# Cross-cutting Issues in Relation to Expenditure on Science, Technology and Innovation

## 1. Overview

This short paper is an input to the deliberations of the Special Group on the cross-cutting issue of spending on science, technology and innovation (STI). Planned expenditure on STI activities over the years 2007-2013 is in the region of €8.2 billion, the majority of which is delivered through the STI Programme of the NDP. The Budget 2009 allocation is €725m.

The difficulty in appraising spending in this area relates to the uncertainty associated with the performance of STI. In many cases - in particular in relation to basic R&D - for a given level of inputs, the outcomes which may arise cannot be determined with any degree of certainty at the outset. It is for this reason that opportunities for savings may have to be identified on the basis of resources available as opposed to outcomes required, or put another way, 'how much can we afford to spend on this?' as opposed to 'how much do we need to spend on this to deliver a given outcome'. With this in mind, this paper identifies a number of issues of relevance in seeking savings in STI spending.

The structure of the paper is as follows: Section 2 sets out the rationale for government spending in this area as generally presented by advocates of STI investment; Section 3 presents details of Programme spending and resources and trends therein over the past number of years; Section 4 outlines the provision of supports under the Programme and the extent to which different mechanisms are subsidising the same or similar activities; Section 5 describes the implementing structures through which the Programme is delivered and comments on issues in relation to economy and efficiency of the current arrangements; Section 6 considers the possibility of displacement in the Programme; and finally Section 7 poses questions in relation to the effectiveness and continued relevance of the Programme, given the changed economic position.

## 2. Rationale

### *2.1 Enterprise Policy*

Support for STI activities has emerged as the central pillar of enterprise policy in recent years. This has been evident through a range of policy statements, most notably the Government's *Strategy for Science, Technology and Innovation 2006 – 2013*.

The broad rationale in terms of enterprise policy is positioned as the need to move the enterprise base further along the 'value-chain' – in other words away from low-cost manufacturing towards higher-tech activities involving better paid employment and higher value added. This policy direction is predicated on the correlation observed internationally between active technological sectors / high performance of R&D and higher standards of living. Business performance of R&D in Ireland is low by international standards.

### *2.2 Market Failures*

The broad rationale for support for R&D is that the private sector will fund less than the socially optimum level. Along with the inherent riskiness of performing R&D, two basic market failures account for this underperformance:

- *Information asymmetries* - firms are often not aware of the potential benefits of performing R&D; and
- *Positive externalities* – where firms do engage in R&D which yields benefits, the social returns often outweigh the private returns.

These characteristics form the key rationale for government investment in business sector R&D.

Where the private sector does engage in R&D, it tends to be more interested in applied research and experimental development[1]; research which is 'closer to market' and can generate greater short-term commercial returns. Some studies have shown however that basic research and research conducted in universities yields greater long term productivity increases[2] and is critical in underpinning national innovation systems. These characteristics represent the key market failure behind the rationale for public support of research conducted in higher education institutes (HEIs), as put forward by its proponents.

### *2.3 Sectoral Research*

Enterprise STI and the promotion of 'World Class Research' through the HEIs are therefore the two largest elements of NDP funding in this area. The Programme also involves estimated investment of over €1 billion in total for supports to the sectoral research agendas, namely agri-food (€641m), health (€301m), marine (€141m), energy (€149m), environment (€93m) and geoscience (€33m). The rationale for this investment relates to industry-specific policy in each of the sectors.

## 3. Programme Spending and Resources

### *3.1 Overview*

Dedicated spending on STI is a relatively new concept in Irish public policy. In the past, funding for the activities of the type supported by the STI Programme would have been included under other headings – e.g. funding for universities through Department of Education and Science spending or grants to industry through IDA Ireland schemes.

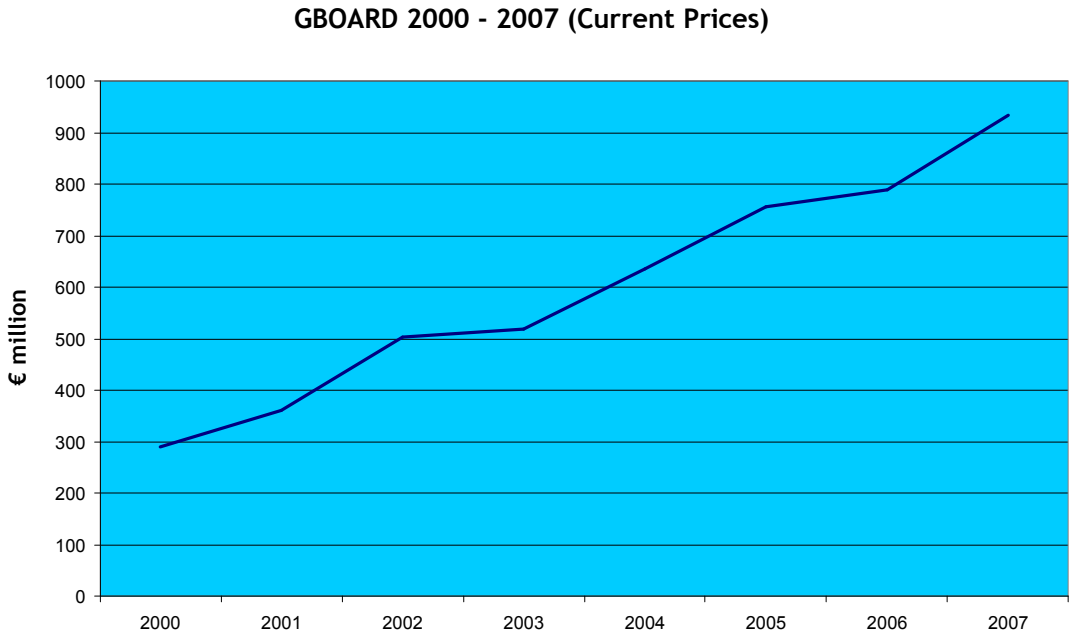
Over the past decade or so however STI activities have emerged as a distinct aspect of Government policy across a range of sectors – most significantly in enterprise and education. Over the same period funding has been significantly ramped up.

