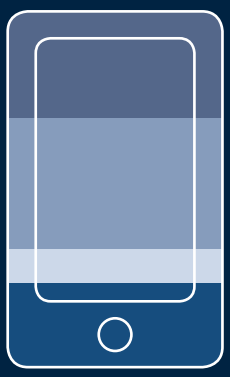
Northern Ireland Knowledge Economy Index

Baseline Report 2011

A benchmarking report tracking the health of the Northern Ireland Economy against other UK regions

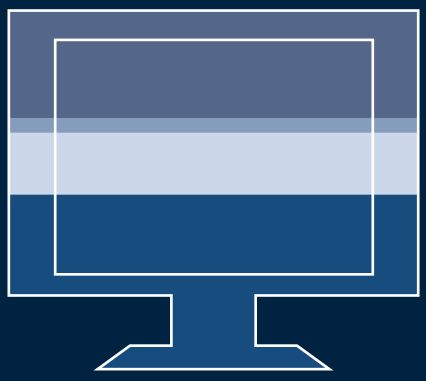
Software/Digital



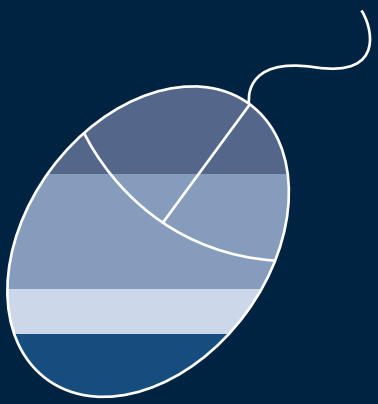
Telecommunications

Aerospace & Transport

Pharmaceuticals and biotechnology



Computing/Advanced Electronics



IT Services

Report prepared by Oxford Economics for Northern Ireland Science Park CONNECT

In partnership with

Contents

Foreword

The "NI Knowledge Economy Index: Baseline Report" could not have been published at a more opportune time. Given the lack of growth in our private sector and the overall impact that the 2008/09 downturn has had on public funding, our labour market and our general prosperity it is now imperative that we become proactive rather than reactive in steering our economic destiny.

The commissioning of this report by NISP CONNECT was prompted by an awareness of successful international experience in terms of achieving high levels of economic growth and job creation through knowledge-based growth. But before we begin to set measurable targets for monitoring progress in this area it is imperative that we have a clear understanding of where our economy currently resides in terms of its knowledge base. In this report Oxford Economics successfully presents a model which not only replicates the key knowledge economy metrics used internationally and applies them to the local economy, but also presents them in a form which is accessible to policy makers, the business sector and educationalists.

The findings of this report show clearly that our current economic model in Northern Ireland is not working. Despite the aspirations set out in the Executive's very first draft *Programme for Government* over a decade ago, our knowledge economy base is still stunted. The bottle-neck in Northern Ireland's economic growth and our inability to create jobs lies in the fact that we require a step-change in our efforts to build a knowledge economy. The report highlights the scale of the gap between our current knowledge economy base relative to international comparators and reveals that even in a UK context we are also lagging other regions. In addition, this report demonstrates that private funding in terms of venture capital activity is virtually non-existent in NI relative to other regions. This problem requires urgent policy attention and one key method of solving this problem is to further extend and develop our research base. International experience tells us that when the capacity of local research institutions is built up this acts as a catalyst for those much needed private capital flows.

This research also presents us with the stark reality of where we are now and the sheer scale of the challenges that we face. The evidence presented here shows us that the status quo renders us incapable of producing a sufficient number of high-tech jobs in the long-term and this research succinctly uses a number of key performance indicators to demonstrate why exactly this is the case.

This report is an essential read for policy makers. If economic growth and job creation are genuine policy priorities then urgent targets for raising our knowledge economy base and the constant monitoring of these NISP CONNECT indicators must be undertaken. Proposed targets and timetables for improving each of our knowledge economy indicators will be developed by an expert panel from the Science Park and the private sector in the coming months and should be built into Northern Ireland's forthcoming economic strategy. This report signals to policy makers that we urgently need a much greater policy focus in terms of innovation, research and business start-up funding. It also highlights the link between successful knowledge economies and a region's skills base. In summary, for Northern Ireland to become a knowledge economy it requires a significant lift in levels of innovation, talent, technology, enterprise and active networks.

This research also makes interesting reading for the private sector - particularly in the current economic climate. The report serves as a reminder that successful regions such as San Diego have managed to up build up significant knowledge economy bases without spending vast amounts of money. For example, R&D and innovation can be increased substantially in the private sector through greater collaboration with local universities, further education colleges and indeed the Science Park.

In its entirety this report demonstrates the willingness of the private sector to engage with policy makers for the purpose of raising our economic game. Key players in the economy can no longer operate in isolation, but with a joint effort and challenging (and realistic targets), we could potentially become one of Europe's leading knowledge economies. Government, business and the higher and further education colleges must all step up to the mark. We should not underestimate the scale of our respective contributions if we are genuinely committed to creating prosperity and raising local living standards for all.

Angela McGowan
Chief Economist
Northern Bank

Executive Summary

The need for knowledge

The economic landscape has changed profoundly over the last 5 years. The global recession ended a period of rapid growth which was underpinned by escalating levels of debt and most developed economies are still struggling to regain the level of economic performance they enjoyed in 2007-2008. Recovery has been slow as cash strapped consumers and governments, allied to nervous businesses reluctant to invest have created conditions that are not supportive of growth. Yet against this backdrop opportunities clearly exist. Growth in emerging markets continues and the growing global population is placing demands on energy, food, products and services that are necessitating new ways of thinking and innovative solutions. How can Northern Ireland capture these opportunities and pull itself up from its traditional position as the economically weakest UK region?

Knowledge is the answer. It is in the knowledge intensive sectors in which the developed world continues to have its comparative advantage. Highly specialised skills, developed business practices and existing business and technological infrastructure are core strengths that emerging nations are only beginning to challenge effectively. Knowledge based jobs are well paid, rewarding and ultimately able to generate global sales, crucial when domestic markets remain subdued.

This report is designed to present a benchmark for the Northern Ireland knowledge economy, mimicking as closely as possible the CONNECT programme based in San Diego. San Diego CONNECT is a highly respected regional programme linking inventors and entrepreneurs with the resources they need for commercialisation of products. It is hoped that the work will help to raise awareness of the sector's importance and provide a platform from which to foster growth, ensure a supportive policy environment and to use as a framework to monitor progress.

Building from a sound foundation

Defining the knowledge economy is difficult, the definition used in this report is based on the definition used in the CONNECT report to allow comparison. This model of economic development that developed so dramatically in San Diego is the 'entrepreneurial knowledge economy'. Though this knowledge economy sector is relatively small in Northern Ireland it is an important one, consisting of:

- 30,500 people employed directly
- 2,000 businesses
- £1.8 bn of direct GVA
- £1 bn in direct wages annually
- 27,000 people employed in the wider economy through the supply chain and wages paid
- £300 million of business R&D expenditure

This suggests a platform exists from which to build; the knowledge economy is flourishing already in Northern Ireland. Looking back further in history the Northern Ireland economy has been a world leader in the knowledge economy, be it the linen industry or the ship building industry. Today within the broad knowledge economy sector Northern Ireland enjoys strength in a number of specialist areas each containing world class firms. These specialist areas include:

- Transport and defence
- Software and digital content
- Manufacture of computing and electronics
- Life sciences

Building on these comparative strengths and broadening the sector's reach into new and evolving areas of the knowledge economy will be necessary to realise the full economic potential in Northern Ireland.

Measuring the challenge

The knowledge economy in Northern Ireland is much too small, less than half the size of the sector in the leading regions of the UK across a number of indicators. The benchmarking analysis draws out a number of key messages with regard to the knowledge economy sector in Northern Ireland:

- The sector is approximately half the size of the leading UK knowledge economy, with a third of the business stock that might be expected
- Levels of R&D in the region are well below the levels in leading 'knowledge intensive' regions
- The venture capital market is small and underdeveloped
- Patent applications are low and linked to only a few major firms

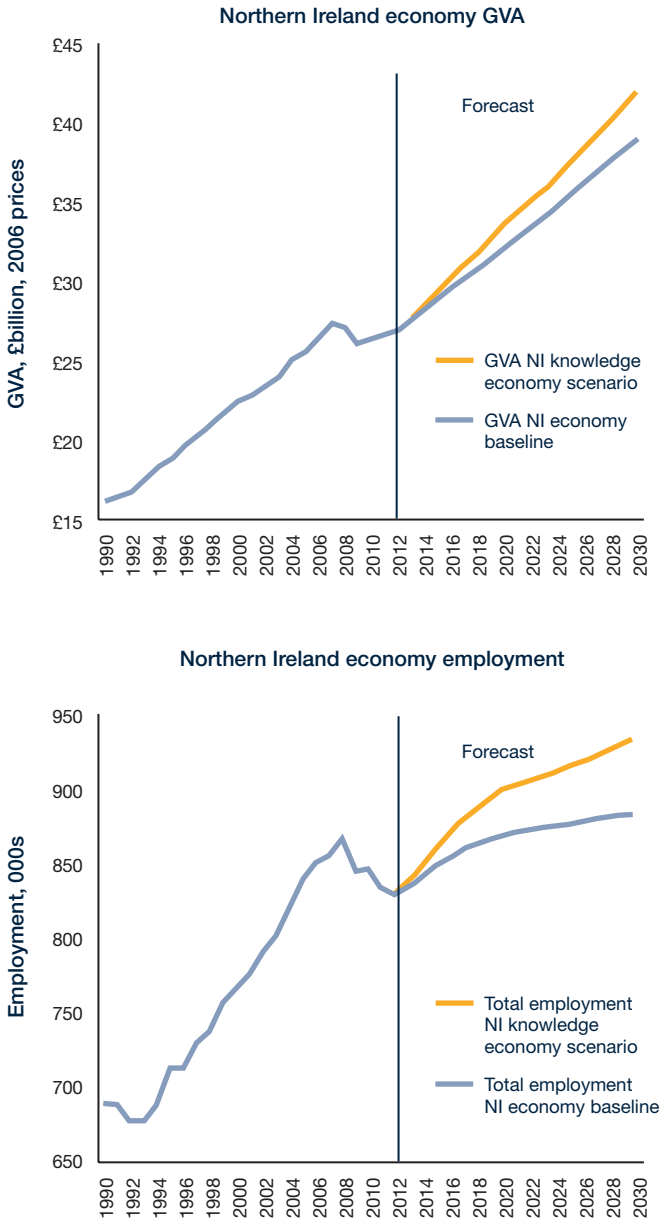
Aspiring to transform

When San Diego set out on its journey to transform its knowledge economy back in the 1960s, it was described as America's "bust" city. In 1985, San Diego had a population of 1.8 million people and faced losing 100,000 jobs. Today it is one of the most successful economies in the US with the knowledge economy now representing 11.2% of the economy's employment and generating a full quarter of the region's wages. Northern Ireland needs to mimic this ambition, and ultimately this success. To do so would have a transformative effect on the Northern Ireland economy; increasing employment, wages and reducing the dependency on the public sector and upon the British taxpayer. Based on the findings of the benchmarking report it is possible to quantify the transformation required to make Northern Ireland the most knowledge intensive region of the UK:

- 25,500 more people employed directly in the knowledge economy
- 6,000 more knowledge economy businesses
- £800 million more spent on R&D annually
- 200 more PhD students per annum
- 42,000 more science and technology graduates working in the economy
- 200 more patent applications annually
- A further 24,000 people employed elsewhere in the economy as a result of the new knowledge jobs

It is customary in Northern Ireland for economic policy to aspire to the average, to move off the bottom, but as San Diego showed aiming for the top is not misguided, just demandingly ambitious. To achieve this step change in the Northern Ireland economy would have a material effect on the economy, as illustrated in this indicative scenario where Northern Ireland achieves its aim of being the UK's leading knowledge intensive region by 2030.

The impact of a knowledge transformation - baseline and scenario forecasts



Ensuring a supportive policy environment

There are many demands of government at present and a shrinking pot of money to meet those demands. The San Diego transformation did not require local government funding (San Diego targeted Federal research funding) and it is the private sector that can lead Northern Ireland's evolution into a leading knowledge region. That does not mean the government cannot play a very effective role in ensuring a fertile soil in which to nurture the knowledge economy. Drawing on the lessons from elsewhere and the evidence in the benchmarking report important government messages include:

- **Research:** Northern Ireland needs to compete to win more than its fair share of UK and EU research funding. Currently Northern Ireland is not even in the game.
- **Ensuring a business friendly tax and policy environment.** This includes a supportive panning system, regulatory framework and firm support network. It may also include specific tax policies (compliant with UK and EU law) to support the sector. Delivering lower corporation tax would be an undoubted help.
- **Promoting and marketing the sector.** Both in terms of Ministerial visits and trade missions but also through the Government investment agency network.
- **Promoting collaboration.** This might include providing government research grants or funding conditional on university links and collaborative bids.
- **Procuring creatively.** The government can look to procure innovative solutions to energy, transport and service delivery challenges helping to promote a vibrant local market for knowledge based firms. The Small Business Innovation Research (SBIR) is a great example of this, a federal fund San Diego tapped into.
- **Ensure pipeline of skills is in place.** Ensuring the knowledge economy has the high end specialist skills it needs to compete globally.
- **Ensuring suitable infrastructure:** both in terms of technology infrastructure but also physical connectivity through the air network.

Acting now

The global economy is moving apace, competitors are growing and all the while the UK's financial position weakens. As a region Northern Ireland relies on the UK for a 'subvention' or transfer of at least £8bn per annum, over 25% of GDP. This is unsustainable and leaves Northern Ireland's economic future largely out of its own hands. There is a need for the private sector to grow and to reduce this dependency, the knowledge economy will be critical in achieving this aim.
Many parts of the sector have performed well during the recession and are already showing their value to the local economy. With a bigger critical mass the impact could be transformative and the future brighter, making Northern Ireland the UK's very own San Diego success story.

The entrepreneurial knowledge economy will be the most difficult to achieve but the most rewarding. The prize is thousands of new high value jobs, thousands of new jobs in support industries, clusters of companies embedded here and not interested in relocating, corporation tax paid by indigenous companies, capital gains tax paid on executive and employee stock options at wealth realisation events such as IPOs and company trade sales and most importantly; an opportunity for any kid with ambition and talent to make it big in Northern Ireland.

There are many versions of what a knowledge economy looks like. This one, the most ambitious, must be the aim.

1. Introduction

1.1 Scope of study

- Oxford Economics were commissioned by the Northern Ireland Science Park CONNECT to develop a baseline report, based on the CONNECT indicators, to track the health of the Northern Ireland knowledge economy on an annual basis against other UK regions, and some international competitors. The report looks to replicate as far close as possible the key innovation metrics used to measure the CONNECT programme in San Diego (see the box below) and where applicable, examine other relevant innovation data.

- These indicators put in place an effective monitoring framework to support the ongoing implementation of the CONNECT programme and help to identify the necessary steps in future to achieve the ambitious goals of the programme.

- The intention is that the results will provide the evidence base upon which the stakeholders of the CONNECT programme can begin to construct an action plan to create the appropriate conditions for knowledge based growth in Northern Ireland. The report will be followed by a conference in Q1 2012 to develop targets against each indicator.

- The majority of data within the report has been sourced from national or international data sources; however, this has been examined and supplemented with additional data where applicable from those involved in the knowledge economy in Northern Ireland. As this is the baseline report it also contains further analysis of contextual data and indicators which are not available for all UK regions and hence cannot be included in those metrics to monitor.

CONNECT

The CONNECT Programme, run from NISP, is based on the highly respected San Diego CONNECT initiative and aims to support potential entrepreneurs and start-up companies within high technology sectors. This support is provided to ambitious high technology companies in a number of ways including business mentoring, networking, interactive workshops and enterprise forums (including a forum for venture capital).

NISP CONNECT brings together a number of stakeholders within the region including the University of Ulster, Queen's University, Belfast and the Agri Food & BioSciences Institute (AFBI).

CONNECT in San Diego has assisted in the formation and development of more than 2,000 companies since 1985 and is a highly regarded regional programme linking inventors and entrepreneurs with the resources they need for commercialisation of products. The programme has been modelled in almost 40 regions around the world.

Today San Diego is home to almost 6,000 technology companies employing almost 140,000 people (11.2% of the total economy). Technology companies represent six percent of the region's employers and they pay 90 percent more than the average salary – a full quarter of the region's wages.

The key indicators used to measure the knowledge economy in San Diego are:

1. **Technology start-ups**
2. **Technology start-ups new job creation**
3. **Technology sector wages and employment**
4. **Venture capital investment**
5. **Merger and acquisition activity**
6. **Private placement investment**
7. **Initial and follow-on public equity offerings**
8. **Patent activity**
9. **Federal and private research grants**

1.2 The innovation agenda in NI – what is the Executive's approach?

- Innovation and creativity are essential for sustainable growth and economic development. There are several core conditions that enable innovation and encourage economic growth, including:
  - Strong standards and effective enforcement of intellectual property protection;
  - Vigorous competition and contestable markets;
  - Open trade and investment in a stable economic environment;
  - A strong and sustainable fundamental research and development infrastructure, sound policies and mechanisms to promote the science-innovation interface;
  - Efficient and transparent regulatory systems;
  - Ethics and the rule of law; and
  - A strong emphasis on education at all levels.

- Innovation policy in Northern Ireland is developed and driven by the Department of Trade and Investment (DETI), whose stated goal is "to grow a dynamic, innovative economy". The central vision of the Regional Innovation Strategy for Northern Ireland (2003) is *'To create a culture and environment within which Northern Ireland will prosper by using its knowledge, skills and capacity to innovate'*. The accompanying 2008-2011 action plan looks to contribute towards addressing the Executives Public Service Agreement (PSA) 1, which seeks to "promote higher value-added activity through innovation and the commercial exploitation of R&D" and progress towards this will be measured in terms of the increase in the average annual growth of Business Expenditure in R&D[1].

- However, the approach to Innovation policy in Northern Ireland is somewhat blurred. Although innovation is prominent in most Government strategy documents, the Regional Innovation Strategy for Northern Ireland[2] was published almost a decade ago. Innovation is concentrated in high-tech industry which is dynamic, ever evolving and rapidly changing with new markets developing all the time (e.g. i-phone application development). However, it is not only the industry that has changed– the Northern Ireland. economy is fundamentally different than a decade ago and faces an entirely different set of challenges in today's global marketplace. Arguably, in today's economic climate without the cushion of a public sector with an abundance of available finance, a strong innovation policy with a clear strategic direction led by the private sector is more important than ever.

- The Executive has already taken the important step of making the economy the top priority in its Programme for Government (PfG), with halving the private sector productivity gap an overarching policy. If Northern Ireland is to achieve the convergence in productivity and living standards with other parts of the UK (as outlined in the PfG), then there needs to be a much greater emphasis on value added investments and growing the knowledge economy, both for indigenous businesses and also as a means of attracting and retaining foreign investors.

- The Independent Review of Economic Policy in Northern Ireland placed a particular emphasis on prioritising Innovation and R&D in the future to meet the goals in the PfG. The PfG will soon be out of date as the associated actions covered the period 2008-2011.

- A new Economic Strategy for Northern Ireland is expected in Autumn 2011 which will focus on competitiveness and short term job creation. It will consider the possible implications of Corporation tax powers if granted and the role of exports in generating economic growth. There is likely to be a strong emphasis on innovation and the knowledge economy (in its widest sense) driving economic growth, although other key challenges such as worklessness will be as important.

- The rebalancing agenda in the UK is gathering pace as an important pillar for future economic growth. Despite Northern Ireland's strong level of dependency on the public sector, activities within the private sector demonstrated by manufacturing, agriculture and tourism activities are fairly diverse. In that regard Northern Ireland's favourable wage rates, rates incentives for manufacturing and skill sets presents a good foundation for private sector growth.

1 Increase by 8% the average annual growth in BERD expenditure in Invest NI client companies with less than 250 employees; and increase by 5% the average annual growth in BERD expenditure in Invest NI client companies with greater than 249 employees.

2 DETI (2003) Think, Create, Innovate: The Regions Economic strategy for Northern Ireland.

- Today, Northern Ireland faces severe economic and social challenges. The 2008-10 economic downturn has led to a fall in output and employment, rising unemployment and soaring public debt has led the UK Government to curb public spending growth, which will have a disproportionately large impact on the NI economy given its high dependence on the public sector.

- To recover, Northern Ireland needs to find new and sustainable sources of growth. Future growth must therefore increasingly come from innovation-induced productivity growth. Innovation is a key route to boosting productivity although it should be recognised that it does not always create large numbers of direct employees. Importantly, the potential devolution of corporation tax powers in Northern Ireland could also have important implications for the knowledge economy, potentially affecting the location choices of global firms which often tend to be more R&D intensive than indigenous companies in Northern Ireland.

1.3 What is a knowledge economy?

- Simply put, a knowledge economy is an economy that is fuelled by innovation, technology and talent. It is characterised by the growth of high wage jobs, the development of high growth industries and the existence of high economic impact multipliers. In the knowledge economy there are large numbers of significant start-up successes, successive waves of new technologies and extremely active networks of people and organisations. Such an economy adapts quickly to change, and effectively responds to market opportunities.

- There are many different definitions of the knowledge economy in terms of specific industrial classifications used by national and international organisations and by academics. Importantly, the definition used here to monitor the size of the knowledge economy is in keeping with the characteristics of the CONNECT programme and the types of companies it assists and does not include the full breath of services that are often captured in the wider uses of the term 'knowledge economy' such as financial and businesses services, which in Northern Ireland's case are typically dominated by 'low innovation' activities such as retail banking and call centres.

1.3.1 CONNECT Sector definition

- In this report the knowledge economy is defined as an aggregation of the following sectors based on the CONNECT report, and represent research intensive sectors that where new ideas, new products and new processes are key determinants of competitiveness[3].
  - Pharmaceuticals and biotechnology/life sciences;
  - Medical devices;
  - Software & digital content;
  - IT services;
  - Telecommunications;
  - Computing and advanced electronics;
  - Other technical services; and,
  - Aerospace and other transport equipment.

- These sectors tend to be high wage, high productivity and more R&D and export intensive than other sectors of the economy. Job creation and business development in these sectors has a more significant economic impact and can help the Northern Ireland economy achieve its objective of closing the productivity gap with the rest of the UK to raise overall prosperity in Northern Ireland.

3 Annex A Technical Notes explains the sector definition in more detail and lists the relevant SIC codes. The definition of the knowledge economy has been devised based on the sector definitions used in the CONNECT programme, which has involved mapping UK Standard Industrial Classification (SIC) codes against the NAICS codes used in the CONNECT programme. In practice the knowledge economy is not measured against this narrow definition for some indicators as the data does not always follow SIC codes (e.g. venture capital data). Also for some indicators it is necessary to present the data against European or International definitions of the knowledge economy.

1.4 Structure of this report

- The report is structured as follows:
  - **Chapter 2: Knowledge Economy**, which examines the current size of the knowledge economy in Northern Ireland, in terms of employment, start-up activity and business stock.
  - **Chapter 3: Investment Activity**, which provides an overview of flows of private equity and venture capital investment and other forms of investment into Northern Ireland.
  - **Chapter 4: R&D and Research Activity**, which looks at the current levels of R&D, research grants, spin outs and other metrics of research activity in Northern Ireland.
  - **Chapter 5: Innovation and Patent Activity**, which examines European patent data and a recent study into patent activity in Northern Ireland.
  - **Chapter 6: Conclusions and Key Metrics**, provides analysis of the key indicators to be used to monitor the knowledge economy moving forwards.

2 The knowledge economy

- This chapter examines the current size of the knowledge economy, in employment and business number terms, and start up activity. These indicators focus on using the CONNECT sector definition but other wider metrics are also examined including Eurostat employment definitions (for international comparisons), entrepreneurial activity across the economy and wage levels across relevant occupations.

- The CONNECT sector definition of the knowledge economy, as outlined in Annex A, is based on 2007 Standard Industrial Classification (SIC) codes at a 5 digit level. This has restricted analysis reliant on SIC codes to 2009-2010 as data for previous years uses 2003 SIC codes. It has not been possible to map the 2007 codes to 2003 codes accurately due to considerable changes in sector codes.

2.1 Skills and external focus

- The knowledge economy tends to be more export focused than other sectors of the economy, and exports will be a major factor in Northern Ireland's recovery from the recession.

- Aerospace and transport equipment represents one of the most export orientated sectors in the economy, with the sector selling over 90% of its sales in export markets- accounting for almost a fifth of all manufacturing exports. Electrical equipment is another expansion within Northern Ireland, accounting for 12% of total exports and exporting over four-fifths of its output.

- Other sectors within the knowledge economy that are important exporters include computer, electronics and optical equipment and pharmaceuticals, which export over 70% of their output, accounting for 11% and 3% of Northern Ireland manufacturing exports respectively.

