



# Sustaining Investment in Research and Development

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Advisory Council for Science  
Technology and Innovation  
An Comhairle Eolaíochta



## Introduction

The Council acknowledges the very significant and tangible commitment that the Government has made to research and development over the past ten years and welcomes the statements of on-going commitment provided in the context of “Building Ireland’s Smart Economy” and other statements of Government policy.

We welcome the evidence that is emerging as to the success of individual programmes and Ireland’s overall Strategy for Science, Technology and Innovation and particularly the indicators that point to increased commitment by the business enterprise sector to research and innovation.

The high-tech industries and internationally traded services have made a very significant contribution to growth in value added in Ireland in the past decade. Future economic growth in Ireland will be dependent on our success in these knowledge-intensive sectors. Therefore, a competitive intellectual infrastructure is essential.

The vision outlined in the Strategy for Science, Technology and Innovation, 2006-2013, is the roadmap for future prosperity in Ireland. In this time of challenge, we must rededicate ourselves to that vision.

We believe that investment in R&D should be sustained at the 2009 level.

At the same time, our research and innovation strategies need to be continuously assessed and fine-tuned. As a specific input to current deliberations on research and innovation policy, we highlight in this statement a number of areas that should receive the immediate attention of Government in order to maximise the impact of public investment in R&D.

## Why are we investing in Science and Technology?

Economic research focuses on two general sources of economic growth: “brute force” (more machines and people) and “smart growth” (better “machines”, i.e. technological progress, and better use of people and “machines”). The robust conclusion from this research is that smart growth - what in technical terms is called total factor productivity - is more important than brute force. This raises two sorts of questions: what are the factors that result in advances in technology and the better use of people and technology in production?, and can governments influence these factors?

In general terms the underlying factors explaining smart growth are: research and development, and improvements in the quality of the workforce. The capacity of a country to grow income per head of population depends on its ability to achieve improvements in total factor productivity. For this reason governments in advanced economies have devoted considerable resources to third level education and research.

Irish economic development over the past forty years has been underpinned by investment in education. This commenced with the decision to make access to second-level education universal. It was followed by the expansion of the third level system to the point where it now seems possible to fulfil an aspiration that 70% of the school leaving cohort attend at third level. In the past decade our focus has been on investing in research capacity in Ireland. This was seen to be a necessary complement to an enterprise policy which recognised that continued success in attracting FDI could not rely on tax or cost advantage.

The need for such investment was recognised by the Economic and Social Research Institute in the 1990s: “the promotion of investment in R&D is seen to be at the heart of national development strategies. The case for support for R&D is extremely strong since it has very significant potential returns on investment. Current levels of public investment in R&D are low by international standards. We therefore recommend a substantial increase in public expenditure on R&D in the next decade.” (‘ESRI: Investment Priorities 2000-2006’).

The approach to the investment followed the recommendations of the Technology Foresight exercise conducted by the Irish Council for Science, Technology and Innovation (ICSTI) in 1998. The ICSTI report identified the need to build world class research capability of sufficient scale in a number of strategic areas and identified potential for commercial exploitation in areas of new technology such as information technology, telecommunications, nanotechnology, biotechnology and medical systems.

The government responded to these proposals by establishing a Technology Foresight Fund of over €630 million for the seven year period of the National Development Plan 2000-2006. It accepted that such a research fund was necessary to:

- Develop world-class research capabilities in strategic technologies to underpin the future development and competitiveness of Irish owned industry,
- Facilitate the undertaking of R&D in this country by multinational companies in order to support the further development of that sector in Ireland,

- Attract more high technology companies to Ireland in the future, and
- To enhance the environment for the creation of new technology-based firms.

A new agency, Science Foundation Ireland, was established to administer this fund and build research capability in the areas identified by the Foresight exercise. In addition the Government sought to build research capacity in the third level sector through the Programme for Research in Third Level Institutions (PRTLII). A key element of this initiative was the requirement that institutions prioritise and collaborate across the sector.