[1] Most recent indicators show that experimental development and applied research account for around 88% of all business expenditure on R&D while spending on basic research makes up the remaining 12% (Forfás BERD Survey)

[2] As cited in Dagg, M. (2006) Public Investment in R&D in Ireland in O'Toole and Aylward (eds) *Perspectives on Irish Productivity*.

### *3.2 Government Budget Outlays or Appropriations for Research and Development (GBOARD)*

GBOARD is the internationally comparable metric for Government investment in R&D. Data on this for Ireland is compiled through the Forfás Science Budget Survey. The graph below illustrates the increase in spending since 2000.




*Source:* Forfás

As is evident from the chart, GBOARD has roughly tripled in current prices since 2000. Along with this significant increase in nominal terms, it has also risen as a proportion of national output, at a time when GDP and GNP were growing at unprecedented rates. GBOARD grew from 0.33 per cent of GNP in 2000 to 0.58 per cent in 2007 (slightly higher than the OECD average for civil R&D[3] of 0.55 per cent in 2007).

### *3.3 Budget Allocations*

The indicative budget for the SSTI over the years to 2013 was estimated at €8.2 billion[4]. In addition a quantum of money – the precise value of which is unknown at present – is spent by the HSE through hospitals on R&D.

The projected funding levels based on the original NDP allocation are given below:

[3] 'Civil R&D' refers to total spending on R&D minus spending on military R&D.

[4] The corresponding figure in relation to the STI Programme of the NDP is €6.1 billion. The discrepancy is accounted for by €600 m in supports for STI activities advanced by IDA Ireland through the Enterprise Development Programme and an estimated spend of €1.5 billion through the Human Capital Priority. This later figure is essentially an estimate of the salary cost of the proportion of university personnel time dedicated to research activities, not funded by the various supports available.

| Table 1 | Original NDP Funding Allocation | | | | |
|---|---|---|---|---|---|
| | 2009 | 2010 | 2011 | 2012 | 2013 |
| **SSTI Funding** | **872,312** | **869,620** | **941,666** | **984,371** | **1,048,951** |

*Source:* Department of Enterprise, Trade and Employment.

The current year allocation to the Programme was substantially reduced in the Estimates for 2009. The table below shows the initial estimated allocation from the NDP, the Budget 2009 allocation and the difference.

| Table 2 | SSTI Funding 2009 | | |
|---|---|---|---|
| | Original NDP Allocation 2009 | Budget Allocation 2009 | Difference |
| | **€ million** | | |
| Department of Education and Science | 256,318 | 210,112 | -46,206 |
| Department of Enterprise, Trade and Employment | 373,546 | 334,912 | -38,634 |
| Department of Agriculture Fisheries and Food | 114,264 | 97,591 | -16,673 |
| Department of Communications, Energy and Natural Resources | 34,186 | 27,484 | -6,702 |
| Department of Health and Children | 43,000 | 41,280 | -1720 |
| Department of Environment Heritage and Local Government | 11,000 | 13,640 | 2,640 |
| Competitive Fund | 40,000 | 0 | -40,000 |
| **Total** | **872,312** | **725,019** | **-147,295** |

*Source:* Department of Enterprise, Trade and Employment.

Alongside direct exchequer funding for science, technology and innovation under the Plan, national policy in this area is also comprised of a number of tax incentives, specifically the R&D tax credit and the patent royalty exemption. The table below shows the most up to date information on claims against eligible expenditure.

| Table 3 | R&D Tax Credit Claims |
|---|---|
| Year | € million |
| 2004 | 70.5 |
| 2005 | 65.2 |
| 2006 | 53.9 |

*Source:* Revenue Commissioners

Despite a reduction in Budget 2009, STI spending has been significantly ramped up in recent years, and budget allocations have been increased three-fold between 2000 and 2006, with further increases projected in the NDP out to 2013. Significant support is also advanced through the R&D tax credit scheme which was made more attractive in Budget 2009.

## 4. Issues Regarding Provision of Supports for STI Activities

The CEEU has gathered information on the range of public supports that make up STI policy. In summary this exercise has shown that there is a large number of Government Departments and State Agencies involved in funding similar activities through a large number of schemes. Furthermore, in many cases different schemes support the same or similar activities.

Appendix 1 provides a description of the supports under each Sub-Programme and information on indicative funding levels. Appendix 2 illustrates the extent of the overlap in the provision of supports

Irrespective of the merits or otherwise of funding these individual schemes, Appendix 2 raises questions relating to the efficiency of the delivery of supports. The analysis yields the following findings:

- The STI sub-programme is made up of approximately 100 schemes. This is in addition to the funding on R&D extended through block grant to universities and the proportion of HSE funding spent on R&D.
- Within this, close to 60 measures involve the funding of PhDs.
- Almost 50 schemes promote some form of collaboration, either between firms, between firms and HEIs or between HEIs.
- Less than one third of all sectoral research schemes target commercialisation.
- There are programmes administered by different agencies which have similar overall objectives and similar target participants.

While some elements of the Programme have sought to achieve administrative efficiencies through shared services[5], further scope for savings remains. A potential approach involves rationalising the funding bodies or integrating into one over-arching funder for human capital. A potential home for this function is a re-organised and expanded SFI or as part of a unified funding stream for STI Activities as proposed in the D/ET&E vote section paper. The potential cost savings associated are not expected to be significant unless actual spending allocations are reduced, which may happen as overlaps are eliminated.

## 5. Efficiency and Cohesiveness in Implementing Arrangements

### *5.1 Proliferation of bodies*

The STI policy landscape in Ireland is characterised by a proliferation of different bodies involved in policy formulation, implementation and oversight. In addition to the seven Government Departments involved, the bodies include:

[5] For example IRCSET run some scholarship competitions on behalf of SEI and Marine Institute in exchange for a set fee.