Table 2.1: Share of Sales, External Sales and Exports by Industrial Sector, 2009/10 (£ million)

Industrial sector	Total sales, £m	% total sales	External sales, £m	% external sales	Exports, £m	% all Northern Ireland exports	Export intensity (exports as % of total sales)
Other transport equipment	£1,076	6.9%	£1,050	8.6%	£991	18.9%	92.1%
Electrical equipment	£765	4.9%	£727	5.9%	£642	12.3%	83.9%
Computer, electronic and optical	£699	4.5%	£683	5.6%	£573	10.9%	82.0%
Chemicals and chemical products	£440	2.8%	£344	2.8%	£323	6.2%	73.4%
Pharmaceuticals	£187	1.2%	£165	1.3%	£134	2.6%	71.7%
Machinery and equipment n.e.c.	£717	4.6%	£574	4.7%	£433	8.3%	60.4%
Rubber and plastics	£720	4.6%	£564	4.6%	£377	7.2%	52.4%
Other manufacturing	£93	0.6%	£59	0.5%	£42	0.8%	45.2%
Paper and paper products	£270	1.7%	£170	1.4%	£118	2.3%	43.7%
Wearing apparel	£71	0.5%	£55	0.4%	£24	0.5%	33.8%
Wood and products of wood & cork	£295	1.9%	£156	1.3%	£93	1.8%	31.5%
Repair and installation of equipment	£62	0.4%	£39	0.3%	£19	0.4%	30.6%
Furniture	£240	1.5%	£108	0.9%	£54	1.0%	22.5%
Basic metals	£18	0.1%	£4	0.0%	£4	0.1%	22.2%
Motor vehicles and trailers	£335	2.1%	£270	2.2%	£69	1.3%	20.6%
Fabricated metal products	£771	4.9%	£421	3.4%	£148	2.8%	19.2%
Printing & reproduction of recorded media	£151	1.0%	£46	0.4%	£28	0.5%	18.5%
Non-metal minerals	£497	3.2%	£198	1.6%	£90	1.7%	18.1%
Food, Beverages & tobacco	£8,076	51.5%	£6,500	52.9%	£1,038	19.8%	12.9%
Textiles	£1,674	10.7%	£143	1.2%	£39	0.7%	2.3%
Manufacture of leather & related products	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Coke & refined petroleum products	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total	**£15,669**	**100.0%**	**£12,278**	**100.0%**	**£5,240**	**100.0%**	**33.4%**

Source: Manufacturing sales and export survey DETI, 2009/10. Note totals may not add due to rounding.

- Although the data presented in the table does not directly correlate to the 5-digit SIC code definitions used to define the CONNECT knowledge economy, it provides a useful indicator of the importance of the knowledge economy in the Northern Ireland economy. The pharmaceutical; computers & electronics and optical equipment; electrical equipment; machinery & equipment; and other transport equipment sectors combined account for over half of all Northern Ireland export sales.
- The knowledge economy is also more graduate intensive than other sectors as shown below. The sectors shaded in darker blue are within the CONNECT definition and have some of highest rates of graduate intensity. For instance 88% and 84% of the total workforce for web portal design and research & experimental development on biotechnology respectively. Overall eight of the top 25 graduate intensive sectors are within the CONNECT knowledge economy definition.

Table 2.2: Graduate intensive sectors

Rank	4 Digit SIC code & sector description	Graduate intensity (%)
1	63.12 Web portals	88%
2	72.11 Research & experimental development on biotechnology	84%
3	72.20 R&D on social science and humanities	82%
4	18.20 Reproduction of recorded media	77%
5	70.21 PR & communication activities	75%
6	64.30 Trusts, funds & similar financial	71%
7	72.19 Other R&D on natural sciences & eng	67%
8	90.03 Artistic creation	67%
9	58.11 Book publishing	66%
10	74.30 Translation and interpretation activities	62%
11	71.11 Architectural activities	61%
12	94.91 Activities of religious organisations	61%
13	90.02 Support activities to performing arts	61%
14	73.12 Media representation	61%
15	74.90 Other professional, scientific & technical act8ivities n.e.c.	60%
16	69.10 Legal activities	59%
17	70.22 Bus & other management consultancy activities	59%
18	90.01 Performing arts	59%
19	58.21 Publishing of computer games	58%
20	91.02 Museum activities	58%
21	26.52 Manufacture of watches and clocks	58%
22	62.02 Computer consultancy activities	58%
23	46.51 Wholesale comp, comp peripheral equipment& software	57%
24	62.01 Computer programming activities	57%
25	60.10 Radio broadcasting	57%

Source: Labour Force Survey (LFS)

2.2 Employment

2.2.1 CONNECT definition

- In 2009 the knowledge economy, according to the CONNECT based definition, was small in the UK, accounting for just 5.7% of total employment, which compares to 14.8% in wholesale & retail, 20% across all business and professional services and 28.4% in the public sector (administration, education & health). Although the sector is larger in employment terms than construction (4.7%), transport and storage (4.6%) and finance and insurance activities[4] (3.9%).

- In Northern Ireland, the total level of employment in the knowledge economy is approximately 30,600 persons, which represents 4.4% of total employment. This compares to 35.6% for the public sector (administration, education & health), 18.1% for wholesale & retail, 4.7% for construction and 2.8% for finance & insurance activities.

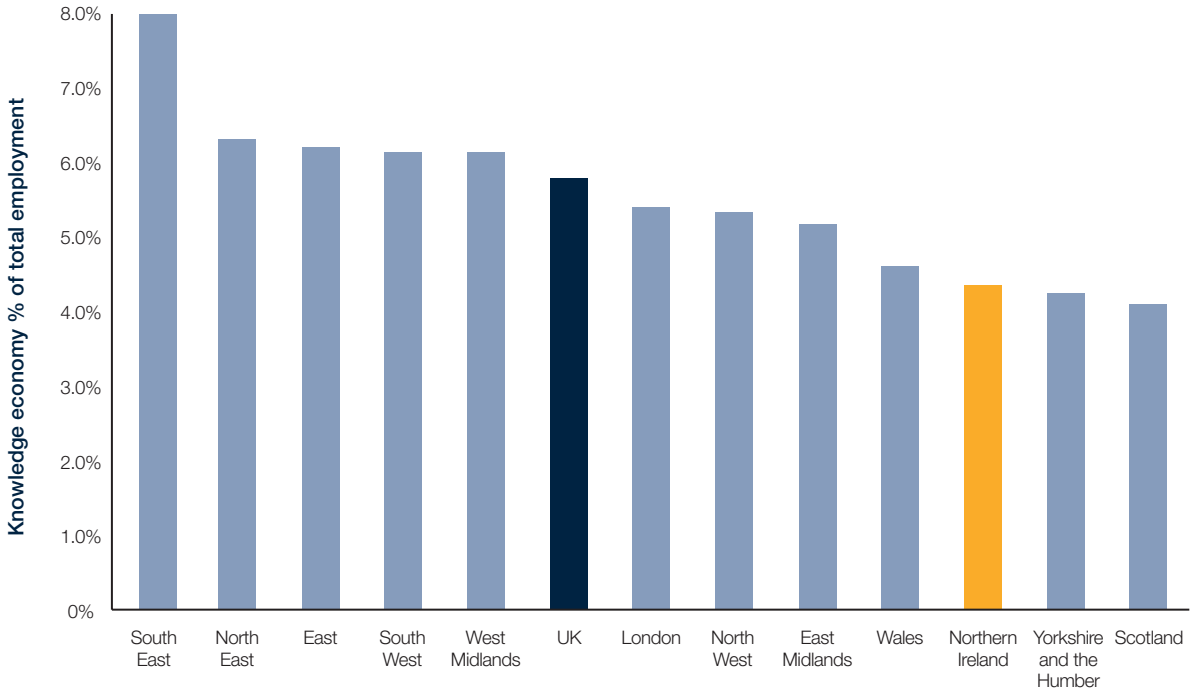
- In relative terms the knowledge economy in Northern Ireland is one of the smallest of all UK regions. Only Yorkshire and the Humber and Scotland have a smaller proportion of employment in the knowledge economy. Northern Ireland's low ranking is unsurprising, as its share of total employment is skewed by the region's large public sector base. There are a number of factors that partially explain why the private sector is small in Northern Ireland such as the legacy of the troubles coupled with the loss of employment in traditional sectors, the region's relative peripherality to the rest of the UK, transport infrastructure and relatively higher energy costs.

- The South East has the largest knowledge economy at 8.1% of total employment followed by the North East, East, the South West and the West Midlands, which have levels above the UK average. The high levels in the South East and East are unsurprising given the presence of the Universities of Cambridge and Oxford and intensity of research in the area. London's ranking is relatively low due to its overreliance on financial and business services which are not included in the CONNECT definition of the Knowledge economy.

- The 2008 employment data, not presented here, also shows the knowledge economy to be largest in these regions although the East outperforms the North East, which is more in line with what would be expected given the characteristics of these economies. It appears from examining the data by sub-sector that the surprisingly high level of employment level in the North East is heavily skewed by a large telecommunications manufacturer.

4 Finance and insurance activities is a subset of business and professional services.

Figure 2.1: Employment in the knowledge economy as % of total[5] employment, 2009



Source: Business Register and Employment Survey (BRES), ONS and Census of Employment, DETI

- To put these figures in context, the knowledge economy[6] in 2010 in San Diego accounted for approximately 11% of total jobs (as of Q4 2010)[7].
- To reach a similar concentration in Northern Ireland (assuming the total level of employment remains similar), employment in the knowledge economy sector would need to grow in absolute terms by approximately 45,700 or alternatively to reach the level in the South East (8.1%), the number of jobs would need to affectively double.
- Due to disclosure issues, employment data has been estimated for Communications, Other Technical Consultancy Services and Software & Digital Content for Northern Ireland. The largest sub-sector and which has a higher proportion of employment than the UK average is transport and defence and reflects the presence of aerospace companies such as Bombardier and BE Aerospace and their tier 1 suppliers. In addition two other sectors represent a higher proportion of total employment than the UK- computing and advanced electronics, and software and digital content (although this sector has been estimated[8]).

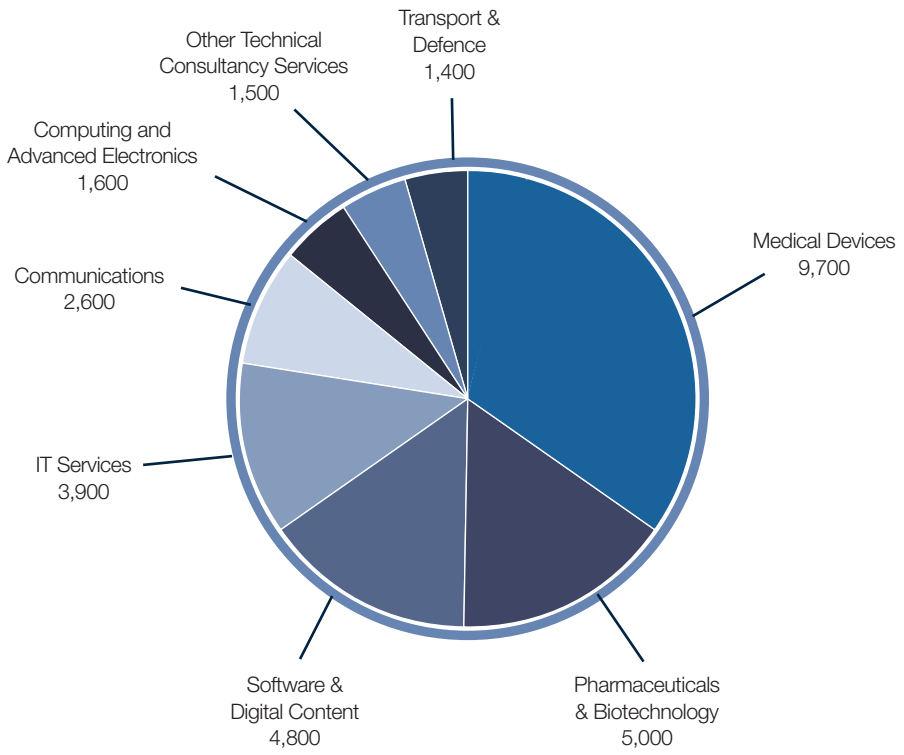
5 The high proportion of employment in the knowledge economy in the North East appears very high. The data has been investigated and appears to reflect high levels of employment in telecommunications, which could represent one or two large companies.

6 Please note that the innovation economy in San Diego does follow a slightly different definition, which the definition here is based on. See Annex A for further details.

7 Connect Innovation Report, Fourth Quarter 2010 and full year 2010 summary, Connect, 2010.

8 These figures have not been disclosed by NISRA.

Figure 2.2: CONNECT sectors, 2009



Source: Census of Employment, DETI. Figures for Software & Digital Content, Other Technical Consultancy Services and Communications have been estimated based on other SIC codes and using employer listings.

Table 2.3: CONNECT sectors as % of total employment, 2009

	As % of total employment	
	Northern Ireland	UK
Communications	0.2% (e)	0.8%
Computing and Advanced Electronics	0.7%	0.3%
IT Services	0.4%	1.5%
Medical Devices	0.6%	0.8%
Other Technical Consultancy Services	0.2%(e)	0.6%
Pharmaceuticals & Biotechnology	0.2%	0.2%
Software & Digital Content	0.7%(e)	0.4%
Transport & Defence	1.4%	1.2%
Knowledge economy	4.4%	5.7%

Source: Census of Employment 2009, DETI. BRES for UK figures. Figures for Software & Digital Content, Other Technical Consultancy Services and Communications have been estimated based on other SIC codes and using employer listings.

- Table 2.4 below explores the CONNECT sectors by region - there are two sectors where NI has a relatively high level of employment compared to other regions, the manufacture of computing and electronics and software & digital content, which both account for 0.7% of total employment, which for both sectors is higher or equal to all other regions. Examples of large companies likely to be captured in computing and electronics are Schrader Electronics and FG Wilson, which employ approximately 700 and 2,300 persons respectively[9]. Within software & digital content it is business and domestic software development activities which dominate the overall sector, representing companies such as Citigroup and Fidessa.

Table 2.4: CONNECT sectors as % of total employment across all UK regions, 2009

	South East	North East	East	South West	West Midlands	UK	London	North West	East Midlands	Wales	Northern Ireland	Yorkshire & The Humber	Scotland
Communications	1.1%	1.3%	0.8%	0.9%	0.7%	0.8%	0.9%	0.7%	0.4%	0.7%	0.2%	0.8%	0.5%
Computing and Advanced Electronics	0.3%	0.4%	0.4%	0.3%	0.2%	0.3%	0.1%	0.2%	0.4%	0.4%	0.7%	0.2%	0.2%
IT Services	2.7%	0.9%	1.3%	1.2%	1.5%	1.5%	2.4%	1.1%	1.2%	0.6%	0.4%	0.9%	1.0%
Medical Devices	1.3%	0.6%	1.5%	0.9%	0.4%	0.8%	0.6%	0.6%	0.5%	0.6%	0.6%	0.5%	0.7%
Other Technical Consultancy Services	0.7%	0.7%	0.8%	0.6%	0.7%	0.6%	0.7%	0.5%	0.6%	0.5%	0.2%	0.2%	0.1%
Pharmaceuticals & Biotechnology	0.2%	0.3%	0.2%	0.2%	0.0%	0.1%	0.0%	0.3%	0.1%	0.1%	0.2%	0.2%	0.1%
Software & Digital Content	0.8%	0.2%	0.3%	0.2%	0.3%	0.4%	0.6%	0.3%	0.3%	0.2%	0.7%	0.3%	0.2%
Transport & Defence	0.9%	1.9%	0.9%	1.8%	2.3%	1.2%	0.2%	1.7%	1.7%	1.6%	1.4%	0.8%	0.7%
Knowledge economy	8.1%	6.3%	6.2%	6.2%	6.1%	5.7%	5.4%	5.3%	5.1%	4.6%	4.4%	4.4%	4.2%

Source: Census of Employment 2009, DETI and BRES, 2009. Figures for Communications, Software & Digital Content and Other Technical Consultancy Services have been estimated.

9 Equality Commission (2010) Monitoring Report No. 20 A profile of the Monitored Northern Ireland Workforce.

2.2.2 EU High-tech employment definition

- To understand how NI compares to Ireland and other selected European countries, the EU definition of High technology sectors has been used, which is a broader definition of the knowledge economy in comparison to the CONNECT definition used above (see Annex A for the full list but the differences are largely due to high technology services being included in the Eurostat definition).
- The European countries selected are considered small open economies that are appropriate benchmarks for Northern Ireland[10]. There is a new data series for this indicator from 2009 onwards, which has led to substantial differences with the historical data. Therefore in order to show a consistent series, only data for 2000-2008 is presented.

Table 2.5: High-technology Sectors as % of total employment (Eurostat), European comparisons, 2000-2008

	2000	2001	2002	2003	2004	2005	20006	2007	2008
Finland	6.4%	6.6%	6.7%	6.4%	6.5%	6.6%	6.7%	6.7%	6.8%
Ireland	7.4%	7.6%	7.4%	6.8%	6.3%	6.3%	6.4%	6.2%	6.3%
Sweden	6.6%	6.9%	6.7%	5.9%	5.8%	6.2%	6.0%	5.9%	n/a
Denmark	6.1%	5.9%	5.8%	5.5%	5.1%	5.2%	5.2%	5.3%	5.2%
Norway	4.4%	5.1%	4.7%	4.4%	4.4%	4.3%	4.4%	4.3%	4.4%
Iceland	4.5%	5.6%	5.1%	4.8%	5.0%	5.0%	4.5%	4.4%	4.2%
Austria	4.9%	4.9%	5.2%	5.0%	3.9%	4.3%	4.1%	3.9%	4.0%
Estonia	4.3%	4.4%	3.4%	3.7%	4.2%	3.7%	3.6%	3.6%	3.9%
United Kingdom	5.9%	6.2%	5.7%	5.6%	5.5%	5.4%	5.2%	5.3%	5.1%
South East	8.5%	8.8%	8.2%	8.2%	7.5%	7.2%	8.0%	7.8%	8.0%
East of England	7.0%	7.7%	7.1%	6.4%	6.3%	6.9%	6.4%	6.3%	6.0%
London	6.3%	7.9%	6.9%	6.5%	6.7%	5.8%	5.7%	6.4%	5.8%
West Midlands	5.2%	5.2%	5.3%	5.0%	5.3%	5.5%	4.7%	5.0%	4.8%
Scotland	6.0%	6.0%	5.0%	5.5%	4.9%	4.1%	4.5%	4.8%	4.5%
North East	4.7%	5.8%	4.4%	4.1%	4.3%	4.3%	4.5%	4.9%	4.4%
South West	5.6%	5.6%	5.7%	5.6%	5.0%	5.4%	4.7%	4.9%	4.3%
East Midlands	4.4%	5.1%	4.6%	4.3%	4.5%	4.6%	4.4%	3.7%	4.2%
Northern Ireland	3.6%	3.4%	3.9%	3.6%	3.5%	3.4%	3.1%	3.4%	4.0%
Wales	5.1%	4.6%	4.4%	3.5%	5.0%	4.5%	4.5%	3.4%	3.8%
North West	5.1%	4.8%	4.6%	4.9%	4.6%	4.7%	4.3%	4.3%	3.7%
Yorkshire & The Humber	3.9%	4.2%	3.8%	4.3%	3.8%	4.2%	3.7%	4.1%	3.4%

Source: Eurostat, 2008 & 2009. Different data series 2005-2007. US figures derived from OECD.

10 This table is to be supplemented with data for the United States to provide further context.

- On this indicator in 2008 the UK had an average proportion of employment in high-technology sectors compared to those selected European countries at 5.1%, with the share decreasing over the past decade as the UK economy became more reliant on finance and business services, as well as debt fuelled sectors – public sector, retail, construction. The shares of high-technology employment in Finland, Ireland and Sweden are the highest – emphasizing success in economies with strong innovation infrastructures underpinned by innovation policy with a clear strategic direction.

- The case of Ireland being a top performer on this metric represents an opportunity for Northern Ireland companies given such close geographical proximity. There is potential for development through either cross border trade, supply chain linkages or through 'collaborative innovation networks' in ventures designed to penetrate global markets. The difference between the ROI and Northern Ireland may also be partially attributable to the differences in tax rates and a main argument for lowering Northern Ireland's corporation tax is to provide a more level playing field.

- At a UK regional level clearly the South East, East and London have consistently had the highest proportions of employment in high technology sectors, which represents the 'golden triangle' of research activities around the University of Oxford, University of Cambridge and London universities and associated private sector activity (an area which attracts a huge proportion of UK venture capital activity in life sciences). The share of high technology employment in Northern Ireland is low compared to most regions except Wales, the North West and Yorkshire and the Humber. London now ranks higher on this measure as the Eurostat definition has a broader definition of high tech services than those within the CONNECT cluster definitions.

2.3 GVA, productivity and wider economic contribution

- The Gross Value Added (GVA) for the knowledge economy (the CONNECT definition) and wider economic impacts (indirect and induced) have been calculated using Oxford Economics regional economic model and Input-Output tables for Northern Ireland.

- Overall total GVA is estimated to be £1.8 billion for the knowledge economy and productivity (GVA per employee) is £60,013, which is almost double the Northern Ireland economy average (£30,934). This clearly emphasises the high value of innovation led activities within the sector.

- The wider employment impacts including indirect impacts (those supported further down the supply chain) and induced impacts (employment and activity supported by the incomes of those directly or indirectly employed) are estimated to be approximately 27,000, which gives a multiplier value of around 1.9. In other words for every 10 new jobs created in the sector around 9 additional jobs can be expected to be created through the supply chain and wages paid.

Table 2.6: Direct, indirect & induced employment and GVA impacts of the CONNECT sectors, 2009

	GVA, £billion	Employment
Direct contribution	£1.8	30,580
Indirect & Indirect contributions	£1.0	27,008
Total direct, indirect & induced impacts	£2.8	57,588

Source: Oxford Economics

2.4 Total business stock

- The Knowledge economy (the CONNECT definition) in Northern Ireland, according to Inter Department Business Register (IDBR), accounted for only 2.5% of total business stock (including local units[11]) in 2009 and 2010.

Table 2.7: Northern Ireland Business Stock - CONNECT Sectors

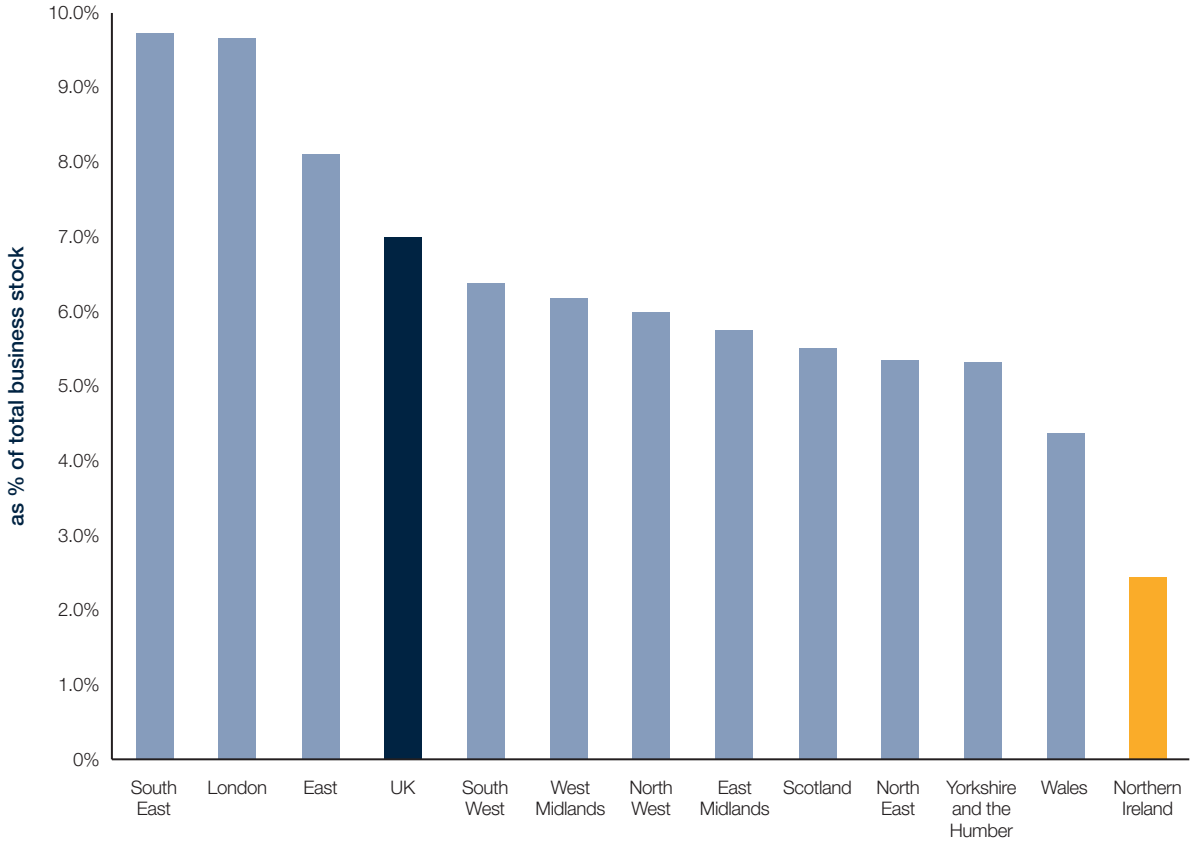
	2009	as % of total business stock	2010	as % of total business stock
Medical Devices	155	0.2%	160	0.2%
Pharma/Biotechnology	20	0.0%	20	0.0%
Software/Digital Content	480	0.6%	465	0.6%
IT Services	450	0.5%	410	0.5%
Communications	100	0.1%	105	0.1%
Computing & Advanced Electronics	60	0.1%	55	0.1%
Other Technical Consultancy Services	635	0.7%	655	0.8%
Transport/Defence	250	0.3%	205	0.2%
Total	**2,150**	**2.5%**	**2,075**	**2.5%**

Source: IDBR, 2009 & 2010. Data for local units so includes all enterprises sites (e.g. an enterprise may have a shop and a factory site).

