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The Irish National Innovation System:

Structures, Performance and Challenges

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HEA
Higher Education Authority
An tÚdarás um Ard-Oideachas

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The Irish National Innovation System: Structures, Performance and Challenges[2]

Abstract

This paper deals with three elements of the Irish National Innovation System namely structures, performance and challenges. The paper begins by outlining the policy context and then focuses on technology trajectories and institutional structures and evolution. In focusing on outputs of the national innovation system key indicators are outlined as well as technology commercialisation initiatives. The paper concludes by outlining the strengths and weaknesses in the Irish National Innovation system and the cultural drivers the have driven it evolution.

[2] The authors wish to acknowledge the funding support of the Higher Education Authority PRTLI Cycle 4 programme in the preparation of this working paper.

'Ireland's ambition is to become a leader in innovation. Our goal is to develop an innovation-driven economy that maintains competitive advantage and increases productivity' Mary Coughlan, TD, Tániste and Minister for Enterprise, Trade and Employment. (Coughlan, 2008)

I Introduction

The Irish economy over the last two decades has been one of the top performing economies in the world with sustainable growth rates, success in attracting leading global companies through foreign direct investment (FDI), flexible labour markets, fiscal policy as well as Irish business attitudes towards competitiveness and globalisation. The antecedents of this success and the development of a national innovation system were laid in the 1960's when Ireland adopted an economic development strategy which had as its central focus the attraction of foreign direct investment. The predominant focus of industrial policy right through to the late 1990's was the attainment of increased employment which was achieved by attracting and retaining Multinational Corporations through the use of tax incentives and leveraging the skilled English speaking workforce. In addition, there was an emphasis on building an indigenous industry base that was export focused. These two policy platforms of FDI and indigenous company growth have resulted in what some have called a dual economy within Ireland.

The Policy Context

Investment in Science, Technology and Innovation (STI) prior to 2000 was extremely limited with researchers in Ireland largely dependent on the EU Framework Programmes (see cordis.europa.eu), and other international funding competitive funding sources to sustain research activities. The investment in STI by the Irish Government in the period of 1994-99 was €0.5 billion. The shortage of national investment in STI was viewed as a major stumbling block that was in large part responsible for the lack of a sustained critical mass of research competence. A Technology Foresight group was created in the late 1990's under the auspices of the already established Irish Council for Science, Technology and Innovation. The report they produced, along with an increasing recognition within public policy circles that there was a need to increase the innovative capacity of Ireland, resulted in the

commitment of €2.5 billion to the area of STI for the National Development Plan for 2000-2006.

An additional key policy document with respect to the role of enterprise in Ireland was the Enterprise Strategy Group (ESG) Report published in July 2004 chaired by Eoin O'Driscoll. That document issued a number of recommendations to sustain Ireland's competitiveness against a backdrop of unemployment of 4.7 per cent and government debt at 34 per cent of GNP at the time. The characteristics of competitive advantage that the ESG identified for Ireland were based on expertise in market, expertise in technology product and service development, world class skills, education and training, attractive tax regime and effective, agile government. Moreover, the report identified the essential conditions for this to occur: cost competitiveness, physical and communications infrastructure, innovation and entrepreneurship and management capability (see Figure 1)

Figure 1: Enterprise Strategy Group: Making it Happen

The ESG (2004) argued '…that enterprise in Ireland, while having highly developed manufacturing ability, lacks capability in two essential areas: international sales and marketing and the application of technology to develop high value products and

services. The report points to areas of activity in services and high value manufacturing which, if enabled by expertise in markets and technology, would significantly enhance the enterprise base.' Specific recommendations of the ESG (2004, pp.xv-xxi) included:

- A market intelligence and export promotion structure
- 1,000 sales and market personnel
- Target sales and marketing and European Headquarters projects
- An R&D and innovation co-ordination structure
- Increase applied R&D funding
- Investment of Enterprise-led networks
- 'One Step Up' initiative, facilitated by the National Framework of Qualifications to encourage greater participation and learning
- Quantity and quality of graduates and post graduates
- Commitment to 12.5% corporate tax rate
- Cabinet enterprise review process.

The Strategy for Science, Technology and Innovation (SSTI) published by the Government in 2006 represents another policy milestone in evolving the economy towards a knowledge based one, and builds on investments made through National Development Plan (2000 to 2006), Programme for Research in Third Level Institutions (PRTLI) and Science Foundation Ireland (SFI). The strategy covered such themes as building world class research; capturing, protecting and commercializing ideas and know-how; research and development for enterprise; innovation and growth; science education and society; research in the public sector; all island and international R&D and implementation issues. Key actions areas of SSTI include building world class research; protecting and commercializing ideas and know-how; research and development for enterprise innovation and growth (see Table 1)

Table 1: Main aims of the Strategy for Science, Technology and Innovation 2006-2013