The pressures that are currently being placed on Exchequer resources are causing the Government, and all interested stakeholders, to examine the impact of public investment in research and development, its contribution to economic growth and the changes that might need to be made to maximise the impact of Exchequer resources. Currently the Strategy for Science, Technology and Innovation budget for 2009 is at €643 million (€751 million for 2008). There has been a loss of the cross departmental competitive fund. Overall, investment is running €229 million behind the NDP projections which were based on a 4% annual economic growth model.

### Council Opinion

- Total factor productivity growth in Ireland has surpassed that of other OECD countries over the past twenty years. This has been driven in large part by the quality of graduates produced and the transfer of technology that has resulted from securing higher value-added foreign direct investment.
- The investment over the past decade in science and technology has created a robust basic research infrastructure. Our capacity to produce PhD graduates and publish in high impact journals is much enhanced.
- These direct (or first round) impacts have enhanced Ireland's capacity to attract new FDI and expand the mandate of foreign multinationals already located in Ireland as evidenced by the fourfold increase in the value of IDA R&D wins in recent years.
- Over the coming decade the challenge will be to see the investment in research translated into job growth in the enterprise sector, including greater focus in the future on indigenous enterprises. This involves the creation of a robust innovation system that effectively combines basic and applied research.
- The Council believes that, in the current circumstances, it is imperative that Ireland rededicate itself to the vision set out in the Strategy for Science, Technology and Innovation. The drop in total factor productivity in recent years demonstrates that traditional sources of employment will not recover and will not provide the source of future jobs growth.

## What is the scale of our commitment to R&D?

In almost every year from the late 1990s, there has been an increase in public funding for R&D centred on a strategy of:

- Investing in people and infrastructure in order to build the “science base” in our higher education institutions and other public research organisations; and
- Direct support to the enterprise sector to help individual companies to build their capacity for research and development.

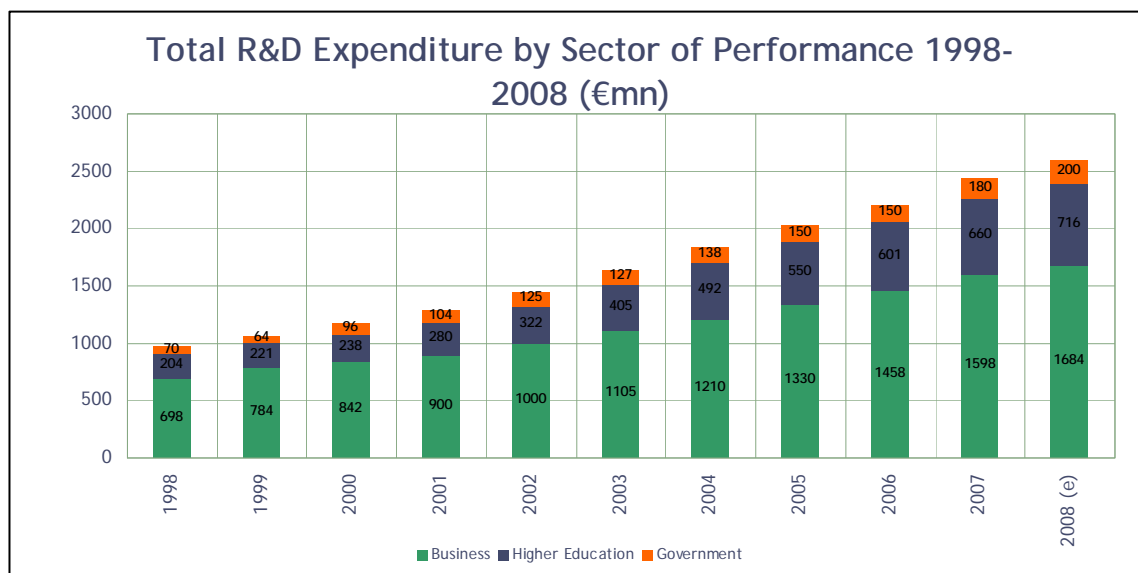
In more recent years, the Government has started to put in place mechanisms and programmes to encourage research linkages between industry and academia.