- Comparatively, the proportion of businesses within the CONNECT sectors is much lower than all other UK regions and the UK average of 7.1%. There is considerable growth needed in the technology business base to reach the levels experienced in those regions topping the analysis - the South East (9.7%), London (9.6%) and the East (8.1%). The proportion is partially very low in Northern Ireland as relative to the UK there are a large number of agriculture businesses (19.4% of total stock compared to 5.4%).

11 A local unit is an individual site (factory, shop, office, etc.) at which an enterprise conducts its business and therefore an enterprise may have more than one local unit.

Figure 2.3: Business stock of CONNECT sectors, as % of total regional business stock, 2010



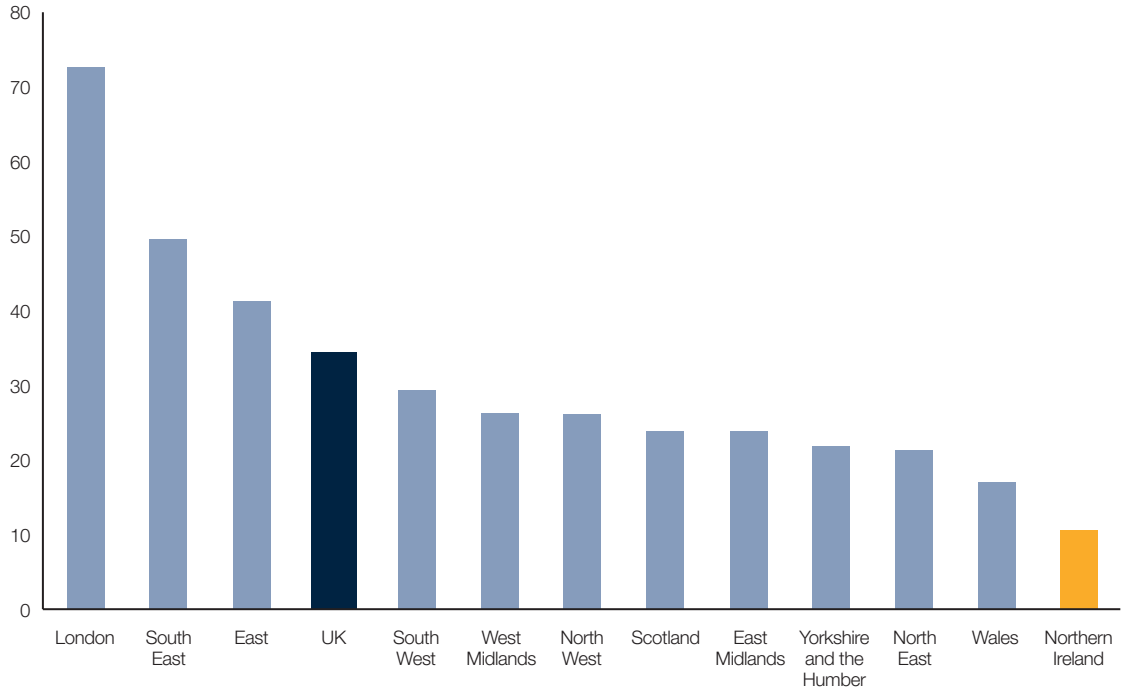
Source: IDBR, 2010. Data for local units so includes all enterprises sites (e.g. an enterprise may have a shop and a factory site).

2.5 New business start ups

- The level of business start ups per 100,000 population in the knowledge economy are clearly highest in London, the South East and East, the regions driving the UK level of 35.5 per 100,000 population in 2009. The level in Northern Ireland is the lowest by a considerable margin at just 11.2 per 100,000 population.

- It is important to note that businesses within this indicator are work place based therefore London will always appear very high because of the high levels of business activity and in-commuting.

Figure 2.4: Knowledge economy (CONNECT) business start-ups per 100,000 population across the UK, 2009

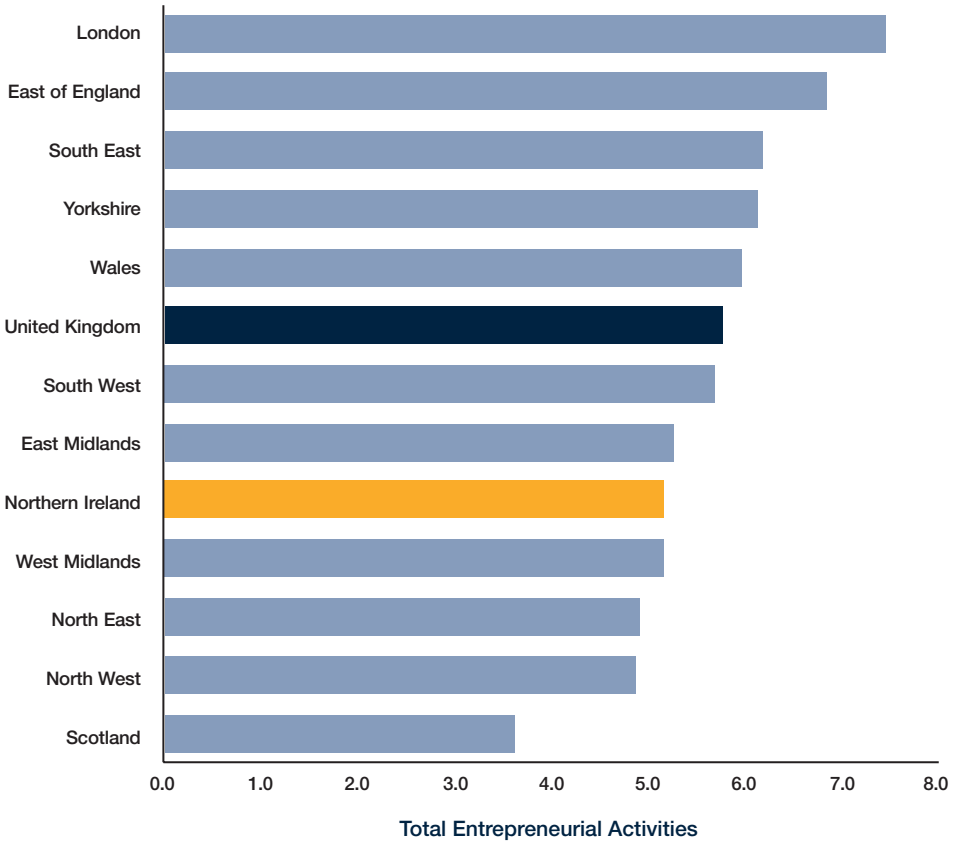


Source: IDBR, 2009

- However, Northern Ireland performs slightly better when entrepreneurship is measured by the Global Entrepreneurship Monitor (GEM). This is a research programme focusing on entrepreneurs rather than the businesses that they run. GEM measures the entrepreneurial activity of people from intention to closure. The first two stages of active business development, the nascent entrepreneur stage and the new business owner-manager stage, are combined into one index of Total early stage Entrepreneurial Activity (TEA).

- On this measure Northern Ireland ranks above the West Midlands, North East, North West and Scotland (Figure 2.5).

Figure 2.5: Total Entrepreneurial Activity, 2009



Source: IDBR, 2009

- Examining business start ups within the CONNECT sectors (Table 2.8 overleaf) reveals that NI has the smallest business start-up rate for all sub-sectors.

Table 2.8: Knowledge economy start ups per 100,000 population, 2009

	London	South East	East	UK	South West	West Midlands	North West	Scotland	East Midlands	Yorkshire and The Humber	North East	Wales	Northern Ireland
Medical Devices	1.7	1.5	1.5	1.1	1.1	0.6	0.7	0.7	0.7	0.9	1.0	0.8	0.8
Pharma/ Biotechnology	0.4	0.4	0.4	0.2	0.1	0.3	0.1	0.2	0.1	0.2	0.2	0.2	0.0
Software/ Digital Content	18.6	12.6	8.6	8.1	6.3	5.6	6.2	4.3	4.8	4.5	4.4	3.5	2.0
IT Services	34.4	21.5	16.1	14.1	11.4	9.7	8.8	7.2	8.8	7.8	5.8	5.5	3.1
Communications	2.5	2.0	2.0	1.4	0.8	1.4	1.2	0.6	1.0	0.9	0.8	0.8	0.8
Computing & Advanced Electronics	0.8	0.7	1.0	0.6	0.5	0.5	0.5	0.3	0.6	0.5	0.4	0.3	0.3
Other Technical Consultancy Services	14.2	10.6	10.1	9.4	8.8	7.9	8.7	11.1	7.4	7.0	8.3	5.7	3.6
Transport/Defence	0.4	0.9	0.9	0.7	1.2	1.1	0.7	0.4	0.8	0.8	0.6	0.3	0.6
Total - Knowledge economy	**73.1**	**50.1**	**40.7**	**35.5**	**30.1**	**27.1**	**27.0**	**24.7**	**24.2**	**22.4**	**21.5**	**17.2**	**11.2**

Source: IDBR, 2009. Data for PAYE or VAT registered enterprises.

Employment in new business start ups

- The total level of employment recorded by IDBR for Northern Ireland business start ups (within the CONNECT sector) was approximately 350 in 2009. Data was not available for three of the sectors as it was deemed disclosive. The 2009 data is also likely to be affected by the recession and future updates should bear this in mind when measuring progress.

- The number of jobs per start up, using a rather crude average measure, are relatively low at 1.7 overall, which is very similar to the other regions and reflects the nature of business start ups in the innovation sector.

Table 2.9: Employment in new business start ups, Northern Ireland, 2009

	Births	Employment	Average business size
Medical Devices	15	n/a	n/a
Pharma/Biotechnology	0	n/a	n/a
Software/Digital Content	35	82	2.3
IT Services	55	78	1.4
Communications	15	27	1.8
Computing & Advanced Electronics	5	n/a	n/a
Other Technical Consultancy Services	65	95	1.5
Transport/Defence	10	n/a	n/a
Total	**200**	**347**	**1.7**

Source: IDBR, 2009

San Diego's Economic Transformation

- San Diego is ranked as the eighth largest city in the United States, with a population of 1.3 million. In recent times, San Diego has reformed and revitalised its economy, following a period of economic decline in the 1950s-60s, and is now a hub for innovation based businesses, particularly in terms of production of communication equipment (wireless cellular technology), pharmaceutical/biotechnology and medical devices manufacturing and software development.
- Through the 1930s-60s, the local economy was dominated by defence manufacturing, small farms, tourism and real estate speculation. The city was characterised by a tradition of failed entrepreneurial and economic development efforts and there were no large corporations based in the city. The post war economy consisted of declining local military and aerospace industries due to budget cutbacks. By the 1960s San Diego was identified by Time magazine as America's "bust" (failed) city- there was a serious need for economic diversification before the economy faced further turmoil.
- Economic development in the city changed focus to tackle these challenges and the transformation of San Diego was influenced by a number of key factors, including:
  - The emergence of a number of key research institutions, particularly the University of California, San Diego. This followed a focus on R&D after World War II. A number of key technology companies emerged from the University in IT, Life sciences and environmental technologies.
  - Strong leadership from small businesses. As there was no history of large business investment in the city or corporate foundations the economic transformation relied on the competitiveness and ambition of smaller businesses.
  - Collaboration among business leaders, enterprises and economic development officials to create a new (albeit uncertain) economic future.
  - Existing competitive capabilities within defence contracting and manufacturing.
- Business leaders created the environment that would incubate and grow these world class R&D institutions, the large number of small high growth technology companies (particularly spin outs) to build up clusters of companies, suppliers and professional services. This included providing leadership, contributing time and money, sharing contacts and networks.
- Most regions across the US, including San Diego, have realised that they need to adopt a comprehensive economic development strategy if they are to achieve job and income growth for a broad spectrum of their population. The strategy for San Diego had seven essential elements:
  - Investment in infrastructure
  - A focus on the manufacturing sector
  - Encouragement of creativity and constant innovation
  - Leveraging the diverse roles of government to achieve broad economic gains
  - Aligning education and workforce systems with sectoral strategies
  - Involvement of the labour community
- The CONNECT programme in San Diego, established in 1985, has helped in assisting this transformation of the San Diego economy through facilitating the convergences of scientific invention, entrepreneurship and smart capital to accessing technology developments in all fields, while providing business planning and marketing intelligence and access to diverse forms of finance.
- To conclude San Diego's lessons learned and previous experience would suggest that to develop and diversify the economy towards high growth sectors requires linking inventors and entrepreneurs through a comprehensive business network infrastructure and developing clusters and entrepreneurial capabilities in those sectors where existing research capabilities are strongest.

2.6 Wages

- The average (mean) annual wage for Northern Ireland in 2010 was approximately £21,700 for all workers across the economy, according to the Annual Survey of Hours and Earnings (ASHE) dataset. Using data from the Labour Force Survey (LFS) the average annual wage for Northern Ireland in the knowledge economy (CONNECT definition) is estimated to be approximately £32,802[12], representing a wage premium of £11,323 for jobs in the sector (or alternatively wages are 52% higher).
- Examining wage levels in the knowledge economy by region shows that the South East, East Midlands and East have the highest wage premiums. In Northern Ireland the wage premium is the 6th highest. London, despite having the highest wage in the knowledge economy, has one of the lowest premiums due to the high wages within financial services, which drives up the average wage across the whole economy.

Table 2.10: Annual mean wages in knowledge economy (CONNECT definition) and wage premium

Region	Knowledge economy (CONNECT) Annual salary, £		Wage premium ratio	
	2009	2010	2009	2010
South East	£48,625	£49,247	1.61	1.65
East Midlands	£37,178	£38,599	1.51	1.59
East	£42,755	£44,383	1.53	1.58
Wales	£29,350	£35,378	1.31	1.58
South West	£37,391	£37,576	1.56	1.57
Northern Ireland	£31,791	£32,802	1.46	1.52
West Midlands	£35,084	£35,439	1.49	1.49
North West	£36,519	£35,709	1.53	1.48
North East	£30,756	£33,087	1.37	1.47
London	£50,271	£53,658	1.34	1.44
Yorkshire and Humberside	£30,907	£33,397	1.32	1.43
Scotland	£34,585	£33,520	1.40	1.37
UK	40,895	41,610	1.55	1.57

Source: Oxford Economics, using LFS data to calculate the premium ratio, applied to the mean average wages from ASHE.

12 The average wages estimated for the sector are also in line with the average wages at the science park, £34,000, as reported in the Evaluation of the NISP, Department of Enterprise, Trade & Industry, Evaluation of the Northern Ireland Science Park, January 2010.

Table 2.11: Average wage premium by sub-sector, 2010

Wages	Annual Salary, £	Annual Salary premium, £
Pharma/Biotechnology	40,842	19,142
Software / digital content	38,827	17,127
Communications	33,470	11,770
Computing and advanced electronics	33,175	11,475
Medical Devices	31,013	9,313
Transport / defence	29,616	7,916
Other technical consultancy services	27,671	5,971
IT services	27,376	5,676

Source: Oxford Economics, using LFS data to calculate the premium ratio, applied to the mean average wage for Northern Ireland from ASHE.

- The average wage premiums for Northern Ireland by sub-sector have also been estimated below and vary considerably. For instance in pharmaceuticals/ biotechnology and software/digital content wages are almost double the size of the whole economy average.

2.7 Summary

- The current size of the knowledge economy in Northern Ireland is very small, accounting for approximately 4.4% of total employment and 2.5% of the local business stock, compared to 5.7% and 7.1% respectively in the UK. In San Diego the knowledge economy accounts for 11% of total employment, which is substantially higher but the growth in the technology based firms and employment is viewed as an economic transformation over a number of decades, linked to closer links between business and research institutions, in a number of specific sector strengths.

- Sectors in which Northern Ireland has a relatively large footprint in the 'knowledge economy' include 'transport and defence' with firms such as Bombardier and BE Aerospace located locally and in the IT sector, particularly the 'manufacture of computing and electronics' and 'software & digital content'. There are also a number of leading 'life science' companies such as Almac and Norbrook.

- Despite the small nature of the 'knowledge economy' it plays a crucial role in the economy and is a key contributor to productivity growth. A Knowledge economy worker will, on average, earn a 52% wage premium above the Northern Ireland mean wage and be 52% more productive than the average private sector worker.

- Additionally, the 'knowledge economy' has wider economic impact through indirect and induced effects via business to business expenditure through the supply chain and consumer expenditure resulting from increased income. It is estimated that although the knowledge economy in Northern Ireland is relatively small at just 30,600, the sector supports an additional 27,000 jobs through indirect and induced effects.

- In conclusion it is recommended that the following key innovation metrics are used to measure the size of the knowledge economy in Northern Ireland.

Table 2.8: CONNECT - Key innovation metrics

San Diego: CONNECT Key Innovation Metrics	NISP CONNECT: Key Innovation Metrics (NI & all UK regions)	Source
Technology start ups Technology start ups new job creation Technology sector wages and employment	Knowledge economy employment, as % of total employment	BERR/Census of Employment
	Knowledge economy businesses, as % of total business stock	IDBR
	Knowledge economy business start ups per 100,000 population	IDBR
	Knowledge economy average annual wage level	ASHE/LFS

Source: Oxford Economics, using LFS data to calculate the premium ratio, applied to the mean average wages from ASHE.

3 Investment activity

- This chapter examines investment activity in Northern Ireland, based on the public data available and supplementary information from those involved in the field. The aim is to replicate the San Diego investment indicators as far as possible:
  - Venture capital investment.
  - Merger and acquisition investment.
  - Private placement investment.
  - Initial and follow-on public equity offerings.
- These indicators are used by the San Diego CONNECT model to assist in monitoring the availability of financial capital to the knowledge economy and represent investment flows across all sectors.
- The only two consistent data series available for Northern Ireland and all other UK regions focuses on private equity investment and M&As and Equity Capital Market (ECM) deal activity, which are examined here. Further information about each data series can be found in Annex B.
- In addition the level of business angel investment and the number of publicly listed companies are examined.
- There are numerous difficulties with data on investment activity in Northern Ireland and no source that can capture all venture capital activity. The BVCA data used here does exclude investments made by ROI based venture capital funds and investments made by USA based venture capital funds and investments made by local providers that are not members (e.g. Crescent Capital). Although a more accurate picture of the level of venture capital investment has been provided by Chartered Accountants Ireland Ulster Society (further details in Annex B), which does indeed demonstrate that BVCA data is likely to underestimate the true level. However, BVCA data is the only consistent source providing regional comparisons and that providing data on the number of companies receiving investments. There is a need to coordinate better data collection for further updates of the CONNECT metrics.
- The report focuses on measuring activity rather than examining the supply of venture capital. Tracking available funds under management for deployment in Northern Ireland is very important but a comparative study was not possible in the timeframe of this study. The venture capital stakeholders perceive a large discrepancy in the amount of available VC funds between Northern Ireland, the Republic of Ireland and other UK regions with Northern Ireland the most disadvantaged. For example there is approximately £7m in seed capital funds under management in Northern Ireland compared with 125 million Euro in the Republic of Ireland. The ongoing debate around VC in Northern Ireland is central to the CONNECT programme and, although out of the scope of this study, should be explored further.

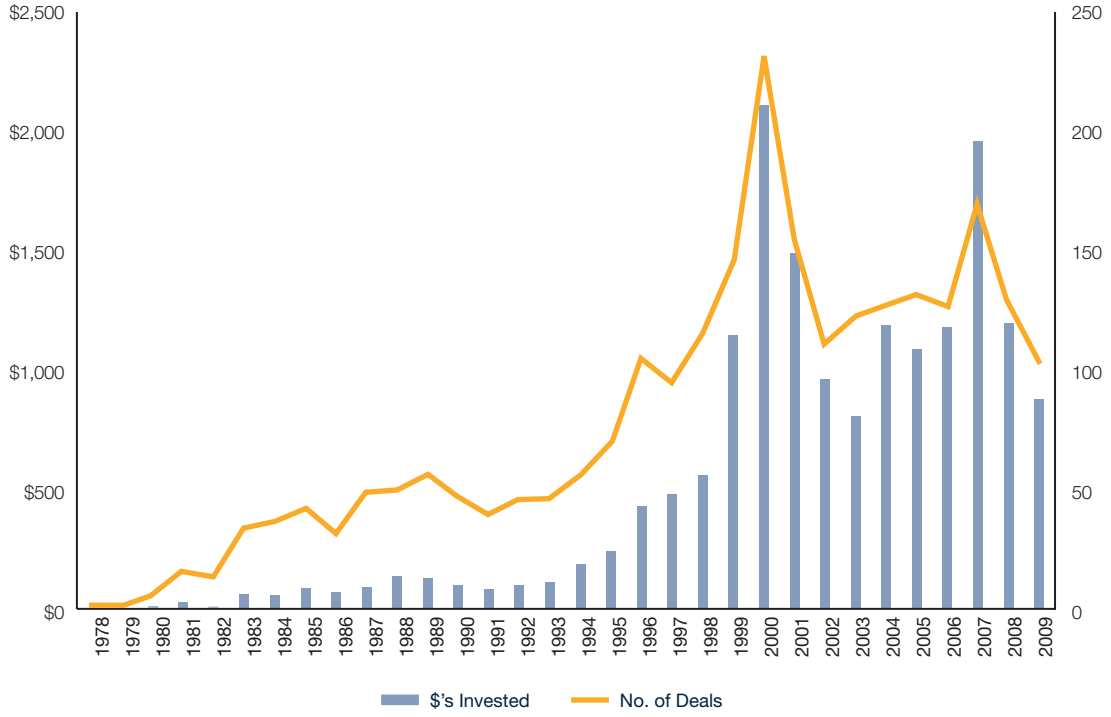
3.1 Private equity investment (covering venture capital)

3.1.1 Context

- In knowledge based economies, economic growth and job creation increasingly depend upon successful innovation, meaning that the results of research and development (R&D) must be effectively translated into commercial outcomes. Access to finance is seen as a key factor in this process of innovation.
- Venture capital, as a specific type of finance that has been developed to fund high-risk projects, has an important role to play in this connection. Venture capital is crucial to the innovation process. For a variety of reasons, it is very difficult for large companies to undertake high-risk innovative projects. Such projects have the greatest chance of success if they are undertaken in small technology-based firms. Venture capitalists are willing and able, through their financial instruments, to invest in such high-risk innovative projects. This is confirmed by the evidence that technological revolutions which have resulted in the transformation of industries have been led by venture capital-backed firms; for example, the firms that have pioneered each new generation of computer technology (PCs, personal computers, software, etc.) have been financed by venture capital.

- San Diego has grown into a vibrant venture capital hub ($1,000 billion in venture capital in 2010) through close cooperation between its public, private and academic sectors. Venture capital investors have been crucial to commercialising ideas from the small companies emerging from the University of California San Diego. The chart below shows that over the last decade VC investment deals have been consistently over 70 and of a value of around $1,000 million in San Diego.

Figure 3.1: Venture Capital Investments in San Diego, 1978 - 2009



Source: CONNECT San Diego

- An important element of the NISP CONNECT programme is encouraging more venture capital investment in start-up companies from the two universities. Measuring the rate of deals and investment is an important element of monitoring the availability of capital investment to support the knowledge economy.

3.1.2 British Venture Capital Association (BVCA) Statistics

- Statistics on private equity investment by UK region are published by the British Venture Capital Association (BVCA), which covers venture capital, expansion investment, replacement capital, Management Buy Outs (MBO)/Management Buy Ins (MBI) and other later stage investments.

