

KNOWLEDGE ECONOMY INDEX

REPORT 2014

19 OCTOBER 2014

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The Knowledge Economy is a vibrant and vital sector of the Northern Ireland (NI) economy, which provides highly skilled and well-paid jobs. The Knowledge Economy is important as it is export intensive, high productivity and generates stable employment and income (or wealth) from abroad contributing to the successful delivery of many of the Programme for Government, MATRIX and Innovation Strategy targets.

Companies within the Knowledge Economy are from a range of sectors that invest in research, development, innovation, creativity, sales, marketing and exporting. The Knowledge Economy is an important and growing component of the NI economy and must be nourished and cultivated.

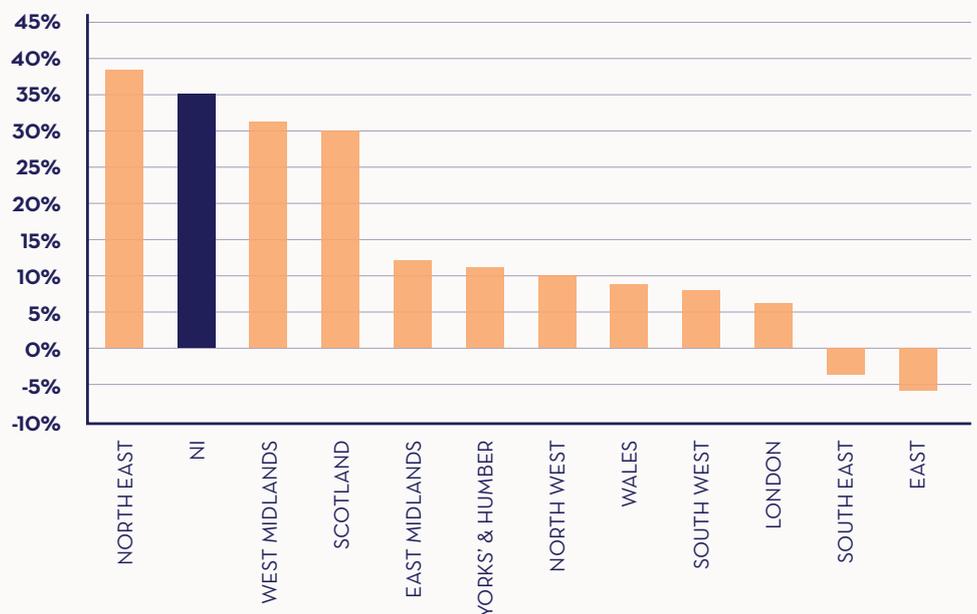
NISP CONNECT is wholly supportive of the NI Executive’s Innovation Strategy launched in September 2014. The Knowledge Economy Index report is an

independent analysis intended to act as an objective barometer to help all stakeholders to understand at a glance where Northern Ireland against our shared ambitions and act as a rallying cry to the private sector to get involved to help and benefit from this transformation. The Knowledge Economy as we have defined it is a sub-section of the broader areas of the Innovation Strategy; the one that returns the greatest economic benefit to NI and the creation of new fast growth export companies.

The NI Knowledge Economy is the second fastest growing of the twelve UK regions, having grown by more than a third over the past five years. Performance was driven by increases in activity in the R&D, investment and innovation pillars at a time when economic conditions were challenging. As a result of this growth, NI is now ranked 10th largest of the UK Knowledge Economies, having moved up from 12th in 2009 when the Knowledge Economy Index (KEI) project was launched.

FIGURE 1.1 GROWTH IN KNOWLEDGE ECONOMY INDEX, UK REGIONS, 2009-2014

SOURCE: NICEP



This positive performance has not yet fed through to a significant improvement in the core metrics (or outcome indicators) contained within the KEI. NI Executive’s Innovation Strategy published a number of ambitious targets for the region to achieve by 2025, some based on the metrics defined in this Knowledge Economy Index. In 2012 NISP CONNECT members

agreed a series of targets for Northern Ireland’s knowledge economy by 2030, which, as an independent and largely private sector-led team, are unsurprisingly more ambitious than those in the Innovation Strategy. When referenced the NISP CONNECT targets are intended to act as “stretch targets” if additional resource or initiatives are implemented.

FIGURE 1.2 NI COMPOSITE KNOWLEDGE ECONOMY INDEX (2009 = 100)

SOURCE: NICEP
NOTE: 2014 is a forecast



1.1 BUILDING AN EVIDENCE BASE FOR COMPANIES AND POLICY

The research for the NISP CONNECT Knowledge Economy Index Report 2014 has revealed a number of areas where additional research would be beneficial in terms of increasing the level of understanding of the sector, filling important gaps in the data and bringing forward additional evidence that will help grow the Knowledge Economy. The key recommendations are;

Policy remarks

1. Innovation into action - is being launched by NISP CONNECT and is supported by DETI and Invest NI. Those involved in the process will seek to translate NI's success in activity across the KEI pillars of innovation, R&D and investment into growing employment, businesses and exports to help deliver the and contribute towards the achievement of the DETI Innovation Strategy targets in 2025 and with a little bit extra, NISP CONNECT ambitious 2030 targets;

2. Research and Development (R&D) - NI is successful in that it has caught up to and exceeded the UK average level in R&D as a % of GVA and Business Expenditure on R&D as a % of GVA. Businesses, academics and policymakers should be congratulated for this achievement. NI's vision for R&D should now become international, promoting R&D activity and implement policies that will broaden the R&D base and continue NI's success; and

3. Research grants - if NI is to grow the R&D base and meet the NISP CONNECT target for the Knowledge Economy, funding for research grants should become a higher priority, which may be a challenge in times of austerity;

Research suggestions

4. Research on supply chain and downstream effects of the Knowledge Economy - this will allow the full impact of the sector on the NI economy and society to be measured and reported;

5. North East of England - further research on the driving factors behind the large increases in investment activity and significant decline in employment; and

6. Matched study with San Diego - a matched firms study would be particularly valuable for NI in order to understand differences in skill levels and human capital, management practices, behaviours and cultures that are prevalent, how companies here may adopt better practices for greater economic benefit and how policy may be formed in order to help Knowledge Economy companies grow.

Improving data

7. Venture capital data - suffers from significant data gaps and an official survey or census is now required; and

8. Wage data - suffers from limited availability and small sample sizes. Other potential data sources are to be examined in more detail during 2015.

1.2

MOVING IN THE RIGHT DIRECTION

Over the past year, the Knowledge Economy in NI has made good progress in a number of areas. The newly developed regional KEI confirms this, as NI is the second fastest growing region in the UK. The regional index provides an additional perspective on the overall health of the sector and should be widely used in the development and measurement of innovation oriented strategies.

It is important also to acknowledge that this is a dynamic environment as all UK regions are striving to grow their knowledge economies, increase employment and productivity and increase overall standards of living. Employment in the

Knowledge Economy now makes up 4.3% of total employment compared to 3.7% in 2009, which is a significant improvement. However, the NI Knowledge Economy must continue to strive not just to be average, but to continue to grow more rapidly if it is to deliver on the goals and targets set out in the Innovation Strategy and the aspirations in the NISP CONNECT targets.

There are a significant number of challenges that NI must overcome to deliver these goals, targets and aspirations. NI is still one of the smallest Knowledge Economies in the UK and innovation remains low. A concerted and collective effort will be required to make further progress going forward. With the level of success in R&D, NI will now need to raise its sights to focus on succeeding at an international level.

In conclusion, 2014 has been a positive year for the Knowledge Economy with progress evident in many areas. The vision for the future of the Knowledge Economy is set, but in order to attain it, efforts must be intensified in a number of areas.

1.3

ACKNOWLEDGEMENTS

We would like to thank those who were part of the Knowledge Economy Steering Group and the wider Knowledge Economy Focus group for their help, knowledge and insightful comments throughout the process of developing this report.

For the case studies that bring the Knowledge Economy to

life in this report, NICEP would like to thank the NI Science Park, Gareth Reid, Northern Ireland Advanced Composites and Engineering Centre (NIACE), Solaform, GetInvited, MOF Technologies, TG Eakin, 8over8, Adoreboard and Lewis Fertility.

We also would like to thank Peter McKerr and Andrew McClements from Edinburgh University and Ryan Hamilton from the University of Ulster who worked on the Knowledge Economy Index project as part of their Internship within the NI Centre for Economic Policy.

TG Eakin

TG Eakin Ltd is a family-owned business which was formed in 1974 by Tom Eakin, a pharmacist in Dundonald, just outside Belfast.

Since then, the company has gone from strength to strength and now supplies ostomy and wound care products to 40 countries around the world with a workforce of 280 employees across their Comber, Cardiff and new Nottingham site due to the recent acquisition of Cliffe Medical.

Just last week Eakin acquired Cliffe Medical who are based in Nottingham with two trading subsidiaries, Ostomart Ltd and Respond Plus, a home delivery service for Northern Ireland patients. This follows the acquisition of Pelican Healthcare in 2007, a leading UK supplier and manufacturer of specialist stoma and feminine health products. The combined Eakin Group will now ensure the production of innovative, quality products to meet the needs of stoma care patients worldwide.

Still a family owned and run business, TG Eakin Limited always ensures that patient needs are incorporated into product design, providing comfort, protection and ease of use.

In 1980, the Eakin Cohesive® Seal was introduced to the UK market and there are now over 15 million Cohesive® Seals being sold worldwide on an annual basis. The Cohesive® Seal is soft and mouldable and fits snugly around the base of the stoma to provide a leak proof seal and help prevent effluent from coming in contact with the skin, hence preventing any potential skin problems.

Eakin Wound Pouches™ provide a comfortable, skin friendly, cost effective and time saving procedure that can be used for various applications such as managing fistulae, multiple or irregular stomas and high output wounds. The wide range of sizes means there is a pouch to suit all eventualities from paediatric care to long incision wounds and extremely large wounds.

Eakin now export a range of ostomy pouches around the world as well as a number of ostomy accessories such as Eakin Cohesive Paste, Release Adhesive Remover, Protect Barrier Film and Perform Solidifying Agent, all of which

are designed to offer a more comfortable, pain-free stoma care routine.

Studies show that up to 30% of ostomates are likely to develop a hernia after stoma surgery due to the weakness in the muscle wall, regardless of the type of surgery, the siting of the stoma or the stoma type. However, use of a comfortable, well fitted support garment will greatly reduce the risk. Eakin Support Belts™ have been specifically designed to provide full and complete abdominal support for prevention and treatment of parastomal hernias.

In 2010, the company was honoured with the Queen's Award for Enterprise for Exporting Achievement, Northern Ireland's Best Small/ Medium Business accolade as one of Ireland's Best Managed Companies in the Deloitte Awards, and 'One to Recognise' in the Sunday Times Profit Track 100 companies.

2.1 WHAT IS THE KNOWLEDGE ECONOMY?

Knowledge economies are comprised of individuals, companies and sectors that create, develop, hone and commercialise new and emerging ideas, technologies, processes and products and export them around the world. In order to maintain their competitive advantage, these companies constantly strive to remain at the forefront of their industry by recruiting highly skilled individuals, investing in R&D, innovation, encouraging creativity, marketing and seeking out new markets. The Knowledge Economy is a vital element of every developed economy around the world as it contributes to and enhances their global competitiveness, which in turn increases their level of economic growth.

One of the key challenges that impacts upon all Knowledge Economy research is the lack of any globally accepted or agreed definition of what a Knowledge Economy is and what sectors and activities should be included. There are a number of definitions in the published literature, such as the Organisation for Economic Co-operation and Development (OECD), although these were discounted in 2009 when the NISP CONNECT model was designed in favour of a private sector and entrepreneurially focussed definition that aligns with the San Diego CONNECT model. This definition includes research intensive sectors where new ideas, new products and new processes are key determinants of competitiveness.