It is clear that Ireland has made a step change over the past 10 years from being significantly below the OECD and EU averages on most indicators of research investment and performance to now being at, and in some cases above, world averages. Figure 1 below shows that in every year from 1999 to 2008, there was an increase in the Government’s budget for R&D.

Placing these figures in an international context shows the transformative effect that this has led to in terms of the landscape for research and technological innovation in Ireland. The Government investment in 1999 represented 0.3 per cent of GNP, placing Ireland 25th out of 28 OECD countries on this measure, with an investment level similar to Mexico, Greece and Poland. By 2008, the Government budget for R&D equated to 0.6 per cent of GNP placing Ireland 18th out of 28 OECD countries with an expenditure level in line with Belgium, Italy and the United Kingdom.

The Government’s commitment to research and development has always been based on the understanding that it would underpin investment by the enterprise sector. In very large measure, this is what we have witnessed over the past 10 years. In parallel with Government investment, the business enterprise sector has also dramatically increased its commitment to R&D, growing from €700 million in 1998 to €1.7 billion in 2008.

Figure 1



Taking public and private investment together, Ireland has increased its Gross Expenditure on Research and Development (GERD) from 1.3 per cent of GNP in 1999 to 1.7 per cent in 2008. While this is a significant achievement, there is a considerable way to go before Ireland achieves the target it has set for itself (in the context of the Lisbon Strategy) of investing 2.5 per cent of GNP by 2013 or the Renewed Programme for Government commitment of 3%.

One of the sub-targets of the Lisbon Strategy is that the business enterprise sector should account for two-thirds of total R&D investment. While this is a goal that a number of other EU member states have yet to achieve, Ireland has maintained this balance of public and private investment over many years indicating that the policy goal of using State investment in R&D to leverage further private investment is being achieved.

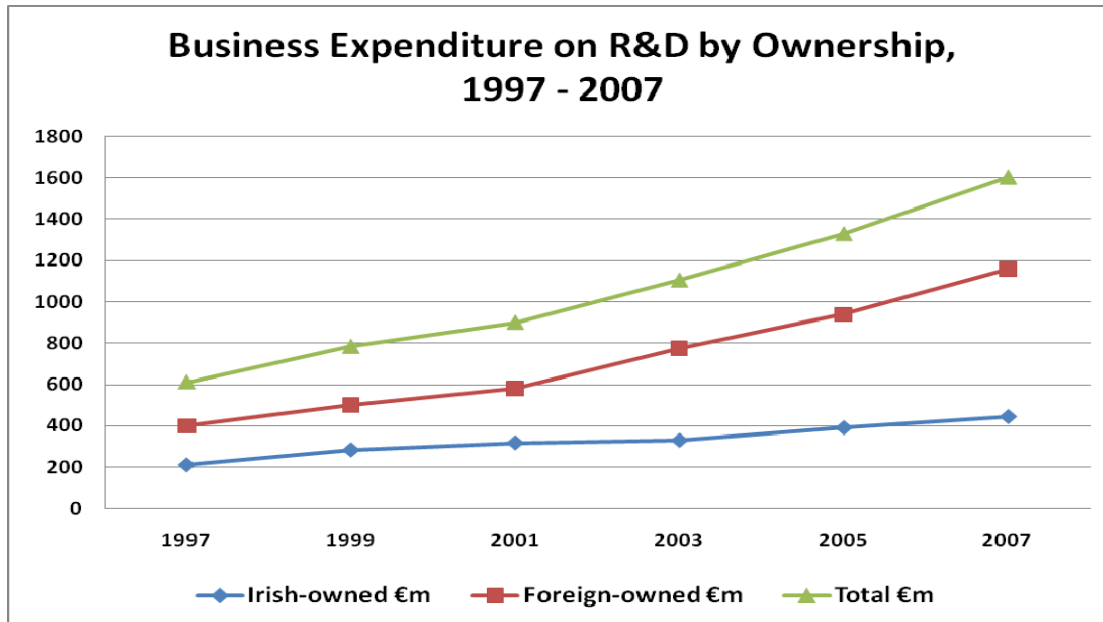
Over 40 per cent of IDA investments in 2008 had a significant R&D dimension and collectively involve R&D investment of €420 million. Currently there are about 170 IDA supported companies with a significant R&D mandate.

