HEA

Higher Education Authority
An tÚdarás um Ard-Oideachas

THE PROGRAMME FOR RESEARCH IN THIRD LEVEL INSTITUTIONS [PRTLI] IMPACT ASSESSMENT - VOL II

REPORT BY THE INTERNATIONAL ASSESSMENT COMMITTEE - SUPPORTING DOCUMENTATION

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FOREWORD

Volume 2 of the PRTLI Impact Assessment Report consolidates the majority of the support documentation to the Main Report (Volume 1) of the PRTLI Impact Assessment. The Independent International Assessment Committee engaged two different consultancies to manage the distinct strands of the Impact Assessment process namely 'Research and Teaching & Learning' (incorporating Bibliometrics) and 'Strategy and Management'.

This Volume brings together the inputs from CIRCA Group Europe Ltd who examined the Research and Teaching & Learning impacts of PRTLI, and Indecon Economic Consultants who examined the 'Strategy and Management' impacts of PRTLI. In addition, this volume incorporates Indicators and Metrics compiled from the six-monthly reports from Third Level Institutions to the HEA, and material collected by the consultants.

Further ancillary documentation is located on the dedicated web pages of the HEA website *www.hea.ie*

ABBREVIATIONS & ACRONYMS

AIT	Athlone Institute of Technology
BCRI	Boole Centre for Research in Informatics (UCC)
BSI	BioSciences Institute (UCC)
BSN	Biopharmaceutical Sciences Network (RCSI)
CAO	Central Applications Office
CI	Citation Index
CISC	Centre for Innovation & Structural Change (NUIG)
CISS	Centre for Irish Scottish Studies (TCD)
CIT	Cork Institute of Technology
CMNES	Centre for Mediterranean and Near East Studies (TCD)
COFORD	National Council for Forest Research and Development
CPP/FCSm	Number of Citations Per Publication/mean Field Citation Score
CSCB	Centre for Synthesis & Chemical Biology (UCD)
CSET	Centre for Science, Engineering and Technology (SFI Programme)
CSHSHC	Centre for the Study of Human Settlement and Historical Change (NUIG)
CWTS	Centre for Science and Technology Studies, Leiden University
DCU	Dublin City University
DES	Department of Education and Science
DG Research	Directorate-General Research
DIAS	Dublin Institute of Advanced Studies
DIT	Dublin Institute of Technology
DMMC	Dublin Molecular Medicine Centre
ECI	Environmental Change Institute (NUIG)
EI	Enterprise Ireland
ERI	Environmental Research Institute (UCC)
ERTDI	Environment Research, Technological Development & Innovation measure
EPA	Environmental Protection Agency
EPO	European Patent Office
ESRI	Economic & Social Research Institute
EU	European Union
EU FP	European Union Framework Programme
FP6	Sixth EU Framework Programme
F & HP	Food and Health Programme (UCC)
FOCAS	Facility for Optical Characterization and Spectroscopy (DIT)
FIRM	Food Institutional Research Measure
FTE	Full-Time Equivalent
GIS	Geographic Information System
GMIT	Galway Mayo Institute of Technology
HE	Higher Education
HEA	Higher Education Authority

HEAnet	Provider of broadband internet services to Irelands third level institutions
HERD	Higher Education Expenditure on Research and Development
HII	Humanities Institute of Ireland (UCD)
HRB	Health Research Board
H&SS	Humanities and Social Sciences
IAMS	Institute for Advanced Materials Science(TCD)
IBEC	Irish Business and Employers Federation
IBIA	Irish Bio Industry Association
IBS	Institute for Biopharmaceutical Sciences (RCSI)
ICT	Information and Communication Technology
ICSTI	Irish Council for Science Technology & Innovation
IDA	Industrial Development Authority
IITAC	Institute for Information Technology & Advanced Computational Research (TCD)
IIIS	Institute for International Integration Studies (TCD)
IIM	Institute of Immunology (NUIM)
IP	Intellectual Property
IPCMF	Irish Pharmaceutical and Chemical Manufacturing Federation
IPR	Intellectual Property Rights
IRCHSS	Irish Research Council for the Humanities & Social Sciences
IRCSET	Irish Research Council for Science Engineering & Technology
ISSC	Institute for the Study of Social Change (UCD)
IT	Institute of Technology or Information Technology
IT Carlow	Institute of Technology, Carlow
IT Sligo	Institute of Technology, Sligo
LIT	Limerick Institute of Technology
Met Eireann	The Irish Meteorological Service
MIC	Mary Immaculate College, Limerick
MIS	Management Information Systems
MRI	Martin Ryan Institute
MSSI	Materials and Surface Science Institute (UL)
M-Zones	Smart Space Management (WIT)
NCAD	National College of Art and Design
NCBES	National Centre for BioMedical Engineering Science (NUIG)
NCC	National Competitiveness Council
NCPST	National Centre for Plasma Science & Technology(DCU)
NCSR	National Centre for Sensors Research (DCU)
NDP	National Development Plan
NICB	National Institute for Cellular Biotechnology (DCU)
NIH	National Institutes of Health (USA)

NIRSA	National Institute for Regional and Spatial Analysis (NUIM)
NMRC	National Microelectronics Research Centre (UCC)
NNF	National Nanofabrication Facility (UCC)
NUI	National University of Ireland
NUIG	National University of Ireland, Galway
NUIM	National University of Ireland, Maynooth
OECD	Organisation for Economic Co-operation and Development
PD	Post doctoral fellow
PG	Post graduate student
Ph.D.	Doctor of Philosophy
PHG	Programme for Human Genomics (RCSI)
PI	Principal Investigator
PRTLI	Programme for Research in Third Level Institutions
RA	Research Assistant
R & D	Research and Development
RCSI	Royal College of Surgeons in Ireland
RINCE	Research Institute for Networks and Communications Engineering (DCU)
RTD	Research and Technical Development
RTDI	Research Technology, Development and Innovation
RTI	Research, Technology and Innovation
SFI	Science Foundation Ireland
SPD	St. Patrick's College, Drumcondra
STRIDE	Forestry Sub-Programme
Teagasc	Irish Agriculture and Food Development Authority
T&L	Teaching and Learning
TCD	Trinity College Dublin
TRIP	Centre for Transportation Research and Innovation
UCC	University College Cork
UG	Undergraduate Student
UCD	University College Dublin
UII	Urban Institute of Ireland (UCD)
UL	University of Limerick
WIT	Waterford Institute of Technology

Countries:
Austria AT, Belgium BE, Czech Republic CZ, Cyprus CY; Denmark DK, Estonia EE, Finland FI, France FR, Germany DE, Greece GR, Hungary HU, Iceland IS, Ireland IE, Italy IT, Japan JP, Latvia LV, Lithuania LT, Luxembourg LU, Malta MT, Netherlands NL, Norway NO, Poland PL, Portugal PT, Slovakia SK, Slovenia SI, Spain ES, Sweden SE, Switzerland CH, Turkey TR, United Kingdom UK, United States of America US.

1 | SUMMARY REPORT ON RESEARCH, TEACHING & LEARNING IMPACTS OF PRTLI (CIRCA GROUP EUROPE LTD)

1.1 Introduction

The HEA appointed Circa Group Europe Limited (CIRCA) to act as research consultants to the Assessment Committee undertaking an assessment of the impacts and progress of the PRTLI over the period since its commencement to March 2004. It should be noted that PRTLI is still in progress. Projects were first funded in late 1999, and both completed and more recently funded projects are included in the assessment.

In broad terms CIRCA was required to cover all aspects of the assessment relating to research and teaching and learning (T&L). Specifically this included managing or undertaking expert peer reviews, bibliometric analysis and site visits in accordance with the more detailed specification laid down in the tender document. The key questions the assessment is expected to address are:

- Has PRTLI helped to enhance the international reputation of the participating institutions?
- Has PRTLI been a catalyst for change in the management, planning and social environment within and between institutions in the research system?
- Has PRTLI helped to improve the quality of curriculum, course provision and instruction at the institution and is it helping to improve the quality of graduate output?
- Has PRTLI encouraged co-operation between researchers by promoting and embedding inter-institutional collaboration between third level institutions in order to counterbalance limitations of scale in individual institutions and to strengthen research outputs?
- Have any commercial opportunities, IP, start-up and technology transfer, investment opportunities or other social, economic or development potentials been created by PRTLI?
- Where does PRTLI fit within national research funding policy going forward?

CIRCA has addressed these questions and has also contributed to monitoring of the programme and the policy review as described in the tender document.

In parallel, Indecon Limited acted as strategy and policy consultants to the Assessment Committee and CIRCA has maintained liaison with them on issues of mutual relevance. CWTS[1] conducted the bibliometric study of research outputs and CIRCA has also maintained a dialogue with them on behalf of the Assessment Committee.

This report describes the methodology used by CIRCA in the study, a synopsis of the results obtained, and our conclusions and recommendations arising from the results. The study involved the four strands of analysis described in the methodology. The full reports on each strand are also available and have been provided independently to the Assessment Committee and/or HEA. The appendices contain summaries of Visiting Experts' Reports (Appendix 4.1), Peer Reviews (Appendix 4.2) and Bibliometric analysis (Appendix 4.3).

1. Centre for Science and Technology Studies, Leiden University (www.cwts.leidenuniv.nl/)

1.2 Methodology

1.2.1 Site Visits

A total of 61 programmes in 23 institutions have been allocated funding under PRTLI. These programmes are involved in a wide range of research topics in Science, Medicine, Humanities and Social Science (H&SS). Nineteen of these sites were selected for visits by expert teams. The sites were selected so as to include all of the major funded institutions, and to also represent a broad range of disciplines. The 9 international visiting teams, totalling 25 people, were usually composed of three international experts selected by the Assessment Committee, and the visits were made between October and early December 2003. Each team was designed to include two specialists in the research area of the centre and one expert in T&L. Their names and affiliations are given in Volume I.

CIRCA accompanied each team on their visits to the centres. In advance of each visit CIRCA briefed each team on the overall educational and research funding systems in Ireland, on the institution and centre to be visited, and on the goals and proposed procedure for the visits. Briefing material was also provided to the teams by the HEA (i.e. extracts from centre proposals, and summary reports as submitted by the institutions). HEA also organised the logistics of the visits. A format of 11 questions was designed by CIRCA and agreed with the Assessment Committee to guide discussions during the visits. Visits took half a day, excluding travel time. Records of each visit were written up by CIRCA and agreed with every team member before they were submitted en bloc to the Assessment Committee. A synopsis of the major points arising during the visits was also submitted. A list of all those interviewed, including people not in the centres, is found in Volume I and the synthesis report is in Appendix 4.1.

1.2.2 Bibliometrics

For the bibliometric process, it was necessary to identify a sample group of researchers and to assess their publication output before and during the PRTLI funding. Drawing on the six-monthly reports submitted by Centre Directors to the HEA, a list of 493 researchers was compiled. This cohort included all of the researchers associated with PRTLI, including funded postdoctoral researchers, during the period from 2000 to late 2002. Postgraduate students were not included.

It was originally intended to conduct the analysis on all 493. However, budget and other reasons required that it be restricted to approximately 200 researchers. After discussion with the centre directors, it was agreed that this group be randomly selected by CWTS (who conducted the bibliometric analysis) rather than nominated by the Centre Directors. The randomly selected names were then sent to the Centre Directors for verification, and to establish any aliases or alternative name-forms used.

CWTS then identified, from their database[2], the refereed papers published by the remaining validated researchers. These publication details were placed on a password-accessible website and researchers were

2. The CWTS ISI CD-Rom based Citation Index (CI) publication database contains papers published in the period September 1992 to September 2002

contacted and asked to verify that the list was valid and complete. The software on the website allowed individual researchers to add or delete papers from the list attributed to them. Approximately 20% of researchers did not comply with this request and their papers were validated to the best ability of CIRCA and HEA staff. Some of the issues that arose, particularly in relation to exclusion of certain papers, are described in the CWTS report.

Following the latter two processes, 193 researchers remained on the list and their papers were the basis of the final bibliometric analysis. An overview is in Appendix 4.3 and the full CWTS report is available at www.hea.ie

1.2.3 Peer Review

Bibliometrics has recognised shortcomings in measurement of the output of certain fields of work, including Social Sciences and particularly Humanities. To complement the bibliometric study, each of the directors of 18 centres which had been visited (excluding the Ussher Library), and also directors of H&SS programmes, was invited to submit approximately ten publications to represent the work of the centre. These were not restricted to refereed papers and included non-refereed papers, books, reviews and conference proceedings, none of which would be captured in a bibliometric study. Table 3.10 shows the importance of such publications in H&SS.

Peer review is an in-depth objective assessment of the assumptions, calculations, extrapolations, interpretations, methodology, acceptance criteria, and conclusions in a body of work.

International peer reviewers selected for the PRTLI impact assessment were qualified individuals, independent of those being evaluated, but at least equivalent in expertise to those who performed the original work. Individual reviewers were selected on the basis that they demonstrated relevant experience in the subject to be reviewed, that they are recognised in their field, that they possess the knowledge of the state of the art of an aspect of the subject matter under review, including national and international perspectives on the issue. In addition, it was ensured that there was an absence of real or perceived conflict of interest and bias. In assessing an individual's qualifications for participation in the peer review process, all relevant career experience, published papers, and participation in professional societies and conferences were considered.

The HEA contacted international peers, following approval by the Assessment Committee in each area of research with a request to review the publications submitted. They provided the peers with an information note on each centre (material based on 6-monthly reports as provided to site visitors) and a template for their comments, designed by CIRCA in consultation with the Assessment Committee. The names and affiliations of the peers are given in Volume I. On average, programmes received three reviews, ranging from a minimum of two to a maximum of five.

The reviews have been analysed by CIRCA and the outcome is discussed in various sections below. An overview of the reviews is in Appendix 4.2.

1.2.4 Input and Output Indicators

Every institution having a programme funded by PRTLI submits a bi-annual report to the HEA. This covers current and capital expenditure, staff numbers, research outputs and curriculum developments. In addition, a quarterly report on capital expenditure is submitted. The data in these reports has been collated for this assessment and has been supplemented by CIRCA by interviewing centre directors and the other funding agencies in order to include information on other sources of research funding in all programmes (excluding the Ussher Library).

Facilities funded by PRTLI are intended both by the HEA and the institutions to be used by as many researchers as possible whether or not they are supported by PRTLI. CIRCA therefore also ascertained the numbers of non-PRTLI-funded Postgraduates using PRTLI facilities. This gives an indication of the multiplier effect of PRTLI on T&L. PRTLI-funded researchers and students are of course listed in the bi-annual reports.

A synopsis of the indicator data is outlined in Chapter 3.

1.3 Results and Discussion

1.3.1 Introduction

The overall study necessarily involved several separate strands of assessment, each of which addressed a specific aspect of PRTLI impact. These strands include the site visits, the bibliometric study, peer reviews and the factual indicators collected by the HEA (through 6-monthly reports) and by CIRCA. In this section we draw together these separate elements so as to provide an overall synthesis of findings. The areas of PRTLI impact which are considered in this process are:

- Quality and Outputs of Research
- Outputs of Teaching and Learning
- Organisation and Management
- Facilities and Equipment

A final overview of the impacts is also provided in Chapter 3. To support the above sections, a more detailed synopsis of the site visits, the bibliometric study, peer reviews and factual indicators are included as appendices.

1.3.2 Quality and Outputs of Research

This section looks at the impacts of PRTLI on research activity in terms of quality, which is the more important metric, and also on the rate and nature of output of PRTLI researchers.

1.3.2.1 Quality of Research

The impact of PRTLI on the quality of the research output can be judged on a centre basis from the (a) international peer reviews (which are summarised in Appendix 4.2), (b) the bibliometric analysis (which is summarised in Appendix 4.3), and (c) from the views expressed by some centre visit teams (Appendix 4.1).

The **peer reviews** were generally favourable, scoring an overall average of 2.65 of a possible 3.0, with science and medicine scoring an average of 2.8 and H&SS 2.5 for question 3 (*Is the research described and its presentation of international quality?*). A sample of answers to this question ranging from very favourable to less enthusiastic is given here:

- *A superb piece of scholarship, which will be the standard book on this topic for decades*
- *The research is very clearly of international quality in both content and presentation. It builds on existing scholarship in a meticulous way and presents new interpretations lucidly and persuasively*
- *The papers are of very high quality and were published in leading international journals. They couple fundamental and applied research ("using basic science for solving real-life problems") and indicate a high degree of innovation*
- *All of the research contained and analysed in the three works I have reviewed are of international quality*
- *Some of the research described in the papers presented is published in high-ranking international journals. The unpublished manuscripts are also of international highly qualified scientific content*
- *This research group is well accepted on both sides of the Atlantic*
- *The papers are all published in relevant recognised journals, are of high quality and likely to have significant impact worldwide*
- *The work is of international quality. The journals where the papers are published are testimony about the international nature of the work*
- *The research as presented in 9 papers submitted to me contains interesting topics. But there are two weaknesses: the package is rather heterogeneous and the individual contributions are rather descriptive*
- *Broadly of international quality*
- *Very diverse, partly because of the diverse aims of the institute*

- *Some of the research is of international quality. 50% of the output has an impact factor <3.0. Not a very high standard*

- *All of the papers are in reputable journals and the presentation reflects this. However, those which seem to be of the highest quality ("seem" because not all of the subject matter is close to my expertise) correlate closely with those which, arguably, are least relevant to the objectives of the centre*

- *The research contained within the representative publications ranges from true international quality down to sub-national.*

The **bibliometric analysis** provides a further measure of the quality of publications by 193 PRTLI-funded researchers. The distribution of researchers by field and its nature is shown in Table 1.1 and Table 1.2 respectively. However, it must be noted that bibliometric analysis is an imperfect mechanism in this study. This is because the bibliometric analysis of the 'during-PRTLI' impact only included papers published (and cited) within a very narrow window, i.e. between the start of 2000 until approximately September 2002. For citation analysis a longer period is required to fully assess impact.

Table 1.1: Breakdown of Publication Outputs of the 193 sample researchers by field

Field	Number of Researchers	Number of CI Publications	Number of Publications /Researcher
Biosciences/Biomedicine	73	1560	21
Chemical & Physical Sciences	35	1011	29
Environment	42	424	10
ICT	13	174	13
Humanities	16	12	1
Social Sciences	14	92	7

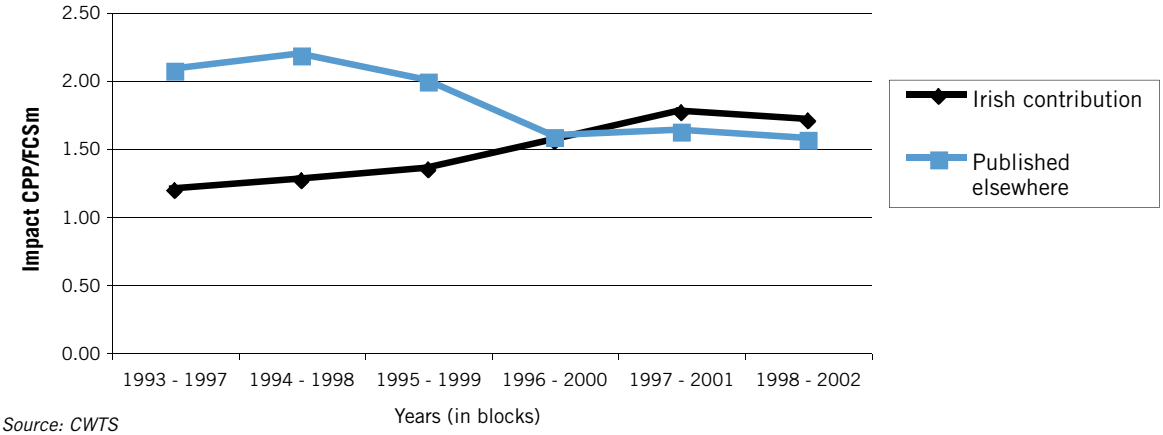
Source: CIRCA analysis of data submitted in 6-monthly reports to HEA by PRTLI-funded institutions.

Nevertheless there are several specific findings from this aspect of the study:

- The impact of publications by PRTLI researchers in all fields increases over the period and the impact in all fields is in the category of 'high to very high'.

- The quality of the researchers attracted to work in PRTLI centres is demonstrated by the high-impact papers they published in the period before coming to Ireland (see Figure 1.1).

Figure 1.1: Impact of Irish and non-Irish contributions to the publication output of PRTLI-funded researchers, 1993-2002.

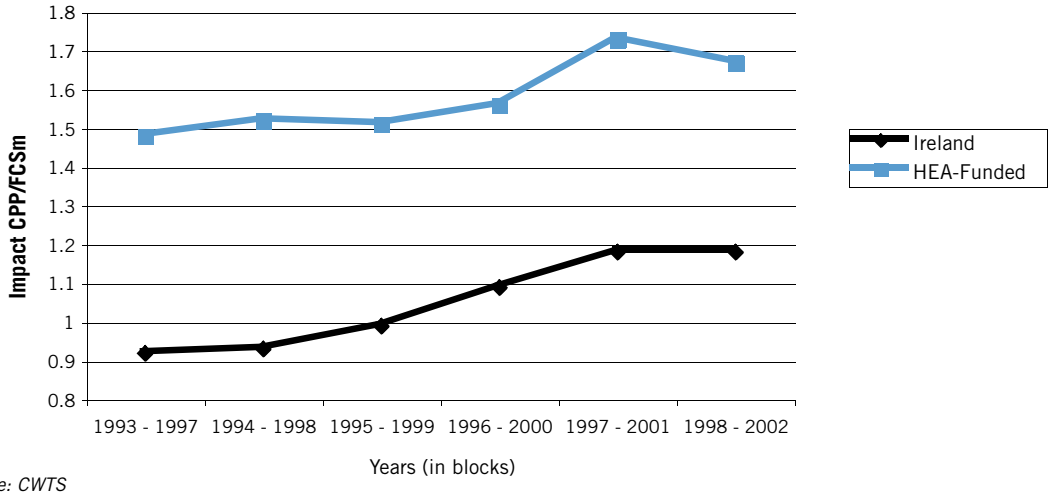


Source: CWTS

- The impact of the papers published by PRTLI funded researchers is significantly higher than the overall Irish rate (see Figure 1.2)

- There is a clearly different pattern of publication impact within each of the areas. In the ICT field there is a very dramatic increase in citation rate, and in impact, beginning in approximately 2000. In this field the impact is 50% above world average from 2000 onwards.

Figure 1.2: Comparing the impact of Ireland and HEA-funded research, 1993-2002.



Source: CWTS

- In comparative terms Irish output between 1993 and 2002 is very low compared to that of researchers in Austria, Denmark, and Finland. The rate of increase in publication output in these countries is also somewhat higher than the Irish output. However, the other three countries show a 'slowing down' in 2001 and 2002, while the Irish output continues to increase in these years, which are the years in which PRTLI would have had its major effect.

- The impact of Irish publications shows a strong increase between 1993 and 2002 in comparison with Austria, Denmark, and Finland. Ireland starts the period (1993) with the lowest impact score and ends with the highest score in 2002.

- Apart from the ICT field, there is no indication from the bibliometric analysis of any reduced interest in international collaboration.

In summary, the publications of the PRTLI researchers are impressive in terms of their impact in their respective fields. Although Irish publication output is still low in comparison with other comparable EU countries, it is increasing steadily. Given that it is still too early to assess the full effects of PRTLI funding (for reasons noted in Appendix 4.3), the general trends in output and impact are considered impressive by the CWTS experts. Direct comparison with the peer review process is not possible, because the process used does not allow comparison on a centre level.

A further comment on the perceived quality of the research comes indirectly from the comments of students who chose to seek a Postgraduate qualification;

I left a well-paid job in industry to come back to university to do a Ph.D. It cost me a drop in salary, but it will be worth it.

They pay me €12,000 a year as a Ph.D. student when I would be getting €25,000 as a fresh graduate in industry. I won't be buying any clothes for three years. But it is worth it to be here.

Three undergraduates said they applied to the CAO to go to Sligo IT because of an interest in the environmental sciences. They gave no other choices to the CAO.

1.3.2.2 *Outputs of Research*

Outputs of research can be measured in many ways. The most usual metrics are published papers, presentations and patents. Other peripheral measures of research activity include grant awards and collaborations.

One of the benefits of PRTLI, which was consistently noted by researchers during site visits, was the enhancement of their ability to do research. Researchers regularly noted the major advantages to the work environment as a result of the building and its facilities, the availability of increased numbers of Postdoctoral Fellows and the easy and regular access to research colleagues from other disciplines.

The building means the world to me

A research leader in the Institute of Molecular Medicine spoke about the effect of the new facilities on his research. It has allowed him to conduct clinical/scientific collaboration in the same way as he did at NIH in the past. The above quotation reflects his view of the importance of the new facility.

Publications

Researchers were themselves consistently of the view that their output of publications and of conference presentations had increased. The bibliometric analysis (see Appendix 4.3) does show an increase in peer-reviewed papers, but it is not as dramatic as the visit interviews might have suggested. Nevertheless, as is also explained in Appendix 4.3, bibliometric analysis may be premature for assessment of the PRTLI programme. The total output of publications (peer reviewed and otherwise) is shown in Table 1.1 and Table 1.2.

Table 1.2: Research communications by PRTLI researchers mid-1999-2003

	Journals	Books	'Grey Literature'	Conference Proceedings*
Biosciences/Biomedicine	2,363	98	8	254
Chemical & Physical Sciences	1,326	53	1	263
Environment	235	54	25	117
ICT	136	20	26	266
Humanities	111	167	6	13
Social Sciences	428	231	217	115
Total	**4,599**	**623**	**283**	**1,028**

Source: Circa analysis of data submitted in 6-monthly reports to HEA by PRTLI-funded institutions.
**PRTLI researchers have made approximately 2,149 conference presentations.*

PRTLI researchers produced almost 4,600 papers since the start of PRTLI and have also made 2,149 conference presentations, of which 1,028 have been published. It is not possible to calculate this in terms of outputs per researcher because of the constantly increasing numbers of researchers involved in this effort.

The bibliometric analysis predominantly deals with peer-reviewed publications, which are mainly contained in the journal column above. However, other fields such as Humanities and Social Sciences are not covered adequately by bibliometric analysis (see Appendix 4.3). From Table 1.2 it can be derived that over 80% of the output of Biosciences/Biomedicine and Chemical & Physical Sciences is in the form of Journal publications. However, almost 60% of the H & SS output is through conference presentations. These are less amenable to bibliometric assessment. Similarly the major form of output for the humanities is in books (56%).

As might be expected, Social Sciences is the most versatile field in form of output. Most significantly, 22% of Social Sciences output is in the form of 'Grey Literature', much of which is policy material provided to relevant users.

Hosting of Conferences

In addition to contributing to the literature, PRTLI research centres also hosted 239 conferences (see Table 1.3). Centres in all fields were active in such hosting. However, if measured in terms of numbers of conferences per principal investigator, Humanities were the most active conference hosts with 1.15 conferences per PI.

Despite the apparent importance of conference presentations as a means of research communication, the ICT centres were the least active in this area, with only 0.1 conferences per PI. Clearly these are very general comparisons that take no account of the scale or quality of the conferences involved. They are intended only to give a general impression of the scale of activity.

Table 1.3: Conferences hosted by field of PRTLI activity

Field	Number	%	Conferences per PI
Biosciences/Biomedicine	61	25.5	0.25
Chemical & Physical Sciences	45	18.8	0.30
Environment	26	10.9	0.20
ICT	8	3.3	0.10
Humanities	46	19.2	1.15
Social Sciences	53	22.2	0.52
Total	**239**	**100**	**0.32**

Source: Circa analysis of data submitted in 6-monthly reports to HEA by PRTLI-funded institutions.

Patents and other IP

PRTLI-funded research has only been in progress since the end of 1998 and it is therefore too early to expect granted patents from the research conducted. The period from submission of a patent application to its granting (if accepted) would normally be 5-7 years. However, there have been 60 patent applications to end 2003. These have almost all arisen from work in Biosciences/Biomedicine (38) and Chemical and Physical Sciences (19).

Several centres report increased patent preparation activity within the last year, some by as much as 100%. The ability of the overall research community to create new IP will also be a source of new industry. Several centres reported that their enhanced facilities and expertise had already attracted additional involvement from industry. Some examples of involvement of PRTLI centres with Irish companies are presented in Appendix 4.4.

Software IP is not usually patented and the production of novel material in this area is less easy to estimate. Indications from site visits would suggest that there is also an increased production of commercial software from PRTLI programmes.

Grant Awards

One of the effects of PRTLI has been to enhance the ability of the centres to compete for funding. Availability of required equipment or expertise, or simply the availability of manpower to conduct the research are practical reasons why this is so.

In competing for international funding, the combined effects of buildings and facilities, increased publication rates etc are further factors providing advantage to PRTLI researchers. Several centres noted that the PRTLI funding had given them the confidence and credibility to compete with the major centres in their field in Europe. The combined effect of all of these factors is that PRTLI researchers won contracts totalling over €270m in the period 1999-2002 from SFI, EU, EI and other sources. It is telling that several of the CSETs recently awarded by SFI, which are partly funded by industry, are located in buildings funded by PRTLI.

1.3.3 Outputs of Teaching and Learning

Research funding provided by PRTLI has had direct effects on third level T&L and education in many different ways. These effects are inter-linked and mutually synergistic and are only fully appreciated by experiencing the enthusiasm of the students at most of the PRTLI centres.

