OECD Economics Department Working Papers No. 1094

From Bricks to Brains: Increasing the Contribution of Knowledge-based Capital to Growth in Ireland

David Haugh

https://dx.doi.org/10.1787/5k3wd358lj8r-en

OECD

Unclassified **ECO/WKP(2013)86**

Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development **12-Nov-2013**

English - Or. English

ECONOMICS DEPARTMENT

ECO/WKP(2013)86
Unclassified

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By David Haugh

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ABSTRACT/RESUMÉ

From bricks to brains: increasing the contribution of knowledge-based capital to growth in Ireland

With sound framework conditions, fine universities, good infrastructure and policies friendly towards foreign direct investment, Ireland scores high in international innovation scoreboards. Overall, policies to boost innovation and entrepreneurship are on the right track, but investment in knowledge-based capital could be made a more dynamic source of growth and jobs. While Ireland has made good progress towards building up its scientific capabilities, innovation capacity remains weaker than in other small advanced OECD countries, such as Austria, Denmark, Sweden and Switzerland. To become more effective, the innovation strategy should be simplified, with a drastic reduction in the number of government agencies involved in funding innovation, so as to better focus on strengthening the linkages between the business and academic communities. While attracting high-tech multinationals should remain central, there is potential to better develop spillovers between these firms and domestic SMEs, notably by establishing applied research centres. Entrepreneurship should be fostered by improving the business environment, including access to non-bank finance, streamlining the insolvency regime and transfer of intellectual property rights, and upgrading the broadband network.

This working paper relates to the *2013 Economic Survey of Ireland* (www.oecd.org/eco/surveys/ireland)

JEL classification: F210, G240, O31, O32, O33, O34

Keywords: Ireland, innovation, higher education, entrepreneurship, direct foreign investment, R&D tax credits, internationalisation, venture capital, SME financing, start-ups, insolvency, intellectual property rights, ICT infrastructure; science

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De l'économie traditionnelle à l'économie du savoir : accroître la contribution du capital intellectuel à la croissance en Irlande

Avec des conditions-cadres propices, des universités de qualité, une bonne infrastructure et des politiques favorables à l'investissement direct étranger, l'Irlande figure en bonne place sur les tableaux de bord internationaux de l'innovation. Dans l'ensemble, les politiques de stimulation de l'innovation et de l'entrepreneuriat vont dans la bonne direction, mais il serait possible de faire de l'investissement en capital intellectuel une source plus dynamique de croissance et d'emplois. Si l'Irlande a bien progressé du point de vue du renforcement de ses capacités scientifiques, sa capacité d'innovation reste plus faible que celle d'autres petites économies avancées de l'OCDE, comme l'Autriche, le Danemark, la Suède et la Suisse. Pour devenir plus efficace, la stratégie d'innovation doit être simplifiée, avec une réduction draconienne du nombre d'organismes publics qui participent au financement de l'innovation, de façon à mieux se focaliser sur le resserrement des liens entre les entreprises et les milieux universitaires. Même s'il doit rester essentiel d'attirer des multinationales de haute technologie, il est possible de favoriser davantage les retombées entre ces entreprises et les PME nationales, notamment en créant des centres de recherche appliquée. Il faudrait stimuler l'entrepreneuriat en améliorant les conditions d'activité des entreprises, notamment l'accès aux financements non bancaires, la simplification du régime de faillite et le transfert de droits de propriété intellectuelle, et en mettant à niveau le réseau haut débit.

Ce Document de travail se rapporte à *l'Étude économique de l'OCDE de l'Irlande, 2013 (www.oecd.org/eco/etudes/irlande)*

Classification JEL : F210, G240, O31, O32, O33, O34

*Mots-clés :*Irlande, innovation, l'enseignement supérieur, entrepreneuriat, investissement direct, crédit d'impôt en faveur de la R-D, internationalisation, capital-risque, financement des PME, jeunes entreprises, coûts des faillites, droits de propriété intellectuelle, infrastructure des TIC, science

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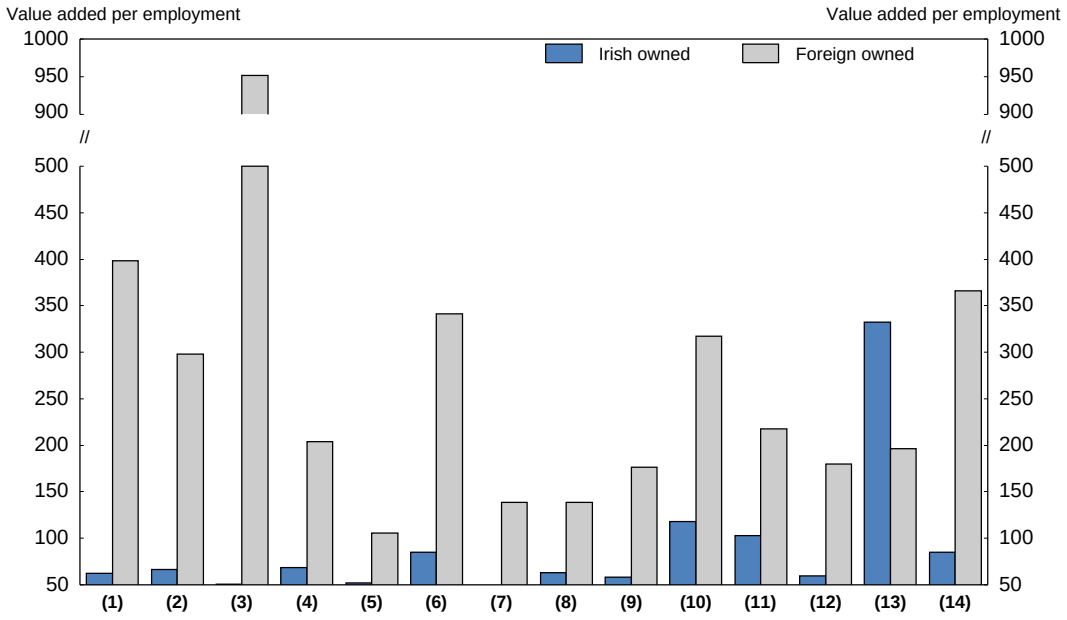
FROM BRICKS TO BRAINS: INCREASING THE CONTRIBUTION OF KNOWLEDGE-BASED CAPITAL TO GROWTH IN IRELAND

By David Haugh[1]

Moving towards a knowledge-capital based economy

To generate sustainable growth and jobs, Ireland needs to continue moving away from "bricks and mortar" towards accumulating knowledge-based capital. The potential benefits for the economy and society are high. OECD empirical work shows that investing in innovation is strongly linked with increased productivity and growth (Box, 2009). There is evidence at the firm level for Ireland that firms with greater sales due to innovation are more productive (Squicciarini et al., 2014). Innovative new firms also tend to be the greatest contributors to job creation (Lawless, 2013, OECD, 2012a; OECD, 2013).

Figure 1. **Labour productivity in selected industries, 2011**



Note: (1): Manufacturing & Other Industry (including Primary Production) of which: (2): Food, Drink & Tobacco; (3):Chemicals; (4): Rubber & Plastics; (5): Basic & Fabricated Metal Products; (6): Computer, Electronic & Optical Products; (7): Electrical equipment; (8): Machinery & Equipment; (9): Medical Device Manufacturing; (10): Information, Communications & Other Services of which: (11): Computer Consultancy; (12): Other IT & Computer Services; (13): Financial Services; (14): Total - All sectors.
Source: Forfás (2013).

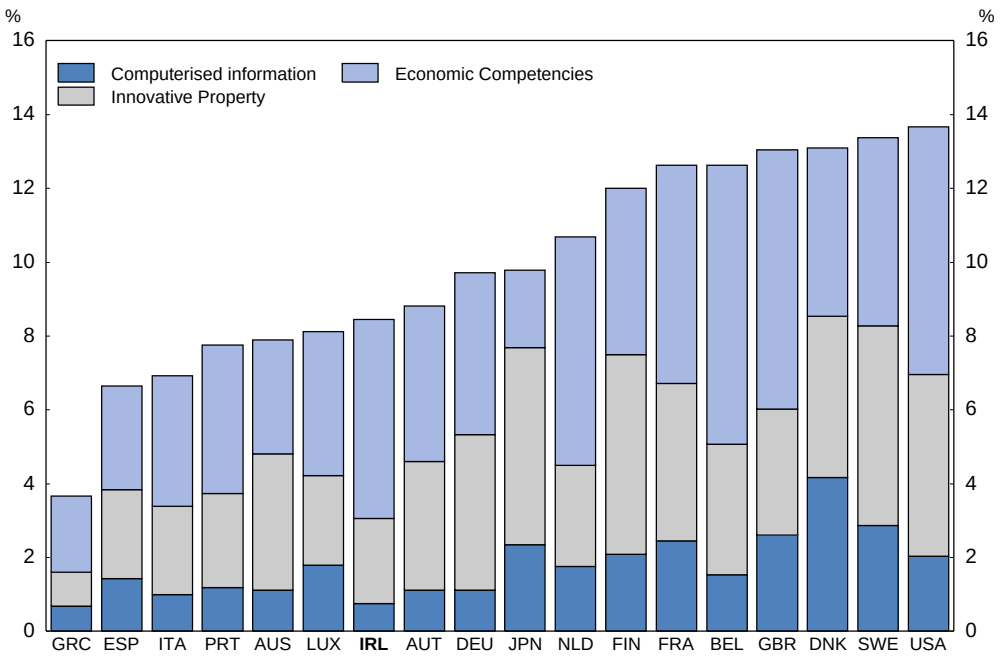
1. This paper is based on a chapter in the OECD Economic Survey of Ireland published in September 2013 under the authority of the Economic and Development Review Committee. It adds material on the modes of innovation, evaluating innovation and evaluating higher education institutions. David Haugh is Senior Economist and Head of the Ireland/Spain desk in the Economics Department at the OECD. The author is grateful to Andrew Dean, Robert Ford, Patrick Lenain, Alberto Gonzalez Pandiella, Dirk Pilat, Jacqueline Allan, Michael Keenan, Dimitrios Pontikakis, Ian Hughes and Elizabeth Harvey for valuable comments and Josette Rabesona for statistical assistance. The views expressed are those of the author, and not necessarily those of the OECD or its member countries.

Ireland provides a favourable environment for innovative activities according to international benchmarking thanks to strong institutions, fine universities, good infrastructure, a well-educated workforce and policies friendly toward foreign direct investment – as testified by large presence of high-tech industries (Global Innovation Index, 2012). However, innovative activities are largely confined to multinational firms, while domestic ("indigenous") SMEs are less innovative and productive than their foreign-owned counterparts (Figure 1).

Knowledge based capital (KBC) is a broad measure of investment in knowledge, which includes computerised information, innovative intellectual property (e.g, patents) and economic competencies (such as organisation capabilities). Ireland's KBC has grown over time but, reflecting weak innovation in SMEs, its intensity remains in the lower half of the 18 OECD countries covered (Figure 2). In nearly all industries, firms' involvement in patenting intellectual property is below the average of 15 other OECD countries (Squicciarini et al., 2014). Building KBC would help Ireland to increase its participation in global value chains. This would in turn allow Irish firms to reap the productivity benefits derived from scale that enterprises in a small economy can only gain through international trade.

Figure 2. **Investment intensity in Knowledge-Based Capital**

As a percentage of market sector value added, 2010



Note: Data refer to the market economy unless otherwise stated, which excludes Real Estate, Public Administration, Health and Education. Figures for the United States correspond to the definition of the Private sector of the National Industry and Production Accounts (NIPA).

Source: OECD calculations based on INTAN-Invest (KBC investment for EU 27 and United States); OECD Main Science and Technology Indicators (EU27 market sector value added); National Accounts from Eurostat (EU 27 tangible investment); United States NIPA from the Bureau of Economic Analysis (United States private sector value added and tangible investment); Australian Innovation System Report (2012) (KBC investment), National Accounts from the Australian Bureau of Statistics (value added and tangible investment) and the Japanese Industrial Productivity database (JIP) (intangible and tangible investment and value added); Corrado et al., (2012).

Foreign direct investment by multinational corporations plays a key role in Ireland's economic development. FDI firms account for nearly 20% of employment in services, but it is in manufacturing that

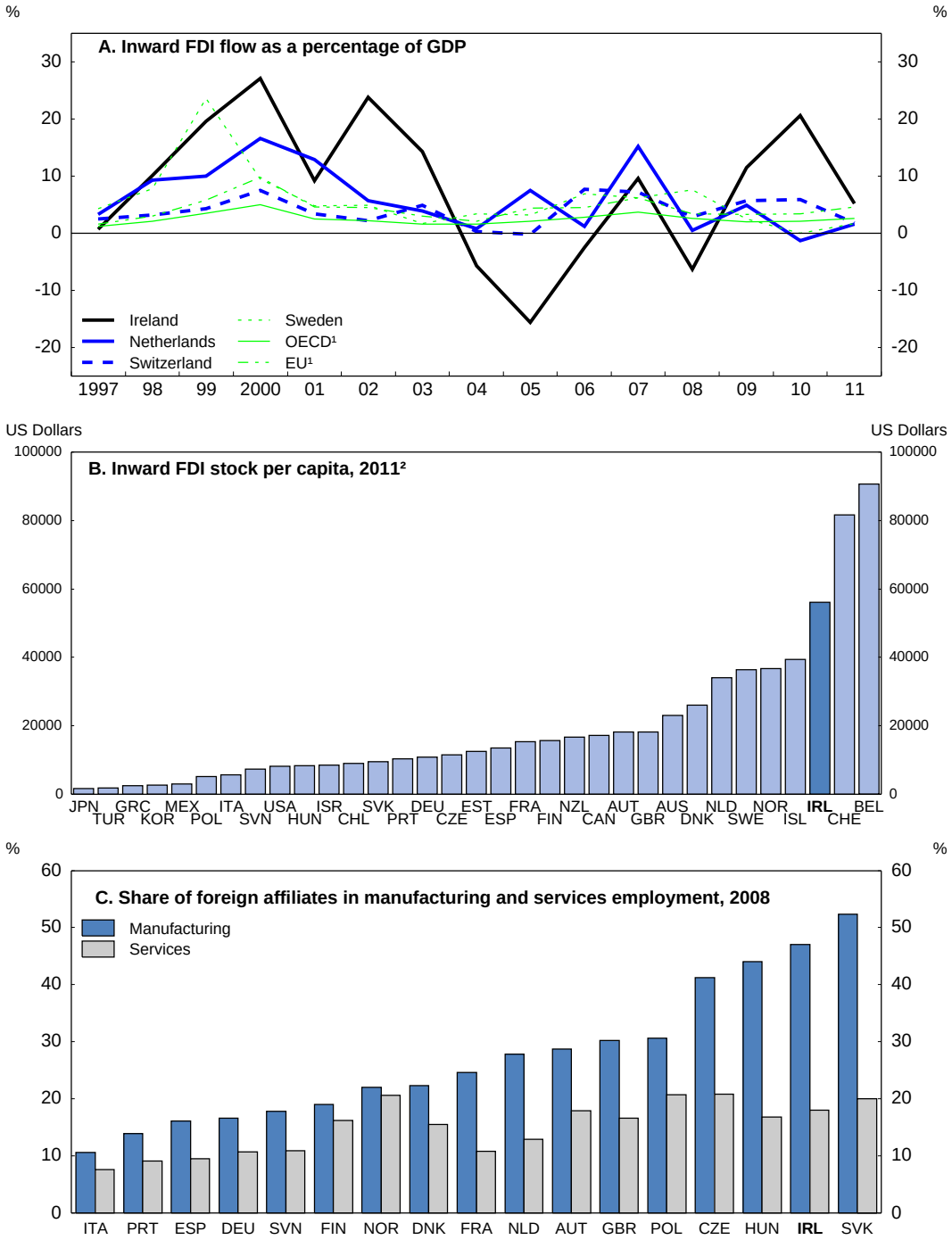
they make an overwhelming contribution (50% of employment and 85% of value added) (Figure 3). FDI flows into Ireland appear to be volatile from year to year, largely reflecting statistical issues, such as loans made by Irish-based foreign companies to their parents or affiliates elsewhere (measured as negative inwards FDI). From a longer term perspective, the stock of FDI equity and reinvested earnings follows on an upward trend, rising from 75% of GDP in 1998 to 143% in 2012. Foreign-owned manufacturing is dominated by three sectors: computer, electronic and optical products; medical devices; and pharmaceuticals and chemicals. The services sector, the most important sub-sectors of which are information, communication and computer services, and business and financial services, has grown in importance over the past decade. All of the top 5 software companies in the world have a significant presence in Ireland (IBEC, 2012). Four hundred and fifty international financial institutions operate from the International Financial Services centre (IFSC) in Dublin, including half of the world's top 50 banks and top 20 insurance companies (Barry and Bergin, 2012).