Academic research	❖ Significantly increase the number of research teams led by internationally competitive Principal Investigators; ❖ Upgrade existing research infrastructure and develop new facilities; ❖ Develop sustainable career paths for researchers; ❖ Enhance the mobility of researchers; and ❖ Double the number of PhD graduates in science, engineering and technology to one thousand per annum by 2013.
Graduate schools	❖ Establish a number of graduate schools to provide high-quality training of researchers, and equip them with generic and transferable professional skills that are relevant modern knowledge-based enterprise economy; and ❖ Accommodate industrial placements to facilitate development of enterprise expertise.
Commercialisation	❖ Increase outputs of economically relevant knowledge, know-how and patents from third-level institutions; and ❖ Strengthen the Intellectual Property/ Commercialisation functions within Higher Education Institutes and provide them with expertise to translate research into applications.
Industrial research	❖ Transform the quality and quantity of research undertaken by enterprise – both and in cooperation with third-level institutions; ❖ Grow business annual expenditure on R&D from €1 billion in 2003 to €2.5 billion and ❖ Develop a number of industry-led research-driven Competence Centres with research facilities in third-level institutes.
Sectoral research	❖ Enhance the contribution of research to economic and social development across relevant areas of public policy; and ❖ Provide a competitive fund to encourage excellent research in areas of social, economic or environmental need, such as sustainable agriculture, treatment of specific medical conditions, and energy security.
Public awareness	❖ Increase public awareness and appreciation of the role of science in society, with particular focus on schoolchildren and those that influence them; and ❖ Increase the number of schoolchildren taking science subjects.
Cross-border and international cooperation	❖ Increase international cooperation in science and technology and participation in transnational research activity; and ❖ Encourage Irish researchers to collaborate internationally and to avail of EU Framework Programme funding. Leverage complementary strengths in institutions and enterprises in Ireland and Northern Ireland through increased cross-border cooperation.

Source: Department of Trade Enterprise and Employment, Innovation in Ireland (2008).

The current cycle of the National Development Plan covers the years 2007-2013 and has set very ambitious output targets and spending commitments for STI – which give concrete public funding commitments to the aspirations as set out in the Strategy for Science Technology and Innovation (2006). During this period over €8.2 billion will be spent overall on STI. This spend will be accounted for on the basis of the following: €3.42 billion will be spent on world class research in STI, €1.5 billion in R&D expenditure in Higher Education, €1.29 billion on Enterprise STI and €1.35 billion on sector specific research in areas such as Agri-Food, Energy, Marine, Geoscience, Health and Environment. (NDP 2007-2013). This targeted spending will enable the achievement of the Strategy for Science, Technology and Innovation which has within it the following key objective:

> '*Ireland by 2013 will be internationally renowned for the excellence of its research and will be to the forefront in generating and using new knowledge for economic and social progress within an innovation drive culture.*'
> (Strategy for Science Technology and Innovation, 2006)

Technology Trajectories

Through sector targeted initiatives by the IDA with respect to FDI, Ireland has built up substantial capabilities through attracting leading multinational companies including some of the most successful companies in computer and software design, communications technology, pharmaceuticals, and medical devices. Cognisant of the existence of these multinational companies and in an attempt to further grow the science and technology base of the country a technology foresight exercise was carried out in 1999 which concluded that biotechnology and information and communications technology represent "the engines of future growth in the global economy" and that Ireland should, as a matter of priority, seek to create a world class research capability in selected niches of these two enabling technologies as an essential foundation for future economic growth in Ireland. This document was the precursor to the establishment of Science Foundation Ireland (SFI) in 2000 which was charged with providing financial research support for are ICT and biotechnology. In 2008 the strategic areas of scientific endeavour to be funded by SFI was extended to include sustainable energy and energy-efficient technologies.

Current Institutional Structures and Evolution

There are a number of different public institutions and statutory bodies which play important roles in the Irish National System of Innovation. The first four: Forfás, Industrial Development Authority, Science Foundation Ireland and Enterprise Ireland are the responsibility of the Government Department of Enterprise, Trade and Employment. The other two – the research councils and the Higher Education Authority are overseen by the Department of Education and Science.

Forfás: Established in 1994, Forfás is the body in which the legal powers of the State for the promotion and development of industry, science and technology are largely vested. It is the national policy and advisory board for enterprise, trade, science, technology and innovation. It provides the Department of Enterprise, Trade and Employment (DETE) and other stakeholders with analysis, advice and support on issues related to enterprise, trade, science, technology and innovation. It also provides administrative and /or research support to a number of independent bodies including: Advisory Council for Science, Technology and Innovation, Expert Group on Future Skills Needs (EGFSN), Management Development Council (MDC), National Competitiveness Council (NCC) and the Small Business Forum. It also hosts the Office of the Chief Scientific Adviser to Government.[3]

Industrial Development Authority (IDA) Ireland: IDA Ireland is a state-sponsored agency funded primarily through Government grant aid. Broadly, the key objective of the IDA is to attract and retain foreign direct investment (FDI) in Ireland, and in so doing contribute to Ireland's economic development. Specifically, it works to develop the strong base of over 1,000 overseas companies already located in Ireland and also to attract new investment. IDA success to date in attracting inward investment is a major driving force behind the growth of the Irish economy. As of 2005 FDI accounts for 35% of GDP and over 85% of manufactured exports, The IDA has and continues to win a disproportionate share of Foreign Direct Investment (FDI) into Europe. Independent reviews confirm that Ireland's market share of new US greenfield manufacturing projects locating in Europe is consistently strong relative to its share of

[3] Source: www.forfas.ie

the EU population and GDP. The US is and continues to be the most significant source of inward investment – accounting for 70% of FDI. [4]

Science Foundation Ireland (SFI): Science Foundation Ireland (SFI), the National Foundation for Excellence in Scientific Research was established in 2000 and is modelled on the National Science Foundation in America. SFI is responsible for the management, allocation, disbursement and evaluation of expenditure for investment in academic researchers and research teams who are most likely to generate new knowledge, leading edge technologies, and competitive enterprises in the fields underpinning two broad areas: Biotechnology, and Information and communications technology.[5]

Enterprise Ireland: Enterprise Ireland provides intense supports for Irish owned businesses (employing between 10 and 250) involved in manufacturing and internationally traded services. They also support start-ups and micro businesses (less than 10 employees) in the same sector, provided they have the potential to achieve rapid growth and international expansion. These later businesses are referred to as High Potential Start-Ups (HPSUs), of which about 70 start-ups receive Enterprise Ireland support each year.