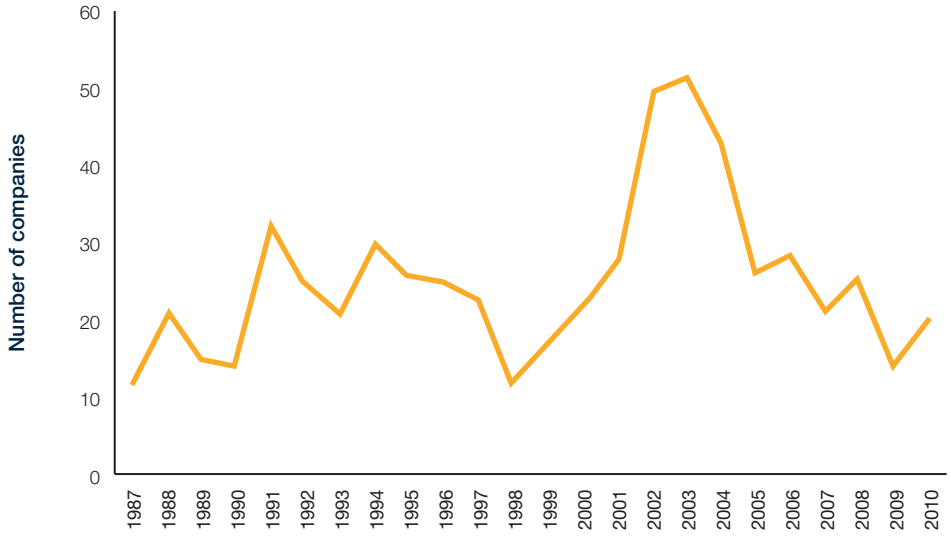
- The major drawback of BVCA statistics is that they only capture investment by venture capital funds that are members and thus underestimate the true level of private equity investment in Northern Ireland (and across the rest of the UK). However, they do capture activity by some overseas funds as well (if these funds work with British based members) and ultimately provide as complete picture as possible from published data of the flows of private equity across the UK region.

- The VC environment in Northern Ireland is very small and it also has more state investment than other regions of the UK with a number of Northern Ireland based firms managing public sector backed VC funds. In order to provide a more comprehensive overview the venture capital sector in Northern Ireland is summarised in terms of VC funds and associated organisations in Annex B.

- BCVA report in their 2010 Investment Activity Report that investment by private equity and venture capital firms in the UK was £20.4bn in 2010, up from £12.6bn in 2009 as the economy started to recover from the recession. Overall in terms of the number of companies there were 823 private equity investments in 2010. In Northern Ireland, a total of £163m was invested representing 20 companies. This was a jump in terms of the level of investment although this appears to have been driven by one large MBO/MBI transaction.

- The number of companies in the UK receiving private equity investment over the period 1987 to 2010 has fluctuated between 800 and 1,300, averaging 1,200 whilst figures for 2009 and 2010 were particularly low. The overall contribution of Northern Ireland to this total has been very low in absolute terms and as can be seen in Figure 3.2, only in 2003 did the number of companies receiving investment increase above 50.

Figure 3.2: Private equity investment by number of companies



Source: BVCA

- It is important to note that private equity investment is highly sensitive to economic downturns and the appetite in markets for new technology based firms. This trend occurs globally, and is illustrated by the recent downturn in the number of companies engaging in private equity investments in the UK.
- Examining the number of investments figures by region (Table 3.1) demonstrates that London and the South East dominate UK private equity investments, accounting for over half of the total amount invested in the UK. Over the period 1998/2010 NI accounted for 2.3% of the total number of companies provided with private equity investment in the UK.

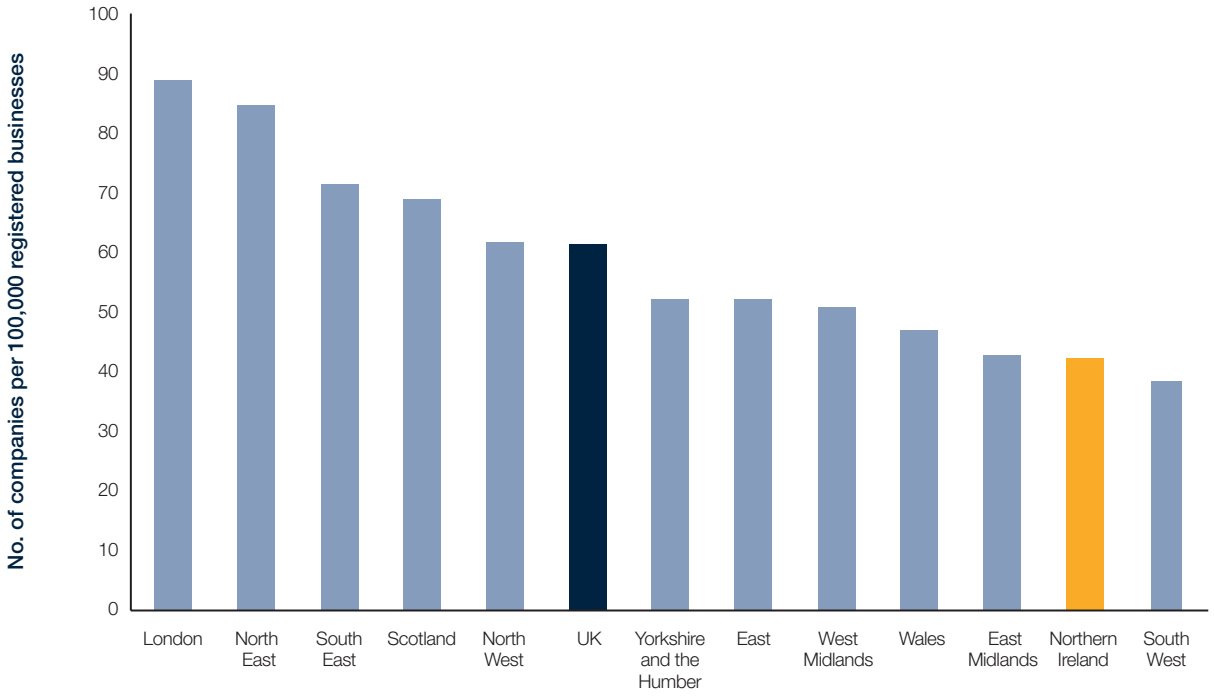
Table 3.1: Private equity investment in Northern Ireland, number of companies, 1998/2010

Region	1998	2002	2006	2010	1998/2010	% of deals 1998/2010	No. of private equity investments per 100,000 VAT registered businesses, 2010
London	184	274	330	212	3,469	22.6%	54.0
South East	204	248	224	125	2,810	18.3%	31.7
North West	111	93	146	66	1,483	9.7%	25.8
East Anglia	85	132	95	47	1,305	8.5%	18.6
Scotland	121	93	78	61	1,182	7.7%	31.6
West Midlands	79	82	90	72	1,051	6.9%	34.3
Yorkshire and the Humber	91	39	83	50	944	6.2%	26.6
South West	76	61	98	46	911	5.9%	19.2
East Midlands	79	29	59	37	732	4.8%	21.2
North	46	47	28	46	550	3.6%	60.5
Wales	33	49	59	41	544	3.5%	36.3
Northern Ireland	12	49	28	20	356	2.3%	23.7
UK	1,122	1,196	1,316	823	15,336	100.0%	32.0

Source: BVCA, Investment reports.
VAT registered data changed in 2008 and now captures PAYE businesses as well therefore in all areas the rate per 100,000 has fallen.

- The average number of private equity backed companies per 100,000 VAT registered businesses (Figure 3.3) over the period 1998/2010 is relatively very low in Northern Ireland (2nd from bottom). This will be an interesting indicator to keep track of as the rate in the bottom half of regions does fluctuate quite significantly with bottom position changing between Northern Ireland, Wales, the South West and the East Midlands in most cases. Interestingly, in 2010 the rate was lowest in the East, caused by a very low level of companies receiving investments compared to earlier in the period.

Figure 3.3: No. of Private Equity backed companies per 100,000 VAT registered businesses, average, 1998 /2010



Source: BVCA, Investment activity reports.

- The amount invested in companies is not extensively analysed here as it is very susceptible to one off transactions. For instance over the period 1998-2010 Northern Ireland has also accounted for a very low proportion of the total amount invested but the 2010 level (despite the number of companies falling) was actually very high because of a major MBO/MBI transaction deal.

Type of private equity investment

- The types of private equity investments are explored below in Table 3.2 (consistent data is only available for the last three years). Overall Venture capital (early stage investment) has accounted for the majority of investments in Northern Ireland at 57.4% of the total number of companies receiving investment over the last three years, which is slightly higher than the UK total of 39.3%. The absolute number of VC investments is very low in NI compared to all regions.
- There is also a very low level of Replacement capital and MBO/MBI activity in Northern Ireland, which indicates that venture capital investment activity, is more predominant than other forms of private equity investment. These forms of private equity investment are important to facilitate M&As given succession issues in family owned businesses and the reluctance of banks to lend at previous levels and the likely reduction in business grants in the near future. A reason for less private equity activity could be the lack of investment by Northern Ireland based financial institutions in private equity funds (e.g. elsewhere in the UK there is considerable activity by, for instance, local authority pension funds in regional private equity firms).

Table 3.2: Private Equity Investment by type, 2008-2010

	Number of companies		% of total	
	Northern Ireland	UK	Northern Ireland	UK
VC	39	1,217	57.4%	39.3%
Expansion	18	1,160	26.5%	37.4%
Replacement Capital	1	160	1.5%	5.2%
MBO/ MBI	5	349	7.4%	11.3%
Other	5	213	7.4%	6.9%
Total	68	3,099	100.0%	100.0%

Source: BVCA, Investment activity reports.

- Examining venture capital investments alone which are of primary interest the rate of investments per 100,000 VAT registered businesses (as an average over 2008/2010) is higher in Northern Ireland than the East of England, the South West and the East Midlands.

Table 3.3: Venture Capital Investment, no. of companies and rate per 100,000 VAT registered businesses, 2008-2010

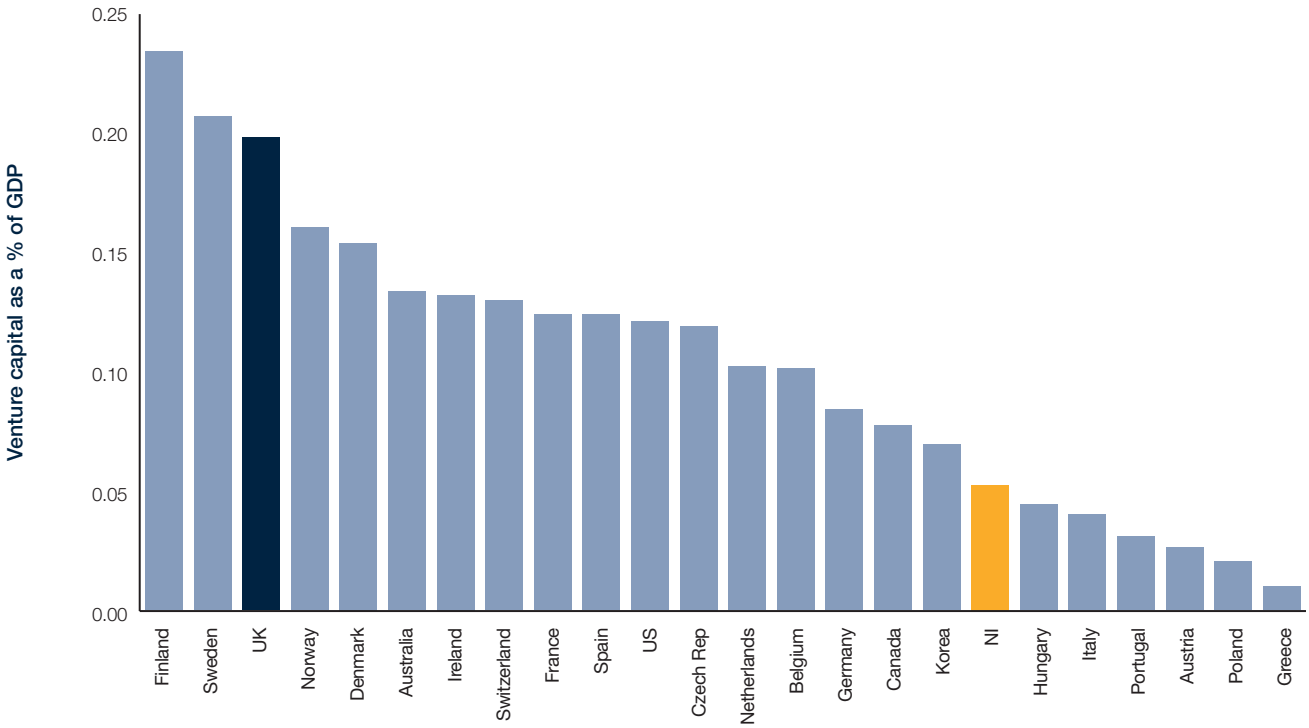
	Number of companies			%			
Region	2008	2009	2010	2008	2009	2010	No. per 100,000 VAT registered businesses (average 2008/2010)
North East	22	18	16	4.8%	4.9%	4.0%	31.5
London	78	90	93	17.1%	24.7%	23.4%	24.9
South East	74	81	70	16.3%	22.2%	17.6%	21.6
North West	79	16	31	17.4%	4.4%	7.8%	20.1
West Midlands	45	22	43	9.9%	6.0%	10.8%	19.9
Wales	13	30	26	2.9%	8.2%	6.5%	19.5
UK	455	365	397	100.0%	100.0%	100.0%	18.3
Scotland	33	17	24	7.3%	4.7%	6.0%	18.0
Northern Ireland	18	7	14	4.0%	1.9%	3.5%	17.9
East of England	29	25	27	6.4%	6.8%	6.8%	12.1
South West	25	28	22	5.5%	7.7%	5.5%	12.0
Yorkshire and The Humber	28	13	13	6.2%	3.6%	3.3%	11.6
East Midlands	11	18	18	2.4%	4.9%	4.5%	10.1

Source: BVCA, Investment activity reports.

- Chartered Accountants Ireland Ulster Society gathered data on venture capital investment directly from active firms and the Irish Venture Capital Association (IVCA) and estimate in 2010 that the total level of investment was approximately £8million in Northern Ireland. The corresponding figures for BVCA are around £5million for 2010, which implies that the level is significantly underestimated using BVCA figures.

- When compared internationally Northern Ireland again ranks relatively low when benchmarked against other similar countries. Figure 3.4 illustrates that venture capital investments were substantial in Finland (0.24%), Sweden (0.21%) and the UK (0.20%).

Figure 3.4: Venture Capital investment as a % of GDP, 2008



Note: The OECD defines here venture capital as the sum of "seed/start-up stages" and "early development and expansion stages".
Source: OECD, BVCA, Oxford Economics.

- Northern Ireland lags behind the UK with Venture Capital investment representing just 0.05% of GDP. Venture Capital Investment is also much lower in Northern Ireland than in Ireland (0.13%) and other small open economies such as Norway (0.16%), Denmark (0.16%) and Switzerland (0.13%).

Private equity investment by sector

- In 2010 in the UK the sectors with the highest investment were Healthcare & Consumer Services, followed by Technology and Oil & Gas. In Northern Ireland investments were also highest in these sectors.

Table 3.4: Private Equity Investment by industry sector and region (UK) – Number of Companies, 2010

Region	Oil & Gas, Basic materials & Industrials		Consumer Goods		Health care & Consumer services		Telecoms, utilities & financials		Technology		Other	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
London	34	15.6%	11	20.4%	80	30.9%	27	39.7%	60	27.4%	0	0.0%
South East	35	16.1%	5	9.3%	40	15.4%	9	13.2%	34	15.5%	2	40.0%
South West	10	4.6%	6	11.1%	13	5.0%	3	4.4%	14	6.4%	0	0.0%
East of England	8	3.7%	3	5.6%	11	4.2%	0	0.0%	25	11.4%	0	0.0%
West Midlands	20	9.2%	4	7.4%	27	10.4%	5	7.4%	14	6.4%	2	40.0%
East Midlands	10	4.6%	4	7.4%	8	3.1%	5	7.4%	10	4.6%	0	0.0%
Yorkshire &The Humber	27	12.4%	3	5.6%	12	4.6%	1	1.5%	7	3.2%	0	0.0%
North West	21	9.6%	2	3.7%	23	8.9%	7	10.3%	12	5.5%	1	20.0%
North East	22	10.1%	6	11.1%	9	3.5%	4	5.9%	5	2.3%	0	0.0%
Scotland	18	8.3%	4	7.4%	12	4.6%	6	8.8%	21	9.6%	0	0.0%
Wales	10	4.6%	4	7.4%	18	6.9%	1	1.5%	8	3.7%	0	0.0%
Northern Ireland	3	1.4%	2	3.7%	6	2.3%	0	0.0%	9	4.1%	0	0.0%
UK	218	100%	54	100%	259	100%	68	100%	219	100%	5	100%

Source: BVCA, Investment activity report 2010.

3.2 Mergers & Acquisitions (M&A and Equity Capital Market (ECM) deal activity levels

- The following table shows the regional M&A and ECM deal activity for 2009 and 2010 for each UK region and ROI, including in terms of deals per million inhabitant (using Experian Corpfin data). This data covers M&As and ECM deals covering flotations, rights issues and placements investments. There is some overlap with the private equity investment in that M&A activity also covers MBO/MBI.

- The largest volume of deals takes place in Greater London whilst the number of deals is also high in the South West (which includes the Channel Islands linked to its finance sector), the North West, the Midlands and the South East (which for the last three because they are large regions). In Northern Ireland the number of deals in 2009 was slightly higher at 47 compared to 32 in 2010.

- The regions with the largest number of deals per 100,000 VAT registrations in 2010 (taking account of the size of the regions) were London and Yorkshire but the rate was also high in the South West and East Anglia. The rate of deals per 100,000 VAT registered businesses in the South East, North West and the Midlands is much lower than other regions. Northern Ireland has the lowest level of activity of all comparator regions and ROI.

Table 3.5: Regional M&A and ECM deal activity by value (£m), volume (no. of deals) and no. of deals per 100,000 VAT registrations

	Value (£m)		Volume (no of deals)		Volume per 100,000 VAT registrations	
Region	2009	2010	2009	2010	2009	2010
Greater London	129,822	127,880	1,539	1,312	4,562	3,342
Yorkshire	5,123	5,987	549	504	3,601	2,684
South West	21,139	19,150	579	589	2,859	2,460
East Anglia	21,329	19,150	579	589	2,657	2,327
North East	1,161	3,084	146	148	2,542	1,948
Scotland	74,831	19,649	361	365	3,924	1,888
South East	16,415	36,129	511	483	1,507	1,224
North West	1,630	4,109	307	304	1,449	1,189
Wales	389	267	105	108	720	957
Midlands	3,647	1,741	208	205	640	533
Northern Ireland	93	1,380	47	32	666	380
UK	275,579	238,526	4,931	4,639	2,291	1,802

Source: Corpfin-Experian.
N.B value of deals only captures the reported value and therefore does not capture all deal activity (compared to the volume).

- The value of deals, although displayed for context, does not capture the full values of all deals as some are not disclosed. Therefore the only data that should be monitored is the volume of deals.

- In addition the list below are examples of the deals that have taken place in Northern Ireland in 2009 to present, collected from NISP stakeholders:
  - Ten Alps acquiring Below the Radar Ltd, a Belfast company specialising in current affairs programming and Country Link Media, Belfast, the production company behind forthcoming public sector online TV channel, Fermanagh TV. Both deals were in 2009.
  - Belfast-based multimedia company Galleon Holdings, raising £3.85m via a share placing, in 2009.
  - Dublin-based Electricity Supply Board agreed to acquire Belfast-based Northern Ireland Electricity Plc for £1.034billion, which was a very large investment dominating the figures in 2010 (and which appeared in the private equity investment data).
  - Acquisition by Surrey-based AES Ballylumford Holdings Ltd of Ballylumford (Northern Ireland)-based Premier Power Ltd, in 2010.
  - £4.03million acquisition by Cambridge based CSR Plc of Belfast-based APT Licensing Ltd in 2010.
  - Lagan Technologies was sold to Kana Inc in November 2010 for £28m.
  - The Hardware division of APT was sold in March 2009 to the Audemat Group for £5.6m.
  - The recent acquisition of gem by Concentrix Corporation (US). gem is a European-based provider of customer contact solutions that supports a global customer base in 28 languages from locations in Belfast, Northern Ireland and Debrecen, Hungary.

3.3 Business Angel investment

- Another source of private equity finance is business angels. These are high net worth individuals who invest their own money, either alone or with others, directly in unquoted businesses in which there is no family connection. Business angels have long been recognised as an important source of finance for entrepreneurial businesses, particularly at their start-up and early growth stages where the amounts required are too small to be economic for venture capital funds to invest.

- There are two Treasury backed schemes, Enterprise Investment Scheme (EIS) and Venture Capital Trusts (VCT), which provide tax incentives to encourage individuals to invest in small, higher risk trading companies.

- The most recent Annual Report on the Business Angel Market in the UK[13] reports figures for the UK, which have been supplemented by NI Halo and are displayed below:

Table 3.6: Business Angel Investment

	No. of deals		Angel Investment, £m		Inv/head per capita, £	
Region	2008/09	2009/10	2008/09	2009/10	2008/09	2009/10
England & Wales	233	238	£44.9	£42.3	£0.8	£0.8
Scotland	74	78	£17.9	£18.2	£3.5	£3.6
Northern Ireland	0	8	£0.0	£0.8	£0.0	£0.4
UK	307	324	£62.8	£61.3	£1.0	£1.0

Source: BBAA BIS Reports, NI Halo

13 Annual Report on the Business Angel Market in the UK, Colin M Mason (Hunter centre for Entrepreneurship, Strathclyde Business School, University of Strathclyde) and Richard T Harrison (Queen's University Management School, Queen's University of Belfast), BIS, May 2011.

- Overall, total business angel investment in the UK was £61.3million in 2009/10, for 324 investments in total. The level of angel investment in Northern Ireland since 2008/09 has been very small (compared to VC also), however, NI Halo reports that for 2010/11 total investment was £2.16m with a total of 11 deals. This puts investment per head per capita at £1.26, which is a significant increase – which is in line with the UK average.

- The NI Halo business angel network was restarted after a gap of more than a year in 2009, which explains the sudden increase. The figures for 2010/11 were not driven by one particular strong investment with 2 deals of over £500,000 each and a number of smaller investments. NI Halo report that in a previous scheme similar to NI Halo angel investing totalled £1m over a 3 year period (2005 onwards), however, one single deal amounted for 66% of this. This demonstrates that the landscape may be starting to change with a higher volume of deals.

- In Scotland the business angel network model is different, comprising 20 self controlled angel syndicates supported by Link Scotland. Investment by these business angel syndicates is supported by the Scottish Co-investment Fund, administered by the Scottish Investment Bank. The availability of this funding has increased the ability of angel investors to do more deals and to undertake follow-on investments in existing portfolio companies. Scotland is renowned for having been successful at generating angel investment and is recognised as a best practice region in Europe (with even the US visiting the area as a best practice case study).

3.4 Public companies

- The main advantage that public traded companies have over privately traded companies is probably access to ongoing finance, through raising additional funds at an efficient market price. Prior to publicly traded corporations it was very difficult to obtain large amounts of capital for private enterprises. Other advantages include access to knowledge as external investment often plays a significant role in accelerating the improvement of systems and practices and attraction and retention of staff, through the use of share options and other financial incentives.

- Loughshore Investments have provided information about the number of registered companies on the London Stock Exchange (LSE) and AIM (LSE's international market for smaller growing companies). There are only three companies headquartered in Northern Ireland listed as public companies:
  - Andor Technology
  - First Derivatives plc
  - UTV Media plc

- Northern Ireland accounts for only 0.14% and 0.02% of total publicly listed companies and market capitalisation in the UK. This compares poorly to other regions of the UK and the Republic of Ireland. The market capitalisation[14] per head for Northern Ireland of £170 is very low compared other UK regions and the ROI.

14 Market capitalization is an estimation of the value of a business that is obtained by multiplying the number of shares outstanding by the current price of a share.

Table 3.7: Publicly listed companies across the UK (LSE and AIM), 2010

Region	No. of companies	Market cap, £m	% total companies	% total Market cap	Market cap per head
London	800	£1,270,175	38.4%	68.1%	162,319
South East	150	£193,016	7.2%	10.3%	22,646
Scotland	129	£75,838	6.2%	4.1%	14,522
East	120	£66,883	5.8%	3.6%	11,469
South West	67	£40,659	3.2%	2.2%	7,710
Midlands	91	£29,754	4.4%	1.6%	2,994
North East	110	£28,599	5.3%	1.5%	3,617
North West	108	£10,388	5.2%	0.6%	1,498
Wales	12	£4,673	0.6%	0.3%	1,554
Northern Ireland	3	£306	0.14%	0.02%	170
UK Total	2058	1,825,941	98.9%	97.8%	29,327
Republic of Ireland	60	£33,122	100%	100%	7,409

*Source: Loughshore Investments, using company listings from LSE and AIM. Population figures from ONS mid year population estimates (2010).

- There are a number of companies worth mentioning which showcase that the area has produced a number of globally competitive firms. The following companies are either public listed companies that no longer have HQ in Northern Ireland (following acquisitions) or were formally public listed companies (before acquisitions): Tayto, Hilton Foods, Moy Park[15] and Viridian.

15 Now listed on São Paulo stock exchange under parent company Marfig.

3.5 Summary

- The capital flows of investment into Northern Ireland are comparatively very low against the three measures used here- private equity investment flows, M&A and ECM deals and business angel investment. Although the BVCA data does not capture all private equity investment it does provide an updatable source for monitoring capital flows in the region.