The sectors included are;

- Pharmaceuticals and biotechnology;
- Medical devices;
- Software & digital content;
- IT services;
- Telecommunications;
- Computing and advanced electronics;
- Creative content and digital media;
- Other technical services; and
- Aerospace and other transport equipment.

A full list of Standard Industrial Classification (SIC) codes used to define the Knowledge Economy is included in Annex A. The sectors align closely with the Matrix defined themes.

2.2

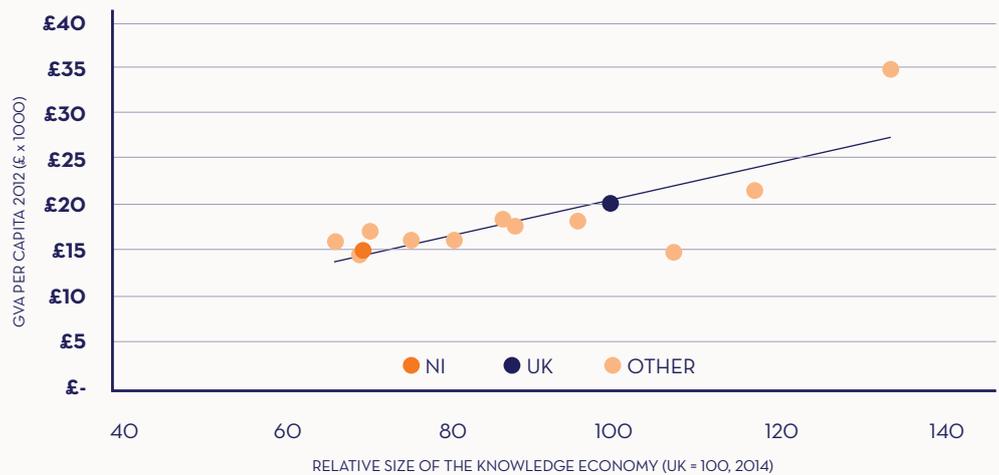
WHY IS THE KNOWLEDGE ECONOMY IMPORTANT?

The Knowledge Economy is important as it is export intensive, high productivity and generates stable employment and income (or wealth) from abroad.

It is an element of the economy in which companies invest heavily in both their employees and physical capital in order to maintain their competitive edge. As a result, regions with a relatively large Knowledge Economy are generally wealthier, as illustrated by figure 2.1.

FIGURE 2.1 GVA PER CAPITA, 2012 VS. SIZE OF KE 2014 (UK=100), UK REGIONS

SOURCE: ONS, NICEP



Boosting exports

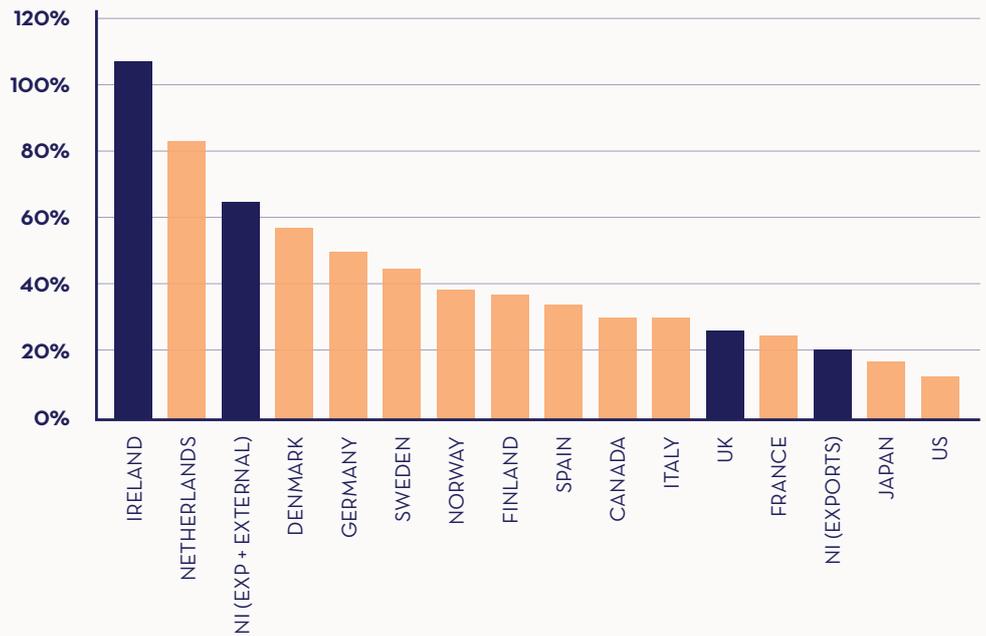
As a small open economy, external markets are important to NI. In recent years, turbulence in global markets has impacted upon NI's export performance. The manufacturing export targets contained within the Programme for Government (PfG) were not achieved in 2014. As an export oriented sector, the Knowledge Economy has the potential to help boost exports and meet the PfG export target in future.

There are two perspectives on NI's export performance. The first is in terms of exports (defined as sales outside the UK), in which NI performs reasonably poorly and well below a number

of other developed nations. The second considers external sales (defined as sales to other regions of the UK) which provides an interesting alternative perspective - NI performs well in this measure. As a regional economy a pound generated from a sale to London will have the same impact as a pound generated by a sale to Luxembourg and therefore, these perspectives matter in setting the context for the economic development policy. Exports are a key component of economic growth (the other components are consumption, investment and government expenditure) and therefore an interesting debate is to be had on how NI's economic success is measured.

FIGURE 2.2 EXPORTS AS A PROPORTION OF GVA, 2012

SOURCE: OECD STATBASE, DETI MANUFACTURING SALES AND EXPORTS SURVEY, DETI EXPORTING NI SERVICES.



Increasing productivity

Productivity, or how much each individual can produce matters as it provides an insight to the competitiveness of a firm, sector or economy. Productivity has remained constant at around £21 per hour worked since 2009 and the stagnation of productivity levels is a key challenge.

Growing employment

Sales from external markets help to generate and support additional employment in NI. Whilst employment levels are recovering in NI, they remain below their pre-recession peak and lag the UK employment rate. The domestic market in NI is relatively small and it will be important that NI firms continue to build their export base. Selling to a range of markets makes employment more autonomous in the Knowledge Economy as it decreases reliance on specific markets. As such, any changes in a specific market will not have much of an impact upon employment.

Measuring the full impact of the Knowledge Economy

This research focuses on measuring and reporting the direct economic impact of the Knowledge Economy in NI. However, there are also downstream effects that arise as a result of all economic activity such as supply chain and wage effects (or indirect and induced effects in economic terms) that are important to providing a more complete perspective of the impact of the sector.

The indirect and induced effects can be calculated through the use of employment and output multipliers. Research carried out in the US by the National University System Institute for Policy Research¹ found that the Knowledge Economy employment

multiplier in San Diego is 2.49, which means that for every job generated within the Knowledge Economy, there are 2.49 other jobs created as those companies buy supplies and their employees spend their wages (known as indirect and induced effects).

This indicates that the impact of the Knowledge Economy has **high employment and output multipliers** relative to other sectors, therefore each pound spent in the sector could have more significant effect on the wider economy than a pound spent elsewhere. Data is available at a sub-sectoral level for Scotland, although it does not provide specific Knowledge Economy multipliers (as the Knowledge Economy is a grouping of very specific industrial classifications); data is available for R&D (1.7), computer services (1.3) and electrical and optical (1.7). Whilst these provide an indication that the indirect and induced effects for Knowledge Economy oriented sectors are generally reasonably high, they are not at a detailed enough level to apply to the NI Knowledge Economy definition and are also published for 2011 for Scotland.

The NI Statistics and Research Agency (NISRA) statisticians are working on the development of Supply-Use tables for NI, which will include employment and output multipliers. This research will provide data at a level of disaggregation that will allow broad estimates of the indirect and induced effects of the Knowledge Economy to be calculated. The NISP CONNECT team will be interested to see the conclusion of the Supply Use research in 2015 and consider how the findings may be integrated into the KEI research project. As the KEI employment definition is based on a finely detailed industrial classification there is a risk that the NISRA publication will not contain the level of disaggregation required by the KEI steering group. However the research is a welcome addition to the information base for NI.

¹ http://www.nusinstitute.org/assets/resources/pageResources/Economic_Ledger_Technology2014.pdf

This research focuses on the direct economic impact of the Knowledge Economy in NI. In terms of modelling the overall economic impact of the sector in NI, it is also important to also consider the downstream effects of the activity that takes place within the Knowledge Economy. Research undertaken in San Diego suggests a relatively high multiplier effect for the Knowledge Economy.

The publication of NISRA's Supply-Use tables in 2015 will be a welcome addition to the data available for NI. NISP CONNECT and NICEP will consider how they are used within this research. However, a set of specific Knowledge Economy employment multipliers may still be required to complete the analysis at the very detailed sectoral level of the KEI project and the steering group will wish to consider the available options in the 2015 Knowledge Economy Index once the NISRA data is available.

It is recommended that firstly, the KEI Steering consider the NISRA supply use tables and their potential use in this research upon publication in 2015 and secondly, that they consider commissioning a specific research project to calculate a set of Knowledge Economy indicators if more specific detail is required in addition to the published Supply Use tables.

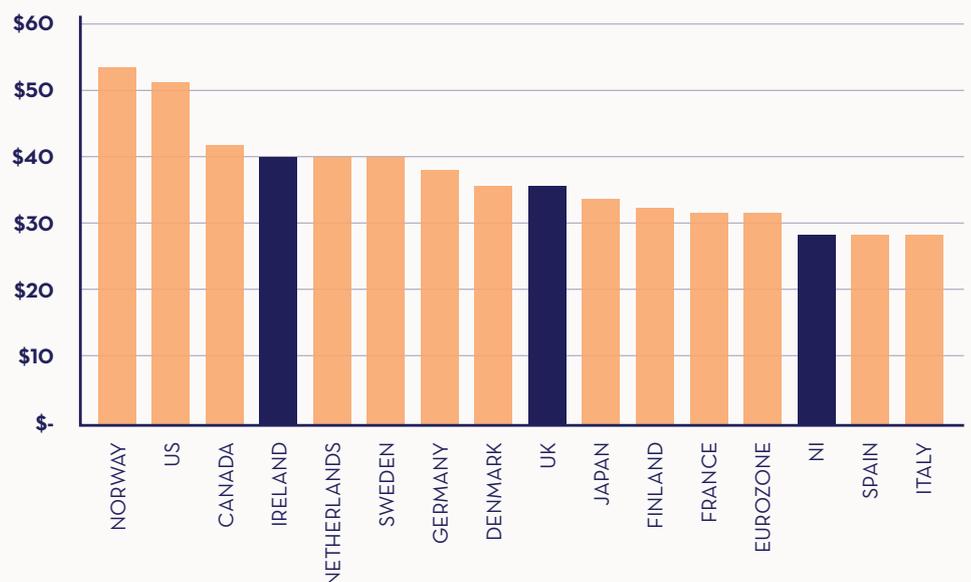
Developing the economy

NI still ranks as one of the relatively less wealthy areas of the UK. There are many regions in the EU where living standards are lower than in NI which now qualify for more generous rates of State Aid and Regional Aid. The key point is that the regional policy challenge of catching up to UK average levels of wealth remains unmet, as NI continues to lag behind as illustrated in figure 2.2. Economy to be calculated. The NISP CONNECT

team will be interested to see the conclusion of the Supply Use research in 2015 and consider how the findings may be integrated into the KEI research project. As the KEI employment definition is based on a finely detailed industrial classification there is a risk that the NISRA publication will not contain the level of disaggregation required by the KEI steering group. However the research is a welcome addition to the information base for NI.