The visiting experts were very positive about the interaction between T&L and research, and found that the HEA insistence on a strong linkage between research and T&L was an advantage of the PRTLI. This is in marked contrast to other funding schemes where research workers are encouraged not to teach by allowing them to buy time out. The major benefits and issues arising were:

The greater numbers of Postdoctoral Fellows and the increased involvement of a greater range of faculty in R&D have enhanced the breadth of expertise available to both Undergraduates and Postgraduates. In some centres the building design has significantly contributed to developing this interaction. In a minority of centres the building design has been an obstacle.

PRTLI has approved funding for 14 professors and 20 lecturers who will be available to contribute to Undergraduate and Postgraduate education

Increased contact between Undergraduates, Postgraduates and Postdoctoral Fellows was a frequently mentioned benefit both in educational terms, and also in encouraging participation in higher degrees. The contacts developed with Undergraduates conducting 4th year theses seem to be particularly effective in this regard.

Development of new interdisciplinary and other courses and modules has benefited both Undergraduate and Postgraduate training. In some cases these have been inter-institutional between colleges in Ireland and elsewhere, with very positive effects.

Research seminars are important mechanisms for communicating R&D developments and other new information to students at all levels. While such seminars are a feature of most centres, efforts to promote these events to Undergraduates (and on occasion to Postgraduates) could be improved.

Many centres are significant national resources and could be made more available for school visits etc. so as to enthuse future science students. In this context it was noted that several institutions have active education departments which could be appropriately used as collaborators in developing such outreach activities.

As noted elsewhere, there are opportunities to develop joint seminars and learning modules for new Ph.D.s. and to address common weaknesses such as lack of IT skills, statistics knowledge, awareness of IP issues and library research techniques.

Research funding provided by the PRTLI has had a direct impact on third level T&L and education in a number of ways:

- The state of the art equipment and facilities defined in Section 1.3.5 below are also used for Postgraduate and Undergraduate projects. The Postgraduate and Undergraduate students interviewed during centre visits highlighted this as a significant advantage of the learning environment within PRTLI centres.

- The physical presence of new buildings and equipment, and the general atmosphere of research activity, impresses and attracts students onto new courses run by the centres

- Support is available for much increased numbers of Postgraduate students. The numbers are outlined in Table 1.5 and 1.8 below. The facilities and equipment now available has been a factor in attracting foreign students to Ireland for their Postgraduate education. Of the 969 Postgraduates funded by PRTLI to date, 20% are non-nationals. This international dimension is consistent with the best traditions in learning and is beneficial both to the student and to the institution in broadening horizons and establishing contacts.

- New modules and courses are being developed and there is an active effort to use current research results within these courses, especially at M.Sc. level, thereby kindling students' interests in the subjects

- Undergraduates carry out fourth year projects as part of a team with Postgraduates and Postdoctoral Fellows. This provides the students with an environment where expertise and equipment is accessible, and gives them confidence to continue to a Postgraduate degree. It also acts as an informal conduit for career guidance. Undergraduates in many centres are required, or at least encouraged, to give research seminars, and in some cases are tutored in presentation skills

- Most centres provide internships or placements for Undergraduates during holidays, giving them real experience of the application of Science and Technology and putting T&L into perspective.

Easier access to more experts for students

Many of the Undergraduate and Postgraduate students were very positive about the impact of PRTLI on increasing access to expertise. There are now more experts in more disciplines available to them and they are available within the building in which the students are also housed.

- Some centres provide modules on aspects of research practice for staff and students. One university, DCU, has a B.Sc. course in Science and Teaching.

- Promotion for staff in some centres depends on excellence in T&L as well as in research, encouraging a synergy between the two. For example, one university, Maynooth, has a Strategic Plan for T&L and a Charter for T&L. Students' opinions on the quality and delivery of courses is formally sought at the end of the course in some institutions and in at least one interviews are held with students who decide not to complete their course.

- The range of expertise in a centre is typically wider than in a traditional department and this is available to students thanks to the open and enthusiastic ethos, which pervades most of the centres. Relations between students and staff in most centres are very open and friendly. This is linked to increasingly inter-disciplinary research projects.

- PRTLI has catalysed more inter-institutional collaboration in Ireland and abroad. A number of centres share equipment for research and teaching purposes. One centre in NUIG teaches a degree course jointly with UCC and the universities of Helsinki and Nijmegen. The improved facilities now available have led to more scholarship exchanges such as Marie Curie Fellowships and exchanges under the Leonardo Programme.

A dramatic shift

Research leaders in MSSI noted the dramatic shift that had occurred from teaching to research as a result of PRTLI. The building, which '*I can't praise highly enough*', has made available a wide range of expertise, and has made collaboration far easier. They also noted that the existence of the building has attracted industry visitors and this has facilitated placement of students and other collaborations.

- In addition, some centres are making positive efforts to reach out to first and second level school children so as to stimulate an interest in science. In general, however, the T&L specialist site visitors felt that much more could be done in this area. In addition, it was felt that centres in some colleges could engage more actively with their Departments of Education to develop outreach activities to schools.

New modules and courses are being developed and there is an active effort to use current research results within these courses, especially at M.Sc. level, thereby kindling students' interests in the subjects. Table 1.4 below shows the increases in courses and modules.

Table 1.4: New courses and modules influenced by PRTLI

Discipline	New courses	Major modules	Minor changes to courses
Bioscience/Biomedicine	10	0	24
Chemical and Physical Sciences	5	3	12
Environment	3	2	26
Humanities	0	0	0
ICT	2	1	1
Social Sciences	2	1	2
Total	**22**	**7**	**65**

Source: Circa analysis of data submitted in 6-monthly reports to HEA by PRTLI-funded institutions.

All of these trends to multi-disciplinary, inter-institutional research activities, coupled with the obvious enthusiasm engendered in the centres by PRTLI, have given students a much wider educational environment in which to learn. The face of third level T&L, as well as of research, has been altered hugely in Ireland.

The teamwork involving researchers at all levels is beneficial also to Postgraduates, who now receive more training and supervision due to the increased numbers of Postdoctoral Fellows. Table 1.5 below illustrates this clearly.

Table 1.5: Staff and Students by field and ratio of postgraduates to researchers

	PIs associated with PRTLI	PD	PGs	Total PI+PD+PG	PGs per PI + PD
Biosciences/Biomedicine	245	204	344	793	0.8
Chemical & Physical Sciences	152	70	185	407	0.8
Environment	130	85	207	422	1.0
ICT	82	31	108	221	1.0
Humanities	40	25	38	103	0.6
Social Sciences	102	39	87	228	0.6
Total	**751**	**454**	**969**	**2174**	**0.8**

Source: Circa analysis of data submitted in 6-monthly reports to HEA by PRTLI-funded institutions.
PD:postdoctoral; PG: postgraduate; PI: Principle Investigator

PRTLI-funded centres are available to members of staff and students not working on projects funded by PRTLI. Table 1.6 below lists the approximate numbers of non-PRTLI-funded Postgraduates who are based at the centre and spend significant periods of time working there and who have regular access to PRTLI facilities. This figure of 1,175 compares to the number funded by PRTLI of 969 (Table 1.5) and indicates a multiplier of 121%. The corresponding figures for post doctoral fellows are 454 and at least 214 respectively.

Due to the interdisciplinary nature of most of the research projects and to the much-increased number of researchers and up to date equipment, it has been possible to introduce new courses, new modules and changes to existing curricula. By August 2003, 22 new courses and 7 major modules had been created and minor changes had been made to 65 courses. The statistics on these are summarised in Table 1.4 (numbers of courses) and Table 1.7 (details of courses).

Table 1.6: Non-PRTLI-funded postgraduates who make significant use of PRTLI facilities and/or equipment

Discipline	Postgraduates
Biosciences/Biomedicine	470
Chemical and Physical sciences	386
Environment	37
ICT	200
Humanities	12
Social sciences	70
Total	**1175**

Source: Circa analysis of data submitted by PRTLI-funded institutions

T&L methods have also changed in that Undergraduates in their final year carry out a significant research project, working to a Ph.D. student, who works to a Postdoctoral Fellow. This introduces the student to the research environment at an early stage, and provides access to state of the art equipment and training in its use. Some Undergraduates who worked in industry during their summer holidays remarked that they were already more advanced than the experienced industrial professional staff.

PRTLI has had an impact on Postgraduate T&L in providing better research facilities and increasing the numbers in training.

Table 1.7: Summary of Courses Developed

Diploma	Bachelor Degree	Postgraduate Diploma	Masters Degree
Biotechnology	Toxicology		Polymer Technology
	Pharmaceutical Science		Toxicology
	Digital Media Engineering		Telecommunications Engineering
Cert. in Plasma & Vacuum Studies			Plasma Science & Vacuum Technology
	Industrial Biology & Bio-informatics	Bio-Informatics	Bio-informatics
	Biological Sciences		
	Bio-informatics		Science Education
			Landscape Archaeology Translation Studies
			Pharmaceutical Science
	Physics and Chemistry of Advanced Materials	Polymer Science and Technology	Polymer Science and Technology

Source: Circa analysis of data submitted in 6-monthly reports to HEA by PRTLI-funded institutions.

For students at all levels the centres have provided open access to a range of disciplines, skills and equipment outside their immediate concern, which would not have been so freely available historically. PRTLI has engendered an openness and spirit of co-operation at all levels, which has a very beneficial effect on T&L.

Although PRTLI centres are significant contributors to Undergraduate education, particularly in 4th year, the main impact is on Postgraduate education. Table 1.8 shows that 969 Postgraduates have been funded by PRTLI to date. As of March 2004, 542 of these students (56%) have completed their projects. The students are widely spread across the fields and almost 80% are Irish nationals.

Table 1.8: Total PRTLI-funded Postgraduates by discipline

Biosciences/Biomedicine	344
Chemical & Physical Sciences	185
Environment	207
ICT	108
Humanities	38
Social Sciences	87
Total	**969**

Source: Circa analysis of 6-monthly reports submitted by PRTLI centres.

1.3.4 Organisation and Management

One of the purposes of PRTLI funding was to enhance the management of research, and also to increase the degree of collaboration between and within institutions. One of the key questions for the impact study is "Has PRTLI been a catalyst for change in the management, planning and social environment within and between institutions in the research system?" All key questions relate, to some extent, to the quality of organisation and management that has been developed through PRTLI. This section deals specifically with formal management of the research programme and facilities, and to the way in which collaboration is organised. Management issues have been assessed through (a) site visit reports and (b) indicators. Some insights on collaboration can also be obtained from the bibliometric analysis and the peer review process.

The overall conclusion of the assessment is that PRTLI has established a network of centres which have fundamentally changed the way in which research is conducted.

> *'I would not be here without it'*
> Several researchers in different centres, including 1 centre director, specifically stated that they would be pursuing their research careers abroad if it were not for the work environment and facilities that had been provided by PRTLI. Some have returned to Ireland as a result of the investment, while others would have left.

The major organisational changes brought about by PRTLI are:

(a) An ability to focus significant RTD efforts on a priority area of research. More particularly, the involvement of independent departments (sometimes in different faculties within the Institution) in a common multidisciplinary research effort.

(b) Creation within universities of managed entities with a wide remit in T&L and research.

(c) Formal collaboration between institutions (and in one instance a joint venture), which have gone some way to counterbalance the small operational scale of many Irish institutions compared to their counterparts internationally

(d) The concept of strategic planning of research has been introduced to Irish universities largely as a result of PRTLI. The establishment of research priorities, and the resulting ability of institutions to focus on specific topics, has allowed institutions to focus their RTD and Teaching efforts. Research programmes are now responding more to the aims and strengths of researchers than to predetermined themes and priorities of certain international funding bodies.

(e) Availability of professional management and technical supports for the research process.

(f) Creation of a work environment which facilitates a greatly enhanced level of social and professional interaction among researchers, with all of the innovative benefits which have been shown to result from such situations.

(g) Creation of a learning environment in which Postgraduates and Postdoctoral Fellows have improved access to a wide range of research expertise, and facilities. (This is further dealt with in the section on Teaching and Learning).

'Dublin' as a research collective

An interesting example of the degree to which the collaboration among PRTLI researchers has succeeded is the way in which DMMC researchers spoke about Dublin city as a major international hub for molecular medicine. The interaction between the three Dublin-based institutions (UCD, TCD & RCSI) is very strong when individuals can talk about a collective effort on such a wide level.

The major issues, which have arisen in the assessment in relation to organisation and management, are:

Centre Management: The centre visits suggest that there is a lack of experience of large-scale RTD management in some centres. This is not an unexpected finding, given the historic lack of national RTD funding. There is no doubting the enthusiasm and competence of the majority of the researchers in most of the centres but what is sometimes lacking is experienced leadership. The directors can acquire this, but some of the essential qualities of leadership are lacking in some centre directors and these are the centres where morale is not as high as elsewhere.

It was the view of visiting experts that there were management deficiencies in certain practical matters: e.g. administrative systems; equipment and facility maintenance arrangements, and building layouts. In other centres a lack of future financial planning was apparent. This was of concern to the centre visitors, some of whom noted an apparent naivete of centre managements as to the full costs of running their centres. This was attributed, to some extent, to a lack of experience in the financial management of large facilities. In other centres, however, the centre management has used PRTLI to build their competence so as to compete for RTD funding from public and private sources. Despite relative inexperience, the planning for post-PRTLI growth in these centres was regarded as appropriate and feasible.

To address this issue, it was suggested that HEA, or another appropriate organisation, should facilitate greater liaison between centre managers so as to share best practice or operational information between centres. Training and other supports for centre management are also required to address this issue.

Centre Role within Colleges: The scope for successful management of a centre is related to the perception by the host college of the role of a PRTLI centre. A centre management team must be given power in order to exercise it. In some colleges the centre management (i.e. director and/or advisory panels) have a strong role, while in a very few, the centre is a weak institution which lacks leadership of its research programme, and common ambition among its researchers. In a small number the centre is little more than a space within which the constituent departments perform research.

A related issue is the nature of agreements within the colleges on the apportionment of overheads on earned research income to centres. This issue is central to the financial planning of centres.

Collaboration: While the enhanced extent of inter-disciplinary collaboration is one of the great achievements of PRTLI, in a very small number of centres it is apparent that the intended collaboration has not occurred. Although collaboration cannot be forced, the colleges in receipt of PRTLI funds should take steps to encourage its development.

IP Management: The low level of awareness of patent and IP basics was a concern to several of the visiting teams. This aspect of staff education and support requires attention.

1.3.5 Facilities and Equipment

The major purpose of PRTLI was to build research capacity and capability within the Irish RTD infrastructure. This involves both increasing the numbers of researchers, but also the buildings and facilities in which these researchers can conduct high quality research. This section assesses the programme's success in the latter objective. The analysis is based both on the statistics from the 6-monthy reports and also the site visits. To date, approximately €140m has been spent on capital items including major items of equipment, buildings and facilities. A further €250m has been approved for capital expenditure over the life of the programme.

A total of seventeen large and (usually) architecturally impressive research buildings have been completed around the country. An additional three buildings (FOCAS in DIT, research building in Sligo IT and IITAC in TCD) are still under construction. Therefore the potential impacts of PRTLI on capital investments are far from realised to date and in fact expenditure will continue until 2008, after the end of the NDP. By 2008 PRTLI will have provided 42,000 m2 of new research laboratory space and 55,000 m2 of new non-laboratory research space, including 19,318 m2 of library space.

Filling the bricks and mortar gap

In regard to one of the roles of PRTLI in the Irish RTD system, one researcher was very positive about the complementarity between the different funds now available. He saw PRTLI as designed to fill the 'bricks and mortar' gap in the Irish RTD system. This was an excellent fit with the SFI programme.

PRTLI is widely seen by the research community as being complementary to SFI in that it focuses mainly on capital while SFI focuses mainly on current funding. The reality is that PRTLI is also a significant funder of research personnel. Nevertheless, the buildings and equipment provided by PRTLI were stated by several centre directors to have been pivotal in securing further funding from other sources such as SFI. The PRTLI funding has also helped in winning EU funding and has allowed at least one centre, ECI, to be recognised for providing training under the Marie Curie scheme. This is an important aspect of PRTLI's impact on the RTD system.

Specific benefits of PRTLI funding of facilities and equipment include:

- New laboratory and non-laboratory (offices and general facilities) buildings. In terms of personnel accommodation, these spaces will provide 5,868 workstations.
- PRTLI has also funded specialised facilities such as pre-clinical units and transgenic facilities, grid computing, clean rooms, synoptic meteorological station, tissue culture units, audio-visual facilities and biohazard facilities.
- State of the art library facilities have also been built which provide an additional 1,650 library stations.
- The range of equipment which has been funded is enormous. A list of major[3] items of equipment is given in the report on indicators. This equipment includes many large items, some of which are unique in Ireland, and even rare by European or world standards. Funding has also been provided for software, some of which, such as multiple user GIS, is very expensive. This funding has made significant progress towards bringing the centres up to the best international standard.

Part of the club
The investment in the Nanofabrication facility has been of '*enormous benefit*' to NMRC, according to Prof. Gabriel Crean. Among other things, it has allowed them to become part of a new European ICT Hub composed of 5 European institutions with the equipment and competence to conduct nanoscale fabrication research.

In 1995, CIRCA attempted to carry out an inventory of buildings and significant equipment in the universities, but failed to find reliable data[4]. It is not therefore possible to precisely quantify now what incremental contributions PRTLI has made to buildings, facilities and major items of equipment. Nonetheless, it is undisputed that PRTLI has brought about an enormous change.

However, it must be recognised that the provision of large numbers of smaller pieces of equipment, such as PCs, can make an equally significant impact on research progress. Purchases of capital equipment are not common in the H&SS but library and IT facilities have been provided where appropriate.

When an undergraduate in the FOCAS centre in DIT remarked to the visiting experts that she was being trained using a particular instrument, the comment was made by one of the experts that it is one of only four in the world.

No excuses!
When asked by one of the visiting experts what excuse he had for not being up to international standards, one centre director said *"None, we are as well equipped as any competing group internationally. This centre provides training for staff from international ICT companies".*

3. 'Major' is defined as greater than €50,000 for the purposes of the assessment
4. A comparative assessment of the organisation, management and funding of university research in Ireland and Europe. CIRCA Report for HEA: December 1996

The statistics for the capital spending approved are provided in Table 1.9

Table 1.9: Capital breakdown (€m)

	Building	Equipment	Furniture	Total
Total all cycles	**259**	**135**	**8**	**402**

Source: HEA

These bare statistics do not paint the full picture. While PRTLI is not concerned with embellishing the landscape, the effect of these purpose built research buildings on students and researchers in engendering a sense of belonging and pride cannot be over-estimated. Morale among students and staff in nearly all centres is very high.

These buildings, and some of the facilities, will have a long service life and constitute a significant contribution to the research and teaching infrastructure of the state. Most of the buildings facilitate or even force communication between staff of different departments because of their design, though a few are less impressive in this respect, and a small number were criticised as having a design which hinders communication between occupants

The buildings, equipment and facilities received general approval, and often open admiration, from the visiting experts. In at least two centres the experts made minor but significant technical observations, which the directors have taken on board and implemented. These will considerably expand the scope of the centres at very modest cost.

Some of the PRTLI facilities are also used by industry at a modest cost. There are also advisory groups for some of the centres, including representation from industry. So as to extend the use of some of the major equipment, user groups from other Irish institutions are planned, or implemented, in several centres. The effects of PRTLI funding will therefore go beyond the immediate academic environment of the centres.

1.3.6 Overview and Summary

The survey reported by CIRCA in 1996 of the funding and management of research in Irish universities painted a picture of a system that:

- Received little or no research funding from public agencies
- In consequence relied heavily on outside sources of funding, in particular the EU
- Had to be opportunistic to a large extent in utilising funding designed to achieve the objectives of non-national organisations
- Had little strategic planning of research or teaching and saw only a weak connection between them
- Competed rather than collaborated internally
- Collaborated internationally very well and succeeded in winning significant foreign funding

The advent of the PRTLI in 1998 changed this picture totally. There are two facets to this change: while providing significant funding to institutions to carry out research of their choosing, PRTLI also required the institutions to draw up strategic plans, to develop intra-institutional collaboration and to collaborate with each other. These conditions were not welcomed by everyone at first, but their benefits are now appreciated and these operating practices will continue.

The outputs of the PRTLI have been listed and discussed in this report and there is no denying the success of the PRTLI. In two different ways, the impacts of the PRTLI on research and T&L were investigated: visits to sites by impartial and highly competent experts from overseas and similar peer reviews of publications. While there certainly were some adverse comments, they were far outweighed by the positive comments made by both experts and peers.

Ireland has long had a cohort of competent and dedicated research workers in its universities and to a lesser extent in its ITs. These researchers succeeded in building up reputations despite the dearth of funding. With the provision of PRTLI funding they have begun to realise their potential, both in universities and in the ITs. However, there are some structural weaknesses which will take time to repair:

- Despite their research competence, few have experience of leading and managing large research budgets, for the obvious reason. We make a recommendation in this regard in section 4.
- Traditionally, academic research was carried out for its own sake. There is a growing emphasis on exploiting IP for commercial gain, which could help sustain research centres into the future. This is a matter appreciated by only a few of the researchers interviewed during this study and again we make a recommendation concerning it.
- The position of PRTLI centres vis-à-vis their host institution is not yet fully clear in all cases and details such as sharing of overheads need to be agreed. In some few cases, intra-institutional collaboration is under developed and needs to be reinforced.
- Not many centres have a convincing strategic plan or business plan for their sustained existence if, or when, PRTLI funding ceases. We make recommendations related to this issue in this regard in Section 1.4.

1.4 Conclusions and Recommendations

What overall conclusions can be drawn from the results of the study?

Firstly, there is no doubt that PRTLI has been a major driver of the improvements that have occurred in the Irish RTD system. The extent of these changes is outlined in Section 1.3.6 where we compare the situation now with that in 1996. The contrasts are stark and PRTLI has undoubtedly been the major contributor to improvements in infrastructure and research management, and a very significant contributor to the increase in research activity and quality.

The basis for these conclusions is largely the opinion of peer researchers, and of the academic experts who took part in the study. It would have been satisfying to present clear statistical evidence of the increasing scale and quality of PRTLI publications. However, the short period in which PRTLI researchers have been publishing does not allow an adequate bibliometric analysis. Nevertheless, even this data indicates a significant improvement. Site visits, on the other hand, provide unequivocal evidence of positive changes. To an overwhelming extent, research in PRTLI centres is pursued in well-equipped laboratories by highly qualified researchers who collaborate with other disciplines and institutions with enthusiasm.

The centres are generally well run, appropriately integrated into their parent institutions, and most are well designed for their purpose. There are concerns about management issues, financial viability and the extent of collaboration in some cases. These, however, relate only to a minority of centres.

The learning environment has also been enhanced by the equipment and facilities available, and also by improved and expanded courses. According to the students interviewed, the major improvement in their environment has been their access to high quality expertise. A student in a PRTLI centre is an apprentice researcher surrounded by advisors and practitioners, often from several disciplines. This is in marked contrast to the Postgraduate of the 90's whose research was often pursued using outdated equipment and inadequate resources, and whose collaborators were often across oceans rather than across corridors.

Below we relate these conclusions to the 'key questions that the assessment will be expected to address' (see Introduction).

- **Has PRTLI helped to enhance the international reputation of the participating institutions?**

The PRTLI funding has not only helped to enhance the existing reputation of participating institutions, it has created the opportunity for development of reputation in areas where none existed. It is interesting to note that the 'awareness' of centres among peer reviewers is relatively low (Appendix 4.2) while the rating of the centres is generally high. In other words, centres that were not known to experts are producing high quality work. Development of a reputation takes time, and will follow if the centres continue to produce good quality output.

In addition, the creation of dedicated research space for multidisciplinary activity will allow the development of new areas of research focus which are likely to significantly enhance the reputation of the institutions, and of Ireland in general.

- **Has PRTLI been a catalyst for change in the management, planning and social environment within and between institutions in the research system?**

PRTLI has been a very significant driver of change in HE attitudes to R&D management. Even before any funding was approved, the requirement that every applicant must have a research strategy forced institutions

to define their research priorities, and to plan for their future development. This was a very significant advance in RTD management among HE institutions. In this respect PRTLI has had an effect which is far wider than the funding of RTD centres.

PRTLI has also been significantly successful in developing inter-departmental and inter-faculty linkages within institutions, and also inter-institutional linkages. These linkages will benefit both research and teaching.

Through the centres, PRTLI has also put in place specialised management in some areas of RTD. Centre Directors are vital to the future success of the new centres, and most of these show the capacity to effectively manage their centres. However, the consensus view is that more could be done to develop the management and planning skills of Centre Directors and their teams, and also to clarify the institutional role and operational status of some centres. See recommendations 2 and 3 below.

- **Has PRTLI helped to improve the quality of curriculum, course provision and instruction at the institution and is it helping to improve the quality of graduate output?**

All of the indications are that PRTLI funding has improved the teaching and learning environment for students within the areas of funded research. However, the extent of the improvement is variable within centres. The consensus view is that, while much has been done, more could be done in this area.

In undergraduate teaching many, if not most, centres have developed new courses or course modules. However, the opportunity for new approaches to teaching has not been taken. Equally there has been little outreach to primary or secondary education, although this is not a primary objective of PRTLI.

- **Has PRTLI encouraged co-operation between researchers by promoting and embedding inter-institutional collaboration between third level institutions in order to counterbalance limitations of scale in individual institutions and to strengthen research outputs?**

PRTLI has been of very significant benefit to the funded institutions in developing collaborative linkages. These include both intra-institutional collaborations designed to develop inter-disciplinary collaboration, and also inter-institutional collaborations, sometimes with overseas organisations. The availability of funding has reduced the competition for limited funds among Irish institutions, and thereby assisted collaboration between national institutions. In the international field, PRTLI has created well-equipped and active centres which are attractive collaborative partners for overseas institutions.

While collaboration efforts are generally been very impressive, there are a few exceptions and these have given rise to recommendation 1 below.

- **Have any commercial opportunities, IP, start-up and technology transfer, investment opportunities or other social, economic or development potentials been created by PRTLI?**

The earliest PRTLI funding began in mid 1999, and it is unrealistic to expect that any major commercial effects could be seen as yet. Nevertheless, over 60 patent applications have been submitted, and some start-up companies are being created, for example Aliope Ltd, Neat Vision.com, Fluorocap Ltd and Intellipak Ltd are all associated with DCU-based PRTLI centres. The increased activity and facilities in the S&T centres is also attracting industry contacts, which will also create opportunities for economic impact. This impact will be in the form of new start-up companies, and also an improved ability to assist existing Irish companies to develop and improve their technology and technical competence. Examples of supports provided to Irish companies are in Appendix 4.4.

In the humanities and social sciences, linkages with relevant policy groups have been developed and information, including policy-informing papers, is being channelled to these users. These include government departments, State bodies, as well as numerous other aid agencies and health research organisations. Examples in this area are also in Appendix 4.4.

One of the areas of concern in the study was the relatively low awareness of IP principles and practices among the funded researchers. This concern gave rise to recommendation 5 below.

- **Where does PRTLI fit within national research funding policy going forward?**

The objectives set for the PRTLI were clear from the beginning.

- To enable a strategic and planned approach by third level institutions to the long term development of their research capabilities so as
- To enhance the quality and relevance of graduate output and skills
- To encourage co-operation between researchers both within the institutions and between them

This study has shown that the PRTLI is on course to fully meet these objectives. However, it must be remembered that the study can be criticised as premature in that it attempts, at an early stage in the life of the programme, to measure effects that can only be adequately assessed in the long-term. Even though the full impacts are still to come, the success of PRTLI is clear. What has emerged very clearly is that there is no deadweight in the PRTLI and very little displacement. Equally, the PRTLI complements other Irish funding programmes, but does not duplicate or overlap them. It has enabled Irish researchers to compete more effectively for EU and other funds and to take their place with other researchers worldwide.

HEA is justifiably uncomfortable with the idea that PRTLI is widely seen as mainly the provider of research space. It has done far more than this. Nevertheless, this role in itself was a major requirement of the RTD system, and it has been addressed very well by PRTLI.

The future for PRTLI would appear to be that of ensuring a balanced development of research and T&L, monitoring the on-going development of the existing centres (see recommendation 6) and the need for new centres, and ensuring that the skills, management resources and financial framework for the continued development of the centres are in place (see recommendations 2, 3 & 4).

Some **recommendations** from CIRCA are listed below. These recommendations derive from issues arising within all elements of the impact assessment. They are confined to matters which are within the remit of PRTLI. Other issues of concern are also noted, particularly in the Visit Reports, but are not the subject of our recommendations to the Assessment Committee as they are effectively the remit of other agencies or institutions.

We make the following recommendations:

1. Intra-institutional collaboration in some centres has not occurred to the extent anticipated and promised in the PRTLI proposals. It is suggested that the institutions involved be encouraged to ensure that this collaboration occurs.

2. Management teams from different centres could benefit from greater interaction with each other. It is recommended that a forum be established to facilitate sharing of best practices and experiences.

3. Specialised training in management of research centres should be provided for Centre Directors and their teams. In particular, training in financial planning for future sustainability is required.

4. Related to the issue of future centre sustainability, an agreement should be sought with host institutions to ensure an appropriate distribution of overheads between the institution and the PRTLI centres.

5. Awareness of intellectual property recognition and protection should be fostered among centre research staff and students

6. HEA should have more active interaction with PRTLI centres so as to ensure useful dialogue on the on-going issues arising from centre establishment and maintenance, and on the day-to-day progress of the programme.

