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Innovation policy in Ireland and Northern Ireland, 1991 to 2001 – the changing face of firm-level financial incentives for R&D

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Abstract:

Technology policy encompasses a number of different strands but can be sub-divided between institutional support e.g. development of educational and technological infrastructure, and financial support, or more specifically support at the enterprise level for R&D e.g. financial incentives to enterprises. It has been suggested that national technology policy tends to reinforce the strengths of a country's industrial system, particularly in relation to large firms and the promotion of R&D in core technologies and focuses less on technology transfer which is often left to regional technological policy initiatives. In lagging regional economies, which are often dominated by SME's, this presents specific challenges for technology policy.

This paper presents a comparative analysis of technology policy at both the national and regional levels in Ireland and Northern Ireland respectively, over the 1990s. In both Ireland and Northern Ireland the period from 1991-99 was marked by expansion as measured by steady output growth for manufacturing as a whole (albeit at substantially lower levels in Northern Ireland than in Ireland). In Ireland this largely reflected rapid economic growth of output in the high-tech sectors, itself a consequence of inward investment and re-investment. Despite growth in gross expenditure on R&D over the 1990s closely related to output growth, Ireland's investment in R&D (at 0.95% of GNP) lags behind Slovenia, Norway, the UK, Austria, Netherlands, Belgium, Denmark, France, Germany, Finland, Sweden, the US and Japan.

Technology policy is examined in terms of direct government financial support for business sector investment in R&D. This is based on a database of all grant offers (Northern Ireland) and payments (Ireland) made by the industrial development agencies in Ireland and Northern Ireland over the 1991 to 2001 period which was developed for this paper. The paper emphasises issues concerning the concentration of R&D investment, change in the balance between pre-competitive and near market R&D and the move towards financial incentives for technology transfer of R&D.

Keywords: Innovation Policy, Ireland, R&D, Grant support

1 INTRODUCTION

Innovation policy, a sub set of industrial policy, has been recognised as being the basis of sustained competitive advantage and economic growth in many countries around the world. Innovation policy encompasses a number of different strands but it can be sub-divided between institutional support, - e.g. development of educational and technological infrastructure -, and financial support, or more specifically support at the firm level for R&D (the focus of this paper). Previous empirical research on an Island of Ireland basis has demonstrated that stimulating the level of R&D in the economy is important for a number of reasons. More specifically, firms undertaking R&D are more likely to:

- Be innovating (e.g. Roper and Hewitt-Dundas, 1998; Love and Roper, 2001)
- Have higher turnover and employment growth, productivity and profitability (Roper and Hewitt-Dundas, 1998)
- Have a longer life-span than similar plants with no in-house R&D capability (Ruane and Kearns, 2000), and
- Sell a larger proportion of their output outside the UK and Irish markets (Roper and Love, 2001)

Focusing on the period 1991-2001, this paper provides a critical comparative analysis of innovation policy in Ireland and Northern Ireland. We examine here innovation policy in terms of targeted assistance i.e. direct government financial support for business sector investment in R&D. Our analysis rests on a database of all grant offers (Northern Ireland) and payments (Ireland) made by the industrial development agencies in Ireland and Northern Ireland over the 1991 to 2001 period.

The paper is structured as follows: Section 2 examines the rationale as to the increased level of focus by policymakers in both jurisdictions regarding the importance of innovation and R&D policy interventions. This section also examines the impact of EU funding for R&D and innovation given that for most of the period under review in this paper (1991-2001) both jurisdictions were classified as Objective-One regions. Section 3 provides a brief overview of the various policy documents both North and South that have to a large degree provided the momentum

for the plethora of R&D and innovation policies witnessed in both jurisdictions, particularly from the mid-1990s onwards. Finally, the section looks specifically at the profile of firms receiving financial assistance in the both jurisdictions. Such detailed analysis is facilitated given the authors' access to micro level data from the Irish Innovation Panel (IIP4) as well as from Forfas in the case of the ROI. Section 4 analyses innovative indicators and outputs (performance) in the two jurisdictions over the period under review. Section 5 provides a number of key conclusions.

2. RATIONALE FOR INNOVATION POLICY IN IRELAND AND NORTHERN IRELAND

2.1 Overview of Ireland and Northern Ireland

The island of Ireland includes two jurisdictions, Ireland (capital city Dublin) and Northern Ireland (capital city Belfast). Ireland is the larger of the two with a population of 3.8 million, compared to 1.7 million in Northern Ireland. Ireland was formerly part of the United Kingdom (UK) but it has been an independent state since 1922, while Northern Ireland continues to be a region within the UK.¹

Although Ireland and Northern Ireland have significantly different administrative, governance and policy systems, economic linkages between the two areas have been similar to that of other adjacent European countries. Economic development in Ireland and Northern Ireland has varied considerably, with Ireland acquiring the reputation of a 'Celtic Tiger', while Northern Ireland is sadly best known for political unrest and the recent troubled peace process.

Current industrial policy in Ireland can be traced to the late 1950s when, with the failure of a protectionist policy, policy adopted three key strands, i. promoting the development of exports, ii. attracting foreign direct investment (FDI) by means of tax and grant incentives, iii. embracing free trade with the UK and EU (from 1966 and

¹ The state named "Ireland" is also sometimes known as the Republic of Ireland or the Irish Republic, but we use the official name "Ireland". We also use the terms "the North" and "the South" to refer to Northern Ireland and Ireland respectively. If we want to refer to the whole island of Ireland (as opposed to the state named Ireland), we make that clear by using terms such as "all-island", "the island of Ireland" or "Ireland, North and South".

1973 respectively). O'Malley (1989) points out that under this new policy regime, indigenous industry suffered, unable to compete with imports and unable to develop competitive exports, with the exception of those sectors with some natural protection against competitors, or involved in basic processing of local primary products such as food.

Ireland's policy to attract foreign FDI from the end of the 1950s was particularly successful. Initially, job maximisation was a driver in attracting FDI, with large MNE's concentrated in traditional and labour-intensive sectors. By the late 1970s and 1980s however, policy began to adopt a more selective approach to the FDI sought, focusing more on high-tech and higher value added firms². Over the same period, the motivation for MNE's to invest in Ireland shifted, from the driver of tax and grant incentives along with low-labour costs in the 1960s, to access to major markets in 1973 with accession to the EU, and access to a skilled labour force which the Irish government had actively tried to develop, particularly in the areas of computers and other electronic products, pharmaceuticals, medical and scientific instruments and software. By the late 1980s R&D in Ireland was increasingly recognised as important for industrial development, in terms of allowing the country to move up the skills ladder, and to prevent its industry from being eroded by cost competition from lower cost countries. This change in policy espoused the theoretical thinking enshrined in the innovation-growth relationship, and it took place against the background of an extremely poor innovation performance of the country, at both a European and international levels.

Historically, Northern Ireland has been heavily dependent on GB with 61 per cent of goods manufactured in Northern Ireland, in 1960 being sold to GB (Harris, 1991; 24). Traditional industries such as textiles, which accounted for over half of employment during the war years declined rapidly from the late 1950s. Government policy therefore sought to attract inward investment to boost employment and diversify the industrial base through a range of financial incentives including interest free loans, grants, tax relief and advance factory buildings. In reality inward investors tended to be concentrated in a few sectors, most notably textiles and clothing, instrument and

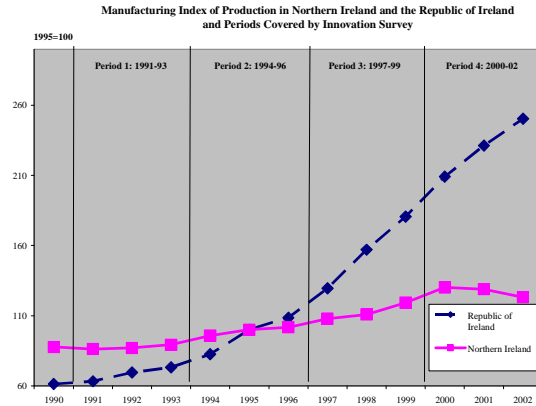
² Industrial Development Authority (IDA) set out a plan to concentrate on attracting investments in electronics, chemicals and other 'high-tech' industries.

electrical engineering, vehicles and aircrafts and food, drink and tobacco. Despite considerable grant assistance to industry in the 1970s further assistance was offered through Selective Financial Assistance. This created a situation where the majority of employment were in grant assisted firms (Harris et al, 1990).

Despite the success of financial assistance to attract inward investors to NI, between 1973 and 1986, 60.5 per cent of the decline in manufacturing was attributed to the colusre of externally owned and government assisted, companies. In 1980 the aggregate value of government grants and subsidies accounted for over 20 per cent of manufacturing GDP in NI, but by the end of the 1980s this had declined to nearer 10 per cent (Murshed et al 1993). Sustaining existing jobs became more important than creating new jobs with financial assistance reflecting this. In NI, a major change in policy came in the early 1990s, away from financial assistance based on job creation, to the provision of financial assistance in improving firms' competitiveness. Government's role would now be to 'increasingly target its support for industry on areas such as training, research and development, quality and design rather than on capital investment... Financial assistance will no longer be related solely to the prospects of additional employment... but rather to greater efficiency out of which additional long-term employment will come' (DED, 1990,17 as quoted in Harris 1993,82).

In both Ireland and NI economically, the early 1990s were a period of expansion. This is reflected in the index of manufacturing production for Ireland and Northern Ireland, 1991 to 2002 (Figure 1).

Figure 1



Sources: DETI, CSO.

For Northern Ireland, the period from 1991-99 was marked by steady output growth for manufacturing as a whole, followed by a small decline in the latter sub-period. By contrast, the unprecedented take off of the Irish economy since 1994 is visible³. This reflects the very rapid expansion of output in the high-tech sectors in Ireland, itself largely a consequence of inward investment. Up until around 1999, was therefore a largely expansionist period with manufacturing output growing, overall, in both jurisdictions. From 2000-2002, the situation looked remarkably different. In Northern Ireland in particular, manufacturing output fell, while the rate of growth of output in Ireland slowed down. This reflects the global downturn in high-tech industry and its impact on other related sectors⁴. The implication is that investing in innovation from 2000 to 2002 was markedly less enticing for firms in most industries, North and South, than in previous periods.

³ For an analysis of the performance of the Irish economy over this period see Barry, 1999 and Gray 1997.