- In knowledge-based economies, economic growth and job creation increasingly depends upon successful innovation, meaning that the results of research and development (R&D) must be effectively translated into commercial outcomes. Access to finance is seen as a key factor in this process of innovation and facilitating the interaction between venture capital and start ups is an important pillar of the CONNET programme. The facilitation of investment through venture capitalists was a vital component of the San Diego transformation.

- There is a strong need to understand and track more closely the supply of VC funds in Northern Ireland, which should be co-ordinated for future updates of the CONNECT report.

- It is recommended that the following indicators should be taken forward as the nearest possible measures to the original CONNECT key innovation metrics.

- In addition it is recommended that data is still collected for the level of business angel investment in Northern Ireland (this is not a key innovation metric as regional data is unavailable).

Table 3.8: CONNECT - key innovation metrics

San Diego: CONNECT Key Innovation Metrics	NISP CONNECT: Key Innovation Metrics (NI & all UK regions)	Source
Venture Capital Investment Merger & Acquisition Investment Private placement investment Initial and follow-on public equity offerings	Number of private equity investments number of companies	BVCA
	Number of private equity investments per 100,000 VAT registered companies	BVCA
	Number of venture capital investments per 100,000 VAT registered businesses	BVCA
	M&A activity: Number of M&A and ECM activity per 100,000 VAT registered businesses	Corpfin-Experian
	Public listed companies: market capitalisation per head	LSE

4 R&D and research activity

- This chapter examines the levels of R&D and research activity across the Northern Ireland economy, compared to other UK regions and international comparators.

- The San Diego CONNECT programme uses the following key metrics in relation to research:
  - Federal research grants
  - Private research employment and wages.

- The first of these captures the level of research being won by companies and institutions from federal research bodies in the most relevant sectors- the National Institutes of Health (NIH), National Science Foundation (NSF), National Aeronautics and Space Administration (NASA) and National Oceanic and Atmospheric Administration (NOAA) and Department of Defence. This innovation metric is not straightforward to apply to Northern Ireland as data breakdowns of research contracts by sector are not easy to collate[16]. Instead the analysis focuses on the total levels of research grants and contracts in Northern Ireland and more general indicators around the levels of R&D in the region and the sources of R&D spend.

- For the second indicator we propose using the overall level of personnel employed in R&D as a proxy measure.

4.1 Research & Development (R&D)

4.1.1 Importance of R&D

- It has long been recognised that firms benefit from R&D undertaken by other firms and institutions (spillovers) as well as from their own research. A recent UK study suggests that a doubling of a firms R&D activity would lead to an increase of 7-13% in productivity (measured in terms of company sales)[17].

- This has led the UK Government's economic strategy to place an increased emphasis on reversing the long-term under-investment in the UK's science base, support knowledge transfer between higher education institutions and firms, and address market failures in business investment in R&D.

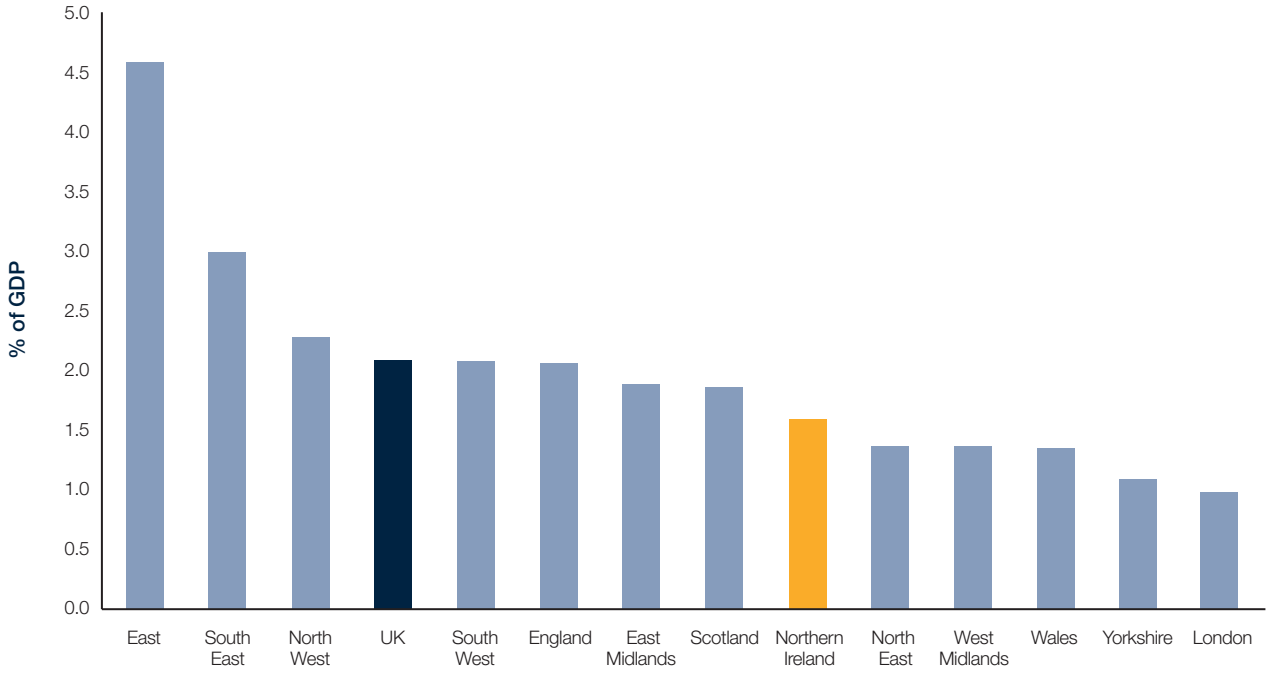
4.1.2 R&D intensity – a UK perspective

- In 2009 Northern Ireland's total expenditure on R&D equated to 1.7% of regional GDP, ranking it 8th of the 12 UK regions with regard to R&D intensity. Northern Ireland ranks below the UK (2.1%), England (2.1%) and Scottish (1.9%) averages, but ahead of Wales (1.4%). The East of England (4.6%) is the most R&D intensive region with its industry structure weighted towards life sciences and high-tech manufacturing. London ranks lowest which is reflective of its business structure, which is weighted towards low R&D sectors such as finance and business services.

16 Although the two universities in Northern Ireland could feasibly report the number of grants won under Framework 7, Technology Strategy Board (TSB) and relevant research councils, these statistics could not be complied for the benchmark areas.

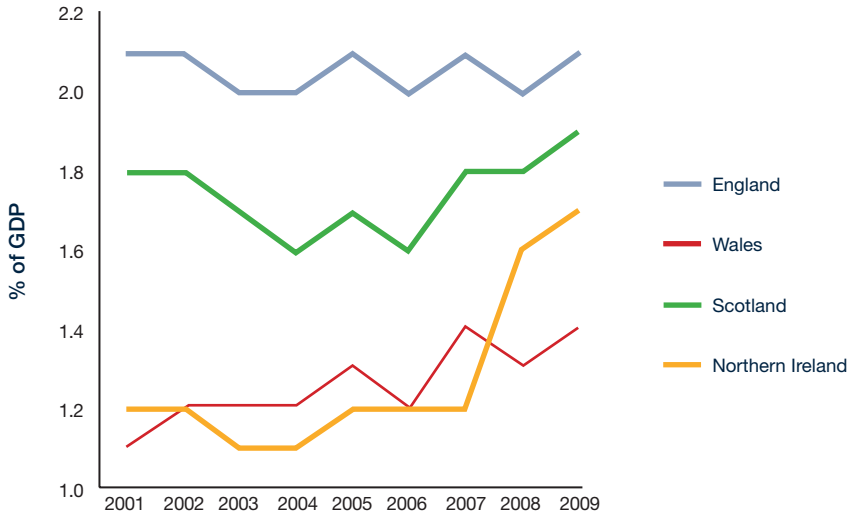
17 Kafouros M and Buckley P J (2008) Under what conditions do firms benefit from the research efforts of other organisations? Research Policy 37 pp225-239. This was a study of productivity change 1995-02 based on a sample of 117 UK manufacturing firms which reported their expenditure on R&D. Around 60% of the sample were firms in hightech sectors and a similar proportion were in large rather than small firms.

Figure 4.1: Gross domestic expenditure on R&D (GERD), as % of GDP- 2009



Source: ONS

Figure 4.2: Gross Domestic Expenditure on R&D (GERD)- 2001-09



Source: Regional Competitiveness Indicators, ONS

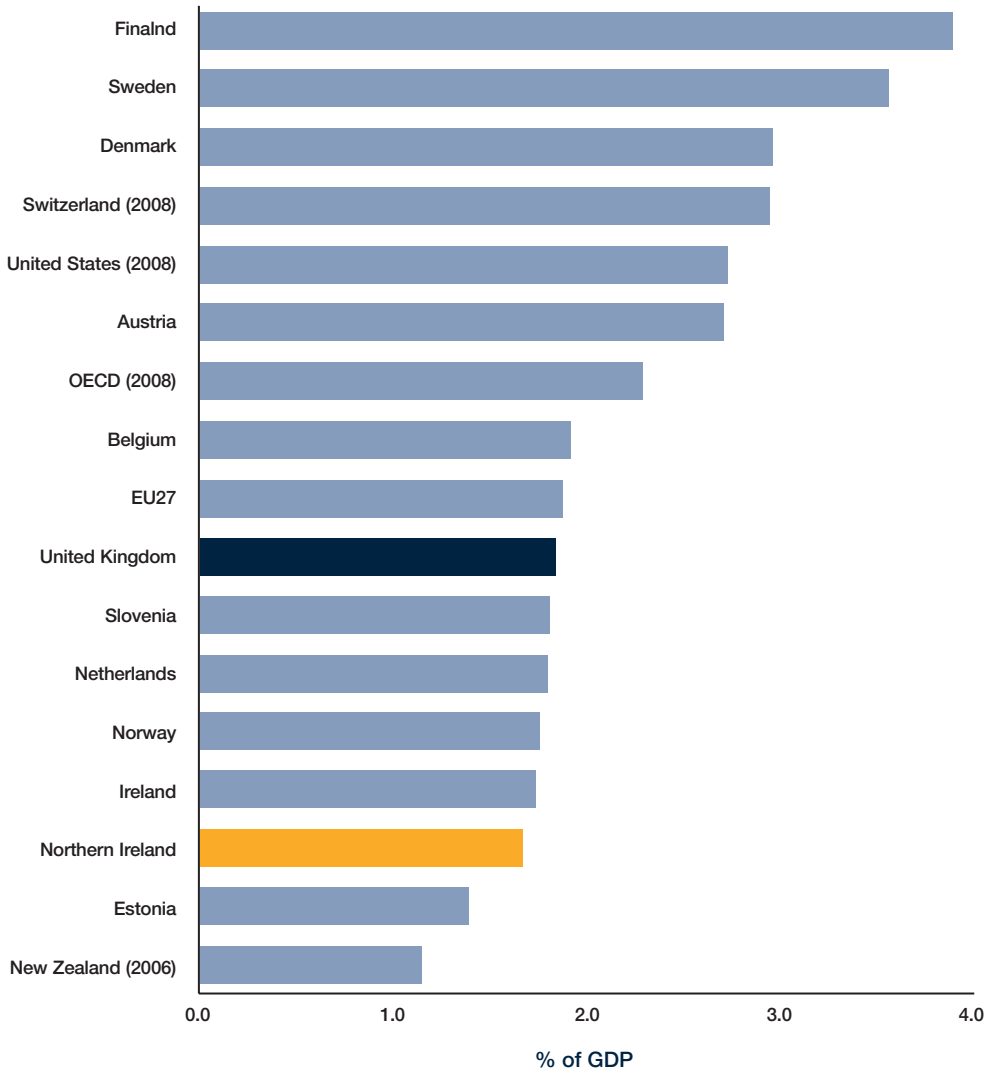
- Northern Ireland's expenditure on R&D oscillated between 1.1-1.2% of GVA in the six years to 2007. In 2008 this increased significantly to 1.6%, with Northern Ireland overtaking Wales and closing the gap on Scotland. In 2009 R&D intensity increased further to 1.7%, building upon the large increase experienced in 2009.

- When benchmarked against a range of comparable countries (i.e. small open economies) and also the OECD, EU27 and US for context, Northern Ireland is towards the bottom of the rankings for R&D intensity.

- Northern Ireland ranks marginally below Ireland (1.8%) and the UK (1.9%). However, Northern Ireland ranks significantly below the leading Scandinavian countries Finland (4%), Sweden (3.6%) and Denmark (3%).

- European Union signatories to the Lisbon Treaty accept the importance of R&D and have agreed to invest significantly to reach the target of spending 3% of GDP on it by 2010. Of the signatories, only Finland, Sweden and Denmark currently exceed the 3% figure. It is clear from the graph below that Northern Ireland is lagging significantly behind both the Lisbon Treaty target as well as other selected relevant countries.

Figure 4.3: Gross Domestic Expenditure on R&D- 2009



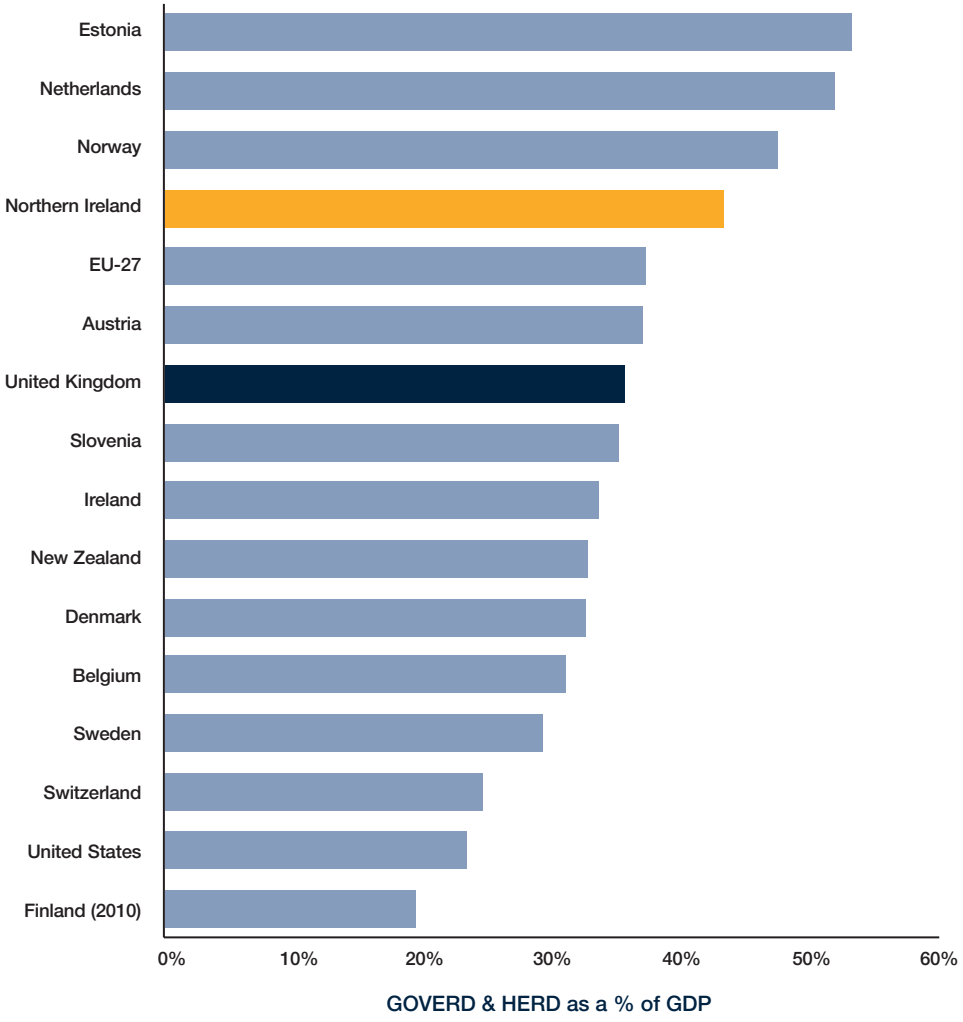
Source: OECD

4.1.3 R&D by Source

- The OECD classifies total R&D (GERD) by source - higher education (HERD), government institutes (GOVERD) and private industry (BERD). Of the three groups, BERD is regarded as making the largest contribution to productivity.

- The chart below shows the composition of GERD for selected economies.

Figure 4.5: GOVERD & HERD as % of GERD



Source: OECD

- In those economies with the highest levels of R&D, as a proportion of GDP, GOVERD and HERD account for relatively little of total expenditure on R&D, accounting on average for less than a quarter of GERD combined. In Northern Ireland, GOVERD and HERD account for 43% of total R&D expenditure in Northern Ireland.

- The level of HERD in NI is high at 30% of total GERD and well above the 20% average for most other countries counties and also above the UK average. This implies that most R&D activity is driven by the two large universities in NI rather than by business although it also likely that HERD makes up a high proportion of GERD as there are less Government Research Institutes, than elsewhere in the UK.

- BERD is generally regarded as the most important source of R&D, which is shown by the literature to have the most influence on productivity and economic growth[18].

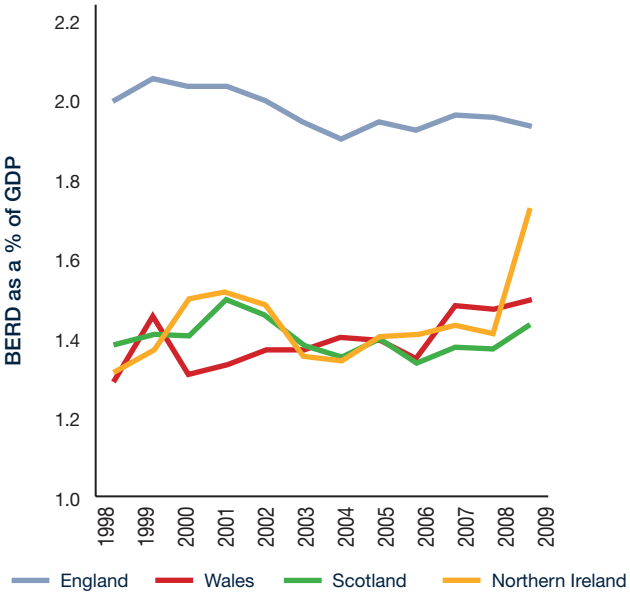
- Northern Ireland currently ranks 6th of the 12 UK Government Office regions when assessed on BERD as a proportion of GDP, which is fairly high given the level of R&D by HERD.

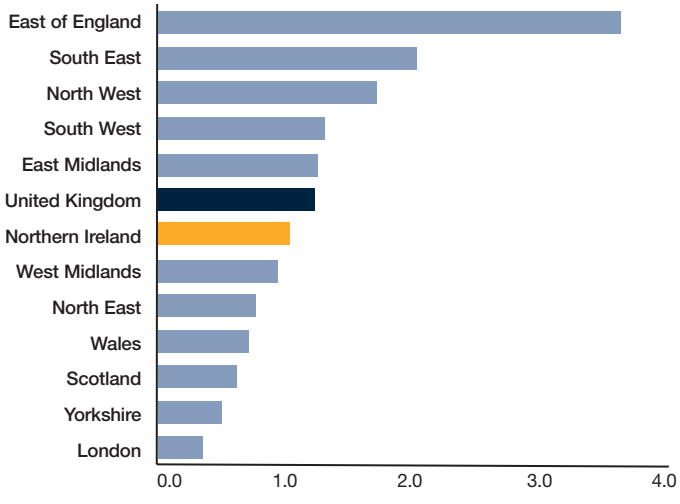
- Overall R&D expenditure grew sharply in 2009, driven by a growth in BERD. This is accounted for by a large increase (100.4%) in R&D expenditure in cash terms by the Manufacturing sector from £114.3m in 2008 to £228.9m in 2009.

- Northern Ireland is dependent on a relatively small number of companies for a significant proportion of R&D expenditure. The ten biggest spending companies accounted for 57% of the total R&D spend in Northern Ireland in 2009, higher than in 2008 (41%).This emphasises the point that Northern Ireland's R&D base is very low, as it only takes a change in R&D activity by one large firm to significantly shift Northern Ireland's BERD – this can be both a risk and an opportunity. It also implies that much of NI's innovation and R&D is concentrated in large firms rather than small companies that characterise innovative economies.

- The 2010 R&D Scoreboard, compiled by the Department for Business, Innovation and Skills (BIS) is the leading source of information and analysis on the world's top R&D active companies, both in the UK and globally. The Scoreboard lists the 1,000 UK companies investing most in R&D in 2009, of which 6 are present in Northern Ireland. These companies include the following: Glen Electric, Randox Laboratories, Norbrook Laboratories, F G Wilson, Andor Technology and Consilium (and for 2008 figures, Meridio). Most of these companies are large employers (over 250 employees) with the exception of Andor (190 employees), Consilium (83 employees) and Meridio (126 employees).

Figures 4.6 and 4.7: BERD as % of GDP, 2009



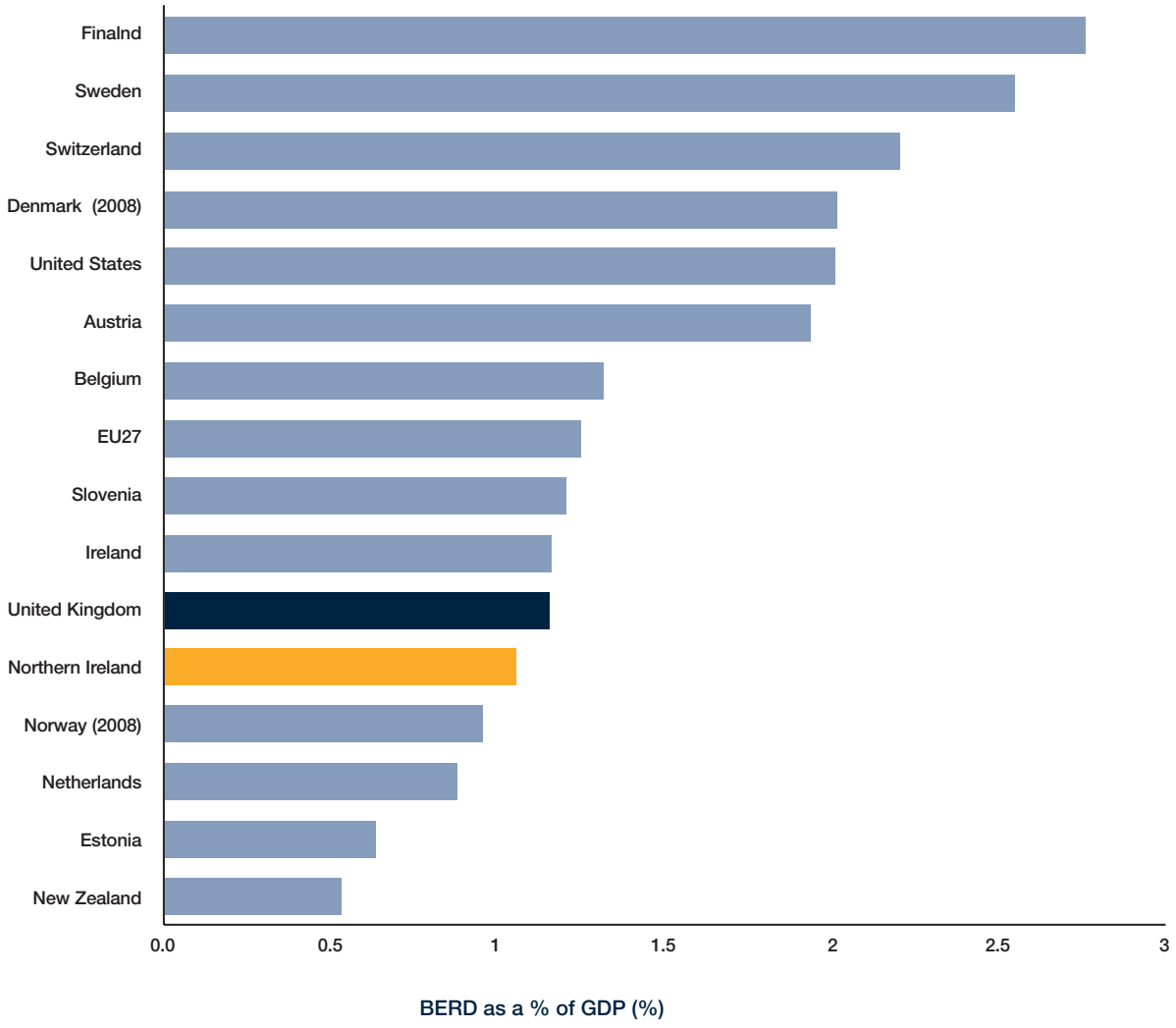


Source: OECD

18 Spending by business on R&D (BERD) has a proven impact on productivity in the firms undertaking the research. Studies show less observable impact on national or regional productivity from public spending by government, where impacts are much more indirect and diffuse. However, in the literature the importance of BERD is generally over-rated. As NESTA shows, BERD only accounts for 7% of market sector investment in the UK, and only 12% of intangible investment contributing in the widest sense to innovation. Most econometric studies of the impact of R&D show that a residual productivity factor over and above the impact of a company's own R&D is more important than company R&D itself in raising productivity. This is assumed to capture the impact of 'spillovers' or generally available technological change beyond that generated directly by BERD.