2 SUMMARY REPORT ON STRATEGY AND MANAGEMENT IMPACTS OF PRTLI (INDECON, INTERNATIONAL ECONOMIC CONSULTANTS)

2 SUMMARY REPORT ON STRATEGY AND MANAGEMENT IMPACTS OF PRTLI (INDECON, INTERNATIONAL ECONOMIC CONSULTANTS)

2.1 Introduction

This report has been prepared for the PRTLI Impact Assessment Committee by Indecon International Economic Consultants. The report constitutes the inputs to the overall impact assessment of the PRTLI in relation to the policy context, and strategy and collaboration elements of the assessment.

The background to this report is that the Programme for Research in Third-Level Institutions (PRTLI) is the government initiative designed to strengthen the basic research capabilities of third-level institutions in Ireland. A high-level international Assessment Committee has been formed by the Higher Education Authority (HEA) to guide an assessment of the impact of the PRTLI from its commencement in 1998 to March 2004. The overall objective of the assessment is to undertake a comprehensive examination of the progress, results and achievements of the PRTLI since its commencement, and to inform future research policy. Indecon have been appointed to assist the Assessment Committee in assessing the institutional strategy and management, and collaboration impacts of the programme, in reviewing policy relevance and coherence, and in assisting with the development of monitoring and benchmarking indicators for the programme. As part of the Institutional Strategy and Management Impacts module, Indecon have assisted the Committee in undertaking a site visit programme to PRTLI-funded institutions. Separate reports on the findings and synthesis of the conclusions from the site visits, and on monitoring and benchmarking indicators, have also been prepared for the Committee.

The objective of the policy relevance and coherence module is to review and assess the relevance and validity of the stated objectives of the PRTLI against the background of current and anticipated developments in research funding and the positioning of the PRTLI in the context of other research funding programmes at national level.

The objective of the collaboration assessment is to establish the quality, value-added, management effectiveness and sustainability of PRTLI supported collaborations between third-level institutions.

2.2 Overview of PRTLI Funding and Research Areas

Before reviewing the policy context for the PRTLI and collaboration activities that have been supported by the Programme, it is useful to firstly recap on the background and objectives of the Programme, and to also describe the level of funding allocated to-date and the institutions and research programmes/centres funded by the PRTLI.

The PRTLI operates under the National Development Plan for Ireland (2000-2006) and is supported by a combination of public, EU (European Regional Development Fund) and private funding. The Programme allocates funding on a competitive basis to third-level institutions.

The primary objective of the PRTLI is to support the strategic development of research capability within the third-level educational and research institutions. This is facilitated through the provision of infrastructural and programmatic support so as to enhance the numbers, quality and relevance of graduate output, and to support high quality inter-disciplinary and inter-institutional research.

To-date, funding for institutions totalling €604.5 million has been approved across Cycles 1 to 3 of the PRTLI. Of this total, €402.7 million relates to capital funding, while €201.8 million concerns funding in respect of recurrent expenditures.

Out of a total of 35 eligible institutions, funding has been approved in respect of 15 'lead' institutions. The largest three recipients of funding have been University College Cork, University College Dublin, and Trinity College Dublin.

Of the 15 lead institutions for which funding has been approved under PRTLI, five have been funded under all three cycles, four have been funded under two cycles and six under one cycle. In total to-date, €206 million has been approved under Cycle 1, €78.5 million under Cycle 2 and €320 million under Cycle 3.

In relation to thematic areas, the principal broad research areas funded by PRTLI under Cycles 1 to 3 have been biosciences/biomedicine (€295 million by October 2003), environment & marine (€62.3 million), chemical & physical sciences (€87.4 million), information & communications technology (€59.3 million), social science (€30 million) and the humanities (€16.3 million). In addition, a total of €54.5 million in funding has been approved in respect of library infrastructures and resources.

A total of 61 research programmes, centres and other support resources have been supported to-date, up to and including Cycle 3 of the PRTLI.

2.3 Review of Policy Relevance and Coherence

Our review of the policy context commenced by presenting an overview of the research funding landscape, both in Ireland and in the EU, and considered the positioning of PRTLI within this landscape. We then reviewed the developments in the external environment, including current and anticipated developments in funding or other policies, and assessed their implications for the ongoing relevance of Programme. Finally, given the above analysis, we assessed the potential future role of the PRTLI.

2.3.1 Overview of Research Funding Landscape

Since the late-1990s the PRTLI has operated within a much more diverse landscape for the funding of research in Ireland, which is supported substantially through the National Development Plan (2000-2006).

In addition to HEA/PRTLI, a wide range of government departments, State agencies and other bodies in Ireland are now directly engaged in the funding of research in Ireland, some of which have been established subsequent to the inception of the PRTLI. These include the Irish Research Council for the Humanities and Social Sciences (IRCHSS), the Irish Research Council for Science, Engineering and Technology (IRCSET), Science Foundation Ireland (SFI), the Health Research Board (HRB), Enterprise Ireland, IDA Ireland, the Department of Agriculture and Food, the Environmental Protection Agency (EPA), the Marine Institute, Teagasc, and COFORD.

The IRCHSS and IRCSET research councils focus on funding research in the humanities and social sciences, and in science, engineering and technology. The Councils differ from PRTLI in that they fund individual researchers rather than capital infrastructure. IRCHSS and IRCSET allocated a total of €8.34 million in research funding between 2000 and June 2002.

SFI was established on a statutory basis in July 2003 and funds fellowships and research programmes in response to applications from researchers in targeted areas of economic importance, currently focused on the areas of biotechnology and ICT. SFI is also engaged in some joint funding with industry. An important distinction between SFI and PRTLI funding is that the former is geared towards funding individual researchers rather than institutions. However, the traditional view that PRTLI funds capital infrastructure while SFI funds individuals is breaking down, as SFI does provide funding for capital equipment while PRTLI also funds researchers. SFI's budget rose from €11 million in its first year of operation to a current allocation of €114 million in 2004.

The Health Research Board (HRB) was established in 1986 and promotes, funds, commissions and conducts medical, epidemiological and health services research in Ireland. Unlike the PRTLI, the HRB does not fund infrastructure such as buildings, although it does provide some funding for equipment. The HRB's budget rose from €21 million in 2002 to €24 million for 2003.

In addition to being the State's primary industrial development agency, Enterprise Ireland also functions as a research council and provides supports for R&D projects and networks involving third-level institutions and industry, including a campus company programme and a research innovation fund. It also provides supports for post-graduate training and development, and supports for industrial innovation. EI allocated some €114 million to the higher education sector in research grants over the period 2000-June 2002. EI primarily funds researchers rather than capital/building infrastructure.

2.3.2 Developments in the External Environment to PRTLI

Among the key policy and other developments in relation to the external environment to the PRTLI, which are likely to have important implications for the future development of the Programme, include the outcome of the work of the Enterprise Strategy Group, the future direction of the National Development Plan, the role of the Government's National Spatial Strategy, the role of competitiveness policy, and developments in relation to the proposed European Research Area.

The Enterprise Strategy Group, which was established by An Tánaiste (Deputy Prime Minister), Mary Harney, in July 2003, is expected to report by mid-2004. Its recommendations are likely to have important implications for the future direction of State supports for industrial development, research and innovation.

A number of important conclusions and recommendations arose from Indecon's report on the Mid-term Evaluation of the National Development Plan Productive Sector Operational Programme in 2003, which are likely to play a key role in shaping funding priorities going forward. These include the need to examine the

profiling of investment in this area to ensure that only those activities are targeted which display public good characteristics and where potential deadweight risks are minimised; to ensure that current and capital spending commitments are more closely aligned; and to improve monitoring and performance indicators to facilitate more accurate assessment of expenditure efficiency, results and impacts.

An important issue concerns how the PRTLI should or should not fit within the National Spatial Strategy. Indecon's report on the 'Mid-term Evaluation of the Productive Sector Operational Programme' also recommended that where feasible, an increased targeting of expenditures on RTDI measures/sub-measures should be implemented, such that the pattern of investment is more closely aligned with the objectives and policies set out in the NSS. This, however, must be addressed without damaging the quality of research.

The National Competitiveness Council submitted a Statement on Innovation to the Enterprise Strategy Group in February 2004. This contained a number of recommendations designed to support the knowledge-creation process and to address deficiencies in the research and innovation agenda in Ireland. The main thrust of the NCC's recommendations was a call for improved development agency collaboration.

The Lisbon Strategy, which was announced by the European Council in March 2000, set out a ten-year strategy to make the EU the world's most dynamic and competitive economy. Among the priorities set out by the Strategy, an important goal is the creation of a European Research Area with the objective of integrating and co-ordinating national and European Union research activities. Discussions have also got under way in relation to the idea of establishing a European research council, which would fund leading researchers across the EU. An important issue for Irish research policy and the PRTLI in particular is how Irish-based funding programmes such as the PRTLI would compete with a Europe-wide funding council.

2.3.3 Assessment of Potential Future Role of PRTLI

In general, across both government departments and state agencies, there is a general view that the PRTLI has been positive in terms of 'raising the game' for research in Ireland. The substantial investment in infrastructure is acknowledged as representing a potentially important development in this regard. Furthermore, it is seen that the Programme has been beneficial in fostering a new strategic approach to research within the third-level sector, and in supporting collaboration both within and between institutions. Another important benefit of the PRTLI is that it has enabled institutions funded by the Programme to leverage other sources of funding, for example, from SFI.

However, a concern raised by some organisations is that outside of the PRTLI no dedicated research funding body exists in Ireland that oversees the research agenda and research funding. Rather, there are several bodies currently in existence which, on their own, contribute significantly but which do not form a fully integrated approach to research funding.

The role of different research funding agencies in relation to the sectoral focus of funding has also been questioned. In particular, it has been observed that several agencies are involved in funding very similar areas

of research, which highlighted the need for a national framework to co-ordinate research funding across different sectors. The ongoing focus of SFI on biotechnology and ICT has been noted as being different to the wider PRTLI strategy, which also provides funding for the humanities and social sciences.

A view noted during consultations with government departments and state agencies in relation to the role of different agencies in research funding in Ireland is that while there are obvious complementarities between the different funding bodies, there is a sense that their precise contributions to the overall support of research have the potential for overlap. The roles of PRTLI and SFI have also been highlighted in this context. On the one hand, it has been expressed that the PRTLI, through the provision of infrastructure, has greatly facilitated the entry of SFI to the research funding landscape. On the other hand, it has been noted that SFI and PRTLI are now both involved in capital and current funding of research, and that it is important to ensure that this is managed in a way that maximises the overall effectiveness of expenditure.

An important difference highlighted between PRTLI and other Irish-based research funding channels is that PRTLI funding is directed at institution rather than individual researcher level. This is seen by policymakers to be beneficial in encouraging greater strategic focus and prioritisation within institutions, although it could detract from the scope to capitalise on individual researcher strengths.

In relation to European funding, one view expressed during policy consultations was that there has been some displacement of EU Framework Programme funding by the PRTLI. However, it was felt that this would be understandable when PRTLI was regarded as 'the new show in town', while the high level of administrative challenges posed by application requirements to the EU programme may have act as a disincentive to some Irish researchers.

In relation to the positioning of PRTLI and the EU FP, the focus of the latter on current rather than capital funding and the transnational aspect of the programme have both been highlighted as important distinguishing features. Notwithstanding these differences, it was felt that there are potential complementarities between the two programmes, particularly in that the PRTLI could place institutions in a much stronger position to access FP6 funding.

A concern has been expressed by some policymakers that a fundamental issue relates to the overall economic return achieved through investment in the PRTLI and the effectiveness of expenditure in terms of final outputs, and not just in terms of encouraging collaboration or improving processes within the third-level institutions.

Moreover, it was suggested during our consultations that it should be realised that the final impacts of the PRTLI would not be known for some time but that it is essential that any review of the Programme would recognise the importance of this factor and consider the feasibility of future monitoring of the Programme to facilitate the measurement of effectiveness and impact and not just process issues.

During the assessment team's site visits to PRTLI institutions, the question was raised as to how institutions would prioritise expenditures under a scenario where a future PRTLI would operate within a much more

restricted budget. The general view among the third-level institutions was that, going forward, the emphasis should be on provision for equipment and people rather than new infrastructure, although there would still be a need for some spending on infrastructure. However, the need for stability and predictability was generally seen as having greater importance than necessarily the level of funding.

The sustainability of the PRTLI was highlighted by a number of agencies as being of particular importance going forward. In particular, the long-term effectiveness of the Programme was seen as being affected by the 'stop-start' approach to funding evident from the 'pause' in capital funding announced in 2002 (though since removed) and the absence of a clear approach to funding infrastructure maintenance and equipment upgrade.

The view was also expressed by some policymakers that the response of institutions to the issue of sustainability needs to reflect more than a sectoral plea for additional resources, and also points to the need for ongoing financial and business planning within institutions for the post-PRTLI environment.

2.3.4 Industry Views on the Role and Future Development of PRTLI

A number of important views were expressed during consultations with industry representatives and leaders, which are summarised below.

In terms of developing future research policy, IBEC's submission noted the existence of "multiple government agencies and departments promoting diverse aspects of research and development without, it would appear, a clear common strategy". It was also highlighted that if Ireland is to attract and foster research projects of a strategic nature it must develop a Co-ordinated National Policy on Research and Development. According to IBEC, capital resources and organisational effort will be largely wasted if no coherent strategy, focussed on a definite goal, is put in place.

Furthermore, according to IBEC, specific focus areas for funding R&D in Ireland must be defined, while a National Policy on Intellectual Property rights should be developed. IBEC member companies also expressed the view that third-level institutions and researchers need to adopt best practice for transparent transfer of technology and commercialisation of research from third-level institutions.

During consultations industry leaders noted that while PRTLI has had a positive contribution, greater coordination is needed between PRTLI and other funding bodies, including SFI. Industry leaders also highlighted a need for an oversight entity in Ireland that coordinates research policy across the different agencies currently involved, which could be in the form of a cabinet sub-committee and the creation of a position of Chief State Scientist. It was also stated that PRTLI does not have any visibility within industry and it is difficult to discern the distinguishing features of the Programme. For example, SFI is seen to have much more visibility, though this may be understandable given the greater political support provided to the agency. Finally, there is a view among industry leaders that we need to have a much more focused strategy for research development, which targets areas where Ireland can develop unique capabilities.

2.4 Assessment of Collaboration Impacts

Our assessment of collaboration impacts of the PRTLI began by considering the different forms of collaboration activities that are evident across institutions. We then assessed the actual extent of collaboration activities, both within and between institutions, and between Irish-based and overseas institutions and researchers. Finally we examined the quality and impact of collaborations, the effectiveness of institutional leadership and management, and the role of collaborations in long-term institutional planning.

In relation to the forms of collaboration, broadly speaking, collaboration can occur within institutions (i.e. intra-institutional collaboration) or be externally based. However, the extent and depth of collaborations can vary substantially depending on the precise nature of interaction involved.

In relation to the nature of intra-institutional collaboration, at one level this could entail ad hoc collaboration between researchers, either within the same discipline or on an inter-disciplinary basis across different disciplines, and in the joint production of research publications. On an ongoing and more formalised basis, it may also involve inter-faculty/department user groups and sharing of resources. At a higher level, intra-institutional interactions may involve inter-disciplinary research teams working together on a day-to-day basis and jointly planning research activities.

Externally based collaboration may involve collaboration with other Irish-based third-level institutions, with other non-education research institutions, with State and other research agencies, or with industrial concerns.

In relation to intra-institutional collaboration, what is notable across all institutions that have been funded under the PRTLI is that inter-disciplinary collaboration has not been limited to co-operation between disciplines within particular faculties, such as between science and engineering. A range of PRTLI programmes have involved co-operation between disparate disciplines from a variety of departments and faculties, notably between science and humanities/social science disciplines.

Our research has indicated that through the provision of extensive infrastructure, centre management and other resources, the PRTLI has facilitated the development of inter-disciplinary research clusters. While the scope for inter-disciplinary interaction is dictated by the nature of research and crossover activities involved, previous delineations have in part become blurred as research is geared more towards problem solving.

Proximity between team members is, however, an important requirement for successful ongoing interaction between researchers. While in the majority of cases centre building design has greatly facilitated staff interaction, in a small number of centres weaknesses are evident in aspects of the functioning of PRTLI buildings, which have detracted from the successful interaction of staff and the development of effective inter-disciplinary collaborations.

In some cases the level of collaboration intended within specific PRTLI centres has not taken place, with centres largely providing additional space for existing faculties/departments rather than adding significant value in their own right.

In one or two other cases, it appears that there is a poor level of communication between the specific centres and the community, which has militated against centre-faculty interaction. A high level of teaching responsibilities appears, on occasion, to have also detracted from a greater focus on research co-operation.
The successful engagement of researchers in teaching & learning activities is often limited by a traditional conflict within institutions between the needs of research and teaching & learning. Striking an optimal balance between the two areas has remained a difficult issue for some institutions and these difficulties have been exacerbated by funding and resource issues in some cases.

Another important aspect of the impact of intra-institutional and inter-disciplinary collaboration concerns the ability of institutions to tap different funding sources, including outside the PRTLI. Through facilitating the integration of different disciplines within dedicated research centres/institutes and the pooling of resources, this has allowed many institutions to apply successfully for additional funding from agencies such as Science Foundation Ireland, the Health Research Board, IRCSET IRCHSS and other organisations.

In relation to inter-institutional collaboration, our analysis has pointed to an extensive network of collaborations evident across the Irish-based third-level institutions that have been funded under Cycles 1 to 3 of the PRTLI. These inter-institutional collaborations have involved a mixture of 'lead' and 'partner' third-level institutions and other organisations, including universities, institutes of technology, state agencies and other bodies. However, inter-institutional collaborations have been more successful in some areas than others. Furthermore, formal, long-term agreements are relatively few, particularly on an international basis. In addition, with some exceptions, the general view is that participation in EU Framework Programme funding has become very challenging and may have been given less attention given the existence of the PRTLI. The extent of industry collaboration, while significant in some institutions, is limited within the wider context of the PRTLI and is often constrained by issues concerning Intellectual Property Rights and other matters. Potential Recommendations for Future Development of PRTLI

From our assessment of institutional strategy and management, our examination of collaboration activities and our review of the wider policy context of the PRTLI, we believe that our analysis points to a number of potential recommendations for the future development of the Programme that could be considered by the Assessment Committee, which are set out in the below in Section 2.5.

2.5 Potential Recommendations (regarding Future Development of PRTLI for Consideration by the Assessment Committee)

- Support for effective research activities that develop Ireland's human capital (encompassing initiatives of the type funded under programmes such as PRTLI) should continue to be given priority. However, there should be a continued emphasis on prioritising those research and collaboration activities where effectiveness and value-added are maximised.

- A review of the roles of different research funding agencies in Ireland should be conducted to ensure that the overall economic return to investment in research is maximised.

- The profiling of future investment in research capacity building should be examined to ensure that an effective balance is achieved between recurrent and capital spending commitments and, in particular, between new infrastructure needs and the need to maintain and upgrade existing buildings and equipment.

- The third-level sector should place a high priority on business planning for PRTLI centres to facilitate long-term sustainability. In addition, the application criteria for research funding under the PRTLI should be re-examined to ensure that institutions have effective long-term financial and business planning capacities in place.

- Attention should be given to encouraging linkages in undertaking of research or in the dissemination of research results to support, where feasible, the government's national spatial strategy, but this must not be at the expense of damaging the quality of research.

- Additional written feedback should be provided to institutions that are unsuccessful in accessing PRTLI funding.

- Priority should be given to improving the future monitoring of investment in research and, in particular, to developing suitable indicators that permit the ongoing assessment of the effectiveness and impact of expenditures.

3 METRICS AND INDICATORS

3.1 Overview

3.1.1 Introduction

This addendum to the PRTLI Impact Assessment publication supports Module 5 laid out in the Terms of Reference for the Assessment. It outlines the rationale behind the selection of key indicators, the collection methods applied and the resulting indicators. It does not include the bibliometric analysis that was carried out to evaluate PRTLI publication outputs as this will be published in detail elsewhere (www.hea.ie). This document is intended to provide an overview of the key input and output indicators from PRTLI and is not in itself intended as a discussion document. In-depth discussion and analysis of the metrics and indicators included here may be found in the appropriate volumes of the Assessment publication including the supplementary web-based material. It is important to emphasise that any consideration of the outcomes of PRTLI must involve review of the indicators included here in parallel with the expert opinions of both the site visitors and the desk reviewers engaged in the process. It is widely accepted that these two measures are complementary to each other given the objectivity of indicator data and the complexity of peer review processes.

3.1.2 Approach

At the outset, it was proposed by the International Assessment Committee that input, output, and impact indicators would be used to supplement the observations, opinions and judgements put forward by the contributors to the Assessment. Indicators were selected on the basis of their ability to reflect the various objectives of PRTLI and to give evidence of the quantity and quality of measures for Strategy Management, Research and Teaching & Learning, and Infrastructure & Equipment. A full listing of Tables and Figures is given in Appendix 4.5.

It was envisaged that analysis of output indicators would facilitate an evaluation of associated impacts of PRTLI. These include impact on research strategy and management at an institutional level, on the institution's international research reputation, on quality of Teaching & Learning, on commercial potentialities, on economic potential and on national research policy. The indicators and impacts included in this document date from the commencement of the first cycle (Cycle 1) of the NDP funded PRTLI and do not include the 1998 Programme which was a forerunner to the NDP funded PRTLI. Awards under PRTLI were first made in mid 1999 with the first round of exchequer payments in early 2000. As a result, it is premature to expect all impacts to be realised at this point in time. However, it is not considered too early for assessment of team building, research alliances, student training, existence of facilities and equipment, preliminary research outputs, establishment of procedures for management of research and so on. Although one can only begin to address more long-term impacts such as lengthy citation analysis, commercialisation of IP, PhD awards and full implications of impacts on society, a step towards this analysis is beneficial. It will be important to review indicators of the Programme at appropriate and regular intervals.

3.1.3 Collection Methods

In order to minimise work-loads at an institutional level, it was proposed to gather key quantitative data directly from the existing interim reports submitted on a regular basis to the HEA by institutions funded by PRTLI. In certain exceptions, additional information was gathered through consultation directly with appropriate contacts at each institution and during the Assessment expert site visits.

3.1.4 Benchmarking

An important additional issue that requires consideration within the context of developing monitoring indicators for the PRTLI is the scope for benchmarking outputs, results and impacts evident from the PRTLI with those evident in other countries. There are a number of specific issues surrounding the development of a workable set of international benchmarking indicators, including:

- The level of indicator used, i.e. institutional and research activity level, programme level or national/macro level indicators;
- The ability to access, on an ongoing basis, data on relevant indicators internationally, which can also be compared over time;
- The degree to which data can be reliably compared across countries, and the approach to 'normalising' data for comparison purposes, if required.

For the purposes of this assessment, a number of international benchmarking indicators, as collected by Indecon, are presented which position investments in research in Ireland and associated outputs in an international context. In terms of monitoring the impact of PRTLI and other government investments these indicators will provide an international context.

3.2 PRTLI Input Indicators

3.2.1 Funding Approved

Over €605 million has been approved to date under PRTLI. Of this, €186 million corresponds to private funds and the remaining €419 million corresponds to Exchequer funds. The breakdown of the exchequer component into current (programmatic) and capital (buildings and equipment) is given by cycle in Table 3.1(Cycle 1); Table 3.2 (Cycle 2) and Table 3.3 (Cycle 3). The total amount awarded to the 15 PRTLI-lead institutions is given in Table 3.4.

Table 3.1: PRTLI Cycle 1 Breakdown of Funds Approved

			Amount	
Institution	**Programme**	**Capital**	**Current**	**Total**
		€000	**€000**	**€000**
AIT	Centre for Biopolymer and Biomolecular Research	1,281	973	2,254
DCU	National Centre for Sensor Research (NCSR)	9,329	1,663	10,992
DCU	National Centre for Plasma Science and Technology (NCPST)	6,119	917	7,036
DCU	Research Institute for Networks and Communications Engineering (RINCE)	9,546	927	10,473
DCU Total		*24994*	*3,507*	*28,501*
DIT	Facility for Optical Characterisation and Spectroscopy (FOCAS)	7,522	2,890	10,412
IT Carlow	Environmental Science	245	959	1,204
NUIG	National Centre for Biomedical Engineering Science (NCBES)	16,319	3,243	19,562
NUIM	Institute of Immunology Institute for Bioengineering and Agroecology	9,104	2,159	11,263
RCSI	Institute for Biopharmaceutical Sciences (IBS)	8,123	2,876	10,998
TCD	Sami Nasr Institute for Advanced Materials Science (IAMS)	10,502	465	10,967
TCD	Institute for Information Technology and Advanced Computation Research (IITAC)	9,645	465	10,110
TCD	Ussher Library Mediterranean and Near Eastern Studies	25,776		25,776
TCD	Centre for Irish-Scottish Studies (CISS) National Political and Social Survey		1,397	1,397
TCD	Molecular Cell Biology		582	582
TCD	Neuro-degeneration		582	582
TCD Total		*45,923*	*3,489*	*49,412*
UCC	Bioscience Institute (BSI)	11,428	861	12,289
UCC	Nanofabrication Facility (in NMRC)	11,885	670	12,555
UCC	Food and Health Programme		790	790
UCC	History and Society		1,175	1,175
UCC Total		*23,312*	*3,496*	*26,808*
UCD	Conway Institute	24,717	2,000	26,717
UCD	Institute for the Study of Social Change (ISSC)	3,468	969	4,436
UCD Total		*28,184*	*2,969*	*31,153*
UL	Materials and Surface Sciences Institute (MSSI)	12,473	2,010	14,483
Total		***177,479***	***28,569***	***206,048***

Source: HEA

Table 3.2: PRTLI Cycle 2 Breakdown of Funds Approved				
			Amount	
Institution	Programme	Capital	Current	Total
		€000	€000	€000
CIT	Ecotoxicology, Waste Reduction & Air Pollution	1,232	1,206	2,438
IT Sligo	Biosolids Research	83	561	644
NUIG	Environmental Science	4,201	4,302	8,503
NUIG	Human Settlement	1,181	1,722	2,903
NUIG Total		*5,382*	*6,024*	*11,406*
NUIM	National Institute for Regional and Spatial Analysis (NIRSA)	1,181	1,531	2,712
RCSI	Biopharmaceutical Sciences Network (BSN)	5,238	4,127	9,364
TCD	Health Informatics (incl DIT)		813	813
UCC	Environmental Research Institute (ERI)	11,728	5,176	16,904
UCD	Urban Institute of Ireland (UII)	3,175	3,021	6,196
UCD	Conway Institute		1,120	1,120
UCD	Dublin Molecular Medicine Centre (DMMC; incl TCD component)	20,809	6,076	26,885
UCD Total		*23,984*	*10,218*	*34,202*
Total		***48,828***	***29,655***	***78,483***

Source: HEA

Table 3.3: PRTLI Cycle 3 Breakdown of Funds Approved				
			Amount	
Institution	Programme	Capital	Current	Total
		€000	€000	€000
DCU	National Institute for Cellular Biotechnology (NICB)	18,538	15,745	34,283
DIAS	CosmoGrid	3,682	8,126	11,808
NUIG	Marine Science	10,421	8,713	19,134
NUIG	National Centre for Biomedical Engineering Science (NCBES)	7,140	5,614	12,754
NUIG	Environmental Change Institute (ECI)	287	694	981
NUIG	Centre for the Study of Human Settlement and Historical Change (CSHSHC)	43	801	844
NUIG	Centre for Innovation and Structural Change (CISC)	901	1,954	2,855
NUIG Total		*18,792*	*17,776*	*36,568*
RCSI	Programme for Human Genomics (PHG)	8,569	12,038	20,607
RCSI	Dublin Molecular Medicine Centre (incl DMMC (UCD/TCD))	9,969	14,246	24,215
RCSI Total		*18,538*	*26,284*	*44,822*
IT Sligo	Biosolids	1,460	1,079	2,539
TCD	Institute for Information Technology and Advanced Computation Research (IITAC)	5,018	3,847	8,865
TCD	Sami Nasr Institute for Advanced Materials Science (IAMS)	457	3,211	3,668
TCD	Institute for International Integration Studies (IIIS)	2,748	5,662	8,410
TCD	Trinity Centre for Bioengineering	2,393	3,036	5,429
TCD	Institute of Neuroscience and National Neuroscience Network	18,208	9,868	28,076
TCD	Mediterranean and Near Eastern Studies		1,227	1,227
TCD	Centre for Irish-Scottish Studies (CISS)		964	964
TCD	Centre for Transportation Research and Innovation (TRIP)		2,024	2,024
TCD Total		*28,824*	*29,839*	*58,663*
UCC	Biosciences Institute	4,752	203	4,955
UCC	Integrative Reproductive Biology	1,101	877	1,978
UCC	Eco-electronics	3,999	752	4,751
UCC	Postgraduate Research Library	27,206	1,428	28,634
UCC	National Nanofabrication Facility (in NMRC)	13,370	1,796	15,166
UCC	Boole Centre for Research in Informatics (BCRI)	3,493	1,664	5,157
UCC	Analytical and Biological Chemistry Research Facility	6,192	1,536	7,728
UCC	Science of Environmental Risk	1,066	4,277	5,343
UCC	Biosciences Institute	1,324	1,098	2,422
UCC	Food and Health Programme	1,365	1,987	3,352
UCC Total		*63,868*	*15,618*	*79,486*

Table 3.3 cont: PRTLI Cycle 3 Breakdown of Funds Approved				
			Amount	
Institution	Programme	Capital	Current	Total
		€000	€000	€000
UCD	Conway Institute	1,790	5,500	7,290
UCD	Centre for Synthesis and Chemical Biology (CSCB)	15,360	10,562	25,922
UCD	Humanities Institute of Ireland (HII)	3,927	3,687	7,614
UCD	Integrative Biology		1,294	1,294
UCD	Institute for the Study of Social Change (ISSC)		3,463	3,463
UCD Total		*21,077*	*24,506*	*45,583*
UL	Materials and Surface Sciences Institute (MSSI)		1,269	1,269
WIT	Smart Space Management (M-Zones)	1,592	3,359	4,951
Total		***176,371***	***143,601***	***319,972***

Source: HEA

Table 3.4: Total Amount Approved under PRTLI by Lead Institution*	
Institution	€000
AIT	2,254
CIT	2,438
DCU	62,783
DIAS	11,809
DIT	10,412
IT Carlow	1,204
IT Sligo	3,183
NUIG	67,536
NUIM	13,975
RCSI	65,185
TCD	108,888
UCC	123,198
UCD	110,938
UL	15,752
WIT	4,952
Total	***604,506***

**note: Institutions may also be receiving funds as collaborating partners*
Source: HEA

3.2.2 Breakdown of Capital Funding Approved

Over €400 million capital funding has been approved to date under PRTLI. This divides into buildings, equipment and furniture and a breakdown is given by cycle (Table 3.5), by discipline (Table 3.6) and by institution (Table 3.7. Individual items of equipment costing under €12,700 may also be purchased from current funds.