⁴ While Figure 1 hides important sectoral variations. O'Malley and Roper (2003), for example, have suggested that during the 1990s marked differences existed between the performance of individual sectors, North and South. In particular, they concluded that sectors could be divided into three groups on the basis of their comparative productivity performance over the 1998-2000 period: a group of mature industries, where inward investment has been limited, and productivity levels are broadly similar, North and South; another group of mature industries in which significant differences are observed between Northern and Southern productivity; and, a third group of high-tech industries where inward investment has been a dominant influence and levels of productivity appear significantly higher in the Republic of Ireland than in Northern Ireland.

2.2. Innovation Policy In Ireland And Northern Ireland

In Ireland, the issue of R&D support was starting to gain momentum in the 1980s, with the 1987 Science and Technology Act, which brought about a number of significant changes to science and technology, such as the development of a national programme for science and technology. Another important stimulus to the development of an indigenous R&D capacity at that time was provided through the participation by firms, by research institutions and by higher education establishments in the R&D programmes of the EC and other programmes of international organisations. In 1992, a policy document, the 'Culliton Report', led to fundamental changes in favour of R&D support in Ireland. The Culliton Report emphasised the importance of state support for R&D and innovation, and argued for a holistic approach to company support⁵. In terms of the importance of R&D and state support for R&D, Culliton (1992) stated that Ireland "was placed 22nd out of 23 industrial countries in its capacity for innovation, in the perception of international industrialists" (Culliton 1992: 55). Culliton outlined the case for active State involvement in the promotion of R&D:

"Without state support and incentives the degree of investment in technology will be less than is desirable from the point of view of national economic development" (Culliton 1992: 55).

The Culliton report – like the earlier Telesis report (Telesis Consultancy Group, 1982)⁶ – advocated a re-focusing of support on indigenous industry in Ireland, and a shift from capacity expansion to developing capability and the funding of skills development in R&D and marketing. With this in mind, the Industrial Development Act, 1993 created three separate agencies for supporting industry and innovation in Ireland. These agencies were Forfás, Forbairt (formed out of EOLAS and that section of the IDA that addressed indigenous industry) and the IDA.

⁵ For example, Culliton (1992) noted that "...without adequate technological developments a decline in competitiveness is inevitable. Ireland cannot expect to develop top class research in the development and application of many modern technologies. The focus should be on the application of technologies that will help the firm to develop new products for which there is demand in the marketplace and to improve competitiveness and the quality of existing products' (Culliton 1992:55). And, in terms of the need for a 'broader approach than has been adopted in the past. It must go beyond traditional departmental demarcation lines to take account of all the major relevant factors, including notably the level and structure of taxation, cost and quality of infrastructure, the relevance and effectiveness of education and training" (Culliton 1992: 9).

⁶ Telesis Consultancy Group. *A Review of Industrial Policy*. Dublin: National Economic and Social Council Report No. 64, February 1982

During the mid-1990s, a period of strong economic growth in Ireland, the Tierney Report (STIAC, 1995) concluded that, despite considerable success in increasing industrial R&D spending, there was still a low level of R&D in Ireland, particularly in the business sector. There was therefore a need to provide increased resources for those involved in “knowledge generation” in higher education and a need to increase the level of understanding of the contribution of science and technology to innovation by business people and policymakers (Government of Ireland 1996). The Tierney Report was followed by Ireland’s first White Paper on Science, Technology and Innovation published in 1996, which led to a number of initiatives designed to stimulate R&D. These included tax incentives, funding of collaborative R&D programmes, funding for regional technology services, and funding to provide training in R&D and innovation management. In 1997, the RTI scheme was launched with wide ranging objectives including supporting research consortia, and encouraging R&D and innovation activity.

The emphasis on nurturing a more innovative and competitive country in the face of growing global market pressure was further emphasised in the 2000-2006 National Development Plan, with a £1.95bn (€2.5 billion) allocation (STI 2002: 1)⁷ for RTDI activities. A prioritisation of support is evident in this most recent funding, towards developing research strengths in Biotechnology and Information and Communications Technology (ICT). For example, the Science Foundation Ireland (SFI)⁸, has a budget of over €634.9m to fund research in niche areas of the biotech and ICT sectors. Forfás stress that the ‘strategic rationale behind this initiative [was] the need to stimulate a greater level of top class research in the economy in support of high-technology sectors and to ensure that a sufficient supply of good researchers become available to drive a more sophisticated research performance in the business sector’ (Forfas, 2000, p.7).

⁷ This National Development Plan (NDP) 2000-2006 was published in November 1999.

⁸ In 2000 the Science Foundation Ireland was formed with a budget allocation of over €634.9m to fund research in niche areas of the biotech and ICT sectors. Forfás stress that the ‘strategic rationale behind this initiative [was] the need to stimulate a greater level of top class research in the economy in support of high-technology sectors and to ensure that a sufficient supply of good researchers become available to drive a more sophisticated research performance in the business sector’ (Forfas, 2000, p.7)

Undoubtedly, the period from the mid-1990s to date has seen the greatest developments in industrial policy towards R&D in Ireland. This again is attributable in no small way to the influence of EU funding for R&D, as well as to the take up of the recommendations of the Culliton Report. By 1993, BERD amounted to IR£271 million, which represented an annual growth level of 17% over the preceding five years (Forfás 1995).

In Northern Ireland, concerns about the relatively low levels of innovation and entrepreneurial activity were mounting from as early as the 1970s. The first comprehensive study of R&D policy and activity in the region was published in the early 1980s (the Osola Report of 1983) after which the development agencies in Northern Ireland were more active in promoting support measures for R&D. In particular, the Industrial Research and Technology Unit (IRTU) was established in 1992 which for the first time, brought together responsibility for all programmes concerning industrial R&D and innovation in Northern Ireland under one roof⁹. At the same time, Northern Ireland government's first strategy document specifically aimed at Research and Technological Development (RTD), 'Innovation 2000', was published (IRTU, 1992), seeking to 'improve the competitiveness of industry and strengthen the economy of Northern Ireland by encouraging industrially relevant R&D and technology transfer'. The overall aim of 'Innovation 2000' was developed into four main strategic objectives¹⁰:

- (1) Raising the status of innovation, technical competence and awareness in Northern Ireland industry through promotional measures.
- (2) Raising participation in EU schemes by encouraging collaboration.
- (3) Raising the level of usage of locally available information sources through enhanced support for technology transfer.
- (4) Raising the level of private sector R&D to that of comparable organisations in GB by the year 2000 by directly supporting R&D in established facilities, encouraging collaborative projects, and by attracting three additional R&D inward investment projects by the year 2000.

⁹ IRTU's approach implicitly reflected the diagnosis of the UK-wide situation outlined in the 1993 UK science and technology White Paper 'Realising our Potential' (Cmnd. 2250). That is, that due to previous investments in basic research activity, a substantial - and, as yet unexploited - knowledge-base existed within the UK, more particularly within UK universities. By promoting the benefits of innovation and technological development, it was hoped that government could - for relatively little cost - encourage businesses and stimulate the commercial exploitation of this knowledge-base.

¹⁰ In addition to these four industry objectives *Innovation 2000* also commits IRTU to providing scientific services to government for environmental monitoring and protection.

In meeting the first three of these objectives IRTU pro-actively developed a programme of initiatives to promote the status of innovation and technological awareness in NI businesses (see Box 1). IRTU's fourth objective, increasing the level of commercial R&D in Northern Ireland, reflected a more interventionist approach than that adopted elsewhere in the UK.

More recent developments both North and South have re-emphasised the importance of both R&D and innovation as a focus of policy. In the Irish National Development Plan 2000 – 2006 for example, €2.5 billion was allocated for RTDI activities in the period 2000-06 (STI 2002, 1). Of this, €1.5 billion was allocated to industrial development to support innovation and competitiveness. Support was to be provided for in-company R&D, the networking of companies with the wider S&T infrastructure, the better use of technology in balanced regional development and the preparation for future technological opportunities through a technology foresight process.

In Northern Ireland, two recent policy developments are also perhaps worthy of note. The first is the clear identification by Invest Northern Ireland of innovation as a central policy objective. This has led to increased public support for R&D and the development of a range of new institutional and investment initiatives designed to strengthen and broaden the research base in Northern Ireland (e.g. the Centres of Excellence programme). The second is the publication in early 2003 of a new Regional Innovation Strategy for Northern Ireland called 'Think, Create, Innovate' (DETI, 2003). This has as a key focus the better integration of public, private and higher education R&D efforts as well as the need to increase levels of R&D expenditure throughout the region. Alongside these local developments, R&D support measures at national (i.e. UK) level have changed with the introduction of R&D tax credits in 2001, a policy also announced by the Irish government in the 2004 budget.

In addition, there were doubts about the strength of the UK innovation system (e.g. Walker, 2003), to such an extent that by the early 1990s, Northern Ireland faced twin deficits in terms of R&D and innovation. First, and reflecting the situation elsewhere in the rest of the UK, the region had what by international standards was perceived as being a relatively weak regional innovation system. Poorly developed institutional

structures sat alongside relatively low levels of innovation capability in firms and supporting institutions. Second, levels of R&D and innovation activity were below those in the UK. Consequently, the realization in the last two decades that innovation lies at the heart of future economic growth led to the vision, perceptible in relatively recent policy statements, that Northern Ireland was to become a 'fast growing, competitive, innovative and knowledge-based economy'. (DETI, 2003¹¹).

Initiatives by IRTU to raise the status of R&D and Innovation in NI

IRTU activity had three main strands. First, through its Industrial Science Centre, IRTU developed its internal capabilities and continued to provide a range of scientific and technical support services to industry and other public bodies in Northern Ireland¹. Alongside laboratory based activities for product development and accredited testing, IRTU developed an Information/Resource Centre to provide an Awareness Service and Patent Search Service along with more specific advice on issues relating to e-business, energy efficiency, environmental concerns and production troubleshooting (IRTU, 2001, p. 28-31).

Second, IRTU in partnership with other local organisations took steps to develop the institutional infrastructure in Northern Ireland to support innovation and local technological development through for example:

- Innovation Relay Centre – established in partnership with LEDU, the small business agency in April 1993 as part of an EU-wide network. Centre aims to facilitate access to, and stimulate the local application of the results of European R&D
- Design Directorate – launched in 1995 to improve competitiveness through the development and enhancement of NI's design capability and promotion of world-class design and best practice.
- Manufacturing Technology Partnership – established by IRTU and partners (University Ulster, Queen's University Belfast and Loughry College) in 1996 with aim of helping NI SME's to identify and adopt appropriate technologies, largely through direct consultancy support.

2.2.1 EU support for R&D

The impact of EU support for R&D and innovation capability development has been important for both Ireland and Northern Ireland, two Objective-One regions for most of the time under review in this analysis.