- Sweden, Finland and Switzerland all exhibit high rates of BERD, greater than the US, and significantly higher than the UK or the EU-27 average. In the early 1980s the USA had the highest level of BERD. Since then first Switzerland and Sweden, and more recently Finland, have overtaken the USA and Austria has risen from a low base to a level now close to the USA. Finland has shown the greatest improvement, with BERD rising almost fivefold from 0.6% of GDP in 1981 to 2.7% today.
- It is not surprising that BERD is high in those countries with strong pharmaceutical, telecommunications and electronics industries. Switzerland, Sweden and more recently Finland all have globally leading companies which invest heavily in R&D. Pharmaceuticals is perhaps the most science-oriented sector, and countries with large pharmaceutical sectors are likely to have high levels of BERD. This is true of Switzerland where this sector accounts for approximately 40% of BERD (compared with 25% in the UK).

Figure 4.8: BERD as % of GDP



Source: OECD

- Unlike most other countries, the UK's level of BERD has fallen as a percentage of GVA, and is now well below the US level. This reflects the decline in the share of manufacturing in the UK economy combined with large financial and business services sectors in which innovative activity is not always recorded as R&D and fast growth in financial & business service GVA.

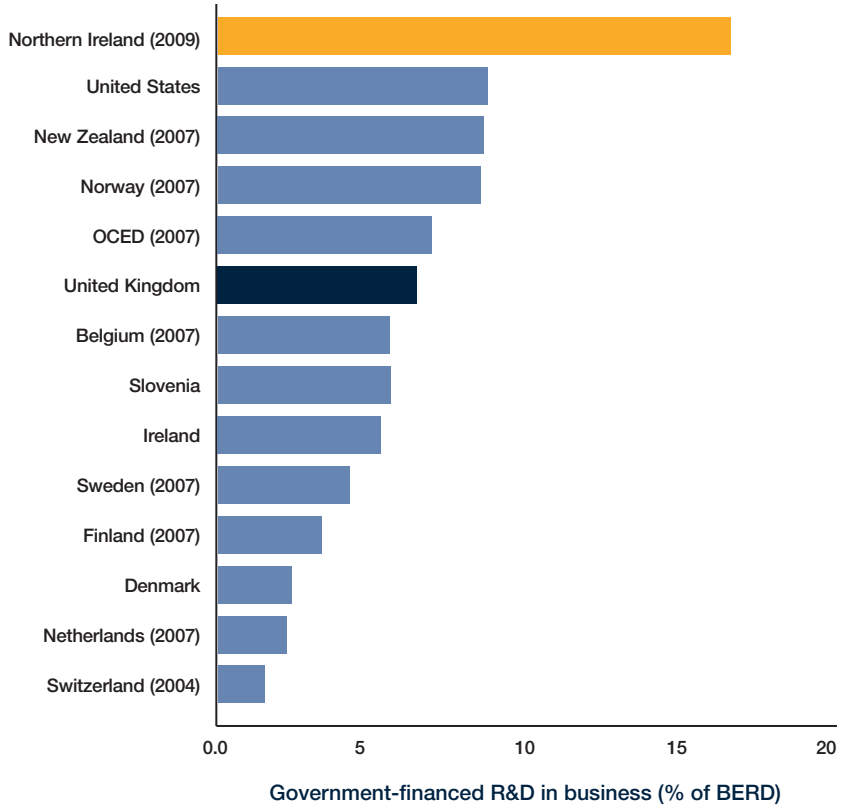
- The chart below shows that most countries with high levels of BERD depend relatively little on public finance for private sector R&D. The fact that direct government support for R&D is low in much of Scandinavia and Switzerland suggests that private companies are willing and able to finance R&D themselves, and perhaps also that the policy framework is sufficiently supportive without direct financial aid.

- In contrast, companies in Northern Ireland depend on government support in financing BERD to a higher degree than elsewhere. Figure 4.9 highlights that the proportion of BERD financed directly by Government in NI is over twice the equivalent proportions for the UK and the OECD average.

- The level of R&D grants from Invest NI, the main source of government-financed R&D in business in Northern Ireland, was £41.5 million. This represented an average grant rate of 34% and total expenditure by those businesses receiving R&D assistance was £139.4m. Given total BERD R&D expenditure in 2009 was £323.7m approximately 43% of monies invested has received some element of grant funding.

- Almost three quarters of business expenditure on R&D in Northern Ireland is conducted by externally owned companies. Considering the fact that, on average, the Government funds 17 pence of every £1 spent of BERD this implies minimal spending on R&D by indigenous companies. Taking this into consideration Oxford Economics estimates that indigenous companies spending on R&D from their 'own funds' or 'privately raised finance' accounts for less than 15% of Gross Expenditure on R&D.

Figure 4.9: % of BERD financed by Government - 2008



4.1.4 R&D Personnel

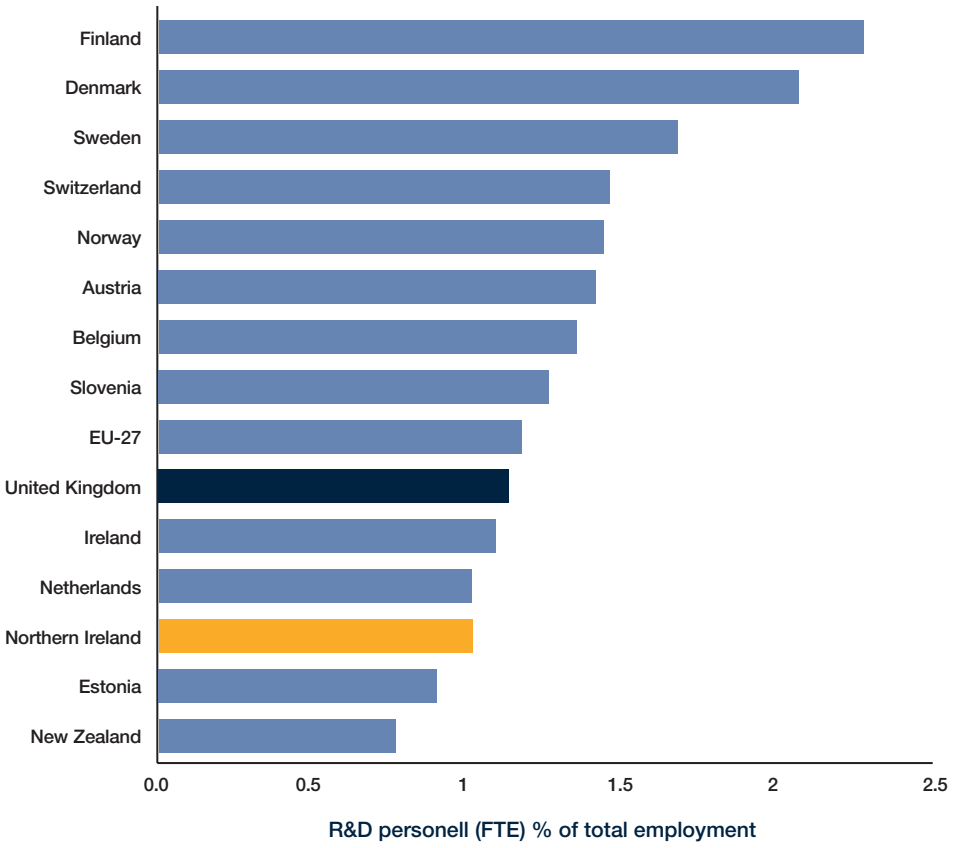
- Northern Ireland has increased its proportion of R&D personnel in the workforce marginally from 0.9% to 1.0% and is now ranked 8th of 12 UK regions. In line with expenditure data the top performing regions are the East of England and the South East, and the bottom performing regions are Wales and Yorkshire and the Humber. However, it is worth highlighting that London ranks third on this measure, but last on R&D expenditure as a percentage of regional GDP – this is as a result of having very high output in financial and business services which makes its proportionate expenditure on R&D appear small relative to other regions.
- In 2009 the Nordic countries had the highest levels of R&D personnel as percentage of total employment and Northern Ireland is substantially below these levels. However, at 1.0% the level of R&D personnel in Northern Ireland does rank above the Estonia and New Zealand, which highlights the importance of university employment and the potential for university-business collaboration (R&D personnel is broken down by researchers, technicians and other support staff).

Table 4.1: R&D personnel employed as a % of total employment

Sub category	2005	2006	2007	2008
Eastern	1.7	1.6	1.8	1.7
South East	1.6	1.6	1.6	1.6
London	1.1	1.2	1.2	1.2
East Midlands	1.1	1.0	1.2	1.1
Scotland	1.1	1.1	1.1	1.1
South West	1.1	1.1	1.1	1.1
Northern Ireland	0.9	0.9	0.9	1.0
North East	0.8	0.9	1.0	1.0
North West	1.0	1.0	1.1	1.0
West Midlands	0.9	1.0	1.0	0.9
Wales	0.9	0.9	0.8	0.8
Yorkshire and Humber	0.8	0.8	0.9	0.8
UK	**1.1**	**1.2**	**1.2**	**1.2**

Source: Eurostat

Figure 4.10: R&D personnel, as % of total employment - 2009



Source: Eurostat, OECD

4.1.5 Science and technology graduates

- A key factor in the future competitiveness of the knowledge economy in Northern Ireland (following the CONNECT sector definition) is the supply of skilled labour. The level of science and technology graduates within the workforce is a valuable indicator of the level of human capital available to support the knowledge economy.

- Using LFS data the number of science & technology degree holders[19] as a proportion of total employment is lowest in Northern Ireland at 7.6% and significantly below the UK total of 10.2%.

Table 4.2: Science & technology graduates, as % of total employment, 2010

	Science & Technology (NVQ level 4 +)	Science & Technology (% of employment)
Scotland	315,405	13.1%
London	482,243	13.0%
South East	434,772	10.9%
East	274,377	10.2%
South West	239,726	10.0%
North West	290,946	9.5%
East Midlands	191,390	9.4%
North East	100,196	9.0%
West Midlands	199,573	8.6%
Wales	98,240	7.8%
Yorkshire and The Humber	179,686	7.7%
Northern Ireland	57,310	7.6%
UK	2,861,929	10.2%

Source: Using LFS. Science & technology graduates does not include medicine and related degrees.

19 Biological Sciences, Agricultural sciences, Physical/environmental sciences, Mathematical sciences and computing, Engineering & Technology.

4.2 Research undertaken by HEIs

4.2.1 Research grants & contracts

- The tables below present data on annual research output from Higher Education Institutions (HEIs) examining the amount of research grants and contracts obtained and the number of PhDs awarded.

- Overall HEIs in Northern Ireland have the smallest annual share of total research grants and contracts in the UK, accounting on average for around 2% of the total.

Table 4.3: Research grants & contracts, £000s, 2002-2009

Sub category	2002/03	2002/03	2002/03	2002/03	2002/03	2002/03	2002/03	Long run average share 2002/08, %
London	642,000	672,000	702,000	778,000	839,000	909,000	1,023,000	25.2%
South East	326,000	344,000	358,000	395,000	428,000	482,000	548,000	13.0%
Scotland	339,000	345,000	355,000	379,000	421,000	481,000	561,000	13.0%
East	210,000	225,000	240,000	267,000	306,000	330,000	353,000	8.4%
North West	245,000	260,000	278,000	90,000	296,000	335,000	361,000	8.7%
Yorkshire & the Humber	199,000	209,000	223,000	227,000	251,000	279,000	302,000	7.7%
West Midlands	130,000	143,000	164,000	170,000	175,000	189,000	211,000	5.4%
East Midlands	142,000	138,000	140,000	151,000	162,000	175,000	186,000	5.0%
South West	101,000	105,000	115,000	130,000	142,000	157,000	180,000	4.2%
Wales	94,000	96,000	104,000	119,000	127,000	142,000	156,000	3.8%
North East	87,000	89,000	101,000	98,000	110,000	122,000	136,000	3.4%
Northern Ireland	42,000	51,000	66,000	70,000	70,000	75,000	80,000	2.0%
Open University	14,000	8,000	8,000	10,000	12,000	14,000	15,000	0.4%
UK	2,570,000	2,687,000	2,855,000	2,882,000	3,340,000	3,689,000	4,113,000	100.0%

Source: HESA.

- Examining research grants & contracts on a per capita basis the level in Northern Ireland is higher at £44.7 per 1,000 population, which is higher than the South West (£34.3), the West Midlands (£38.9) and the East Midlands (£41.8) but much lower than the UK average. The per capita level in Scotland and London is very high compared to all other regions.

Table 4.4: Research grants & contracts funding per 1,000 population (£) 2002-2009

Sub category	2002/03	2002/03	2002/03	2002/03	2002/03	2002/03	2002/03
London	87.0	90.6	93.8	103.1	110.4	118.5	131.9
Scotland	67.1	68.0	69.7	74.0	81.8	93.1	108.0
South East	40.4	42.4	43.8	48.0	51.6	57.6	64.9
East	44.9	47.3	50.0	16.0	52.5	58.6	62.7
Yorkshire and the Humber	39.6	41.3	43.7	44.1	48.5	53.5	57.4
North East	34.1	35.2	39.6	38.2	43.1	47.6	52.6
Wales	32.0	32.6	35.2	40.0	42.6	47.5	52.0
North West	30.9	33.0	35.1	38.9	44.6	48.0	51.2
Northern Ireland	24.6	29.8	38.0	40.0	39.6	42.2	44.7
East Midlands	33.3	32.2	32.5	34.5	36.9	39.4	41.8
West Midlands	24.6	26.9	30.7	31.7	32.6	34.9	38.9
South West	20.1	20.9	22.7	25.3	27.4	30.1	34.3
UK	**43.2**	**44.9**	**47.4**	**47.6**	**54.8**	**60.1**	**66.6**

Source: HESA.

4.2.2 Research activities

- Expressed as a proportion of total university income collaborative research activities involving public funding is much higher in Northern Ireland at 6.2% compared to the rest of the UK (2.8%). The level of university income from business and community services is also very high compared to the UK, which is driven by income from regeneration and community schemes representing ERDP and other EU monies. Although within this category the proportion of total income derived from facilities and equipment services from Northern Ireland HEIs is also higher than elsewhere in the UK (at 1.2% compared to 0.4%). The income derived from consultancy contracts is lower than the UK at 1%, although on a par with Wales.

- Interestingly the proportion of income from intellectual property is the highest of all provinces of the UK although this could be skewed by the smaller sample base of universities and those in England may receive more relative income from students for instance (particularly foreign students). However in absolute terms income from IP is higher than Wales and not far behind Scotland, which implies that QUBIS and Ulster Innovation are successful university spin out organisations.

Table 4.5: University income from research activities, £000s and % of total income, 2009/10

Sub category	NI	Scotland	Wales	England	UK
Income from collaborative research involving public funding	32,500	103,800	48,200	564,400	748,800
Total value of contract research	18,200	92,900	29,400	843,000	983,500
Business and community services	33,800	125,300	60,100	1,052,200	1,271,300
Intellectual Property	4,100	6,300	1,600	45,900	57,900
Total income	521,000	2,803,900	1,235,700	22,235,200	26,795,800
As a % of total income Income from collaborative research involving public funding	6.2%	3.7%	3.9%	2.5%	2.8%
Income from contract research	3.5%	3.3%	2.4%	3.8%	3.7%
Business and community services	6.5%	4.5%	4.9%	4.7%	4.7%
Intellectual Property	0.8%	0.2%	0.1%	0.2%	0.2%

Source: HESA HE Business and Community Interaction Survey 2009/10 and Finances of UK HE institutions

Table 4.6: University income from business and community services by sub-category, as % of total income, 2009/10

Sub category	NI	Scotland	Wales	England	UK	2007/08
Consultancy contracts	1.0%	1.6%	1.0%	1.4%	1.4%	400
Facilities and equipment related services	1.2%	0.6%	0.1%	0.4%	0.4%	325
Courses for business and the community	1.4%	1.9%	2.8%	2.2%	2.2%	278
Income from regeneration and development programmes*	2.9%	0.4%	1.0%	0.8%	0.8%	277

Source: HESA HE Business and Community Interaction Survey 2009/10 and Finances of UK HE institutions

4.3 Number of PhDs

- The table below presents the number of PhDs expressed on a per million inhabitant basis. The data on PhDs relates to all subject areas. The rate at around 230 in Northern Ireland is on par with the North East but lower than all other regions except the South West and the West Midlands. The rate in London is particularly high due to the large amount of in commuting.

Table 4.7: Number of PhDs awarded per million inhabitant (2002-2009)

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09
London	327	357	345	419	435	400	448
Scotland	311	313	344	331	348	325	341
Yorkshire & the Humber	268	278	263	262	299	278	293
East	267	273	276	113	300	277	282
South East	248	258	254	255	261	258	267
East Midlands	214	196	242	236	287	250	257
Wales	207	184	222	203	220	224	247
North West	209	217	223	218	242	231	239
North East	207	213	245	239	264	214	232
Northern Ireland	223	202	226	241	225	220	232
West Midlands	211	215	207	188	204	190	193
South West	145	156	147	156	171	151	173
UK	245	251	259	249	284	263	279

Source: HESA.

4.4 University spin off activity

- The HE Business and Community Interaction Survey shows that approximately 2,700 new spin-off companies were set up in 2009/10 in the UK to exploit intellectual property originating in higher education institutions (HEIs). There are 4 categories of spin offs from the survey - spin-offs with some HEI ownership, formal spin-offs, not HEI owned and staff start-ups. Of this the vast majority of new start-up companies (2,423) were set up by staff and recent graduates of HEIs. Unfortunately, in Northern Ireland spin off activity is only captured for the first of these categories and the data is compared to England, Wales and Scotland below.

- The level of university spin offs with some HEI ownership for 2008/09 was fairly high on a per million inhabitant basis but for 2009/10 was below the UK average. Ideally examining total spin offs across all categories would be more appropriate for the CONNECT metrics and it should be investigated further why figures are not collected for graduates, staff and formal spin offs.

Table 4.8: Number of new university spin offs per year - with some HEI Ownership

	Total spin offs		Per million inhabitant	
	2008/09	2009/10	2008/09	2009/10
NI	8	5	4.5	2.8
Wales	7	10	2.3	3.3
Scotland	12	23	2.3	4.4
England	154	168	3.0	3.2
UK	181	206	2.9	3.3

Source: HE Business and Community Interaction (HE-BCI) Survey, 2008/10, HESA and QUBIS and University of Ulster.

4.5 Summary

- In Northern Ireland overall R&D expenditure (GERD) has traditionally been low, measured as a proportion of GDP relative to other UK regions. In recent years Northern Ireland has overtaken Wales and narrowed the gap with Scotland demonstrating significant progress in this area. Although expenditure on R&D by businesses accounts for the highest proportion of R&D expenditure by international standards the proportion is low and expenditure by government and higher education is higher. Furthermore almost three quarters of business expenditure on R&D is conducted by externally owned companies and the government funds a large proportion of the total expenditure by businesses (16%).
- The level of university funding per capita through research grants and contracts has improved over the past 10 years. However, it remains well below the UK average. Interestingly university income data illustrates that intellectual property and business and community services and collaborative research income account for a greater proportion of income than England, Scotland and Wales. Although within business and community services consultancy contracts with business in the HE sector are low.
- The number of PhDs per million inhabitants is low in Northern Ireland compared to the UK average although above a number of regions. The level of university spin-offs are difficult to assess against the UK and it is recommended that the collection of graduate, staff and formal spin-offs is organised to monitor these more effectively for future updates.

Table 4.9: CONNECT - Key innovation metrics

San Diego: CONNECT Key Innovation Metrics	NISP CONNECT: Key Innovation Metrics	ROI
(NI & all UK regions) Private sector research employment	Source	ONS
	R&D (BERD) as % of workplace based GVA	ONS
	R&D personnel as % of total employment	Eurostat
	Number of PhDs per million inhabitant	HESA
	Science & technology graduates as % of employees with degrees	LFS
	HEI Research grants and contracts per 1,000 population	HESA

5 Patent activity

- This chapter examines patent activity in Northern Ireland. The San Diego CONNECT programme measures patent density – the number of patent applications and patent grants per 100,000 residents. This measure is used by the CONNECT programme as a proxy for the level and pace of innovation in the region.

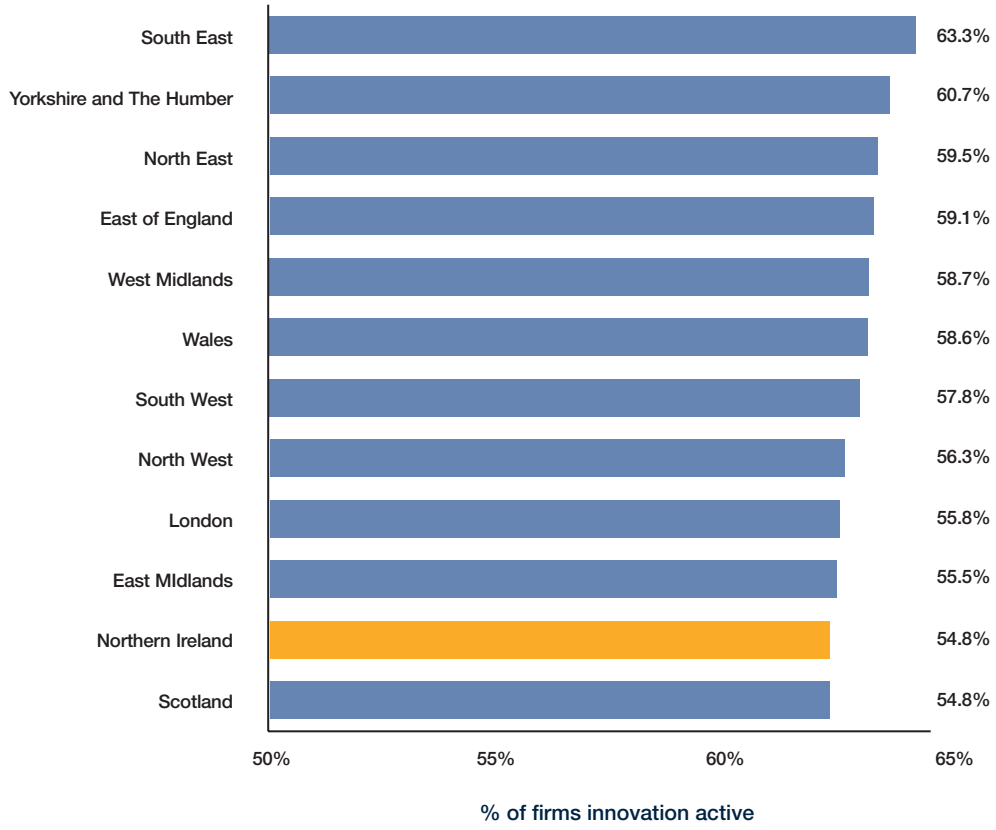
- Patent data (particularly grants) is not as accessible in the UK, however, the OECD does provide data on patent applications to the European Patent Office (EPO), which are the focus of analysis here. In addition a recent study by DETI provides a further overview of patent activity in Northern Ireland. As a precursor the level of companies reporting that they are innovation active is provided for context.

5.1 Innovation activity

- The UK Innovation Survey[20] provides information on the level of 'innovation active' businesses by region. Innovation activity is defined here as where enterprises were engaged in any of the following:
  - Introduction of a new or significantly improved product (goods or service) or process;
  - Engagement in innovation projects not yet complete or abandoned; and
  - Expenditure in areas such as internal research and development, training, acquisition of external knowledge, or machinery and equipment linked to innovation activities.

20 This data is to be supplemented with international comparisons. The UK Business Innovation Survey forms the UK's submission to the EU Community Innovation Survey

Figure 5.1: Percentage of firms reporting that they were innovation active, 2009



Source: UK Business Innovation Survey 2009, BIS

- In Northern Ireland slightly more companies reported themselves product innovators (16.8%) than process innovators (10.6%). For both categories there was a lower proportion of companies reporting 'yes' than any other UK region.

5.2 Patent activity

5.2.3 Context

- Historical patent data is a good source from which to examine technological change as it can be interpreted as an output from R&D. Although they do not cover every kind of innovation, they do include many of them. Patents have become one of the most widely used sources of data in the construction of indicators of inventive output, as they are closely linked to invention and provide detailed information in relatively long time series.

- Nevertheless, patent indicators also have several shortcomings that should be highlighted. Two major drawbacks are that not all inventions are patented and not all patents have the same value. It is widely recognised that the value distribution of patents is skewed: a few patents have a high value, whereas a greater number have a lower value.

- In general, inventors first apply for a patent at their national patent office. Following this, they also have 12 months to apply to another patent office, such as the European Patent Office (EPO).