Table 3.5: Breakdown of Total Capital Approved by Cycle

	Building	Equipment	Furniture	Total
	€000	€000	€000	€000
Cycle 1	119,255	53,925	4,336	177,516
Cycle 2	35,283	12,142	1,403	48,828
Cycle 3	104,925	68,571	2,875	176,371
Total	***259,463***	***134,639***	***8,613***	***402,715***

Source: HEA

Table 3.6: Breakdown of Total Capital Approved by Discipline					
	PRTLI Cycle	**Building €000**	**Equipment €000**	**Furniture €000**	**Total €000**
Biosciences/	1	48,231	21,240	1,760	71,231
Biomedicine	2	17,684	7,784	578	26,046
	3	51,232	37,599	1,677	90,508
Sub total		***117,147***	***66,624***	***4,015***	***187,786***
Chemical & Physical	1	28,482	28,956	402	57,840
Sciences	3	6,402	17,616		24,018
Sub total		***34,884***	***46,573***	***402***	***81,859***
ICT	1	15,250	3,665	279	19,195
	3	7,301	6,424	60	13,785
Sub total		***22,551***	***10,089***	***339***	***32,979***
Social sciences	1	2,913	64	491	3,468
	2	3,581	648	127	4,356
	3	3,060	91	542	3,693
Sub total		***9,555***	***802***	***1,161***	***11,518***
Library	1	24,378		1,403	25,781
	3	25,751	1,455		27,206
Sub total		***50,130***	***1,455***	***1,403***	***52,987***
Environment*	2	12,901	3,710	633	17,244
	3	9,592	3,228	414	13,234
Sub total		***22,492***	***6,938***	***1,047***	***30,478***
Humanities	2	1,116		65	1,181
	3	1,587	2,159	182	3,927
Sub total		***2,704***	***2,159***	***246***	***5,108***
Total		***259,463***	***134,639***	***8,613***	***402,715***

Source: HEA

**note: Environment category includes Marine Programmes*

Table 3.7: Breakdown of Total Capital Approved by Lead Institution*

Institution	Building	Equipment	Furniture	Total
	€000	€000	€000	€000
AIT	511	634	137	1,281
CIT	563	631	38	1,232
DCU	24,965	18,483	89	43,537
DIAS	2,343	1,280	60	3,682
DIT	5,596	1,865	62	7,523
IT Carlow	166	79		245
IT Sligo	1,008	402	133	1,543
NUIG	24,317	15,365	814	40,497
NUIM	8,865	1,346	76	10,287
RCSI	14,361	15,536	903	30,800
TCD	64,544	19,499	3,197	87,239
UCC	60,579	38,368	724	99,671
UCD	41,067	17,918	2,126	61,111
UL	8,987	3,234	254	12,475
WIT	1,592			1,592
Total	***259,463***	***134,639***	***8,613***	***402,715***

**note: Institutions may also be receiving funds as collaborating partners*
Source: HEA

3.2.3 Payments made under PRTLI

The HEA administer the Exchequer component of the PRTLI awards. Exchequer payments to the end of 2003 are given, by institution and cycle, in Table 3.8 (Capital payments) and in Table 3.9 (Current/Programmatic payments). A total of €126 million Exchequer payments had been made at end 2003. Although payment of private funds is not reported here in detail, in excess of €100 million of the approved €186 million had been paid at end 2003 (including capital and current funds).

Table 3.8: Capital Exchequer Payments to end 2003

	Cycle 1 Capital Exchequer		**Cycle 2** Capital Exchequer		**Cycle 3** Capital Exchequer	
Institution	**Approved €000**	**Paid €000**	**Approved €000**	**Paid €000**	**Approved €000**	**Paid €000**
AIT	641	427				
CIT			616	411		
DCU	12,497	8,331			18,157	
DIAS						
DIT	3,761	2,249				
IT Carlow	123	82				
IT Sligo			41	28	1,206	
NUIG	8,159	6,195	2,691	2,021	18,284	
NUIM	4,552	3,465	1,143	382		
RCSI	4,061	2,707	2,618	1,523	18,157	
TCD	22,961	16,385	6,276	3,919	23,301	
UCC	11,656	7,716	5,863	1,651	37,013	
UCD	14,092	9,542	7,405	4,293	19,426	
UL	6,236	4,747				
WIT						
Total	***88,739***	***61,846***	***26,652***	***14,227***	***135,544***	***0***
Total Exchequer Capital Approved: €251 million						
Total Exchequer Capital Paid: €76 million						

Source: HEA

Table 3.9: Current/Programmatic Exchequer Payments to end 2003

	Cycle 1 Current Exchequer		Cycle 2 Current Exchequer		Cycle 3 Current Exchequer	
Institution	**Approved €000**	**Paid €000**	**Approved €000**	**Paid €000**	**Approved €000**	**Paid €000**
AIT	670	670				
CIT			1,206	908		
DCU	2,360	2,360			14,856	1,280
DIAS					8,126	705
DIT	1,687	1,687				
IT Carlow	612	612				
IT Sligo			561	457	1,079	90
NUIG	2,533	2,533	3,713	3,713	15,872	1,390
NUIM	1,327	1,327	427	457		
RCSI	2,065	2,065	4,128	3,327	8,959	1,425
TCD	2,152	2,152	3,758	3,221	28,431	2,090
UCC	2,512	2,512	5,178	4,311	14,792	1,280
UCD	1,736	1,736	3,894	3,822	23,876	1,895
UL	1,392	1,392			1,270	110
WIT					3,360	235
Total	***19,046***	***19,046***	***22,865***	***20,215***	***120,621***	***10,500***

Total Exchequer Current Approved: €162.5 million
Total Exchequer Current Paid: €50 million

Source: HEA

3.3 Output Indicators

3.3.1 Capital Infrastructure

Over €400 million capital funding has been approved to date under PRTLI. Table 3.10 details the area of new building that will result from the PRTLI investment. A total of 97,000 square metres of research and library space are planned with in excess of 56,000 square metres currently complete. The human capacity or number of work stations in these completed facilities amount to spaces for over 5000 researchers with in the region of a further 2,500 planned.

A total of 33 new state-of-the-art facilities/centres will result from PRTLI, with 19 currently complete. These are listed in Table 3.11. Over €134 million has been awarded for purchase of equipment and details of key equipment acquisitions to date are given in Table 3.12. A number of specialised facilities are located in these research centres and are listed in Table 3.13. These lists of equipment and facilities are not exhaustive but serve to illustrate key acquisitions.

Table 3.10: PRTLI funded Capital Infrastructure Output Indicators and associated Capacity as at February 2004

	Completed	In progress	Projected for Completion (2008)
Facilities	**m^2**	**m^2**	**m^2**
Square metres of new research laboratory space	25,836	16,164	42,000
Square metres of new non-laboratory research space	30,185	24,815	55,000
(Above includes square metres of new library space)	(11,619)	(7,699)	(19,318)
Total	***56,021***	***40,979***	***97,000***
	Completed	**In progress**	**Projected for Completion (2008)**
Work Stations[a]	**number**	**number**	**number**
PRTLI-funded work stations	4,284	1,584	5,868
PRTLI-funded library work stations	775	875	1,650
Total	***5059***	***2459***	***7518***

Source: HEA

[a]A work station is defined as an area where a person is assigned to work

Table 3.11: PRTLI funded New Facilities with dates of completion

2001	2002	2003/2004	Under Construction/ In Progress
• Institute for the Study of Social Change (ISSC, UCD) • Biotechnology and Environmental Science (IT Carlow) • Institute of Biopharmaceutical Sciences (RCSI) • Institute for Advanced Material Science (IAMS, TCD)	• Centre for the Study of Human Settlement and Historical Change (CSHSHC, NUIG) • Nanofabrication Facility (NNF, UCC) • Biosciences Institute (UCC) • Materials & Surface Science Institute, UL (MSSI) • National Centre for Plasma Science and Technology (NCPST, DCU) • Research Institute in Networks and Communications Eng (RINCE, DCU) • National Centre for Sensor Research (NCSR, DCU) • Urban Institute Ireland (UII, UCD) • Institute of Immunology (IIM, NUIM) • Ussher Library (TCD)	• Conway Institute for Biomolecular and Biomedical Research (UCD) • Dublin Molecular Medicine Centre (DMMC, UCD/TCD) • Environmental Change Institute (ECI, NUIG) • National Centre for Biomedical Engineering Science (NCBES, NUIG)* • National Institute for Regional and Spatial Analysis (NIRSA) housed in John Hume Building	• Optical Characterisation and Spectroscopic Facility (FOCAS, DIT) • Institute for Information Technology & Advanced Computation (IITAC, TCD) • Environmental Research Institute (ERI, UCC) • Biopolymer & Molecular Research (AIT) • Institute of Neuroscience (TCD)

** Note ECI and NCBES housed in same building*

Table 3.12: Examples of PRTLI-funded Equipment purchases above €50,000 (2000 to end 2003)			
Area of Research or Types of Equipment	**Number**	**Examples of Equipment Type**	**Typical Approximate Unit Cost**
Analytical – X-ray systems	3	X-ray diffraction systems	€200,000 to €300,000
Analytical instruments - various		Rheometers, CCD detectors, differential scanning calorimeters, etching systems, particle sizers, gas analysers, tensile tester, chromatography systems.	€50,000 to €250,000
Biacore	2	2 x Biacore biomolecule interaction analysis systems	~€250,000
Biosciences/Biomedicine - Molecular Biology	8	DNA sequencers, robot for DNA arrays, scanner for arrays, fluorescence hybridisation system, 2xAffymetrix system,	Systems up to €360,000
Biosciences/Biomedicine _ Protein analysis	3	Peptide synthesisers and sequencers	€75,000 to €125,000
Biosciences/Biomedicine –Cell biology	8	2x FACS, 2x cryogenic microtome, microbiology fermentation system, 3x ultracentrifuge	€50,000 up to €190,000
Biosciences/Biomedicine - Thermal Cyclers	5	Real time PCR systems	€65,000 to €120,000
ICT – Network	25	High performance clusters including installation of new servers, workstations, modelling software, network analysers etc	€50,000 to €150,000
Imaging	6	Imaging systems including video cameras, audiovisual equipment.	various
Lasers	14	Lasers for multiple purposes including: argon, nitrogen, carbon dioxide, femtosecond, e-beam, pulsed IR, picosecond, ablation	€15,000 to €100,000
Meteorological equipment	10	Including gas analysers, synoptic meteorological station, integrating nephelometer, bathymetry system etc	€65,000 to €150,000
Microscopes	22 new and upgrade	Including atomic force, near-field scanning, UHV scanning, scanning tunnelling, scanning electron, confocal laser scanning, cathode luminescence, transmission electron, Raman and scanning laser opthalmoscope.	€60,000 to €380,000
Physical & Chemical Sciences -Oscilloscopes	3	Tunable optical parametric oscillator, high speed oscilloscope	Up to €220,000

Area of Research or Types of Equipment	Number	Examples of Equipment Type	Typical Approximate Unit Cost
Physical & Chemical Sciences –Plasma chemistry	2	Plasma deposition and plasma process monitor	€100,000 to €300,000
Spectrometers	38 new and upgrade	Including mass, raman, photon fluoresecence, FTIR, Photo-acoustic, UV/VIS / NIR , X-ray fluorescence, plasma, deep Level transient spec (DLTS) and NMR.	€100,000 to €300,000

Source: HEA

Table 3.13: Examples of PRTLI-funded Specialised Facilities (2000 to end 2003)

Discipline	Type of Facility	Institution*	Facility operated jointly by collaborating institutions
Biosciences/ Biomedicine	Genome Analysis including robots, scanners, Affymetrix	DMMC, UCD	DMMC facility operated by UCD & TCD.
Biosciences/ Biomedicine	Biacore	DCU, NUIG	
Biosciences/ Biomedicine	Proteomics, Genomics and Bioinformatics facilities	UCD, RCSI, UCC, TCD	Programme for Human Genomics operated by RCSI, UCD & TCD.
Biosciences/ Biomedicine	Peptide Synthesis	RCSI UCC	
Biosciences/ Biomedicine	Probiotics Facility – Germ Free Facility		Part of Biopharmaceutical Sciences Network operated by RCSI & UCC
Biosciences/ Biomedicine	Video Conferencing	DMMC	
Biosciences/ Biomedicine	Tissue Culture Facility	NUIM, NUIG, UCD	
Biosciences/ Biomedicine	Transgenic, Germ-Free and other pre-clinical facilities	TCD, UCC, NUIM, UCD.	TCD Transgenic Facility is operated jointly by Biopharmaceutical Sciences Network

Discipline	Type of Facility	Institution*	Facility operated jointly by collaborating institutions
Biosciences/ Biomedicine	Gene Vector Core Facility (GMP)	NUIG	
Biosciences/ Biomedicine	Category III laboratory for Pathogens	NUIM	
Biosciences/ Biomedicine	Implant Testing facility	TCD	
Biosciences/ Biomedicine	Genome Hospital-based Clinical Resource Units	RCSI, UCD, TCD	Facilities operated jointly by Biopharmaceutical Sciences Network and DMMC
Biosciences/ Biomedicine	Clinical Research Facility at Beaumont Hospital	RCSI	
Biosciences/ Biomedicine	Microthermal Analysis facility	AIT	
Chemical & Physical Sciences	National Nanofabrication Facility	UCC	
Chemical & Physical Sciences	Focused Ion Beam Milling Facility	UL	
Chemical & Physical Sciences	Clean Rooms	DCU, TCD	
Chemical & Physical Sciences	Optical Characterisation and Spectroscopic Facility	DIT	
Chemical & Physical Sciences	Microfabrication Facilities	DCU	
Environment	Green Building	UCC	
Environment	GIS (Geographic Information System) facility	NUIG	
Environment	Carron Research Station (Refurbishment)	NUIG	
Social Sciences	Irish Social Science Data Archive	UCD	Operated jointly by ISSC and ESRI
Humanities	Virtual Research Library and Archive	UCD	
ICT	Virtual Reality Visualisation Facility	TCD	
ICT	Cosmogrid (3 clusters with 150 processors) and other High Performance Computing Facilities	DIAS, UCC, TCD	Cosmogrid is operated jointly by several partners
Library	Library and Information research system	TCD	

**Where several institutions are listed this means facilities are available on all sites listed.*

Source: Circa analysis of data submitted in 6-monthly reports to HEA by PRTLI-funded institutions.

3.3.2 Human Capital

Over €200 million current funding has been approved under PRTLI. This has enabled the funding of almost 1000 postgraduate students to date and over 450 postdoctoral researchers and 70 research assistants (Table 3.14). Table 3.14 also shows that over 750 principal investigators are directly associated with PRTLI programmes, many receiving their salary from the institutional block grant and other sources. The gender composition of these groups is evenly distributed (Table 3.15). PRTLI has resulted in attraction of foreign researchers and in the repatriation of Irish nationals. These measures for postgraduate students and postdoctoral researchers are captured in Figure 3.1. The breakdown of these researchers by discipline is given in Table 3.14 and in Figure 3.2 to Figure 3.4. A total of 34 senior researchers and professors have been funded directly under PRTLI (Table 3.16).

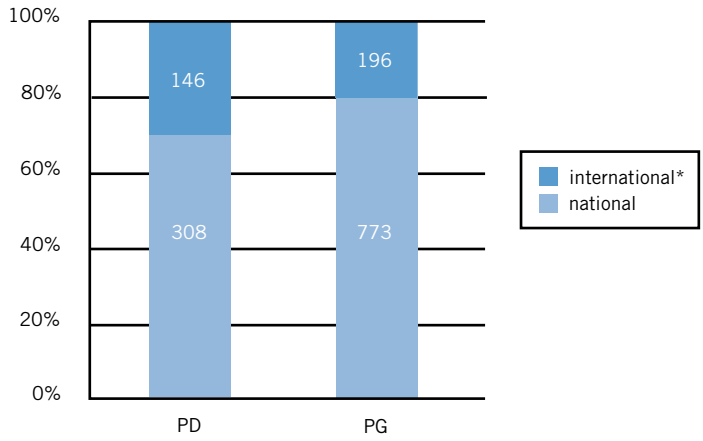
Table 3.14 Numbers of PRTLI associated researchers (mid 1999 to end 2003)

Discipline	PI	PD	PG	RA
Biosciences/ Biomedicine	245	204	344	14
Chemical and Physical Sciences	136	57	170	31
Environment	130	85	207	13
Humanities	40	25	38	11
ICT	98	44	123	1
Social Sciences	102	39	87	2
Total	***751***	***454***	***969***	***72***

PI: principal investigator; PD: postdoctoral researcher; PG: postgraduate; RA: research assistant

Source: Circa analysis of data submitted in 6-monthly reports to HEA by PRTLI-funded institutions.

Figure 3.1 PRTLI Postgraduate and Postdoctoral Origin Breakdown



** international figure includes repatriation of Irish nationals*

Source: Circa analysis of data supplied in 6-monthly reports to HEA by PRTLI-funded institutions

Table 3.15: Gender ratios of PRTLI researchers				
	postdoctoral		postgraduate	
	male	female	male	female
cycle 1	52%	48%	48%	52%
cycle 2	55%	45%	53%	47%
cycle 3	51%	49%	48%	52%
Overall	**53%**	**47%**	**50%**	**50%**

Source: Circa analysis of data submitted in 6-monthly reports to HEA by PRTLI-funded institutions.

Table 3.16 Numbers of Academic Staff Approved for funding under PRTLI (mid 1999 to end 2003)	
	Numbers
Professor	14
Lecturer	20
Total	***34***

Source: Circa analysis of data submitted in 6-monthly reports to HEA by PRTLI-funded institutions.

The existence of new research centres funded by PRTLI has allowed for almost 1200 additional postgraduate students who currently are based largely in these centres while they receive their funding from other sources. (see Table 3.17 below)

Table 3.17 Postgraduates not funded by PRTLI but based largely in PRTLI Centres	
Discipline	**postgraduate number**
Biosciences/Biomedicine	470
Chemical & Physical Sciences	390
Environment	37
Humanities	0
ICT	106
Social Sciences	82
Total	***1175***

Source: Circa analysis of data submitted by PRTLI-funded institutions.

Figure 3.2 Postdoctoral Breakdown by Discipline

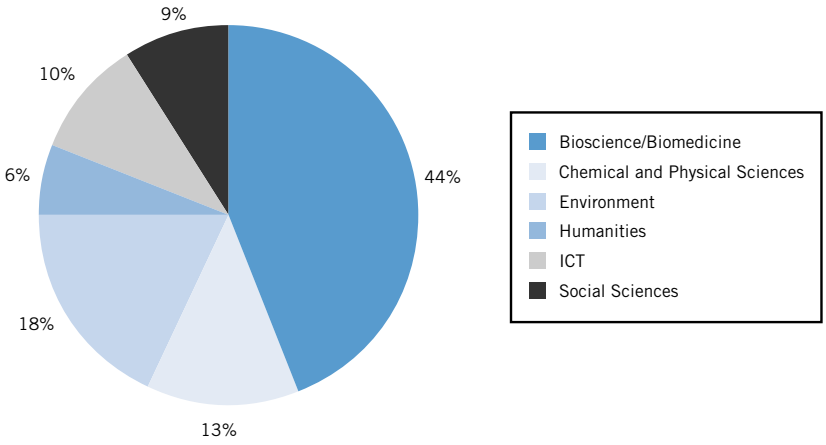


Figure 3.3 Postgraduate Breakdown by Discipline

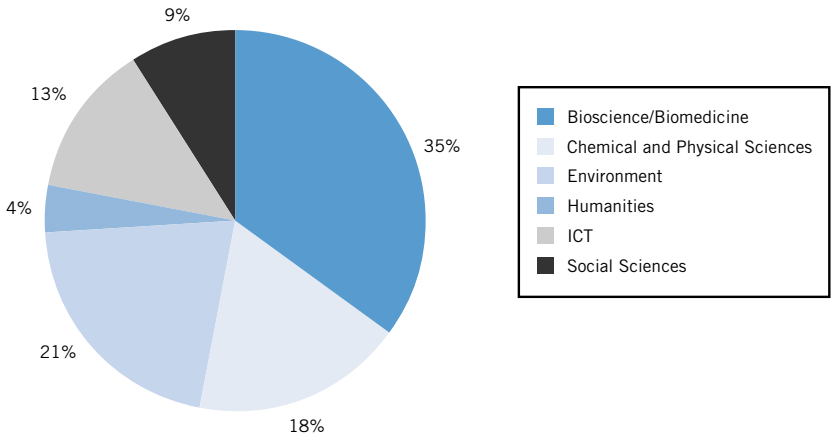
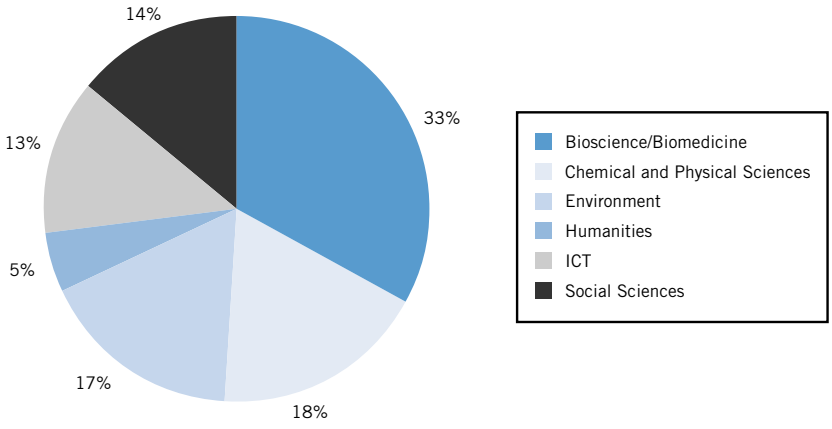


Figure 3.4 Principal Investigator Breakdown by Discipline



3.3.3 Research

3.3.3.1 *Publications*

As well as the completion of new research centres and the provision for a new generation of researchers, the impact of PRTLI may be measured in the volume of publications that have been produced by PRTLI researchers. Table 3.18 details these outputs by discipline and the breakdown is depicted in Figure 3.5 to Figure 3.11.

Table 3.18: Publication Output of PRTLI researchers (mid 1999 to end 2003)

	Journal Articles	Books & Chapters	'Grey Literature'[a]	Conference Proceedings[b]
Biosciences/Biomedicine	2363	98	8	254
Chemical & Physical Sciences	1326	53	1	263
Environment	235	54	25	117
Humanities	111	167	6	13
ICT	136	20	26	266
Social Sciences	428	231	217	115
Total	***4599***	***623***	***283***	***1028***

a *Definition of 'Grey Literature' here is that which is produced on all levels of government, academia, business and industry in print and electronic formats, but which is not controlled by commercial publishers. Examples include policy papers, industry reports, EU reports etc.*

b *Contributions to published Conference Proceedings and does not include oral or poster presentations in their own right.*

Source: Circa analysis of data submitted in 6-monthly reports to HEA by PRTLI-funded institutions

Figure 3.5 PRTLI All Publications - Output Type

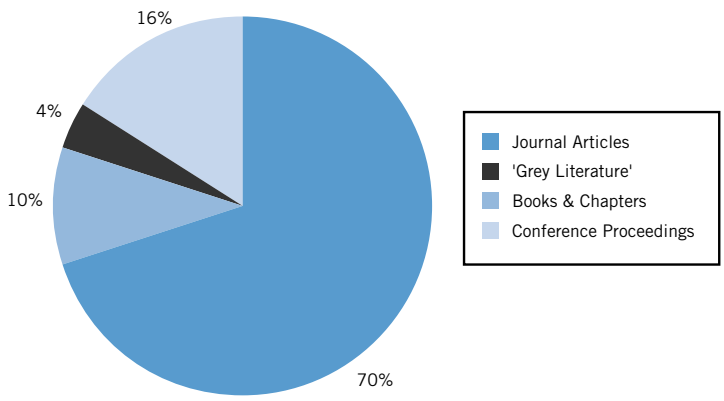


Figure 3.6 PRTLI Bioscience/Biomedicine Publications - Output Type

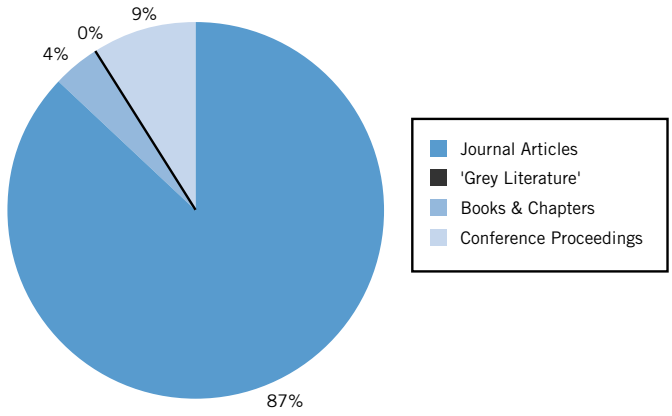


Figure 3.7 PRTLI Chemical & Physical Science Publications - Output Type

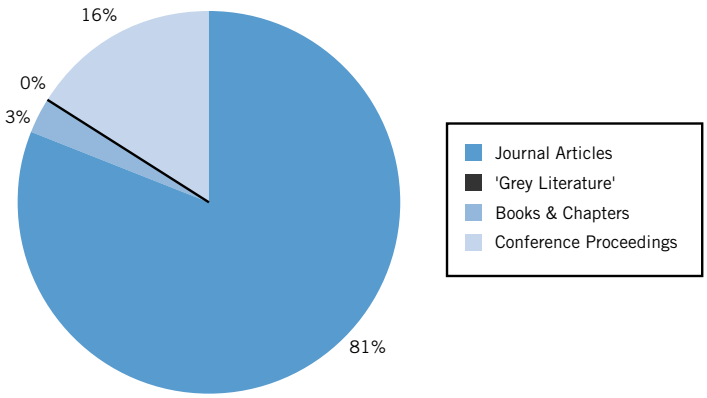


Figure 3.8 PRTLI Environment Publications - Output Type

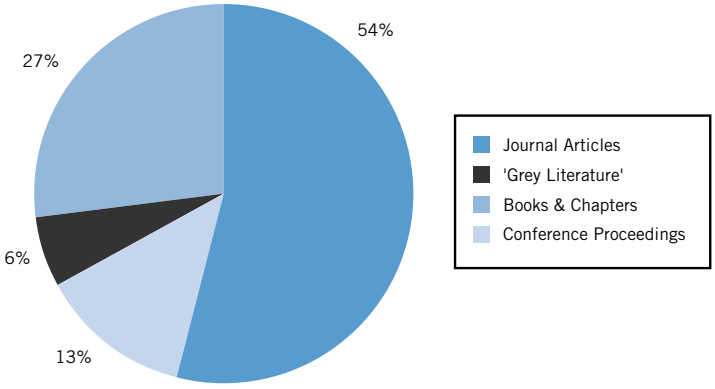


Figure 3.9 PRTLI ICT Publications - Output Type

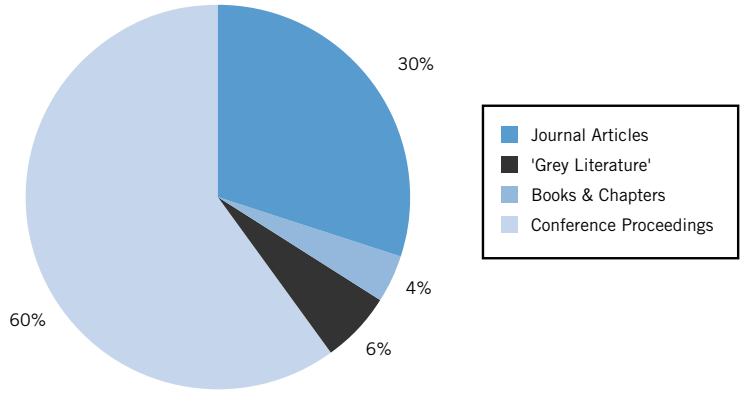


Figure 3.10 PRTLI Humanities Publications - Output Type

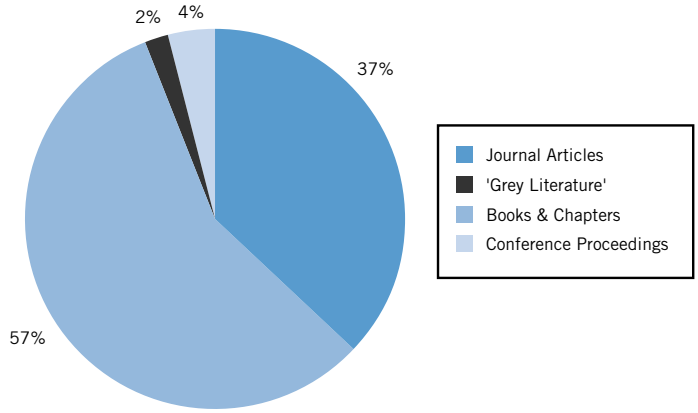
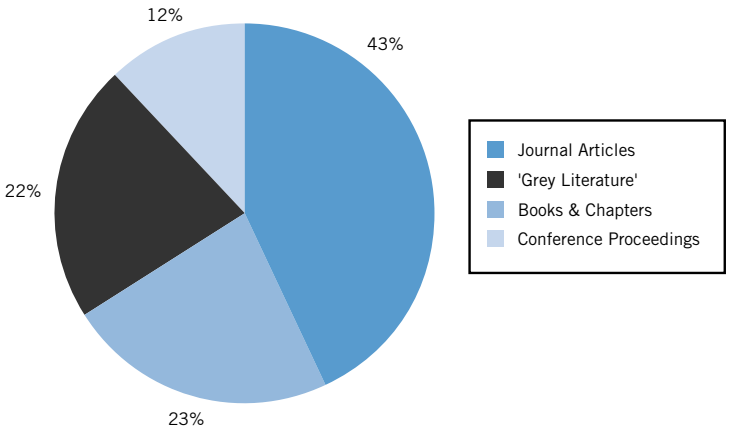


Figure 3.11 PRTLI Social Science Publications - Output Type



3.3.3.2 *Research Exposure*

It is vital for researchers to present and discuss their findings in international fora. Since the commencement of PRTLI, researchers have made in the region of 2200 oral presentations at international meetings and have been host to a further 239 conference (Table 3.19).