FIGURE 2.3 REAL GDP PER HEAD (US \$ x 1000 PURCHASING POWER PARITY²), 2011

SOURCE: OECD, ONS & NICEP
NOTE: GVA PER HEAD FOR NI. NI = 80% OF UK



The Knowledge Economy is important as it can help to grow the NI economy by generating additional export sales and

investment which will help to grow the private sector and increase the overall standard of living in NI³.

² Purchasing power parity measures the adjustments that are required to exchange rates to make both currencies on a par with the purchasing power of each other. i.e. the expenditure on a similar commodity must be same in both currencies when accounted for exchange rate.

³ As measured by GVA per capita

The NI Executive has published the Innovation Strategy, which draws on the Knowledge Economy Index as a source of independent evidence. This document sets the vision for an innovative business base and aspires to step change in

innovation culture and to increase the level of knowledge generation, exchange and exploitation. NISP CONNECT aspires to be a key partner in helping to deliver this vision for NI.

2.3 ECONOMIC CONTEXT

The economic recovery in NI has been evident since 2013 and growth has continued during 2014. InterTradeIreland's research supports this, reporting that four out of five NI businesses are currently in growth mode.

The recovery was driven in the main, by consumers and has been broadly based; a number of sectors have enjoyed employment growth and 27,000 new jobs have been created since 2012. However, challenges remain which include the high levels of Government and consumer debt, the implementation of austerity plans and whilst inflationary pressures have subsided the levels of disposable household income remains constrained. NICEP forecasts suggest that NI will continue to recover over the next five years; however, the rate of growth will slow in 2017 and 2018 as the consumer renaissance decelerates.

TABLE 2.1 KEY ECONOMIC INDICATORS FOR NI

NOTE: 2014 UNLESS OTHERWISE STATED

Data	Source	Change on Qtr	Change on Yr
GVA (2012)	ONS	...	^
Employment	ONS	v	^
Employee jobs	ONS	^	^
Self employment	ONS	v	v
Unemployment	ONS	v	v
Economic inactivity	ONS	v	v
House prices	ONS	^	^
Skills- NVQ 4+ (2013)	ONS	...	^
Business start ups (2012)	ONS	...	^
Exports (2013)	DETI	...	^
Redundancies	DETI	v	v
Tourism	DETI	^	^
Composite economic index	DETI	v	^
Index production	DETI	^	^
Index services	DETI	v	^
BERD/HERD/GOVERD (2012)	ONS	...	^
Car sales	SMMT	^	^

2.4

SCOPE OF THIS RESEARCH

The NI Centre for Economic Policy and Oxford Economics have been commissioned by the Northern Ireland Science Park CONNECT (NISP CONNECT) to update the CONNECT innovation indicators formulated in the 2011 Knowledge Economy Baseline Report⁴.

These indicators were designed to track the health of the Northern Ireland Knowledge Economy on an annual basis against other UK regions and are based on the San Diego CONNECT model. A total of twenty one indicators make up the KEI under the sub headings of core indicators, investment, R&D and innovation & patent activity; the next five years; however, the rate of growth will slow in 2017 and 2018 as the consumer renaissance decelerates.

The indicators form an effective monitoring framework to;

1. Measure the progress of the Knowledge Economy;
2. Support the on-going implementation of the NISP CONNECT programme; and

3. Help to identify the areas on which stakeholders, businesses and policy makers must focus in order to achieve the ambitious goals and targets of the Innovation Strategy and the NISP CONNECT programme.

The KEI research is now in its second year of a three year contract and NICEP are pleased to have developed the composite Knowledge Economy Index during year one, which provides a clear, comprehensive and easily understood measure of progress within the NI Knowledge Economy. This Index is also part of DETI's Innovation Strategy target framework, demonstrating how the priority areas which NISP CONNECT focuses upon are key to helping DETI and the NI Executive develop a more innovative, competitive and export oriented private sector.

As part of this research report, NICEP have developed Knowledge Economy indices for each of the UK regions. Our most significant finding is that the NI Knowledge Economy has been the second fastest growing of the UK regions on the basis of this measure and its regional ranking has improved to 10th from 12th. The speed at which the NI Knowledge Economy has grown is impressive, but a significant challenge remains if NI is to attain the ambitious targets.

MATCHED STUDY WITH SAN DIEGO

Given the genesis of the programme in San Diego, a matched firms study would be particularly valuable for NI in order to understand differences in management practices, behaviours and cultures that are prevalent, how companies here may adopt better practices for greater economic benefit and how policy may be formed in order to help such companies grow in the Knowledge Economy in NI.

2.5

STRUCTURE OF THIS REPORT

The remainder of this report is structured as follows:

- Chapter 3** presents the updated Composite Knowledge Economy Index and newly developed regional comparisons;
- Chapter 4** updates the core metrics of the CONNECT indicators;
- Chapter 5** examines the latest investment data;
- Chapter 6** presents the newest R&D information;

- Chapter 7** discusses the most up to date Innovation and patent information;
- Chapter 8** reviews the performance of the indicators relative to the NISP CONNECT targets for 2030; and
- Chapter 9** summarises the key messages and progress since the 2009 NISP CONNECT baseline report.

⁴ For the full report please visit: http://www.nisp.co.uk/?page_id=302

MOF Technologies

MOF Technologies shakes up old assumptions about mechanics and chemistry with a new process for producing a powder that could help resolve some of the world's most urgent ecological and social problems.

Metal-Organic Frameworks ('MOFS') are sponge-like materials which are among the most exciting high profile developments in nanotechnology to emerge over the past decade.

They are created by mixing metals with organic materials in varying compositions for different uses. The result is an innocuous-looking powder that is typically clean, biodegradable and highly stable.

Their attributes give them broad industrial applications. For example, their extremely large surface area - material the size of a pea can have a surface area of up to 40 tennis courts - means they are very good at storing gases.

As a result, they are highly suited to capturing carbon from power plant emissions, as well as enabling the high-density storage of a range of gases, including methane and hydrogen.

The variation of their structures also means they are very flexible, light and robust, with high mechanical and thermal stabilities - unique properties which are leading to the rapid development of new applications in pharmaceuticals, medical imaging and sensing.

Prevalent natural gases like methane have shown big potential for clean fuel sources, such as for cars, but their storage

can be costly and dangerous. MOFs could be an answer to this problem.

They could also help the reduction of CO2 emissions, which is a critical part of the global battle against climate change. Here, MOFs offer a clean way to capture carbon from fossil fuel combustion.

One of the most promising areas of MOF applications is the use of these materials as heat adsorbents in both domestic and industrial heating/cooling applications - including data centres, vehicular transport and heaters.

In another area, the biodegradability and non-toxicity of some MOFs present the potential for safe, targeted delivery of medicinal drugs into the body.

The industrial production of MOFs is currently a single-player market, monopolised by the global chemicals giant BASF, which has several patents in this space.

The chemistry employed in production requires large amounts of solvents to produce small volumes of MOFs, after which the solvents, often toxic, go to waste.

Enter the MOF Technologies team, a Queen's University Belfast spin-out led by CEO Dr Paschal McCloskey, who has

a background in science from Imperial College London and experience in the commercialisation of research, along with CTO Prof Stuart James, who holds the Chair of Inorganic Chemistry at QUB.

They have made the business and commercial world sit up by rejuvenating a previously sidelined field of science called mechanochemistry to create a simple mechanical process for the synthesis of MOFS.

This involves no solvents, no waste and no toxins - just the requisite components mixed in a chamber and shaken vigorously in an uncomplicated process that could be applied not only to the production of MOFs but also many other materials.

As a bonus, MOF Technologies doesn't need to focus specifically on any particular sector, instead the company is seeding customers with materials to test for their efficacy in many applications.

MOF Technologies has validated its innovation for small batches and is scaling its production capabilities to 100kgs. As it takes the next step to industrial scale production, the result could lead to groundbreaking new products for a cleaner, greener world.

In the first year of NICEP’s research relationship with the NISP CONNECT team, a composite Knowledge Economy Index⁵ (KEI) was constructed for NI and the UK for the first time. The index is an indicator of the overall performance of the Knowledge Economy and has been adopted by DETI as one of the independent measures of progress in the recently published Innovation Strategy⁶.

This year, the KEI project was expanded to include the other eleven Government Office Regions within the UK. An attempt was made to gather data to build a comparable index for the Republic of Ireland but unfortunately, much of the

required data is not available on a comparable basis.

The inclusion of regional KEI’s is another significant step forward for the NISP CONNECT team as they enable a

comparison of NI’s relative progress, its regional rankings from 2009 to 2014, a calibration of the scale of the challenge to catch up to UK levels and also to help to identify regions from which lessons could be learned and applied to NI.

3.1 SMALL, BUT FAST GROWING

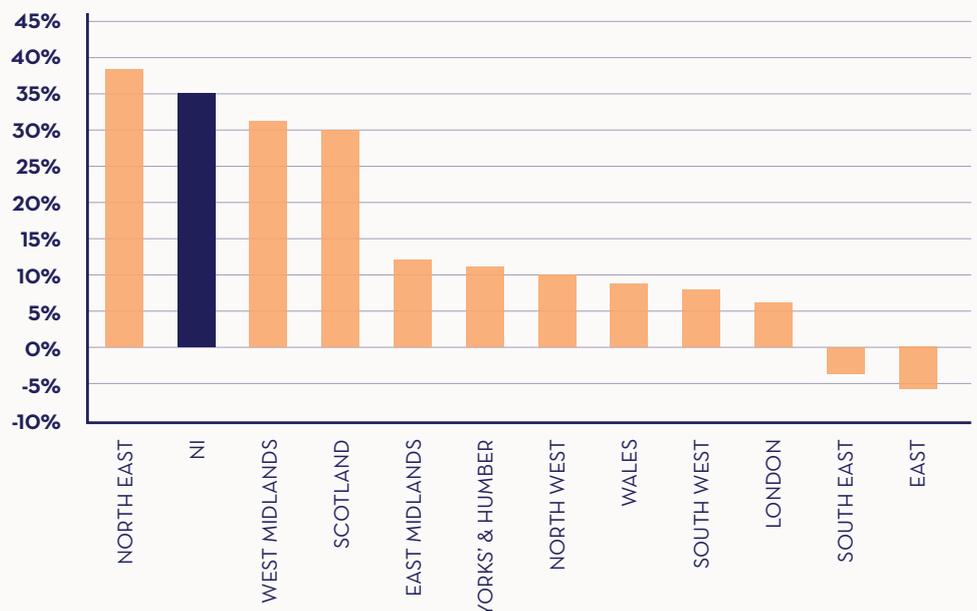
The most interesting and significant finding is that NI’s Knowledge Economy Index has been the second fastest growing of the UK regions since 2009, only slightly behind the North East of England on the basis of the composite KEI’s.

The rapid rate of growth means that the **NI Knowledge Economy is now ranked 10th of the 12 UK regions.**

The rate of growth is a very positive finding for NI, as **the Knowledge Economy grew by more than a third since 2009.** It provides evidence that a large amount of activity is underway, businesses are investing and growing and the policy environment is bearing some fruit.

FIGURE 3.1 GROWTH IN KNOWLEDGE ECONOMY INDEX, UK REGIONS, 2009-2014

SOURCE: NICEP



⁵ The Knowledge Economy Index is a composite index in that includes all twenty one of the indicators listed in table one. It is calculated using the weighted average growth rate of each of the indicators from 2009. Weights are detailed in Annex C.