In the case of Ireland, the Operational Programme for Industrial Development, 1989-93, for example, provided continuing funding for capability development which in all probability could not otherwise have taken place given the state of public finances at the time. At the same time, the Community Structural Fund R&D Programmes (1989-93) and the later (1994-99) had clear targets to increase the number of R&D

¹¹ DETI, (2003) Think, Create, Innovate – A Regional Innovation Strategy for Northern Ireland, DETI, Belfast

performers. The 1994-99 Operational Programme in Ireland again, emphasised the importance of R&D: 'firms which possess and exploit technology are best positioned to take maximum advantage of shifts in the world economic environment. Without a strong technological capability Ireland's industry is likely to be little more than a pawn on the battlefield of global competition' (Government of Ireland, 1994, 59).

In reviewing EU involvement in promoting R&D in Ireland, Cogan and McDevitt (2000:11) describe it as having been of 'critical importance' to Irish S&T policy. They describe three benefits of the EU involvement. Firstly, they cite the organisational and institutional learning it engendered. They state, rather philosophically, that Ireland missed out on the industrial revolution and somehow expected to catch up with other nations by using imported innovation and without building up a domestic innovation and R&D capability. Secondly, the EU structural funds brought with it a disciplined evaluation of policy, something which was missing from policy prior to this. Thirdly, rather than concentrating on research that had little bearing on Irish industry, the Structural Funds were geared towards stimulating a self-sustaining capacity for innovation.

At the same time, Cogan and McDevitt (2000) highlight that somewhat paradoxically while R&D activity and expenditure has declined in recent years, this has coincided with unprecedented funding from Community Structural Funds and EU RTD Framework Programmes. This raises the question, why are Irish firms not motivated by financial incentives to undertake R&D? The answer to which they suggest lies in the absence of S&T capability of low/medium tech SMEs to appreciate the potential of R&D activity.

In Northern Ireland, EU funding has been an important component of R&D support. During the early 1990s, EU funding supported R&D infrastructure development, and throughout the 1990s EU structural funding was used to co-fund (with the UK treasury) the whole range of R&D and innovation support measures (e.g. Roper, 2001). In addition firms in both the Republic of Ireland and Northern Ireland had access to EU-wide collaborative R&D programmes such as the Framework measures.

In contrast with firms in the Republic of Ireland, Northern Ireland firms had additional access to a range of UK national R&D and innovation support measures, of which perhaps the most consistently important were:

- Link – which provides funding for R&D collaboration between higher education and companies;
- Smart – which provides limited funding for R&D or innovation based start-up businesses as part of a national competition; and, the
- Teaching Company Scheme – which provides support for university graduates working towards a Master’s degree to work with a specific company with a view to technology transfer.

3. Government Financial Support For Innovation In The Business Sector

Government financial support (direct or indirect) can affect the level of R&D and innovation undertaken in the economy. Financial support can be provided to each of the sectors performing R&D, namely, the business sector, the third level sector and the public sector. In particular, innovation grants or loans may enable firms to undertake projects which would otherwise be too risky or unviable, as well as to develop capabilities with long-term competitive benefits. Public support may also enable universities to establish Centres of Excellence providing a knowledge resource for a number of local companies. Alternatively, direct funding may be provided to organizations in the public sector. Although detailed data on the public sector expenditure on R&D in Ireland is only available from 1999, even from the limited data available, it is evident that, there has been a major increase in the level of public support for R&D.

Focusing on government financial support to the business sector, our analysis uses micro-level data which has been published in successive IRTU Annual Reports in Northern Ireland, as well as from data provided directly by Forfás in the case of the Ireland.

For Northern Ireland data collated from IRTU Annual reports provide detailed information on grant offers to individual businesses for R&D and innovation between 1991 and 2002. As the data for Northern Ireland relate to grant offers, this suggests a

number of caveats. First, although a grant offer is made it may not be taken-up either in part or fully by the company or university concerned. In general therefore 'offers' will tend to over-estimate the value of support finally received by the organisation although the extent of this over-estimation is hard to assess a priori. Second, the timing of grant offers and grant payments - particularly in longer-term R&D projects - may be very different. For example, some START and Compete projects, for example, have durations of 2-3 years and although an offer may be made at the start of the period, grant payments will be spread over the project's lifetime. In terms of the analysis presented here this means that although a company may have received grant offers of a certain amount over the 1992/93 to 2000/01 period this does not necessarily reflect the amount of grant support it received. For example, if a company was engaged in other grant supported R&D projects (e.g. Product and Process Development projects) prior to 1992/93, the amount of actual grant support received over the 1992/93 to 2000/01 period may be larger than the value of offers received. Alternatively, if a company was new to R&D and innovation over the 1992/93 to 2001/02 period, the value of grant offers received is likely to over-estimate the actual value of grant support received over the period. A third issue relates to the fact that in some pre-competitive R&D schemes (particularly TDP and START), support was offered for collaborative projects between companies/universities and only the total value of the offer is published rather than the individual shares of the participants. In these cases, we have simply assumed that the value of the offer is allocated equally between the applicants. These issues introduce a degree of uncertainty into the analysis at the level of the individual business.

In Ireland, micro-level data on public sector support for R&D and innovation is derived from grant payments data for individual businesses, between 1991 and 2002. This provides a more accurate profile of the precise level of intervention in terms of R&D at the firm level compared with grant offers.

Overall, in comparing the data for Ireland and Northern Ireland it must be remembered that grant offers are being compared with grant payments. Again this raises two specific caveats. First, the timing of the grant value in Northern Ireland will pre-date the R&D and innovation investment by businesses, while the grant payment in Ireland will post-date business investment. Care should therefore be taken

in comparing data for Ireland and Northern Ireland on specific years. Second, based on the available data, grant assistance in Northern Ireland is likely to be slightly higher than in Ireland, as businesses typically do not claim all of the finance offered to them and therefore the payments will tend to be lower than offers. Unfortunately data is not available to estimate the difference between offers and payments or indeed to approximate the percentage of offers that are paid. However, unpublished data for Ireland suggests that payments may account for 60 per cent of offers, with the timing often displaying a lag of one or more years.

Despite these limitations, unless there is some systematic relationship between these factors and the sectoral breakdown/type of R&D being supported, an analysis of grant offers/payments should provide a reasonable indication of the overall structure of R&D and innovation support offered in Northern Ireland and Ireland. By using these data, certain trends in R&D expenditure can be analysed and some tentative conclusions can be drawn as to whether government programmes and policies towards the promotion of R&D actually resulted in increased R&D funding being awarded.

As a starting point it is useful to distinguish between the different groups of grant-based measures offered to firms over the period, on the basis of the type of technological development activity they support and the funding-body. As already outlined, in Northern Ireland the primary provider of grant-based support for R&D and innovation was IRTU. In Ireland however provision has been more complex, being offered by different agencies over the years, and including Enterprise Ireland, the Industrial Development Authority (IDA), Shannon Development, and Udaras na Gaeltachta.

In general, grant-based support can be sub-divided into the following:

- (a) *Near-market R&D support* schemes to support the development of specific products and or processes with an immediate and clearly identified market application.
- (b) *Pre-competitive R&D support* schemes to fund applied research which has commercial potential but which is not linked to any specific product or process development. This type of R&D may be conducted within a company, university or through a collaborative arrangement

(c) *Technology Use* measures to support firms in auditing and developing their use of best practice technologies. The measures implemented in Northern Ireland have had a specific emphasis on environmental impact and management.

(d) *Other R&D Support Measures* normally designed to promote international collaboration.

Grant-based support available in Ireland and Northern Ireland between 1992 and 2001 are summarised in Figures 2 and 3 respectively. In Ireland direct support for enterprise R&D has tended to focus on near-market developments and only in recent years have greater resources been allocated to pre-competitive R&D. In contrast support for pre-competitive R&D in Northern Ireland has been important throughout the period with relative levels of funding for pre-competitive R&D far exceeding that for near market and other R&D support measures from the mid- to late 1990s (see Figure 4).

Figure 2: Time Profile of R&D and Innovation Support Measures Available in Ireland

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
A. Shannon Development										
Near Market Support										
Product and Process Dev.										
R&D Capability										
RTI										
Measure I										
Measure III										
B. IDA Ireland*										
Near Market Support										
R&D										
C. Udaras na Gaeltachta										
Near Market Support										
DEO27 [Technology Transfer]										
DEO 39 [Measure I, >50K]										
DEO 40 [Measure I, <50K]										
DEO47 [Measure III]										
DEO48 [Change]										
DEO49 [RTI]										
D. Enterprise Ireland**										
Near Market Support										
Measure 1										
Measure 6										
Research & Development										
RTI										