Foreign direct investment is an important contributor to Ireland's innovative activities. MNCs have facilitated innovation by transplanting the technological capability to produce new products and services in sectors that now play a large role in the Irish economy. Nearly three quarters (the highest share in the OECD) of business enterprise spending on R&D (BERD) in Ireland is carried out by foreign-owned firms that spend more on R&D as a share of value added than their domestically owned counterparts.

Foreign direct investment is also largely responsible for Ireland's high participation in global value chains (GVCs) (Figure 4). Foreign-owned firms were responsible for around three quarters of total Irish exports in 2010 (Forfás, 2012). The high overall GVC ranking is due to the extensive use of foreign inputs in Irish exports (backward participation) as opposed to Ireland producing inputs used in third country exports (forward participation) (OECD, 2013a). Participation in GVCs is strong in pharmaceuticals, food, finance and business services, where Ireland accounts for a substantial share of value added in world exports (OECD, 2013b), and Ireland is the 10$^{th.}$ largest exporter of services in the world. However, despite some impressive successes in the agri-food sector, Irish-owned firms are not integrated enough into GVCs, particularly in terms of providing inputs to be used in other country exports.

Irish-owned firms need to become more knowledge driven. Technical innovation is low by EU15 standards, especially in large Irish firms (250+ employees) (Figure 5). In addition, the share of firms engaged in any type of innovation cooperation with outside partners (government, higher education, other firms) is below that of foreign-owned firms and below the EU medians for their counterparts This, and especially a low rate of cooperation with other firms, has performance implications as being part of a group with other firms tends to raise the productivity returns from innovation spending (Squicciarini et al., 2014). Even foreign–owned firms have a potential for higher gains. The pharmaceutical, computer and electronic hardware and computer software sectors, with a strong multinational presence in Ireland, are highly innovative industries, but Ireland is not getting a large share of the global investment in R&D in these sectors (ACSTI, 2010).

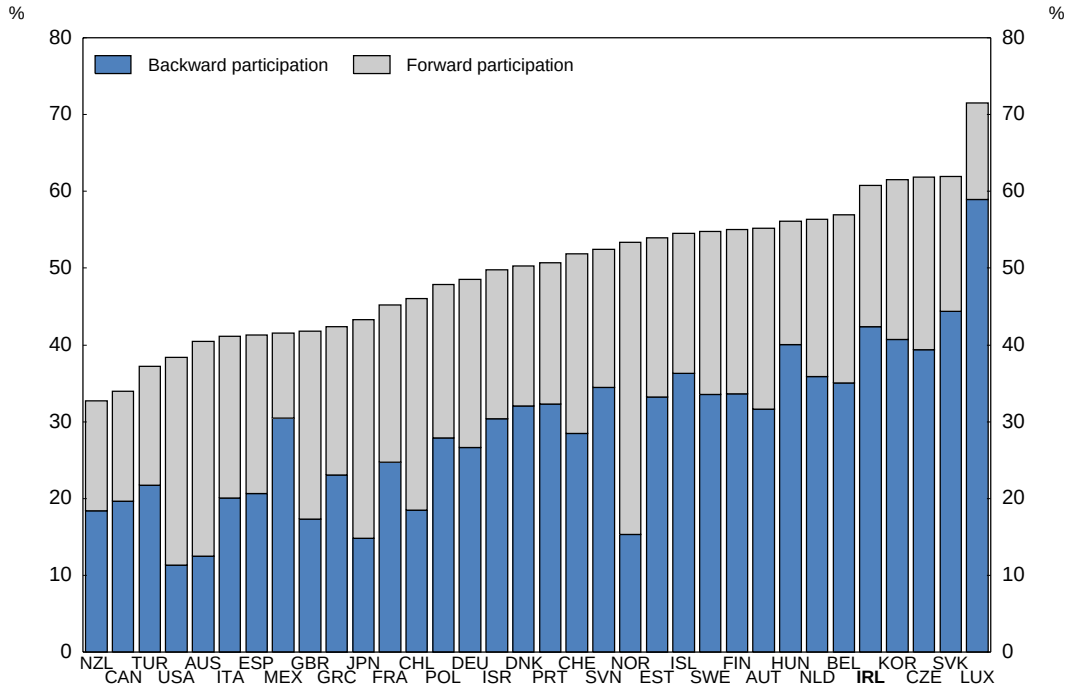
Figure 3. **Foreign direct investment intensity**



1. Unweighted. The EU area refers to the OECD countries members.
2. 2010 for Germany, Mexico and United Kingdom.

Source: OECD, Foreign direct investment (FDI) Database, Activities of Foreign Multinationals (AFA) database and National Accounts database.

Figure 4. **Participation in GVCs, 2009**

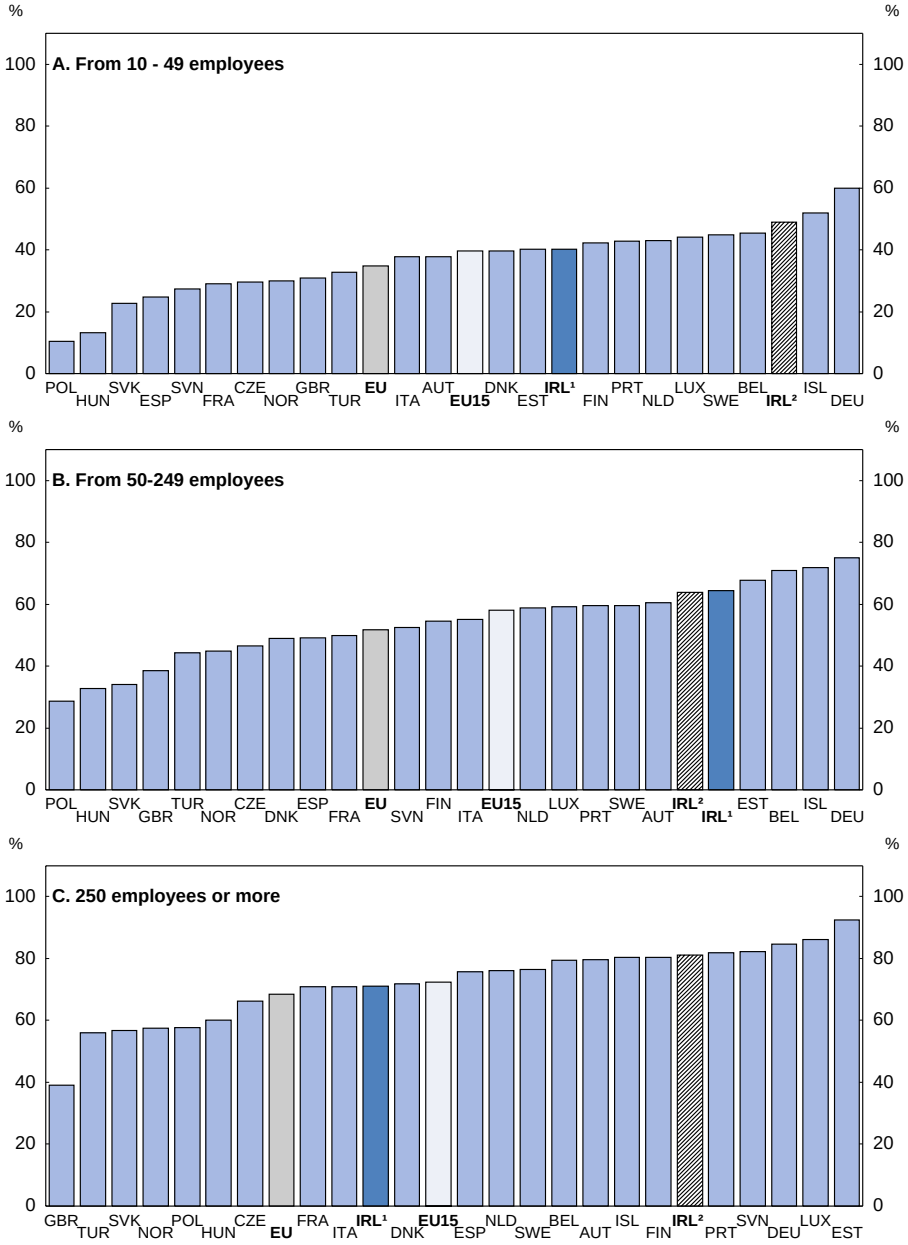


Note: Foreign inputs and domestically-produced inputs used in third economies' exports, as a share of gross exports.

Source: OECD inter-country Input Output model, December 2012.

Figure 5. **Innovation rates by size of enterprise in 2010**

Percentage of firms which innovate



1. Indigenously owned firms in Ireland, data refer to persons engaged.
2. Foreign owned firms in Ireland, data refer to persons engaged.

Source: Eurostat, Community Innovation Survey and Central Statistics Office (CSO).

Irish firms also need to reap greater rewards from a wider range of innovation activities. Frenz and Lambert, 2012) have identified innovation strategies, or mixed modes of innovation, that are common to firms across the OECD (Box 1).

Box 1 **Modes of innovation**

IP/technology innovating mode

Firm engages in developing mainly new-to -market products and services, which it seeks to protect through patenting, design registration and copyright. Firm also tends to engage in in-house R&D.

Marketing based innovating mode

Firm engages in developing products and services that are both new-to-market and new-to-firm. It places high importance on marketing its products and services, and less emphasis on patenting, design registration and copyright.

Process modernising mode

Firm engages in process innovation. Firm innovation expenditure is focused mainly on the acquisition of machinery and on staff training.

Wider innovating mode

Firm engages mainly in innovation aimed at improved management and business strategy changes, including new sales and distribution methods.

Networked innovating mode

Firm engages in external knowledge sourcing in the form of bought-in R&D, licences or other know-how and formal collaboration on innovation projects. Universities and research organisations are an important innovation partner. In-house R&D helps with the absorption of external knowledge.

The most common mode of innovating for innovating firms in Ireland is wider innovating, which is used in around 45% of innovating firms. Around 24% of innovating firms are engaged in process modernising. IP/technology innovating and marketing-based innovating are the least prevalent modes of innovation, with each used by around 11% of innovating firms in Ireland. IP/technology innovating and marketing-based innovating are both associated with traditional technological innovation and the development of new goods and services. While further data from other countries is needed to make a definitive conclusion, Ireland's share of firms engaged in new product and services development, at 22% of innovating firms, appears to be low when compared to similar data for other countries (OECD, 2009).

The economic impact of the innovation strategies employed by firms in Ireland appears to be lower than in other OECD countries. Frenz and Lambert also investigated correlations between each of the five mixed modes of innovation and increased labour productivity, change in turnover, and change in employment, by country. Even though common innovation modes can be identified across all participating countries, the economic impact of each of these mixed modes varies widely between countries (Table 1). This suggests that although the innovation activities of firms may be similar across countries, the returns from those innovation activities appear to be dependent on the local (national) environment. Irish firms reap the benefit of innovation specifically through modernising their production processes, unlike firms in other countries (such as Austria and the Netherlands) which reap returns from other innovation activities, including technological (patenting) type innovation (Frenz and Lambert, 2012; Table 1).

Table 1. **Correlation of innovation mode with productivity, turnover or employment**

	IP/Technology Innovating	Marketing Based Innovating	Process Modernising	Wider Innovating	Networked Innovating
Austria	YES	YES	YES	YES	YES
Spain	YES	YES	YES	YES	YES
Netherlands	YES	YES	YES	YES	YES
Korea	YES	YES	YES	YES	YES
Czech Republic	YES	YES	NO	YES	YES
Estonia	NO	YES	YES	YES	YES
Belgium	NO	YES	YES	YES	YES
United Kingdom	YES	YES	YES	NO	YES
Canada	YES	YES	YES	NO	NO
Luxembourg	NO	YES	NO	YES	NO
Chile	NO	NO	YES	NO	YES
Ireland	NO	NO	YES	NO	-
Denmark	NO	NO	NO	NO	YES
Iceland	NO	NO	NO	NO	NO

Note: Yes means that there is at least one significant correlation with productivity, turnover and employment.

Barriers to innovation

All firms, whether foreign or Irish owned, identify a number of barriers to innovation, including the high cost of R&D, a shortage of industry-relevant R&D skills, and barriers to greater enterprise links with higher education institutes (ACSTI, 2010). Problems more specific to SMEs and Irish-owned firms are a lack of firm absorptive capacity and accessing finance. Challenges more specific to the Irish operations of MNCs are the need to be competitive vis-à-vis subsidiaries elsewhere in the world on R&D cost and attracting R&D talent from within the company. Establishing effective MNC - higher education sector linkages also requires the higher education sector to have research centres with critical mass.

Foreign direct investment by large high-tech multinationals has the potential to remain a key driver of growth, hence the importance of continuing to be attractive to such firms. Experience shows that a favourable business environment, including the low and stable corporate tax rate, relatively low skill-adjusted wages and a well-qualified labour force are important (Barry and Bergin, 2012). Export-platform investments in small countries by US corporations tend to be in low-tax countries (Slaughter, 2003). For example, most pharmaceuticals companies have only invested in active ingredients plants located in one of three locations - Ireland, Puerto Rico, and Singapore - all of which have these main characteristics (van Egeraat and Barry, 2009).

Foreign direct investment is also attracted by the talent pool. To support the IFSC as a world-leading centre for aircraft leasing - rivalling London - , specialised training in aircraft management and leasing is offered in Limerick. Similarly, the Galway higher-education sector provides specialised training and research programmes in the field of medical devices (Ryan and Giblin, 2012). Making an effort to attract an anchor MNC, as IDA Ireland (the inwards investment promotion agency) has done in the past, also appears to pay off due to strong gravity effects - the presence of a leading international firm in Ireland tends to attract others (Barry, Goerg and Strobl, 2003). Initiatives to deepen the EU single market also play a role, such as changes allowing life insurers headquartered in one EU country to sell insurance elsewhere in the EU helped encourage the development of the IFSC (Barry and Bergin, 2012).

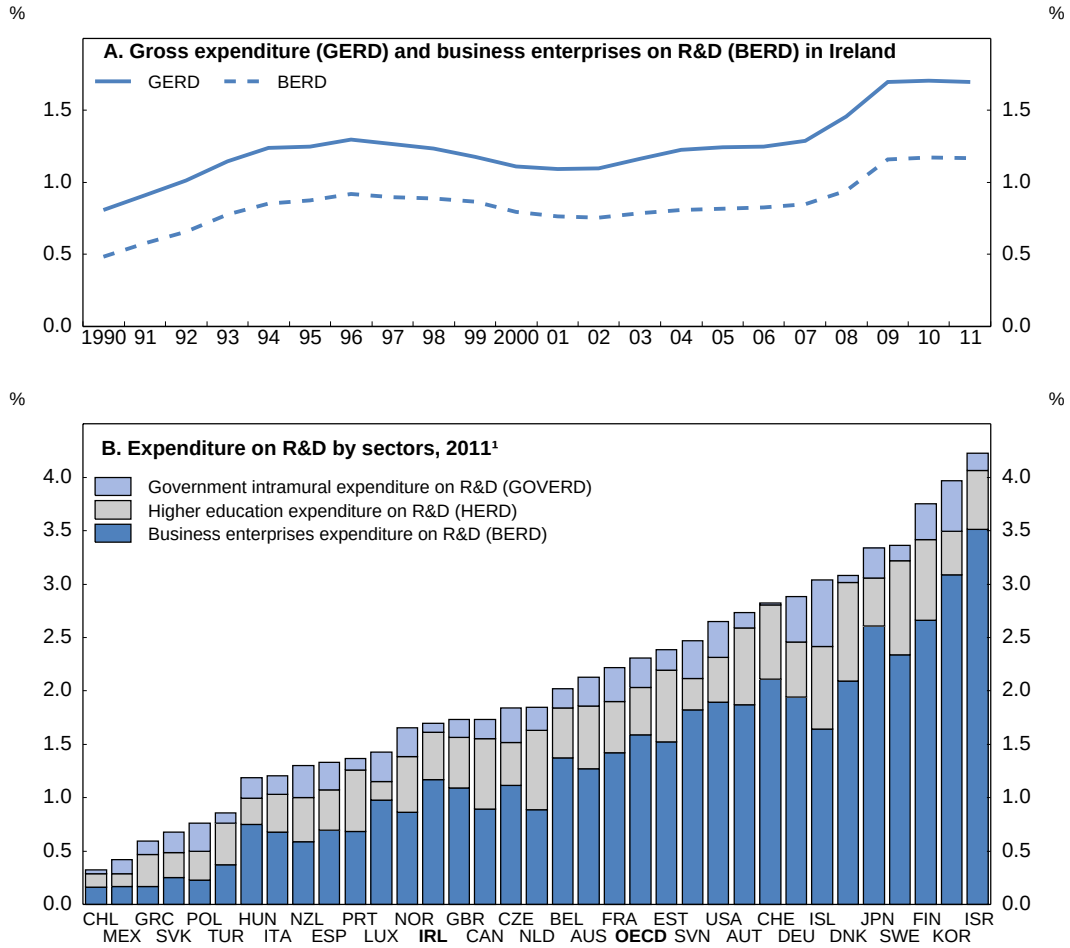
Efforts to foster more innovation in Irish-owned SMEs as well as multinationals should continue, while further building linkages between the foreign and Irish-owned sectors and HEIs. Three policy areas are at stake: the institutional and policymaking framework; government financial support; and framework conditions. Within these areas, a mix of solutions broadly applicable to the enterprise sector (such as improving the certainty of R&D tax credit rules) as well as actions more tailored to specific problems of different enterprise classes is required (such as improving SME access to non-bank sources of capital).