Research Councils: Coinciding with the increased attention that was focused on research and development in the 2000-2006 National Development Plan two core research councils were established. The Irish Research Council for Humanities and Social Sciences (IRCHSS) was constituted in 2000 and the Irish Research Council for Science Engineering and Technology in 2001. Both research councils operate and manage numerous research schemes such as graduate and post-graduate fellowships, and research grants for new and established academic researchers.

HEA: The Higher Education Authority is a statutory body with responsibility for the planning and policy development for higher education and research in Ireland. The HEA has wide advisory powers throughout the whole of the third-level education sector. In addition, it serves as the funding authority for the universities and institutes

[4] Source: IDA Freedom of Information Manual, November 2006, page 9, www.ida.ie

[5] Source: www.sfi.ie

of technology. One of the key research funding programmes administered by the HEA is the Programme for Research in Third-Level Institutions (PRTLI) which was launched in 1998. It has invested €866 million to date over four funding cycles (See Table 2) in strengthening national research capabilities via investment in human and physical infrastructure. The aim of the programme is to advance Ireland in its bid to establish itself internationally as a premier location for carrying out world class research and development in all academic disciplines. The PRTLI awards are evaluated by an international panel of distinguished researchers and scholars on the basis of excellence in: Strategic planning and focus, Inter-institutional collaboration, Research quality and impact of research on teaching and learning.[6]

Table 2: PRTLI Funding Cycles

	Year	**Funding Period**	**Buildings & Equipment €(M)**	**Research Programmes & People €(M)**	**Total €(M)**
Cycle 1	1999	2000 - 2003	177.5	28.6	206.1
Cycle 2	2000	2001 - 2004	48.8	29.7	78.5
Cycle 3	2001	2002 - 2006	178.0	142.4	320.4
Cycle 4	2007	2007 - 2010	108.8	120.3	261.2
TOTAL			**513.1**	**321.0**	**866.2**

Source: www.hea.ie

Public and Private Institutions and their Linkages

The main public institutions have been discussed in a previous section. All of these public institutions have extensive linkage with private institutions. Both Industrial Development Authority and Enterprise Ireland have, by virtue of their remits, extensive interactions with businesses. Forfás creates multiple linkages with private institutions by appointing a number of industrialists to the Forfás Board. In addition,

[6] Source: www.hea.ie

the major reports commissioned by Forfás and its associated bodies are overseen by task forces that have substantial private institutional representation.

Science Foundation Ireland ensures collaboration with industry by the funding structures that it administers. For example one of its major funds – Centres for Science Engineering and Technology (CSETs) has as a requirement that industry partners are willing to contribute and support financially to the research programme. In return key industrial partners have the first call on IP exploitation.

II Summary of Output Trends

In terms of innovation activity the top four active innovative sectors are chemicals, medical precision and rubber and plastics, and food and beverages. The top four service sectors in terms of activity include computer related services, communications, engineering and technical services, and transport. For firms the total estimate of spending of innovation activities was estimated to be €5.72 billion, with 60 per cent being spend on machinery and equipment, 24 per cent on in house R&D and 12.7 per cent being spend on external knowledge (Forfás, 2006).

A strong contributor to the growing R&D has been expenditure within third level educational institutions. The rate of R&D expenditure in higher education has tripled since 1998 from €169 million to €568 million and between 2004 and 2006 the rate of growth of R&D expenditures increased by 23.1 per cent (see Table 3).

Table 3: Main Higher Education R&D (HERD) Indicators 2000-2006

	2000	2002	2004	2006
Higher education expenditure on R&D (€, millions)	238	322	492	601.4
HERD as a % of GNP (Ireland)	0.27%	0.31%5	0.40%	0.40%
HERD as a % of GDP (EU-25 average)	0.37%	0.40%	0.39%	0.40%
Ireland's rank among 29 OECD countries	22nd	19th	16th	14th
Total researchers in the HE sector (FTE)	2148	2695	4152	4689
HE Researchers per 1,000 labour force (Ireland)	1.2	1.5	2.2	2.2
Ireland's rank among 29 OECD countries	24th	23rd	14th	13th

Source: Forfás 2008 The Higher Education R&D Survey 2006 Detailed Findings, p.6.