- The OECD produces regional statistics on patent applications to the European Patent Office (EPO) (derived from the EPO Patstat database) and those filed under the Patent Co-operation Treaty (PCT). Although patent applications are not always granted, each one nevertheless represents the inventor's technical efforts. Patent applications can therefore be considered as an appropriate indicator of inventive activities. It takes, on average, just over four years for a patent to be granted by the EPO.

- The following sections examine the patent activity in Northern Ireland in some detail (based on a key study prepared for DETI[21]) and then the OECD data in order to make comparisons between Northern Ireland and other UK regions.

21 Mapping Organisational Capabilities for Innovation and Competitiveness: Research Performance and Patenting in Small Open Economies, Bradford University School of Management, Manchester Institute of Innovation Research, Manchester Business School and University College Cork, Department of Economics, August 2009.

5.2.1 Northern Ireland patent activity – in depth study

- The study 'Mapping Organizational Capabilities for Innovation and Competitiveness' examines patent activity in Northern Ireland in detail by examining the EPO Patstat database in some detail[22], against the ROI. The total number of applications, grants, inventors and patent owners are examined below including the rates per million inhabitants.

- Overall, the total number of patent applications is highest in the ROI, which at 4,026 per million inhabitants over the period 1999/08 is much higher than in Northern Ireland (2,714).

Table 5.1: Total applications, grants, inventors, and patent owners (1999-2008) and per million inhabitant (average population 1998-2008)

Patent activity	NI	Per million inhabitant	ROI	Per million inhabitant
Applications	2,714	1,585	16,183	4,026
Grants	1,310	765	5,647	1,405
Inventors	545	318	3,557	885
Patent owners	75	44	793	197

Source: Mapping organisational capabilities using Patstat. Supplemented with average population figures 1998-2008 from ONS and OECD.

- The study also examined the ratio of grants to applications to understand how successful organisations were when seeking patent protection. It reports the following ratios: 0.26 for the ROI and 0.32 for Northern Ireland[23]. The number of patent grants by country has varied within the time period, although the average growth (reported in the study) has been higher in Northern Ireland than in the ROI.

22 The EPO database captures patent data for more than 160 countries and patent authorities, including important patent offices such as the US Patent and Trademark Office (USPTO), the Japanese Patent Office (JPO) and EPO. The analysis in the report is based on more than 50,200 patent records corresponding to patents for inventions with at least one inventor or assignee in Northern Ireland, Republic of Ireland, Singapore and New Zealand and granted during the ten year period between 1999 and 2008.

23 These rations are only valid for patent records included in Patstat at the point in time of the study's analysis and do not consider patents filed during this period but that are granted after July 2008.

Table 5.2: Total patent grants for country inventors or assignees

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Average annual growth
Northern Ireland- total	100	103	79	138	131	150	163	175	154	161	8.5%
Per million inhabitant	60	61	47	82	78	89	97	104	92	96	
ROI- total	464	422	430	545	694	670	636	694	682	680	5.7%
Per million inhabitant	124	113	115	146	185	179	170	185	182	182	

Source: Mapping organizational capabilities using Patstat. Supplemented with average population figures 1998-2008 from ONS and OECD.

- The study also examined the differences between the number for country inventors and assignees[24]. Overall for Northern Ireland the number of patents for inventors has always been higher than the number for assignees, which indicates to some extent that the share of local patent inventions are assigned to foreign entities.

- Most of the top 20 national patent assignees for Northern Ireland are companies. Randox Laboratories Ltd tops the analysis, which is a privately owned diagnostic reagent and equipment manufacturing company. The Queen's University of Belfast also has a high share of the country's grants at 10.1%. The top 20 national patent assignees for Northern Ireland are presented below, clearly advanced manufacturing and life sciences (including medical devices and pharmaceutical) companies account for a large proportion of patent grants.

24 Assignee of patent is a person who holds, by a valid assignment in writing, the whole interest of a patent.

Table 5.3: Top-20 granted patent assignees from Northern Ireland (1999-2008)

Rank	Rank	Rank	Organization	Activity
1	85	11.5%	Randox Laboratories Ltd	Diagnostic reagent and equipment manufacturing
2	74	10.1%	The Queen's University of Belfast	University
3	66	9.0%	Short Brothers Plc	Aircraft components and engines company
4	33	4.5%	Norbrook Laboratories Ltd	Pharmaceuticals- veterinary and animal health medicines
5	32	4.3%	Camco Drilling Group Ltd	Mechanical engineering
6	28	3.8%	Uutech Limited	University of Ulster spin out company
7	24	3.3%	Valpar Industrial Limited	Plastic manufacturer
8	18	2.4%	Munster Simms Engineering Limited	Precision engineering (pumps and valves)
9	12	1.6%	European Components Co Limited	Transport equipment manufacturer
10	12	1.6%	Morphy Richards Limited	Professional appliances
11	10	1.4%	Glitspur Scientific Limited	Agriculture- bovine and equine (variety of care)
12	10	1.4%	Sepha Pharmaceutics Limited	Pharmaceuticals
13	9	1.2%	Heartsine Technologies Limited	Medical Devices
14	9	1.2%	University of Ulster	University
15	8	1.1%	E.D. Medical Ltd	Biotechnology
16	8	1.1%	Expotech Limited	Transport equipment manufacturer.
17	8	1.1%	F.G. Wilson	Power generation
18	8	1.1%	T.G. Eakin Limited	Medical devices
19	8	1.1%	Ulster Carpet Mills	Manufacture of textiles
20	7	1.1%	Denroy Group Limited	Plastics manufacturer
	284	38.6%	Other 142 Assigneses	n/a

Source: Mapping organisational capabilities using Patstat. Company activity listed by Oxford Economics.

- The analysis of patent grant inventors and ownership reveals that although there are more foreign owned granted patents in Northern Ireland the proportion of local inventors is much higher than foreign or local/foreign co-inventors. The majority of foreign assignees are reported as being from GB (10%), the US (9%), Ireland (8%) and Canada (7%). In the ROI US ownership is much higher at 22%, which reflects the presence of more US corporations within the business base. Among the top foreign assignees for Northern Ireland patents are Nortel Networks (the Canadian telecommunications company) and Proctor & Gamble (US).

Table 5.4: Patent grant inventors and ownership for selected countries (1999-2008)

	Local Assignee	Foreign Assignee	Local/ Foreign	Local Inventor	Foreign Inventor	Local/ Foreign
Northern Ireland	56.2%	46.7%	6.0%	86.7%	52.8%	39.5%
Republic of Ireland	59.8%	38.9%	5.2%	70.7%	56.8%	28.4%

Source: Mapping organizational capabilities using Patstat. Total share of local and foreign assignees/ inventors may exceed 100 percent due to collaborations (co-assignees or co-inventors) or add up to less than 100 per cent when no data for assignee country is available.

5.2.2 EPO Patent Applications – UK Regional Analysis

- In 2007, there were approximately 5,400 patent applications to the EPO in the UK. Over 1998/2007 the largest number of patent applications to EPO, by inventor address, has overwhelmingly been in the South East and East, accounting for around 38% of the UK total.
- With regard to patents filed per million inhabitants, the rates in the South West and the East are very high, which are evidently driving UK innovation activity. Although Northern Ireland's rate per million inhabitants is low compared to the other UK regions it has been consistently increasing over the period from a very low base in 1998.

Table 5.5: Patent applications per million inhabitants by UK region, 1998-2007

	1998	2002	2007
North East	60	56	51
North West	68	70	55
Yorkshire and the Humber	53	63	62
East Midlands	77	76	85
West Midlands	74	75	52
East	164	176	148
London	75	65	65
South East	144	163	151
South West	96	110	96
Wales	50	41	41
Scotland	59	64	73
Northern Ireland	14	23	35
UK	89	94	89

Source: OECD, EPO Patent applications by inventor.

- The rate of high technology patent applications per million inhabitant is lowest in Northern Ireland, but is very similar to levels in the North East, the North West and Yorkshire and the Humber and Wales. High technology patent applications in the UK are driven by the East and the South East, representing the significant strength in life sciences.

Table 5.6: High technology patent applications per million inhabitant, 1998-2007

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
East	111	113	103	123	100	92	84	84	74	70
South East	74	90	101	77	90	89	86	80	74	68
South West	50	69	68	71	55	50	52	44	41	41
UK	42	47	51	49	44	41	39	39	36	35
London	46	52	53	48	38	33	34	35	32	33
Scotland	32	28	34	44	35	35	34	35	36	31
East Midlands	23	29	30	27	22	21	16	24	18	22
Wales	17	16	19	23	16	16	16	14	12	15
North East	6	7	12	11	14	14	9	11	12	14
North West	23	20	26	18	18	14	13	17	12	14
West Midlands	20	18	23	23	23	22	18	13	18	14
Yorkshire and the Humber	10	23	23	21	17	15	15	16	11	13
Northern Ireland	8	10	16	20	12	12	19	12	18	12

Source: OECD, EPO Patent applications by inventor. High technology patents cover ICT, Biotechnology and Nanotechnology (data for environmental technology was not available).

- Although the volume of patent applications from Northern Ireland on a per capita basis is very low encouragingly there is a high proportion of applications relating to high technology products/ services. Indeed 14.3% of all patent applications over 1998-2007 were within Biotechnology, which was the highest of all regions. Therefore, within some of the fastest growing innovation sectors in the global economy, the Northern Ireland economy is punching above its weight and developing products designed to compete in export markets.

Table 5.7: ICT, Biotechnology and Nanotechnology patent applications as % of total patent applications over 1998-2007

	ICT	Biotechnology	Nanotechnology
South West	46.5%	4.8%	0.8%
London	43.7%	12.9%	0.8%
South East	43.5%	7.2%	0.8%
East	43.1%	11.2%	1.3%
Scotland	39.0%	12.8%	1.0%
Northern Ireland	31.2%	14.3%	0.5%
Wales	25.4%	10.3%	0.5%
West Midlands	24.0%	3.1%	0.6%
East Midlands	21.9%	5.3%	0.6%
Yorkshire and the Humber	19.4%	6.7%	0.7%
North West	17.8%	7.0%	0.7%
North East	13.8%	5.1%	0.9%
UK	35.9%	8.1%	0.8%

Source: OECD, EPO Patent applications by inventor.

5.2.3 EPO patents per million inhabitant by national economies

- The table below examines EPO patents per million inhabitants by national economy for 2010. In relative terms, Switzerland reported the highest number of patent applications per million inhabitants (441), followed by Sweden (319), Finland (250) and Denmark (233). The rate in the UK is much lower at 90 although in absolute terms accounts for the highest number of applications excluding the US.
- The OECD provides data on patent applications by selected high technology sectors to the EPO, which are highlighted below for 1998-2007 (2008 data is not yet available). Overall, ordered by ICT patent applications per million inhabitants the rate is particularly high in Finland (skewed by Nokia) at 1,365 and the Netherlands, Switzerland and Sweden (all above 800), which is significantly above the rate in the US (442) and the UK (338).

Table 5.8: EPO Applications and granted applications to the USPTO by country, selected years and selected countries

	Patent applications to the EPO			High technology patent applications to the EPO			Patents granted by the US		
	(number of patent applications)		(per million inhab.)	(number of patent applications)		(per million inhab.)	(number of patents granted)		(per million inhab.)
	2003	2008	2008	2003	2008	2008	1999	2004	2004
Switzerland	2,762	3,351	441	355	205	27	1,547	896	121
Sweden	2,029	2,928	319	456	337	37	1,816	540	60
Finland	1,278	1,327	250	578	199	38	1,199	636	121
Denmark	1,071	1,275	233	260	106	19	574	349	65
Austria	1,358	1,932	232	224	99	12	645	426	52
Netherlands	3,459	3,711	226	1,012	342	21	1,553	1,227	75
Belgium	1,340	1,519	142	278	205	19	805	484	46
EU-27	50,462	59,468	120	10,446	5,375	11	31,541	18,153	32
Norway	342	563	119	69	19	4	306	194	42
United States	32,601	31,602	104	11,150	2,967	10	105,015	83,784	283
United Kingdom	5,555	5,511	90	1,399	482	8	4,524	2,195	37
Iceland	31	28	89	13	2	8	33	18	62
Ireland	223	324	74	51	37	8	221	179	43
Slovenia	73	119	59	6	8	4	115	10	5
Estonia	11	35	26	7	1	1	5	8	6

Source: Science, Innovation and Technology in Europe, 2010, Eurostat. NI figures supplemented from OECD database. Data is available from Eurostat for national economies only. High technology patent applications are a subset of patents defined by Eurostat. A full definition is in Annex B.

Table 5.9: EPO Applications by selected technologies, 1998-2007 and per million inhabitants (average 1998-2007 population)

	ICT		Biotechnology		Nanotechnology	
	No. of applications	per million inhabitant	No. of applications	per million inhabitant	No. of applications	per million inhabitant
Finland	7,113	1,365	411	79	44	8
Netherlands	15,128	938	2,239	139	339	21
Switzerland	6,780	927	1,453	199	202	28
Sweden	7,996	892	1,194	133	143	16
US	127,801	442	33,990	118	3854	13
Denmark	2,358	438	1,727	321	43	8
Austria	2,924	359	721	88	75	9
United Kingdom	20,144	338	4,535	76	468	8
Belgium	3,397	327	1,402	135	140	14
Iceland	86	296	53	183	7	24
Norway	1,148	252	279	61	29	6
Ireland	909	228	170	43	18	5
New Zealand	378	94	260	65	10	3
Northern Ireland	161	94	74	43	3	2
Slovenia	106	53	42	21	8	4
Estonia	59	43	26	19	2	1

Source: EPO applications, OECD.

5.3 Summary

- Patent activity is used by CONNECT in San Diego as a proxy for the level and pace of innovation in the region. Over the past decade patent applications from Northern Ireland have been very low compared to all UK regions and internationally. They have also been dominated by a few organisations rather than across the economy.

- Encouragingly, although the volume of patent applications is very low those applications from biotechnology and ICT in Northern Ireland do account for high proportions of the total.

- The following key innovation metrics are proposed for monitoring the CONNECT programme, which can be updated on an annual basis.

Table 5.10: CONNECT - Key innovation metrics

San Diego: CONNECT Key Innovation Metrics	NISP CONNECT: Key Innovation Metrics (NI & all UK regions)	Source
Patent activity- applications and grants	% of firms stating that they are innovation active	CIS
	Number of patent applications per million inhabitant (to the EPO)	EPO
	Number of high technology patent applications per million inhabitant (to the EPO)	EPO

6 Conclusions

- The Northern Ireland Knowledge Economy Index: Baseline report 2011 is a status report on the health of the nation's Innovation performance and infrastructure. The report draws on current data to present an overview of specific trends in research, technology and innovation and show how Northern Ireland compares both regionally and internationally in specific areas. The key innovation metrics presented in the report are to be updated annually to track the health of the Northern Ireland knowledge economy.

- The CONNECT Programme, run from NISP, is based on the highly respected San Diego CONNECT initiative and focuses on fostering entrepreneurship by accelerating the growth of promising technologies and early stage companies.

- The intention is that the results will provide a greater awareness of how Northern Ireland ranks on key metrics and provide stakeholders of the CONNECT Programme with a body of evidence to assist in constructing an 'agenda for action' that the public and private sectors can use to help create the appropriate conditions for knowledge based growth in Northern Ireland. The list of key innovation metrics to be taken forward are summarised at the end of this Executive Summary in Table 1. The implications and key messages of the baseline report for the knowledge economy in Northern Ireland and those involved in the sector and the CONNECT initiative are summarised below.

6.1 Economic context

- In the past three years the Northern Ireland economy has suffered a contracting economy, a house price collapse, increased unemployment and an end to the growth in public expenditure. Due to its overreliance upon the public sector as an engine of growth over the past forty years the local economy is particularly exposed to the 'aftershocks' of the global recession.

- The current economic context is set against a backdrop of low consumer sentiment, cautious business investment, and an increasingly competitive market for internationally mobile companies and austerity measures in the public sector curbing spending growth.

- To recover and move towards a more sustainable growth path, new sources of growth are urgently needed that are based on innovation and trading internationally in global markets.

6.2 The innovation agenda in Northern Ireland

- The approach to Innovation policy in Northern Ireland is somewhat blurred. Although innovation is prominent in most Government strategy documents, the Regional Innovation Strategy for Northern Ireland was published almost a decade ago. Innovation is concentrated in high-tech industry which is dynamic, ever evolving and rapidly changing with new markets developing all the time. . However, it is not only the industry that has changed – the Northern Ireland economy is fundamentally different than it was a decade ago and faces an entirely different set of challenges in today's global marketplace.

- The nature of government support is changing in Northern Ireland with the ability to provide grants to firms for capital projects through the Selective Financial Assistance Programme ending in 2013 and EU funding programs evolving in response to shifting economic priorities. With an ever more connected global economy providing ever more aggressive global competition the need to innovate and to look beyond local shores for opportunities is very evident. In aspects of the knowledge economy Northern Ireland holds a comparative advantage but the competition is increasing all the time. Developing this aspect of the economy which is harder for developing nations to compete for, at least initially, will be essential to ensuring economic growth and continued prosperity.

- In today's economic climate without the cushion of a public sector with an abundance of available finance, a strong innovation policy with a clear strategic direction led by the private sector is more important than ever.

6.3 Sizing the 'knowledge economy'

- The Northern Ireland economy is dominated by the public sector, which accounts for over a third of employment and has done since the start of the troubles. Therefore Northern Ireland, relatively, has a smaller private sector in comparison to other UK regions and correspondingly has one of the smallest 'knowledge economies' in the UK. The 'knowledge economy' in Northern Ireland is estimated to account for approximately 4.4% of total employment and 2.5% of the local business stock, compared to 5.7% and 7.1% respectively in the UK.

- Sectors in which Northern Ireland has a relatively large footprint in the 'knowledge economy' include 'transport and defence' with firms such as Bombardier and BE Aerospace located locally, and in the IT sector, particularly the 'manufacture of computing and electronics' and 'software & digital content'. There are also a number of leading 'life sciences' companies such as Almac and Norbrook embedded in the Northern Ireland economy.

- Despite the small nature of the 'knowledge economy' it plays a crucial role in the economy and is a key contributor to productivity growth. A Knowledge economy worker will, on average, earn a 52% wage premium above the Northern Ireland mean wage and average productivity is over double.

- Additionally, the 'knowledge economy' has wider economic impact through indirect and induced effects via business to business expenditure through the supply chain and consumer expenditure resulting from increased income. It is estimated that although the knowledge economy in Northern Ireland is relatively small at just 30,600, the sector supports an additional 27,000 jobs through indirect and induced effects. The ability to reduce imports in the supply chain provides the potential for even higher multipliers as the sector grows and attains a critical mass.

6.4 Investment Activity

- Access to finance is a key constraint for business-led innovation, which is inherently risky and may require a long-term horizon. Well-functioning venture capital markets and other investment such as 'business angels' are key sources of finance for many innovative start-ups and need to be developed further. The facilitation of investment through venture capitalists was a vital component of the San Diego transformation and the CONNECT programme.

- The capital flows of investment into Northern Ireland are comparatively very low against all activity investigated- private equity investment flows, M&As and ECM deals and business angel investment.

- Access to finance is a key factor in the innovation process and facilitating the interaction between venture capital and start ups is vital to this. The supply of venture capital has not been comprehensively reviewed here and arguably the lack of supply of venture capital funds could be a key constraint on uptake, rather than lack of demand. The dynamics of the venture capital market should be explored further to understand how the levels of investment in Northern Ireland can be improved.

- Business Angel Investment is becoming an increasingly important source of private equity finance for local businesses. In 2010/11 Angel Investment has more than doubled from £0.8m in 2009/10 to £2.2m in 2010/11. The increase has been driven by a larger number of small deals.

- Northern Ireland is an economy based upon small to medium sized enterprises with 98.2% of businesses employing less than 50 people. There are currently only 3 publically listed companies from Northern Ireland. This compares to 60 in the Republic of Ireland and 129 in Scotland indicating that NI has much fewer 'leading' companies than would be expected after adjusting for its small population size. Similarly private equity investment at more mature stages of the business cycle (MBO/MBI and Replacement Capital) is also very low.

- With small businesses being squeezed by stricter lending criteria in the aftermath of the global financial crisis, private equity finance through venture capital and business angel investment will become increasingly important for 'cash hungry' innovative businesses in the 'knowledge economy'.

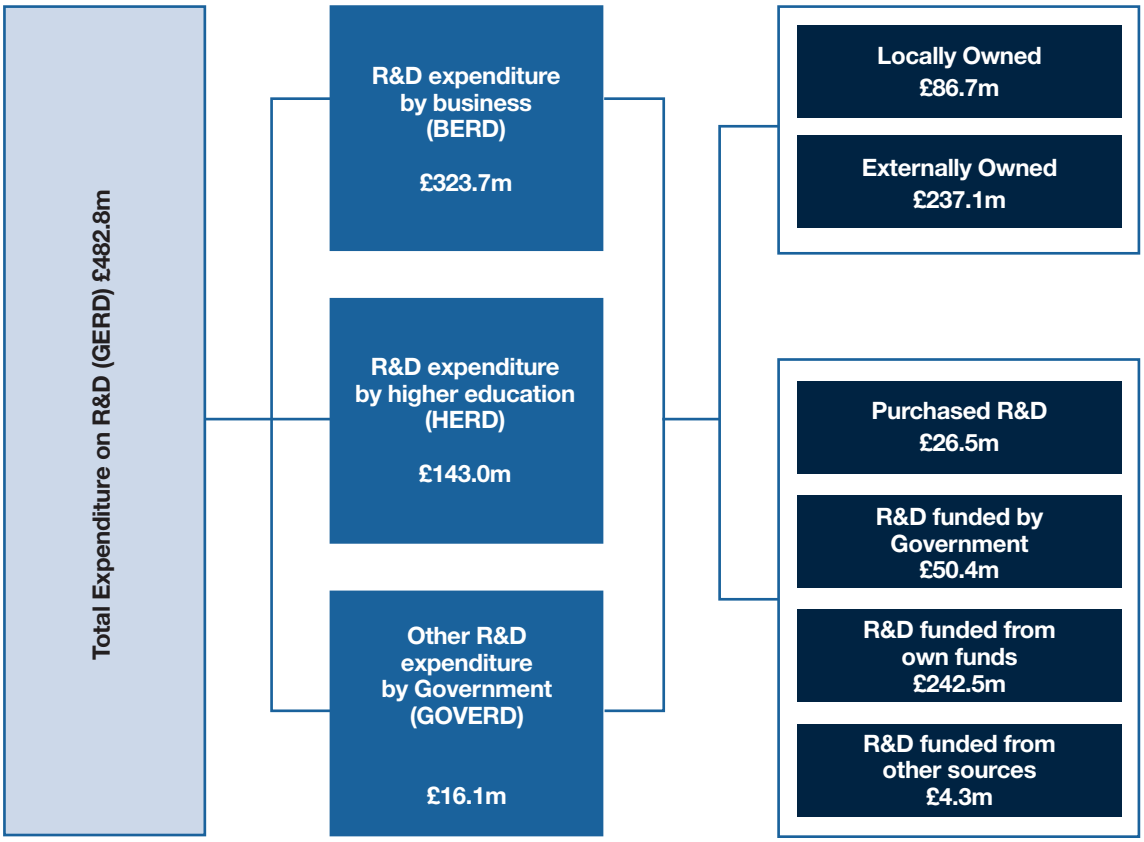
6.5 Research and development activity

- The link between research and development (R&D) activity and innovation and the resulting impacts on productivity are well established in the economics literature, which is reflected in the increasing policy emphasis on R&D in both developed and developing economies across the globe.

- In Northern Ireland overall R&D expenditure (GERD) has traditionally been low measured as a proportion of GDP relative to other UK regions, varying between 1.1-1.2% of GVA in the six years to 2007. This compares to 1.8% and 3.9% in the ROI and Finland. However, in recent years Northern Ireland has overtaken Wales and narrowed the gap with Scotland demonstrating progress in this area.

- Overall R&D expenditure is dominated by Government (GOVERD) and higher education expenditure (HERD). In Northern Ireland this accounts for over half of R&D expenditure – which is extremely high by international standards. The schematic in Figure 1 below illustrates the structure of R&D activity in Northern Ireland.

Figure 6.1: The structure of R&D activity in Northern Ireland (2009, DETI)



- Companies in Northern Ireland depend on government support in financing BERD to a higher degree than other national economies. The proportion of BERD financed directly by Government in NI is over twice the equivalent proportions for the UK and the OECD average. Almost three quarters of business expenditure on R&D in Northern Ireland is conducted by externally owned companies. Considering the fact that, on average, the Government funds 17 pence of every £1 spent on R&D this implies minimal spending on R&D by indigenous companies – estimated at less than 15% of Gross Expenditure on R&D.

- In total the public sector accounts for 44% of all R&D spending in Northern Ireland, which is very high by international standards – and an unsustainable proportion if R&D spending in Northern Ireland is to reach levels comparable with leading innovative regions such as the Nordic countries or the United States. In other words, if R&D expenditure is to reach benchmarks close to those set by leading economies future spending on research and development will need to be driven by the private sector.