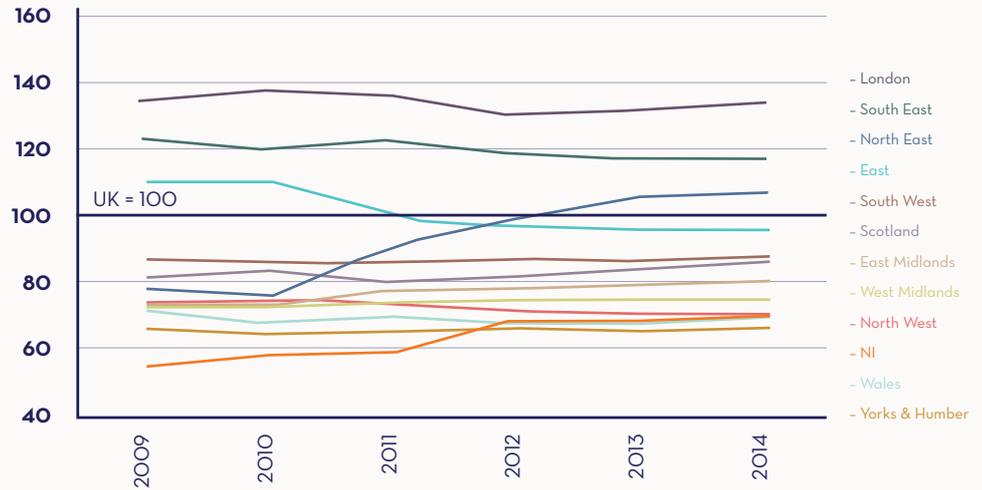
⁶ <http://www.deti.ni.gov.uk/innovationstrategy>

Figure 3.2 illustrates that NI's performance has been impressive over a five year period from a very low base. It also shows the scale of the challenge for NI to catch up with UK average level - which will require an additional 40% growth. The initial stages of catching up to the UK average may be relatively easier for

NI as knowledge and technology transfers, new products and processes will stand to generate more significant change than when NI gets closer to the average. In addition, all other UK regions will be working to grow their own Knowledge Economy and therefore, no region is standing still.

FIGURE 3.2 COMPOSITE KNOWLEDGE ECONOMY INDICES, BY REGION (UK= 100)

SOURCE: NICEP



The specific indicators which are the major driving factors behind NI's success include;

- Private equity and VC investments per 100,000 VAT registered businesses;
- Number of private equity and VC investments;
- Public Listed Companies: Market capitalisation per head;
- Business Expenditure on R&D (BERD) as a % of workplace GVA;
- The proportion of firms that are Innovation active; and
- The number of patent applications granted per million inhabitants.

All of these specific indicators have grown by more than thirty per cent between 2009 and 2012/13. The fact that these indicators are spread across a number of the KEI pillars is encouraging as progress is broad based, rather than being focussed in a single area.

3.2 IMPROVING REGIONAL POSITION

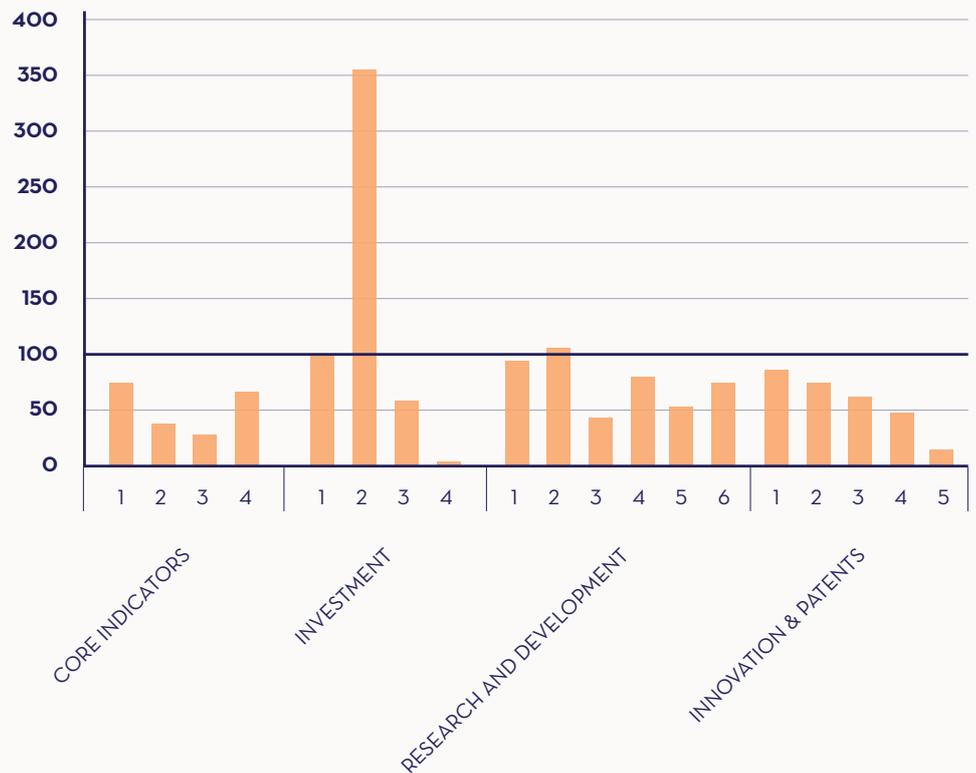
Figure 3.3 shows each of the indicators within the KEI, presented relative to the UK. It is particularly noteworthy that three indicators (number of private equity investments per 100,000 businesses, number of VC investments per 100,000 businesses and BERD as a % of workplace GVA) are above the UK average.

In particular, **the number of VC investments per 100,000 businesses outpaces the UK average by a large degree**, with a flurry of small VC deals.

FIGURE 3.3 NI KNOWLEDGE ECONOMY INDICATORS, 2013 (UK = 100)

SOURCE: NICEP

NOTE: THE NUMBER OF VC INVESTMENTS AND VALUE OF VC INVESTMENTS ARE NOT INCLUDED AS THESE ARE IN ABSOLUTE RATHER THAN RELATIVE TERMS.



Lewis Fertility

From an innovator's perspective, the fertility treatment process seems ripe for improvement. In most cases it's slow, expensive and emotionally strenuous. While the woman's biological clock is ticking relentlessly, couples spend thousands of pounds over many months.

Infertility affects one in six couples and is increasing by 8-9% per year throughout Europe while birth rates are slowing. And while infertility is often assumed to be the woman's problem, 40% of the time it comes from the man. Add to that, at least a quarter of couples tested are given "unexplained" reasons. The uncertainty alone can be a stress factor. Lewis Fertility in Belfast offers a new sperm test that saves time, money and heartache for the couple.

The SpermComet test evolved from a research group including Lewis Fertility's founder, Professor Sheena Lewis, working out of Queen's University Belfast. Of those with "unknown" reasons for their infertility issues, the group found that 80% had significant DNA damage in the sperm. A standard semen analysis is often the first step in fertility testing but it's a

blunt instrument. The results provide little to indicate a man's fertility potential or predict how well the couple will do with infertility treatment.

The SpermComet gives a neat visualisation of the problem. The sperm sample is taken through a process called gel electrophoresis. The sample is embedded between two layers of agarose (a polymer) where DNA strands are released from their encapsulating material. Then, just like in electrolysis experiments at school, electrical charge is applied to a high pH solution and any damaged (ie. broken) DNA strands are drawn from the sperm head. The image resembles a comet, with healthy DNA as a bright cluster at the comet "head" and a tail-like cloud of damaged DNA trailing away from it.

The world is starting to pay attention. Clinics in places including China, Scandinavia, the US and the Middle East have been sending samples, frozen in liquid nitrogen, to Lewis Fertility for testing. They get the results back in their email inboxes within a week. While most activity has been in the UK and Ireland so far, the company hopes to expand rapidly through clinics around the globe.

Fertility treatment typically costs a minimum of £5,000, when this new test costs less than 10% of that. But the savings go further than money. Professor Lewis believes these couples need more support and care than they get, as they experience strains in many areas such as their relationships, jobs and emotions. Ultimately, for couples trying to have a child, SpermComet means being able to make better decisions sooner.

4.1 CORE METRICS

This section examines the current size of the Knowledge Economy and provides an update performance for the core (or output focused) metrics.

They are:

- Knowledge Economy employment, as % of total employment;
- Knowledge Economy businesses, as % of total business stock;
- Knowledge Economy business startups per 100,000 population; and
- Knowledge Economy average annual wage level.

4.1.1 Employment

KE employment grew by 5.5% from 2011 to 2013, which is impressive when considered in the context of a 0.2% decline in workforce jobs over the same period, illustrating the resilience of the sector. The rate of growth also outpaced the UK average (+4.0%). The Knowledge Economy now accounts for 4.3% of total employment compared to 5.3% in the UK, and whilst the differential with the UK has been narrowing a little, the proportion remains lower.

When the sectoral patterns are examined, five out of the nine sectors within the Knowledge Economy grew more rapidly in NI than they did in the UK (highlighted in green in table 3). Two sectors that give cause for concern are Communications, which has contracted by almost 44 per cent and computing and advanced electronics which contracted by almost 15 per cent, according to the DETI Census of Employment. The decline in employment to 2013 does align to reductions in the numbers of businesses in these sectors declining from 2011 to 2012 (latest available data) and also to the UK pattern. It would therefore appear that these sectors are under some competitive pressures.

TABLE 4.1 EMPLOYMENT IN THE KNOWLEDGE ECONOMY (CONNECT DEFINITION), 2011 AND 2013

	Northern Ireland			UK		
	2011	2013	% ↕	2011	2013	% ↕
Aerospace & other transport equip.	9,919	10,831	9.2%	299,480	311,218	3.9%
Software	5,581	6,366	14.1%	132,758	157,538	18.7%
Computing & advanced electronics	5,206	4,388	-15.7%	75,032	69,698	-7.1%
Medical Devices	4,015	4,387	9.3%	207,211	205,988	-0.6%
IT services	2,992	3,592	20.1%	451,762	463,372	2.6%
Pharmaceuticals	1,870	2,322	24.2%	49,549	51,644	4.2%
Communications	1,555	875	-43.7%	193,528	197,239	1.9%
Other technical consultancy	1,819	2,022	11.2%	149,303	173,935	16.5%
Creative content and digital media	413	438	6.1%	72,473	66,367	-8.4%
Knowledge Economy	33,370	35,221	5.5%	1,631,096	1,696,999	4.0%
% of total employment	4.1%	4.3%	-	5.2%	5.3%	-

SOURCE: BUSINESS REGISTER AND EMPLOYMENT SURVEY (BRES) AND CENSUS OF EMPLOYMENT (COE).

NOTE: NI SECTORS THAT GREW FASTER THAN THEIR UK COUNTERPART ARE HIGHLIGHTED IN GREEN. NI SECTORS THAT GREW MORE SLOWLY THAN THEIR UK COUNTERPART ARE HIGHLIGHTED IN RED.

In the context of the other UK regions and over the year, NI's regional ranking declined by one place to 11th (out of the twelve UK regions). Scotland's Knowledge Economy employment grew most rapidly (+18.7%) and moved ahead of NI in the regional rankings followed by Wales (+12.1%).