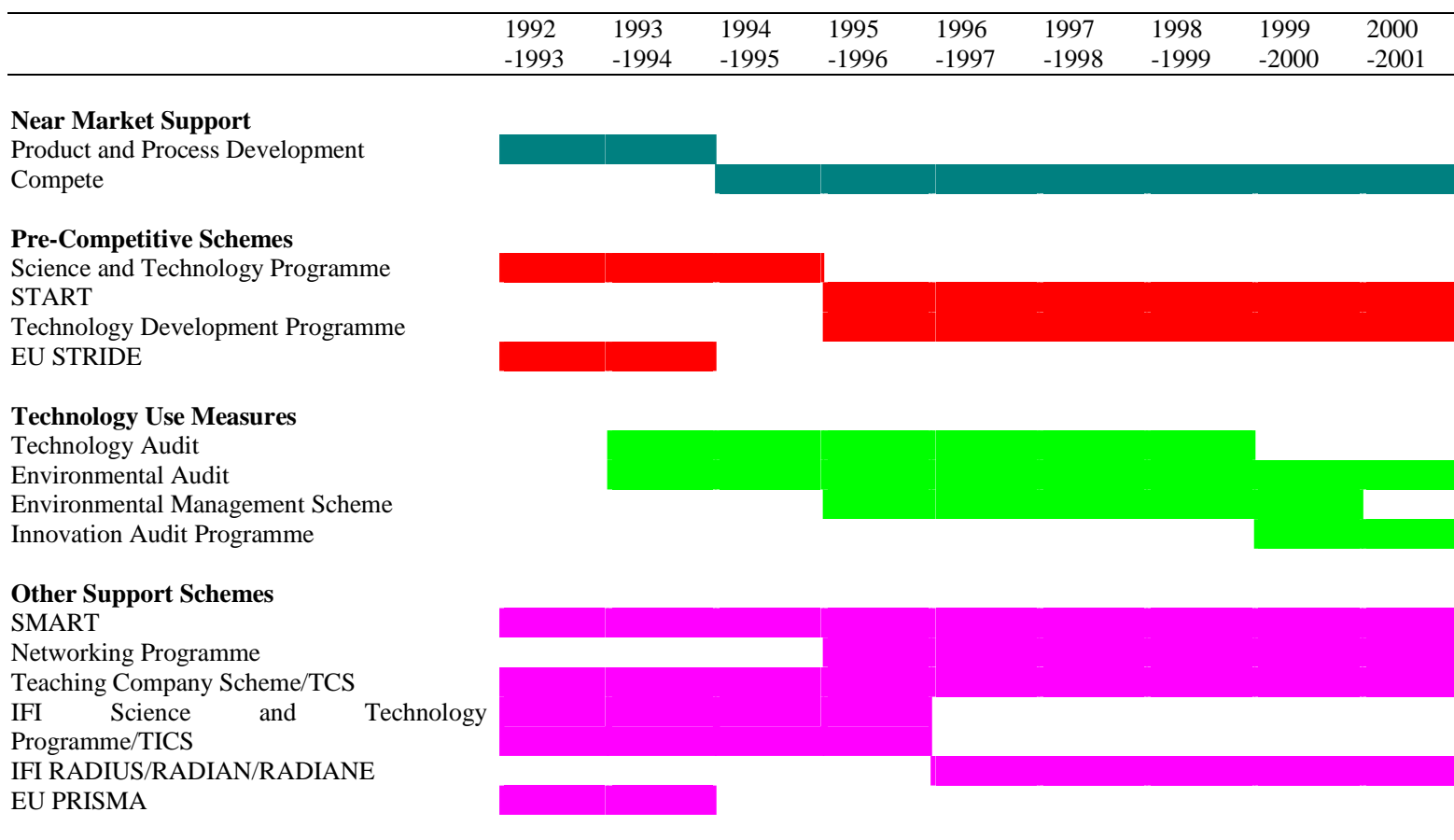
*No classification by schemes. In 1994 IDA Ireland was divided into three separate organisations following a government review: Forfas, IDA Ireland, Enterprise Ireland.

IDA Ireland initiated the Pre-Competitive Scheme in 2004. The data for that scheme is not available as of August 2004.

** The agency was established in 1994.

Source: Shannon Development, IDA Ireland, Enterprise Ireland and Udaras na Gaeltachta.

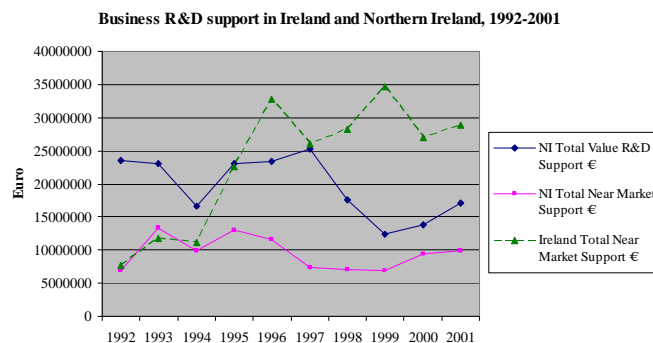
Figure 3: Time Profile of R&D and Innovation Support Measures Available in Northern Ireland



3.1. R&D Grant Offers In Ireland And Northern Ireland

Forfás and IRTU data allow us to examine in detail total R&D grant payments made by the four main development agencies in the South (i.e. IDA Ireland, Enterprise Ireland, Shannon Development, and Údarás na Gaeltachta) to Irish (ROI) firms and by IRTU to Northern Ireland firms.

In Ireland, between 1992 and 2001, total R&D grant assistance to businesses amounted to €240,963,836 with a significant increase in grant allocation to R&D occurring from 1994 (Figure 4). Indeed, between 1994 and 1996, the level of grant aid almost tripled in value (€11.1m to €32.8m), despite a modest increase in the number of firms aided over that period (up from 285 to 330). This was largely due to the introduction of Measure 1 support for R&D under the Operational Programme for Industrial Development and funded by the CSF. Consequently, the average level of R&D grant aid per firm increased from €39,262 in 1994 to €99,460 by 1996. The



other noteworthy period where the value of payments for R&D increased was between 1997 and 1999. Total value of R&D support in Ireland rose from €26,021,708 in 1997 to €34,729,467 in 1999 which was largely due to the introduction of the Research Technology and Innovation Initiative (RTI) in November 1997, as supported by EU Structural Funds.

Figure 4

Source: IDA Ireland, Enterprise Ireland, Shannon Development and Údarás na Gaeltachta (various years); IRTU Annual Reports

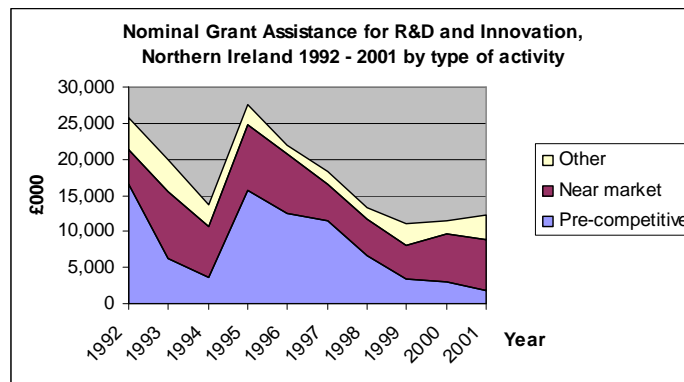
In Northern Ireland, total R&D grant offers between 1992 and 2001 amounted to £172,184,724 (€245,332,006). Of this, £34,826,981 (€49,622,144) was offered to the 2 main universities in Northern Ireland, Queen's University Belfast, and University of Ulster. Therefore, £137,357,743 (€195,709,922) was offered to businesses for R&D in Northern Ireland, between 1992 and 2001. In total, 2,720 R&D and R&D related

grants were offered over the period, to businesses and universities, with 95.7 per cent of these being made to businesses (2,603).

In Northern Ireland, the average value of R&D and R&D-related grants offered to businesses over the 1992 to 2001 period was £52,788 (€75,213 compared to €47,294 in Ireland). For Northern Ireland businesses average grant offer followed a declining trend from 1992 (£117,498 or €167,413) to 1999 (£23,415 or €33,362), before rising slightly in 2001 (to £45,677 or €65,081). Confining the analysis to near market R&D grants in Northern Ireland, then the total number of business R&D grants over the period were 1,382 (53.1 per cent of all the business R&D grants). This amounted to £66,885,379 (€95,299,558) between 1992 and 2001, with average grant offer of £48,397 (€68,956). When grants to universities are excluded from the analysis therefore, and comparison is made solely between near market grants in Northern Ireland and Ireland, average near market grant support in Northern Ireland is 45.8 per cent higher than in Ireland.

Support for R&D has changed significantly from the early 1990s (Figure 5) particularly in Ireland where total R&D grant payments have risen substantially since 1994. This has largely been due to the introduction of grant support for R&D through Measure 1, as funded through the EU CSF and later in 1997-99 through the introduction of RTI support, as funded through EU Structural funds. In the case of the RTI initiative, this opened access for R&D funding, especially to indigenous firms with a key focus of support being to encourage non-R&D performing indigenous firms to undertake R&D. This is reflected in the significant increase in the number of grant payments made to businesses in 1999 as compared to the previous period. At the same time, it is important to note that between 1998 and 1999 the total amount of support increased only marginally, from €28.2m to €4.7m. Not surprisingly, therefore, the average grant awarded to firms between 1998 and 1999 dropped sharply from €82,753 to €40,103. The average R&D grant awarded dropped further in 2000 to €37,885 before increasing again in 2001 to €52,465. When compared with an average R&D grant amount in 1980 of €22,571, average grant levels have not increased significantly overtime.

In Northern Ireland, across the period there was an overall decline in R&D grant allocations, although this has mainly been in terms of pre-competitive R&D with near market support increasing slightly as a share of total R&D support. In the early 1990s EU funding through STRIDE in 1992/93 for pre-competitive research increased the total amount of funding available for R&D and concentrated it away from near-market research. In 1994 with the ending of STRIDE funding grant support for pre-competitive R&D declined significantly and near-market R&D became proportionately more important. This was short-lived however as TDP funding from 1995 to 1997 in particular, led to a significant increase in grant support available for



R&D and a decline once more in the share of total funding for near-market R&D. Overall, the composition of offers for R&D support has varied markedly over the period, from 1992/93 to 2000/01 although on average around 50 per cent of the value of offers has been for pre-competitive research, 35 per cent for near-market activity and the remaining 15 per cent being allocated to other support measures. In the period since 1998, however, offers to support near-market R&D have become more important accounting for around 50 per cent of the value of all new offers of support.

Figure 5

Source: IDA Ireland, Enterprise Ireland, Shannon Development and Údarás na Gaeltachta (various years); IRTU Annual Reports

3.1.1 Sectoral Composition of R&D support

Information on the sector of each business receiving grant offers in Northern Ireland and payments in Ireland, enable the analysis of grant support for R&D over from 1992 to 2001 to be extended to the composition of grant payments by industry. The significant finding to emerge from the available data is that the majority of financial support for R&D in both Ireland and Northern Ireland over the period was made to

manufacturing firms. Nevertheless, in Ireland the contribution of support to the services sector increased in the 1990s; the services sector attracted some 33 percent of all grant payments made in 2001 against 17 per cent in 1991 (Figure 6). Within the manufacturing sector, the majority of financial assistance received by firms is clustered in seven specific industries.¹² When examined closer, it also appears that all agencies with the exception of Údarás na Gaeltachta focused the majority of their support on one specific area, electrical and optical equipment (NACE 30-33). An area that has received a significant increase in the amount of support over the years is computer and related activities (NACE 72); total payments made to this area grew from 2 per cent in 1980, to 24 per cent in 2001.

In NI, a similar distribution of R&D grant support is found as for Ireland over the 1992/93 to 2000/01 period, with 66.4 per cent of all support for R&D and innovation going to firms in the manufacturing sector (Figure 7). Again, as for Ireland, this support was clustered in the Chemicals & Man-made fibres sector (SIC92 24), the Electrical and optical equipment sector (SIC92 30-33) and Basic Metals and Fabricated Metal products sector (SIC92 27-29). In non-manufacturing sectors, support for R&D was dominated by the public services sector, which includes the universities (22.6 per cent of public sector investment in R&D) and Real estate and business services – including software development (7 per cent).