Table 3.19 Conference Output of PRTLI researchers (mid 1999 to end 2003)

Discipline	Conferences Hosted	Oral Presentations made at Conferences
Biosciences/Biomedicine	61	735
Chemical and Physical Sciences	45	433
Environment	26	507
Humanities	46	75
ICT	8	136
Social sciences	53	263
Total	***239***	***2149***

Source: Circa analysis of data submitted in 6-monthly reports to HEA by PRTLI-funded institutions.

3.3.4 Teaching & Learning

A key requirement of PRTLI programmes is that processes are established to enhance the transfer from research into teaching and learning. This has led to a significant number of modifications and addition of modules to existing undergraduate and postgraduate taught courses (Table 3.20). In addition at least 22 new courses have been developed with the direct involvement of PRTLI researchers and PRTLI research. These are summarised in Table 3.20 and are listed by title in Table 3.21.

Table 3.20 Creation of new courses and modifications to existing courses (mid 1999 to end 2003)

Discipline	New Courses Created	Module creation	Changes to existing Modules*
Biosciences/Biomedicine	10	3	24
Chemical and Physical	5	2	12
Environment	3	0	26
Humanities	0	1	0
ICT	2	1	1
Social sciences	2	0	2
Total	***22***	***7***	***65***

**e.g: introduction of a new lecture*

Source: Circa analysis of data submitted in 6-monthly reports to HEA by PRTLI-funded institutions.

Table 3.21 New Courses Created since the Commencement of PRTLI in PRTLI Fields of Research and with input from PRTLI Researchers (mid 1999 to end 2003)

	Diploma	Bachelor Degree Diploma	Postgraduate	Masters Degree
	Diploma in Biotechnology	BSc in Toxicology	Bioinformatics	MSc in Polymer Technology
	Certificate in Plasma & Vacuum Technology	BSc in Pharmaceutical Science	Polymer Science & Technology	MSc Toxicology
		BSc in Engineering Digital Media Engineering		Masters in Telecommunications Engineering
		BSc in Industrial Biology & Bioinformatics		Masters in Plasma & Vacuum Technology
		BSc in Biological Sciences		MSc in Bioformatics x 2
		BSc in Bioinformatics		MSc in Science Education
		BSc in Physics and Chemistry of Advanced Materials		MA in Landscape Archaeology
				MA in Translation Studies
				MSc in Pharmaceutical Sciences
				MSc in Polymer Science & Technology
Subtotal	**2**	**7**	**2**	**11**
Total				***22***

Source: Circa analysis of data submitted in 6-monthly reports to HEA by PRTLI-funded institutions.

3.3.5 Collaboration

The encouragement of collaborative and interdisciplinary research became a key criterion for PRTLI funding so as to address the identified lack of inter-institutional and inter-disciplinary collaboration in third level institutions. PRTLI has given rise to forty new inter-institutional research programmes. Figure 3.12 depicts the network of PRTLI collaborative links on the island of Ireland.

Figure 3.12 PRTLI networks of Collaboration in Ireland

Source: HEA publication 2003 "The Programme for Research in Third Level Institutions (PRTLI)"

3.3.5.1 *Change in Collaborative Research Landscape*

For the purposes of benchmarking PRTLI outputs compared with the position of institutions pre-PRTLI, it is useful to set out indicators that measure the outputs in relation to collaboration. For this purpose, we set out two indicators, namely the existence of collaborative agreements with other Irish-based third-level institutions and the existence of inter-institutional structures for the management of inter-institutional collaboration.

In Table 3.22 below, the extent of inter-institutional collaborative research agreements among Irish-based institutions in 2003/2004 is compared with that prevailing in 1995. According to the figures, in 1995, no

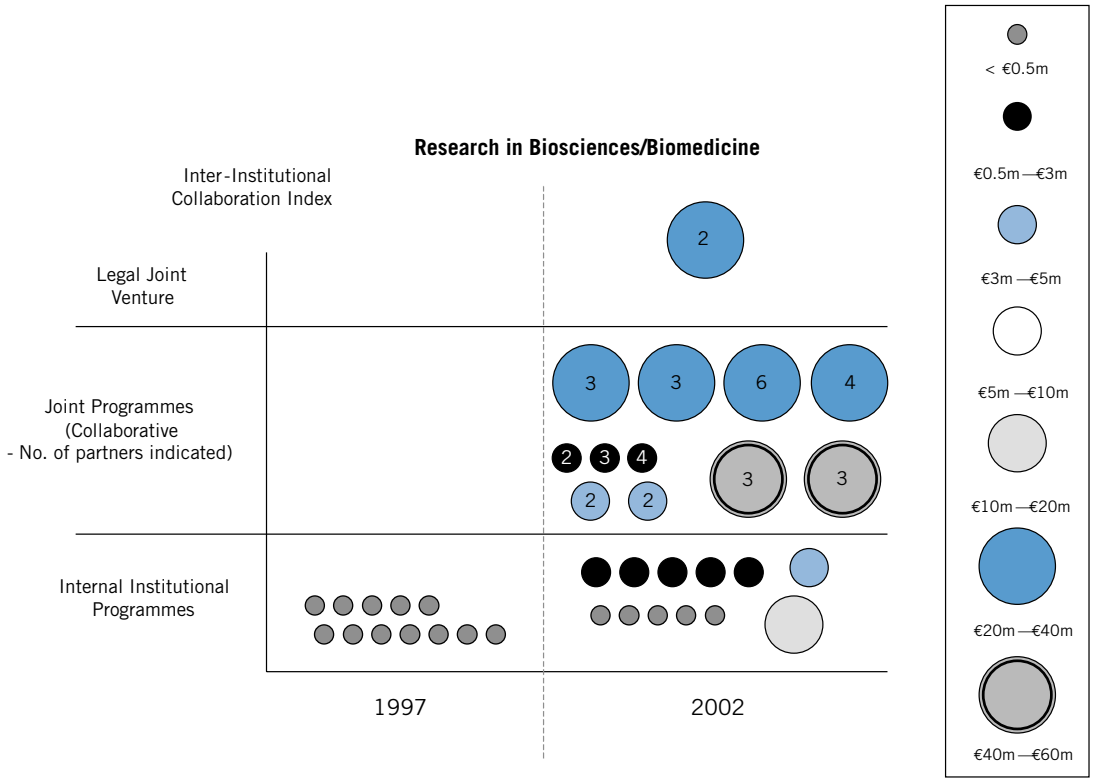
collaborative research agreements were in operation across the seven institutions profiled. By comparison, by 2003/04, collaborative research agreements were in place across all seven institutions. By way of example, the lack of collaborative research agreements in the area of Biosciences/Biomedicine pre-PRTLI is illustrated in Figure 3.13. This figure depicts the change in collaborative agreements in that field pre and post- PRTLI inception. The number of new collaborations, the number of partners involved and the amount of funding involved is included.

Table 3.22 Existence of Collaborative Research Agreements with other Irish-based Third-Level Institutions Number and % of PRTLI-Lead Institutions*

Collaboration Indicator	2003/04			1995*
	Yes	No	Total	Yes
Existence of collaborative research agreements with other Irish-based third-level institutions - Number of PRTLI-lead institutions*	7	0	7	0
% of institutions*	**100**	**0**	**100**	**0**

*Source: Indecon analysis of data supplied by PRTL- lead institutions**
**Note: Data relates to 7 institutions for which comparable data is available for 1995 from CIRCA (1996) report: DCU, NUI Maynooth, NUI Galway, TCD, UCD, UL, and UCC.*

Figure 3.13 Collaborative Agreements in Biosciences/Biomedicine, pre- and post- PRTLI inception.



Source: HEA publication 2002 "Creating and Sustaining the Innovation Society"

Twelve third level institutions have received funding for research in Biosciences/Biomedicine from PRTLI. In 1997, each of these 12 institutions was in receipt of less than €0.5m for research in these fields. In 2002, twelve collaborations have been formed, with 7 of the 12 instituions also receiving significant funding for intramural research in these fields. The numbers in the discs represent the number of third level institutions involved in each collaboration.

According to the figures presented in table 3.23 below, in 2003/04 all institutions profiled had formal structures in place for the management of inter-institutional collaborations. This compares with two out of seven institutions having such structures in place in 1995.

Table 3.23 Existence of Inter-institutional Structures for Management of Inter-institutional Collaboration Number and % of PRTLI-Lead Institutions*

Collaboration Indicator	2003/04				1995*
	Yes	No	In Process	Yes	Yes*
Existence of Inter-institutional Structures for Management of Inter-institutional Collaboration - Number of PRTLI-lead institutions	7	0	0	7	2
% of institutions*	**100**	**0**	**0**	**100**	**28.6**

Source: Indecon analysis of data supplied by PRTLI-lead institutions
** Note: Data relates to 7 institutions for which comparable data is available for 1995 from CIRCA (1996) report: DCU, NUI Maynooth, NUI Galway, TCD, UCD, UL, and UCC.*

3.3.5.2 *Funding To Collaborative Partners*

Of the €202 million programmatic funds approved under PRTLI a total of almost €60 million or 29.7% has been awarded to partner institutions in collaborative programmes. The breakdown of contribution to partner by cycle is given in Table 3.24. It can be seen from this table that the percentage of funding that was allocated to collaborating partners in Cycle 1 was only 3.6%. Points were not specifically awarded to collaboration at this stage. This had changed by Cycles 2 and 3 and a significant rise in awards to partners took place. The following table lists the lead institutions funded under PRTLI and their collaborative partners that receive PRTLI funds (Table 3.25). This table also shows that almost 1,950 researchers are directly involved in these programmes.

Table 3.24 Proportion of PRTLI Current Funds Approved in inter-institutional Collaborative Programmes by Cycle

PRTLI Cycle	% To collaborating partner
Cycle 1	3.6%
Cycle 2	35.4%
Cycle 3	33.7%
Total	***29.7%***

Source: HEA

Table 3.25 Proportion of PRTLI Current/Programmatic Funds Approved in inter-institutional Collaborative Programmes and Associated Human Capital (All PRTLI Cycles)

PRTLI-Lead Institution	PRTLI Collaborating Partners	To Lead Institution	To Collaborating Partners	Total Associated Human Capital to end 2003
		%	%	No. Researchers
AIT	NUIG, University of Coleraine	99.80	0.20	25
Cork IT	UCC, NUIG	66.68	33.32	32
DCU	NUIM, IT Tallaght	82.37	17.63	241
DIAS	DCU, NUIG, UCD, TCD, UCC, HEAnet, Met Eireann, Armagh Observatory, Grid Ireland	42.02	57.98	44
DIT and TCD	joint award[b]	0.00	100.00	25
DMMC (cycle 2 & 3)	joint award[b] (UCD/TCD/RCSI)	0.00	100.00	50
IT Carlow	NUIG	94.22	5.78	21
IT Sligo	NUIG, UCD, UL, LIT,TCD	89.52	10.48	23
NUIG	UCC, UL, UCD, TCD and AIT, IT Sligo, DCU, GMIT	89.52	10.48	363
NUIM	DIT, IT Sligo, GMIT, WIT, MIC, IT Carlow	95.35	4.65	85
RCSI	UCC,TCD, NUIM	53.90	46.10	146[a]
TCD	NUIG, UCC, UCD, DCU, NUIM, RCSI, Queens University Belfast	79.64	20.36	311
UCC	NUIG, UL, UCD, DIT, IT Carlow, IT Tralee, IT Tallaght, GMIT, RCSI, NUIM, CIT, Queens University Belfast	90.22	9.78	367
UCD	TCD, SPD, RCSI, NUIM, DIT	92.02	7.98	134
UL	WIT, NUIG, UCC	96.08	3.92	38
WIT	CIT, TCD, UL	33.33	66.67	31
Total		***(see Table 3.24)***		***1936***

(a) This figure includes those RCSI researchers involved in DMMC collaborative programme. (b) Note: in joint programmes including DMMC and Health Informatics all partners are considered here as equal collaborating partners

Source: HEA and Circa analysis of data submitted in 6-monthly reports to HEA by PRTLI-funded institutions.

3.3.6 Other Sources of Funding

In assessing the broader impacts of the PRTLI, one important aspect concerns the impact on institutions' research reputation. One useful measure of the impact on research reputation is the extent to which institutions can access a wider range of funding sources. Firstly, we detail the breakdown of new national, international and private research contracts secured by PRTLI researchers in areas of research complementary to PRTLI programmes. This is a measure of PRTLI funding leverage.

3.3.6.1 *Funding Leverage*

Table 3.26 details the amount of research awards by other funding sources in PRTLI funded research fields since the commencement of PRTLI. In excess of €249 million has been secured with a total of 1,023 individual awards. This data is also presented in Figures 3.14 and 3.15. Complementarity between SFI Centres for Science, Engineering and Technology (CSET) and PRTLI Programmes is given in Table 3.27.

Table 3.26 Funding Leverage: Attainment of funding from other sources in PRTLI funding research fields by PRTLI Centres/Programmes since the commencement of PRTLI. Amount awarded and number awards (mid 1999 to end 2003)

Source	€000	Number of awards
EU[a]	*26,858*	*133*
Enterprise Ireland	*32,979*	*250*
Science Foundation Ireland	*122,702*	*54*
Health Research Board	*21,473*	*84*
Other Irish[b]	*56,304*	*436*
Other international[c]	*7,219*	*30*
Private sector[d]	*3,284*	*36*
Total	***249,346***	***1023***

a. underestimation owing to incomplete dataset. This represents approximately 87% of research awards reported. Amount awarded was not given for remaining 13%. b. includes for example IRCSET, IRCHSS, EPA, Marine Institute etc (IRCSET & IRCHSS were established 1999/2000). c. includes for example Wellcome Trust, NIH etc. d. Does not include Atlantic Philanthropies contribution.

Source: Circa analysis of data submitted in 6-monthly reports to HEA by PRTLI-funded institutions.

Figure 3.14 Distribution of other funding sources in PRTLI research fields by amount of Grant (%).

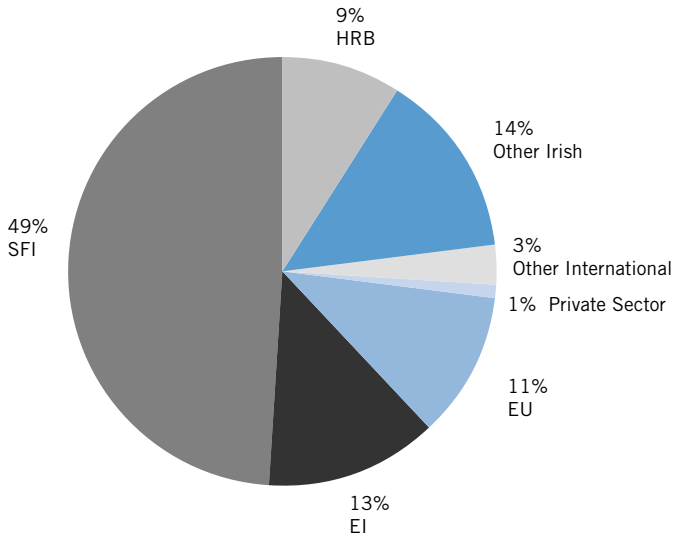


Figure 3.15 Distribution of other funding sources in PRTLI research fields by number of awards (%)

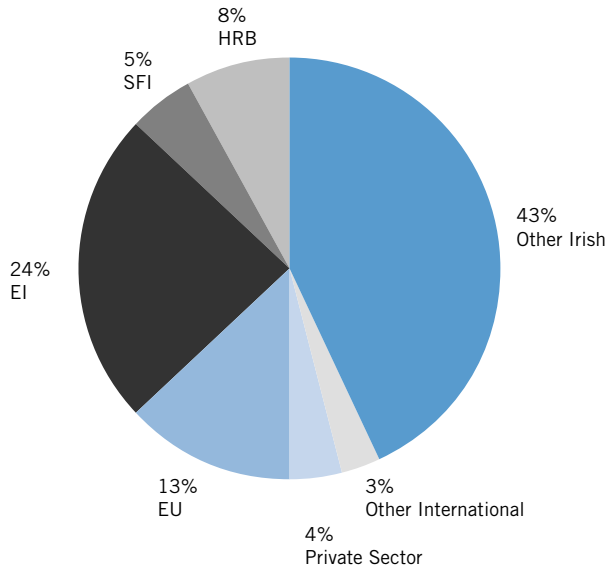


Table 3.27 Complementarity between PRTLI Centres and SFI Centres for Science, Engineering and Technology (CSET): Campus-Industry Partnerships

CSET Award	Director	Institution	SFI Grant	Previous PRTLI investment	PRTLI Centre/Programme	PRTLI Grant
Alimentary Pharmabiotic Centre (APC)	Prof. Fergus Shanahan	UCC	€16.5m	Yes	Biosciences Institute including the Food & Health Programme	€25.8m
Centre for Human Proteomics (CHP)	Prof. Dolores Cahill	RCSI	€13.5m	Yes	1. Institute of Biopharmaceutical Sciences and Biopharmaceutical Sciences Network, and 2. Programme for Human Genomics (Cycle 3)	€29.8m €20.6m
Digital Enterprise Research Institute (DERI)	Prof. Dieter Fensel	NUIG	€12m	No		
Regenerative Medicine Institute (REMEDI)	Prof. Timothy O'Brien	NUIG	€15m	Yes	National Centre for Biomedical Engineering Science	€32.3m
Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN)	Prof. John B. Pethica	TCD	€10m	No		

3.3.6.2 *Contract Research Budget*

In addition to the direct awards secured by PRTLI researchers, one indicator was proposed to gauge the impact of the PRTLI on institutions' ability to leverage alternative funding sources, namely the percentage breakdown over time of institutions' contract research budgets pre- and post- PRTLI inception. The data underlying this indicator is presented in the table below (Table 3.28), where the breakdown of contract (non-capital) research budgets according to PRTLI and non-PRTLI funding sources, including other Irish public sector funding, EU and other international funding, and private sector/industry and other funding is provided. Averaging the figures provided by twelve PRTLI-lead institutions in respect of their contract research incomes in 1998 and in 2003/04, it can be seen that as PRTLI funding came on stream in 1998/99, the proportion of institutions' contract research funding income from this source rose from an average of 0.1% in 1998 to an average of 20.6% in 2003/04. It is also notable that the average proportion of funding received from other Irish public sector sources (including Enterprise Ireland, Science Foundation Ireland, the Health Research Board, Teagasc and the Environmental Protection Agency) rose from 46.2% in 1998 to 50% in 2003/04. By contrast, funding from EU sources (including the Framework Programme and Marie Curie), which was the primary source of funding pre-PRTLI, fell from an average across the twelve institutions profiled of 27.2% in 1998 to 16.2% in 2003/04. In addition, funding from other international sources fell from an average of 7.9% in 1998 to 3.1% of contract research budgets in 2003/04. The average proportion of institutions' contract research budgets deriving from the private sector, industry and related sources also fell during this period, from an average of 18% in 1998 to 10.4% in 2003/04. It should be cautioned, however, that the figures presented constitute averages across the twelve lead institutions profiled and that there are significant variations in the composition of contract research budgets across institutions.

Table 3.28 Core Indicators for Assessment of PRTLI Impacts - % Breakdown of Institutions' Contract Research Budget Pre- and Post-PRTLI Inception

Contract Research Budget Funding Source	Average % of Total Funding* across PRTLI-Lead Institutions	
	1998	2003/04
PRTLI	0.1%	20.6%
Other Irish public (incl. EI, SFI, HRB, Teagasc, EPA)	46.2%	50.0%
EU (e.g. Framework Programme, Marie Curie)	27.2%	16.2%
Other international	7.9%	3.1%
Private sector/industry and other	18.0%	10.4%
Total	**100%**	**100%**

Source: Indecon analysis of data supplied by PRTLI-lead institutions
** Includes 12 institutions: DCU, NUI Maynooth, NUI Galway, TCD, UCD, UL, UCC, IT Carlow, Dublin Institute of Technology, IT Sligo, RCSI, and Cork IT*

It is important to also note that the global contract (non-capital) research income for third level institutions has increased considerably in real terms pre- and post- PRTLI inception. Examples have been selected for two institutions (UCD and TCD) and a 2 to 3 fold increase in research budget has taken place over time (Table 3.29). The amount of research income less the PRTLI contribution is also presented.

Table 3.29 Contract Research Income by Year for Two PRTLI-Lead Institutions

	UCD		TCD	
Year	€000		€000	
	Total	Total less PRTLI	Total	Total less PRTLI
1996-1997	€14,724		€16,858	
1997-1998	€17,056		€18,958	
1998-1999	€16,329		€19,342	
1999-2000	€17,346		€19,845	
2000-2001	€20,676	€19,053	€24,883	€23,892
2001-2002	€26,959	€24,534	€38,620	€33,517
2002-2003	€34,732	€32,567	€45,864	€40,272

Source: Contract research expenditure from individual institutional annual financial statement and consultation with individual institution.

3.3.7 Commercial Potentialities

Although commercial potential of PRTLI funded research is not a requirement of the programme, it is nonetheless a vital part of the creation of the knowledge society and early impacts of the programme indicate that sixty patent applications have been made by PRTLI researchers since the start of the programme. These are listed by discipline in Table 3.30.

Table 3.30 Commercial Outputs. Number of Patent Applications made by PRTLI researchers (mid 1999 to end 2003)

Discipline	patent number
Biomedicine	38
Chemical & Physical Sciences	19
Environment	1
Humanities	0
ICT	2
Social Sciences	0
Total	**60**

Source: CIRCA analysis of 6-monthly reports submitted by PRTLI centres

3.3.8 Strategic Management of Research

In Table 3.31 core indicators for the assessment of PRTLI outputs in relation to the strategic management of research activities across PRTLI institutions are set out. The indicators presented focus on a benchmarking of progress since the inception of PRTLI with that obtained pre-PRTLI in relation to the existence and updating of strategic planning, the management of intellectual property, the preparation of financial projections and the operation of management information systems for research. The data underlying each of these indicators is described in the subsequent paragraphs and in Table 3.32 to Table 3.35.

Table 3.31 Core Indicators for Assessment of PRTLI Outputs re Strategic Management of Research
Long-term strategic plan in place?
Most recent reconsideration of strategic plan
Strategic planning process for research in operation?
Number of institution reviews of strategic plan since introduction
Intellectual Property management practices in place?
Financial targets/projections (short- and long-term) in place?
Management Information Systems in place for management of research activities?
*Source: Indecon and Higher Education Authority * Benchmarking with CIRCA report 1996*[5]

In Table 3.32 details are presented of the extent to which long-term strategic planning exists among lead institutions funded through the PRTLI.

Table 3.32 Existence of Institution Long-term Strategic Plan Number and % of PRTLI-Lead Institutions*

Indicator	Yes	No	In Process	Total
Long-term institution strategic plan in place- Number of institutions	12	0	0	12
% of PRTLI-lead institutions*	**12**	**0**	**0**	**12**

Source: Indecon analysis of data supplied by PRTLI-lead institutions
** Includes 12 institutions: DCU, NUI Maynooth, NUI Galway, TCD, UCD, UL, UCC, IT Carlow, Dublin Institute of Technology, IT Sligo, RCSI, and Cork IT*

5. 'A Comparative Assessment of the Organisation, Management and Funding of University Research in Ireland and Europe' – report prepared for the HEA by CIRCA and published in December 1996.

Table 3.33 Strategic Management of Research - Most Recent Reconsideration of Strategic Plan for Research By Year Number and % of PRTLI-Lead Institution

Indicator	2001	2002	2003	2004	2005	Total
Most recent reconsideration of strategic plan for research – Number by Year	1	0	4	6	1	12
% of PRTLI-lead institutions*	**8.3**	**0.0**	**33.3**	**50.0**	**8.3**	**100**

Source: Indecon analysis of data supplied by PRTLI- lead institutions
** Includes 12 institutions: DCU, NUI Maynooth, NUI Galway, TCD, UCD, UL, UCC, IT Carlow, Dublin Institute of Technology, IT Sligo, RCSI, and Cork IT*

An important issue in relation to long-term strategic planning concerns the extent to which institutions engage in periodic review or reconsideration of their strategic plans. In the table below we indicate the pattern of review of strategic plans of the PRTLI-lead institutions profiled (Table 3.33). According to the figures, of the eleven institutions that have, or are in the process of putting, strategic plans into operation, 6 institutions (50%) are currently in the process of reviewing their plans, while 1 institution intends to review its plan in 2005. A total of 5 institutions completed their most recent review of their strategic plan in the period 2001-2003.

The figures in the table below indicate the total number of reviews by PRTLI-lead institutions of their strategic plans since introduction. According to the figures, a total of 18 reviews have taken place to-date across the twelve institutions profiled (Table 3.34)

Table 3.34 Strategic Management of Research - Number of Institution Reviews of Strategic Plan Since Introduction

Indicator	Total Number of Reviews	Average Number per Institution	Total Number of Institutions
Number of institution* reviews of strategic plan since introduction	18	1.5	12

Source: Indecon analysis of data supplied by PRTL- lead institutions
** Includes 12 institutions: DCU, NUI Maynooth, NUI Galway, TCD, UCD, UL, UCC, IT Carlow, Dublin Institute of Technology, IT Sligo, RCSI, and Cork IT*

It is also important to benchmark institutions' recent progress in developing a long-term term approach to strategic planning for research activities compared with the position previous to the inception of PRTLI. It is a requirement for PRTLI funding that participating institutions have research strategic plans in place. Across the seven PRTLI-lead institutions profiled in 1995, only one institution at the time had developed a long-term strategic planning process for research activities. By 2003/04, however, all seven of these institutions had long-term strategic research plans in place (Table 3.35).

Table 3.35 Core Indicators for Assessment of PRTLI Outputs re Strategic Management of Research Number and % of PRTLI-Lead Institutions

Indicator	2003/04				1995*
Number of Institutions	**Yes**	**No**	**In Process**	**Total**	**Yes**
Strategic planning process for research in operation?	7	0	0	7	1
% of institutions*	**100**	**0.0**	**0.0**	**100**	**14.3**
Research VP, Dean or equivalent in Place?	7	0	0	7	2
% of institutions	100	0	0	100	28.6
Research Committee or equivalent in place?	6	1	0	7	4
% of institutions	**85.7**	**14.3**	**0**	**100**	**57.1**
Intellectual Property management practices in place?	7	0	0	7	7
% of institutions	**100**	**0.0**	**0.0**	**100**	**100**
Financial projections (short- and long-term) in place?	7	0	0	7	1
% of institutions	**100**	**0.0**	**0.0**	**100**	**14.3**
Management Information Systems in place for management of research activities?	4	0	3	7	3
% of institutions	**57.1**	**0.0**	**42.9**	**100**	**42.9**

Source: Indecon analysis of data supplied by PRTLI-lead institutions
** Note: Data relates to 7 institutions for which comparable data is available for 1995 from CIRCA (1996) report: DCU, NUI Maynooth, NUI Galway, TCD, UCD, UL, and UCC.*

Another aspect of the strategic planning of research activities concerns the extent to which the PRTLI has facilitated the development of institution-wide research management structures. According to the figures presented in Table 3.35, across the seven lead institutions profiled in the 1996 research, two institutions (or 28.6%) had a vice-president or dean of research or equivalent position in place in 1995, while four institutions (57.1%) had a research committee in place. By 2003/04, all seven institutions had a vice-president or dean of research or equivalent position in place, while six had a research committee in place.