- The Cabinet Sub Committee on SSTI (CSC)
- The Interdepartmental Committee on SSTI (IDC)
- The Joint Secretariat to these groups
- The Higher Education Research Group (HERG)
- The Health Research Group
- Technology Ireland (TI)
- The Chief Scientific Advisor to the Government
- The Advisory Science Council
- The Enterprise Feedback Group
- The Irish Research Council for Humanities and the Social Sciences (IRCSET)
- The Irish Research Council for Science, Engineering and Technology (IRCHSS)
- The sectoral research funding agencies in the agriculture and food, health, environment, marine and energy sectors.

These bodies operate alongside the statutory agencies central to STI policy including Forfás, IDA Ireland, Enterprise Ireland, Science Foundation Ireland and the Higher Education Authority.

While many of the implementing groups listed above do not involve significant additional exchequer costs[6], the current configuration is not ideal. In terms of the research funders, creating a unified funding stream for STI Activities, possibly through a re-organised SFI would enable rationalisation of the implementing arrangements by merging some of the functions of the various bodies (including IRCSET and IRCHSS and the research related functions of a number of state agencies[7]). Again significant cost savings are not envisaged in the absence of reductions in actual programme spending.

### *5.2 Integration of sectoral research agendas*

The reorganised science governance structures which were announced with the SSTI include two new implementation groups, HERG and TI. These feed into the IDC and in turn, the CSC. While the sectoral research performers are represented at HERG and IDC, there are indications that the relevant research funders are less integrated with the larger agencies and with each other than ought to be the case. This increases the risks of overlap in funding of research activity, diminishes opportunities for economies of scale and – if sectoral performers and the enterprise mission agencies are not coordinating enough – reduces potential for the commercialisation of sectoral research output.

The task of prioritising and integrating the sectoral research agendas so as to maximise the potential for harnessing economic benefits of investment could be given to the Office of the Chief Science Advisor[8], or as part of a unified funding stream for STI Activities as proposed in the D/ET&E vote section paper.

[6] As these groups are staffed in the main by existing public servants.
[7] The OECD's 2004 review of the higher education system recommended that these agencies be incorporated into SFI.
[8] The OECD's 2004 review of the higher education system recommended that the CSA have responsibility for the coordination of science across all Government Departments.

## 6. Potential Deadweight and Displacement in STI Spending

### *6.1 Overview*

This Section looks at the questions of deadweight and displacement in two ways: first it briefly assesses trends in public versus private funding for R&D, second, trends in the drawdown of EU funded STI supports are outlined.

### *6.2 Sources of funding for R&D*

Exchequer funded R&D has increased as a proportion of total expenditure on research performed in both the business and higher education sectors. Public sector funding of national R&D has increased from 26 per cent in 2000 to 32 per cent in 2006[9]. (Because the later year was the first year of the SSTI, this figure could be expected to have increased in the interim, as the SSTI envisaged a cumulative additional funding requirement of €1.88 billion in the years to 2013 over and above existing capital allocations.) This increase is largely accounted for by the increase in GBOARD discussed at Section 3 above.

Government funding of research performed in the higher education sector grew from 79 per cent in 2002 to 85 per cent in 2006. Private support for higher education research is considerably lower in Ireland than internationally – business sourced funding for HERD represents 2.6 per cent, compared to an OECD average of 6.5 per cent, with contributions as high as 14 per cent in Germany[10].

The exchequer funded element of business sector R&D has also grown over the past decade or so. Between 2001 and 2005, government funding of BERD grew from 2.7 per cent to 4 per cent (€24m to €55m). Data for 2008 will be available in early March. Over this period the EU financed element of BERD also shrank. This is discussed in further detail below.

Overall exchequer funding as a source of expenditure on business and higher education R&D has grown at a faster rate than private funding, indicating that the increase in GERD as proportion of GNP has been disproportionately driven by public spending.

### *6.3 Exchequer versus EU funded Schemes*

In addition to the exchequer funded supports that make up the STI Programme of the NDP, substantial funding is available through the EU via the Framework Programmes to support scientific development across the member states.

There is evidence to suggest that as exchequer funding of STI has been ramped up, international funding has been crowded out to some extent. The success of Irish research bids in winning funding through the Framework Programmes has declined, as detailed below.

[9] Forfás (2007) *Research and Development Statistics in Ireland, 2006 – at a glance*.
[10] Forfás (2008) *Higher Education Research and Development Survey 2006*.

| Table 4 Framework Programme Funding Secured by Irish Researchers | | |
|---|---|---|
| **Programme** | **Irish drawdown** | |
| | **% of total** | € million |
| FP 2 (1987 – 1991) | 1.03 % | 44 |
| FP 3 (1990-1994) | 1.61 % | 88 |
| FP 4 (1994-1998) | 1.59 % | 191 |
| FP 5 (1998-2002) | 1.08 % | 148 |
| FP 6 (2002-2007) | 1.20% | 199 |

*Source:* Forfás

As is evident from Table 3, there was a significant fall in the level of funding secured by Irish researchers from FP3 to FP5, followed by a slight regain in FP6. The largest driver of this trend was the collapse of private sector participation in the Programmes. While this has been observed across participating countries on the whole, it is considerably more pronounced in Ireland than elsewhere.

| Table 5 Proportion of Irish Framework Programme Funding Secured by the Business Sector in Ireland | |
|---|---|
| **Programme** | **Drawdown** |
| FP 4 (1994-1998) | 33 % |
| FP 5 (1998-2002) | 19 % |
| FP 6 (2002-2007) | 14% |

*Source:* Forfás

In order to bolster Ireland's success in winning FP 7 funding, the Enterprise STI Programme includes supports designed to assist researchers in Ireland in leveraging FP 7 funding, managed through EI. Between December 2006 and September 2008, a total of 90 EI supports were funded to the value of €1.4m. This yielded €5m in FP 7 awards.

Comparison of these applicants with those of researchers not in receipt of EI funding shows an almost identical success rate, however the average award to EI supported applicants was over twice the value of those to non-supported applicants.

Nevertheless, the available data seems to suggest that the up scaling of domestic funding for R&D has crowded out domestic researcher's participation in EU programmes to some extent, particularly in the case of private firm's engagement.