In Northern Ireland, the concentration of offers of R&D support to manufacturing firms is even more marked in terms of near-market R&D activity, accounting for four-fifths of the total value of such offers. At the opposite extreme, only around two-thirds of the value of offers of support for pre-competitive research are made to manufacturing firms, with the remainder going to the universities. However, the bulk of offers to the universities came with the STRIDE funding in 1992/93 and the TDP in 1994/95. In compositional terms, some more long-term trends are apparent with an increasing share of R&D grant offers being made to private services companies and a declining share going to the universities

¹² These areas include; Food, drink & tobacco (NACE 15-16); textile, clothing & leather (NACE 17-19); chemicals and man-made fibres (NACE 24); basic metals & fabricated metal products and other machinery & equipment (NACE 27-29); electrical and optical equipment (NACE 30-33); and transport equipment (NACE 34-35).

Figure 6

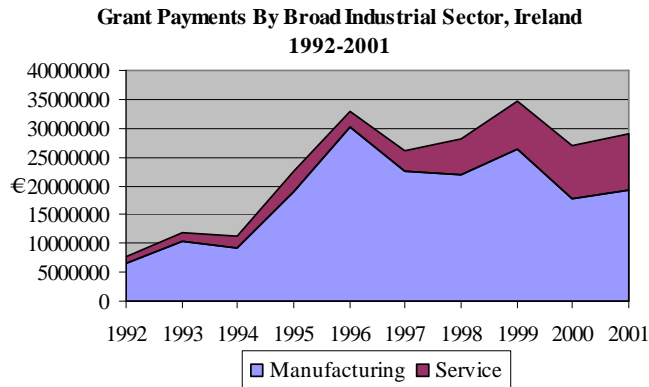
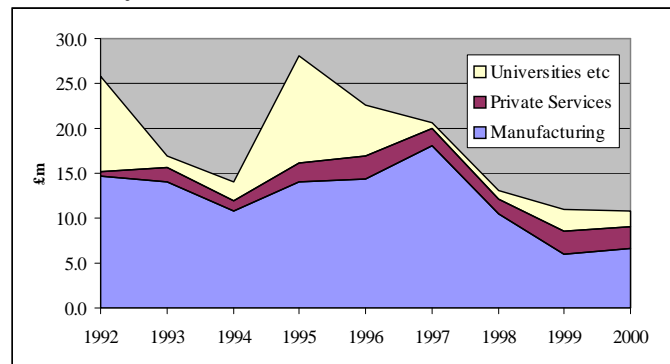


Figure 7: Grant Offers by Broad Industrial Sector, Northern Ireland, 1992/3 to 2000/01



3.1.2 Concentration of R&D support

Even more remarkable than the sectoral concentration of grant payments, is the strong concentration of grant support among few companies in both Ireland and Northern Ireland.

Table 1 lists the twenty largest private sector recipients of grant offers from 1992/93 to 2001/02 and the type of support they have been offered. For Ireland, when each of the agencies figures are combined together, it is evident that the ten largest private sector recipients of grant payments account for 11.9 per cent of the cumulative agency grant payments, with the twenty largest accounting for 15.6 per cent of the value of all financial support.

In Northern Ireland concentration of support among a few businesses is also very strong. Bearing in mind the caveats made earlier with reference to the data source, overall, the ten largest private sector recipients of grant offers accounted for 40.9 per cent of total IRTU grant offers, with the twenty largest accounting for 49.8 per cent of the value of all offers of support. Ranking companies in terms of different types of offers of R&D, however, suggests a very different picture and the much stronger concentration of pre-competitive R&D support offers. For example, the top 10 firms in receipt of pre-competitive R&D offers accounted for 84.6 per cent of all offers, and the top 20 accounted for 94.9 per cent. In contrast, concentration of offers of support for near-market R&D is less marked with the top 10 firms accounting for 20.0 per cent of the value of all offers and the top 20 accounting for 28.9 per cent of the value of all offers.

In Northern Ireland, the strong concentration of offers of R&D support reflects closely the concentration of business R&D spending itself in Northern Ireland which has changed little over the last decade. In 1999, for example, the ten biggest R&D spenders in NI accounted for 59 per cent of all civil R&D spending compared to 55 per cent in 1996 and 61 per cent in 1993 (DED, 1999 - R&D Survey Report). The lack of progress in distributing R&D activity more widely in Northern Ireland raises important doubts about the capability of an essentially demand-led R&D support regime to widen the base of R&D performing companies¹³. It is important, however, to recognise that more recently some progress has been made in this area with IRTU reporting an increase in the number of companies in NI undertaking pre-competitive research to 60 in 2000/01 and attracting around 30 new companies each year into the near-market Compete programme from 1998/99 to 2000/01 (IRTU, 2001, p. 12-13).

Table 1: Concentration of R&D Grants in Ireland and Northern Ireland, 1992-2001, by top 20 businesses.

Company	Rank	Total	Cumulative %	Company	Rank		Cumulative %	
		Grant						
		Offers						
		€'000					€'000	

1. Indeed, it could be argued that the tendency is for demand-led support regimes to perpetuate and perhaps reinforce the concentration of R&D activity. In competitive schemes, for example, firms with an established track record of pre-competitive R&D will find it easier to make a compelling case for support compared to those planning to undertake such R&D activity for the first time.

Analog	1	8,458	3.5	Du Pont (UK) Ltd	1	14858.9	7.6
Taighde Mara Teo	2	4,004	5.2	Seagate Technology (Ireland)	2	13359.0	14.4
Green Isle Foods Portumna Limited	3	3,467	6.6	Radox Laboratories Ltd	3	9577.5	19.3
Waterford Crystal Ltd.	4	2,192	7.5	Galen Ltd	4	7864.3	23.3
Green Isle Foods (Portumna) Ltd	5	1,868	8.3	Bombardier Aerospace - Shorts	5	7512.7	27.2
Dairygold Co-operative Society	6	1,791	9.0	Norbrook Laboratories Ltd	6	7038.9	30.8
Elan Corporation	7	1,770	9.8	Nortel Networks	7	3781.2	32.7
Rye Valley Foods Limited	8	1,751	10.5	Thales Air Defence Ltd	8	3764.1	34.6
Medtronic Ave Ireland	9	1,737	11.2	Montupet (UK) Ltd	9	3069.4	36.2
Bio-Medical Research Ltd	10	1,611	11.9	Perfecseal Ltd	10	3061.0	37.8
Lake Communications Ltd	11	1,600	12.6	Mackie International Ltd	11	2377.1	39.0
Golden Vale Plc	12	1,578	13.2	F G Wilson Engineering Ltd	12	2100.5	40.1
Moffett Engineering Limited	13	1,533	13.8	Moy Park Ltd	13	1952.4	41.1
Waterford Stanley Ltd	14	1,457	14.4	Integrated Silicon Systems Ltd	14	1654.5	41.9
Ivax Pharmaceuticals Ireland	15	1,449	15.1	Omagh Meats Ltd	15	1501.7	42.7
Qualceram Shires Plc	16	1,361	15.6	Powerscreen International Ltd	16	1312.5	43.3
Loctite (Ireland) Limited	17	1,296	16.2	Dairy Produce Packers Ltd	17	1229.8	44.0
Applied Micro Electronics Ltd	18	1,262	16.7	ICS Computing Group Ltd	18	1167.8	44.6
Microelectronics Development	19	1,255	17.2	Unibol Ltd	19	1077.5	45.1
Tyco Healthcare Galway	20	1,235	17.7	Clarehill Plastics Ltd	20	998.8	45.6
Total		42,675				89,259.5	

3.1.3 Ownership of firms receiving R&D support

Another key aspect of industrial support in Ireland is the proportion of grant aid provided to Irish-owned firms relative to foreign-owned firms. Table 2 shows that almost 85 per cent of firms that were grant aided for R&D activities in Ireland during the period 1980-2001 were Irish-owned. Given the remit of Enterprise Ireland in

supporting indigenous industry, it is not surprising that 96.3 per cent of firms allocated R&D grant aid from Enterprise Ireland were Irish-owned. Likewise, for the IDA, 98.5 per cent of firms that received R&D grant aid from that agency were foreign-owned. What is also interesting to note is the high proportion of grant aid to Irish-owned firms administered by Shannon Development and Údarás na Gaeltachta.

Table 2: Ownership of Grant-Aided Firms in Ireland, by Agency

	Total	Irish		Foreign	
		Owned	%	Owned	%
Total	3189	2707	84.9	482	15.1
Enterprise Ireland	1974	1901	96.3	73	3.8
IDA Ireland	343	5	1.5	338	98.5
Shannon Development	137	115	83.9	22	16.1
Udaras na Gaeltachta	735	686	93.3	49	7.1

Source: IDA Ireland, Enterprise Ireland, Shannon Development and Údarás na Gaeltachta (various years)

Of the foreign-owned firms that received R&D grant support in Ireland, the largest proportion (41.3 per cent) were US-owned while the next highest proportion (16.6 per cent) were British.

4. Innovation Indicators and Outputs (Performance Metrics)

R&D grants are important input indicators of innovation (others include scientific staff etc) which are supposed to stimulate innovative output. We will consider R&D as one input into the innovation process, although the main focus of this section is on innovation outputs or innovation performance of the two jurisdictions over the period under review.

For Ireland and Northern Ireland, like most other industrialised countries, the largest proportion of total R&D is performed by the business sector. Just as grant support for R&D has risen significantly in Ireland over the 1990s, so too has Business Expenditure on R&D (BERD). By 2001, BERD in Ireland had reached €917million (at constant prices) equivalent to 0.95 per cent of GNP from 0.89 per cent in 1993 (Figure 8).

Despite a declining trend in the level of grant support for R&D in Northern Ireland over the 1990s, as for Ireland, BERD increased throughout the 1990s rising to a high of £159.4m in 2001 (representing 0.83 per cent of GDP) before declining slightly in the 2001 to 2002 period. While the majority of BERD is funded from business's own resources (c.78 per cent), in 2002 government funding amounted to £11.3m, or 7.2 per cent of total BERD. With the exception of the 2001-2002 period, the proportion of BERD funded by government has declined from a high in 1993 of 25.5 per cent to 18.3 per cent in 1996, 10.3 per cent in 1999 and 5.5 per cent of BERD in 2001.