Business expenditure on R&D (BERD) in real terms has shown strong growth in Ireland – nearly tripling in the ten years between 1995 and 2005 (Table 4). The majority of the expenditure is incurred by foreign-owned firms, who in 2005 spent €939m or 71% of the total BERD expenditure. The source of funding for business R&D is overwhelmingly private funding (95% of 2005 total) with the bulk of the remaining 5% accounted for by Irish Government funding. The extent of R&D expenditure is highly concentrated – with 50 firms accounting for 57.7% of total R&D spend in 2005. The make up of the R&D being carried out is also changing with 12% of all spending being classed as basic research in 2005, as against only 4% in 2001.[7]

[7] Source: Forfás 2007: Research & Development Performance in the Business Sector Ireland 2005/6

Table 4: Business Expenditure on R&D (BERD)

	1995	2001	2003	2005
BERD Ireland (Current Prices €m)	470	900	1,105	1,329
BERD Ireland (Constant Prices 2006 €m)	658	1,059	1,201	1,380
BERD (%GNP) Ireland	1.00%	0.92%	0.94%	0.98%
BERD (% GDP) EU	1.05%	1.17%	1.15%	1.14%
BERD (% GDP) OECD	1.39%	1.57%	1.53%	1.54%
BERD (% GDP) Ireland	0.89%	0.77%	0.80%	0.82%

Source: Forfás 2007: Research & Development Performance in the Business Sector Ireland 2005/6

In terms of patent activity, Ireland's activity level is growing but remains low (see Table 5) One explanation, as Forfás (2004, p.21) outlines, is 'Ireland's dual industry structure and a foreign- owned sector that, with few exception, does not carry out high value-added activities in Ireland.' The growth rate in patent filing at the EPO between 1995 and 2000 was 26 per cent per annum. Nevertheless, Ireland's share of European and US granted has been increasing but remains low. The top three technology classification patent activity by sector 1999-2001, were health (including medical devices), electronics and medicines and toiletries (Forfás, 2004, pps23-24).

Table 5: Patenting Filing

Patent Filing and Grants by Office						
	Resident Direct Filing 2005	Non Resident Direct Filing	PCT National Phase Entries	PCT International Applications 2006	Grants to Residents 2006	Grants to Non Resident 2005
Ireland	789	75	N/A	144	300	210
Patent Filing by Country & Territory of Origin						
	Non Resident Direct Filing	PCT National Phase Entries 2005	PCT International Applications 2006	Grants to Non-Resident 2005	Patents in Force 2005	
Ireland	815	910	407	572	2,882	
Patenting Filing by Population, GDP and R&D Expenditures						
	Resident Filings per Million Population 2005	Resident Filings per $ Billion GDP 2005		Patent Filing per $ Million R&D Expenditures 2005		
Ireland	**190.09**	**3.34**		**0.48**		

Source: WIPO (2007) The Patent Report: 2007 Edition Activities, pp.46-51.

III Technology Commercialisation Initiatives (National Level)

In the last fifteen year Ireland has made some significant strides in responding in a coherent manner to the developing technology commercialisation initiatives that are targeted at the dual economy. Nevertheless, Ireland's track record of exploiting intellectual property has been poor given the low levels of patent registration in Ireland compared to EU countries. In addition further weaknesses lay in staffing levels in technology transfer offices within the third level sector as Forfás (2004, p.34) noted: 'Not all Irish research institutions have clearly identified the role and the function of IP management and have created specific positions to manage it. In these institutions approximately 62 people, (22 full-time equivalents (FTE), are regarded as being involved in commercialisation activities – providing an average of 0.96 staff per

research institution.' Such staffing levels are well below international norms required to achieve appropriate level of IP exploitation.

Clarity about IP ownership and management of strategy funded research is seen as another barrier to technology transfer and further research collaboration between industry and academia. The publishing of a National Code of Practice in 2004 with respect to IP ownership and management for purely publicly funded research removed uncertainties around IP ownership. The National Code of Practice clarified issues to do with invention disclosures, share of income and IP assignments, and the state's right to retain an interest in IP management.

The publication of the Strategy for Science, Technology and Innovation is designed to scale and co-ordinate the national efforts in commercialisation and technology transfer and set out clear key actions to enhance technology commercialisation within the Irish economy. Key actions with respect to IP management and exploitation include (SSTI, 2006, p17):

- Ensure that Higher Education Institutions (HEIs) encompass IP management and commercialisation as a central part of this mission, equal to teaching and research.
- Strengthen institutional competence at Technology Transfer Offices (TTOs) level and among researchers.
- Establish competitive fund administered by Enterprise Ireland to assist strengthening of IP management function.
- Establish a new function in Enterprise Ireland providing centralised support to HEIs thereby maximising the commercialisation of IP.

The ongoing investment, implementation and enhancement of technology commercialisation initiatives led by Enterprise Ireland (EI) with third level institutions and firms are designed to address the dual economy focus. To date Enterprise Ireland is responsible for the administration of six schemes that are designed to bring technology to the market place. These include the commercialisation expertise; commercialisation fund; patent fund and advice; campus

incubation centres; applied research enhancement programme and technology transfer strengthening initiatives.