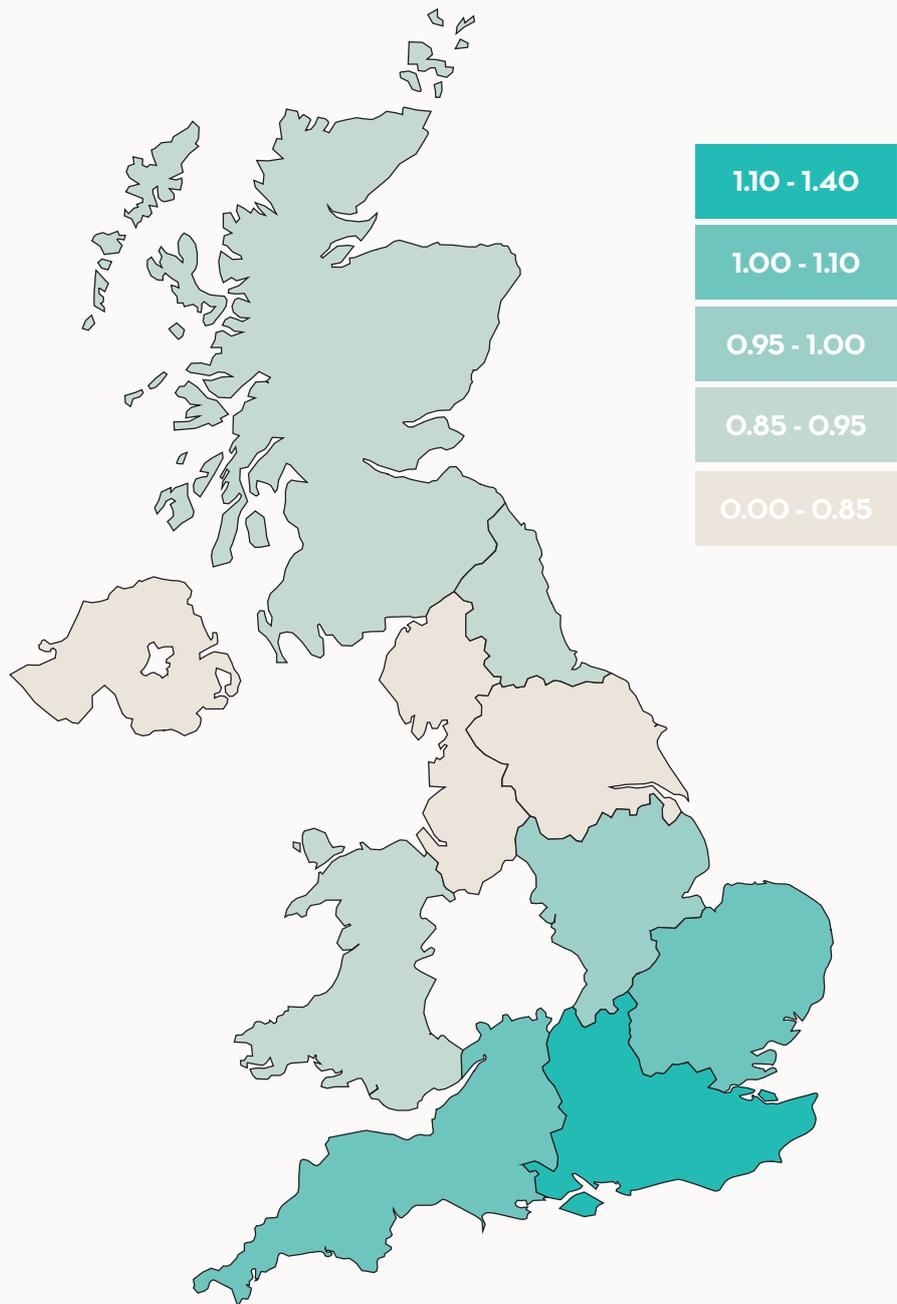
The Knowledge Economy is heavily concentrated in the South Eastern corner of England, as would be expected. Figure 4.1 illustrates where the knowledge economy is most concentrated (darkest) and least concentrated (lightest) and shows that NI is one of three lagging regions along with the North West and Yorkshire and the Humber.

FIGURE 4.1 CONCENTRATION OF KNOWLEDGE ECONOMY EMPLOYMENT IN THE UK REGIONS, 2013

SOURCE: BUSINESS REGISTER AND EMPLOYMENT SURVEY (BRES) AND CENSUS OF EMPLOYMENT.

NOTE: LOCATION QUOTIENTS SHOW THE CONCENTRATION OF KNOWLEDGE ECONOMY EMPLOYMENT.

1 = UK AVERAGE, >1 = MORE CONCENTRATED THAN UK AVERAGE, <1 = LESS CONCENTRATED THAN UK AVERAGE



North East employment declines

The North East witnessed a significant decline of 20.7% in employment terms which is a huge loss to the sector and does not align well with the North East’s strengths in terms of investment activity. Knowledge Economy employment fell in eight of the nine Knowledge Economy sectors and the main drivers of decline in employment were other technical consultancy (-51%), IT services (-43%) and medical devices (-28%).

Whilst it is beyond the scope of this research, the scale of employment loss in the context of an overall UK recovery is worthy of further investigation. The North East performs well in a range of other Knowledge Economy indicators, especially investment, and is the fastest growing of the UK regional Knowledge Economies.

The Knowledge Economy in the North East of England is the fastest growing of the UK regions from 2009 – 2014, driven in the main by very high levels of investment activity.

Despite this success, Knowledge Economy employment in the North East fell by 20.7% (13,898 jobs) from a high point in 2011 to the latest data in 2013.

Eight out of nine of the Knowledge Economy sectors contracted. The greatest declines were in other technical consultancy (-51%), IT services (-43%) and medical devices (-28%).

The dichotomy between the enormous success in investment activity and very large declines in employment is startling. It is recommended that further investigation is carried out on the data for the North East of England to identify the reasons for the employment declines and also to consider how, if and when increased investment activity might lead to better outcomes for the core metrics of employment, business stocks and starts and wages in the Knowledge Economy in the North East.

In summary, the NI Knowledge Economy performed well in terms of employment growth. Despite this, NI's regional ranking slipped back one place to 11th of the 12 UK regions - which highlights the scale of the challenge in which is illustrated by figure 4.1. More specifically, NI would need to create almost eight thousand Knowledge Economy jobs just to equal the UK as a proportion of total employment.

4.1.2 Higher proportions of Knowledge Economy businesses but numbers not growing fast enough

The proportion of firms that are in the Knowledge Economy has increased from 4.0% of total business stocks in 2010 to 4.4% in 2012. The increase is due to the combined influence of an increase in the number of Knowledge Economy businesses and the decline in total number of businesses in NI. The number of businesses has grown in five out of the nine Knowledge Economy sectors, presenting a mixed picture in terms of overall business performance.

TABLE 4.2 NI KNOWLEDGE ECONOMY BUSINESS STOCKS - CONNECT SECTORS

SOURCE: ONS, INTERDEPARTMENTAL BUSINESS REGISTER

	2010	2011	2012	% ↕ (2010-12)	% Total KE (2012)
Aerospace & transport	215	190	185	-14.0%	7.5%
Communications	90	100	80	-11.1%	3.2%
Computing	65	60	55	-15.4%	2.2%
Creative content	195	210	220	12.8%	8.9%
IT services	485	500	545	12.4%	22.1%
Medical devices	155	155	150	-3.2%	6.1%
Other technical consultancy	670	700	735	9.7%	29.8%
Pharma/biotech	15	15	20	33.3%	0.8%
Software	475	485	480	1.1%	19.4%
Total Knowledge Economy	2,365	2,415	2,470	4.4%	100.0%
Total active businesses	58,985	57,370	56,255	-4.6%	-
% of business stock	4.0%	4.2%	4.4%	-	-

Despite the fact that NI has experienced some growth in the proportion of firms that are in the Knowledge Economy, the rate at which the number of Knowledge Economy businesses grew was the lowest of the UK regions between 2010 and 2012, with

the result that NI still lags behind all the other regions. For context, **NI had 2,470 Knowledge Economy businesses in 2012 and would need an additional 3,212 businesses in order to match the UK proportion of 10.1%.**

FIGURE 4.2 KNOWLEDGE ECONOMY BUSINESS STOCKS AS A PROPORTION OF TOTAL REGIONAL BUSINESS STOCKS

SOURCE: ONS, INTERDEPARTMENTAL BUSINESS REGISTER RATHER THAN RELATIVE TERMS.



4.1.3 Higher numbers of Knowledge Economy startups

Arguably the most important of the Knowledge Economy indicators and one of the key indicators from the San Diego CONNECT programme is the number of business starts. Within NI business births grew from 260 in 2010 to 295 in both 2011 and 2012. This is an increase of 13.5%, which is very slightly lower than the UK rate, illustrated in table 4.2. Over the same period, total business births declined by 14.3% in NI, which further demonstrates the resilience of the sector.

The absolute number of Knowledge Economy business starts is still relatively low in NI and when the figures are standardised in terms of business starts per 100,000 population, NI is still ranked 12th of the UK regions. To put this into context, the Knowledge Economy business birth rate in **NI would need to more than treble, from 295 to 922 births per annum in order to post a performance that is equal to the UK.** The South Eastern corner of England (which includes London, South East and East) is again, the most productive in terms of Knowledge Economy startups and drives the UK average to a significant degree.

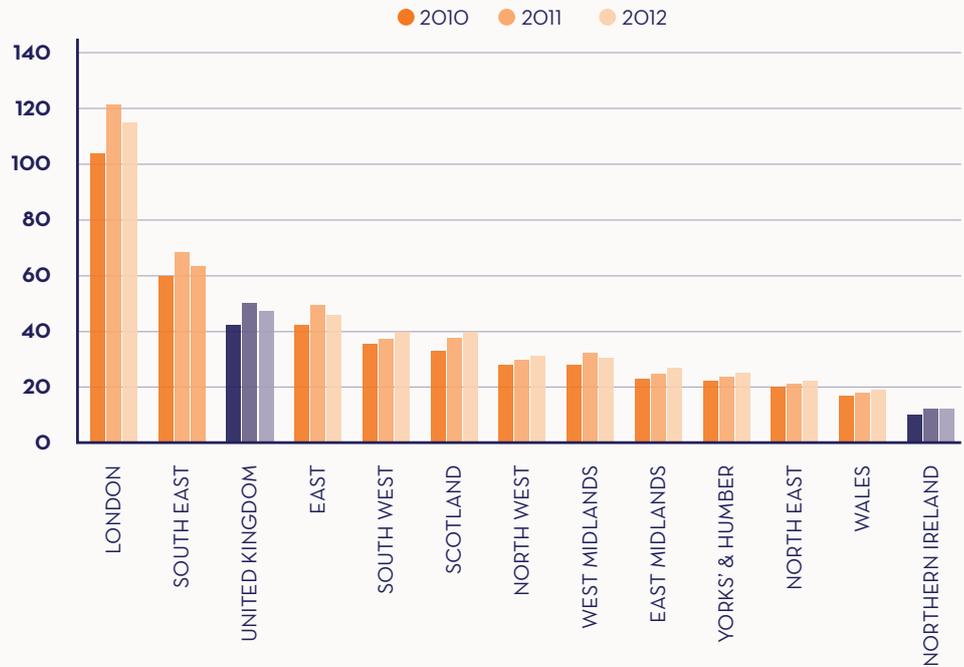
TABLE 4.3 NI KNOWLEDGE ECONOMY BUSINESS STARTS, 2010 - 12

SOURCE: ONS, INTERDEPARTMENTAL BUSINESS REGISTER (BUSINESS STARTS)

	2010	2011	2012	% \updownarrow (2010-12)
North East	590	695	740	25.4%
East Midlands	1,180	1,345	1,430	21.2%
West Midlands	1,625	2,005	1,965	20.9%
Scotland	1,840	2,165	2,215	20.4%
South West	1,925	2,170	2,250	16.9%
North West	2,170	2,445	2,500	15.2%
Wales	580	625	665	14.7%
United Kingdom	28,205	32,430	32,045	13.6%
Northern Ireland	260	295	295	13.5%
Yorkshire and The Humber	1,370	1,430	1,540	12.4%
London	8,725	10,250	9,760	11.9%
South East	5,285	6,040	5,800	9.7%
East	2,660	2,965	2,885	8.5%

FIGURE 4.3 KNOWLEDGE ECONOMY BUSINESS STARTUPS PER 100,000 POPULATION

SOURCE: ONS, INTERDEPARTMENTAL BUSINESS REGISTER (BUSINESS STARTS) & NOMIS (POPULATION)



4.1.4 Declining wage levels

Wage levels for the Knowledge Economy are measured by the average annual wage of Science and Technology degree holders⁷ who are in employment. This measure does not account for the sector in which the individual is employed.