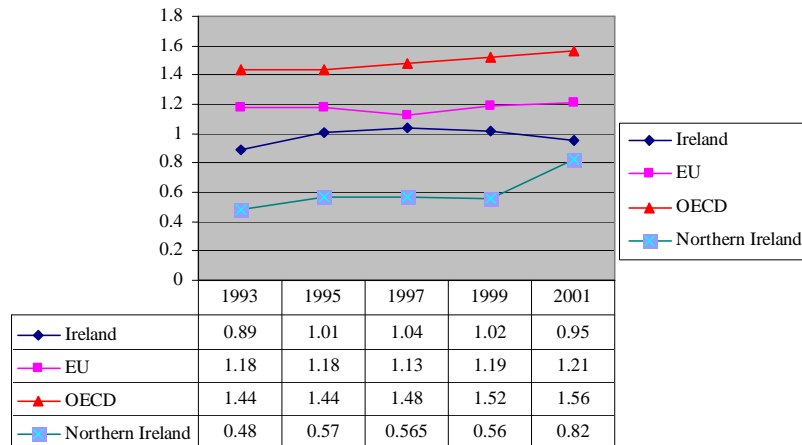
There are a number of possible interpretations of these change in Northern Ireland, first, grant support has been important in encouraging firms to perform R&D, often for the first time, after which they sustain this into the future. Second, the strategic objectives outlined in Innovation 2000 have been fulfilled in terms of raising the status of innovation, technical competence and awareness of innovation, of raising participation in EU schemes and in increasing the use of local information sources through enhanced support for technology transfer. Third, it is also possible that levels of BERD would have increased in the absence of government support for R&D. Indeed, relative to EU and OECD averages, levels of BERD in both Northern Ireland, and Ireland, increased at a proportionately greater rate than in EU and OECD.

Despite these relative increases in both Ireland and Northern Ireland, the level of R&D investment in both jurisdictions has lagged considerably behind both the EU and OECD averages (Figure 8). For example, R&D investment in Ireland was only 78.5 per cent of the EU average and 60.9 per cent of the OECD average in 2001. Further, if Ireland is compared to similar economies with a substantial high technology sector, then the under-investment in R&D by the business sector is further accentuated.¹⁴

¹⁴ For example BERD as a percentage of GDP in Sweden is 2.9%, Japan and Korea is 2.1%, and US and Finland is 2.0% (Forfas 2003) Research and Development in the Public Sector, 2000 – Volume Two – The Research and Development Element of the Science and Technology Budget, Forfas, Dublin.

Figure 8

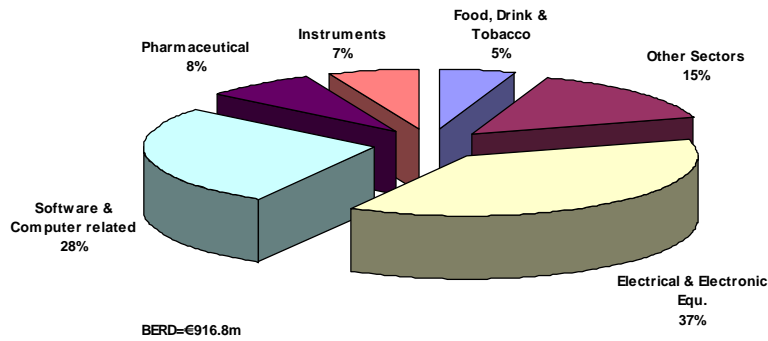
Business Expenditure on R&D as % of GDP/GNP - Ireland, EU and OECD, 1993 to 2001



Source: EU (2003)

In terms of sectoral variations in R&D investment, in general, the variations evident in grant support for R&D by sector are reflected in relative levels of R&D investment. Two sectors dominate BERD in Ireland, namely the electrical and electronic equipment sector (accounting for 37 per cent of BERD) and the software and computer related services sector (accounting for 28 per cent of BERD) (Figure 9). Indeed, combining the R&D undertaken in the Electrical and Electronic equipment sector, the Software and Computer Related services sector along with the Pharmaceuticals, Instruments and Food, Drink and Tobacco Sectors this accounted for 85% of BERD in 2001 (Forfas 2003).

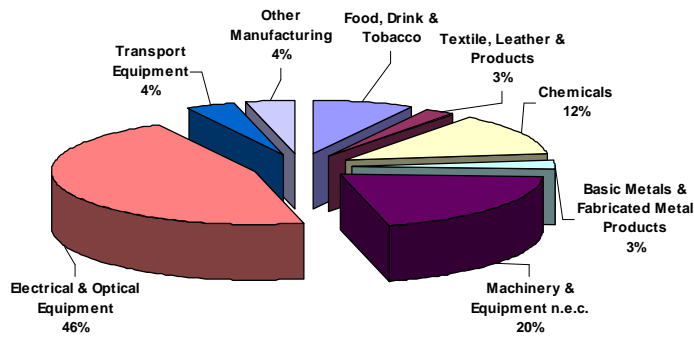
Figure 9: BERD by industry in the Ireland, 2001



Source: Forfas Business R&D survey, 2002

Similarly, in Northern Ireland, the Electrical and Optical Equipment industry dominates R&D spend accounting for 46 per cent of total manufacturing BERD. Other significant contributors to total manufacturing BERD are Machinery and Equipment (20 per cent) and Chemicals (12 cent) (Figure 10).

Figure 10: BERD by Industry in Northern Ireland, 2001



Source: DETI Statistics Research Branch, 2003, Northern Ireland Research & Development Statistics, 2002

In Ireland the relative importance of these sectors to BERD has changed somewhat since the early 1990s, with the industries experiencing the greatest change in share of BERD over the period being the Software and Computer Related Services sector and the Food, Drink and Tobacco sector. The Software and Computer related services sector grew dramatically during the 1990s and with it, the share of BERD undertaken in this sector, rising from 7 per cent in 1993 to 27 per cent by 2001. In contrast the share of R&D performed by the Food, Drink and Tobacco sector in Ireland has declined throughout the 1990s from 12 per cent of BERD in 1993 to 6 per cent by

2001. The pharmaceuticals industry's share of BERD has also declined over the period from a high of 18 per cent of BERD in 1993 to 8 per cent in 2001.

Although the Electrical and Electronic equipment industry had the highest share of BERD (37 per cent), it also had the third lowest share of R&D being undertaken by Irish owned enterprises at 15.6 per cent. The only industries where this share is lower are Instruments (13.8 per cent) and Pharmaceuticals (12.2 per cent). Together these three sectors accounted for approximately 52 per cent of total BERD in 2001 and they are dominated by foreign owned businesses.

In contrast to this, in the Software and Computer related services sector, which had the second highest level of BERD in 2001 (28 per cent of total BERD) at €252.3m, 49.1 per cent of this was undertaken by Irish owned enterprises. Indeed, nominal levels of BERD in this sector among indigenous firms increased by 996 per cent compared to 192 per cent growth in total BERD for indigenous firms across all sectors between 1993 and 2001. Therefore, against the background of R&D spend being dominated by foreign owned enterprises (in sectors such as Chemicals, Electrical and electronic equipment, Instruments and Pharmaceuticals), other industries such as Paper, Print and Publishing, Other services, Other manufacturing, Basic and fabricated metals etc. are dominated by Irish owned enterprises.

Controlling for Sector and Ownership in Ireland presents a slightly different perspective on relative levels of BERD. The indigenous sector invested a higher proportion of its output in R&D (0.8 per cent) compared to the foreign-owned manufacturing sector (0.6 per cent). With the exception of foreign-owned plants in the non-metallic mineral products and wood and wood products sectors, R&D intensity was higher among indigenous plants for each of the manufacturing sectors. Even in those sectors where BERD is dominated by foreign investment, such as Pharmaceuticals, Instruments, Electrical and Electronic Equipment and Chemicals, relative to output, indigenous plants are investing substantially more in R&D. Yet, for the majority of sectors, whether in terms of indigenous or foreign-ownership, relative R&D intensities remain significantly below OECD levels.

4.1 Innovative Outputs

Evidence suggests that innovative outputs reflect the extent of investment in R&D (innovative inputs). In light of this, the following sub-section concerns itself with innovative outputs.

Drawing on a survey of innovation capability and activity in Irish plants over the period of the analysis, the Irish Innovation Panel (IIP)¹⁵, it is possible to profile innovation outputs throughout the period of analysis for both Ireland and Northern Ireland. Table 3 summarises a number of broad key innovation indicators for the four survey periods. Overall, the proportion of manufacturing plants undertaking R&D, product innovation and process innovation increased steadily across the island through the 1990s but fell back during the 2000-02 period. This is clearly what was anticipated given the economic conditions pertaining over this latter period; surprisingly perhaps, the level of innovative activity on each measure is below that of the early-1990s. This is an indication of both the scale of the impact of the 2000-02 slow-down on innovation activity, and more generally the importance of the economic environment on plants' innovation investments.

New products accounted for around one-sixth of plants sales throughout the 1991-02 period, although again a slight fall is evident from the late 1990s to the 2000-02 period. The broader measure relating to new and improved products suggests that around a third of plants' sales came from these products over the sample period, with again a slight fall between the late 1990s and the 2000-02 period.

Table 3: Innovation Indicators from the Irish Innovation Panel: 1991-2002

	1991- 1993	1994- 1996	1997- 1999	2000- 2002	1991- 2002
Ireland					
R&D in plant (% plants)	50.8	48.3	52.6	44.6	49.4
Product innovation (% plants)	62.8	65.9	65.3	56.7	62.8
Process innovation (% plants)		57.7	65.8	53.9	59.8
New products in sales (mean %)	18.1	13.8	17.1	13.5	15.7

¹⁵ For further details of the Irish Innovation Panel see Roper et. al. 1996, Roper and Hewitt-Dundas 1998, Roper and Anderson 2000 and Roper et ,al. 2003

New/Improved prods. In sales (mean %)	32.1	30.5	29.2	27.3	29.7
Northern Ireland					
R&D in plant (% plants)	38.7	44.1	45.3	36.1	41.3
Product innovation (% plants)	51.9	56.5	58.5	53.8	55.3
Process innovation (% plants)		46.0	57.5	50.1	51.6
New products in sales (mean %)	13.8	12.3	11.9	13.5	12.8
New/Improved prods. In sales (mean %)	29.6	26.1	26.5	24.5	26.7

Notes and Sources:

1. Table relates to manufacturing plants with 10 or more employees. Survey observations are weighted to give representative results for each area.
2. Product innovators are those plants introducing new or improved products during the last three years. Process innovators are plants introducing new or improved processes over the same period.
3. Data from the Irish Innovation Panel.