Commercialisation Expertise: Enterprise Ireland provides expertise to companies as well as researchers in helping them access new technology. The focus of this is to seek to improve company competitiveness on an international level by concentrating on higher value market arenas. This expertise is provided in three domain areas: Biotechnology (BiotechnologyIreland.com) Industrial Technologies and Informatics. Technology commercialisation activities supported by EI in 2006 in the biotechnology arena equated to an investment of €5.5 million in 14 new biotechnology research projects, 9 technologies licences and three start-ups. This support is valued at €10 million, bringing total investment in biotechnology by EI to €40 million since 2001. In 2006, the Industrial Technologies group supported technology commercialisation which accounted for 41 proof of concepts projects, 23 technology development projects, 8 technologies were licences and three start-ups were formed. The Informatics Commercialisation supported by EI in 2006 lead to 24 POC projects, 14 technology development projects, 7 technologies were licensed and one start-up, in addition to holding of an Informatics Technology Commercialisation Showcase (Enterprise Ireland, 2006).

Commercialisation Fund: This fund is administered over three phases – Proof of Concept Phase, Technology Development Phase and Business Development Phase (CORD) and is designed to bring new technologies to the market place by improving technical and business cases. The Proof of Concept Phase is aimed at researchers within third level institutions who seek to explore commercial applications for their technology. The grants cover 100 per cent of eligible costs (personnel, equipment, material and travel) and range from €50,000 to €100,000 over a twelve month period. Since the launch of the Proof of Concept fund in 2003 over 350 proposals have been funded to the tune of over €28 million. The next phase of support is through the Technology Development fund which is targeted at scaling a technology aimed at a particular market arena, through licensing or new business start-up. The support levels available under this scheme to the researcher's institution range from €100,000 to €400,000 over an 18 to 36 month period. In 2006 alone, EI supported and funded 155 research projects through the POC and Technology Development stages which

equated to €29.7 million (Enterprise Ireland, 2006, p.27) of investment. Finally, the Business Development Phase is designed to support bringing new technologies from third levels institutions to the marketplace. Typical types of support under this scheme include market research, product trials/market assessment, cost analysis, financial projections and establishing potential joint venture partners. The level of support is an approved grant which may be for up to 50% of eligible expenditure with a ceiling of €38,000 per grant (see Table 6 for details of maximum expenditure limits).

Table 6: Business Development Phase: Maximum Level of Funding

Expenditure Item	Level of Funding
Salaries/Wages	€950 per week (non if employed by the college)
Consultancy	€650 per day
Travel	Economy class fare
Mileage within Ireland	€0.40c per mile
Subsistence	€100 per night within Ireland, €200 per night outside Ireland
Prototype	50% of costs
Promotional materials	€6,350

Source:www.enterprise-ireland.com/ResearchInnovate/Research+Commercialisation/Campus_Enterprise.htm

Patent Fund and Advice: Enterprise Ireland provides professional advice and some financial assistance towards the cost of patenting for client companies. The advice provided includes the use of IPR, confidentiality agreements, licensing and technology acquisition. EI also administers the IP Fund for Higher Education Sectors, designed to provide support to protect IP that has marketplace potential. This support is open to all third level colleges and associated teaching hospitals. Funding can come in three stages, as follows:

- Stage 1: Up to €7,000 to assist with the costs of preliminary patent protection;
- Stage 2: Up to €20,000 to support patenting costs arising in the continuing prosecution of an already filed initial patent application or extension of patent coverage to other countries.

- Stage 3: Funding to provide support for the later stages of the patenting process.

The amount is determined by Enterprise Ireland for each case but normally is not more than €50,000. Funding is restricted to costs directly associated with the protection of the invention concerned. It will normally cover 100% of such costs[8].

Campus Incubation Centres: To date there are 14 campus incubators centre with six bio-incubation facilities offering resources and facilitates to start-up companies. Since 1998 Enterprise Ireland has invested €47 million in campus incubation centres and between 2001 to 2006 181 companies have used campus incubation centres. This equates to 67 university linked start-ups and 114 companies located in incubation spaces within 16 institutes of technology. *Changing Worlds* founded in 1999 by Professor Barry Symth and Paul Cotter University College Dublin who commericalisation their research from UCD's Smart Media Institute. Based at NovaUCD the company is a provider of intelligent personalisation technology for telecommunication. In 2007over 200 companies are located in campus incubation centres employing more than 900 people (Enterprise Ireland, 2007, p.53)

Applied Research Programme: This research programme is aimed specifically at enhancing the level of applied research in the Institutes of Technology. In particular Institutes of Technology have achieved success in applied research areas against a backdrop of resource research deficits in comparison to Irish universities. Funding of €1.25 million is available for up to a 3 to year period. To date, eleven centres of excellence have received funding under the programme.

Technology Transfer Strengthening Initiatives: This intervention is the implementation of the SSTI recommendation on enhancing the capabilities and operations of Technology Transfer Office within the third level system and was a response to the identified TTO staffing deficit. Enterprise Ireland has been tasked with rolling out this initiative which has a budget allocation of €30 million from 2007 to 2011. To date nine universities have received funding of €15.6million which has lead

[8]Source:http://www.enterpriseireland.com/ResearchInnovate/Research+Commercialisation/Intellectual+Property+Fund+for+the+Higher+Education+Sector.htm)

to an additional 29 trained technology transfer professional being hired by these TTOs.

One of the most significant developments on technology commercialisation initiatives has been the establishment of Centres of Science Engineering and Technology (CSET) funded by Science Foundation Ireland, which are located in Irish universities. These Centres are designed to build a critical mass of excellence in biotechnology and ICT which can be exploited by their commercial partners, who have first right of their IP (see Table 7). In addition to their IP exploration and exploitation, these CSETs also have a strong outreach element to their activities, for purposes of raising awareness of science and highlighting career and education opportunities.