In 2008, Enterprise Ireland (EI) supported 794 companies to engage in RD&I. Over the period 2000 to 2007, EI supported 430 High Potential Start-Ups (HPSUs), 40 per cent of which were entirely R&D based. EI's investment in the 430 HPSUs over the period yielded direct sales of €638 million, exports of €344 million and generated employment for 5,500 people.

However, R&D investment in Ireland by foreign-owned companies is increasing at a faster rate than it is for indigenous companies. Therefore, while it is clear that Government investment in R&D has significantly leveraged increased expenditure on R&D by foreign-owned companies, thereby helping to

embed them in this country, further actions are necessary to increase the level of R&D investment by indigenous companies.

Figure 2



## What are the direct impacts of investment in R&D?

The Government's report on "Delivering the Smart Economy"<sup>1</sup> sets out a range of direct impacts of recent investment in science and technology, including the following:

- By the end of 2008, SFI was supporting 322 Principal Investigator (PI) led research teams including a large share attracted to Ireland from overseas. It is estimated that over 40 per cent of researchers in large research centres (funded by SFI and others) have been attracted to Ireland from overseas.
- Publications by SFI funded researchers have grown from 1,252 in 2005 to 1,730 at the end of 2007 helping to move Ireland from 647 publications per million (below EU average) to 1,100 (34 per cent above EU average). The increase in research output raises Ireland's reputation as a country of science and acts as a pull factor for venture capital and other private investment.
- The quality of research output (as measured by citation impact) has also increased, bringing Ireland from a global citation ranking of 27th in 2003 to 17th in 2008. In 2008, Ireland entered the top 20 list for citations in all fields for the first time.
- One third of SFI investment is allocated to activities undertaken directly with the enterprise sector (e.g. CSETs and Strategic Research Clusters). SFI funded researchers are undertaking direct collaborations with 279 companies (173 multinationals and 106 SMEs).
- Under PRTLTI, 30 high quality research centres have been established adding more than 100,000m<sup>2</sup> to physical research space within the public research system. The PRTLTI investment complements SFI investment - over 70 per cent of SFI research teams are housed in PRTLTI funded facilities.
- Of the €865 million expended under PRTLTI, one third of the funding has come from private sources.

The indicators above highlight some of the positive changes taking place in the public research base in Ireland. It is important that the impact of this investment be examined in an international context. The Academic Ranking of World Universities (ARWU) uses quantitative data on publications and citations to rank universities and affords a comparative basis to assess the direct impact of university research spending. Table 1 compares the 2009 rankings for countries with the same population share as Ireland.

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<sup>1</sup> Science, Technology and Innovation: Delivering the Smart Economy, Department of Enterprise, Trade and Employment, August 2009



**Table 1 Country's Share of Top 100 and Top 500 Universities Relative to Share of World GDP and World Population**

Country	Share of Top 100	Share of Top 500	Share of World GDP	% of World Population
Sweden	3.00%	2.20%	0.80%	0.10%
Switzerland	3.00%	1.60%	0.80%	0.10%
Denmark	2.00%	0.80%	0.60%	0.10%
Israel	1.00%	1.40%	0.30%	0.10%
Finland	1.00%	1.00%	0.50%	0.10%
Norway	1.00%	0.80%	0.70%	0.10%
Austria	-	1.40%	0.70%	0.10%
New Zealand	-	1.00%	0.20%	0.10%
Ireland	-	0.60%	0.50%	0.10%
Hungary	-	0.40%	0.30%	0.10%
Singapore	-	0.40%	0.30%	0.10%

Source: ARWU 2009 for University Rankings. World Bank. GDP (2008) and Population (2008).]

Care must be taken in drawing causal inferences from this data and it is known for example that wealthier countries account for a disproportionate share of the top ranked institutions (55% of the Top 100 institutions are located in the US which accounts for 23.6% of World GDP). However, Ireland's positioning vis-à-vis Sweden, Switzerland, Denmark, Finland and Norway merits further investigation and may provide a better guide to appropriate best practice than benchmarking with larger countries.