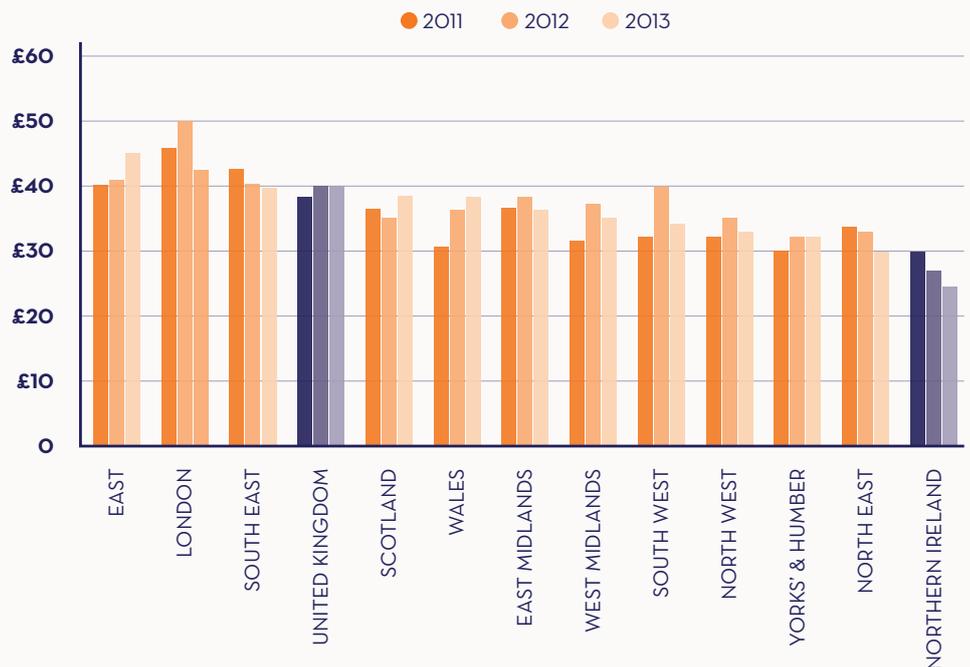
The average wage for Science and Technology degree holders in NI has fallen in 2012 and 2013 to £25,475, the lowest of the UK regions. It should be noted that the data source is the

Labour Force Survey, which is based on a relatively small sample (86 records in the case of NI for 2013). The preferred source of wage data is the Annual Survey of Hours and Earnings; however NISRA statisticians have advised that the data cannot be released due to small sample sizes.

This pattern is concerning for Northern Ireland but must be viewed in the context of other indicators of Knowledge Economy progress, a reasonably small sample size and some volatility in the other UK regions.

FIGURE 4.4 AVERAGE ANNUAL GROSS WAGE FOR SCIENCE AND TECHNOLOGY DEGREE HOLDERS, 2013 (£ x 1000)

SOURCE: LABOUR FORCE SURVEY



The Knowledge Economy provides relatively highly paid employment across the UK, however it appears that in NI, average annual wages are 8.5% lower for Knowledge economy jobs (£25,475) than the NI average (£27,827). **This could be due to a number of factors including;**

- A shift in the balance of power towards employers and away from employees as the demand for labour has been relatively weak since the recession;
- An increase in the number of graduate starter jobs, where employees are entering employment at the lower end of the spectrum; and
- The volatile nature of the data source as it would be expected there to be a positive wage premium as seen in the rest of the UK excluding London. The volume of highly paid jobs in the finance industry in London could explain its negative wage premium.

⁷ Science and technology includes biological, veterinary, agricultural, physical, mathematical and computer sciences and engineering and technology.

The average Knowledge Economy wage in NI is easily the lowest of the UK regions, at 64.4% of the UK Knowledge Economy average.

TABLE 4.4 AVERAGE WEEKLY GROSS WAGE IN THE KNOWLEDGE ECONOMY, 2013

SOURCE: LABOUR FORCE SURVEY AND ANNUAL SURVEY OF HOURS AND EARNINGS.

	KE average annual wage	All economy average wage	Wage premium
East	£44,732	£35,018	27.7%
London	£42,921	£43,866	-2.2%
South East	£39,872	£38,202	4.4%
United Kingdom	£39,575	£33,288	18.9%
Scotland	£38,088	£31,598	20.5%
Wales	£37,961	£28,096	35.1%
East Midlands	£36,025	£30,251	19.1%
West Midlands	£35,490	£30,113	17.9%
South West	£33,780	£30,536	10.6%
North West	£33,290	£29,742	11.9%
Yorkshire and The Humber	£32,531	£29,218	11.3%
North East	£30,280	£28,495	6.3%
Northern Ireland	£25,475	£27,827	-8.5%

WAGE DATA - MORE ACCESS TO OFFICIAL DATA AND RESEARCH REQUIRED

The Labour Force Survey data is the currently the only available source of data for Knowledge Economy wages. However, the samples are small and the trend is worryingly, going in the wrong direction.

It is recommended that the Annual Survey of Hours and Earnings carried out by NISRA and Destination of Leavers from Higher Education surveys are re-examined, along with any other potential data sources that may provide a more complete perspective on wages paid to Knowledge Economy employees.

Given the importance of this sector for economic development, it is essential that accurate and up to date information forms the base for analysis and building subsequent policy recommendations. This issue should be explored further with NISRA / DFP.

4.1.5 Core metrics summary

The performance of the core metrics within the Knowledge Economy is mixed over the last year with evidence of increased growth in a number of areas. There is ample evidence of increases in activity in the three activity focussed pillars of the KEI (R&D, innovation and investment) but this additional activity has not yet fed through to increases in the output measures contained within the core metrics.

NI is ranked on average, 12th of the 12 UK regions and the only change to regional rankings was a one place decline to 11th in employment. As can be seen from the UK figures, NI has a long way to go to catch up with the UK in these indicators.

TABLE 4.5 KNOWLEDGE ECONOMY - CORE METRICS

SOURCE: INDIVIDUAL INDICATOR DATA
SOURCES LISTED ABOVE.

NOTES: REGIONAL RANKING: 1 = HIGHEST, 12 = LOWEST

Key indicators for the Knowledge Economy	Baseline Position	Current Position		Regional Ranking	Latest Data
	NI (2009)	NI	UK	NI	
Employment as a % of total employment	3.7%	4.3%	5.3%	11	2013
Businesses as a % of total business stock	3.9%	4.4%	10.1%	12	2012
Business start-ups per 100,000 population	12.5	16.2	50.3	12	2012
Average weekly wage level	£26,704	£25,475	£39,575	12	2013

Northern Ireland Advanced Composites and Engineering Centre

The Northern Ireland Advanced Composites and Engineering Centre is a hi-tech hub for the research and development of advanced engineering and materials technologies across a range of industrial sectors.

Its vision is to establish a world leading knowledge hub that delivers innovative solutions for industry through collaborative research and technological advancement. NIACE wants to help the local manufacturing sector develop and grow world class technology solutions for a breadth of manufacturing applications, enabling local businesses to compete more successfully in the global arena.

Opened in January 2012, and based at purpose built, state of the art facilities in Belfast, NIACE currently has 14 participating companies from a variety of areas, and two university partners, namely Queen's University Belfast and the University of Ulster carrying out research. Trade body ADS is also an associate participant.

With a capacity for 120 research and technical staff from industry and academia, NIACE allows participants to work side by side staff from the two

universities with the aim of working collaboratively to develop innovative technology solutions for industry.

NIACE supports the development of advanced engineering companies of all sizes, and has the facilities and services to support the participation of companies from multiple areas within the advanced engineering sector, including Aerospace, Automotive, Civil Engineering, Marine, Renewable and Space. Companies currently on-site include B/E Aerospace, CCP Gransden, LPE, BASE, Thales and Wrightbus. All participant companies can gain insight into different aspects of advanced engineering, manufacturers, designers, and end users, as well as access to valuable seminars and workshops on new technologies and market opportunities.

Participants can work at a scale and in collaborations not previously feasible and

can access funding sources and new business opportunities outside of Northern Ireland. This can mean a reduction in development times, shared responsibility for projects, access to manufacturing and testing equipment, and opportunities to explore different manufacturing technologies.

NIACE also accommodates the Northern Ireland Advanced Engineering Competence Centre, which was launched in July 2014, and received £5m government funding to support research for the next five years to deliver market focused projects, which have the potential to generate benefits for Northern Ireland industries and the economy overall. In liquid nitrogen, to Lewis Fertility for testing. They get the results back in their email inboxes within a week. While most activity has been in the UK and Ireland so far, the company hopes to expand rapidly through clinics around the globe.

Access to appropriate sources of finance at competitive rates is important to enable firms to invest and grow. Since the recession, many issues have impacted upon finance for business including the requirement on the banks to replenish their balance sheets, reductions in demand and decreased confidence which has led to more risk aversion. NI also had a more severe overhang of property debt, as prices in NI fell by much more than in other parts of the UK.

Access to appropriate forms of finance is important, especially to Knowledge Economy firms that have the capability of rapid growth given the level of global demand for their products and services. This pillar of the KEI monitors access to the forms of finance that are important to this sector.

5.1.1 Venture capital - a flurry of small deals

Northern Ireland has performed well in terms of VC and private equity activity as a flurry of small deals pushed NI close to the top of the league table for number of VC investments per 100,000 businesses. However, the total value of VC deals is lower than at any stage since 2005 and the average size of deal is £114k. The value declined significantly from £21m to £4m to 2012 (although the £21m figure is thought to include a single large deal).

This element of the research is very much a two sided story, where NI is ranked 2nd in the UK in VC and private equity activity, but 10th and 12th respectively in the number and value of these deals.

It is encouraging to see such high levels of activity, which may be signs of the VC and private equity market beginning to function. Hopefully, the size of deals will begin to increase as NI recovers from the recession and larger companies begin to make use of the finance that is available through the VC and private equity funds.

TABLE 5.1 PRIVATE EQUITY AND VENTURE CAPITAL INVESTMENTS, 2012

SOURCE: BRITISH VENTURE CAPITAL ASSOCIATION (BVCA), IRISH VENTURE CAPITAL ASSOCIATION (IVCA) AND INVEST NI

NOTE: TOP TWO REGIONS SHADED GREEN AND BOTTOM TWO REGIONS SHADED RED
DATA INCLUDES ALL INVEST NI SUPPORTED VC ACTIVITY
*DATA ON THE NUMBER OF VAT REGISTERED BUSINESSES FOR IRELAND IS NOT PUBLISHED; THE NUMBER OF ACTIVE ENTERPRISES HAS BEEN USED INSTEAD

	Number of private equity investments, number of companies	Companies invested in per 100,000 VAT registered businesses	No. of VC investments per 100,000 VAT registered businesses
North East	82	108	106
NI	38	67	63
Wales	37	33	21
London	191	54	19
West Midlands	77	37	16
Scotland	67	34	16
South East	115	29	15
East Midlands	32	18	12
North West	66	26	11
Yorkshire & Humber	39	27	9
East	39	15	8
South West	49	120	5
Ireland*	139	75	75
UK	832	31	18

The North East of England is noteworthy in this context, in that its performance on the standardised metrics for Venture Capital is significantly ahead of NI, the next best performing UK region. The data for the Republic of Ireland highlights that it is much

more successful than the UK. Whilst it is beyond the scope of this research, it would be interesting to compare the RoI and UK / NI policy environments and identify the main reasons for the strength of the RoI performance.