Table 7: Centres of Science Engineering and Technology (CSETs)

Alimentary Pharmabotic Centre €16.5 Million SFI Funding (2003) 48 SFI funded staff
Biomedical Diagnostics Institute €16.5 Million SFI Funding (2005) Industrial Partners (Amic, Analog Devices, Becton Dickinson, Enfer Scientific, Hospira, Inverness Medical Innovations/Unipath)
Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN) €10 Million SFI Funding (2006) Industrial Partner – Intel
Centre for Telecommunications Value Chain Research €20 Million SFI Funding (2004) 97 academic staff
Digital Enterprise Research Centre €12 Million SFI Funding (2003) 80 full time staff Industrial Partner – HP
LERO – The Irish Software Engineering Research Centre €9.1 Million SFI Funding (2005) 40 researchers and PhD students
Regenerative Medicine Institute (REMEDI) €14.9 Million SFI Funding (2003) Industrial Partner – Medtronic

Source SFI (2006) Annual Report, pps. 9-13.

Private Firm Level State Support of SSTI

At the firm level, Enterprise Ireland has again been the lead agency tasked with encouraging and supporting greater R&D and technology commercialisation. To this end, EI provide R&D funding, New R&D Collaboration, R&D Management and Technology Management. In 2006 Enterprise Ireland reported that 601 client companies invested in excess of €100,000 in R&D and 40 client companies invested in excess of €2 million in R&D development. During 2006, EI approved 194 in-company R&D projects which represents financial support of €52.9 million in research funding (Enterprise Ireland, 2006, p.25).

R&D Support: There are four strands to the support that EI offer: a) Stimulating Research and Innovation Grants, b) R&D Fund, c) Collaboration, and c) Innovation Expertise. The Stimulating Research and Innovation grants are specifically targeted at firms with an export orientation who have little or no R&D but who wish to build this capability within their firm. The aim of the support at a firm level is the achievement of at least one of the following outcomes:

- At least one individual full time person dedicated to R&D
- A continuing R&D budget of between €100-200K per annum
- A written plan for R&D projects being/to be carried out[9]

The R&D Fund is aimed at supporting research, development and innovation at all stages of firm development. The fund is designed to increase the breadth and depth of research and development among Irish firms which will equip them to scale and compete in international markets. To avail of this fund companies must be an Irish based manufacturer or an internationally traded company and the company must demonstrate that it has sufficient resources to implement the proposed project. The outcomes this funding attempts to achieve at a firm level include the establishment of R&D budgets, recruiting of dedicated R&D resources, investment in R&D facilities, formal R&D management procedures and the development of a firm level innovation

[9]Sources:http://www.enterpriseireland.com/ResearchInnovate/R+and+D+in+your+Enterprise/RandD+Stimulation+Grant.htm

culture. The maximum R&D grant that a company can receive is €650,000 and Table 8 provides a breakdown of grants per size.

Table 8: R&D Fund Grants as Per Size

The maximum grant rates are given in the table below:

	Small Co.	**Medium Co.**	**Large Co.**
Innovative Projects that are technically challenging and involve significant risk Max Project funding	45%	35%	25%
Innovative Projects where there is collaboration between two companies Max Project funding	+15% 50%	+15% 50%	+15% 50%

Source: Enterprise Ireland

New R&D Collaboration: Enterprise Ireland provides a number of different types of support and enhancements to encourage the development of new R&D collaboration. These include innovation partnerships between firms, third level institutions and competence centres.

Innovation partnerships are designed to provide support of between 50 to 70 per cent of eligible costs of research projects for collaborations between a firm and third level institutions. In 2006 Enterprise Ireland supported 63 innovation partnerships (Enterprise Ireland, 2006, p.25). The innovation partnership projects are managed by the Technology Transfer Offices within the third level sector.

The Competence Centres concept and ancillary support was formed in 2007. It is designed to achieve greater research and development collaboration between a number of firms and research institutions through undertaking industry led research which has a clear market orientation. As a result of the establishment of competence centres it is envisaged that research organisations will deepen their expertise in particular domains oriented towards addressable market problems as a research provider. For Irish firms it means that they can direct the research, access the IP,

enhance their competitiveness in international market through technology making which is normally high risk in nature.

R&D Management: The focus of this initiative is to provide training at a firm level that is needed to support R&D development initiatives at a firm level by typically subvention of participation fees of up to 70 per cent for SMEs and 50 per cent for non SMEs eligible companies. Training programmes include Introduction to Innovation and R&D Management, Innovation to Profit, BA in Technology Management, MSc in Technology Management, MSc in Technology Management distance education, and the Champion of Innovation Programme.

Technology Acquisition: Technology acquisition is supported and managed through the TechSearch web portal (http://www.enterprise-ireland.com/TechSearch) which provides information and overviews of technology that are available to licence through the Innovation Relay Network (from 33 countries from 2,500 technology solutions) into a firm. In 2006, this intervention assisted 160 client companies, resulting in 35 licence agreements which equates to over €2 million of an investment with a sales potential of €15 million based on these licences (Enterprise Ireland 2006, p.25). EI also runs several Technology Mapping briefing sessions designed to support technology acquisition.