An important aspect of the management of research activities at institution level concerns the approach to management of intellectual property rights (IPR), and in particular the extent to which research institutions have formal IPR management practices in place. Here, we compare the picture across institutions in 2003/04 with that in 1995 in relation to the existence of IPR management practices. Our research indicates that of the PRTLI-lead institutions profiled, all seven institutions had formal IPR management practices both in 1995 pre-PRTLI and in 2003/04 that have evolved over this period of time (Table 3.35).

Another important feature of the strategic management of research activities concerns the existence, at institution level, of financial targets and projections for research activities, included in relation to funding and research outputs. In 1995 prior to the inception of PRTLI, only one institution, out of seven profiled had financial targets and projections in place for the management of research activities. However, by 2003/04 all seven institutions had developed financial targets and projections (Table 3.35).

In the table below we benchmark progress across PRTLI-lead institutions in relation to the presence of management information systems (MIS) for research activities (Table 3.35). The figures indicate that three out of seven institutions had MIS systems in place in 1995. By comparison, by 2003/04, four institutions had MIS systems in operation while three institutions were in the process of introducing such systems.

3.4 Key National Indicators

3.4.1 Higher Education Expenditure on R&D (HERD)

In Table 3.36 below the investment in research and development in higher education institutions (HERD) in Ireland pre- and post- PRTLI inception is given.

Table 3.36 Higher Education Expenditure on R&D (HERD)

	1995	1997	1999	2001
€m	137	178.4	249	294
As a % GDP	0.26	0.27	0.28	0.26
As a % GNP	0.29	0.30	0.33	0.31
Ireland's rank*		19	21	
EU Average (%GDP)	0.38	0.39	0.39	0.40
OECD average (%GDP)	0.37	0.37	0.38	0.40

** out of 26 OECD countries*
Source: Forfas "Research and Development at a glance, 2001" & OECD

3.4.2 Enrolments of PhD and Masters students pre- and post- PRTLI inception

In the tables below the enrolments for higher degrees in both universities and institutes of technology are detailed (Table 3.37 and Table 3.38). It can be seen that there was a 1.5 fold increase in enrolments in the university sector and a 2.5 fold increase in the IT sector with the creation of 78 PhD studentships not represented in 95/96.

Table 3.37 Total Higher Degree Enrolments in University Sector in Ireland

		PhD	Masters	Total
1995/96	full time	1,755	4,912	
	part time	296	1,895	
	Total	***2,051***	***6,807***	***8,858***
2001/02	full time	2,687	6,195	
	part time	569	3,157	
	Total	***3,256***	***9,352***	***12,608***

Source: HEA and DES

Table 3.38 Total Higher Degree/Diploma Enrolments in IT Sector in Ireland					
		PhD	**Degree**	**Diploma**	**Total**
1995/96	full time		150	172	
	part time		89	233	
	Total		***239***	***405***	***644***
2001/02	full time	78	527	227	
	part time	0	516	316	
	Total	***78***	***1043***	***543***	***1,664***
Source: HEA and DES					

3.5 International Benchmarking

3.5.1 International Case Study Benchmarking

It may be instructive to explore the feasibility of comparing the outputs and impacts at institution and research centre level arising from the PRTLI with those pertaining in institutions and research centres in other countries. An advantage of this approach is that it could permit a micro-level comparative assessment of the impacts of a publicly funded research programme such as the PRTLI with similar research programmes in other countries. A disadvantage, however, is that it may be very difficult to isolate the impacts of a particular funding programme from those resulting from more general research supports. A related issue is that it may also be difficult to identify appropriate comparitor institutions and inappropriate selection may give rise to the charge that Irish-based institutions may be unfavourably compared with other institutions. Notwithstanding the above observations, it is instructive to present a number of case study comparisons of Irish institutions and overseas institutions. In the table below (Table 3.39) a number of Irish and overseas third-level research institutions are listed for the purposes of examining comparative positions based on a limited number of headline indicators, described subsequently.

Table 3.39 International Case Study Benchmarking – Selected Comparitor Institutions
Irish Institutions
University of Dublin, Trinity College (TCD)
University College Dublin (UCD)
University College Cork (UCC)
Overseas Institutions
University of Edinburgh, UK
University College London, UK
University of Uppsala, Sweden
University of Leiden, The Netherlands
University of Helsinki, Finland
University of Utrect
Source: Indecon

For the purposes of undertaking a comparison of key headline indicators concerning the scale of institutions and research activities we propose to consider a range of benchmarking indicators, which are set out in the table below (Table 3.40).

Table 3.40 International Case Study Benchmarking – Selected Headline Benchmarking Indicators

Indicator	Source/derivation
Total research grants and contract income - €Million (A)	University annual reports
Total number of academic/research staff (B)	University annual reports
Total number of students (C)	University annual reports
Total research income per academic/research staff member	(A)/B)
Total research income per student (undergraduate)	(A)/(C)

Source: Indecon in consultation with the Higher Education Authority

In the following table (Table 3.41) the data underlying the above headline benchmarking indicators in comparing three of the largest Irish third-level research institutions with six institutions located in the UK, Finland, Sweden and the Netherlands is presented. While a more detailed comparative analysis of research scale would be required across a larger number of institutions and indicators to comprehensively assess the recent progress achieved by Irish-based institutions funded by the PRTLI, which is beyond the scope of this exercise, it is nonetheless instructive to note the comparisons on the basis of the institutions and indicators shown. In particular, on the basis of total research income per staff member and total research income per student, it can be seen that the three Irish institutions shown, while among the largest recipients of PRTLI funding since the Programme's inception, lag behind each of the six overseas institutions included in this exercise.

Table 3.41 International Case Study Benchmarking – A Comparison between Irish and European Research Institutions - 2002*

Indicator/Institution	TCD	UCD	UCC	University of Edinburgh[1]	University College London	University of Uppsala[2]	University of Helsinki	University of Leiden	University of Utrecht
Estimated Total Research Grants and									
Contract Income - €Million	38.6	27.0	33.8	139.6	235.3	257	165.0	68.0	126.6
Estimated Total Academic and									
Research Staff	1,721	2,367	1,382	2,500	3,833	3,800	3,507	2,025	2,700
Total student population[3]	15,201	19,607	13,227	24,070	17,805	41,500	37,685	16,614	23,716
Total Research Income per Academic and									
Research Staff Member - €	**22,440**	**11,390**	**24,463**	**55,856**	**61,401**	**67,521**	**47,049**	**33,580**	**46,889**
Total Research Income per Student - €	**2,541**	**1,375**	**2,556**	**5,801**	**13,218**	**6,183**	**4,378**	**4,093**	**5,338**

Source: Indecon analysis of figures from Irish and overseas institutions indicated. Data in relation to estimated total research grants and contract income for Irish institutions are sourced from individual institutions' financial statements.
** Figures presented are for 2002, except where otherwise stated*
1 Staff figures pertain to 2003
2 All figures pertain to 2003
3 Includes full-time and part-time undergraduate and postgraduate students

3.5.2 National / Macro-level Benchmarking

As indicated above, one approach to overcoming the issues of access to data at research programme level and comparability of data across countries is to compare outputs and impacts at national level.

Table 3.42 Selected Proposed International Benchmarking Indicators

Proposed Indicator	Comparitor Countries	Data Source and Frequency
Number of Full-Time Equivalent Researchers by Sector	EU-25, OECD and selected non-OECD countries	EU Commission, DG Research – Annual data; Current latest year 2001
Number of Full-Time Equivalent Researchers per 1,000 of Labour Force	As above	As above
R&D Expenditure per Researcher – Current	As above	As above
Number of Graduates by Field of Study (incl. Science and Technology fields)	As above	As above
Number of New PhDs Created by Discipline per 1,000 of Population Aged 25-34	As above	As above
Number of Scientific Publications per 1 Million of Population	As above	As above - current latest year 2002
Number of European Patent applications per 1 Million of Population	As above	As above; latest year 2000

Source: Indecon

In the table above a number of proposed indicators are set out which could be applied within the context of benchmarking progress in Ireland with that pertaining across a number of countries (Table 3.42). A number of tables and charts describing the data underlying each of these indicators follows. These indicators capture the outputs and impacts over time deriving from all national research supports, including the PRTLI. However, it should be noted that in most cases the data currently available covers the period 1996-2001. As the impacts of the PRTLI and other research programmes may only become evident over a longer period, it will be necessary to update the data underlying these indicators on an annual basis.

Table 3.43 below presents a comparative analysis of the number of full-time equivalent researchers, the average annual growth in the numbers of researchers between 1996 and 2001 and the sectoral breakdown of researchers across the EU-25, the US and Japan. This data is sourced via the European Commission from the OECD and Eurostat. Of the EU-15 Member States, it is notable that Ireland had a total of 8,516 full-time researchers employed in 2001. Furthermore, the growth in the number of researchers averaged 7.3% per annum between 1996 and 2001, ranking Ireland in 5th place across the fourteen Member States for which data is displayed. This also compares with an EU-15-wide average growth rate of 3.9% per annum and average growth rates in the US and Japan of 4.3% and 1.8% respectively over this period. It is also instructive to note the sectoral focus of researchers employed. According to the figures, the largest proportion of researchers (66.1% in 2001) in Ireland are employed in the business sector, followed by the higher education sector (25.2%) and the government sector (8.7%). This compares with a breakdown of 49.7%, 34.5% and 13.4% respectively across the EU-15 as a whole.

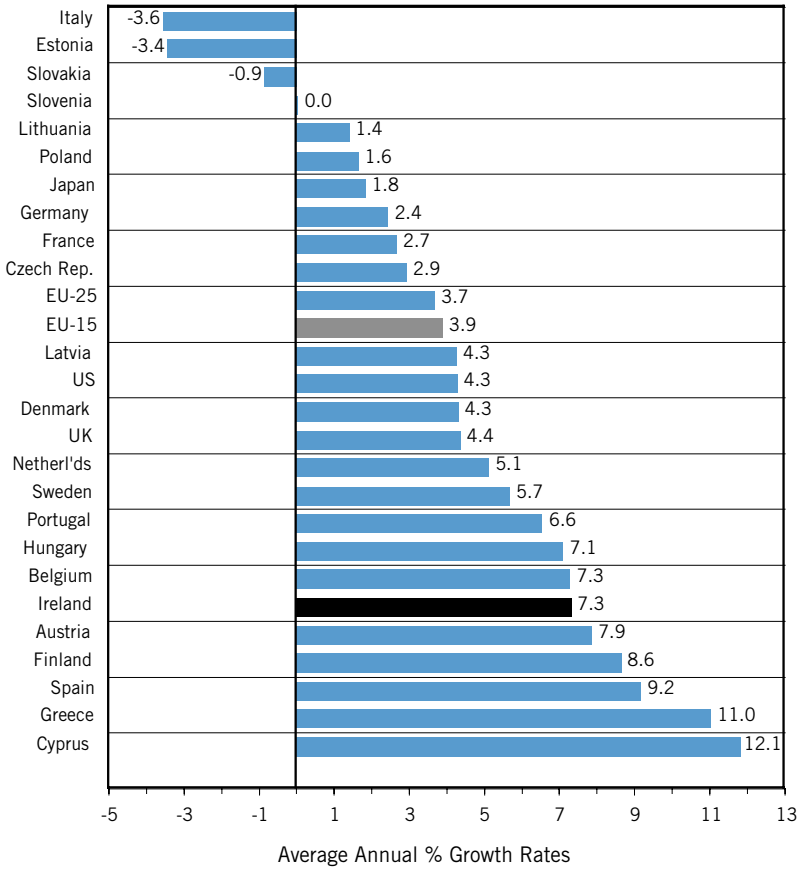
Table 3.43 Researchers (Full-Time Equivalent) – Total Numbers and % by Sector - 2001[1]

	Business Enterprise	Government	Higher Education	Total number of researchers - 2001	Average annual % growth rates 1996-2001[2]
Belgium	54.5	4	40.4	30,219	7.28
Denmark	47.9	20.7	30.2	18,944	4.3
Germany	59.3	14.4	26.3	259,597	2.43
Greece	15.2	13.6	71	14,748	11.03
Spain	23.7	16.7	58.6	80,081	9.17
France	47.1	15.2	35.8	172,070	2.67
Ireland	66.1	8.7	25.2	8,516	7.32
Italy	39.5	21.7	38.9	66,110	-3.56
Netherlands	47.6	14.1	37.2	42,085	5.11
Austria	62.6	5.1	31.8	18,715	7.86
Portugal	15.5	21	50.3	17,584	6.55
Finland	56.9	12.3	29.8	36,889	8.64
Sweden	60.6	4.9	34.5	45,995	5.68
UK	57.9	9.1	31.1	157,662	4.37
EU-15[3]	**49.7**	**13.4**	**34.5**	**972,448**	**3.9**
Cyprus	n/a	n/a	n/a	333	12.08
Czech Rep.	38.4	32.3	28.4	14,987	2.94
Estonia	n/a	n/a	n/a	2,681	-3.44
Hungary	27.8	31.8	40.5	14,666	7.1
Lithuania	n/a	n/a	n/a	8,075	1.4
Latvia	n/a	n/a	n/a	3,497	4.26
Poland	16.9	18.7	64.3	56,919	1.64
Slovenia	33.6	32.3	30.7	4,498	0.04
Slovakia	23.5	25.4	51	9,585	-0.86
EU-25[3]	**47.3**	**14.5**	**36**	**1,084,726**	**3.68**
US	80.5	3.8	14.7	1,261,227	4.28
Japan	63.7	5	29.6	675,898	1.83

Source: DG Research Key Figures 2003-2004
Data : OECD, MSTI 2003/Vol.1, for non-OECD members: Eurostat/Member States
Notes:
The sectors do not add up to 100%
(1) or latest available year: AT, UK: 1998, BE, DK, EL, US: 1999; FR, IE, IT, NL, EU-15, EU-25, TR, CH: 2000.
(2) or nearest available years: AT: 1993-1998, EL: 1995-1999, US: 1997-1999; BE, DK: 1996-1999; FR, IE, IT, NL, EU-15, EU-25, TR, CH: 1996-2000; PT, FI, SE, IS, NO: 1997-2001; CY, EE: 1998-2001.
(3) EU-15, EU-25 data are estimated by DG RTD and total numbers do not include LU or MT. EU-25 by sector data exclude LU, CY, EE, LT, LV and MT.

Figure 3.16 provides a graphical representation of the average annual growth over the period 1996-2001 in the number of full-time equivalent researchers employed, again indicating an average annual growth of 7.3% in Ireland.

Figure 3.16 Number of Researchers: Average Annual % Growth Rates, 1996-2001*



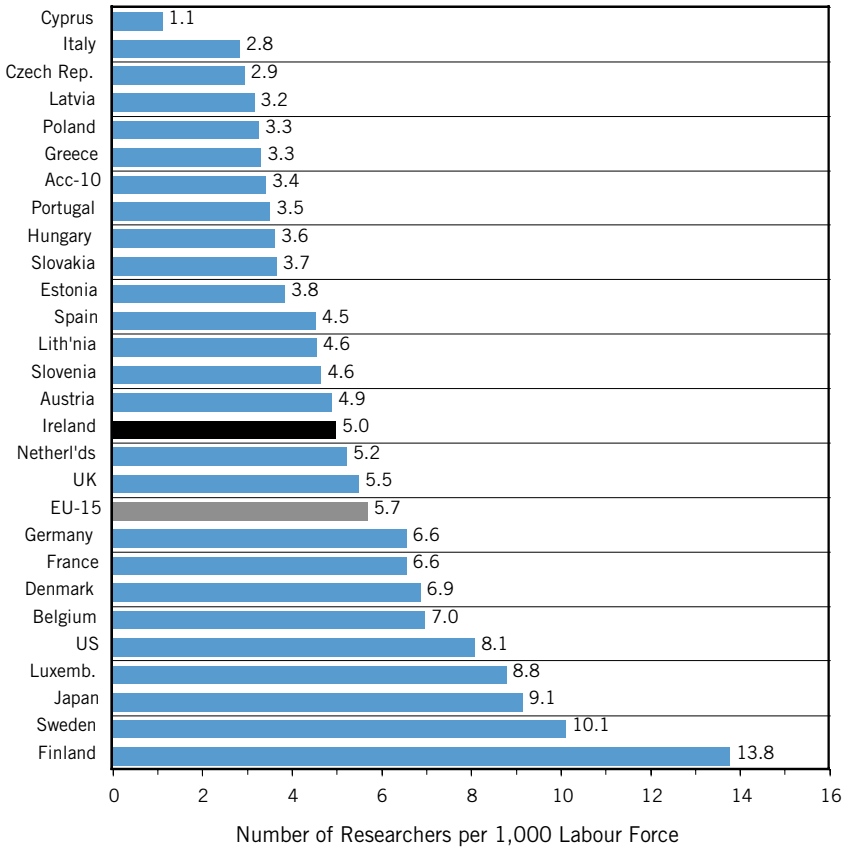
Source: DG Research Key Figures 2003-2004

Data : OECD, MSTI 2003/Vol.1, for non-OECD members: Eurostat/Member States

Note: * or nearest available years: AT: 1993-1998, EL: 1995-1999, US: 1997-1999; BE, DK: 1996-1999; FR, IE, IT, NL, EU-15, EU-25, TR, CH: 1996-2000; PT, FI, SE, IS, NO: 1997-2001; CY, EE: 1998-2001.

Another perspective on the comparative scale of the researcher population can be had by comparing the number of full-time equivalent researchers with the labour force in each country. Figure 3.17indicates that there were approximately 5 full-time researchers employed per 1,000 of the labour force in 2001, placing Ireland about mid table across the countries shown. This was below the figure of 5.7 researchers per 1,000 of the labour force across the EU-15 as a whole and it is also notable that Ireland lags considerably behind countries such as Finland, Sweden and Japan in relation to the scale of its research population.

Figure 3.17 Number of Researchers per 1,000 Labour Force, 2001*



Source: DG Research Key Figures 2003-2004

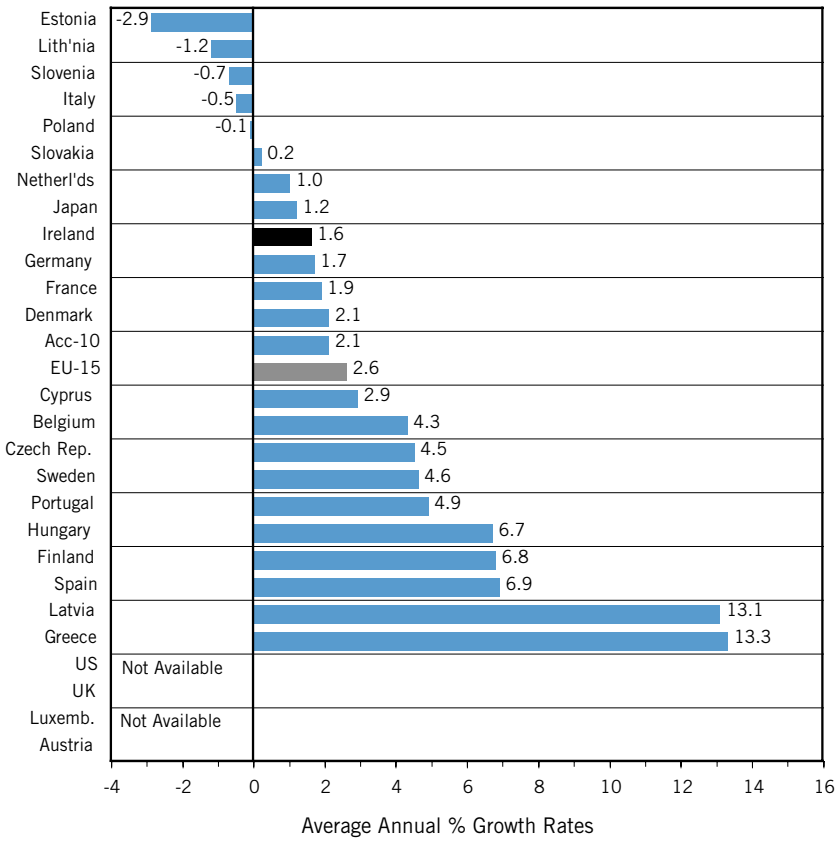
Data: Benchmarking Indicator, Eurostat/Member States

Notes: Data for DE, PT, JP are estimated. EU-15 data do not include UK, ACC data do not include MT.

* or latest available year: PT, IS, JP: 2002; FR, IT, LU, NL, CH: 2000; BE, EL: 1999; AT, UK: 1998; US: 1997.

To what extent have research programmes, such as the PRTLI, assisted in allowing Ireland to catch up with its European counterparts in relation to the number of researchers per 1,000 of the labour force? Figure 3.18 indicates the comparative average annual growth rates in the number of FTE researchers per 1,000 of the labour force. Interestingly, this indicator places Ireland, with an average growth rate of 1.6% per annum, significantly below the EU-15 average growth of 2.6% per annum between 1996 and 2001, and considerably below the rates of growth achieved in Finland (6.8% per annum) and Spain (6.9% per annum) over this period.

Figure 3.18 Number of Researchers per 1,000 Labour Force, 2001: Average Annual % Growth Rates, 1996-2001*



Source: DG Research Key Figures 2003-2004

Data: Benchmarking Indicator, Eurostat/Member States

Notes:

Data for DE, PT, JP are estimated. EU-15 data do not include UK, ACC data do not include MT.

* or nearest available years: PT, IS, JP: 1996-2002; SE, CZ, PL, RO, NO: 1997-2001; IT, NL, CH: 1996-2000; BE: 1996-1999; EL. 1997-1999; CY: 1999-2001; BG: 2000- 2001.

It is also instructive to compare Ireland's position in relation to the level of government, business and higher education sector expenditure on research activities. In the table below (Table 3.44) the level of R&D expenditure per full-time equivalent researcher in 2001 across a number of countries in Europe, in addition to the US and Japan is described. In terms of the total level of R&D expenditure per researcher, Ireland (at €139,000) is positioned at mid-table across the 25 countries shown. Notably, while this was below the EU-15 total of €171,000 per researcher, it was just above the total for Finland in 2001.

In terms of the sectoral composition of R&D expenditure, the level of expenditure per researcher is highest in Ireland in the business enterprise sector (€151,000 per researcher in 2001), followed by the government sector (€130,000 per researcher) and the higher education sector (€111,000 per researcher). A comparison with the EU-15 breakdown suggests that the contribution of the business enterprise sector to total R&D expenditure is lower in Ireland.

Third-level Graduates

Table 3.45 describes the comparative growth in the numbers of university graduates over the period 1998-2001, including the breakdown in relation to science and engineering fields of study. The analysis indicates that total of 45,818 individuals graduated from the third-level university system in Ireland in 2001, of which 14,038 graduates were from the science and engineering fields of study. However, in terms of comparative growth in graduate numbers, it is notable that Ireland lagged behind both the total across the EU-15 and the EU-25 (i.e. including the Accession Countries) over this period.

Table 3.44 R&D Expenditure (in Current €000) per Researcher (FTE) - 2001[1]				
	Totals	**Business Enterprise**	**Higher Education**	**Government**
Sweden	227	291	128	132
Japan	212	245	103	404
Germany	199	236	121	186
Denmark	188	254	121	132
Italy	188	239	150	165
Netherlands	186	223	145	170
US	182	169	171	361
France	180	239	94	205
Austria	180	183	168	228
EU-15	171	225	103	170
EU-25	156	214	90	147
Belgium	153	201	90	127
UK	145	164	92	214
Ireland	139	151	111	130
Finland	125	156	76	103
Cyprus	81	67	47	140
Spain	78	172	41	74
Slovenia	76	131	40	57
Portugal	58	121	41	59
Czech Rep.	55	87	31	41
Greece	54	101	38	86
Hungary	37	54	24	30
Poland	23	49	12	39
Slovakia	16	45	3	15
Estonia	14	30	11	15
Latvia	10	15	7	13
Lithuania	9	55	5	12

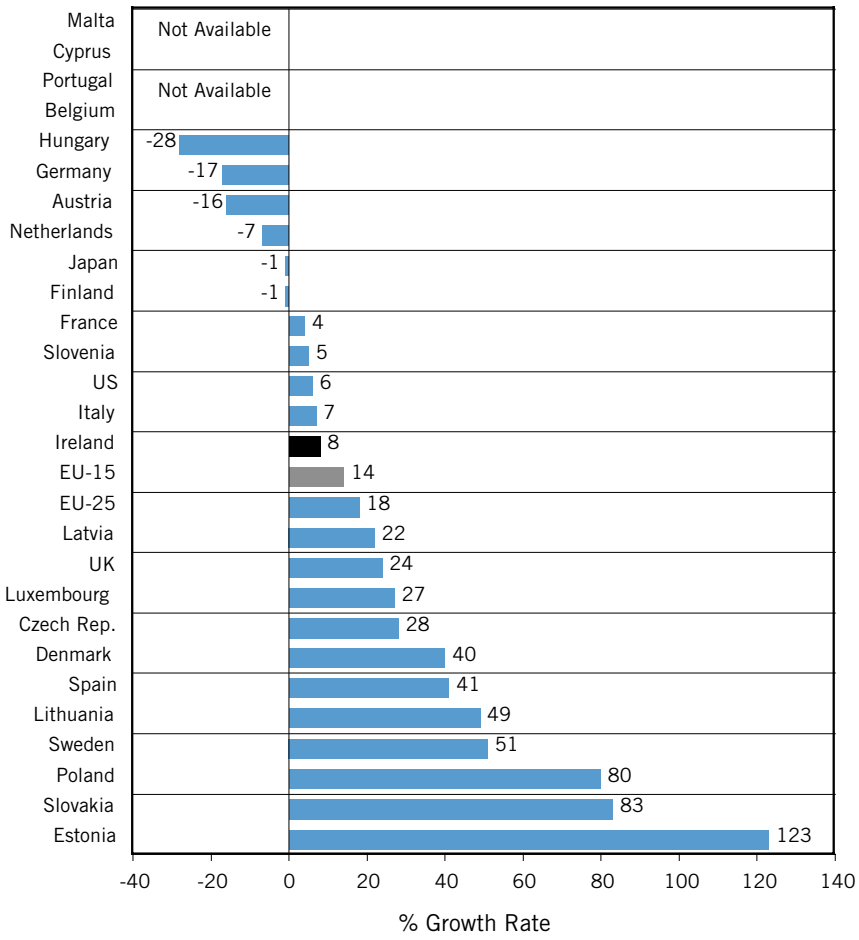
Source: DG Research Key Figures 2003-2004
Data: OECD, MSTI 2003/Vol.1, for non-OECD members: Eurostat/Member States
Notes:
(1) or latest available year: AT, UK: 1998; BE, DK, EL, US: 1999; FR, IE, IT, NL, EU-15, EU-25, TR, CH: 2000. EU-15, EU-25 data are estimated by DG RTD and total numbers do not include LU or MT. EU-25 by sector data exclude LU, CY, EE, LT, LV and MT.

Table 3.45 University Graduates - 2001[1]			
	All fields of study	In S&E fields of study	Total growth rates in % - 1998-20012
Estonia	7,600	1,379	123
Slovakia	26,272	6,733	83
Poland	431,104	44,842	80
Sweden3	42,741	13,702	51
Lithuania	27,471	7,025	49
Spain	277,853	74,312	41
Denmark	39,017	8,456	40
Czech Rep.	43,629	9,586	28
Luxembourg	680	99	27
UK	551,665	150,865	24
Latvia	20,308	2,473	22
EU-25	2,872,166	675,313	18
EU-15	2,241,093	593,122	14
Ireland	45,818	14,038	8
Italy	202,309	46,590	7
US	2,150,954	369,391	6
Slovenia[3]	11,991	2,432	5
France	508,189	154,756	4
Finland	36,141	10,104	-1
Japan	1,067,878	233,386	-1
Netherlands	81,603	12,664	-7
Austria	27,099	7,423	-16
Germany	296,640	76,617	-17
Hungary	57,882	5,820	-28
Belgium	70,202	13,239	n/a
Portugal	61,136	10,257	n/a
Cyprus	2,813	336	n/a
Malta	2,003	186	n/a

Source: DG Research Key Figures 2003-2004
Data: UOE database, Benchmarking indicators Eurostat/Member States,
Notes: The %'s in fields of study do not add up to 100%.
(1) DK, FR, IT, LU, FI, CY, HU: 2000.
(2) DK, FR, IT, LU, FI, CY, HU: 1998-2000.
(3) EU-15, EU-25 data do not include EL. EU-15 growth rate does not include BE, PT.

A graphical illustration of the comparative growth in the numbers of university graduates over the period 1998-2001 is shown in Figure 3.19 below. This indicates that the growth rate in the number of graduates in Ireland (at 8%) was noticeably lower than that across the EU-15 (14%) and the EU-25 (18%) over this period. Interestingly, however, the growth in graduate numbers in Ireland compared with a decrease in Finland over the same period.