The impact of public investment has not been confined to the academic sector. There is strong evidence that public investment in R&D has impacted positively on the commitment to research and innovation in the business sector:

- The number of firms performing significant R&D (>€2 million per annum) rose to 164 in 2007 compared to 118 in 2005.
- The number of researchers employed in the enterprise sector increased from 7,000 in 2001 to 8,300 in 2007. Half of all research personnel employed since 2001 were PhD qualified researchers.
- In 2007, 40% of IDA "project approval" included a strong R&D dimension- 54 R&D investment projects with a value of almost €470m. In 2008, a similar picture emerged- 43% of projects - 55 in number - valued at €420m.

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- Through its Commercialisation Fund, Enterprise Ireland supported 138 projects in 2008, facilitating 7 start-ups and 29 licences.
  - Over the period 2000 to 2007, Enterprise Ireland supported 430 High Performance Start-Up companies, 40% of which were specifically R&D projects. This investment yielded sales of €638 million, exports of €344 million and generated employment for 5,500 people.
  - From its Enterprise R&D Fund, Enterprise Ireland supported 110 companies to undertake 240 R&D projects in 2008. In a recent independent survey of 203 companies that had received R&D support from Enterprise Ireland, on average 4 products were newly introduced or significantly improved as a result of R&D funding. Both productivity and sales increased for the majority as a direct result of the funding with average growth of 18% and 24% respectively and over 70% of companies employed new staff as a result of R&D funding.
  - Overall improvements in R&D spending continue to be a strong driver of innovation performance in the business sector. Between 2004 and 2006 over 47.2% of firms were engaged in innovation activities, with 56.7% of industrial firms and 41.3% of service industry firms being active in innovation of some kind.

## What actions are required to improve the effectiveness of Science & Technology spending?

The achievements secured from ten years of investment place Ireland in a strong position to realise the vision associated with the Strategy for Science, Technology and Innovation (SSTI) of a country renowned for the excellence of its science and an ability to convert knowledge into innovation. The pressures currently being placed on Exchequer resources require all of us to apply our minds to the changes required to ensure that Ireland can realise and exploit the benefits of recent investments and to ensure that long term goals continue to be pursued, albeit in changed circumstances.


It has always been clear that a country of Ireland's size is not in a position to develop critical mass in each and every field of science. Therefore, some element of prioritisation, implicit or explicit, is required. Previous initiatives, such as the Technology Foresight exercise leading to the creation of SFI and the approach adopted under PRTL (encouraging priority-setting at an institutional level) have served the country well and have helped to give a focus to STI investment linked in particular to the enterprise sectors accounting for most of Ireland's export activity.

The Council believes that it is timely to undertake a new priority-setting exercise at this juncture in order to identify areas in which Ireland should excel. This should take stock of the outputs and impacts of investment since 2000 (by field of science), assess the relevance of publicly funded R&D to the current enterprise base and explore, in consultation with the enterprise development agencies and relevant stakeholders, the fields of science and technology that are most likely to be relevant to the enterprise base in Ireland over the coming 10-15 years. Forfás and the Higher Education Authority are well advanced in a project to map public and private research activity which would provide the basis for such a prioritisation exercise.

We believe that the bulk of STI investments should continue to be in fields of science that underpin Ireland's economic development. We believe that the vast bulk of the competitive funding for R&D should be focused on:

- Fields of science that underpin the enterprise sectors within manufacturing and internationally traded services that contribute most to GDP today;
- Fields of science that underpin enterprise sectors where there is a reasonable chance that Ireland can build a competitive advantage in the medium term (i.e. 10-15 years);
- Institutions and individuals that have an excellent track record of delivery on investment to date.

By prioritising resources, Ireland will be able to build critical mass in a number of key areas. The critical mass generated will, in turn, allow Irish researchers to participate in the strongest international networks and access international research funding such as the EU Framework Programme. Access to such funding is key to maximising the impact of Exchequer investment.