Enterprise Ireland also provides additional support to improve the productivity and competitiveness of client companies through their Business Innovation Offer Supports which compromises of three elements namely: stimulating business innovation; growth expertise and a growth fund

Within the Stimulating Business Innovation supports EI provides supports such as Supply Chain Management (SCM), eBusiness Management Initiative (eBMI), Green Technologies, Feasibility Studies and Innovation Vouchers. Growth expertise support is focused on providing best practice support to clients firm in the areas of automation, benchmarking, ebusiness, environmental management and supply chain management. The Growth Fund is specifically designed to improve innovation and productivity of client companies. This fund supports capital investment, technology acquisition, talent recruitment, management development and training (See Table 9

for maximum support limits). In 2006, 200 EI client companies participated in management development programmes such as Leadership 4 Growth delivered by Stanford Graduates School of Business.

Table 9: Growth Fund Maximum Support Limits

	Max. Funding	Funding Type	Min. Company Spend
Capital Investment	€300,000	Grant / 50% repayable	€75,000
Technology Acquisition	€300,000	Grant	€50,000
Training & Management Development	No specific limit	Grant	€25,000
Consultancy	25% of total project	Grant	n/a
Recruitment of Key Managers	€200,000	Grant	n/a
Workplace Innovation & Management Development	No specific limit	Grant	€25,000
Overall Maximum Support for Submission	€650,000		

Source: www.enterprise-ireland.com/Grow/Finance/Growth+Fund.htm

V Relative Strengths and Weaknesses in Technology

The policy agenda being pursued by the Irish Government and its stakeholders is designed to build on the strengths of the NSI and to address some of the current deficits. Under the aegis of the Office of the Chief Science Adviser a SWOT analysis was conducted of Ireland's National R&D Action Plan in 2006 (see Table 10). From this analysis it is evident that strengths in the NIS lie in the ability to be adaptive and responsive to change given the size of the economy. Key weaknesses are in developing sustainable collaboration and linkages between research organisations and Irish business.

Table 10. Strengths and Weaknesses of Ireland's Research in Technology and Innovation (RTI) Performance

Strengths	Weaknesses
Government's commitment to driving Ireland as a Knowledge Based Economy and strong Government commitment to Research	Historic absence of a fully developed national strategy for Science Technology and Innovation (STI), and integration of sectoral and socio-economic research within that framework
Success in attracting high quality, high technology Foreign Direct Investment please spell out.	Research Capacity in Universities/Instititutes of Technology (IoTs) and Industry (Numbers; quality supervision) in context closing output/quality gap with competitors
Highly adaptive manufacturing base	Lack of Research and Technology absorption capabilities by companies and weak commercialisation structures
Importance of engineering and the quality of Irish engineers	Number studying science subject to Leaving Certificate leve
Government support for enterprise	Structural weaknesses in universities/institutions
Positive fiscal environment	Lack of funding for research support disciplines
European Union Framework Programme 7 (FP7): Ability to organise ourselves and influence the make-up of FP7	Low availability of Seed Capital
Government responsiveness to changing competitive environment	
Emerging whole of government approach to Science Technology and Innovation	

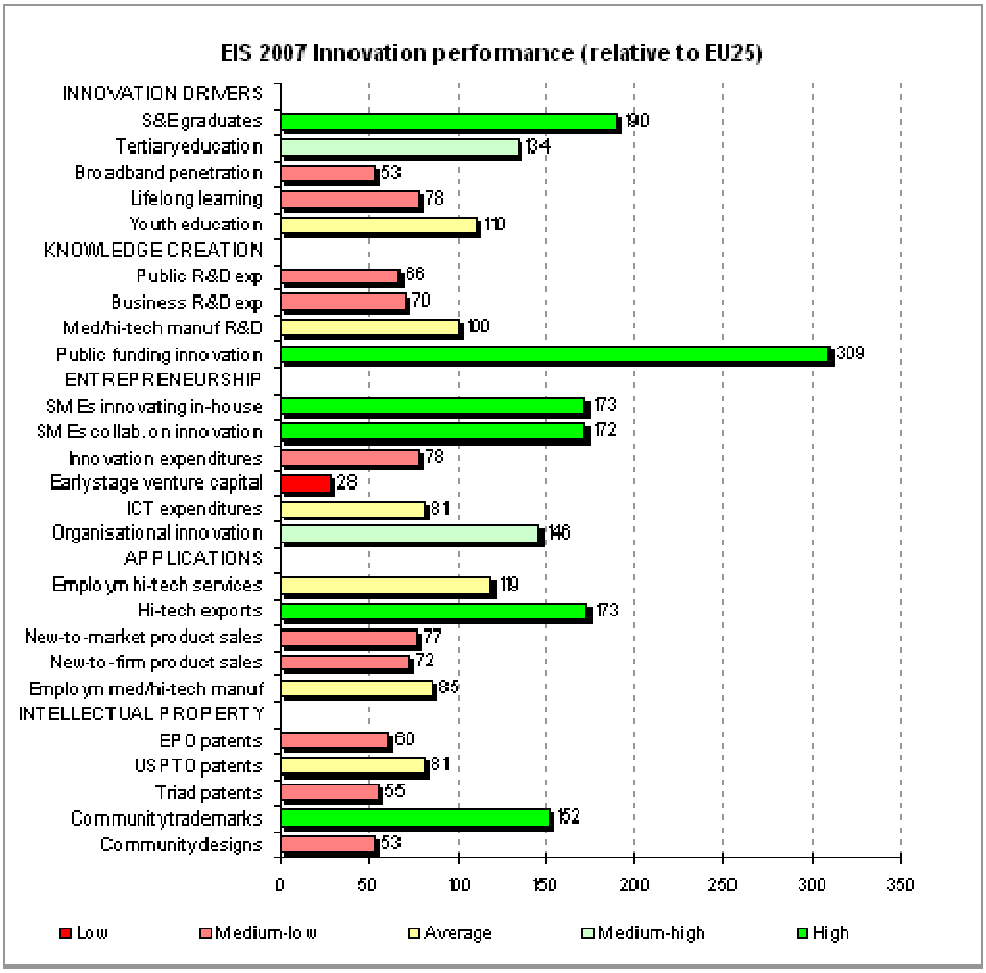
Source: Source: *Strategy for Science Technology and Innovation* (2006-2013) Government Publications, Dublin, Ireland, pp. 89-90.