Strengthening the institutional and policy making framework

From a low base in the late 1990s, Ireland embarked on a strategy of substantially strengthening public research and promoting business innovation. The government expanded research funds available to the higher-education institutions and established a new agency, Science Foundation Ireland (SFI), to promote research excellence in ICT, biotechnology and, later on, energy. It also introduced a large variety of programmes to boost firm absorptive capacities and linkages across different actors. An R&D tax credit was introduced in 2004.

Figure 6. **Research and development expenditure**

As a percentage of GDP



1. Or latest year available.

Source: OECD Main Science and Technology Indicators database.

There are signs that Ireland has significantly expanded its scientific capabilities. Since 2000, both Gross Expenditure on Research and Development (GERD) and Business Enterprise Expenditure on Research and Development (BERD) have risen as a share of GDP, although not as much as was targeted in the Strategy for Science, Technology and Innovation 2006-2013 (SSTI) (Figure 2.6). There has been a rapid increase in PhD graduates and researchers employed in the economy, as well as the number of scientific and engineering articles (Figure 7). Partial indicators also suggest that Ireland is getting a good return on its R&D spending in terms of the quality of scientific articles, as indicated by citations with particular strengths in genetics, immunology and materials sciences (Figure 2.8), the output of trademarks and the overall proportion of firms that are innovative (Squicciarini et al., 2014).

A broader strategic approach to ensure a successful innovation system

Building on progress in expanding the science base, and driven by a need to generate growth and jobs, the government's policy focus has shifted to getting greater economic return from its investments in innovation. Following the *Report of the Research Prioritisation Steering Group* (Forfás, 2011), the

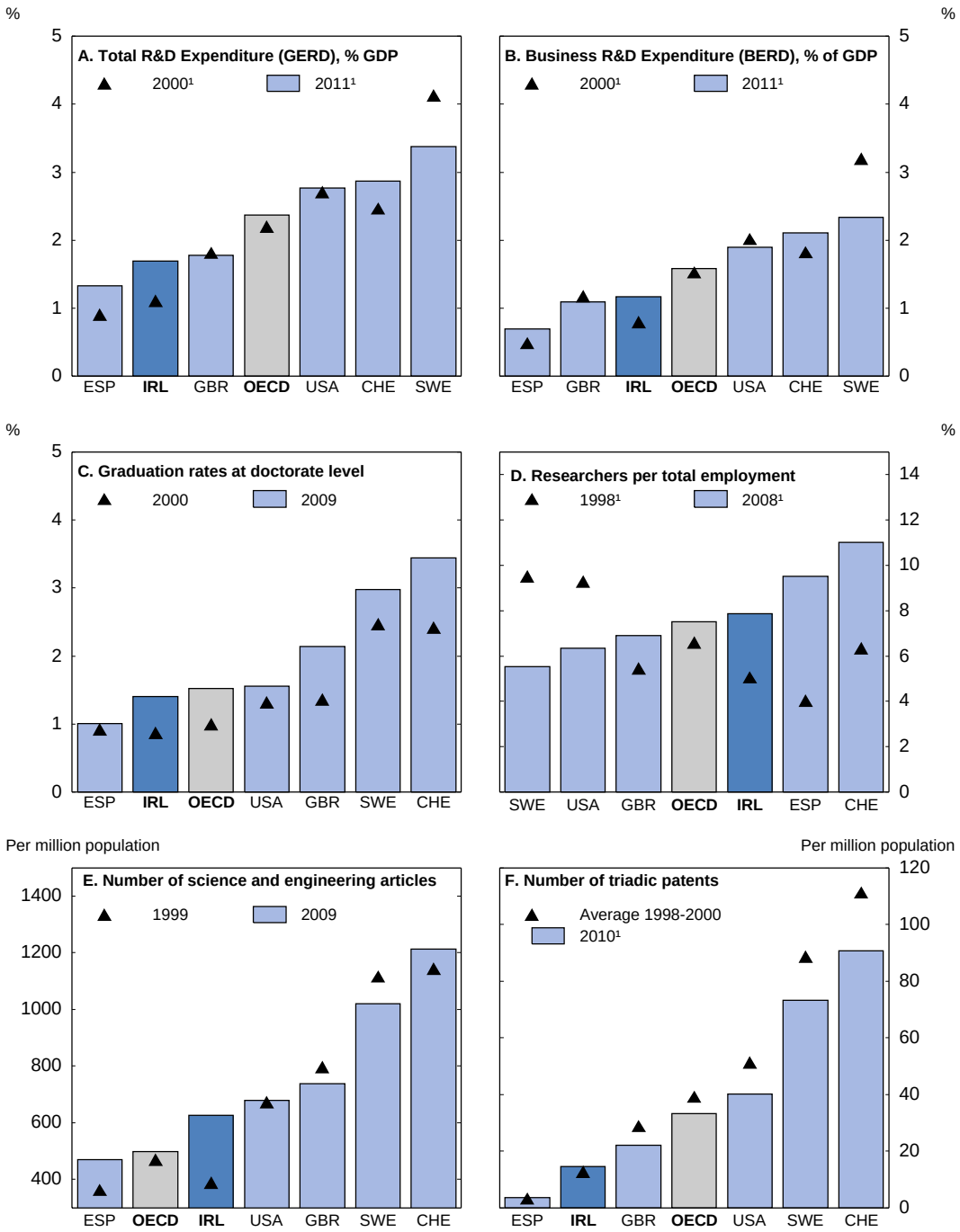
government is moving to target publicly-funded research performed in HEIs and public research organisations more towards the needs of the enterprise sector. Research in this category is being focused on 14 priority areas. The intention is to build on the science and skills base that has been developed over the past decade with a move towards a more applied research focused on areas likely to show economic returns within a 5-year timeframe and better coordinate funding support across programmes. The new, larger SFI-funded research centres will all be required to have industry collaboration component to projects.

The move towards more applied research, as recommended by the *Report of the Research Prioritisation Steering Group*, is in line with trends for public research institutes in other OECD countries (OECD, 2011). It is also part of wider trend of a revived interest in industrial policy and prioritising sectors, including in France, Korea, Japan, the Netherlands and the United Kingdom. International experience suggests that horizontal measures that improve the business environment regardless of sector are preferable, but that in some policy areas strategic decisions may need to be made. In these cases, to minimise the risks associated with selectivity, the government should, as appears to be the case in Ireland, adopt a "soft" approach to industrial policy where the government plays essentially a coordinating role, building on capabilities that have already emerged (Warwick, 2013).

However, aside from the dangers of trying to “pick winners”, Ireland's innovation system is young and risks trying to move too fast with too few resources. As there is a particularly high level of uncertainty about which policy tools are the most effective, the authorities should stand ready to reallocate resources as needed. This involves rigorous evaluation of programmes (discussed below), and shutting down those that are shown not to work. Given political economy realities, sunset clauses attached to innovation and enterprise support measures would help to enforce such a policy. Although sunset clauses reduce the certainty of funding, they would speed up the reallocation of funds to the most effective programmes by making it easier to support strong performers and wind up weak ones. In implementing this approach, effort should be made to avoid “short-termism” - some programmes will take time to show results and therefore a mix of short and long-term indicators is needed. Excessive policy uncertainty should also be minimised by explicitly taking into account policy volatility in any cost-benefit analysis.

The international economic context has changed significantly since 2006, when the government last formulated its innovation strategy (Strategy for Science, Technology and Innovation for 2006-2013). The new strategy should be informed by international best practice and help to ensure greater consistency of policy. In addition, it should seek greater cost-efficiency in the current context of fiscal tightness. Hence, it should hold accountable all major actors in the system, not just those directly involved in commercialising research.

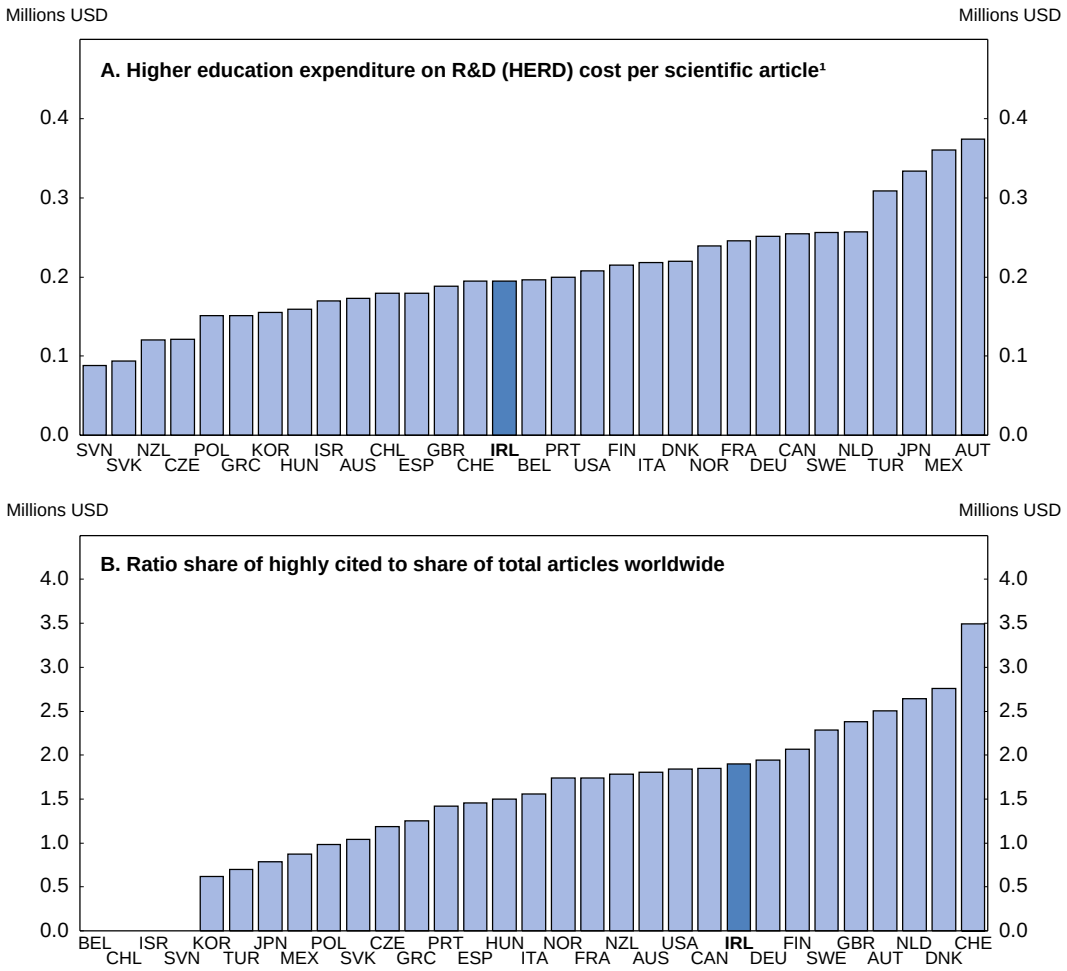
Figure 7. **The expanding Irish innovation system**



1. Or nearest/latest data available.

Source: National Science Foundation, National Center for Science and Engineering Statistics, and The Patent Board, Special tabulations (2011) from Thomson Reuters, SCI and SSCI, http://thomsonreuters.com/products_services/science; OECD Science, Technology and Industry Scoreboard 2011, OECD 2011 and OECD Main Science and Technology Indicators database.

Figure 8. **Cost and quality of scientific articles**



1. HERD measured as average annual expenditure 2000-2010 and in million 2005 US dollars (constant prices and PPP). Science and engineering articles produced in all fields in 2009.

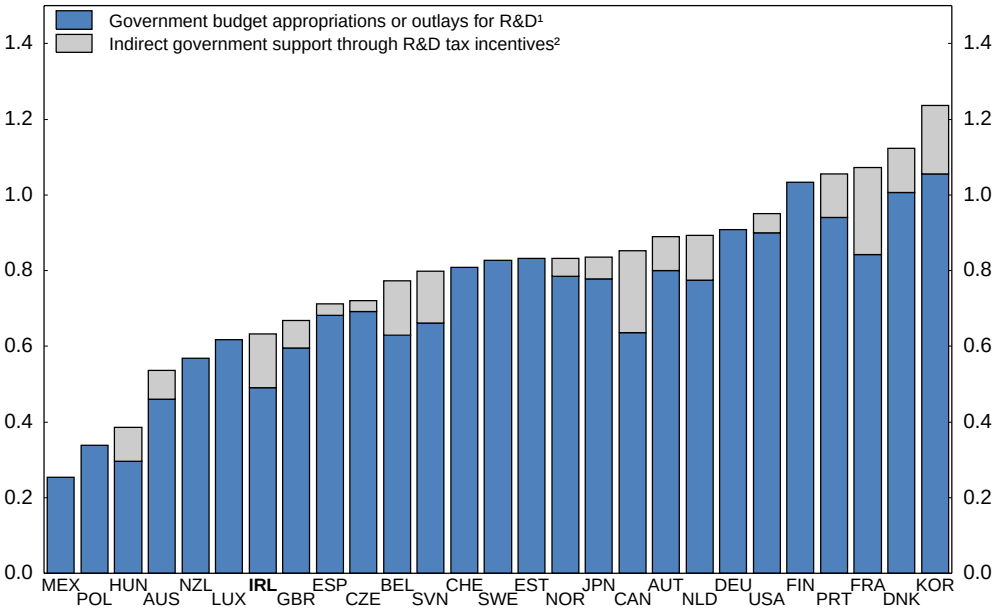
Source: OECD Main Science and Technology Indicators database: HERD data; OECD based on Scoops Customs Data for highly cited articles; National Science Foundation for total articles.

Streamlining institutional funding

Although the total government funding envelope for innovation support of around EUR 1 billion (0.6% of GDP) including approximately EUR 200 million in R&D tax credits, is small by international standards (Figure 9), the most recent Science Budget lists over 170 separate budget lines, sometimes for very small amounts of money, and 11 major funding agencies or departments (Annex A1) – a very large government administration for a small-size country like Ireland. These various agencies seek to build the science base through funding research personnel and infrastructure and boosting enterprise R&D, collaboration, commercialisation and international networking (Annex A2).

Figure 9. **Government support for research**

As a percentage of GDP



1. 2012 or latest year available. Measures the funds committed by governments for R&D to be carried out domestically or abroad (including by international organisations).

2. 2009.

Source: OECD Main Science and Technology Indicators database.

The main agencies and departments involved in funding science and basic research and innovation in Ireland are:

- *Higher Education Authority* (HEA): tertiary education and research including competitive funding of research in HEIs;
- *Science Foundation Ireland* (SFI): competitive funding of research in HEIs;
- *Irish Research Council* (IRC): building research human capital;
- *Enterprise Ireland* (EI): agency promoting indigenous firms, supports business innovation and HEI commercialisation;
- *IDA Ireland*: supporting foreign-owned enterprise;
- Specific funding departments and agencies include: Department of Agriculture, Food and the Marine; *Teagasc* (Agri-Food); Department of Health; Health Research Board; Department of Energy and Natural Resources; and Department of the Environment.