## 7. Effectiveness and Continued Relevance

### *7.1 Overview*

The economic context in which the SSTI and NDP were framed was clearly dramatically different from that which prevails at present. This raises obvious

questions with regard to the continued affordability of this investment and the need for investment of this scale to deliver demonstrable economic benefits.

### *7.2 Achievements in Capacity Building*

Given Ireland's low base in terms of scientific and technological capacity, there was a strong case for the significant expansion in public investment in the innovation infrastructure pursued since the turn of decade. While identifying further areas for improvement, a number of reviews in this area have pointed to the success of PRTLI and more recently SFI in building research capacity.

While Ireland does not have the same investment intensity when measured as a proportion of GDP as many of its competitor countries, the increase in investment in recent years has gone some way to bridge that gap.

Annual average growth in total R&D investment in Ireland over the years 2001-2006 was 12.4 per cent, far outstripping countries such as Denmark (4.6), Germany (2.3) Sweden (2.2), Finland (2.5), Luxembourg (5.3), the Netherlands (2.6) and France (2.9)[11]. This increased investment - and in particular the publicly funded component which grew faster than private investment - was important in improving Ireland's capacity to perform private sector R&D. Given the levels of investment experienced, this capacity must now be superior to the 2000 base.

### *7.3 PhD Targets*

The SSTI set ambitious targets with regard to up scaling the number of PhD graduates, seeking to almost double the number of new doctorates awarded annually in science, engineering and technology by 2013. As shown in Section 4 above, this goal is supported by a proliferation of schemes across the Programme.

The rationale for this target was derived from the 2004 Review of higher education in Ireland, undertaken by the OECD. That study cited Ireland's relatively low population of researchers in the workforce, low proportion of doctorate holders and low research activity of university staff. It recommended that if the planned funding increases were to be spent effectively, the potentially significant bottleneck of low numbers of appropriately qualified researchers should be addressed.

There are potential issues however in relation to the absorptive capacity of industry for the new doctorate holders. The business case for this rate of expansion in PhD numbers has not been articulated, and indeed IBEC – in a submission to the CEEU on STI expenditure - has questioned the rationale for this investment and the ability of enterprise to provide employment.

There are two clear risks to this strategy:

- PhD graduates will not be able to find employment and will emigrate; and
- PhD graduates will be under-employed, taking up employment that does not require this level of education.

[11] Eurostat

Both scenarios involve considerable waste of exchequer resources. Both scenarios are also more likely to occur given the contraction in aggregate economic activity currently being experienced. Limited data pertaining to 2006 is available to attempt to answer some of these questions:

- Slightly less than half of the stock of PhD graduates is employed in the education sector[12].
- In terms of new PhD graduates, the first career destination for some 73 per cent of those who find employment is 'non-market service' sector[13].
- The limited data available does show that doctorate holders earned more than higher degree holders, on average. This is not of itself evidence that doctoral qualifications were necessary for the positions obtained, but could simply reflect a crowding out of bachelor's and higher degree holders by doctorate holders, a type of 'qualification inflation'
- In relation to the point on the propensity of doctorate holders to emigrate, a HEA survey showed that the first destination of some 20 per cent of new PhD graduates was employment overseas. PhD graduates also have a higher propensity to emigrate than honours primary degree holders (8.3 per cent) and master's degree holders (10 per cent)

This data may indicate over-provision of PhD supports, particularly given the deteriorating fiscal position.

### *7.4 Spending on HEI-based Research*

Much of the increase in public funding of STI has been expended on R&D in HEIs. In the region of 85% of all exchequer financed R&D is carried out in HEIs, and often tends to be on basic – as opposed to applied - research. As noted in Section 2, analysis has shown that basic research can have greater longer term benefits in terms of productivity. At the same time however, the ultimate societal and economic benefits of the majority of this research are not fully known at the outset and there are generally long time lags between expenditure on the research and discernable commercial benefits, where they arise. The performance indicators articulated for these activities in the SSTI include bibliometric outputs such as publications and citations. While these may be important in establishing international reputations and a 'world class research' base, they tell little about ultimate economic impacts of the investment

In 2006, the latest year for which data is available, direct[14] and indirect[15] exchequer funding for R&D performed in HEIs amounted to €513m out of a total of €601m[16].

In the years since 2000, direct exchequer supports have grown from €67m to €266m, representing an increase from 24 per cent to 44 per cent of funding for R&D performed in HEIs.

[12] Forfás (2009) *Analysis of 2006 Census Statistics on Doctorate Holders in Ireland*.
[13] HEA (2006) *What do Graduates Do? The Class of 2005*
[14] i.e direct funding mechanisms such as SFI, PRTLI etc.
[15] i.e. the component of the HE block grant to HEIs estimated to have been expended on research.
[16] The remainder is financed through a combination of EU funding, business funding and other sources such as philanthropy.

Given the uncertainty in relation to the ultimate effectiveness and impact of this spending, there are serious question marks as to the continued affordability of programmes in this area in the prevailing environment.

### *7.5 Sectoral Research Funding*

In addition to the key strategic priorities of world class research and enterprise STI, the NDP includes over €1 billion for sectoral research across a range of Government Departments.

While investment in these priorities is positioned as an integral aspect of the Government's unified, strategic approach to STI, the relative levels of funding seem somewhat arbitrary, and more the product of individual decisions of Government Departments than the outcome of a whole-of-government strategy.

The case for funding of the sectoral research agendas should be fundamentally reviewed. Priorities should be evaluated alongside each other. For instance, what is the basis of allocating €149m to energy research, but €641m to agri-food research over the lifetime of the Programme? In the main, sectoral research funding is the product of decisions taken by individual Government Departments, without reference to a unified approach or the activities of other Departments. Further, some of the research activities relevant to the sectoral performers are also eligible for funding under World Class Research Sub-Programme.