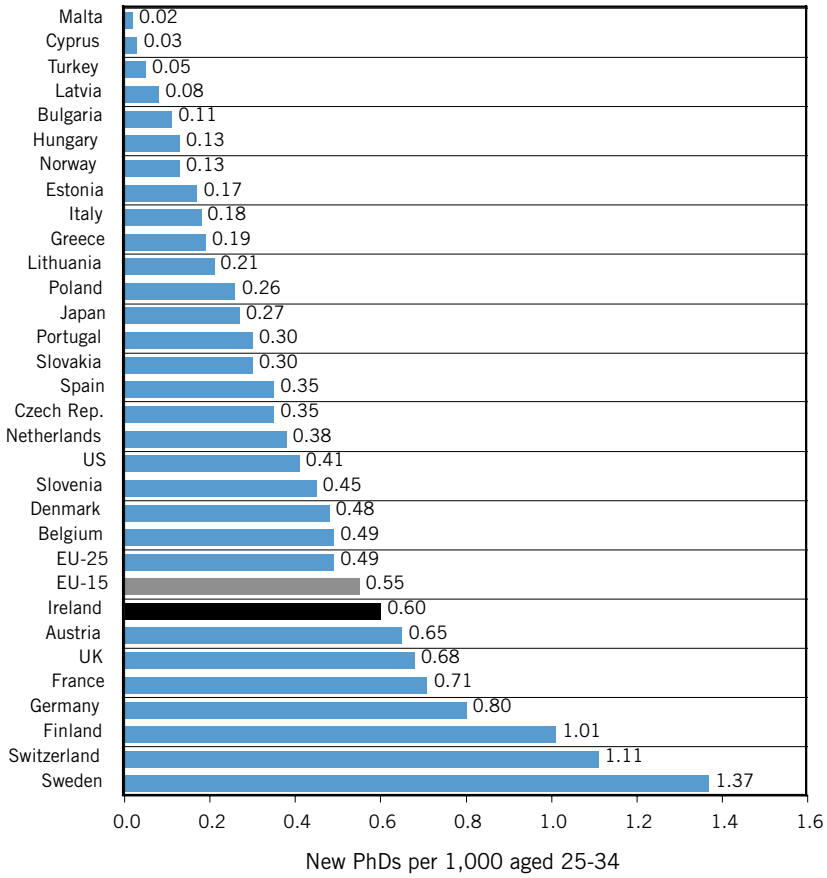
Figure 3.19 University Graduates: Total % Growth Rates, 1998-2001*



Source: DG Research Key Figures 2003-2004
Data: UOE database, Benchmarking indicators Eurostat/Member States
*Note: * DK, FR, IT, LU, FI, CY, HU: 1998-2000.*

One measure of the production of researchers is the number of new PhDs produced relative to a country's population. In Figure 3.20 a comparison across a number of countries of the numbers of new PhDs produced in 2001 in science and engineering fields of study relative to the population aged 25-34 is presented. In 2001, Ireland produced 0.6 new PhDs in the science and engineering fields per 1,000 of then population aged 25-34. This was slightly above the EU-15 level of 0.55, although Ireland lagged behind countries such as Finland (1.01), Switzerland (1.11) and Sweden (1.37) during this period on the basis of this measure.

Figure 3.20 New PhDs in Science and Engineering Fields of Study per 1000 population aged 25-34, 2001*



Source: DG Research Key Figures 2003-2004.

Data: UOE database, Benchmarking indicators Eurostat/Member States

Notes:

LT: Data include only PhDs at universities. Changes in LT education system distort data for 2000/2001

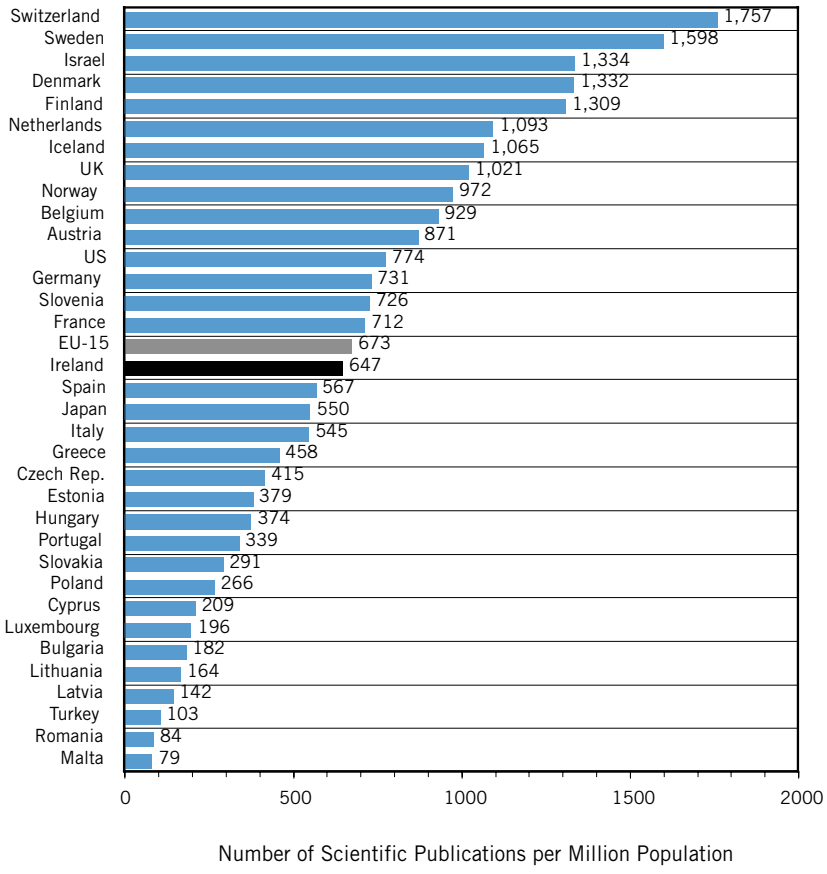
** or latest available year: EU-25: 2000-2001. EU-15, FR, IT, FI, UK, CY, US: 2000, EL: 1999.*

Population data for US, JP, TR are from 2002.

Research Outputs

In comparing the outputs from national research programmes one useful cross-country measure is the number of scientific publications produced relative to a country's population. Figure 3.21 below presents a comparative illustration of the number of scientific publications produced per 1 million of population across 34 countries internationally in 2002. According to the figures, a total of 647 scientific publications were produced per 1 million of population in Ireland in 2002, which is about mid-table across the countries shown. However, Ireland's publication rate in 2002 was slightly below the total across the EU-15 (673 publications per 1 million of population) and substantially below that evident in the UK (1,021 per 1 million population) and Scandinavian countries including Finland (1,309), Denmark (1,332) and Sweden (1,598 per one million of population).

Figure 3.21 Number of Scientific Publications per Million Population, 2002*



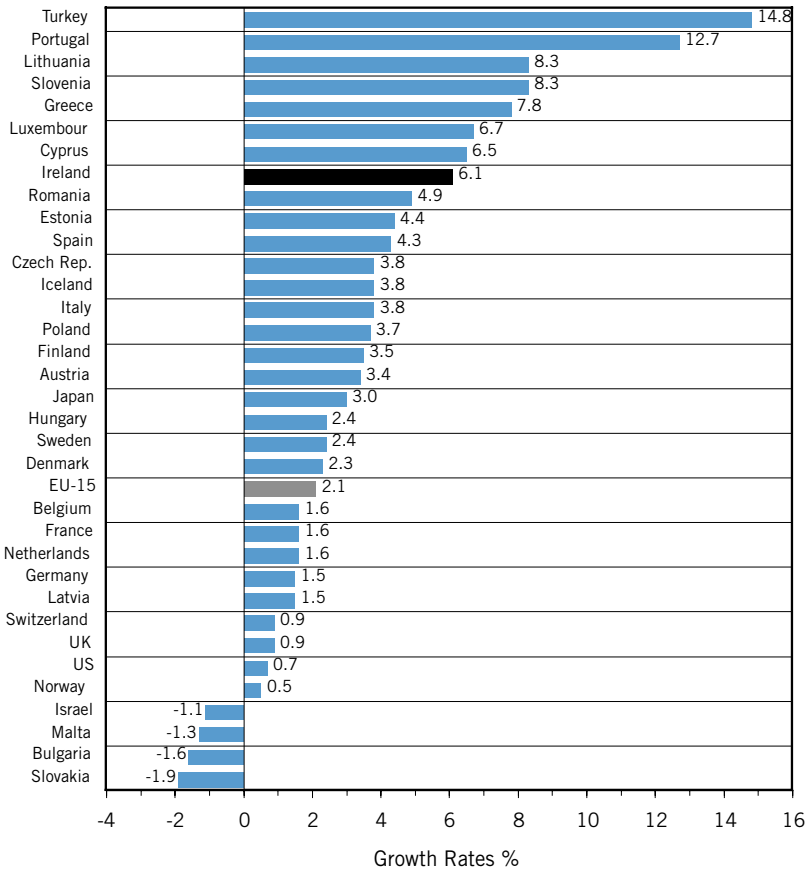
Source: DG Research Key Figures 2003-2004.

Data: Publication data: ISI, CWTS (treatments), population data: OECD: MSTI 2003/1; Eurostat: NewCronos

*Note: * Population: 2001.*

It is also important to look outside a single year and consider the comparative growth rate in publications over a longer time period. Figure 3.22 compares the growth rates across 34 countries internationally in the number of scientific publications over the period 1995-2002. Ireland recorded a 6.1% growth in the total number of scientific publications produced over this period, which was substantially above the EU-15 rate of growth of 2.1% and the eight highest rate of growth recorded across the countries shown. While this is an eight-year time span and it would be necessary to look at progress in each year since the commencement of the PRTLI in 1998/1999, the figures nevertheless provide some evidence that Ireland's research outputs have been catching up with other countries internationally since the mid-1990s.

Figure 3.22 Growth Rates of Scientific Publications (%), 1995-2002



Source: DG Research Key Figures 2003-2004.

Data: Publication data: ISI, CWTS (treatments), population data: OECD: MSTI 2003/1; Eurostat: NewCronos.

Patent Applications

A key aspect of the assessment of the impacts of large-scale research programmes, including the PRTLI, is the impact evident in relation to innovation and the diffusion of knowledge. One useful indicator of innovation impacts is the number of patent applications and the growth in such applications over time.[6] The table below presents a comparative analysis of the level and growth in shares by country in total European Patent Office applications (Table 3.46).

6. The number of patent applications, as opposed to the number of patents registered, is considered a more useful measure, as the time lags involved in the patent registration process are such that the impacts of the PRTLI are not likely to be evident at this juncture.

Table 3.46 European Patent Office Patent Applications: Country Shares and Average Annual Growth in Country Shares (1995-2000)

	Shares EPO (2000) - %	% Growth in shares EPO (1995-2000)
Belgium	1.23	-0.6
Denmark	0.78	1.4
Germany	20.6	1.2
Greece	0.04	0.6
Spain	0.69	3.2
France	6.87	-2.2
Ireland	0.23	10.7
Italy	3.61	-0.4
Luxembourg	0.06	8.9
Netherlands	2.88	4
Austria	1.03	-0.7
Portugal	0.03	4.3
Finland	1.29	3.9
Sweden	2.13	0.4
UK	5.33	-1.3
EU-15	46.79	0.4
Cyprus	0	n/c
Czech Rep.	0.06	11.9
Estonia	0.01	n/c
Hungary	0.1	7.4
Lithuania	0	n/c
Latvia	0	n/c
Malta	0.01	n/c
Poland	0.03	1.8
Slovenia	0.03	5.2
Slovakia	0.02	12.2
EU-25	47.06	0.4
US	27.54	-1.5
Japan	17.2	0.2

Source: DG Research Key Figures 2003-2004 Data: OECD

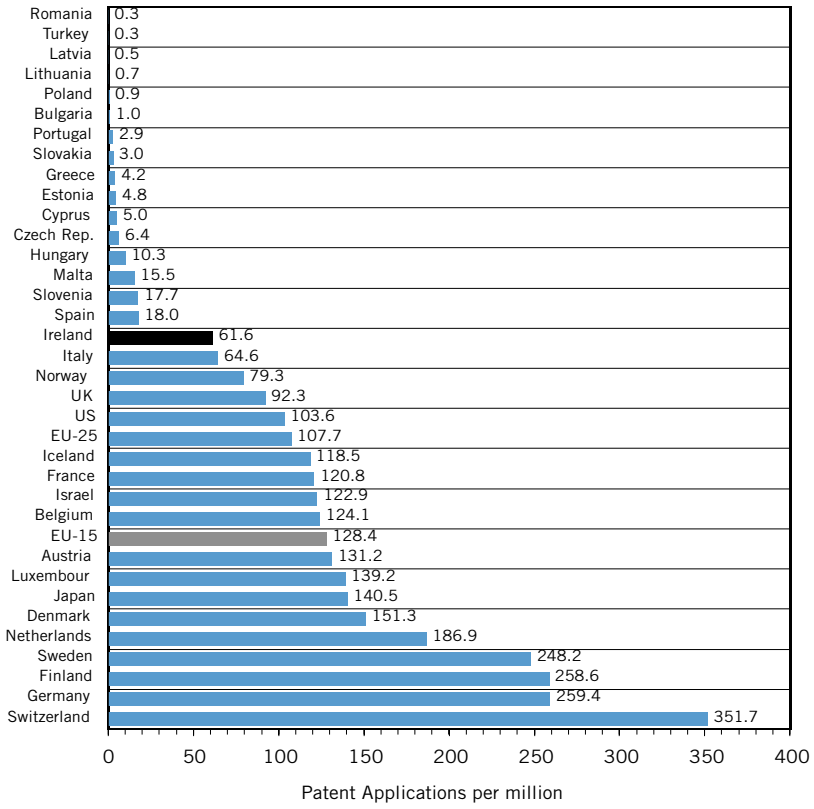
Note: * European Patent Office (EPO) data refer to patent applications by year of application.

n/c - growth rates not calculated for countries with less than 20 patents during the previous three years.

According to the figures, Ireland's share in the total number of applications to the European Patent Office reached 0.23% in 2000. However, it is notable that this represented an increase of 10.7% since 1995, which was the third highest rate of growth recorded over this period among the countries shown. While more up to date data would be required to discern any impact arising from the PRTLI, these figures suggest a substantial increase in commercial innovation activity in Ireland based on patent applications since the mid-1990s.

Another perspective on patent activity is shown in Figure 3.23 below which relates the number of patent applications to each country's population. On this basis, Ireland's rate of patent application reached 61.6 per million of population in 2000. However, this was less than half the level recorded across the EU-15 as a whole (128.4 per million of population) and substantially below that seen in countries such as Finland, Germany and Switzerland.

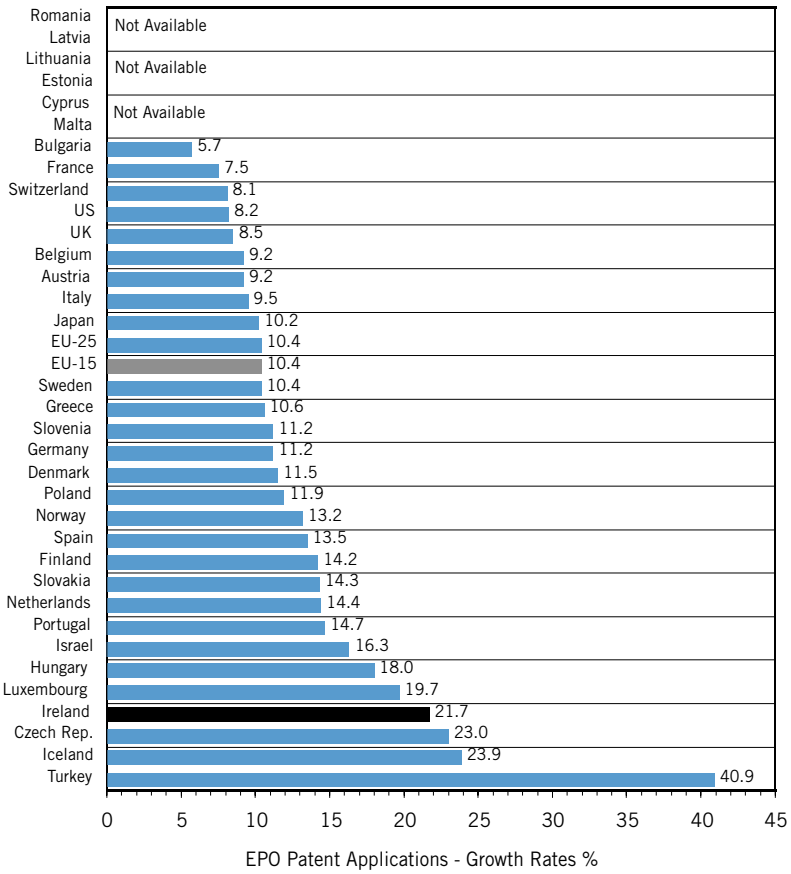
Figure 3.23 Patent Applications at the European Patent Office per 1 Million of Population - 2000



Source: DG Research Key Figures 2003-2004.
Data: OECD, Eurostat

Figure 3.24 below describes the growth rates in the actual number of patent applications by country through the European Patent Office over the period 1995-2000. On this basis, Ireland recorded the fourth highest rate of growth in the number of applications through the EPO, at 21.7% between 1995 and 2000. This compares with an increase across the EU-15 as a whole over this period of 10.4%.

Figure 3.24 Growth Rates of Patent Applications at the European Patent Office - 1995-2000 - %



Source: DG Research Key Figures 2003-2004.

Data: OECD, Eurostat

Note: Not available - Growth rates not calculated for countries with less than 20 patents during the previous three years.

4 | APPENDICES

4.1 Visiting Experts Synthesis Report

1. Does the added value justify the investment in the centres?

The overwhelming view of the experts is that the PRTLI investment is fully justified by the evidence of the visits. However, the added value needs to be sustained with further funding (from whatever sources) if the value is to be maintained. These issues are detailed below.

In addition to these issues, there are other issues which are outside the scope of PRTLI, but which should be addressed if PRTLI is to achieve its full potential.

(a) **Management and Leadership.** There is little experience of large-scale RTD management within the Irish RTD system. This point has been highlighted in other reports on Irish S&T.[7] The lack of experience is evident in some centres in the areas of future financial planning, and in equipment and facility maintenance. Training and other supports are required to address this issue.

(b) **Collaboration.** In a very small number of cases it is apparent that the collaboration which was intended in particular centres has not occurred. While collaboration cannot be forced, the colleges in receipt of PRTLI funds should perhaps take steps to encourage its development.

(c) **IPR Awareness and Training.** Awareness of the principles of IPR is a fundamental need for R&D professionals. While many colleges offer such training, the experience of the visiting teams is that a high proportion of students and staff have had no training in this issue. See also 5 below.

(d) **Career Structures.** Development of a career structure for post-Doctoral Fellows is also a requirement for a viable RTD infrastructure (see also 3). This is outside the scope to PRTLI, but nevertheless important in ensuring the sustainability of the benefits of PRTLI.

(e) **The Role of the Centre within college.** Several of the issues which arose hinge on the perception by the host college of the role of a PRTLI centre. In some colleges the centre clearly has a high status as a decision-making unit for future research directions etc. In others it is little more than a space within which the constituent departments perform research.

(f) **Overheads.** Fundamental to the issue of future funding of centres is the proportion of overhead costs which are returned to the centres. (See 7).

7. e.g. Baseline Assessment of Public Research System in Ireland in Biotechnology & ICT. Forfas 2002.

2. What has been the greatest research impact of PRTLI?

PRTLI has had a major impact on RTD in the Irish HE system. In many colleges the funding has totally transformed the environment for R&D and, in many cases, for T&L. Although the impact is variable between centres, the overall impact is hugely positive. The impacts are many, but the main apparent benefits are:

- PRTLI has provided resources which allow a significant number of Irish researchers to pursue world-class research, and to participate in the international R&D community as peers.
- The Centre buildings and management have facilitated significant increases in interdisciplinary research. In many cases building design has greatly contributed to this factor by facilitating staff interaction.
- The additional RTD activity, multidisciplinarity, research facilities and funding has greatly increased ability to attract overseas talent (Postdoctoral Fellows etc)
- The facilities, and increased numbers and wider expertise of centre staff have greatly enriched the educational environment for Undergraduates and Postgraduates. Once again, building design has, in some cases, contributed by facilitating Undergraduate/Postgraduate/Postdoctorate/faculty interaction.
- The additional facilities, expertise and scale of R&D activity has greatly enhanced the ability of centres to compete in a wider range of national and international funding programmes.
- It has also significantly increased the output of publications and presentations.

3. Has participation in the PRTLI process resulted in problems?

The centres identified no major issues. However, some issues which were noted by the visiting experts include:

- There is little experience in Ireland in managing RTD activities at the scale made possible by PRTLI & SFI funding. This is evident in some centres regarding future planning (see 7), and also in relation to equipment and facility maintenance.
- As might be expected, a small number of centres had not achieved real interaction between the different disciplines involved.
- The increased numbers of Postgraduates and Postdoctoral Fellows, and their importance to the centres, have highlighted the need to develop a career structure for research professionals. However, this issue is clearly outside the scope of PRTLI.

4. How does the R&D programme interact with T & L activities?

The experts were very positive about this interaction, and found that the HEA insistence on a strong linkage between R&D and T&L was an advantage of the PRTLI. The major benefits and issues arising were:

- The greater numbers of Post-docs and the increased involvement of a greater range of faculty in R&D have enhanced the breadth of expertise available to both Undergraduates and Postgraduates. In some centres the building design has significantly contributed to developing this interaction. In a minority of centres the building design has been an obstacle.
- Increased contact between Undergraduates and Postdoctoral Fellows was a frequently mentioned benefit both in educational terms, and also in encouraging participation in higher degrees.
- Development of new interdisciplinary and other courses and modules has benefited both Undergraduate and Postgraduate training. In some cases these have been inter-institutional between colleges in Ireland and elsewhere, with very positive effects.
- Research seminars are important mechanisms for communicating R&D developments to students at all levels. While such seminars are a feature of most centres, efforts to promote these events to Undergraduates (and on occasion to Postgraduates) could be improved.
- Many centres are significant national resources and could be made more available for school visits etc. so as to enthuse future science students. In this context it was noted that several colleges have active education departments which could be appropriately used as collaborators in developing such outreach activities.

5. How do you ensure that commercial, policy and other outputs of research are protected, & communicated to potential users?

All centres had developed initiatives to communicate their findings and/or developments to potential users and these are generally appropriate in their intent. However, the scale and quality of the specific activities was highly variable and many centres are still exploring appropriate mechanisms. Development of such initiatives is an on-going activity which must be continually addressed.

A major concern of the experts is that formal training in IPR is non-existent in almost all of the centres visited. The issue of IP protection and management was, in many centres, regarded as a responsibility of the wider college rather than as a core need of the centre. Whereas most colleges do have IP management staffs that are available to the PRTLI centres, the centres should also ensure that their researchers and students are familiar with the principles of IPR. There was little apparent effort to ensure that this was so. The perception that IP protection is necessarily adverse to the need to publish would appear to remain within many centres.

6. How does your centre's activity fit into the overall college RTD strategy, and vice versa?

Generally there was a good match between the college RTD Strategy and the PRTLI activities.

7. How are you planning for post-PRTLI growth?

Lack of future financial planning was a concern to many of the visiting experts. Several teams commented on the apparent naivety of centre managements as to the full costs of running their centres. Many centres have no plan for funding of their future growth, or even for maintenance of their existing facilities.[8] Some centres view PRTLI as being necessarily a recurrent and guaranteed source of future income and seem entirely dependent on further rounds of PRTLI funding.

In contrast, other centres have viewed PRTLI as a means to build their competence to compete for funding from a wide range of public and private sources. These centres appropriately look to a wide range of national and international public and industrial sources for their future R&D funding. Given the uncertainty of such funding, it is not reasonable to expect detailed financial planning from these centres. However, their planning for post-PRTLI growth is appropriate and feasible.

The return of overhead funding to the centres also concerned several of the visitors. Policy in some colleges means that as little as 10% of overheads on their external funding would be returned to the centres for maintenance of their facility. The visiting experts fully accept that the college should receive a fair return on their inputs to the centres. However, this low level of overhead charges will not allow the centre to maintain its equipment. If centres were allowed to keep a higher proportion of overheads it would contribute significantly to their future needs for equipment maintenance and replacement.

A similar principle should be applied in regard to returns on patenting and royalties.

8. How does PRTLI complement other Irish S&T supports?

PRTLI enhances the ability to compete for all available R&D supports. It is believed to be particularly complementary to SFI funds. In very general terms the PRTLI is thought to provide the 'bricks and mortar' while SFI provides the staffing.

9. What impact has PRTLI had on the Europeanisation of research?

There is no evidence that PRTLI has reduced the interest of researchers in international collaboration. There has been a significant increase in the numbers of non-national researchers, which has increased contacts with overseas groups. There has also been an increase in participation in international events by RTD staff. Reduced participation in FP6, where it was acknowledged, was attributed to changes in the Framework programme rather than to any lack of interest or intent among the centres.

8. It should be noted that some centres are in the early stages of their development and have not yet completed their buildings.

10. How do you perceive the management of PRTLI overall

Centres are generally positive, or at least satisfied, about the HEA's management of the PRTLI. The reporting requirements are not regarded as being onerous, but could be simplified. There was a very consistent complaint about the lack of feedback to centres from the 6-month reports. Some centres also noted the lack of visits by HEA staff.

11. Are all funds agreed being allocated to the project

In so far as it could be determined without an audit, all funds appeared to be allocated as intended. There is no apparent mechanism by which the colleges could divert funds.

4.2 Summary Report on Peer Reviews

4.2.1 Background

Centre directors were asked to submit approximately ten recent publications for peer review. While a bibliometric study has been carried out for the PRTLI centres, it is broken down by discipline rather than centre and therefore does not provide a view of the research quality of individual centres. This peer review of publications goes some way to provide that missing dimension on a centre basis. This is particularly important for centres working in the Humanities and Social Sciences (HSS) where conventional bibliometric studies are less reliable.

The intention was that appropriate international peers should review the ten publications submitted. Additional reviews were planned for the HSS centres so as to offset inherent and well-recognised problems with bibliometrics in their case. This note summarises the review results to date. It is not intended as a comparison between centres. Equally, it is not intended to be in any way judgemental, in that there are perfectly good reasons for low scores, such as relative immaturity of a centre or the inherent distance of the research from application.

Reviewers were asked to answer seven questions:

1) Are you aware of this Centre or Research Group?
2) Do these papers present research consistent with the objectives of the Centre and do the results contribute to achieving the objectives?
3) Is the research described and its presentation of international quality?
4) Does this research represent a significant contribution to knowledge at the international scale?
5) Is this body of knowledge likely to have socio-economic, policy or cultural implications?
6) Have you any additional comments or observations?
7) Please score the research content of this body of work with reference to its quality by ticking one of the boxes below

Rating	Poor	Weak	Good	Excellent	Outstanding
Please tick one box					

4.2.2 Methodology

The reviews are qualitative in nature. CIRCA have applied a quantitative scale to them grading the opinions given on the first six questions on a scale of zero (totally negative) to three (very positive). In the last question a rating on a scale of zero to five was used. The total represents marks scored as a % of possible marks for that number of reviews and the number of questions answered, as not all reviewers answered every question. It is fully realised that this is not a precise analysis but it may be a useful overall guide to the views expressed by the reviewers. The results of all the reviews are shown in Table 4.1 by sector.

