small amounts involved. However all the small R&D jobs lumped together are significant. On larger jobs An Bord Trachtala have given significant help."
Irish-owned plastics company employing less than 50 persons.

Research and Development in the Business Sector 1993

GOVERNMENT LACK UNDERSTANDING OF THE IMPORTANCE OF R&D

- "The government has shown a lack of understanding or a will to ignore how vital R&D is to industrial development. Only with the push from the EU are they starting to show an interest."
Irish-owned chemical company employing less than 50 persons.
- "Government should focus R&D at 3rd level institutions to ensure that it meets industry needs - at present universities and industry are not well enough co-ordinated in our sector and we do not have a full picture of 3rd level R&D."
Irish-owned engineering company employing less than 50 persons.
- "I understand that for government assistance in the development of a new product they receive a certain percentage payback from the stream of future revenue from the new product. This is not acceptable to us. I have heard that Mercedes receive 30% of their total R&D from the German government. Government have no awareness of the increasing substantial job creation potential of R&D in Irish industry. They should completely change their approach to R&D funding."
Foreign-owned engineering company employing 100+ persons.
- "The government R&D budget is pathetically inadequate both to industry and university sector. There is far too much politics and lack of honesty, merit and transparency in the distribution of what funding is available. The Civil Service has far too much influence in budgeting and distribution. A system of independent reviewers/talent spotters/ linkage creators should be set up and paid only on performance. University Basic R&D is a vital national resource and the government should fund this heavily. They should also pay entrepreneurs to assess this research for exploitation potential."
Irish-owned engineering company employing less than 50 persons.
- "Policy not clear to us. Seems to lack focus. Patent/copyright protections should be reviewed on EU wide basis. Greater tax incentives for R&D should be considered."
Irish-owned plastics company employing less than 50 persons.
- "It is vital that firstly the government acknowledges the importance of R&D especially for a country like Ireland. R&D is the one path that has the potential to improve the unemployment situation. Look at the importance Japan and America puts on R&D."
Irish-owned software company employing less than 50 persons.
- "R&D is seen as the life blood of our industry and its part in job maintenance and creation cannot be overstated. Government support for R&D can only be welcomed and encouraged. If the benefits of R&D were fully appreciated by government they would increase their support tenfold."
Irish-owned engineering company employing 100+ persons.

FOCUS OF GOVERNMENT SUPPORT FOR R&D IS BIASED IN FAVOUR OF RESEARCH RATHER THAN DEVELOPMENT.

- "The challenge to government is not to be duped by academia into allocating, at the expense of the industry, funding to be used by their own institutions. Indigenous industry has little formal R&D, however, there is significant activity on an ongoing informal basis."
Irish-owned packaging company employing less than 50 persons.
- "Not channelled correctly - too much to third level institutions."
Irish-owned electronics company employing less than 50 persons.

Research and Development in the Business Sector 1993

- "It is our view that funds granted through government for R&D into specific areas are more likely to be secured by consultants or universities etc. than by companies who may already have experience (practical) in specified area."
Irish-owned plastics company employing less than 50 persons.
- "Government support is essential. Far too large a proportion of EU funds are taken up by the State (Universities/RTCs etc.). These institutions know how to write proposals - industry needs help in this area."
Irish-owned engineering company employing 50-99 persons
- "Far too much support is given to universities and research institutes whose work may never be applied.
- More support should be given to applied R&D."
Irish-owned services company employing 100+ persons.

GOVERNMENT SHOULD NOT INTERVENE IN BUSINESS SECTOR R&D.

- "Industries should set aside resources to fund its own R&D and remain independent of the government."
Foreign-owned engineering company employing less than 50 persons.
- "I think main role should be in support of university/research agency facilities to provide basics of R&D, leaving specific sales related research in hands of individual firms."
Irish-owned food company employing 100+ persons.
- "I believe government's only role in industry should be less taxation. No other role is required."
Irish-owned plastics company employing less than 50 persons.
- "Government involvement in funding R&D in industry is not necessary - a business shouldn't require incentives to invest in the fundamental "lifblood" of its existence."
Irish-owned engineering company employing 100+ persons.
- "Under the existing regime, there is a confusion of agencies seeking to direct companies as to how they should run their business, including R&D. These agencies cost money. A direct tax rebate of 25% of R&D expenditures, deductible directly from corporation tax might be a better road to go. This would make concrete the government's duty to encourage R&D and re-investment."
Irish-owned clothing company employing less than 50 persons.
- "The government should try to govern. It should stay away from private enterprise."
Foreign-owned engineering company employing 50-99 persons.