Ireland should put in place a mechanism that allows for a more regular review of S&T priorities, approximately every 3 to 4 years. This would introduce flexibility to incorporate domains of increasing importance and would help to improve the alignment with existing and emerging needs of the enterprise base in Ireland.

As is the practice internationally, a portion of funding should continue to be available for fields of science outside of the prioritised areas including funding that is allocated purely on the basis of scientific excellence as this type of funding allows for work to be undertaken in entirely new and inter-disciplinary areas and/or areas that make unexpected contributions to economic and enterprise objectives.

### Council Opinion

- A priority-setting mechanism should be put in place to validate the areas/disciplines in which investment should be concentrated. Priorities should be reviewed every 3 to 4 years so that research and innovation policies are kept under continuous review and not “set in stone”.

## Do we have the appropriate balance between basic and applied research?

Linked to the question of the important fields of research, there is much debate on the nature of the R&D that should be supported in Ireland and, in particular, the balance between “basic” research and “applied”. While some argue with the relevance of this terminology, the Council believes that there is a need for balance between work which is focused on knowledge creation and work that is more focused on technological problem solving for industry. The terms “basic” and “applied” are used below as one shorthand for two extremes on the research continuum.

While there are many benefits and outputs from basic research, we believe that the two key benefits are:

- The scientific discoveries that are made, which we know from numerous studies are discoveries that ultimately lead to, or get absorbed in, products and processes or contribute to solutions around societal objectives such as environmental protection, healthcare and other aspects of public policy. New medicines and therapeutics based on knowledge generated from proteomics and genomics, the development of laser technology and new materials and coatings used in everyday life are some of the frequently cited examples of industrial applications arising from basic research.
- At least as important, however, is the training of researchers that is associated with undertaking basic research. People engaged in basic research develop an understanding of fundamental scientific principles that can be brought to bear on complex tasks in any walk of life. If Ireland is serious about developing as a truly knowledge-based economy, it needs to develop people who have a deep understanding of fundamental scientific principles. This type of learning and the type of approach to complex tasks does not “age” – it can be brought to bear on any branch of economic activity or any societal challenge that faces the country.

An appropriate level of investment in basic research, including training of PhDs, is a way of future-proofing Ireland’s economic development strategy and is important to developing a sustainable STI system. Rather than thinking about basic research and applied research as alternatives, Ireland should continue to build on initiatives taken in recent years to connect research of all types with the needs of the enterprise sector and other “end-users”. The aim should be to develop research groups in Ireland that are of sufficient scale and house enough expertise to serve the demands associated with basic research (e.g. scientific excellence in terms of publications etc.) while, at the same time, having the resources and the mission to address the more immediate needs of other stakeholders, in particular the needs of industry for scientific and technological solutions to be incorporated in new and improved products and processes.

The Centres for Science, Engineering and Technology (CSETs), Strategic Research Clusters (SRCs), and Innovation Partnerships provide useful approaches for facilitating collaboration with enterprises of different scale and innovative capacity. Where choices have to be made regarding STI investment, we believe that mechanisms that are facilitating interaction between industry and academia should receive priority. New industry-led approaches, such as Competence Centres, have not received sufficient

resources to demonstrate their potential contribution and we believe that there is a case for prioritising some of these initiatives in the short term.

In the context of new funding arrangements for R&D such as the “single funding stream” recommended within the “McCarthy Report”<sup>2</sup>, greater emphasis should be placed on “translational” mechanisms that bridge the gap between industry and academia. Pending the implementation of any new funding structures, we believe that:

- There should be further roll-out of the joint SFI/Enterprise Ireland pilot initiative to strengthen the enterprise and innovation focus of CSETs including funding for senior innovation specialists;
- All existing R&D funding programmes should be examined to ensure that they operate in an integrated fashion so that research groups/centres can align their commercialisation and translational strategies to national funding schemes. A cross-agency communication should be developed to provide clarity to research groups/centres as to the funding instruments available to support research across the full continuum and steps taken to ensure that these are operating as part of an integrated system.

The Council plans to examine the sustainability of research centres, including centres that bridge the link between industry and academia, and will develop recommendations around the long-term funding and governance models for such centres.