### *7.6 Contrary arguments and the Smart Economy Framework*

Potential contrary views include:

- The importance of consolidating the supply side of the enterprise base. The up-skilling of the labour force that will take place through the planned expansion in PhD numbers will position Ireland to attract high-value FDI and promote indigenous enterprise as the global economy recovers.
- The contention that spending on HEI research is very much valued by the business community, and the recent VfM Review of SFI found that IDA Ireland sees this investment as a key 'reference sell' in attracting new investment projects.
- The idea that in lag-countries with lower levels of investment, there is a greater role for public spending in building scientific capacity to facilitate convergence.
- The view that international mobility is a critical element of a researchers career and necessary in terms of gaining exposure to excellence overseas.

In December 2008 the Government launched its framework for economic recovery, 'Building Ireland's Smart Economy'. That document placed STI policy at the core of enterprise-led plans for economic expansion and announced new funding mechanisms for supporting business R&D.

## 8 Potential Approaches to Savings

As noted above, appraising STI expenditures is fraught with difficulty owing to the uncertainty associated with the performance of STI. In many cases - in particular in

relation to basic R&D - for a given level of inputs, the outcomes which may arise cannot be determined with any degree of certainty at the outset. It is for this reason that opportunities for savings may have to be identified on the basis of resources available as opposed to outcomes required.

In line with this, the following examples illustrate the potential cost savings associated with reviewing the expansion in STI funding experienced over the past number of years.

As discussed, private sector funding has not increased as rapidly as public sector support for R&D. The primary goal public R&D spending is to facilitate, increase and embed STI activity in the private sector. It is a cause of concern therefore, if the increase in GERD is being driven to a significant extent by public spending rather than private investment. While it can be argued that public investment in R&D needs to lead private investment in order to overcome the market failures outlined at Section 2 above, the extent of increase in public spending in this area and the acknowledged uncertainty about the measurable value-added from it would suggest that it might be prudent to scale public R&D spending back at this time. A number of approaches can be used to illustrate the potential extent of savings, based on various scenarios.

Table 6 below analyses the growth in the private component of total R&D expenditure since 2000. This rate is then applied to the 2000 base level in an attempt to ascertain the public funding commitment that would maintain the funding ratios for the year 2000.

**Table 6 Sources of GERD** **€ million**

| | 2000 | 2006 | Difference | Growth |
|---|---|---|---|---|
| Industry | 843 | 1,525 | 682 | 81% |
| Public Sector | 316 | 764 | 448 | 142% |
| Other sources | 16 | 40 | 24 | 150% |
| Total | 1,176 | 2,329 | 1,154 | 98% |

| | |
|---|---|
| *Applying private sector growth rate to public sector spending base as at 2000* | |
| Base level | €316 |
| Growth rate | 81% |
| Gives 2006 level | €572 |
| Actual 2006 level | €764 |
| **Potential saving** | **€192** |

*Source:* Calculated from Forfás data

From the table above it can be seen that, based on 2006 data, setting the public contribution at 2000 levels, and up-scaling by the same ratio that the enterprise sector increased its funding of STI yields a saving in the region of €200m.

Table 7 below illustrates the original estimated allocation under the NDP and the implications of holding expenditure at the Budget 2009 level (which itself was some €145m lower than the original NDP allocation for 2009).

**Table 7 Budget 2009 Allocation Vs NDP Allocations**

| € million | | | | |
|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 |
| Original NDP Allocation | 869,620 | 941,666 | 984,371 | 1,048,951 |
| Capping at Budget 2009 levels | 725,019 | 725,019 | 725,019 | 725,019 |
| **Potential Savings over NDP Allocation** | **144,601** | **216,647** | **259,352** | **323,935** |

*Source:* Calculated form Department of Enterprise, Trade and Employment data.

The uncertainty over these projected figures should be noted however as they were predicated on larger capital envelopes for 2010-2013 than are currently envisaged. Adjustments to these indicative allocations in the 2009 Budget may have included downward adjustments to STI related allocations but the revised figures were not calculated at that disaggregated level.

A further illustration of potential for cost savings shows the possible reduction achievable by scaling back GBOARD for Ireland to the OECD average level.

**Table 8 Reducing Ireland's GBOARD to comparable international levels**

| | |
|---|---|
| Ireland GBOARD 2007 | €930m |
| | GBOARD as percentage output |
| Ireland (GNP) | 0.58% |
| OECD[17] (GDP) | 0.55% |
| | |
| *Reducing Ireland's GBOARD to OECD level* | €882m |
| **Potential saving on 2007 levels** | **€48m** |

*Source:* Calculated from Forfás data

As discussed, a range of funding schemes within the Programme are concerned with enhancing collaboration between HEI researchers and the private sector. A number of these initiatives require some co-funding from the private sector participants. Examples include:

- Centres for Science, Engineering and Technology;
- Strategic Research Clusters; and
- IRCSET's enterprise partnership awards.

[17] Refers to civil - i.e. excluding military - R&D

A potential scope for savings regarding such schemes could involve increasing the industry cost-sharing ratio. Table 9 below illustrates some potential savings based on 2008 data.

**Table 9 Potential for Savings through increased industry contribution**

| Scheme | Exchequer cost 2008 | Industry cost-share | Potential revised industry cost share | Illustrative saving |
|---|---|---|---|---|
| CSETs | €27m | 25% | 33% | €3m |
| SRCs | €20m | 25% after 3 years | 33% | Tbc |
| IRCSET industry partnership | €0.8m | 33% | 50% | €0.2m |

*Source*: Calculated from SFI, IRCSET data

It should be noted that this analysis does not account for the incentive effects of these supports – i.e. increasing the private funding necessary may lead to reduced enterprise participation. The 2009 allocation to CSETs and SRCs is also expected to be lower than the 2008 value. It would not be possible to realise the full extent of the savings as illustrated for 2008 in 2009 because of existing commitments, however restructuring cost-sharing arrangements can be expected to yield more substantial savings into the medium-term.

While the indicated savings in relation to the IRCSET programme are comparatively low, a co-funding mechanism could be built in to other post-graduate and post-doctoral supports in order to realise greater cost savings. By promoting greater industry participation in graduate education, this approach could also yield positive benefits in relation to the issues of absorptive capacity and employability of graduates mentioned earlier.