In terms of the Ireland-Northern Ireland dimension, the proportion of plants undertaking R&D in Ireland has been consistently higher than that in Northern Ireland. As with the majority of innovation indicators, however, both proportions declined between the late 1990s and the 2000-02 period.

In terms of the proportion of innovating plants, both product and process innovation were more common throughout the sample period among Ireland than Northern Ireland firms. This again reflects the higher proportion of firms undertaking R&D in Ireland, which in part, reflects the differences in sectoral structure between the two economies. Interestingly, however, the differential in the proportion of plants introducing product and process innovations between Northern Ireland and Ireland narrowed somewhat during the 2000-02 period.

In terms of the proportion of sales coming from innovative products we see a broadly similar pattern to that of the extent of innovation: plants in Ireland derive a consistently higher proportion of sales from new and new and improved products than those in Northern Ireland. These differentials, however, were again smaller for the 2000-02 period than for other periods, particularly for the sale of new products.

Some salient key points seem to emerge from this data. First, there have been significant attempts to use policy initiatives to support innovation activity on the Island of Ireland in a number of ways. One important channel has been by boosting R&D through direct grant support for innovative projects. Second, there seems to be a clear relationship between R&D and the innovation output measures.

4.2 Summary

A number of key points have emerged from this analysis in terms of changes in public policy towards support for R&D and innovation from the late 1980s. The analysis has focused on public sector support for R&D specifically in terms of business-level grant support and how this has changed over the 1992 to 2001 period. While a quantitatively-based evaluation of this support is beyond the scope of this paper, innovation policy and business-level support has been considered in terms of changes in business expenditure on R&D, engagement in R&D and innovation activity and innovation outputs. The main points can be summarised as follows:

Innovation Policy – R&D and innovation increased as a policy priority in both Ireland and Northern Ireland towards the end of the 1980s and early 1990s with the publication of key policy documents (Culliton report in Ireland and Innovation 2000 in Northern Ireland). In both Ireland and Northern Ireland, considerable emphasis was placed on increasing direct state support for R&D and innovation, but this was encompassed in a holistic framework of support. For example, in Ireland this included tax incentives, funding of collaborative R&D programmes, funding for regional technology services and funding for training in R&D and innovation management. In Northern Ireland, emphasis was also placed on raising the status of innovation, technical competence and awareness and encouraging greater usage of locally available information sources.

EU funding has been critical in promoting the number of firms performing R&D and innovation in both Ireland and Northern Ireland, regions which were both Objective-One regions for most of the study period. EU funding was important not only in providing infrastructural support for R&D and innovation, particularly through the Structural Funds, but also facilitated collaboration for R&D through Framework Programmes. Cogan and McDevitt (2000) conclude however, that the key benefits arising from EU funding were organisational and institutional learning, the engendering of disciplined evaluation of policy and in building capability to sustain R&D and innovation beyond the initial funding period.

R&D Support - Total grant support for R&D between 1992 and 2001 amounted to €240,963,836 in Ireland, which was largely focused on near-market programmes. In Ireland, grant allocation increased dramatically between 1994 and 1996 and later between 1997 and 1999. This corresponded to the introduction of Measure 1 support for R&D under the Operational Programme for Industrial Development and funded by the CSF in the earlier period and then the introduction of the Research Technology and Innovation Initiative (RTI) in November 1997, as supported by EU Structural Funds. Again this emphasised the importance of EU funding in stimulating direct state support of R&D.

In Northern Ireland, grant support for R&D between 1992 and 2001 amounted to €245,332,006. Approximately 95.7 per cent of all grants for R&D were to the business sector, with 53.1 per cent of business grants for near market R&D. Over the period, average near market grant support to businesses was €68,956, which was 45.8 per cent greater than that for Irish businesses. Overall, funding in Northern Ireland has been split over the period between pre-competitive R&D (c.50 per cent of grant offers), near-market activity (c.35 per cent) and other support measures (c.15 per cent). Since 1998 however offers for near-market support have become more important accounting for around 50 per cent of the value of all new offers of support.

Manufacturing businesses dominate grant support in both Ireland and Northern Ireland, with the electrical and electronic equipment sector dominating this. In recent years however a larger proportion of funding has been directed at tradable services businesses. An important issue for policy in both Ireland and Northern Ireland has been encouraging non-R&D performers, and in particular, indigenous businesses, to undertake R&D for the first-time. A high concentration of R&D spend among a small number of businesses is a particular problem for Northern Ireland, with 59 per cent of R&D spend in 1999 undertaken in 10 businesses. This concentration of R&D activity is also reflected in the distribution of grant support for R&D. In Ireland 17.7 per cent of total grant support for R&D between 1992 and 2001 was based in 20 companies, with the top 10 firms receiving 11.9 per cent of support. In Northern Ireland this concentration is even more stark, with 45.6 per cent of R&D grant offers to 20 businesses, and the top 10 accounting for 37.8 per cent of all grant offers.

What is interesting is that this concentration does not just reflect the size of grant-support received by these businesses, but the recurrence of funding. For example, Du Pont (UK) Ltd, received 17 offers of support over the period concentrated in the early-1990s with a focus on pre-competitive R&D activity. By contrast, other businesses such as Radox Laboratories Ltd, Galen Ltd and Norbrook Laboratories Ltd had a more balanced profile being offered support for both near-market and pre-competitive R&D. Bombardier-Shorts were offered the highest number of R&D grants over the 1992/93 to 2000/01 period by IRTU although again these awards were concentrated in the early 1990s.

Innovation Indicators and Outputs - BERD has increased throughout the period – from 0.89 per cent of GNP in 1993 to 0.95 per cent in 2001 in Ireland and from 0.48 per cent of GDP in 1993 in Northern Ireland to 0.82 per cent by 2001. At the same time, government funding of BERD has declined. Just as was found in Northern Ireland in terms of the parallel between businesses investing in R&D and those in receipt of grant support, again a similar trend is evident in terms of sectoral spend and grant support. For example, the electrical and electronic equipment sector and the software and computer related services sector not only receive the largest proportion of R&D grant support in Ireland, but they also make the largest investments in R&D.

Despite the rise in R&D investment, expenditure on R&D remains low by international standards, and indeed it is doubtful if either Ireland or Northern Ireland will achieve the Barcelona target of 3 per cent of GDP invested in R&D by 2010. At the same time, the proportion of firms investing in R&D, or undertaking product or process innovation has increased throughout the period in both Ireland and Northern Ireland. On average, however, sales from product innovations have remained constant throughout the period for both Irish and Northern Ireland firms.

5 Conclusions

In general, the evidence presented in this paper suggests a positive relationship between innovation policy as reflected in financial support to firms for R&D and business level investment in R&D and innovation activity. R&D financial assistance to firms has been a significant feature of industrial development policy on the Island of Ireland since the 1980s. At the same time, the proportion of manufacturing firms undertaking R&D, product and process innovations increased steadily throughout the 1990s¹⁶. Differences are apparent between Ireland and Northern Ireland however, with the proportion of firms undertaking R&D as well as product and process innovation in the ROI being greater than in Northern Ireland throughout the period (although this gap narrowed during the 2000-02 period). ROI firms also derived a higher proportion of their sales from new and improved products than NI firms.

One possible explanation for this difference between the two jurisdictions is the size and structural composition of the business sector. For example in Ireland, a higher proportion of firms with a greater propensity to invest in R&D (most notably firms in hi-tech sectors such as computers and other electronic products, pharmaceuticals, medical and scientific instruments and software) has a positive effect on the overall level of R&D investment relative to Northern Ireland¹⁷. Another explanation could be the extent of grant support. For example, in Ireland the level of grant support to firms for R&D increased dramatically throughout the 1990s, while in Northern Ireland the level of grant support declined overall and remained relatively stable for near market R&D. At face value this could be interpreted as positively related to changes in business level investment in R&D and innovation activity. However, in Northern Ireland, despite a decline in grant support, BERD as a proportion of GDP increased throughout the period as did the number of firms undertaking R&D and innovation. This suggests the interaction of other factors in the relationship between grant support and R&D investment, such as general economic climate. This is evident in Ireland with grant payments for R&D reducing from 1999 to 2001, coinciding with a downturn in the global IT sector.

¹⁶ There was a decrease during the period 2000-02, however this can broadly be attributed to the weaker economic conditions pertaining in both jurisdictions at that time.

¹⁷ see Roper and Hewitt-Dundas 2004 for a discussion of structurally adjusted innovation indicators.

A further important issue, and one which is beyond the scope of this paper relates to the level of additionality and deadweight associated with grant support for R&D. In both Ireland and Northern Ireland, grant support has been largely demand-led with the highest investors in R&D also being the largest recipients of grant support. In Northern Ireland in particular high concentration of total R&D grant support in a small number of companies as well as high levels of recurrent funding among particular firms in Ireland and Northern Ireland, also point to funding being demand-led. In other words, a large proportion of firms receiving grant support are in sectors where R&D is established in the organisational ethos of the industry and many of these firms are large, foreign-owned plants with well-developed R&D capability. Certainly in Northern Ireland where grant support for pre-competitive R&D was important in the early to mid-1990s, this was almost exclusively dominated by larger businesses in the hi-tech or knowledge-based sectors.

Other studies have highlighted that demand-led initiatives, such as the EU Framework programmes (particularly FP5) have not been successful in stimulating firms' participation (Cogan and McDevitt, 2003). One explanation for this is that firm's are unable to participate in such programmes if the underlying capability to undertake R&D does not exist. Therefore, it is likely that those firms receiving grant support for R&D in Ireland and Northern Ireland over the 1992 to 2001 period, were those with an established, or potential R&D capability, suggesting that deadweight has been high and additionality beyond (NOLA: Should this not read additionality below the optimum level??) the optimum level.

At the same time policy, in Ireland in particular, has attempted to increase through grant support for R&D the number of first-time R&D investors, with a particular focus on indigenous firms. Evidence from the analysis suggests that this has had some success, with the RTI initiative in Ireland and the Compete scheme in Northern Ireland being particularly successful in targeting first time investors in R&D (see also Cogan and McDevitt 2003). Further, data on the increasing percentage of R&D and innovation activity plants from the Irish Innovation Panel also provides support for an increase in first-time R&D investors. Uncertainty exists however over the sustainability of this approach. For example where R&D grant support encourages a firm to participate in R&D and innovation is this then embedded in the culture of the

organisation and sustained over time? Empirical evidence on this is weak, however deducing from the IIP statistics on the proportion of R&D and innovation active businesses, as well as evidence on the recurrence of funding from the grants databases - even for smaller firms - suggests that R&D grant support may be important in providing a catalyst to sustained R&D and innovation capability.