### Council Opinion

- Special attention should be given to the link between academic research and the needs of the enterprise sector in any review of funding priorities. The aim should be to build centres with critical mass so that the full spectrum of research can be supported and to ensure that the interfaces between basic and applied research and the translation of research into innovation are all working smoothly.
- Any adjustments to the R&D funding structures in Ireland should prioritise the link between research and innovation, including appropriate support for the industry-led “competence centre” model.

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<sup>2</sup> Report of the Special Group on Public Service Numbers and Expenditure Programmes, July 2009

## What actions can be taken to promote enterprise research and innovation?

The Government's Strategy for Science, Technology and Innovation will ultimately be assessed in terms of its ability to bring about a transformation in the innovative capacity of the indigenous enterprise base and the extent to which foreign-owned multinationals build sustainable businesses in Ireland including a strong Irish-based research and innovation component. The mix of incentives directly targeted at the business sector (including enterprise R&D grants and the R&D tax credit) are an important part of the Government's "policy mix" and the evidence to date suggests that these are having positive impacts.


The reality is, however, that all of Ireland's competitors are continuously looking at ways to promote research and innovation in their own countries and Ireland has to ensure that it continues to offer a world beating business environment that facilitates enterprise research and innovation. The Council will continue to advise Government on steps required to have in place the most attractive incentives to encourage research and innovation within the enterprise sector. Some immediate issues that the Government should consider are presented below.

The R&D tax credit has the potential to be a powerful instrument in stimulating additional R&D activity in both indigenous and foreign-owned enterprises and the Council welcomes the improvements that have been made in recent times in terms of the rate and the basis of computation of the credit. We support the call by others to examine the possibility of allowing the R&D tax credit to be claimed against general payroll costs (e.g. PRSI). This would ensure that the benefit of the R&D tax credit would accrue to the Irish-based operation of multinational enterprises and thereby help to secure more R&D activity within Ireland.

Within the framework of EU State Aid rules, the Government should examine its programmes for supporting enterprise R&D to assess whether Ireland is placing unnecessary restrictions on itself in terms of the levels of grant aid allowable. Other EU member states may be offering more advantageous R&D incentives up to the limit of the State Aid rules, particularly in the case of fundamental research which can be funded up to 100 per cent. Assessing the merits of changes to national legislation may help Ireland to compete on a more equal footing with other Member States.

Public procurement is used in many countries as an instrument to stimulate innovation, particularly within the SME sector. The Government has expressed openness to exploiting the potential of public procurement to stimulate innovation, within the framework of EU State Aid rules, and has also produced useful guidelines targeted at public sector organisations.

There is little evidence to date, however, that public sector organisations have embraced the role and potential of public procurement to stimulate innovation and thereby achieve new solutions that in the longer term are likely to offer better value for money as compared to less innovative counterparts.



It is unlikely that public procurement will become a genuine instrument of research and innovation policy unless specific metrics are enforced including, for example, the weighting that should be given to innovation objectives in the evaluation of tenders or the share of budgets that should be allocated specifically for “innovation-based” solutions including purchases from innovative SMEs.

The Small Business Innovation Research (SBIR) program in the United States is frequently cited as an effective programme for stimulating research and innovation in SMEs. The Government should consider implementing a model that takes the best features of the SBIR programme by establishing a fund for procuring research-based solutions to meet the business needs of Government Departments, agencies and local authorities. Such a fund could be established within the context of the “single funding stream” for research proposed within the “McCarthy Report”.

### Council Opinion

- The terms of the R&D tax credit should be altered so that it can be claimed against general payroll costs (e.g. PRSI).
- Within the framework of EU State Aid rules, the Government should examine its programmes for supporting enterprise R&D to assess whether there are unnecessary restrictions in terms of the levels of grant aid allowable.
- The guidelines on public procurement for innovation that have been published by the Government should be put into practice by Departments, agencies and local authorities by attaching specific metrics for innovation outcomes and, where appropriate, ring-fencing resources for innovative solutions within the framework of EU State Aid rules.



## Appendix Members of the Advisory Council for Science, Technology and Innovation

### Council Members

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