The Irish NIS has acknowledged key strengths other than those outlined in the SSTI report. The FDI investment in Ireland has meant that the country has many of the tier one players in ICT and bio medical industries. In essence, Ireland has a a significant presence of world innovative firms located in Ireland, through FDI initiatives. In real terms the life science sector in Ireland accounts for €5 Billion in exports and over 35,000 employees .US FDI into Ireland between 2000 and 2006 totalled $44.3 billion in comparison to $15.4 billion into China and $5.3 billion into India (Hamilton, 2008). Consequently, this provides Ireland with a key strength as many of these companies have expanded their initial remit in Ireland into value adding activities. In addition, the talent, flexibility of Irish management teams and employees also supported and underpinned this expansion of activities Cunningham (2008).

Some weakness still pervade Ireland's NIS in addition to those outlined in Table 10. The National Competitive Council (2007, p.3) notes that there are significant weaknesses in prices and costs, domestic competition, infrastructures, innovation and R&D and sustainability of the environment which is undermining national competitiveness. In addition, several operational barriers and weaknesses to research commercialisation still remain within the third level sector. These include lack of space, research and funding treadmill among the contract research community definable career paths for contract researchers (Cunningham and Harney, 2006). Other weaknesses in the Irish NIS include the absorptive capacity of SMEs, the breadth and depth of expertise in IP management and exploitation, IP registration and exploitation, firm and public investment in R&D, early stage seed capital and life long learning.

The European Innovation Scorecared (2007) captures the key strengths and weaknesses for Ireland in relation to EU 25. Clearly, the investments in public funding of innovation, entrepreneurship levels and high tech exports reflect NIS strengths but the medium to averages levels of IP exploitation is currently a deficit within the NIS.

Figure 2: EIS 2007 Innovation Performance



Source: European Innovation Scorecard, 2007 (http://www.proinno-europe.eu/)

VI Funds Flow for Innovation

The expenditure by the state on Ireland's total science budget reached €2.5 billion by 2007, with education and training accounting for 45.9% of spending in 2007, and 1,344 R&D personnel employed by the government sector. The science budget allocations for 2007 included Education and Training €907 million; Research and Development €907 million; Technical Services €231 million; Technology Transfer €123 million and other S&T activities €96 million. The top three government department and agencies funding R&D activities were the Department of Education and Science at €497 million, Department of Enterprise Trade and Employment at €243 million and Department of Agriculture and Food at €83 million (Forfás, 2007, p.10) .

VII Concluding Thoughts: Key Cultural Drivers

We see four main cultural drivers within the Irish NIS that have supported its evolution. The first cultural driver has been the increasing levels of entrepreneurship within the Irish economy, where entrepreneurship is accepted within society as a legitimate career path. The success stories of Irish entrepreneurs have pervaded all parts of Irish society. As Forfás (2007, p.44) notes "Entrepreneurs are held in very high esteem in Irish society and this high regard is re-enforced by a very supportive media in which positive stories, about entrepreneurs and their successful companies abound"

The second driver is the interconnection through social networks of policy makers, private industry and the third level sectors which has lead to an agility and capability to responding to change within the economy. Such interconnections provide a nimbleness of response and action which other NIS would find difficult to replicate given their greater scale. This is further enabled by the strong and established tradition of social partnership, and the successive agreements which have been the bedrock for negotiated job conditions, wages increases as well as social issues. Moreover, the medium terms focus on innovation at the heart of policy making is summarised in Innovation in Ireland (2008) published by the Department of Enterprise Trade and Employment: 'In short, our ambition is to put innovation at the core of our policies and strategies for the future, so that Ireland becomes a leader in innovation.'

The third cultural driver has been the responsiveness of policy initiatives through the auspices of Forfás and its ability to convene specialised task forces which have membership from the economic and social pillars of the country.

The fourth and final cultural driver is the importance of educational attainment within Irish society, where education is still seen as an enabler for individuals. This is reflected in the abolition of fees for undergraduate programmes at third level institutions in the mid 1990s and various policy initiatives targeted at lifelong learning, educational access and disadvantage.

Finally, the challenge for Ireland is to continue to develop cultural drivers, in addition to the effective implementation of innovation policy with high levels of collaboration

between all stakeholders, if we as a country are going realise our innovation ambitions.

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