This diversity of funders and budget lines reflects a system that has undergone rapid expansion during the boom period. However, a large number of agencies risks resulting in excessive overhead, because each agency has its management structure, and agencies and departments naturally want to protect their resource base, thereby creating blockages to resource reallocation within the government's overall support envelope. Coordination committees such as *Technology Ireland* can help to generate synergies, but this does not change the fundamental set of incentives. Any savings generated by the consolidation of agency funding for science basic research and innovation should preferably be ploughed back into innovation support, and not returned to the Exchequer, as overall government spending on innovation support is already low by international standards.

The two Irish research councils (humanities and science) have been combined into one. In addition, *Forfás*, the policy advisory board for enterprise, trade and innovation, will be merged into its parent ministry, the Department of Jobs, Enterprise and Innovation (DJEI), by end 2013. *County Enterprise Boards (CEBs)* are being dissolved and replaced with *Local Enterprise Offices* (LEOs). Unlike the CEBs, which had separate legal status with their own CEOS and Boards, the LEOs will be business units within the local authority reporting to the county manager. The LEOs will cover firms with fewer than 10 employees, as the CEBs did, as well as non-exporters with more than 10 employees. *Enterprise Ireland*, through its Centre of Excellence will be charged with spreading best practice among LEOs. Service level agreements between *Enterprise Ireland* and the local authorities will set out LEO budgets, targets and evaluation criteria. *Enterprise Ireland* is also setting up a *Central Technology Transfer Office* (TTO) to be an advisory body for the 10 HEI-based TTOs. *Technology Ireland* (a group of senior officials in DJEI and its funding agencies) has responsibility for coordinating programmes and research centres to ensure consistency and avoid overlaps, including setting up a central portal that will direct enterprises to research centres that can collaborate in R&D in their chosen field.

Notwithstanding these reforms, there is scope for still more consolidation. Consolidation would contribute to a more streamlined, transparent and accountable innovation strategy. Gains would be achieved by consolidating funding into a smaller number of agencies, with one group dealing with applied research and innovation, and another with science and basic research. This should be coupled with a high-level coordination committee to prevent gaps or duplication. This division between business-orientated innovation and basic research is the norm in almost all other small OECD countries and reflects the large differences in the types of activities, rationales for support and policy instruments.

A proliferation of innovation agencies and programmes is a common problem internationally. Austria, Finland and the Netherlands have consolidated support in the past (OECD, 2005) and consolidation has been recommended for Sweden, which has also a large number of funding agencies (OECD, 2012b). Austria now has a national "one-stop-shop", the FFG, for funding applied research and development as a result of a merger of several agencies. Consolidation would make it easier to evaluate the overall economic impact of the innovation system and improve the government's ability to direct investment for maximum returns. In Finland, the *Tekes* agency, funds applied research conducted by all types of firms, whether small or large, regardless of ownership and also researchers in universities and elsewhere. A similar approach could help to build linkages across firms and with HEIs and break down the divide between domestic and multinational firms that exists in Ireland.

For example, business innovation funding could be concentrated with EI, which has the largest budget and the most responsibilities, but with a mandate to support innovation across the whole business sector, so as to help break down barriers between the foreign and Irish owned sectors. EI could seek IDA advice on particular MNC clients as projects arose. At a minimum, there needs to be a business innovation funding structure that is flexible enough to adapt to new ways of doing business, regardless of firm ownership or size or whether they export or are for profit. Steps have been taken in this broad direction with the setting up a senior management team of Enterprise Ireland and IDA officials to increase collaboration on priorities

that cut across the two such as increasing MNC purchases of intermediate inputs from Irish-owned firms (global sourcing). Such efforts should be intensified in the innovation arena. Globalisation and rapidly changing business practices mean that having an agency devoted to multinational innovation (IDA Ireland) and another devoted to innovation in domestic enterprises ready to export, which up until recently also required 10 or more employees (Enterprise Ireland), can result in firms, and especially innovative start-ups, falling through the gaps.

On the science and basic research side, SFI already has the largest budget for competitively- allocated funding and has developed significant expertise in allocation of resources based on international peer review. There appears to be potential to merge further science and basic research funding with SFI due to strong crossovers in terms research fields and activities with other agencies. For example, as recommended by the *OECD Review of Higher of Education*, Science Foundation Ireland's role should be merged with the IRC as both support the development of research human capital.

Rigorous system evaluation and indicators

Over the past two decades, innovation policy has become more strategic in OECD countries (OECD, 2010). This is evidenced by the increased use of various forms of *ex-ante* evaluation, such as technology assessment and technology foresight. Fiscal constraints in the aftermath of the economic crisis have also led governments to better focus research efforts. Ireland too is moving in this direction. In particular, it is now an established practice among research funding bodies to carry out reviews. These reviews have taken place at both the programme and agency level. In addition, funding bodies are proactive in collecting a wide range of metrics to gauge the programmes.

Specifically, the *Report of the Research Prioritisation Steering Group* made a number of recommendations aimed at improving the effectiveness of the Research, Development and Innovation evaluation system. In line with this, Forfás (policy advisory board on enterprise and science) has undertaken a systematic review of all enterprise supports using a new methodology for carrying out evaluations of a large number of programmes simultaneously. This methodology is an important development, novel by international standards and provides an important platform for building a more robust evaluation culture in Ireland.

Ireland can build on this progress. At present there is no formal or consistent process of *ex-ante* evaluation undertaken systematically within and across funding bodies. There is a need to embed a culture of *ex-ante* evaluation, including pilot experiments into programme design and start-up, and to clearly document how each new programme aligns with national policy and strategy, across all funding bodies. Despite the copious amount of data being gathered by funding bodies, it is often not possible to link metrics from individual programme evaluations to overall system targets or to determine the extent to which each individual programme contributes to the achievement of system-level goals. This should include tracing better how outputs from the innovation system (such as PhD graduates) are affecting the economy - for example, how many graduates were eventually employed in the enterprise sector and their role in start-ups (discussed further below).. Evaluations should be independent, i.e. undertaken by bodies that are separate from funding agencies, and should use statistically-robust methods, such as randomized trials, rather than expert judgements that tend to be opinion-based and prone to cognitive biases.

Because the returns to innovation can take a long time to materialise, an overemphasis on short-term targets should therefore be avoided, and appropriate metrics for measuring change in the more medium and longer terms should be developed. For example, current approaches to evaluation are being tested by new formulations of industrial policy that challenge the idea that governments can operate industrial policy levers that affect business in predictable ways. New thinking is emerging which views the implementation of industrial policy as requiring new types of collaboration, not only between government, higher

education institutions, and the private sector, but also involving a wider range of stakeholders, including the general public. This requirement for collaboration involving multiple stakeholders can be seen in practice in Ireland in the implementation of the Research Prioritisation Exercise (RPE). The implementation of many of the priority areas identified in the RPE, such as Smart Grids and Smart Cities, Connected Health, Food for Health, and Marine Renewable Energy will involve the simultaneous development of, and real time use of, new technologies by consumers. The piloting and scaling up of new technologies in these scenarios will involve multiple testing and continuous co-learning by all the stakeholders involved.

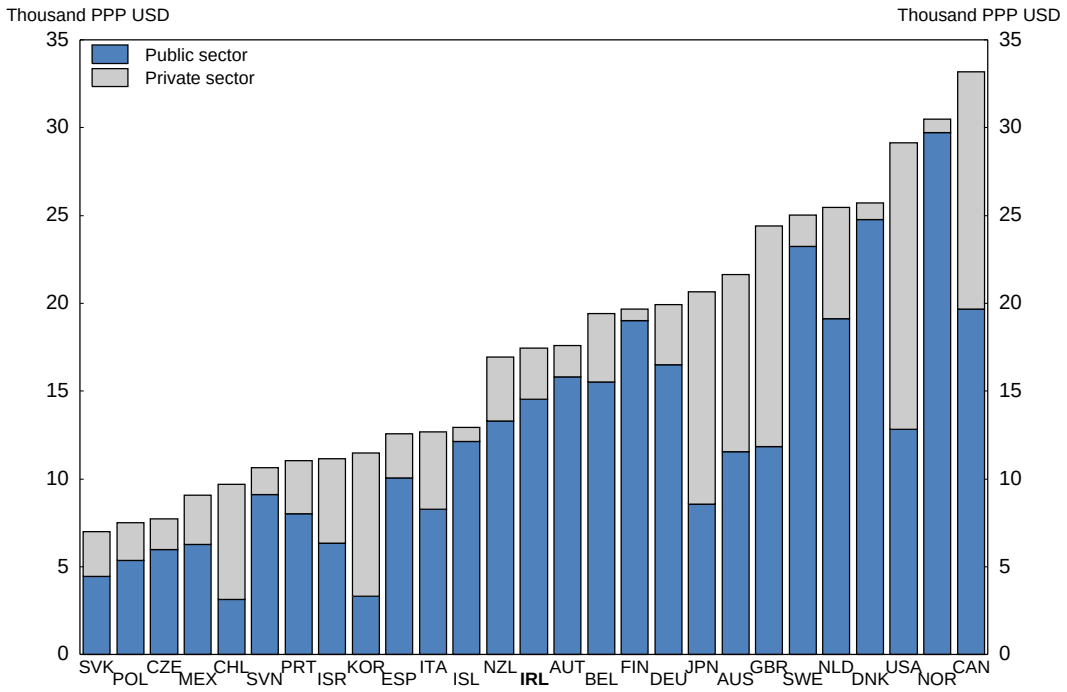
In such scenarios, the developmental role of evaluation will be paramount. An overemphasis on short-term targets should be avoided, and appropriate metrics for measuring change in the more medium and longer terms should be developed. In this vein, new approaches to evaluation in such complex developmental scenarios are being developed based on the principle that the state and market are both ignorant and informed in different ways; that they require flexible roadmaps towards agreed goals rather than targets based on any one agent's understanding of the problem; and that they require local knowledge to be elicited and aggregated on an on-going basis for learning and policy development (OECD, 2013c).

Strengthening the higher education funding system and governance

HEIs are at the core of the innovation system, especially in Ireland where, by international standards, very little research is done in the broader public sector. They are the source of research centre staff, train future researchers and conduct basic research on which the rest of the system rests. The government has allocated significant funds to HEI-based research centres but the broader HEI funding and governance model is a concern. In 2009, Ireland's total spending (public and private) per tertiary student was around the OECD median (Figure 10). However, since then a reduction in government funding of HEIs has been only partially offset by rising student contributions (fees). This has been exacerbated by an increase in student numbers leading to a cut in the recurrent funding per student (public plus student contribution) by approximately 20% that pushes Ireland down the OECD ranking. Academic staff numbers in HEIs fell by around 5% from 2009 to 2011. HEIs have responded with a range of efforts to increase efficiencies including new ways of working, but nonetheless their international ranking has fallen due to academic reputational effects (HEA, 2011) (Figure 11).

The reductions in funding directly from the Exchequer will require careful management to ensure that the higher education system continues to underpin Ireland’s attractiveness as a location for multi-national investment and Ireland’s capacity to operate as a high quality research partner. Ireland should ensure that its allocations of public funding to higher education promote the optimal alignment of the higher education system with innovative, high-value enterprise. Managing HEI funding involves balancing quantity, cost and quality. In the face of rising student numbers, the government's policy has been to offset increasing student contribution by declining public funding. Thus, in recent years it has achieved increased quantity and lower public costs but more could be done to improve quality. Ireland's fiscal position is a constraint, but there are nevertheless a number of financial and governance levers that could be used to underpin quality.

Figure 10. **Expenditure per student by funding source in the tertiary education system in 2010[1]**

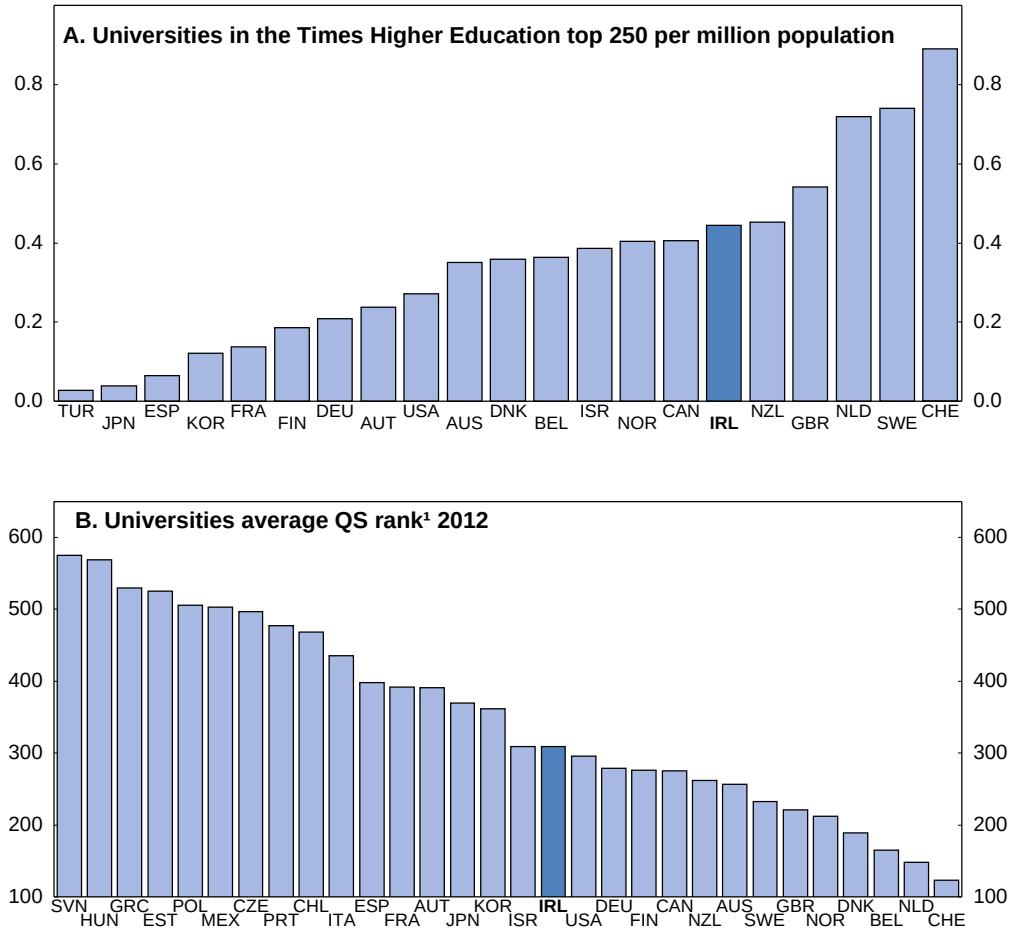


1. 2009 for Germany.

Source: OECD Education database.

HEIs should be given multi-year funding envelopes. Creating greater funding certainty is particularly important from the perspective of research, which is often conducted over longer horizons (OECD, 2006). In addition, HEI funding should better take account of differing levels of student growth across sectors – enrolments in institutes of technology grew faster than universities from 2008 to 2012 although this trend has tapered off more recently. The Higher Education Authority (HEA) determines how funding is allocated between HEIs. In 2007, funding for Institutes of Technology (IoTs) was transferred to the HEA from the Department of Education and Skills. Since then, the HEA has applied the percentage change in the overall budget line for IoTs and universities equally to both the IoT and university sectors. Funding to each HEI is then allocated using a formula-based funding model which links student numbers to course types. To allow better reallocation of funding in line with changing patterns of student demand, the percentage change in the overall allocation to the IoT and universities sectors should be in line with the overall relative demand for places by students in the IoT and university sectors. This would also facilitate the greater clustering of HEI institutions to facilitate more joint research as planned by the government. The Government should also, as it intends as part of its third level reform agenda, continue to move towards complementing core funding with a more comprehensive performance funding component than at present, based on agreed strategy and output targets. This would allow institutions to specialise in different strategies of teaching or research excellence. Private funding from non-household sources is particularly low in international comparison and the government should also encourage HEIs to raise funding from these sources by guaranteeing that the HEIs are entitled to keep any funds they raise in this way with no prejudice to public funding levels (OECD, 2006).

Figure 11. **University rankings: summary**



1. Rankings of over 700 of the world's best universities. Rankings above 400 are given in ranges only so the mid range value was applied and 601 was applied for all those given the rank 601+.

Source: Times Higher Education World University rankings; QS World University Rankings and OECD Calculations.