Table 4.1 Summary of all peer reviews								
Centre	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Total%**
Biosciences and Biomedical programmes								
A	0, 1,	2, 3,	2, 3,	2, 2,	0, 1,	2, 2,	3, -,	64 (2)
B	3, 2, 3,	3, 3, 3,	3, 2, 3,	3, 3, 3,	3, 3, 2,	-, 2, 3,	4, 4, 4,	89 (3)
C	2, 3, 3,	3, 2, 3,	3, 2, 3,	3, 2, 3,	3, 2, 1,	3, 2, 2,	4, 3, 4	83 (3)
D	3, 1, 3, 0, 0	2, 3, 3, 1, 3	2, 2, 3, -, 3	2, 2, 3, -, 3	0, 3, 3, 1, 3	1, -, 2, -, 2	3, 3, 3, 3, 4	68 (5)
E	3, 0, 3,	3, 3, 1,	3, 3, 2,	3, 3, 3,	3, 3, 1,	3, 3, 2,	5, 4, 3,	83 (3)
F	3, 0, 3,	3, 3, 3,	3, 3, 3,	3, 1, 3,	3, 0, 3	2, 2, -	4, 3, 3	77 (3)
Chemical and Physical Sciences programmes								
G	0, 0	3, 3	3, 2	3, 2	2, 2	-, -	-, 4	69 (2)
H	3, 3, 2, 3	3, 3, 3, 3	3, 3, 3, 3	3, 3, 3, 3	2, 2, 2, 3	3, 2, 3, 3	4, 4, 4, 4	90 (4)
I	3, 0, 1, 0	3, 3, 2, 2	3, 2, 3, 2	3, 2, 3, -	3, 0, 3, 3	2, 1, 2, -	4, 3, 4, 4	68 (4)
J	3, 1,	3, 3,	3, 3,	3, 3,	3, 3,	3, 3,	4, 4,	91 (2)
Information and Communications Technologies programmes								
K	0, 2, 2,	2, 2, 3,	2, 2, 3,	2, 1, 3,	2, 2, -,	2, 2, -,	4, 3, 4,	73 (3)
L	3, 1, 2	3, 3, 3	3, 3, 3	3, 3, 3	2, 3, 3	3, 1, 3	4, 4, 5	91 (3)
M	0, 3, 0,	1, 2, 3,	3, 3, 3,	0, 3, 2,	0, 2, 1,	1, 2, -,	2, 4, 4	68 (3)
Humanities programmes								
N	0, 0, 2, 2, 3	3, 3, 3, 3, 3	3, 2, 1, 3, 3	3, 2, 1, 3, 2	2, 1, 3, 2, 0	3, -3, 2, 2	4, 4, 3, 4, 4	92 (5)
O	3, 3, 0, 3, 1	3, 3, 3, 3, 3	2, 2, 3, 3, 3	3, 3, 3, 3, 3	1, 3, 1, 3, 2	2, 2, 3, 4, 2	4, 4, 4, 5, 3	89 (5)
P	3, 3,	3, 3,	3, 3,	3, 2,	3, 2,	2, 2	4, 4,	87 (2)
Social Sciences programmes								
Q	0, 1,	-, 2	3, 3	3, 2	3, 2	3, 3	4, 4	77 (2)
R	0, 0, 0, 3, 0	3, -, 3, 3, 0	3, 2, 2, 3, 1	3, 1, -, 3, 0	2, 1, 3, 3, 1	3, 2, -, 3, 0	4, 2, 3, 4, 1	55 (5)
S	0, 0,	1, 1,	2, 2,	2, 1,	2, 1,	1, 1,	2, -,	39 (2)
Environment and Marine programmes								
T	0, 0, 0	3, 3, 3	3, 3, 3	3, 3, 2	3, 1, 2	3, 2, 2	4, 4, 3	72 (3)
U	0, 0, 0,	3, 2, 2	3, 2, 3	2, 2, 2	2, 2, 2,	-, -, 2,	4, -, 4	64 (3)
Overall Averages	1.42	2.6	2.65	2.47	2.06	2.24	3.60	75.4
Averages, Science & Medicine	1.5	2.7	2.8	2.5	2.1	2.2	3.7	77
Averages, H & SS	0.9	2.4	2.5	2.4	2.0	2.2	3.2	70

The numbers shown in each cell are the "scores" given by the individual peers to the centre for each question respectively. "-" indicates no answer. The number of peers who reviewed each centre is shown in brackets in the "Total" column. The last three rows give the average scores for each question for the 21 centres, the 15 in Science and Medicine and the 6 in HSS respectively.

4.2.3 Discussion of results

Given the qualitative nature of the reviews and the rating system used, it would not be realistic to carry out any statistical analysis more refined than that presented in Table 4.1.

A number of trends can be seen:

- The spread of scores in each cell was generally tight i.e. there was fairly good agreement between the peers
- There is no obvious correlation between the overall score attained by a centre and its antecedent's performance and maturity. Obvious examples are the low scores given to some centres, which are built around long-established groups, whereas some more recently established centres, which have not got a strong research background, are very well known to their reviewers. This is an indication that PRTLI has been effective in building fresh research capability and capacity in the Irish HE sector
- While the HSS centres scored somewhat lower than the centres working in Science and Medicine, the only big difference is the extent to which the former are known internationally.

In detail:

- The average level of the peers' awareness of the centres was surprisingly low at 1.39 overall of a possible 3.0 (Q1). This is equally true for the newer centres and those founded on existing research records. However, the HSS centres are significantly less well known than those in Science and Medicine. Some of this may be due to the authors' failure to cite the centre as their affiliation and more generally the short period in which the centres have been establishing their names. An objective of PRTLI is to promote inter-disciplinary research and collaboration. It is therefore inevitable that some reviewers may be unaware of particular centres whose publications cover a wide range of topics, some of which are outside the reviewers' ken
- There is a high degree of correlation between the publications and the objectives of the centres (Q2)
- Due to the manner in which the bibliometric exercise was carried out it is not possible to compare the results of the peer reviews with the bibliometric analyses. However, the peers were generally of the opinion that the publications are of a high international standard and do represent a major contribution to knowledge (Q3 and Q4).
- The question (Q5) covering socio-economic, policy and cultural impacts may not have been interpreted by peers as intended. "Socio-economic" was intended to cover social benefits such as improved quality of life, improvements to the environment or increased employment and economic benefits such as increased GNP, exports or profitability of the private sector. "Policy implications" referred to possible contributions to national policy formulation. "Cultural" was intended to refer particularly to HSS centres, whose work would be less

likely to contribute to socio-economic development but could bring about cultural changes in Irish society. For example, some answers did not address the question, were too general to be informative, were given in the context of fundamental scientific impact, or lacked any detail. One reviewer "deemed it inappropriate to answer this question"

The relatively low average score is also due in part to the fact that some of the research is removed from the marketplace, and some centres are still immature

- The additional comments and observations (Q6) varied widely in content and thrust. It is not possible to rank them on the same points and the scores shown reflect the degree of approval of each centre's progress rather than comment on the same points. These opinions may have been influenced by the relatively low scores given to questions one and five.

4.2.4 Conclusions

The centres are producing publications of relevance to their objectives, of a high international quality and constituting a significant contribution to knowledge. Their overall performance is only slightly short of "excellent" with two centres regarded as "outstanding". However, the centres are not generally well known for a variety of reasons, and have not yet had very large socio-economic impacts.

A number of comments are presented here as examples for high-scoring centres:

- The papers presented here are all of high international standard. Some of the manuscripts for publication are not internationally reviewed up to now but these also reflect the high scientific standard of the centre
- This paper is excellent and appears as the result of an efficient international co-operation
- Overall, the publications are strong and represent substantial, very sound research at the international level. I do emphasise that all I have seen is uniformly of very good if not excellent quality
- Both papers are clearly polished pieces produced by mature, accomplished scholars. The Centre has apparently produced good work.
- I am impressed by the very well structured activity of the centre
- The results are published in well-recognised international journals throughout. In general I would rank the contributions as good and solid research clearly consistent with the objectives of the centre. They are no doubt internationally competitive without however reaching a really leading position so far. I would not judge the latter as a major criticism since the centre is still rather young

Some comments on the lower-scoring centres:

- (The papers) vary quite markedly in quality: one, clear, international: the second high national, the third sound national
- This is a sound paper with some useful insights, but has not much research content
- 50% of the papers are international, 25% are national and 25% sub-national. One of the last is an unrefereed review which does not contribute to knowledge
- The evidence submitted does not support the concept of a coherent research effort, but appears to represent a series of essentially unrelated themes.
- What I see in these individual studies is exciting novel work in a spectrum of scientific areas. Each, alone, stands perfectly well. The centre might achieve greater impact if these various research groups work together, for just 10% of their time on mutual projects
- Even on first glance, and before reading the overview document of the centre, it was patently clear that the papers represent a highly eclectic and divergent body of research work that appears to have no unifying theme or relationship between the individual components

In addition to the peer reviews described above, a different set of experts, comprising teams of scientific and educational experts, visited each of the same centres. This part of the overall review has been reported separately to the Assessment Committee. The questions posed to the groups of visiting experts were not the same as those discussed here, but there are some overlaps which may confirm answers given by the peer reviewers:

- The visiting experts noted that in a very few cases there was a significant lack of collaboration within centres. This reinforces the view of the peer reviewers that the publications submitted did not always form a logical homogenous body of work, although in general they supported the objectives of the centres.

- The visiting experts noted a lack of experience in managing large research budgets and an associated lack of awareness of commercial implications for research results. The peer reviewers noted a lack of socio-economic impacts at this stage, though adduced on different evidence.

- Overall, the visiting experts were genuinely impressed with the organisation and quality of work carried out in the centres. This reflects the opinion of the peer reviewers.

4.3 Summary of Bibliometric Assessment

4.3.1 Background

A bibliometric analysis of publication output and citation levels was included as part of the PRTLI Impact study. While the limitations of citation analysis in the case of recent papers were fully realised, it was equally felt that an impact study that did not include a bibliometric analysis would be incomplete. The overall purpose of the bibliometric analysis was to compare the output and citation levels of papers published before PRTLI and during PRTLI.

The methodology employed is described in Section 1.2.2

In assessing the results of the analysis, it is useful to note some limitations inherent in the data and the process used. Some of these issues have been described in detail in the appended CWTS report. The more significant points are:

(a) Because the authors were selected on a random basis by CWTS, it was not possible to compare the results between centres. The publications have therefore been broken down by discipline, using standard classifications of disciplines used by CWTS. However, this approach can be problematic in dealing with research groups, which are involved in multi-disciplinary research, which is the case in most PRTLI centres.

(b) Citations of papers will occur over a period of years following the initial publication of the paper. Papers influenced by PRTLI funding cannot have appeared before approval of PRTLI funding, and most publishing activity would have been significantly later due to the practicalities of obtaining staff and equipment, and conducting the research. The dates on which PRTLI centre funding was approved[9] were:

- Cycle 1: July 1999
- Cycle 2: July 2000
- Cycle 3: December 2001

It is therefore reasonable to assume that PRTLI funding could not have affected output for at the very least 6 months after these dates and could not logically affect citation rates for at the very least 12 months. The earliest effect of PRTLI on output would therefore be in early 2000, and on citation in late 2000. The optimistic 'window' in which the bibliometric analysis can be expected to show an impact on output would therefore be from the start of 2000 until approximately September 2002, when the CWTS database ends. Effects on citation will only be evident in the 2-year period from approximately September 2000 to September 2002. Many of the papers published in this period will be further cited after Sept. 2002. CWTS also note "it is perhaps too early to draw conclusions on the effectiveness of the (PRTLI) funding".

9. The actual payment of exchequer funding did not occur for a further 5-9 months due to negotiations and administrative requirements.

Some disciplines are under-represented in the index of periodicals used in the analysis. In particular, Humanities and Social Science papers are generally not included in the CI Database, i.e. the set of periodicals used for citation analysis[10]. The table below shows the breakdown of the 193 researchers by discipline, and the numbers of their papers which are in the CI Database. The low numbers of papers in the last 2 fields mainly reflect their low representation in the CI database journals. It is therefore not appropriate to use citation analysis in these fields. For this reason, they were given less consideration in the bibliometric analysis and additional attention in the peer review process.

Table 4.2 Breakdown of the 193 randomly sampled researchers by Discipline of work and their outputs

Discipline	Number of Researchers	Number of CI Publications	Number of Publications / Researcher
Biosciences/Biomedicine	73	1560	21
Chemical & Physical Sciences	35	1011	29
Environment	42	424	10
ICT	13	174	13
Humanities	16	12	1
Social Sciences	14	92	7

Source: Source: Circa analysis of data submitted in 6-monthly reports to HEA by PRTLI-funded institutions.

(c) The Irish research community is in continual change, and particularly so over the last 5 years. The sample of 193 researchers includes individuals who have worked in Ireland since 1993 (i.e. throughout the period of analysis) and also those who have arrived in Ireland since 1993. It is important to note that the data includes all of the papers of each of the 193, regardless of their location when publishing.

4.3.2 Results

The data has been analysed to show some general effects on the publishing performance of PRTLI researchers. The analysis was conducted in total and by field. The results in the different fields of activity show very different patterns.

The overall **output** of the 193 researchers shows a slow increase over the period 1993-2002. This is mainly accounted for by increases in the research outputs of Environment and Biosciences/Biomedicine researchers. Researchers in Chemical & Physical Sciences and ICT show a 'stable output' over the period (see Figure 4.1).

Further analysis of output shows some interesting aspects. Firstly, it should be recalled that the analysis is of specific researchers who are currently working in PRTLI centres, but who may have been working elsewhere during an early part of the period of analysis. Figure 4.2 shows that the proportion of researchers who are publishing from addresses outside Ireland gradually reduces over the sample period. In 1993 over 30% of

10. TCWTS ISI CD-Rom based publication database 1980-2002 – covers about 10,000 journals

output was published outside Ireland, while in 2002 it was less than 10%. The reason for this is that recent appointees publish from the address at which the work was conducted. This reflects the move to Ireland of a significant proportion of the sample researchers.

Figure 4.1 Output trends per field (blocks of publications) 1993-2002

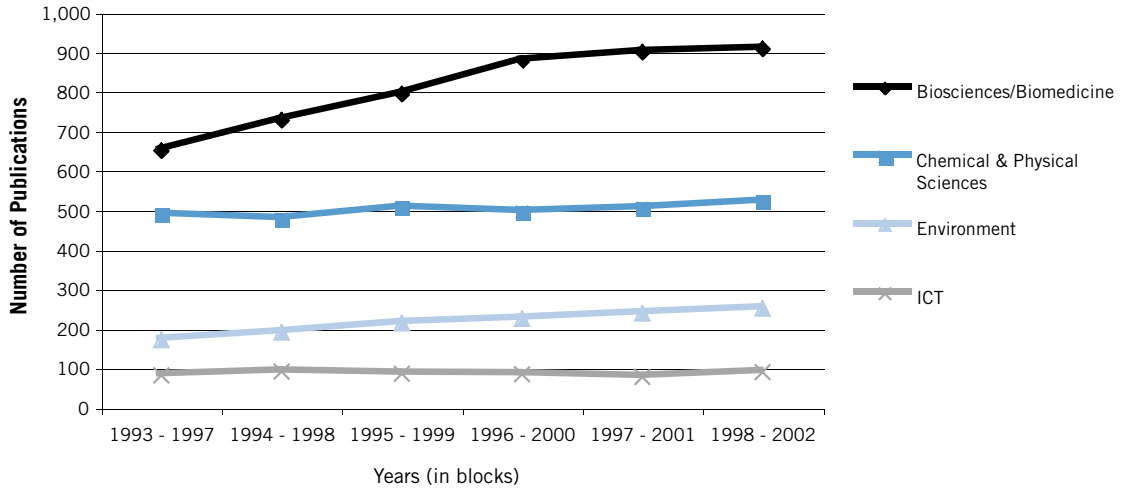
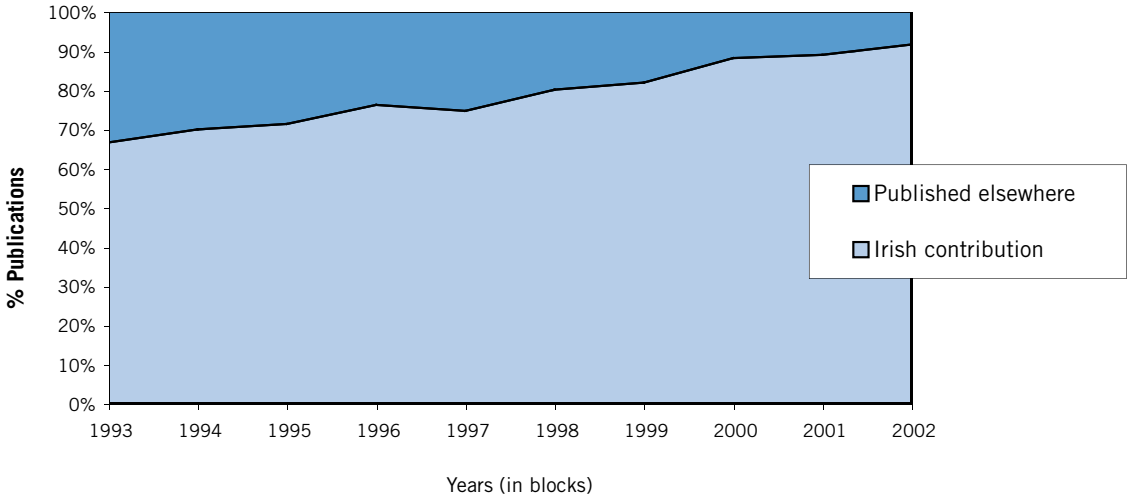


Figure 4.2 The share of Irish and non-Irish contributions to the publication output of PRTLI-funded researchers, 1993-2002.



The **impact** of these papers on international science is measured by comparison of the citation rates of these researchers with those of other researchers publishing in the same fields and journals[11]. Figure 4.3 compares the output of all of Irish research with the sample researchers. The impact of the PRTLI funded group is significantly higher than the overall Irish rate as shown in Figure 4.4. PRTLI-funded researchers also publish in higher impact journals than the average Irish researcher.

11. This measure is abbreviated as CPP/FCSm in the CWTS report

Figure 4.3 Comparing the output of Ireland and HEA-funded research, 1993-2002.

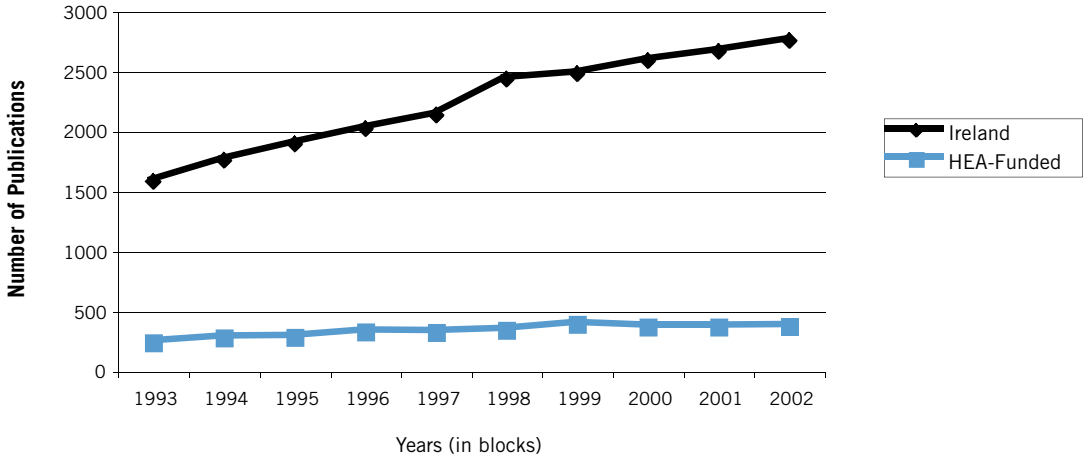


Figure 4.4 Comparing the impact (CPP/FCSm) of Ireland and HEA-funded research, 1993-2002.

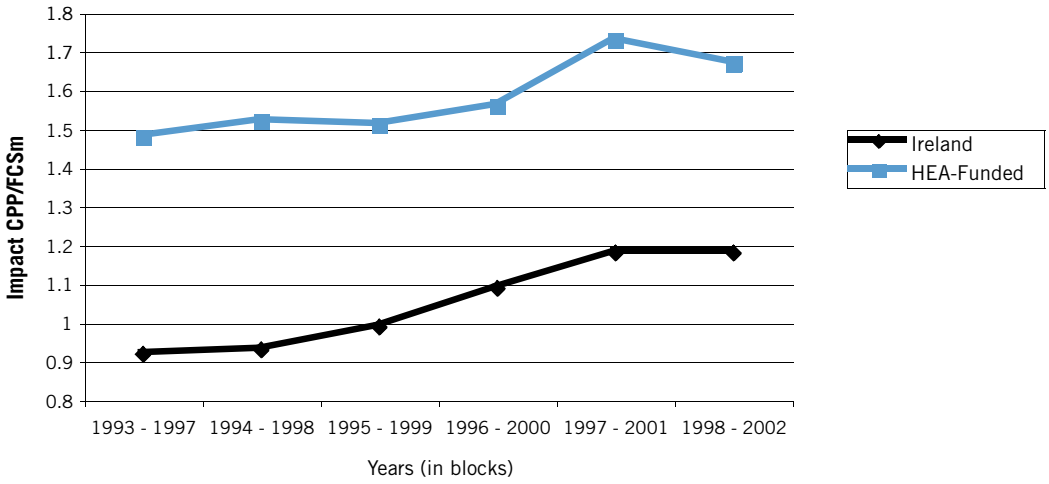
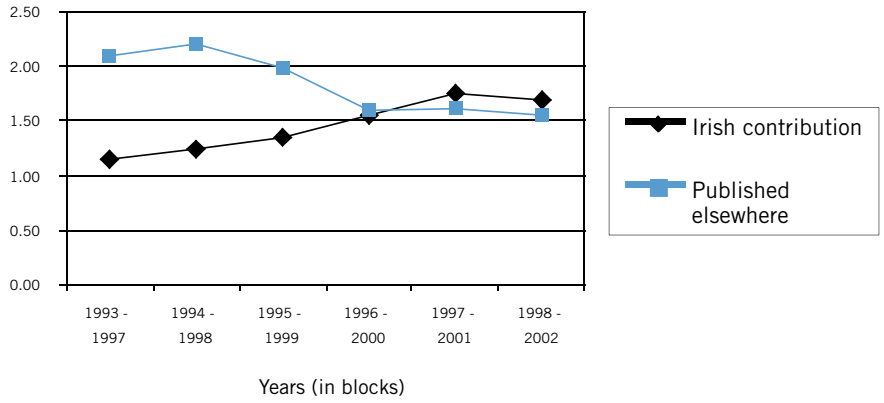


Figure 4.5 shows an analysis of the impact of the papers from the 193 researchers from Irish or non-Irish addresses. In other words it separates the papers published by the researchers while working outside Ireland from those published while in Ireland. This clearly shows that the research published abroad was of higher impact than that conducted in Ireland. One conclusion that can be drawn is that the researchers attracted to work in PRTLI centres are authors of high-impact papers. The reason why the papers from this group reduce in impact over the period of analysis is less clear but may be due in part to the demands made in starting up new facilities and groups. This figure also shows that the papers from Irish addresses also increase in impact over the period.

Figure 4.5 Impact of Irish non-Irish contributions to the publication output of PRTLI-funded researchers, 1993-2002.



Looking at the impact by field, there is a clearly different pattern within each of the areas. Overall, there is an increasing impact in all fields over the period and the impact in all fields is in the category of 'high to very high'. However, in the ICT field there is a very dramatic increase in citation rate, and in impact, beginning in approximately 2000. In this field the impact is 50% above world average from 2000 onwards.

In comparative terms, Irish output between 1993 and 2002 is very low compared to that of researchers in Austria, Denmark, and Finland (See CWTS Report). The rate of increase in their outputs is also somewhat higher than the Irish output. However, the other three countries show a 'slowing down' in 2001 and 2002, while the Irish output continues to increase in these years.

However, the impact (***CPP/FCSm***) of these publications shows a strong increase in the period in comparison with Austria, Denmark, and Finland, which are generally comparable smaller EU countries. Ireland starts the period (1993) with the lowest impact score, and ends with the highest score in 2002. It should also be noted that the PRTLI-funded research has even higher impact scores (see above).

The bibliometric analysis also measured international collaboration. Publications with international collaboration account for approximately 30% of output in total, and in the fields other than ICT the level of collaboration shows a small increase over the period of analysis. Initial concerns that the level of funding from national sources might reduce interest in international collaboration (e.g. through participation in Framework Programmes) seem to be unfounded. The ICT field, however, shows a very different pattern (See relevant Fig. 32 in CWTS Report WWW.hea.ie/). At the start of the analysis period this field had the highest levels of international collaboration, while at the end of the period it had dropped to the lowest in any field.

12. There may of course be other reasons for work to be published from a non-Irish address, but this is the general reason for this to occur.

The overall results are consistent with the findings of the centre visits, which was that there is no evidence of a reduced interest in international collaboration.

In summary, the publications of the PRTLI researchers are impressive in terms of their impact in their respective fields. Although Irish publication output is still low in comparison with other comparable EU countries, it is increasing steadily. Given that it is still too early to assess the full effects of PRTLI funding (for reasons noted in section (b) above), the general trends in output and impact are considered impressive by the CWTS experts. Direct comparison with the peer review process is not possible, because the process used does not allow comparison on a centre level.

4.4 Examples of PRTLI Researcher involvement with Industry and other users of research output*

Start-up companies that have been created with strong links to PRTLI-funded research include the DCU-based Aliope Ltd, Neat Vision.com, Fluorocap Ltd and Intellipak Ltd. PRTLI-researchers at the Biosciences Institute and the Analytical and Biological Chemistry Research facility at UCC were behind the spin-out company, Luxcel Biosciences.

In association with the Conway Institute researchers at UCD are involved in several ventures including Cytrea, Analytical Drug & Data, Celtic Catalysts and Enzolve Technologies. In addition, as a consequence of the development of the Conway Institute, investigators have been involved in the UCD-based NOVA Innovation Centre as well as contributing to the production of a business plan for a National Bioincubator to house new start up bioscience-based companies. On the campus at TCD and associated with IITAC, the spin-out activities of the Centre for Research on Exposure Modelling Estimates (Creme) are at an advanced stage.

The heightened research activity and new PRTLI facilities nationwide are also attracting industry interest, thus creating new opportunities for economic impact. In some cases new PRTLI centres provide laboratory space for industry contacts to perform their research. Materials Ireland, an EI initiative to support materials industry, carry out research in the Sami Nasr Institute of Advanced Material Sciences (IAMS), thus exploiting both equipment and research expertise of academic researchers. IAMS in conjunction with the Physics department at TCD has forged strong links with Intel Ireland, which resulted in capital investment of approximately €2.5m in the IAMS facility. Intel also continues to support research and teaching activities including the support of a new interdisciplinary research degree. The relationship with Intel has continued with the planned establishment of the new SFI CSET Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN). Researchers at IAMS have also contributed to Allegro Technologies Ltd (now Deerac Fluidics), a spin-out which started in 2000 (IAMS first received PRTLI funding in the pilot phase in 1998). Other Trinity spin-offs that have associations with IAMS include Magnetic Solutions and Eblana Photonics.

The Nanofabrication Facility in the NMRC at UCC has made new research collaborations with industrial partners possible through the availability of enhanced infrastructure and specialised equipment. During 2003 more than 70 industrial clients, including over 50 Irish companies, made use of NMRC's extensive research capability and infrastructure through research contracts, equipment usage and consultancy. These include indigenous companies such as Eblana Photonics, Firecomms and Plasma Ireland, and multinationals Boston Scientific, Dell Products, IBM microelectronics, Intel and Pfizer Pharmaceuticals. Direct project interactions with industry partners include Aerogen, Silmac, Celestica, Kamelian, Mesophotonics, NanoComms and Agilent.

At NUI Galway, several companies, including Serusa, Proxy Biomedical and Labcoat Ltd, are provided support by the NCBES and in some cases have researchers based in the centre. Other strong links exist between industrial partners through research expertise and/or use of equipment, although not housed on campus. For example Scientific Systems Ltd. is a spin-off company from DCU with a strong ongoing partnership with the NCPST. In TCD, The IITAC programme has resulted in additional investment by Hitachi Dublin in the centre's facilities and research contracts have been secured with this company.

Strong links with Science Foundations Ireland's CSETs also exist. Currently three out of five of CSETs are housed in PRTLI Centres. This includes the Alimentary Pharmabiotic Centre (APC), housed in UCC's Biosciences Institute and associated with the PRTLI Food and Health Programme. This CSET has strong links with the start-up company Alimentary Health Ltd. and its partner Procter & Gamble. Although Alimentary Health ltd. pre-dates PRTLI, activities are highly complementary. Other CSETs include REMEDI in the NCBES in NUI Galway and the Centre for Human Proteomics (CHP) housed in the Institute of Biopharmaceutical Sciences in the RCSI.

PRTLI researchers have secured in the region of €3.3m directly from industrial partners for research activity in areas of PRTLI focus. Some examples include collaborative agreements between FOCAS (DIT) and Littelfuse Ltd and Sortex Ltd; the Materials and Surface Science Institute (UL) have established several research alliances with for example Abbott, Uro Devices Ltd, Kerry Algae, Howmedica and Aughinish Alumina. Researchers involved from the Institute of Biopharmaceutical Sciences (RCSI) have reached agreements or are in final stages of negotiation with Aventis, Servier, Pfizer, Siemens, Clonmel Healthcare, Allegro and Genera. In addition, Researchers at DCU have set up an agreement leading to the signing of a €1.2 million commercialisation co-operation agreement with an Irish-based venture capital firm. The Trinity Centre for High Performance Computing (part of IITAC, TCD) are currently working on two software commercial contracts, one with a Japanese multinational and one with an Irish-based telecommunications company.

In the humanities and social sciences, linkages with relevant policy groups have been developed and information, including policy-informing papers, is being channelled to these users. Examples of these include government departments (Department of Enterprise, Trade and Employment, Department of Justice, Department of Finance), government bodies (Dúchas, Office of Public Works, Irish Council for Science, Technology and Innovation), Foundation for Fiscal Studies, Economic and Social Research Institute, Combat Poverty as well as numerous other aid agencies and health research organisations.

PRTLI researchers have generated publications with immense social benefit and impact on wider society. Some of these areas of research include:

- Healthcare
- Education and childcare
- Literacy and special needs
- Social inclusion
- Irish economy and poverty
- Foreign investment
- EU enlargement
- Competitiveness and globalisation
- Enterprise and entrepreneurship
- Irish voting habits
- Peace and reconciliation
- Immigration, asylum seekers, integration and racism
- Urban regeneration and housing
- Energy efficiency and climate change
- Environmental risk

4.5 List of Tables and Figures

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Higher Education Authority.

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Department of Economics,
National University of Ireland, Galway

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Mr. Patrick J. Kirby
Group Commercial Director, Alphyra

Ms Monica Leech
Communications Consultant

Professor Tom McCarthy
Professor of Economics and Dean of Business School,
Dublin City University

Ms Antoinette Nic Gearailt
Principal, The Donahies Community School, Dublin

Mr. Barry O'Brien,
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Royal College of Surgeons in Ireland

Professor Sarah Moore,
Dean of Teaching and Learning, University of Limerick

Professor Ciaran Murphy,
Department of Accounting , Finance & Information Systems,
University College Cork

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