The scale of grant support for R&D in both Northern Ireland and ROI, as a proportion of GNP or GDP has declined in recent years, with the average grant for R&D given to firms also declining. Despite this, grant support for R&D is still substantial, especially when viewed in the context of the other forms of grant support that have been introduced in recent years, such as funding through Science Foundation Ireland. In both Ireland and Northern Ireland this raises important questions about the regional 'value added' from such investments. In other words, what is the social rate of return to such investments compared to other types of public investment either in other forms of industrial support or other public services? Fundamentally, the answer to this question remains uncertain with estimates of the social rate of return to R&D investment varying widely between different industries, technological and geographical contexts. There is now evidence, however, from a range of studies *'all pointing in the same direction: R&D spillovers are present, their magnitude may be quite large, and social rates of return remain significantly above private rates'* (Griliches, 1995, p. 72). However, this general result depends significantly on the ability of a host region or nation to capture both the 'private' and 'spillover' benefits from any R&D investment. Griliches (1995) therefore concludes that:

'All of the recent studies of R&D returns at the industry or national levels continue to find significant social returns to it A caveat should be entered here, however. For a relatively small country ... such as Sweden or Israel, the same spillover arguments may not apply. Most of the technological spill-out is to the rest of the world and it is not clear why it should be supported by the citizens of the originating country. The social argument for R&D support in this case depends on externalities in education and training and on the development of a 'knowledge -from-abroad-absorbing system which as a social

good may not be provided adequately by the private market' (Griliches, 1995, p. 83).

For a small region such as Northern Ireland as well as a small country such as Ireland with a high proportion of foreign-owned businesses, the force of Griliches' argument is increased, particularly in situations where even the private benefits of the R&D being supported may accrue to company shareholders or owners located externally. In general, Ireland has been more active in establishing policy initiatives to maximise the social benefit from knowledge generation. These have included the forming of a Technology Transfer and Partnership Programme in 1994¹⁸ and the National Linkages Programme in 1985.

Finally, despite an increased emphasis on innovation policy in recent years in both Ireland and Northern Ireland, and an increase in the amount of grant support directed towards business level R&D throughout the 1990s in Ireland, levels of R&D investment, while increasing, still lag behind both EU and OECD averages. If this position is to improve and the Barcelona target reached then some important issues must be addressed (and indeed are in more recent policy documents) in Ireland and Northern Ireland.

For Ireland, a key challenge is not only in encouraging foreign owned multinational enterprises (MNE's) to increase their investment in R&D undertaken in Ireland, but to ensure that the social benefits arising from this are maximised. This could be through greater partnerships and collaboration between universities and the MNE's as well as through vertical supply links with local suppliers. This will develop R&D capability in indigenous firms and increase the propensity of them subsequently undertaking R&D.

For both Ireland and Northern Ireland, a continued focus on encouraging non-R&D active firms to invest in R&D is to be encouraged. This aim will only be achieved however where a holistic approach to business support and development is adopted in

¹⁸ The primary objective of TT&P programme was to facilitate agreements with indigenous companies capable of offering complementary assets to other partners, in Ireland and further afield in Europe (Cogan and McDevitt, 2003)

building R&D capability alongside the provision of R&D support. In Northern Ireland, concerted efforts must be made to reduce the very high concentration of grant support among a small number of firms. In achieving this aim current levels of near market grant support for R&D could be reviewed, given that current levels have changed little from the early 1990s, as opposed to a substantial increase in Ireland.

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Northern Ireland: Near Market R&D Support Measures, NI and Ireland

Northern Ireland

The **Product and Process Development Scheme**, first introduced in 1977, provided grant support for innovative (near market) product and process development. The programme was administered first by the Ministry of Commerce then by IDB before being transferred to IRTU. PPD was replaced by Compete in 1994.

Compete was introduced in 1994 following a review of PPD in 1993. Like the PPD Compete supported innovative, near-market product and process development through the provision of grant support. The Compete scheme did, however, introduce a number of new features: (a) a two phase structure with an initial small-scale project definition phase for which up to 50 per cent grant was available; (b) a 'green' bonus (i.e. a 5 per cent addition to the grant rate) for projects which are judged beneficial to the environment; (c) a maximum of three Compete projects per company at any one time. From 1992/92 to 2000/01 total grant offers through Compete Phase 1 were £6.7m, an average of £10-12,000 (Table 2). Over the same period Compete Phase 2 offers totalled £36.1m, an average in 2000/01 of £108.0

Northern Ireland: Pre-Competitive R&D Support Measures, NI and Ireland

Northern Ireland

The **Science & Technology Programme** (STP) was introduced in 1989 to support pre-competitive research either by companies alone or through collaborative projects between the universities and industry. STP was reviewed in 1995 and the result was a change of name to **START** with 'aims to support pre-competitive research and development in Northern Ireland'. The objectives of the scheme were also broadened following the review to allow support to be offered to areas which represent 'longer-term priorities that are likely to emerge from the outputs of the Technology Foresight exercise' (IRTU, 1996, p. 24). Total grant offers made through STP and START from 1992/92 to 2000/01 were £45.3m (Table 1).

The **Technology Development Programme** was introduced in October 1994 to replace the EU STRIDE programme to support regional R&D infrastructure and promote pre-competitive and collaborative R&D. Funded partly through the ERDF, TDP aims to support self-sustaining research infrastructure to improve the competitiveness of NI manufacturing. STRIDE (Science and Technology for Regional Innovation and Development) itself began in 1992 funding (a) R&D infrastructure projects e.g. the Engineering Composites Research Centre at the University of Ulster, the Kevlar development line at Du Pont and a research and technology centre at Bombardier-Shorts and (b) a networking programme. Total TDP grant offers over the 1992/92 to 2000/01 period were £21.1m.

Northern Ireland: Technology Use Measures

These schemes consist of a range of subsidised consultancy services designed to allow firms to audit their use of technology and environmental management and implement appropriate development plans. The **Technology Audit Scheme**, for example, was launched in August

1993 and aims to increase competitiveness by accelerating the uptake of technology relevant to the company's needs. Initially, the scheme offered 66 per cent support for eligible consultancy (up to a max of 14 days) to eligible firms. Total offers made through the Technology Audit Scheme from 1992/92 to 2000/01 were £428,600 (Table 1) representing an average grant offer of £3-4,000 (Table 2)

The **Environmental Audit Scheme** follows a similar pattern to the Technology Audit Scheme and from 1996-1999 was complemented by the Environmental Management Support Scheme. This provided grant support for up to 30 days of consultancy for the development, implementation and certification of an environmental management plan up to a limit of £15k. The aim of the scheme was to help companies work towards BS7750 or the EU's Eco-management and Audit Scheme. Total offers through the Environmental Audit and Management Support Scheme totalled £3.7m, with grant offers averaging 3-5,000 for the Audit scheme and 7-12,000 for the Management Support scheme (Table 2).

In 1999, the Technology Audit Scheme was renamed the **Innovation Audit Programme** with the aim of 'assisting small and medium sized companies to improve their use of technology, enhance their design capability and improve their product development process' (IRTU, 2000, p. 21). In 1999, IAP offered support of 50 per cent to small and medium sized manufacturing businesses to employ a consultant to conduct an audit including a review of current status, the development of an innovation plan and help with implementation. Spending on the Innovation Audit Scheme has averaged around £25-30,000 since its introduction (Table 1).

Northern Ireland: Other R&D and Innovation Support Measures

The **SMART (Small Firms Merit Award for Research Technology)** award scheme operates throughout the UK and provides financial support to individuals and small companies to develop innovative ideas on a competitive basis. Initial awards of around £50k help companies to carry out technical and/or commercial feasibility studies with a further c.£100k available to help develop to pre-production prototype stage. Total SMART grant offers made in Northern Ireland from 1992/92 to 2000/01 amounted to £3.2m.

The **Networking Programme** was launched in October 1994 and continued the networking strand of the EU STRIDE programme. The scheme provides small grants to assist with travel and network development as part of product development activities and in support of EU collaborative programmes. Awards as part of the Networking Programme are typically small (i.e. less than £3,000) and no consistent information is published on individual grant awards.

Teaching Company Scheme (or TCS) is a well-established UK-wide scheme supporting technology transfer and university-industry collaboration through graduate placements. On average, around 20 new projects are initiated in Northern Ireland each year. In addition IRTU have managed a number of schemes in Northern Ireland on behalf of IFI. The IFI Science & Technology Programme, for example, supported technologically innovative proposals either project specific or infrastructural. Reshaped in 1995 as Technological Innovation Centres Scheme (TICS) programme, this aimed to create centres to allow research capabilities of Irish universities to be used for benefit of Irish industry. Total spending on STP/TICs from 1992/92 to 2000/01 was £8.1m (Table 1). Other IFI support programmes have sought to encourage collaboration between NI firm and those elsewhere. RADIUS (Research and Development between Ireland and the US), for example, was modelled on the BIRD programme and was introduced in 1996-97. The scheme was renamed RADIAN (Research and Development between Ireland and North America) in 1998 and the geographical coverage was extended to include Canada. The geographical coverage of the scheme was again extended in 2000/01 to include partners in the EU (outside the UK and Ireland) and renamed RADIANE (Research

and Development between Ireland and North. Total spending on these measures was £4.0m from 1992/92 to 2000/01.

Ireland: Near Market R&D Support Measures

The **R&D Capability Grant Scheme** aims to help companies establish or expand their Irish R&D function. IDA contributes to the capital costs of establishing an R&D unit (e.g. buildings, equipment, etc.) in addition to the current costs of running the unit for a defined period. The development must present a clear and substantial step change in R&D in Ireland. [Include types of costs??]

Research Technology and Innovation (RTI), aims to bring about a substantial increase in the level of high quality R&D in businesses in Ireland. It supports commercially focused, industry led projects in product and process development.

Technology Transfer Scheme is the external acquisition of technology, rather than the more common internal development of technology through R&D. The usual methods of technology transfer are: Licence agreements; joint ventures; and, technical cooperation.

Measure 1, Measure 6: The Industry and Development Initiative – Measure 1 is part of the Science and Technology Sub Programme of the Operational Programme for Industry 1994-1999. The new initiative is called Measure 1. This replaces the old Measure 6 Initiative, which operated on a pilot basis during 1992 and 1993, and was administered by Deloitte & Touche. Funding in excess of £100 million is available for Measure 1 during the period of the Operational Programme. The scheme was in place during the period of 1994-1999; however, the payments continue after 1999.