Subject to independent auditing against specified individual performance targets, HEIs, including research centres, should also have more autonomy over employment and salary conditions in certain defined cases consistently with overall public pay policies. Importantly, research centres should no longer be required to hire staff as civil servants, but be given the authority to negotiate ordinary contracts, perhaps fixed terms, that better match their needs subject to controls. Moreover, autonomy over salaries would help in recruiting top-end research talent, which universities note is becoming increasingly difficult (HEA, 2011).

With the exception of the Nordic countries and Switzerland, Ireland's public funding per student, although slipping, remains at the higher end of the OECD, and the share of public funding of the education system is above the OECD average. Less private funding is an important reason for the difference between Ireland and countries with higher total funding per student. The student contribution fee (tuition fee) has risen rapidly in recent years and will reach around EUR 3 000 by 2015/16. Ireland should explore the remaining potential for a greater contribution from students themselves to the cost of higher education, together with a student loan scheme. Ireland already has a grant scheme for students from lower income

families, but should also introduce an income-contingent loan scheme, as in other countries with high fees, such as Australia and the United Kingdom (OECD, 2006) to better ensure financial access to higher education. Finally, even more focus should be put on the acquisition of high-quality skills, rather than the quantity of students enrolled. Participation rates already rank well and a key pillar of Ireland's economic success rests on its ability and reputation for generating high-quality graduates and research and therefore more use should be made of student number caps to preserve funding levels per student and quality. Student demand is generally quite responsive to labour market conditions but public funding should be reduced for areas where there is a demonstrated over-supply relative to labour market needs (HEA, 2012).

Measuring Higher Education Institution Performance

Measuring the economic impact of public investment in R&D in higher education is substantially more difficult than measuring the economic returns from investment in R&D in firms. One reason for this is that the type of research carried out in higher education institutions is more likely to be basic research, with outputs that are further from market, than the R&D conducted by firms. A second reason is that the outputs from research in higher education institutions are typically more diverse than the outputs of research conducted by firms, and include publications, patents, trained human capital and tacit knowledge (OECD, 2013d).

The outputs from research in higher education institutions often form the inputs to the innovation activities of firms. The transfer of knowledge generated by public research takes place through a wide variety of channels, many of which are difficult to monitor with statistically robust information, including the movement of highly skilled students and faculty staff from universities to industry; the publication of research results; people-based interactions between creators and users of new knowledge; industry sponsored contract research projects; individual faculty consulting arrangements; IPR activities such as patenting; and entrepreneurial activities and people-based interactions involving faculty, graduates and students (Hughes et al., 2011).

The diversity of knowledge transfer channels between higher education institutions and firms is one of the main reasons for the difficulty in assessing the economic impact of public investment in research in higher education. The identification of mixed modes of innovation commonly utilised by firms across the OECD (Frenz and Lambert, 2012) offers the possibility of bridging the gap between the outputs of publicly funded R&D in higher education institutions and their use in the innovation activities of firms.

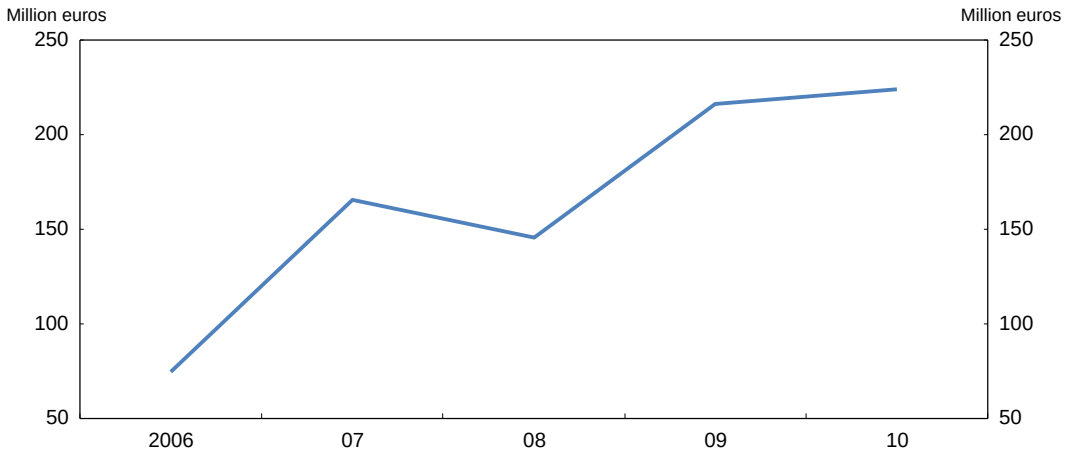
A preliminary mapping of PhD researchers onto the different mixed modes of innovation for Ireland was carried out as part of the OECD mixed modes of innovation project (Frenz and Lambert, 2012). This analysis showed that the highest concentration of PhD researchers in 2007 were in firms utilising the IP/technology innovating mode (1.1 PhD researchers per firm), followed by firms using the marketing based innovating mode (0.7 PhD researchers per firm). Firms using the process modernising employed half the number of PhD researchers per firm than those utilising the IP/technology innovating mode (0.5 PhD researchers per firm). The lowest concentration of PhD researchers were in firms utilising the wider innovating mode (0.2 PhD researchers per firm). PhD researchers therefore map predominantly onto IP/technology innovating and market based innovating modes among innovating firms in Ireland, i.e. those modes of technological innovation that lead to the development of new products and services.

Frenz and Lambert's mixed modes of innovation typology offers the possibility to similarly determine the various ways in which other outputs from research in higher education institutions e.g. publications, patents, etc., are used by firms in different ways depending on their type of innovation activity.

Government financial support

Ireland's R&D tax credit was introduced in 2004, allowing firms to offset 25% of their R&D expenses, over the 2003 level, against their corporate tax liability. The government has over time increased the generosity of the scheme by: increasing the rate of relief from 20 to 25%; allowing cash refunds for companies with insufficient corporate tax liabilities; permitting credit to be claimed against employer social security contributions; and unlimited carry forward of credits (Figure 12). In line with the *2011 OECD Economic Survey of Ireland*, in 2012 the government also introduced a hybrid of volume and incremental credit schemes. Lower research expenditure amounts are credited on a volume basis - a 25% credit is available for every euro of the first EUR 100 000 in R&D expenses, including subcontracted R&D, which was raised to EUR 200 000 in 2013. Beyond this amount, the credit is only available for R&D expenditure that exceeds what the amount spent by the firm in the base year, 2003. Hybrid schemes are particularly useful if the objective is to maintain the level of, and reward high growth of, R&D (Criscuolo et al., 2009). As measured by the tax subsidy provided per euro of R&D expenditures, Ireland's scheme was around the OECD median in terms of generosity in 2008 (OECD, 2009a), although this was before recent changes that increased generosity. Features of the scheme including unlimited carry forward, cash refunds and ability to claim for contracted out R&D expenses should help SMEs that may not yet be profitable and/or not have the in-house skills to carry out R&D.

Figure 12. **Budgetary cost of the R&D tax credit**



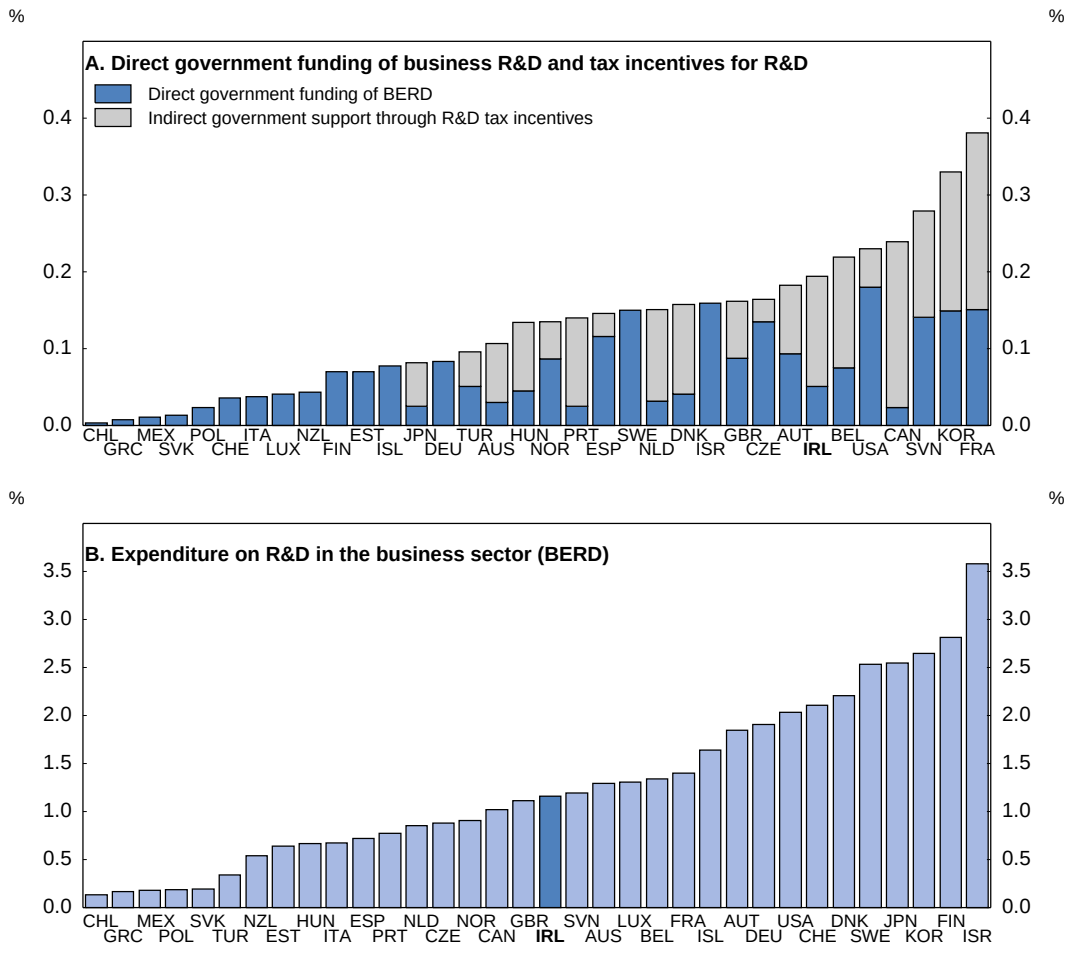
Source: Department of Finance.

The government should maintain a mix of R&D tax incentives and selective direct grants to firms (Andrews and Criscuolo, 2013), as each has strengths and weaknesses. R&D tax credits have the large advantage that they avoid the "picking winners" problem associated with direct grants. They also should require fewer administrative resources to operate than direct grants, which is particularly important in a small country. However, Ireland's low corporate tax rate means the credit may have less leverage on R&D activities since there is a small tax liability to offset. R&D tax incentives can also have unintended consequences including protecting incumbents to the detriment of new entrants (Bravo-Biosca et al., 2012), sometimes generate little additional R&D, and can be used as tax shelters, especially via cross-border tax planning by MNCs (OECD, 2013). By contrast, direct support makes SMEs more likely to carry out R&D and results in a wider distribution of R&D activities - larger companies benefit from a higher likelihood of receiving a subsidy, but this is offset by more small firms doing R&D (Czarnitski and Ebersberger, 2010). Indeed, even if R&D tax incentives contain carry-over provisions and refunds, young firms may not fully benefit from the schemes if they lack the upfront funds to start an innovative project, and in these cases public funding may be more beneficial (Busom et al., (2012).

R&D tax incentives account for about three-quarters of total government financial support to business innovation - among the higher shares in the OECD (Figure 13). This share is likely to grow because the aggregate amount of R&D tax credit is not capped, unlike the science budget. Further major extensions of the credit appear unwarranted without greater evaluation. The government has appropriately launched a new review of the R&D tax credit in 2013. OECD empirical work suggests that reducing R&D cost through incentives by 1% will increase R&D by around 1% in the long-run (Westmore, 2013). Ireland needs to carry out more evaluation of the effectiveness of its particular scheme using statistical methods that generate control groups to isolate the effect of the credit beyond other factors (OECD, 2010a).

Figure 13. **Fiscal support business Research and development expenditure, 2009[1]**

As a percentage of GDP



1. Or latest year available.

Source: OECD Science, Technology and Industry Scoreboard 2001 and OECD Main Science and Technology Indicators database.

The government could improve the implementation of the current R&D tax credit scheme. In particular, heavy auditing by the Revenue Commissioners (tax collection authorities), and the unpredictability of their rulings as to whether a research activity is eligible for a credit, are disincentives for enterprises to take up the credit. The Revenue Commissioners should work closely with the enterprise support agencies to develop a clearer set of guidance and rulings on what research activities are eligible for a credit. The choice of 2003 base year is also essentially arbitrary and appears to unnecessarily penalise

corporations whose R&D expenditure spiked in that particular year. A move to an average of years should be considered to reduce this risk. Consideration could also be given to lifting the proportion of research that can be contracted out, which would help to encourage linkages between enterprises and the higher education sector without increasing the fiscal cost of a given project. Finally, Ireland's economy and export performance are increasingly driven by services. The *Frascati Manual* (OECD, 2002) discusses what can constitute R&D in the services sector, and consideration could also be given to widening the definition of R&D for R&D tax credit purposes to better encompass services R&D (Forfás, 2008).

Investing in skills will help foster spillovers from the multinationals to Irish SMEs

New OECD evidence suggests that more collaboration, as proxied by the share of higher education sector research financed by industry, is associated with higher firm-level total factor productivity (TFP) (Andrews and Criscuolo, 2013). Linkages between MNCs, Irish-owned firms and the higher education sector have built up over time to varying degrees (Table 2). They are concentrated in several industrial clusters including medical devices in the west of Ireland (Galway), pharmaceuticals in the south-east (Cork) and computer hardware and software in Dublin. MNCs have also provided a fertile training ground for indigenous entrepreneurs and a source of start-ups in software. Irish entrepreneurs specialised in medical devices had previously worked in multinationals, building on earlier experience and contacts. MNCs also provide exposure to business practice outside Ireland (Barry, 2008).

However, the number of such linkages remains low by international standards. Spillovers from foreign to domestic firms have tended to benefit from an increased supply of higher-skilled graduates (van Egeraat and Barry, 2008). The proportion of the young population graduating in Science, Technology, Engineering and Mathematics (STEM) appears relatively strong (Figure 2.14). However, SMEs still lack the knowledge capacity to provide technological solutions to MNCs, and mainly specialise in basic raw materials and standard parts, which MNCs can also source from lower labour cost countries. The expansion of Masters and PhD programmes that include substantial work placements in firms is an important way to increase the employability of these students and increase firm innovation rates and linkages with the higher education sector other firms (ACSTI, 2009). These placements have also been the precursor to firms' moving to increase their innovation output using government innovation and enterprise support programmes. The proportion of doctoral graduates, despite rapid growth, remains below the OECD average and further expansion of structured graduate student programmes with significant work placement components should be considered using resources freed from reducing other courses that have shown little prospect of future employment.

Existing research capability in the higher education and hospital sectors can also be better organised to encourage greater interaction with the multinational sector. The move to create larger SFI- funded research centres in the higher education sector is a step in the right direction in this regard. The new health innovation hub, which will allow enterprises to access the public hospital system for clinical drug trials, is also an important step towards building greater linkages between the heretofore largely unconnected hospital and the MNC pharmaceutical sectors. The government should as intended create a national health innovation hub in 2014 to ensure there is a health research "place to go" for the MNC sector.

Make a greater investment in Research Technology Organisations

A major element of the growing innovation system has been an expansion in the number and range of publicly-funded research centres. There are around 108 of these centres, 97 of them based within the HEI system. They play a key role in encouraging linkages and spillovers in the innovation system. The larger and more successful centres, for example CRANN and Clarity (being merged to become Insight), provide a critical mass of research excellence that has encouraged multinationals such as Intel to bring core R&D functions to Ireland.