Appendix B

Methodology employed in R&D surveys

1. Definition of Survey Population The survey population of the biennial "Survey of Technology" in the business sector has been traditionally selected by a two-stage process:

(i) A full census of all manufacturing companies is carried out every 5 or 6 years asking companies to indicate whether or not they spend money in-house or externally on R&D, or are involved in technology transfer activities. Companies responding positively to either of these questions form the core for future surveys. The last full census was carried out in 1988.

(ii) For every survey the 'core' list is supplemented by companies known to be involved in R&D activities in the year in question. The sources of these supplementary companies are:

- Recipients of SFADCo / Forbairt / Udaras na Gaeltachta R&D grants;
- Participants in research schemes such as the Higher Education Industry Co-operation Scheme and the Applied Research Programme;
- Participants in EU Framework Programmes;
- Campus companies;
- Clients of PATs;
- Recipients of Measure 6 funding (1993 only).

An additional element was introduced for the 1993 survey, arising from the 1992 Survey of Innovation in Irish Manufacturing Industry, which was directed to all manufacturing companies employing more than 10 people. Respondents were asked, inter alia, about their R&D activities. This survey was also used as a source of company names for inclusion in the 1993 survey of technology.

2. Survey Method and Response Rate

A postal questionnaire was sent to over 2,000 companies in June 1994. Prior to posting, each company was contacted for the name of the person to whom the form should be sent.

A series of follow-up phone calls was initiated one month after the questionnaires were despatched. Field-work finished in December 1994 with an overall response rate of 70%.

Since December extensive cleaning and checking of the data has taken place. Estimates have been made for those companies known to be R&D performers but from which no replies were received, with all secondary sources of information being trawled to provide the information on which to base them.

3. Comparison with 1991 Survey

Every effort is made to ensure consistency in survey populations from one survey period to another. The 1992 innovation survey, however, acted as an effective census of manufacturing industry and enabled the base listing of R&D performers to be updated.

In common with the experience of other countries the innovation survey identified a large number of relatively small companies, whose R&D activity had not been included in the 1991 survey. This exclusion was due to one of two factors:

- they were not involved in R&D in 1988;
- they are companies which started-up in business since 1988.

Research and Development in the Business Sector 1993

Thus, the 1993 analysis includes companies which were not included in the 1991 analyses. Table A-1 summarises the impact these companies have on the 1993 data.

Table B-1
1993 Business Sector R&D Expenditure by Type of Respondent

| | £m | % Total |
|---|-----|---------|
| Companies which were R&D performers in 1991 | 218 | 81% |
| Companies not included in the 1991 survey | 53 | 19% |
| Total | 271 | 100% |

The total number of new performers in 1993 is 239, but 106 large spenders (>£100,000) accounted for £45m of the £53m.

Appendix C

Tabular Data from the 1993 Census of R&D Performers is available from the [Evaluations and Indicators Department of Forfas](#).

LIST OF TABLES

Intramural R&D Expenditure by Ownership
Intramural R&D Expenditure by Type of Cost
Intramural R&D Expenditure by Source of Funds
Intramural R&D Expenditure by Type of Research
Intramural R&D Expenditure by Objective of Research
Intramural R&D Expenditure by Research Activity
In-House R&D Personnel by Research Activity
Personnel Engaged in R&D by Sector
Total R&D Expenditure (intramural and extramural) by Sector
Number of R&D Performers with Formal R&D Departments
Intramural R&D Expenditure as a Percentage of Sales
Intramural R&D Expenditure per Employee by Ownership
Intramural R&D Expenditure by Category of Sales
Intramural R&D Expenditure by IDA and Structural Fund Regions
Intramural R&D Expenditure by Number of Employees
R&D Performers Involved in Co-operative Research by Ownership and Size
R&D Performers Involved in Co-operative Research by Sector

LIST OF REFERENCES

- The Irish Economy in a Comparative Institutional Perspective, NESc (1993)
- A Strategy for Competitiveness, Growth and Employment, NESc (1993)
- A Time for Change - Industrial Policy for the 1990s (Culliton Report), Department of Industry and Commerce, 1992
- Making Knowledge Work For Us - Report of the Science, Technology and Innovation Advisory Council (Tierney Report) - Stationery Office 1995
- Foley A. and Griffith B. "Indigenous Manufacturing Enterprises in a Peripheral Economy and the Single Market - The Case of the Republic of Ireland" Regional Studies Vol 26.4
- Census of Industrial Production - Central Statistics Office, 1982 and 1990
- Main Science and Technology Indicators, OECD 1995