## 9 Conclusions

This paper draws the following broad conclusions in relation to current spending programmes on STI activities:

- Spending on STI is promoted as a key element of enterprise and education policy on account of the correlation observed internationally between STI intensity and higher standards of living. Often however, the ultimate economic impacts of STI expenditure are not known with certainty at the outset.
- Government Budget Outlays or Appropriations for Research and Development (GBOARD) have been increased from €290m in 2000 to €930m in 2007.
- The Budget 2009 allocation for all elements of the NDP STI Programme was €725m. This was €147m lower than the original estimated allocation for 2009 under the NDP.
- There is a large proliferation of supports for STI activities implemented across Government Departments and State Agencies. Many of these are involved in supporting the same or similar activities and could be rationalised

- There is a multiplicity of bodies involved in the formulation and implementation of science policy and in some cases there is scope for greater coordination in order to bring greater efficiency to STI expenditure and maximise the potential for the commercialisation of sectoral research output in particular.
- Exchequer funding (as opposed to business funding, philanthropy etc) has grown as a proportion of both business expenditure on R&D and higher education R&D in recent years. This may suggest some displacement of private funding by public funding.
- The success of researchers in Ireland in winning funding under the EU's Framework Programmes diminished during the initial stages of the ramping up of exchequer funding for R&D. In particular the participation of the enterprise sector collapsed.
- There are question marks in relation to the absorptive capacity of industry for the expansion in doctorate holders being funded.
- In the absence of a clear business need for this up-scaling in the number of doctorate holders, there are risks that graduates will be underemployed or forced to emigrate. While we do not have detailed information in relation to the first point, there is survey evidence to suggest that 20% of new doctorate holders find employment overseas, a significantly larger proportion than any other cohort of degree holders.
- Approaches to identifying savings include reversing trends in public funding patterns and increasing business cost-sharing of relevant schemes.

## Appendix 1

The table below presents summary data in relation to the types of activities supported under the STI Programme and expands on the information provided in Appendix 2. Financial information is also provided where appropriate. Because this has been compiled from different sources (data on individual scheme spend was provided by relevant Departments and Agencies where available and data on capital vs current split at Sub-Programme level was sourced from the original NDP allocations which were scaled back in Budget 2009) some arithmetical discrepancies may be evident. For illustrative purposes, the indicative funding levels are nonetheless useful.

| **World Class Research SP: SFI** | | |
|---|---|---|
| Pay €4.6m | Non-pay current €6m | Capital €189m |
| Approximately 70% of SFI expenditure is spent on measures broadly addressing improving the human capital of the Irish science system with the remaining 30% supporting measures which target improvements to the stock of knowledge capital. In terms of human capital, the key supports take the form of principal investigator style awards whereby HEIs take on world-class researchers to undertake specific research projects in the biotechnology, ICT and energy sectors. The research teams are staffed by post-doctoral and PhD researchers.<br><br>Regarding knowledge capital, the key supports are Centres for Science, Engineering and Technology (CSETs) and Strategic Research Centres (SRCs). These schemes fund the development of collaborative industry-academia research centres through personnel and equipment. Industry partners must share costs to the value of 25% for CSETs and 25% subsequent to year 3 of the SRCs. | | |
| **World Class Research SP: PRTLI, IRCSET, IRCHSS, TSRI** | | |
| Current €85m | Capital €135m | |
| These are the supports administered by the Higher Education Authority and its associated agencies. The Programme for Research in Third Level Institutes is the key support in this area, and will provide €120m for research infrastructure (facilities/buildings, equipment and refurbishment). The scheme will also fund the development of a number of structured PhD programmes (€9m), open to all disciplines and supports (funding for research teams in HEIs) for R&D in identified emerging areas of strategic interest (€20m). Potential areas for funding under emerging areas include plant/crop bio-science, new ways to generate and manage electricity, and the development of research agendas in support of the services/business and IT sectors of the economy.<br><br>The Irish Research Councils for Science Engineering and Technology (IRCSET, €25m 2009) and Humanities and the Social Sciences (IRCHSS, €15m 2009) fund talented researchers at early stages of their careers. The main focus is post-docs and PhDs.<br><br>The Technological Sector Research Initiative (TSRI, €7m) is designed to build early stage capacity in IoTs and get them to a base level where they can compete for PRTLI funding. Funding will be | | |

provided in 2009 for equipment and human capital (€3.5m) and MSc programmes (€2m). The measure also includes €2m for IoTs to provide training for local innovators in entrepreneurship.

**Enterprise STI SP**

| EI Pay €6.3m | Non-pay current €11.5m | Capital €160m |
|---|---|---|

There are three pillars to EI's STI activities: *Transforming R&D Activity in Enterprise*; *Industry/Higher Education Institutes Collaboration*; and *Realising the Commercial Potential of Ireland's Research Community*. The main funding mechanism is the R&D Fund which takes the form of grants to firms for research personnel, equipment and facilities. Under the Fund Enterprise Ireland can provide support of up to €650,000 to companies, up to a maximum co-funding rate of 45% of project cost for small firms, 35% for medium firms and 25% for large firms. A maximum contribution of 50% is available in the case of projects involving collaboration with another company.

Eleven other supports target various aspects of enterprise STI. The types of activities supported include funding for firms towards the cost of technology management and innovation courses; supports for technology transfer to other companies; funding for firms to undertake collaborative research with HEIs; funding to increase the research capacity of IoTs (a similar objective to TSRI above); funding for industry networks and competence centres; innovation vouchers for firms to commission small research projects from IoTs; supports to assist in leveraging FP7 funding; supports for research commercialisation and IP development; a campus incubator scheme to fund the construction of office space for entrepreneurs who wish to develop projects within the structures of college campuses; and technology transfer offices to assist in getting HEI research out to market.

The National Digital Research Centre (€5m) conducts research on translational digital technology. It is located in the Digital Hub, staffed by HEI researchers and conducts near to market research on the development of new digital applications.