Table 2. **Foreign Direct Investment Spillovers and Linkages with the Domestic Economy**

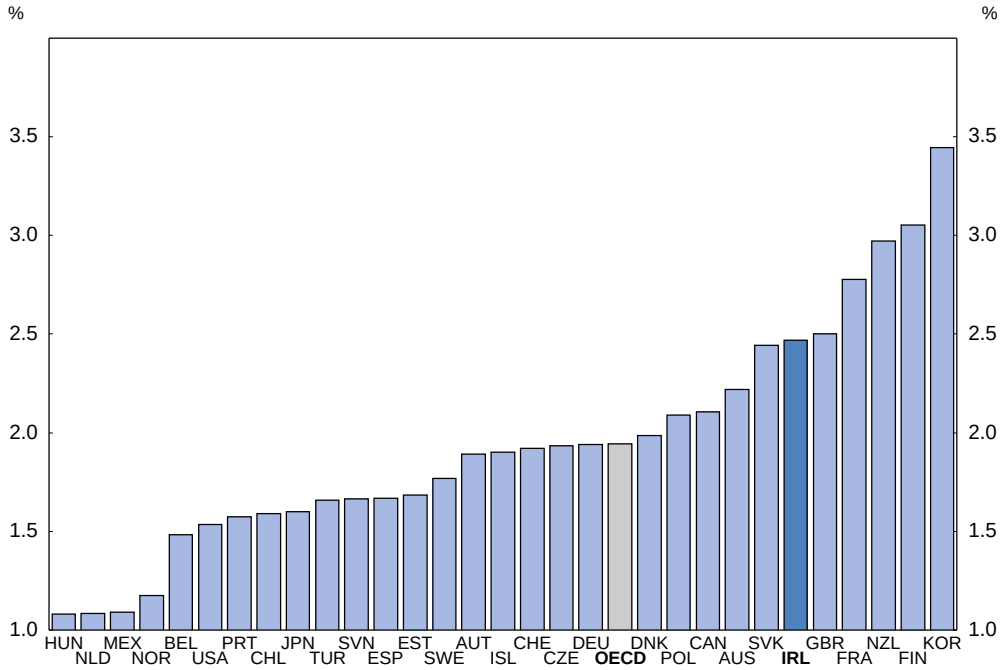
		Firm Ownership		
	Indicator	Indigenous	Foreign	Ratio Indigenous/ Foreign
Supply Purchases from firms in Ireland				
	Per cent of total purchases 2001	89	50	1.78
	Per cent of total purchases 2010	83	18	4.61
New indigenous firm activity in sectors with high FDI presence[1]				
Chemicals	Employment change 2002-2011	-355	-445	
Computer, electronic and optical	Employment change 2002-2011	-141	-5 102	
Medical and dental	Employment change 2002-2011	257	6 073	
Computer services	Employment change 2002-2011	2 072	2 697	
Financial services	Employment change 2002-2011	3 588	8 613	
Engage in joint research				
Any	Per cent of firms 2009	33	40	0.82
Other firms in Ireland	Per cent of firms 2009	11	10	1.09
Other firms outside Ireland	Per cent of firms 2009	17	26	0.65
Higher education or other institutes in Ireland	Per cent of firms 2009	17	22	0.78
Higher education or other institutes outside Ireland	Per cent of firms 2009	8	9	0.88
Engage in technological cooperation of any type				
	Per cent of firms 2008	21	33	0.65
	Per cent of firms 2010	25	38	0.65
Location of technological cooperation partner				
Ireland	Per cent of firms 2010	22	26	0.84
United States	Per cent of firms 2010	4	16	0.22
Europe	Per cent of firms 2010	16	34	0.48
Other	Per cent of firms 2010	2	9	0.22
Likelihood of firm increasing Ph.D researchers				
	Per cent of firms likely or very likely to hire 2007	66	58	1.15
	Per cent of firms likely or very likely to hire 2009	69	62	1.11

1. Data refer to employment in government-agency assisted firms. Central Statistics data for manufacturing industries suggests that this is fairly representative of the economy.

Source: Central Statistics Office based on the Community Innovation Survey; Forfas (2012), *Annual Business Survey of Economic Impact*; Forfas (2012), *Annual Employment Survey 2011*.

Research Technology Organisations (RTOs) are present in all EU15 countries (Arnold et al., 2010) and include Germany's Fraunhofer Institutes, Finland's Technical Research Centre, the Netherland's Applied Scientific Research Organisation and Ireland's agri-food focused, Teagasc. However, they are less of them present in Ireland, especially RTOs that serve SMEs outside the agri-food area. RTOs focus on providing firms with technological and other knowledge related solutions, raise a substantial amount of their funding privately and have a shorter-term focus of 2 to 3 years than more academically focused centres. RTOs can act as bridge from HEIs to the private sector and play an important role in supporting SMEs in future innovation activities. In particular they can provide consultancy and technological expertise tailored to firm needs and nearer to market activities.

Figure 14. **The share of STEM graduates in total employment of persons aged 25-34, 2010[1]**



Note: Scientific fields include life sciences; physical sciences, mathematics and statistics, computing; engineering and engineering trades, manufacturing and processing, architecture and building.

1. For Australia, Canada and France: the number of scientifics graduates refers to the year 2009.

Source: OECD Education at a Glance 2012.

It is important that RTOs are primarily industry focussed and that staff have the incentives to produce industry-focused research. This would mean that their performance and promotion would be based primarily on commercially-related outputs rather than academic ones, such as papers published and citations. To integrate RTOs into the wider innovation system it is important that staff could rotate between them and more academically focussed positions, which would mean treating progression equivalently in an RTO or a more academically orientated centre. An RTO would need more operational freedom, for example, over employment contracts than current HEI centres, although this kind of discretion could also benefit HEIs more generally as discussed above.

Although the centre landscape is evolving, it does not seem that this gap is being filled in Ireland. The new larger research centres (merging CSETS and SRCs) fulfil a different and important role of longer-term strategic research and academic performance metrics remain dominant. *Enterprise Ireland*'s new technology centres are industry rather than firm focussed and their scale is relatively small and project based and therefore not likely to build the critical mass and continuity that an RTO can bring. The government should move to setting up a pilot RTO. The aim should be that the RTO/s are eventually seen as “the place to go” for technological solutions for firms, especially SMEs, in the same way that Teagasc, the food and agriculture research institute, is regarded in its field.

Encouraging internationalisation

Investing in international sales education would help to better leverage the government's annual investment in innovation and enterprise supports and help Irish firms integrate better into global value chains. Innovation support funding is helping to improve Ireland's scientific base and innovation outputs

such as patents. Greater returns will be had if Irish firms can better sell their inventions and technology in the international market place (Kernel Capital, 2012). Higher levels of international sales will also help to set up a virtuous circle as exporters are more likely to innovate, innovate more intensively and have higher levels of productivity than non-exporters (Squicciarini et al., 2014; Siedschlag et al., 2010, 2011). As a discipline, international sales is distinct from marketing and is about getting the buyers in to purchase once they have been made aware of a product and service through marketing.

The government should provide funding for academics expert in the field of international sales and set up a virtual international sales institute within the current university system, incorporating academics from sales-relevant disciplines including law and applied languages. The institute should draw on expertise existing within the multinational sector in Ireland and build linkages with the existing enterprise support agencies. This would provide the academic teaching and research base to build international sales into a scientific discipline in Ireland, which educates future and existing entrepreneur/innovators in evidence-based methods for selling the products and services that they invent. Indeed, Ireland, with its strong multinational base, has a unique opportunity to become an international academic leader in this field as, although the United Kingdom has recently appointed a chair in international sales, there is generally very little research in this field in Europe. Beyond sales there is also a need to build up the broader set of skills in management, logistics and customer relations required to be a successful exporter (EGFSN/Forfás, 2012).

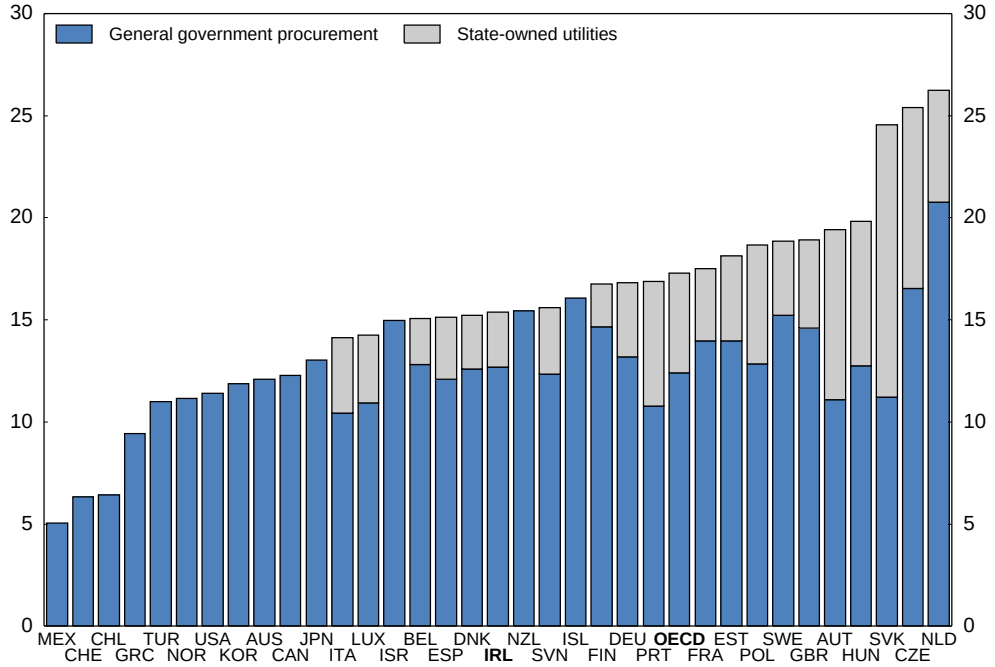
Public procurement should be more open to SMEs and incremental innovation

Government (including State-Owned Enterprises) procurement in Ireland is around the OECD median (Figure 2.15) and has the potential to be better harnessed to encourage innovation, especially in SMEs. The government has taken steps in this direction with the new *Procuring Innovation Initiative* to increase procurement of innovative solutions from SMEs. Using procurement to encourage innovation is not without risks and important challenges are: ensuring sufficient public sector capacity to effectively procure innovative products and services; reducing fragmentation of procurement across different parts of government; and establishing cooperation between procurement and innovation agencies (Beltramello and Nolan, 2012). It is therefore welcome that Ireland, as outlined in the *Jobs Action Plan 2013*, will concentrate procurement. This will be done by means of a *National Procurement Office* situated in the existing *Office of Public Works*, which will also cooperate with *Enterprise Ireland* to improve SMEs capacity to tender for public contracts.

Procurement of innovation also entails risks beyond those in traditional procurement, such as distorting competition, including technological or non-completion, and user non-uptake (Beltramello and Nolan, 2012). These risks, especially the first, can be mitigated by demanding incremental innovations starting with "off the shelf" products firms already produce rather than a "big bang" solution, for example a completely new IT system for government departments, which have become expensive failures in many countries (ASCTI, 2010). The government should be careful not to be overly prescriptive as experience in the United Kingdom suggests that a contributor to success was to begin by asking what was needed, not what was thought to be available or affordable. This allowed companies the freedom to innovate and explore new technologies (Beltramello and Nolan, 2012).

Figure 15. **Public procurement spending**

As a percentage of GDP, 2008



Source: OECD Government at a Glance 2011.

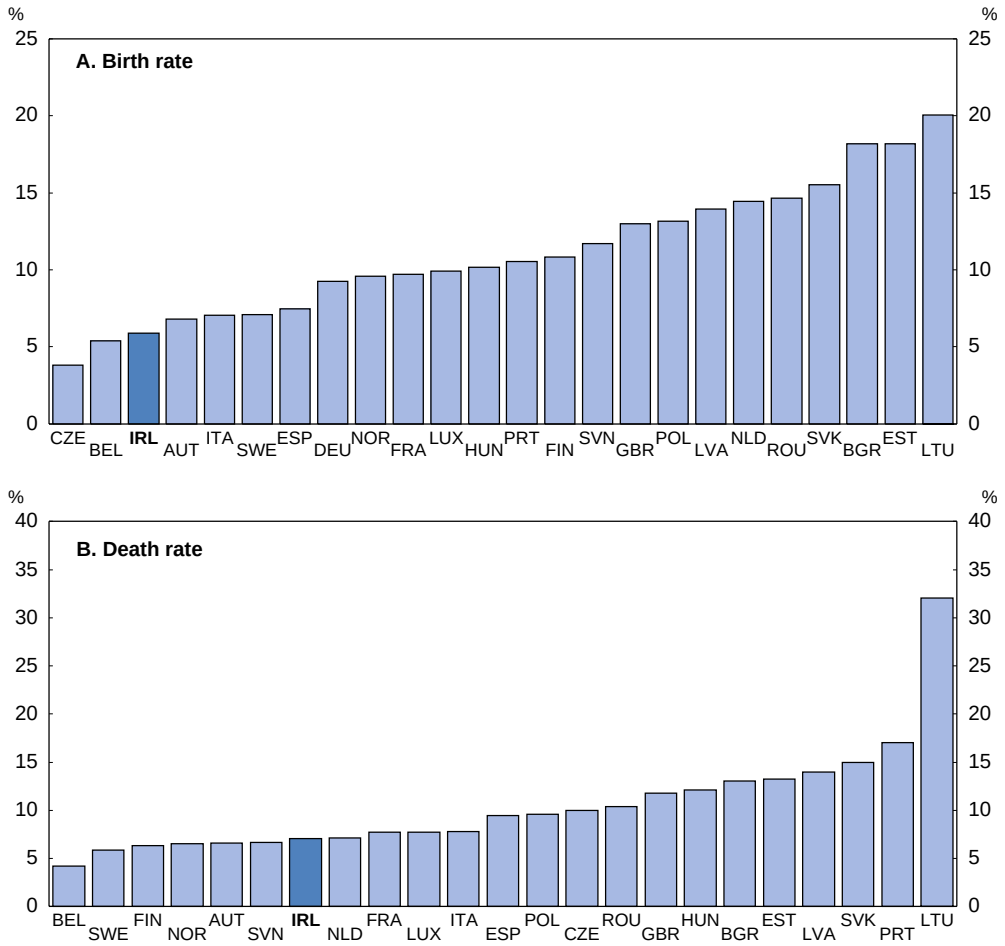
To assist SMEs while mitigating competition risk more the government should, within the current procurement spending envelope, allocated funds to a small business innovation research (SBIR) programme that gives grants for R&D in line with agency and department goals, with firms selected through a competitive tendering process. Indeed widening procurement to SMEs can increase competition. Such programmes exist in Australia, the United States, the United Kingdom and the Netherlands and have been effective in widening the suppliers of R&D in the SME sector (Beltramello and Nolan, 2012). The government is committed under the *Jobs Action Plan 2013* to studying the feasibility of a SBIR. A SBIR programme is an important complement to Ireland's existing programmes to build SME innovation capacity. A significant risk with an SBIR is that government funds might simply crowd out privately-financed R&D and SBIR schemes should attempt to only finance proposals not likely to receive funds from private sources (Wallsten, 2000). Seeking solutions to problems in areas where the government is the largest or only buyer, such as healthcare, can help achieve this goal. Keeping the innovation problems close to core government business will also enhance the chances of the public sector being able to understand the issue and effectively procure a solution.

Enhancing framework conditions for entrepreneurship and innovation

Beyond innovation specific policies it is important to establish a business environment where entrepreneurship and innovation can flourish. New firms tend to have high innovative output with almost half of all young firms (aged 5 years or less) located in Ireland filing patents. This proportion is the highest among all 16 OECD countries covered and young firms generate around 30% of all patents filed by Irish firms (Squicciarini et al., 2014). Encouraging new firms is also important because they tend to be the greatest contributors to job creation (Lawless, 2013, OECD, 2012a). However, Ireland's enterprise sector is not as dynamic as many other OECD countries, as measured by birth and death rates (Figure 16). Once

firms are started they tend to have a high survival rate, perhaps indicating that Ireland is not "daring to fail" enough (Figure 17).

Figure 16. **Birth and death rates of businesses[1], 2008**



Note: The data do not include holding companies.

1. Number of enterprise births/deaths in the reference period (t) divided by the number of enterprises active in t. Data are based on NACE rev.2.

Source: Eurostat.

In addition the Irish perception of entrepreneurship opportunities is low in international comparison and entrepreneurship is not seen as a good career good option (OECD, 2012c). Firms that employ fewer than 10 employees account for a lower share of employment than average, but the share of firms with 10-249 employees is higher than the median, leaving the overall share of SMEs (249 or less employees) around the median. This may be related to the fact that the main government enterprise support agencies have up until recently only dealt with firms that have 10 or more employees. Ireland's general business environment ranks well in many respects but there is room for improvement in a number of areas with potency for entrepreneur-innovators, including improving access to capital, the intellectual property and insolvency regimes as well as availability of broadband internet. Expediting immigration approvals for foreign entrepreneurs could also play a role as immigrants tend to be more entrepreneurial in Ireland, as elsewhere. Increasing competition in sectors providing inputs to all businesses to lower input costs and

increase quality is also an important way to encourage greater entrepreneurship. Enforcing contracts and registering property remains difficult for business due to legal and court fees underlining the importance of passing new Legal Services Regulatory Bill that contains a number of measures to increase competition including establishing an independent legal services regulator.