INVESTMENT ACTIVITY FLOURISHES IN THE NORTH EAST

Investment activity in the North East of England far outstrips the next best performing region (NI). Whilst the NI performance is prodigious in terms of activity, the North East of England is still more than sixty per cent ahead of NI.

The North East should be considered as a potential case study for further research to help to understand the driving factors

behind its success and their applicability to NI.

5.1.2 Venture capital - getting to the kernel of the issue

The measurement of Venture Capital and Private Equity activity in NI has been a challenge from the outset of the Knowledge Economy Index project and also for researchers and policy makers who work in this area. There is no official data source for Venture Capital and Private Equity data in NI.

The main source of UK data is the British Venture Capital Association (BVCA) and their counterpart, the Irish Venture Capital Association (IVCA) which have provided data for the Republic of Ireland. The issue that bedevils Venture Capital data provision is that not all Venture Capital companies or funds are members of either the BVCA, or IVCA. Whilst they are the best available sources of data, they do not include a significant number of private sector deals and publicly funded

organisations. The very limited amount of data available makes it particularly difficult to assess the relative health of the sector, challenges that are faced and develop appropriate policies.

Crescent Capital, NISPO E-Synergy and the Kernel Capital Development funds, which are funded by Invest NI and are not members of the BVCA, were able to provide data on the number and value of deals completed each year to Invest NI's VC team for use in this project. Invest NI's VC team very helpfully provided the data for use in this research and although some funds were not able to provide any data to Invest NI, a reasonable amount of coverage has been attained. Not including the activity of these funds will leave some gaps in the data, but should not significantly impact upon the conclusions drawn from this section of the research.

VENTURE CAPITAL - TIME FOR AN OFFICIAL SURVEY

As raised in the 2011, 2012 and 2013 Knowledge Economy Index reports, there are numerous difficulties with securing adequate data on investment activity in Northern Ireland. There is no single source that captures and reports on all venture capital activity.

There is no single source that captures and reports on all venture capital activity for NI which presents significant issues in terms of measuring activity and developing effective policies.

NICEP's recommendation is an annual Venture Capital and Private Equity survey or census should be carried out.

⁸ <http://www.ivca.ie/wp-content/uploads/2014/06/IVCA-VenturePulse-Q1-2014-Publish.pdf>

5.1.3 Mergers and acquisitions - a flurry of smaller deals

The number of mergers and acquisitions (M&A) increased from 40 to 64 from 2012 to 2013, which means that NI saw the greatest increase in activity of any UK region (60%). However,

the average value of deals in NI declined by 15.3% to £537m over the same period meaning that the average deal size halved to £8m. This flurry of activity has increased NI's regional ranking by one place to 11th.

FIGURE 5.1 MERGER AND ACQUISITION ACTIVITY PER 100,000 BUSINESSES

SOURCE: EXPERIAN CORPFIN (VALUE AND VOLUME), VAT REGISTERED BUSINESS STOCK FROM IDBR



5.1.4 Low numbers of Public Listed Companies (PLCs)

With only four listed companies and relatively low market capitalisation per head, NI lags significantly behind the UK average and the next lowest UK region (Wales). NI companies

that are publicly listed are Capital Gearing Trust, First Derivatives, Galleon holdings and UTV Media PLC, with Andor removed from the list as the result of a takeover.

TABLE 5.2 PUBLICLY LISTED COMPANIES, BY UK REGION, 2013 AND 2014

SOURCE: LONDON STOCK EXCHANGE

NOTE: TOP TWO REGIONS SHADED GREEN AND BOTTOM TWO REGIONS SHADED RED. POPULATION DATA IS PROVIDED ON USING GOVERNMENT OFFICE REGIONS. LSE DATA IS PRESENTED USING STANDARD STATISTICAL REGIONS AND NICEP HAVE ESTIMATED BUSINESS STOCK FIGURES FOR THE SSRS TO CALCULATE MARKET CAPITALISATION PER HEAD.

	2013		2014	
	# of companies	Market capitalisation per head	# of companies	Market capitalisation per head
London	795	£177,207	856	£185,814
UK	1,642	£32,228	1,624	£33,519
South East	146	£25,502	162	£22,816
Scotland	105	£16,381	108	£16,926
South West	67	£9,652	73	£11,947
East Anglia	122	£10,126	116	£9,989
North East	86	£6,606	98	£7,497
Midlands	86	£4,876	95	£6,145
North West	76	£2,694	89	£3,620
Wales	10	£1,448	11	£1,614
Northern Ireland	5	£248	4	£282
Ireland	51	£10,049	54	£12,712
Overseas/unallocated	144	-	12	-

5.1.5 Investment activity summary

The performance of the indicators within the investment pillar has been mostly positive with high volumes of small deals driving up performance in the activity oriented elements of the index. However, the value and raw number of deals remains low (especially following one large deal in 2011). There are significant issues with data availability for four out of six of the indicators within this pillar. It is recommended that NISRA consider a census or survey of Venture Capital and Private Equity activity in the NI market place in order to provide a robust evidence base upon which to assess the relative health of the sector and develop appropriate policies.

In addition to the data captured by the Knowledge Economy Index, recently published research by Deloitte⁹, on behalf of the UK Business Angels Association¹⁰, found that NI accounted for 6% of all UK Angel Investment in the UK during 2012/13. This is a respectable performance for NI, as it is punching above its weight when considered relative to the proportion of UK population or businesses located in NI. It also highlights that the indicators used in the KEI should be kept under review as revisions may be required on occasion, as the types of available finance may change over time.

TABLE 5.3 SUMMARY OF INVESTMENT ACTIVITY INDICATORS

* TENTH OUT OF THE TEN REGIONS USED BY THE LONDON STOCK EXCHANGE

Investment Activity	Previous Year	Latest Data	Regional Ranking	Progress since last year (ranking)	Year	Sources
No. of private equity and VC investments (no. of companies)	17	38	10	▲ x2	2012	BVCA, IVCA, InvestNI
No. of private equity inv' per 100,000 VAT registered businesses	30	67	2	▲ x3	2012	BVCA, IVCA, InvestNI
No. of venture capital inv' per 100,000 VAT registered businesses	25	63	2	▲ x1	2012	BVCA, IVCA, InvestNI
Amount of VC investment, £M	£21	£4	12	▼ x8	2012	BVCA, IVCA, InvestNI
No. of M&A and ECM deals per 100,000 VAT registered businesses	71	113	11	▲ x1	2013	Experian Corpfin
Public listed companies: Market capitalisation per head	£248	£282	10*	...	2014	London Stock Exchange

⁹ http://www.ukbusinessangelsassociation.org.uk/sites/default/files/media/files/taking_pulse_of_the_angel_market_02_07_2013_0.pdf

¹⁰ <http://www.ukbusinessangelsassociation.org.uk/research-policy/market-research>

8over8

8over8[®] was formed in 2000 and is an established software provider to leading Oil and Gas companies supplying its contractual risk management platform, ProCon[™], which identifies and mitigates contractual risks associated with large and complex projects, thereby helping to minimize delays, cost overruns, and disputes.

It significantly reduces associated risks and costs of major projects through monitoring the status of such complex commercial engagements by alerting the Operators to any problems before likely delays, overruns, and disputes occur.

With 14 years under its belt, 8over8 has established a very strong customer base, among them the largest international and independent oil and gas companies. Now targeting emerging national oil companies and addressing new markets in mining, smart cities, and smart energy grids, 8over8 is expanding its capabilities in predictive analytics and behavioural trend analysis.

8over8's current offering, ProCon 2014, was released in June 2014 and is their contractual risk management platform that captures all relevant communications among all parties on any given project.

ProCon allows the Owner Operator to view the status of their project at

any given time, and highlights early warnings on factors such as the likelihood of an overrun and likely outcomes if relationships are not managed. ProCon standardizes workflows and clarifies obligations, and shows whether these are being followed or met. It monitors change orders and identifies potential conflicts, delays, and errors, and automatically sends alerts. These capabilities help reduce mistakes and delays and enable quicker corrective action when necessary. They also establish an audit trail to analyse problems, document disputes, assign responsibility, and simplify cost recovery from both contractors and significant joint venture partners.

In addition to the platform, 8over8 also offers three analytics tools - ProCon Analytics, ProCon Insights, and ProCon Trends and is now developing semantic analysis capability to help identify leading performance indicators which will be accessible from smartphones as well as PCs in the very near future including an

executive dashboard that can be queried by many business intelligence tools.

Globally the company has managed more than \$600bn of capital contracts with ProCon, including six of the 10 largest energy projects in the world. Its customers estimate that ProCon reduces their final project costs by a minimum 3%.

Headquartered in the UK, 8over8 also has offices in North America, Australia, UAE, Oman, and Qatar. Its customers include the super majors Shell, BP, and Chevron; majors such as Husky Energy, Inpex, Santos, Wintershall, and Woodside; the national oil companies of Abu Dhabi and Oman; Nexen, a subsidiary of China National Offshore Oil Corporation (CNOOC); and the Kazakhstan joint venture Karachaganak Petroleum Operating B.V.

The value of R&D activity within an economy is a key driver of productivity and longer term economic growth. As such, the UK's Science and Innovation Investment Framework sets out the UK Governments ambition of increasing expenditure on R&D to 2.5% of GDP by 2014.

In 2012, with the UK figure at 2.0% of GVA, there remains a significant challenge if the UK is to deliver against its ambition. Within the R&D activity element of the KEI, NI has performed well, ranking on average, eighth of the UK regions across the six indicators contained within this element.

6.1.1 Strong performance in R&D expenditure

NI has performed very well in terms of R&D as a proportion of GVA, and is now ranked fifth of the UK regions, raising its R&D level to 2.0% of GVA. Whilst a small number of large firms carry out a

significant proportion of the R&D, this is a noteworthy achievement for NI in that R&D as a proportion of GVA hovered at around 1.2% from 2006 - 08. It then stepped up to 1.7% in 2009 which was maintained in 2010 and 11 and has risen further still in 2012. The Republic of Ireland's R&D expenditure as a proportion of GVA is currently at 1.3% which lags behind NI quite considerably.

6.1.2 Business Expenditure on R&D rising

R&D is defined as "Creative work undertaken on a systematic basis in order to increase the stock of knowledge of man, culture and society and the use of

this stock of knowledge to devise new applications". Business expenditure on R&D or BERD is the component that is carried out by businesses and is generally regarded as the most important source of R&D as the academic literature suggests that of all the forms of R&D, it has the most influence on productivity and economic growth.

NI's performance in terms of BERD has been very good, with NI now ranked fifth of the UK regions, ahead of the UK and RoI averages. When historical patterns are examined, it is clear that significant progress has been made as in 2005-08 the average was 0.6% of GVA.