**Agri-food SP**

| Current €92m | Capital €3m |
|---|---|

The Research Stimulus measure provides funding (€6m) for HEI researchers to undertake research of a 'public good' nature and the results are made freely available. The involvement of industry partners is welcome where appropriate on a self-financing basis. The Food Institutional Research Measure (FIRM) provides funding (€13m) for HEI and Teagasc researchers to carry out projects of a public good nature in the food sector. COFORD, the National Council for Forest Research and Development provides funding (€4m) for research in HEIs in the areas of forestry sustainability and competitiveness.

Teagasc (€73m) undertakes in-house research in the areas of food production and processing, value-added food processing, agri-environmental products and services and energy and bio-processing

**Energy Research SP**

| Current €1m | Capital €24m |
|---|---|

This Sub-Programme provides funding for basic research awards in the energy sector (PhDs, post-docs, PIs) through the Charles Parson scheme, now administered by SFI; for the development of sustainable energy alternatives such as ocean energy (e.g. grants to firms for developing prototypes) and grants to

| |
|---|
| firms for demonstration projects in relation to energy efficiency. |
| **Marine Research SP** |
| Current €8.3m (Marine Institute) \| Capital €10.5m |
| Capital funding is provided for HEI research for the development of the marine industry and the identification of new research and marine related business opportunities (€5m), for marine-related equipment in HEIs (€3m) and a number of other supporting measures. |
| **Environment Research SP** |
| Current: nil \| Capital €11m |
| The Sub-Programme consists of the measures that make up the EPA-run Programme Science Technology, Research and Innovation for the Environment (STRIVE). The main focus is on supporting researchers in HEIs. The main research themes are sustainable development, environmental health and cleaner production. |
| **Geoscience SP** |
| Current: nil \| Capital 4.5m |
| The elements supported under this Sub-Programme are INFOMAR, the national seabed survey, the national resource and environmental survey and more coordinated research to support national physical infrastructure development. |
| **Health Research SP** |
| Current €33 m \| Capital €10m |
| Current expenditure in this area refers to grants to research teams in HEIs and hospitals provided by the Health Research Board for research aimed at both improving the health of the population and leading to marketable products. The capital component refers to grants in respect of buildings and equipment provided.<br><br>In addition to this, the HSE also funds some R&D through its core grants to hospitals, the full value of this funding is not known. |