Getting the business environment right, especially for start-ups, is challenging. It seems to involve fine-tuning and coordination of policies with an understanding of what makes start-ups thrive and cities attractive places to live and work. The Creative Dublin Alliance of high level representatives of central and local government and enterprises seeks to do just that to boost Dublin's already existing computer software cluster and start-up community and increase Dublin's international competitiveness (Box 2).

Box 2. **Turbo-charging the environment for high-tech entrepreneurship in Dublin**

The Creative Dublin Alliance is developing a suite of initiatives to make Dublin a better place to live and start-up a high tech firm under three main headings: getting business on line; provision of open data; and "turbo-charging" Dublin's IT start-up community. In the latter area, a group of business and government representatives is identifying Dublin's current strengths, including large internationally-sourced talent pool as well as potential barriers to high tech start-ups and linkages with multinational firms. A horizontal approach is being taken to look at initiatives that will encourage new firms regardless of ownership or sales destination. The group is examining a number of areas including: identifying gaps in the current government enterprise support framework, such as where the firm has owner-employees in both Ireland and abroad; ensuring that building leasing arrangements are flexible enough for young firms that want to be close to their peers and multinationals, and for whom standard arrangements such as long-term leases over single occupier spaces Is unsuitable; creating pathways for youth from training to IT entrepreneurship by creating networking opportunities and reducing barriers to IT entrepreneurship talent from abroad coming to Dublin through reform of the visa system; creating "one-stop" shops for start-ups that would provide a single location for entrepreneurs to access the accounting, legal, tax and other regulatory advice required to get started quickly; and consolidating the number of innovation hubs within the city. Once a successful approach is developed for Dublin it could potentially be replicated for other high-tech clusters elsewhere in Ireland.

Financing of firms and capital markets including venture capital

Even with a normal bank lending channel operating, innovative start-ups and SMEs face particularly high barriers to obtaining finance due to their lack of collateral, cash flows and track record. This is exacerbated in Ireland by the impairment of the bank lending channel, further increasing the importance of other sources of finance for SMEs including angel investors (OECD, 2011a), mezzanine finance (hybrid debt/ equity instruments) (OECD, 2012), SME loan securitisation (including covered bonds), venture capital and public equity offerings (OECD, 2013e). Angel investors and venture capitalists also provide other benefits to start-ups and SMEs beyond including business expertise on commercialising an invention and creating connections that will facilitate an eventual trade sale. Venture capital provision in Ireland is around the OECD median. Raising venture capital has generally become harder since the financial crisis with funds raised in Europe declining by 40% from 2007 to 2011 (OECD, 2013f). In line with trends elsewhere in the OECD, the Irish government is increasing its supports for capital supply to SMEs. As discussed further below this exposes the government to substantial financial risks particularly as the interventions tend to be to high risk firms. Public funds committed via eight initiatives total approximately EUR 1 billion (0.6% of GDP) with the intention of generating at least EUR 1.3 billion in co-funding by investors (Table 3). Other measures include SME lending targets for the two domestic "pillar" banks and an SME credit guarantee scheme. An examination of evidence of Credit Guarantee Schemes across OECD countries suggests that they have increased credit availability but also substantially lifted the risk exposure of the guarantors. There is very little evidence about whether they increase welfare in terms of greater sales, employment and innovation of SMEs (OECD, 2012d).

Table 3. **Facilitating SME Access to Finance**

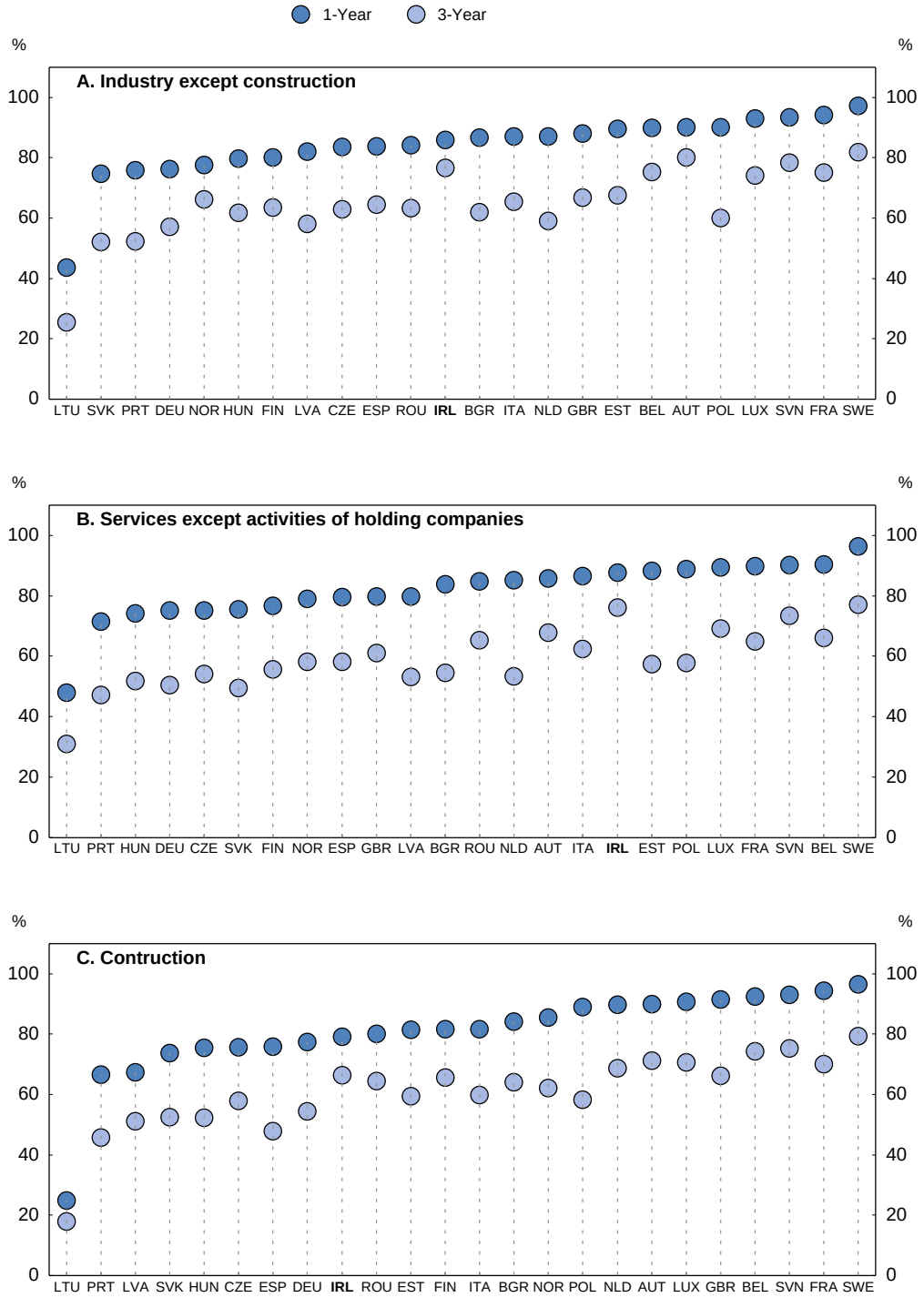
Body	Instrument name	Year launched	Public Funds millions of euro	Desired outside private investment
Enterprise Ireland	Innovation High Potential Start-Up Funding (HPSU)	2008	23	0
Enterprise Ireland/ National Pension Reserve Fund	Innovation Fund Ireland	2010	250	minimum 250
Enterprise Ireland	Development Capital	2012	75	150
Microfinance Ireland	Micro enterprise Loan Fund	2012	10	30
Enterprise Ireland	Seed and Venture Capital	2013	175	525
National Pension Reserve Fund	SME Equity Fund	2013	125	175-225
National Pension Reserve Fund	SME Turnaround Fund	2013	50	50
National Pension Reserve Fund	SME Credit Fund	2013	175-325	minimum 125
Approximate Total			958	1 330

Source: Jobs Action Plan 2013, Enterprise Ireland, National Pension Reserve Fund.

Although information asymmetry problems can give rise to market failure, public intervention can result in trying and failing to pick winners (Avinimelech and Teubal, 2006) and crowding out effects (Cumming and MacIntosh, 2006) and the government should ensure all public intervention schemes have majority private co-funding (OECD, 2013f). The intention of 7 of the 8 schemes to raise matching or greater funding from the private sector is therefore welcome. Direct intervention should also be avoided and preference given to public investment via fund of funds. Although some evaluation has taken place at the scheme level, the increasing range of schemes and amounts of public money being committed calls for a more unified and transparent approach to the reporting and evaluation of these schemes. This is particularly important as the risk levels associated with this type of investment are extremely high. An empirical investigation showed around two thirds of a venture capital portfolio generates only 4% of the returns, while 4% of the portfolio generates more than 60% of the returns (Nanda, 2010). Regular summary reports should be publicly available comparing the performance of *all* schemes using financial, particularly risk adjusted rates of return, and other metrics.

Ireland's range of SME access to finance tools appears to be broad by international comparison (OECD, 2013f). However, for the financial system to work well in supporting firm growth there needs to be coverage from the seed capital stage right through to emergence as a medium to large firm and to date less initiative has been taken to encourage stock market listing. The Irish stock exchange is one of the smallest in the OECD relative to GDP (Figure 18) and the number of Initial Public Offerings (IPOs) is low by international standards and similar to countries with far smaller economies (Weild et al., 2013). A vibrant IPO market is an important complement to earlier stage finance, allowing venture capitalists and angel investors to exit and recycle their funds into new companies (OECD, 2013f). It also provides an important alternative for the merger and acquisition exit route, which should remain as a key exit route as well, especially for high growth companies. The *Action Plan for Jobs 2013* includes a commitment to develop proposals to incentivise dynamic companies who choose to continue to use the IPO route to raise development finance as an alternative to a trade sale exit.

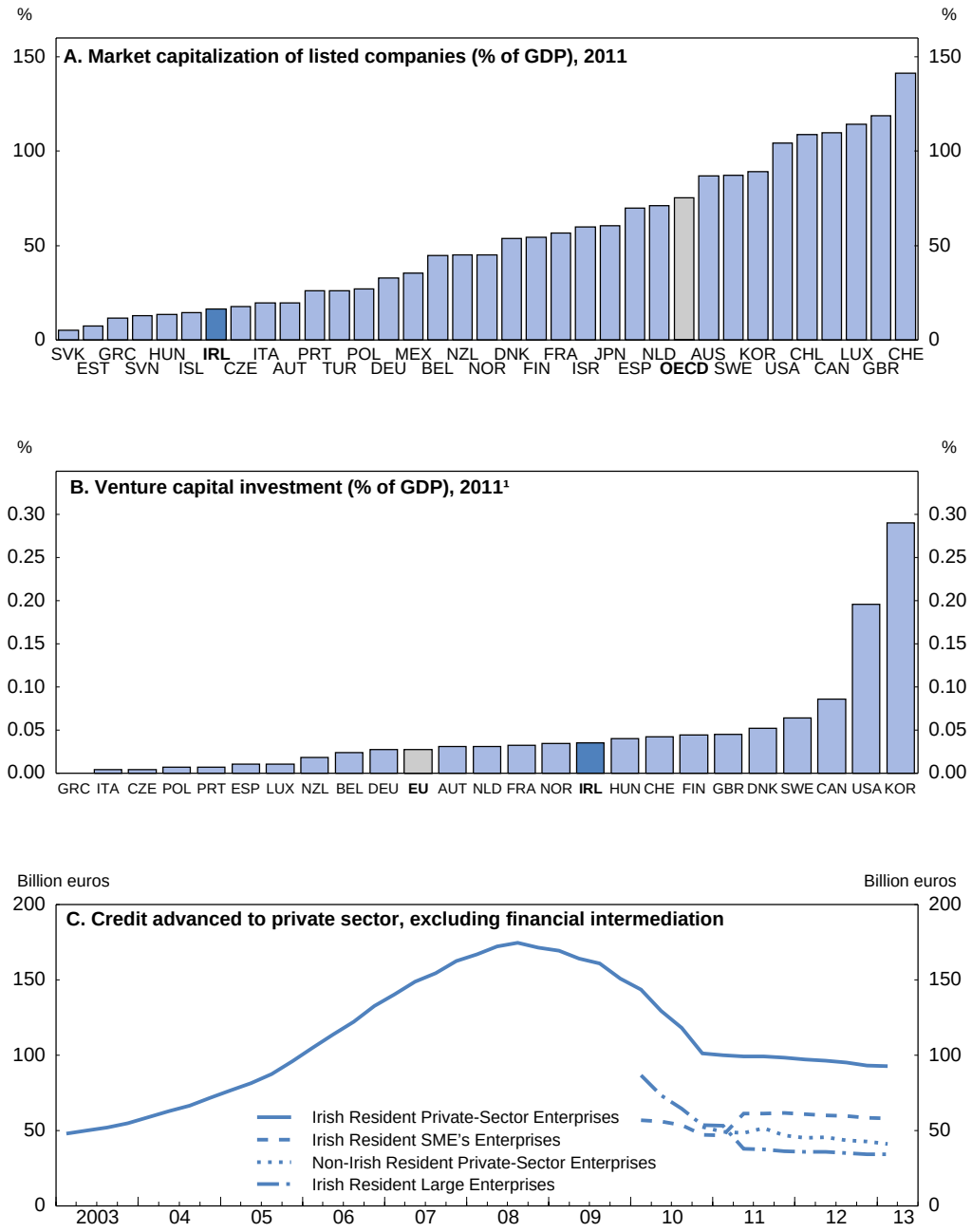
Figure 17. **Survival rates[1] of firms by sector as 2009**



1. Survival rate as defined as number of enterprises in the reference period (t) newly born in (t-n) having survived to (t) divided by the number of enterprise births in (t-n). Data are based on NACE rev.2.

Source: Eurostat.

Figure 18. **Financing of the private sector**



1. 2009 for New Zealand.

Source: Bank of Ireland; World Bank, World Development Indicators (WDI); European Equity and Venture Capital Association (EVCA), Yearbook 2012; Canada's Venture Capital and Private Equity Association (CVCA); Private equity and Venture capital in New Zealand (NZVCA); Korean Venture capital Association (KVCA); Price WaterHouse Coopers and National Venture Capital Association.

SME listings face an uphill battle against an international trend towards high-frequency electronic and often computer algorithm based trading, for which relatively illiquid small-capitalisation (small-cap) stocks are not suited. IPO activity has stagnated in the United Kingdom and shrunk in the United States over the past 15 years (Weild et al., 2013). Aside from illiquidity, small-caps rely on attracting fundamentals investors, which requires good information flows, and have only a small revenue base over which to spread regulatory and listing compliance costs. Initiatives, such as the ones to be developed under the *Jobs Action Plan*, to boost IPO activity should address these characteristics and could include reducing regulatory reporting requirements for newly listed companies, and increasing incentives for brokers and analysts to research and promote SME listings. International experience suggests that higher tick sizes for smaller-cap stocks, and therefore greater spreads (Harris, 1997; Goldstein, 2000) and revenue for brokers, are associated with greater IPO activity (Weild et al., 2013). Demand for longer-term investments in small-cap stocks could be increased by reducing capital gains taxes for those who hold the stock for several years (IPO Taskforce, 2011).

The Irish stock exchange and brokers have an important role to play in promoting IPOs. Ireland currently has broker over-capacity in the wake of the collapse of the banks and associated equity trading, and the exchange is under pressure with Irish companies moving their listings to London. However, SME IPOs need a vibrant local stock exchange and broking industry with the local knowledge and contacts to conduct the research and carry out the promotion that is required for SME IPOs. A worldwide trend towards demutualisation and publicly listing stock exchanges, as well as technological change, that has multiplied electronic trading options has increased competition for listings and trading volume (Cristiansen and Koldertsova, 2009). Demutualising and publicly listing the Irish exchange itself in an IPO would help it to compete better by providing fresh capital to the exchange and incentivising stronger performance (Forfás, 2013a). Demutualisation would also increase the exchange's competitive edge by conferring greater decision-making flexibility on management than in a mutual form where member consent is usually required (Fleckner, 2006).