- The idea that 'market failures' related to access to finance lead to under-investment in research has long been the principal rationale for government funding of research and development (R&D). However, the presence of other failures that impede the operation of the innovation system can also constitute crucial obstacles to the effectiveness of the innovation effort (e.g. skills shortages).

6.6 Research activity in universities

- The level of funding per capita through research grants and contracts has improved over the past 10 years. However, it remains well below the UK average. Interestingly University income data illustrates that intellectual property, business and community services and collaborative research income account for a greater proportion of income than in England, Scotland and Wales.

- The latter point is increasingly important as innovation also rarely occurs in isolation. It is a highly interactive and multidisciplinary process and increasingly involves collaboration by a growing and diverse network of stakeholders, institutions and users. In small open economies firms and institutions often lack sufficient critical mass when trying to compete in global markets in isolation. However, industry-academic and inter-industry collaborations can often act as enablers for firms to compete in global markets that they would otherwise have been excluded from as well as the different skill profiles of different companies complementing each other in new product development.

- The major policy challenge is to recognise the essential role of universities in the innovation and enterprise rather view them simply as providers of essential public goods. This requires a greater focus of policy makers on ensuring independence, competition, excellence, entrepreneurial spirit and flexibility in universities. It also relies on increasing collaboration between universities and business and the commercialisation of research ideas.

6.7 Patent Activity

- Patents are a good indicator of the degree of entrepreneurialism in an economy as essentially patents are designed to protect the intellectual property rights of new inventions and products being designed for commercial purposes. In the past decade the number of patents granted per capita has been half that of the Republic of Ireland.

- Although patents granted per capita has grown by 8.5% per annum over the past decade, the overall level of patent activity (measured by patent applications) in Northern Ireland remains the lowest of the UK regions. This is further highlighted by the fact that almost a third of all patents granted in the past 10 years have been by three organisations (Randox, the Queen's University of Belfast and Short Brothers).

- Northern Ireland also ranks bottom of the UK regions with regard to 'high technology' patents granted per capita. However, within the patent applications submitted by Northern Ireland over the period 1998/2007 patent applications within ICT and biotechnology account for 31.2% and 14.3% of total applications respectively. For biotechnology this proportion was higher than all other UK regions.

- Therefore, within some of the fastest growing innovation sectors in the global economy, the Northern Ireland economy is punching above its weight and developing products designed to compete in export markets.

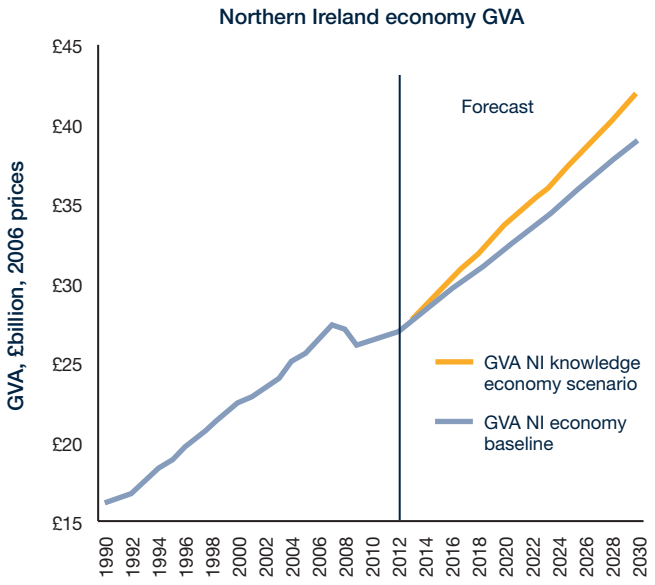
6.8 Aspiring to transform

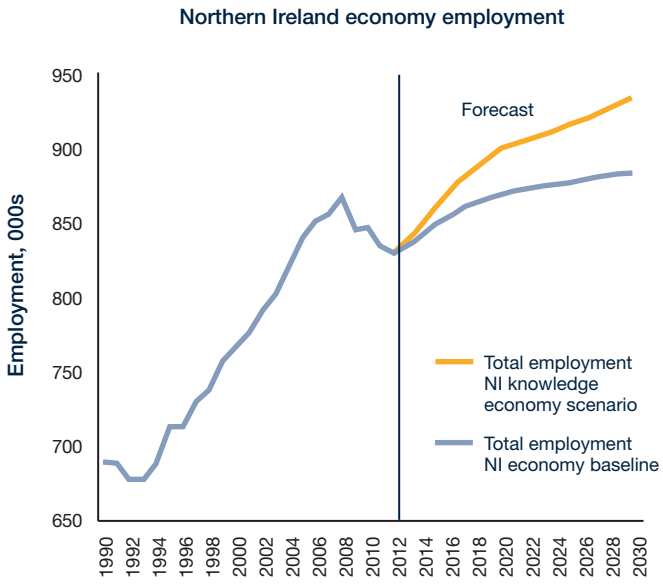
- The key CONNECT innovation metrics to take forward, based on the San Diego model, are listed in Table 6.1. These should be updated on an annual basis to track the health of the Northern Ireland knowledge economy.

- For illustrative purposes Table 6.2 examines the growth implications for Northern Ireland against the innovation metrics of moving up towards the UK and best performing regional levels. Overall the transformation required to make Northern Ireland the most knowledge intensive region of the UK is:
  - 25,500 more people employed directly in the knowledge economy
  - 6,000 more knowledge economy businesses
  - £800m more spent on R&D annually
  - 200 more PhD students per annum
  - 42,000 more science and technology graduates working in the economy
  - 200 more patent applications annually

- To achieve this step change in the Northern Ireland economy would have a material effect on the economy. The indicative scenario NI knowledge economy scenario below is a variant on the Oxford Economics regional model based on assuming that the knowledge economy in Northern Ireland transforms (25,500 additional jobs) and clearly shows that the transformation would have a material effect on the economy by 2030. A further 24,000 jobs in the economy would be created as businesses make purchases and staff spend their wages, which would generate an additional £3 billion in GVA. This scale of change would have a profound impact on the Northern Ireland economy, helping to close the productivity gap with the UK.

The impact of a knowledge transformation-baseline and scenario forecasts





- Moving forwards, the tougher UK macroeconomic environment and implications for public expenditure means that a transformation of the Northern Ireland economy is imperative. Although Northern Ireland does lag behind at present there are some strengths within the sector and the wider economy (low wages coupled with high skills) and a diverse platform to build on.

- Competition in the global economy is strengthening all the time and it is essential that Northern Ireland can compete on knowledge and ideas. If Northern Ireland does not innovate and sell on the basis of its innovation then other places will (such as those strong European countries) and the region will be left further behind. Understanding how Northern Ireland compares is the first step in building an evidence base to set a trajectory of ambition and identify market failures and potential roles for policy, programmes and business led initiatives. San Diego went from a failed city to one of the most successful cities in the world, which should inspire Northern Ireland to look towards emulating this transformation to become one of the UK's most innovative regions.

Table 6.1: CONNECT - Key innovation metrics

Key Indicators	NI- Current position	UK	NE	NW	YOH	EM	WM	EE	L	SE	SW	W	S	Baseline date & source
Knowledge Economy- Core characteristics (CONNECT definition)														
Knowledge economy employment, as % of total employment	**4.4%**	5.7%	6.3%	5.3%	4.4%	5.1%	6.1%	6.2%	5.4%	**8.1%**	6.2%	4.6%	4.2%	2009, BRES/Census of Employment
knowledge economy businesses, as % of total business stock	**2.5%**	7.1%	5.5%	6.1%	5.4%	5.9%	6.3%	8.1%	9.6%	**9.7%**	6.5%	4.3%	5.6%	ABS/ONS, 2010
Knowledge economy business start ups per 100,000 population*	**11**	36	22	27	22	24	27	41	**73**	**50**	30	17	25	IBDR/ONS, 2009
Knowledge economy average wage level	**£32,800**	£41,600	£33,100	£35,700	£33,400	£38,600	£35,400	£44,400	**£53,700**	**£49,200**	£37,600	£35,400	£33,500	LFS/ASHE, 2010
Investment Activity														
Number of private equity investments and venture capital investments (number of companies)	**20**	823	46	66	50	37	72	47	**212**	**125**	46	41	61	BVCA, 2010
Number of private equity investments per 100,000 VAT registered businesses	**24**	32	**61**	26	27	21	34	19	54	32	19	36	32	BVCA, 2010
Number of venture capital investments per 100,000 VAT registered businesses	**17**	15	21	12	7	10	20	11	**24**	18	9	23	12	BVCA, 2010
M&A activity: Number of M&A and ECM deals per 100,000 VAT registered businesses	**380**	1,800	1,950	1,240	**2,680**	530	530	2,330	**3,340**	1,220	2,460	960	1,890	Experian/Corpfin, 2010
Public listed companies: Market capitalisation per head	**£200**	£29,300	n/a	£10,400	n/a	n/a	n/a	£11,500	£162,300	**£22,600**	£7,700	£1,600	**£14,500**	LSE, 2011
R&D and Research Activity														
R&D as % of workplace based GVA	**1.7%**	2.1%	1.4%	2.3%	1.2%	1.9%	1.4%	**4.6%**	1.1%	3.0%	2.1%	1.4%	1.9%	ONS Regional Competitiveness Indicators, 2009
R&D (BERD) as % of workplace GVA	**1.1%**	1.2%	0.8%	1.7%	0.5%	1.3%	1.0%	**3.6%**	0.3%	2.0%	1.3%	0.7%	0.6%	ONS Regional Competitiveness Indicators, 2009
R&D personell as % of total employment	**1.0%**	1.2%	1.0%	1.0%	0.8%	1.1%	0.9%	**1.7%**	1.2%	1.6%	1.1%	0.8%	1.1%	Eurostat, 2008
Number of PhDs per million inhabitant*	**232**	279	232	239	57	42	193	**282**	**448**	267	173	247	341	HESA, 2009
HEI Research grants and contracts per 1,000 population*	**45**	67	53	51	57	42	39	63	**132**	65	34	52	**108**	
Number of science and technology graduates (NVQ Level 4+) as % of total employment	**7.6%**	10.2%	9.0%	9.5%	7.7%	9.4%	8.6%	10.2%	13.0%	10.9%	10.0%	7.8%	**13.1%**	LFS, 2010
Innovation and Patent Activity														
% of firms stating that they are innovation active	**54.8%**	58.2%	59.5%	56.3%	60.7%	55.5%	58.7%	59.1%	55.8%	**63.3%**	57.8%	58.6%	54.8%	BIS, 2009
Number of patent applications per million inhabitant (to EPO)	**35**	89	51	55	62	85	52	148	65	**151**	96	41	73	OECD, 2007
Number of high technology patents per million inhabitant (to EPO)	**12**	35	14	14	13	22	14	70	**33**	68	41	15	31	OECD, 2007

Magenta shading denotes region with highest value

* In some instances London is a sigicant outlier and the data is skewed by commuting patterns hence the second highest region is also highlighted

Table 6.2: CONNECT- Selected key innovation metrics, illustrative growth

Key Indicators	Current position	Increase needed to reach UK level	Increase needed to reach top performing UK region*
Knowledge economy employment, number of employees	30,500	9,000	25,500
knowledge economy businesses, total no. of businesses	2,000	4,000	6,000
Knowledge economy business start ups (number of companies)	200	400	700
Knowledge economy average wage level	£32,800	£37,400	£40,200
INVESTMENT ACTIVITY			
Number of private equity investments (number of companies)	20	3	27
Number of venture capital investments (number of companies)	14	n/a	6
Number of M&A and ECM activity (number of companies)	30	100	280
R&D AND RESEARCH ACTIVITY			
Total expenditure on R&D, £million	£500	£100	£800
Total expenditure on Business R&D (BERD), £million	£300	£50	£750
R&D personnel, number of employees	6,500	900	2,500
Number of PhDs per annum*	400	100	200
HEI Research grants and contracts, £000s*	£79,956,000	£39,106,000	£113,231,000
Number of science and technology graduates (NVQ Level 4+)	57,000	20,000	42,000
INNOVATION AND PATENT ACTIVITY			
% of firms stating that they are innovation active	46,000	3000	7,000
Number of patent applications to EPO	60	100	200
Number of high technology patents applications to EPO	20	40	100

Top performing region comparison denotes region with highest value, except for knowledge economy business start ups where London acts as an outlier in the data, which is largely due to commuting patterns. In addition for the average wage levels due to the differences in the cost of living the aspirational figures for the UK and London (the highest region) have been adjusted to 75% and 85% of the total.

Annex A: Knowledge economy sector definition

- The definition of the knowledge economy has been based on that used to define the industrial clusters covered by the CONNECT Innovation report for San Diego.
- The San Diego clusters include the following: Biomedical Products, Biotechnology & Pharmaceutical, Communications Equipment Manufacturing, Computer & Electronics, Defence and Transportation, Environmental Technology, Recreational Goods, Software and Other Technical Consulting.
- These clusters are based on the definitions used by the San Diego Association of Governments (SANDAG), which use North American Industry Classification System (NAICS) codes.
- The definition here has been based on matching UK Standard Industrial Classification (SIC) codes, used to classify economic activity in the UK, to the NAICS codes. In addition there were a number of CONNECT sectors removed or merged as either SIC codes did not cover them appropriately or there was duplication of SIC codes across sectors, which would have double counted the figures. Therefore the final sectors and their definitions were identified as follows:

Table A.1: Knowledge economy definition

Sector	SIC Definition
Medical Devices	26600 Manufacture of irradiation, electromedical and electrotherapeutic equipment
	32500 Manufacture of medical and dental instruments and supplies
	26701 Manufacture of optical precision instruments
	74202 Other specialist photography
	72190 Other research and experimental development on natural sciences and engineering
	26511 Manufacture of electronic instruments and appliances for measuring, testing, and navigation, except industrial
	26513 Manufacture of non-electronic instruments and appliances for measuring, testing and navigation, except industrial
	26600 Manufacture of irradiation, electromedical and electrotherapeutic equipment
	32500 Manufacture of medical and dental instruments and supplies
	26701 Manufacture of optical precision instruments
Pharmaceuticals/Biotechnology	21100 Manufacture of basic pharmaceutical products
	21200 Manufacture of pharmaceutical preparations
	72110 Research and experimental development on biotechnology

Software & digital content	58210 Publishing of computer games
	58290 Other software publishing
	62011 Computer programming activities
	62012 Business and domestic software development
	63120 Web portals
	18201 reproduction of sound recording
	18202 reproduction of video recording
	18203 reproduction of computer media
IT Services	62020 Computer programming, consultancy and related activities
	62030 computer facilities management
	62090 other information technology and computed service activities
	63110 Data processing, hosting and related activities
Communications	26301 Manufacture of telegraph and telephone apparatus and equipment
	26309 Manu of communications equipment
	61900 Other telecommunications activities
Computing and advanced electronics	26200 Manufacture of computers and peripheral equipment
	26512 Manufacture of electronic industrial process control equipment
	26110 Manufacture of electronic components and boards
	26400 Manufacture of consumer electronics
	26512 Manufacture of electronic industrial process control equipment
	27110 Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus

	27200 Manufacture of batteries and accumulators
	27310 Manufacture of fibre optic cables
	27900 Manufacture of other electrical equipment
Other technical consultancy services	71121 Engineering design activities for industrial process and production
	71122 Engineering related scientific and technical consulting activities
	71200 Technical testing and analysis
	74100 specialised design activities
	74901 Environmental consulting activities
	28131 Manufacture of pumps
	28132 Manufacture compressors
	28150 Manufacture of bearings, gears, gearing and driving elements
	29100 Manufacture of motor vehicles
	29201 Manufacture of bodies
	29202 Manufacture of trailers and semi-trailers
	29310 Manufacture of electrical and electronic equipment for motor vehicles
	29320 Manufacture of other parts and accessories for motor vehicles
	30110 Building of ships and floating structures
	30120 Building of pleasure and sporting boats
	30200 Manufacture of railway locos
	30300 Manufacture of air and spacecraft and related machinery
	30400 Manufacture of military fighting vehicles

- The following table presents the Eurostat definition of high technology sectors, which is similar to the CONNECT sectors and is used to make international comparisons in Chapter 2.

Table A.2: Eurostat definition- High Technology Sectors

Sector	SIC Definition
High-technology Manufacturing	24.4 Manufacture of pharmaceuticals, medicinal chemicals and botanical products. 30 Manufacture of office machinery and computers. 32 Manufacture of medical, precision and optical instruments, watches and clocks 35.3 Manufacture of aircraft and spacecraft
High-technology Services	64 Post and telecommunications 72 Computer and related activities 73 Research and development

NISP tenants and employment

- The total level of employment at NISP based on tenants which predominantly operate in the CONNECT sectors is 1,380. The largest employers are Citigroup (375), Fidessa (54), L&T Infotech (45) and Meridio (60). The total number of businesses present at NISP is 98.

Annex B: Technical Notes

BVCA data

- The British Venture Capital Association (BVCA) data is obtained from their members. Overall a 97% response rate was achieved by BVCA, which includes virtually every major private equity firm in the UK. In order to ensure only qualifying investments were included in the analysis certain criteria were applied to the data received and are outlined below.

- The BVCA survey includes all investments 'made' or 'advised by' the BVCA full member firm, 'regardless of whether the investing fund is UK or overseas-based'. This means that the figures relate to investments undertaken by BVCA full member firms based in the UK, and also to those undertaken through an overseas office where the UK office was the lead adviser, regardless of where the investment fund was domiciled. As a result, more cross-border investments have been included in the BVCA data which therefore reflect more accurately the activity of BVCA full members, particularly those that invest through pan-European or global funds.

Private Equity Definitions

- The term private equity is generally used in Europe to cover the industry as a whole, including both buyouts and venture capital. Venture capital is a subcategory covering the start-up to expansion stages of investment.

- Private equity describes equity investments in unquoted companies, often accompanied by the provision of loans and other capital bearing an equity-type risk.

Additional VC Data

- As raised in the main report there are considerable concerns about using BVCA data given that not all VC companies in Northern Ireland are members.

- The following data has been obtained from the Chartered Accountants Ireland Ulster Society regarding venture capital into Northern Ireland in 2010. Overall in 2010 total flows of venture capital are estimated to be approximately £8 million. The flows collected from the Irish Venture Capital Association demonstrate that funds in the Republic of Ireland are considerably higher.

Table B.3 Estimated VC Investment in Northern Ireland, 2010

Data Source	Fund name	Other Investor(s) who made co-investments	Value co-invested	Total capital invested by the fund
Directly from HALO	HALO	Numerous		1,662
Directly from CFM	Clarendon Fund Managers	Other VC's (excl local), Privates, UK Funds	1,715	280
IVCA and Direct	Crescent Capital	Siemens in Axis 3	1,000	3,155
BVCA	Enterprise Equity		1,000	900
Directly from Esynergy	e-Synergy	Privates, etc	300	680
	Innovation Ulster Limited (UoU)			393
	Totals invested above in deal range 0-5m		**4,015**	**7,070**
	Other known deals not included above			
	Sophia Search	Privates		900
		TOTAL Capital invested		**7,970**

Table B.4: IVCA Venture Pulse 2010 - Funds raised by Irish SMEs

2010	€ '000
Disclosed	247,159
Undisclosed	63,052
Total	310,211

Source: Chartered Accountants Ireland Ulster Society.

M&A and ECM data

- M&A refers more specifically to mergers and acquisitions, but will include Acquisition, Acquisition - Tender Offer, Demerger, Development Capital, Divestment, Employee Buy-In, Employee Buy-Out, Investor Buy-In, Investor Buy-Out, Investor Buy-Out Tender Offer, Leveraged Buy-Out, Management Buy-In, Management Buy-In / Buy-Out, Management Buy-Out, Merger, Minority Stake, Minority Stake - Tender Offer, Reverse Takeover and Secondary Buy-Out.

Enterprise Investment Scheme

- The Enterprise Investment Scheme (EIS) is a UK scheme which is designed to help smaller higher-risk trading companies to raise finance by offering a range of tax reliefs to investors who purchase new shares in those companies. The uptake of companies accessing the scheme is another indicator of the level of investment from angels to innovative start-up businesses; overall the Annual Report on the Business Angel Market reports that approximately 70% of angels take advantage of EIS[25].
- The following data explores the number of companies that have taken advantage of the EIS by region and the level of investment obtained. Overall the number of companies accessing the scheme in Northern Ireland is very low compared to the UK average although the rate is also low in Wales, Yorkshire and the Humber and the North East. The level has been consistently high in London, the South East, Scotland, the East of England and the South West.

Table B.5: Enterprise Investment Scheme, amount of funds raised, £m

	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09
London	431	243	179	199	205	206	315	285	224
South East	189	129	149	100	107	152	127	108	96
Scotland	54	40	39	46	45	47	43	54	32
East of England	68	51	40	40	45	51	58	54	31
North West	79	68	51	80	48	51	47	46	26
Yorkshire & the Humber	40	38	36	20	21	19	18	38	21
West Midlands	35	37	46	37	29	23	30	23	19
South West	70	58	46	38	28	35	37	45	19
North East	17	18	24	12	17	12	14	15	13
East Midlands	56	25	23	16	22	27	22	15	11
Wales	17	11	12	9	7	8	12	15	8
Northern Ireland	10	43	22	30	29	17	8	8	4
UK	1,065	761	667	627	606	647	732	706	503

Source: HM Revenues & Customs, claims received by November 2010

25 Annual Report on the Business Angel Market in the UK, p.8

- The Halo scheme is still relatively new in NI and as of yet does not capture a significant share of UK EIS deals. The figures are higher than the angel deals above as Halo covers mostly start-up companies and many of the deals taking advantage of EIS will not be captured under the scheme.

Table B.6: Enterprise Investment Scheme, number of companies taking up the scheme by region and per million inhabitant

	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09
London	137.1	111.6	92.0	87.0	86.3	87.6	94.1	90.0	76.7
South East	75.8	64.9	58.4	50.1	49.9	50.3	50.2	50.6	41.8
Scotland	52.9	44.8	36.8	33.2	36.8	34.2	30.5	32.7	27.5
East of England	52.7	39.4	37.8	32.0	30.4	33.0	31.1	33.8	26.2
South West	51.7	45.5	40.8	35.6	30.4	33.0	30.4	32.2	23.4
North West	40.4	34.1	29.8	27.2	27.1	21.5	19.8	22.0	18.2
West Midlands	30.2	28.8	25.1	23.5	19.7	19.3	21.6	20.6	17.6
Yorkshire & the Humber	29.2	33.8	24.8	20.9	19.7	16.6	17.5	19.1	17.4
East Midlands	35.7	28.4	25.6	19.3	25.4	21.3	18.3	17.5	16.9
North East	25.6	26.8	19.3	11.0	15.7	16.1	17.6	19.9	16.7
Wales	26.1	23.4	21.2	17.8	19.7	19.7	16.9	20.2	14.7
Northern Ireland	25.6	27.2	21.2	16.4	21.6	10.4	17.2	14.2	9.0
UK	**56.3**	**48.3**	**41.4**	**36.5**	**36.5**	**35.5**	**35.6**	**36.1**	**30.0**

Source: HM Revenues & Customs, claims received by November 2010.

Other research activities

- The 7th Framework Programme for Research and Technological Development (FP7) has a total budget of over € 50 billion and will last for seven years from 2007 until 2013. This money is accessible to not only HEIs but to research actors all over Europe and beyond, in order to co-finance research, technological development and demonstration projects. The other main source of research funding in the UK is the Technology Strategy Board (TSB), which companies can bid directly into.

- Unfortunately, data on FP7 is not available on a regional basis to compare. However, figures for 2007-2010 are available from Northern Ireland from Invest NI. In total the (approximate) breakdown of FP7 funding from 2007-2010 is as follows:
  - 2007 - €13.5 m
  - 2008 - €6 m
  - 2009 - €5 m
  - 2010 - €5 m

Patent Data Notes

- The patent analysis in section 5 largely focuses on EPO data as this makes a patent a member of the 'triadic patent family', data on patent families is generally less biased as the 'home advantage' disappears to a certain extent. A patent family is a set of patents taken in various countries to protect a single invention in more than one country. This data also emphasises the value of such triadic patents, which is supposedly higher than the value of other patent applications or patents granted because applying for a patent at these three offices involves additional costs and administrative work.

- **Triadic patents** are a series of corresponding patents filed at the European Patent Office (EPO), the United States Patent and Trademark Office (USPTO) and the Japan Patent Office (JPO), for the same invention, by the same applicant or inventor. [1] Triadic patents form a special type of patent family.

- **High technology patents** (used in Table 5.8) relate to different criteria than biotechnology, ICT, and nanotechnology in Table 5.9. They count activities in technical fields such as: Computer and automated business equipment; micro-organism and genetic engineering; aviation; communications technology; semiconductors; lasers. For full list see: http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/Annexes/htec_esms_an6.pdf

Acknowledgements

NISP wishes to thank Miriam Ferrari and Mark Magill for their contribution to the development and production of the NI Knowledge Economy Index: Baseline Report.

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