## Appendix 2 Activities Supported across NDP STI Sub-Programme

| | Programmes | Human Capital | | | | | | | Physical Capital | | | | | | Collaboration and Commercialisation | | | | In House Research |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MSc | Phds | | Post Docs | PIs | Other Research & Support Personnel | Personnel in Firms | Facilities | | Equipment | | Reurbishment | | Industry Academia Collaboration | HEI - HEI Collaboration | Industry - HEI Collaboration | Commercialisation | In Public Sector bodies |
| | | | Programmes | Individuals | | | | | HEIs | Industry | HEIs | Industry | HEIs | Industry | | | | | |
| WCR SP PRTLI | Capital Facilities | | | | | | | | ■ | | ■ | | ■ | | | ■ | | | |
| | Strategic National Initiatives | | | | ■ | ■ | ■ | | | | | | | | | ■ | | | |
| | National Shared Facilites | | | | | | | | | | | | | | | | | | |
| | Structured PhD Programmes | | ■ | | ■ | ■ | ■ | | | | | | | | | ■ | | | |
| | New and Emerging Areas | | | | | | | | | | | | | | | | | | |
| SFI | PI Programme | | | ■ | ■ | ■ | | | | | ■ | | | | ■ | | | | |
| | Research Professor | | | ■ | ■ | ■ | | | | | ■ | | | | ■ | | | | |
| | PIYRA | | | ■ | ■ | ■ | | | | | ■ | | | | ■ | | | | |
| | Stokes | | | | | ■ | | | | | | | | | | | | | |
| | Walton | | | | | ■ | | | | | | | | | | | | | |
| | PICA | | | ■ | ■ | ■ | | | | | ■ | | | | ■ | | | | |
| | Research Frontiers | | | ■ | ■ | | | | | | ■ | | | | ■ | | | | |
| | CSETs | | | ■ | ■ | ■ | | | | | ■ | | | | ■ | | | | |
| | SRCs | | | ■ | ■ | ■ | | | | | ■ | | | | ■ | | | | |
| | Short Term Fellowships | | | ■ | ■ | ■ | | | | | ■ | | | | | | | | |
| | SIRG | | | ■ | ■ | ■ | | | | | ■ | | | | | | | | |
| | UREKA | | | | | | | | | | ■ | | | | | | | | |
| | US Ireland | | | ■ | ■ | ■ | | | | | ■ | | | | ■ | | | | |
| | Supplements | | | ■ | ■ | ■ | | | | | ■ | | | | ■ | | | | |
| | Women in Science & Eng | | | | | | | | | | ■ | | | | ■ | | | | |
| | NanoSci-E | | | ■ | ■ | ■ | | | | | ■ | | | | ■ | | | | |
| | Conference & Workshop | | | ■ | ■ | ■ | | | | | ■ | | | | ■ | | | | |
| | Strategic Collaborations | | | ■ | ■ | ■ | | | | | ■ | | | | ■ | | | | |
| | Equipment Supplement | | | | | | | | | | ■ | | | | | | | | |
| IRCSET | EMBARK | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | |
| | INSPIRE/EMPOWER | | | | ■ | | | | | | | | | | | | | | |
| | New and Emerging Areas | ■ | | ■ | ■ | ■ | | | | | | | | | | | | | |
| | Enterprise Partnership | ■ | ■ | ■ | | | | | | | | | | | | | ■ | ■ | ■ |
| | GREP | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | ■ | ■ | | |
| | Ulysses | | | | ■ | | | | | | | | | | | ■ | | | |
| | | | | | | | | | | | | | | | | | | | |
| IRCHSS | Postgraduate | | | ■ | | | | | | | | | | | | | | | |
| | Postdoctoral | | | | ■ | | | | | | | | | | | | | | |
| | Academic Staff | | | | | ■ | | | | | | | | | | | | | |
| | Projects | | | ■ | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| TSRI | Research MSc in IoTs | ■ | | | | | | | | | | | | | | | | | |
| | Entrepreneurship Training | | | | | | ■ | | | | | | | | | | | | |
| | Research Capacity | | ■ | | ■ | | | | | | | | | | | ■ | | | |
| North-South | Collaborative Projects | | | | | | | | | | | | | | | | | | |
| Infrastructure Support | | | | | | | | | | | | | | | | | | | |
| Electronic Infrastr | Core Infrastructure Project | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | | ■ | |
| | e-INIS | | | | | | | | ■ | | ■ | | | | | ■ | | ■ | ■ |
| | Schools Network | | | | | | | | | ■ | ■ | | | | | | ■ | ■ | |
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| Enterprise STI SP | Transforming R&D | R&D Fund | | | | | | | ■ | | ■ | | ■ | | | | ■ | ■ | |
| | | Innovation and R&D Management Trainin | ■ | | | | | | | | | | | | | | | | |
| | | Technology Transfer | | | | | ■ | | | ■ | | | | | | | | | |
| | Industry Collabora | ARE | | | | | | | | ■ | | | | | | | | | |
| | | Industry-led networks | | | ■ | ■ | ■ | | | ■ | | ■ | | | | | | ■ | ■ |
| | | Competence Centres | | | | | | | | | | | | | | | | | |
| | | Innovation Vouchers | | | | | | | | | | | | | | | ■ | | |
| | | International Collaboration | | | ■ | ■ | ■ | | | | | | | | | ■ | ■ | | |
| | Realising Commer | Commercialisation fund | | | ■ | ■ | ■ | | | | | | | | | | | ■ | |
| | | Campus incubators | | | | | | | ■ | ■ | | | | | | | | | |
| | | TTOs | | | | | | | | | | | | | | ■ | ■ | ■ | ■ |
| | | IP Supports | | | | | | | | | | | | | | ■ | ■ | ■ | ■ |
| Agri-food SP | TEAGASC | Agriculture Research | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | | ■ | | ■ | | ■ | ■ | ■ | ■ |
| | | Food Research | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | | ■ | | ■ | | ■ | ■ | ■ | ■ |
| | FIRM | Project Funding | ■ | | ■ | ■ | | | | | | ■ | | | | ■ | | | |
| | | Strategic Equipment Initiative | | | | | | | | | | ■ | | | | | | | |
| | | Network Initiative | ■ | | ■ | | | | | | | | | | | ■ | | | |
| | | Graduate Development Programme | | ■ | | | | | | | | | | | | | | | |
| | | Collaborative Projects | ■ | | ■ | ■ | | | | | | ■ | | | | | | | |
| | RSF | Project Funding | ■ | | ■ | ■ | | | | | | ■ | | | | ■ | | | |
| | COFORD | Research Programme | ■ | | ■ | ■ | ■ | ■ | ■ | | | ■ | | | | ■ | ■ | | |
| | | Services & Technology Transfer | ■ | | ■ | ■ | ■ | ■ | ■ | | | | | | | | ■ | ■ | |
| | | Networking & Researcher Training | ■ | | ■ | ■ | ■ | ■ | ■ | | | | | | | | | ■ | |
| Energy Research SP | | House of Tomorrow | ■ | ■ | ■ | | | | ■ | ■ | ■ | | ■ | | | ■ | | | ■ |
| | | Low Carbon House | ■ | ■ | ■ | | | | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | | | ■ |
| | | Smart Metering, NEEAP and DSM | | | | | | | | | | | ■ | | | | | | |
| | | RERDD Programme | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | ■ | | | ■ | | ■ | ■ |
| | | Ocean Energy | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | | ■ | ■ | ■ |
| | | Integration of RE into Transport | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | ■ | ■ | | | | ■ | ■ | ■ |
| | | Microgeneration/PV | | | | | | ■ | ■ | | | | ■ | | | ■ | | ■ | ■ |
| | | Grid Infrastructure R&D | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | ■ | | | ■ | ■ | ■ | ■ |
| | | EPPSU and Modelling | ■ | ■ | ■ | ■ | ■ | ■ | | | | ■ | ■ | | | ■ | ■ | ■ | ■ |
| Marine Research SP | | Marine Industry Research Measure | ■ | ■ | ■ | ■ | ■ | | | | | ■ | | | | | ■ | ■ | |
| | | Discovery Research Measure | | ■ | ■ | ■ | ■ | | | | | ■ | | | | | ■ | | |
| | | Policy Support Research Measure | | ■ | ■ | ■ | ■ | | | | | | | | | | ■ | ■ | |
| | | Marine Innovation Support Measure | | | | | | | | | | | | | | | ■ | ■ | ■ |
| | | Infrastructure Support Measure | | | | | | | | | | | | | | | ■ | ■ | |
| Health Research SP | | Career Support Funding Schemes | ■ | ■ | ■ | ■ | ■ | ■ | | | | ■ | | | | | | | |
| | | Project & Programme Funding Schemes | ■ | | ■ | ■ | ■ | ■ | | | | ■ | | | | | | | |
| | | Infrastructure-related Funding Schemes | | | ■ | ■ | ■ | ■ | | ■ | | ■ | | | | ■ | | ■ | |
| | | Mental Health Research Unit | | | | | | | | | | | | | | | | | ■ |
| | | Alcohol & Drugs Research Unit | | | | | | | | | | | | | | | | | ■ |
| | | Disability Database Research Unit | | | | | | | | | | | | | | | | | ■ |
| | | Child Health Research Unit | | | | | | | | | | | | | | | | | ■ |
| Environment Research SP | | Sustainable Development Measure | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | |
| | | Cleaner Production Measure | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | ■ | | | | | | | |
| | | Environment and Health Measure | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | |
| | | Support Measure: Environ Research Centre | | | | ■ | ■ | ■ | | | | | | | | | | | |
| | | Support Measure: Capacity & Capacity B | ■ | | ■ | ■ | ■ | | | | | ■ | | | | | | | |
| | | Climate Change Research Programme | | ■ | ■ | | ■ | | | | | | | | | | | | |