Insolvency regime

The insolvency regime is an important part of the incentive structure for entrepreneur-innovators. If the consequences of failure are harsh or it is difficult and costly to exit a failed business, this will discourage entrepreneurs from starting new ventures in the first place. Entrepreneurs, creditors and the economy stand to gain from greater efficiency in insolvency procedures. According to the *World Bank Doing Business* indicator Ireland's overall insolvency procedures rank relatively highly with the 8th. most efficient insolvency regime in the OECD. However, there is potential for further improvements. Corporate insolvency of any kind has a strong stigma in Ireland. The government, media, the enterprise sector and unions all have a role to play in casting honest business failures not as something repugnant despite the sometimes painful consequences, but rather as events to be resolved so entrepreneurs can start over. In addition, the cost of the procedure as a share of debtor assets remains higher than countries ranked overall lower for insolvency.

In Ireland corporate insolvency results in one of three main procedures: liquidation (winding up the business); receivership (enforcement of collateral against a loan); or examinership, where a court appointed official takes control of the company and develops a proposal to keep it going. The proposed reform in the Companies Bill 2012, which allows small companies to apply to the cheaper Circuit Court instead of the High Court to enter examinership, is therefore welcome. The government should also introduce a non-judicial debt settlement process for SMEs, as announced in the *Jobs Action Plan 2012*, as soon as possible. A possible mechanism is the Company Voluntary Arrangements in the United Kingdom, whereby the debtor appoints an insolvency practitioner to draw up a debt restructuring plan, allowing the company to continue to trade, to be put to creditors for a vote.

Intellectual property rights

Intellectual property rights (IPR) can have a large bearing on firms' willingness to innovate either individually or cooperate with others. Firms report that difficulties in negotiating intellectual property rights agreements are significant barrier to collaborative projects with the higher education sector and this is more difficult in Ireland than with institutions elsewhere (ACSTI, 2010). Contract negotiations are protracted and Technology Transfer Offices (TTOs) prefer licensing agreements over outright sales of IPR while firms often preferred the latter. The government has developed a new IPR protocol to improve the regime (DJEI, 2012). A new Central Technology Transfer Office is also being set up to advise the 10 HEI based TTOs.

The current configuration could end up increasing bureaucracy without operational benefits. Greater efficiency gains could be potentially had if the new Central TTO took as much as possible operational responsibility for the legal processes that surround negotiations that are conducted at the individual TTO or research centre level. The new protocol also retains as the default position in the case of co-funded collaborative agreements that ownership of IPR will be retained by the HEI and only sold if it a non-severable improvement (i.e. the IPR cannot be commercialised without infringing on background IPR brought to the collaboration by the industry partner). This seems overly restrictive and the starting position should be more neutral, and the approach tailored to the capabilities of the enterprise partner to successfully commercialise research for the wider benefit of Ireland. While the government should get fair value for its contribution to IPR, the principle goal of the IPR policy should be to facilitate clusters of companies around the HEIs and to build long term HEI-Enterprise relationships (ACSTI, 2010). To this end, TTOs should not be evaluated on financial performance but rather their achievements in building in such clusters and effectively transferring technology, especially to the Irish-owned SME sector.

The government should investigate whether it can encourage greater SME innovation activity by providing a wider IPR toolbox. In particular it should seek the support of the European Commission and other EU countries to examine whether a useful addition to patent protection would be to extend the use of direct protection of intellectual property (DPI), which has been the main way of protecting new plant varieties since the 1960s, and used in Ireland to protect new potato varieties (Kronz, 1983, Kingston, 1987, 2012). Patent protection depends on the connection between the particular new idea patented and the product brought to the market. In pharmaceuticals this is almost direct (the chemical compounded patented and the drug sold have to be identical), but in other manufacturing areas the connection is much looser and therefore the protection is weaker. DPI can add to the incentive IPRs provide by protecting the effort of turning patent ideas into a commercially viable product by protecting that end product for a limited period. DPI has the advantage that it more directly incentivises what the government really wants more of - end-user products - as opposed to patents, which are just a means to an end. In the United States direct protection is given for boat hulls that have been moulded, not just designed and the European Union provides direct protection for databases. DPI is a strong form of protection and as such would be most likely be suited for areas where social benefits are high, but so are the costs of producing a marketable product, and there is little evidence of commercial research taking place. It can be seen as a fiscally cheap form of demand-led innovation.

ICT infrastructure

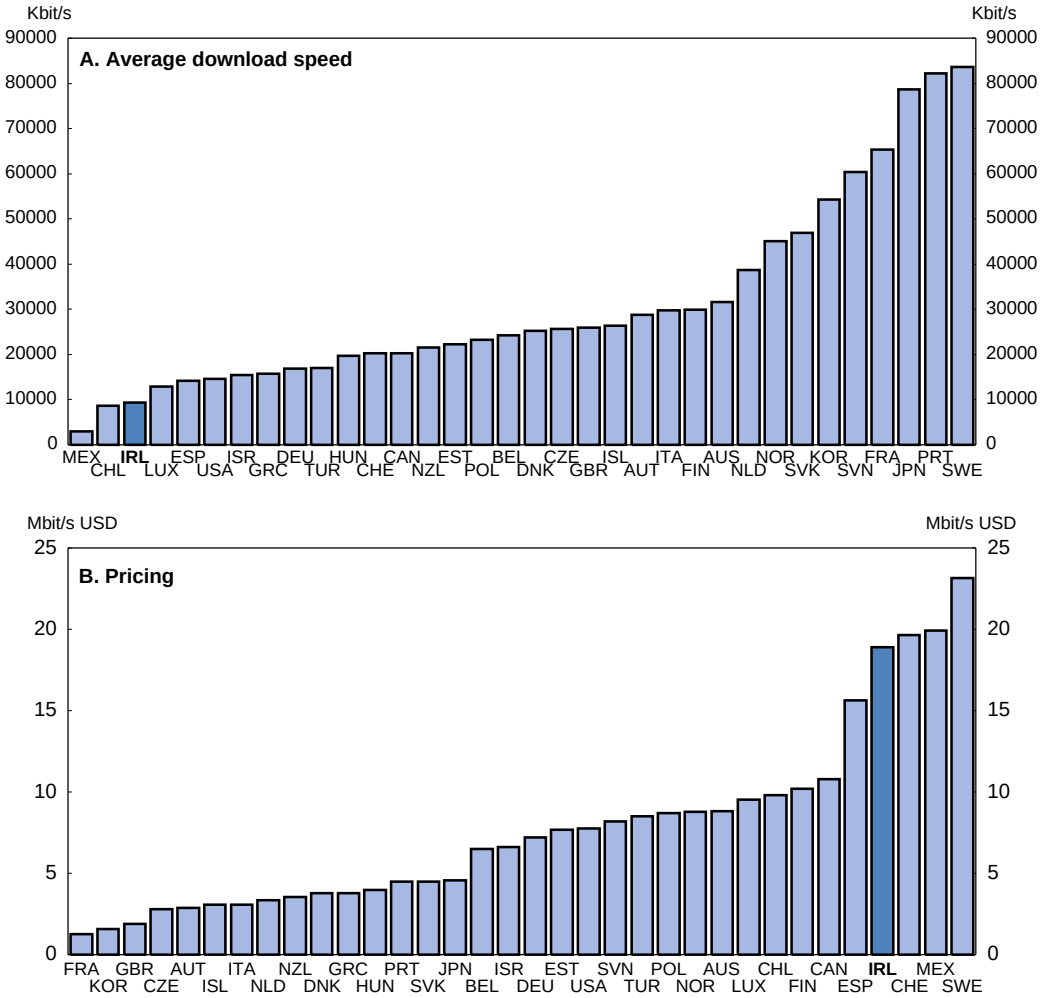
Improving broadband internet infrastructure can potentially strongly foster both innovation and enterprise growth. The importance of broadband internet for innovation arises from its general purpose technology (GPT) characteristics. It can be used in many sectors, it is technically dynamic and, crucially, has strong potential for innovation complementarities (i.e. the productivity of R&D in other sectors increases due to innovation in broadband (Bresnahan and Trajtenberg, 1995)). As such it has the potential to spark a long wave of innovation and productivity as electricity did in the 20th century (David, 1991).

Empirical work using panel datasets of OECD countries consistently finds a significant relationship between broadband penetration and per-capita and aggregate GDP growth (Koutrompis, 2009; Czernich et al., 2011; Atif et al., 2012). However, there is more uncertainty at the micro-level. Grimes et al. (2012) using data on a broad sample of New Zealand firms find that broadband adoption increases firm productivity by 7-10%, while Hallar and Lyons (2011) using data for Irish manufacturing firms conclude that broadband has no effect on firm productivity. However, as acknowledged by the authors, the latter result does not exclude the possibility that the strongest firm level effects lie in the services sector. For example, in Ireland there are strong potential complementarities between broadband internet and Ireland's revealed comparative advantage in sectors such as computer software and international financial services, and its specialisation strategy to encourage growth in internet intensive sectors, for example, cloud computing and gaming.

Although large firms in Ireland appear to be well served with access to extremely rapid broadband speeds, broadband download speeds for households and SMEs are among the lowest in the OECD and prices among the highest (Figure 2.19). Although the figure relates to residential users access, data from the Irish Telecoms Regulator, Comreg, for households and firms is consistent with this picture, with around 70% of households and 90% of SMEs having contracted access at between only 2 and 10Mbps. In addition, around 10% of firms are not using the internet at all (NGBT, 2012). The government's *National Broadband Plan* aims to increase broadband speeds across the country to speeds comparable with the best performing OECD countries today for more than half the population by 2015 as well as significantly lifting the minimum speed for all households. The plan aims to achieve this by facilitating private investment in the rollout and, but will fall back on government investment where there is evidence that the market will not provide the services. An area of uncertainty is just how fast private-sector investment will proceed and the extent of actual demand for high-speed broadband. In both respects, the government should examine the progress and be guided by cost-benefit analyses. In this regard, an important consideration is that providing high broadband speeds via ADSL using the existing copper network allows access to a wide range of services, and the cost of ADSL is far lower than installing fibre, which requires a whole new network to be built (Kenny and Kenny, 2011).

An important barrier to broadband infrastructure is development contribution fees for installing telecommunications masts and opening roads to lay copper or fibre cables, which are sometimes very high. Fees vary significantly across counties and appear to be motivated by revenue raising rather than cost recovery. Indeed, charges tend to be levied in inverse proportion to costs in that the fees tend to be the highest in rural low population counties where negative externalities from these developments are lowest (such as fewer people live close to the mast, there is less traffic disruption from road openings). As a sometimes significant and unpredictable tax on new investment, these fees are particularly distorting way to raise revenue and empirical work shows that higher fees reduce the number of masts controlling for the usual determinants such as population density (Gorecki et al., 2011). The government has moved to partially address these obstacles by changing the planning guidelines to local government by advising that permissions for telecommunications masts should be permanent rather than for only 5 years (DECLG, 2012). In addition draft central guidelines on development contribution fees propose requiring waivers for broadband infrastructure but acknowledge that these schemes are still decided at the local authority level. The government should take a broader approach than this to reduce the development fee impediment for all infrastructure development rather than making a special exception for broadband.

Figure 19. **Broadband for residential users, September 2010**



Source: *OECD Communications Outlook* 2011.

To remove unwarranted impediments to infrastructure development, including the extension of high-speed broadband, central and local government should work together to implement uniform and predictable charges and licence application procedures. Local government reliance on the current fee system should be reduced by replacing it with revenue with recurrent property taxes that are more stable and less distorting to investment and growth. The cost of broadband rollout could be reduced with reforms to require open access ducting in new buildings as part of the planning process (Forfás, 2011a). The payoff from higher speed broadband in terms of innovation and enterprise would be increased by putting more government services online. In this regard, the eGovernment Strategy could usefully be coordinated with the rollout of high speed internet. For example, health services are a core government activity where high speed internet creates many new opportunities, such as remote diagnostics.

Box 3. **Recommendations for fostering innovation and entrepreneurship**

Reflecting significant uncertainties about the effectiveness of various innovation policy tools, independently and regularly evaluate all actions in this area, strengthen programmes with proven higher returns, and wind down the others. To promote effective evaluation, ensure all innovation and enterprise supports have sunset clauses.

To increase the effectiveness and cost-efficiency of the innovation and research policies, and make it easier for businesses to access support, consolidate innovation funding and actions into a smaller number of government agencies.

To increase capital supply and encourage entrepreneurship, lower costs for small-cap IPOs, centralise legal processes for intellectual property rights (IPR) transfers with the new central Technology Transfer Office, introduce changes to the examinership process and remove unwarranted licensing and cost barriers to the rollout of high-speed broadband.

To improve Higher Education Institution (HEIs) quality, make a significant portion of their funding performance related, provide multi-year funding envelopes for HEIs, adjust their funding to reflect different student growth patterns across institutions and give them autonomy over staff salaries.

To encourage MNCs to move advanced R&D functions to Ireland and build HEI-firm linkages, continue the strategy of building up fewer, larger academic research centres. Increase Masters and PhD graduates with significant firm placement components in order to provide firms, and particularly SMEs, with the innovation capacity to engage with HEIs. Further enhance SME-HEI links by setting up Research Technology Organisation/s targeting SME needs.

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Annex A1

Main innovation support agencies and programmes

Government department	Estimated expenditure in 2012 EUR million	Per cent of total expenditure	Estimated number of R&D programmes	Principal programmes*	Budget EUR million	Per cent of total budget	Principal aim	Funding body
Department of Jobs, Enterprise and Innovation	361.9	40	44	IDA RD&I	63.0	7	Business R&D	IDA
				EI R&D Fund	54.2	6	Business R&D	EI
				Principal Investigators	41.9	4	Human Capital	SFI
				CSET	34.6	3	Collaboration	SFI
				Commercialisation Fund	24.0	2	Commercialisation	EI
				SRC	21.6	2	Collaboration	SFI
				Technology Centres	20.8	2	Collaboration	EI
				ESA	14.8	1	EU & International	DJEI
				TIDA-HIPA	12.5	1	Commercialisation	SFI
				Innovation Partnerships	10.0	1	Collaboration	EI
Department of Education and Science	344.9	39	27	Block Grant (Uni7)	233.8	26	Infrastructure; Human Capital	HEA
				PRTLI	53.2	6	Infrastructure; Human Capital	HEA
				IRCSET	20.1	2	Human Capital	IRCSET
				Block Grant (IoTs14)	14.6	1	Infrastructure	HEA
				IRCHSS	10.7	1	Human Capital	IRCHSS
Department of Agri-culture, Food and the Marine	98.4	11	22	Agri-Food Research	60.5	6	Human Capital	Teagasc
Department of Health	39.8	4	8	Health Research	33.9	3	Human Capital; Infrastructure	HRB
Department of Energy and Natural Resources	16.1	1	14	No programmes >EUR 10 million				
Department of the Environment	10.6	1	11	No programmes >EUR 10 million				
Other	5.0	-	19	No programmes >EUR 10 million				
Total	876.7		82		724.2	74		

*Programmes with expenditure >EUR 10 million in 2012. There are 17 such programmes which together make up around 75% of total R&D budget.

Source: Preliminary data from the 2013 Science Budget, Department of Finance.

Annex A2.

Main objectives of innovation support programmes

Principle objective of programme	Number of programmes with this principal objective	Expenditure on programmes with this principal objective EUR million	Per cent of total government budget	Number of funding bodies involved
Underpinning Infrastructure (including Human Capital from Block Grant to Higher Education Institutions)	12	324.1	38	3
Human Capital/Funding for Research Personnel (mostly competitive funding)	24	155.1	18	10
Financing Business R&D (excluding R&D Tax Credit*)	8	124.8	14	5
Facilitating Collaboration (includes programmes to facilitate HEI-HEI, HEI-Firm, and Firm-Firm collaborations)	12	95.4	11	4
Commercialisation and Translation of Research (includes direct commercialisation and technology testing and adoption)	8	43.0	4	4
Participation in European and other International Programmes	14	18.7	2	5
Other(mainly Grant Payments to individual institutions, including Teagasc)	53	91.7	10	~15
Total	131	852.8		

* Estimated cost of R&D Tax Credit in 2010 was EUR 224 million.

Source: Preliminary data from the 2013 Science Budget, Department of Finance.

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