FIGURE 6.1 R&D AS A % OF WORKPLACE GVA, 2010-12

SOURCE: ONS, BUSINESS ENTERPRISE RESEARCH AND DEVELOPMENT SURVEY, 2010-12, CENTRAL STATISTICS OFFICE (CSO)

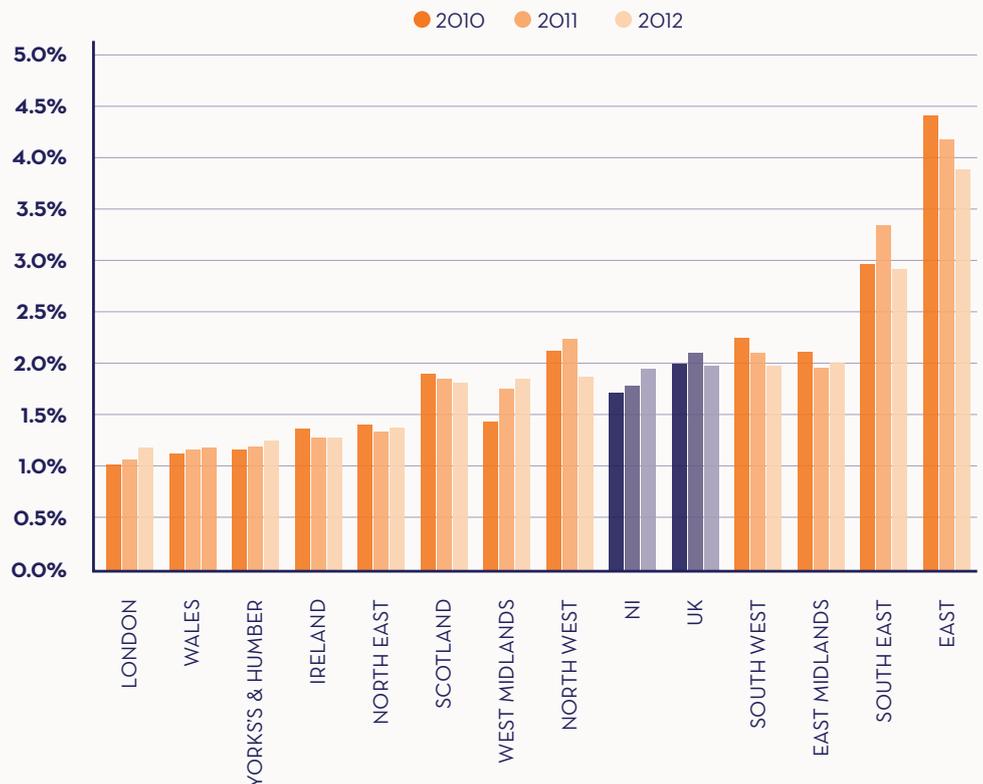
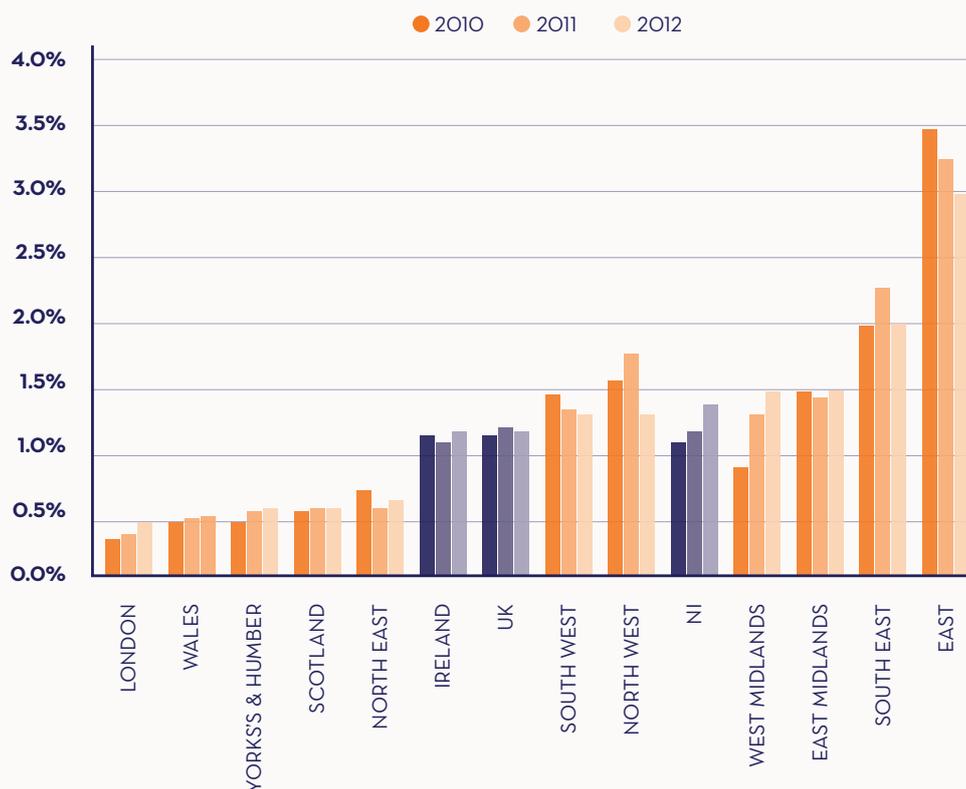


FIGURE 6.2 BUSINESS EXPENDITURE ON R&D AS A % OF WORKPLACE GVA, 2010-12

SOURCE: ONS, BUSINESS ENTERPRISE RESEARCH AND DEVELOPMENT SURVEY, 2010-12, IRISH DATA FROM CSO



R&D - FOCUSING INTERNATIONALLY

Northern Ireland has been particularly successful in terms of R&D and Business Expenditure on R&D. Over the past decade NI has gone from being one of the lowest ranked regions to being at, or above, the UK level.

Businesses, academics and policymakers should be congratulated for this achievement.

If a forecast had been made in 2000 that NI would be ahead of the UK average in BERD in 2012, it is likely that forecast would have been treated with derision. The step change in R&D performance, sustained throughout the recession

demonstrates what can be achieved by businesses in NI with support from policymakers, academia, stakeholders like NISP and funders such as Invest NI.

NI's vision for R&D should now become international, promoting R&D activity and implement policies that will broaden the R&D base and continue NI's success

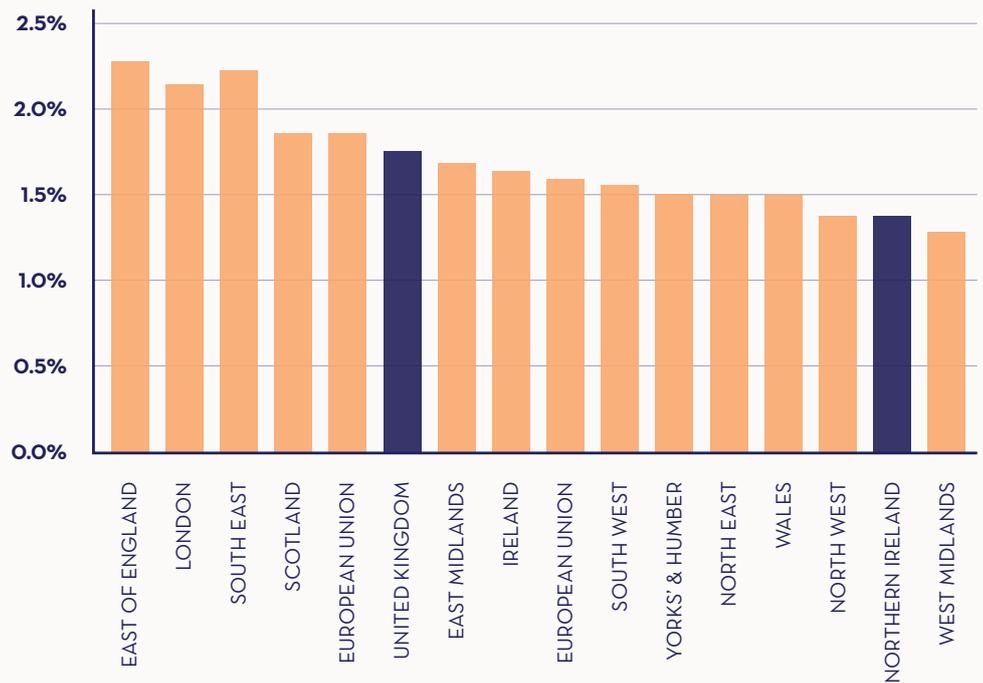
6.1.3 R&D personnel numbers remain lower than expected

Eurostat data shows that R&D personnel made up 1.4% of total employment in 2011 which is the second lowest of the UK regions. R&D employment has not caught up with R&D

expenditure, although it is worth noting that the latest available data for R&D personnel is 2011, which is a one year lag to the R&D expenditure data.

FIGURE 6.3 R&D PERSONNEL EMPLOYED AS A % OF TOTAL EMPLOYMENT, 2011

SOURCE: EUROSTAT



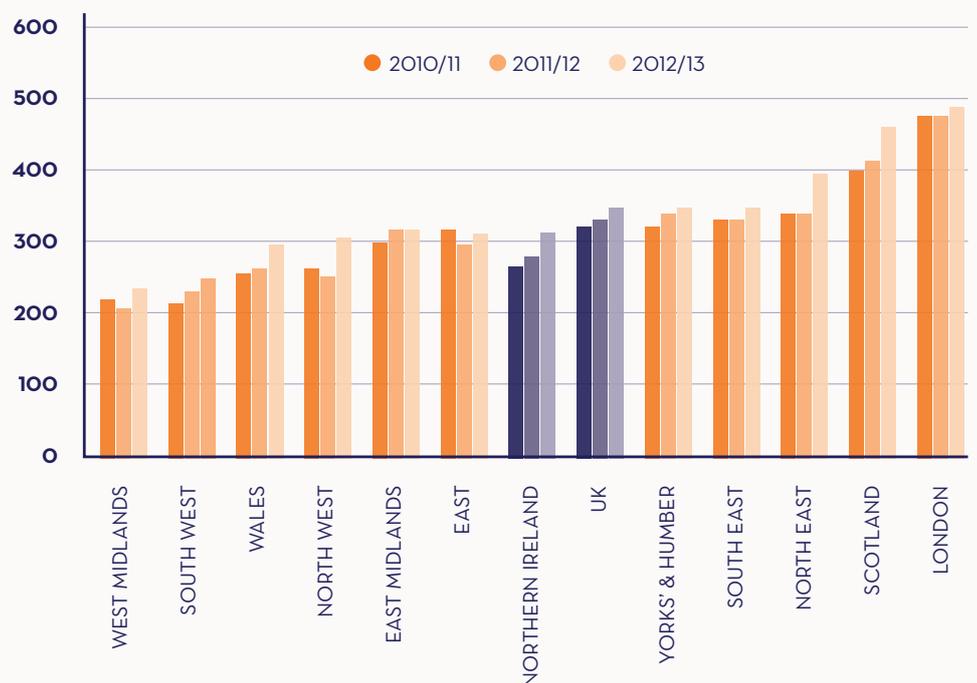
6.1.4 Boost in the number of PhDs

PhD graduates are highly skilled individuals who are invaluable when it comes to producing and transferring knowledge in an innovation based economy. NI has shown significant increases in the number of PhDs awarded per million inhabitants over the last four years. In 2010/11 262 PhDs were completed per

million inhabitants in NI, which increased to 314 by 2012/13. This is a positive trend which moves NI closer toward the UK average of 318 and increased NI's regional ranking from ninth to sixth over the period. London and Scotland both outperform the UK average, presumably due to the concentration of Higher Education Institutions located in each (fifty-five and twenty respectively).

FIGURE 6.4 NUMBER OF PHDS AWARDED PER MILLION INHABITANTS

SOURCE: HIGHER EDUCATION INFORMATION DATABASE FOR INSTITUTIONS (HEIDI)



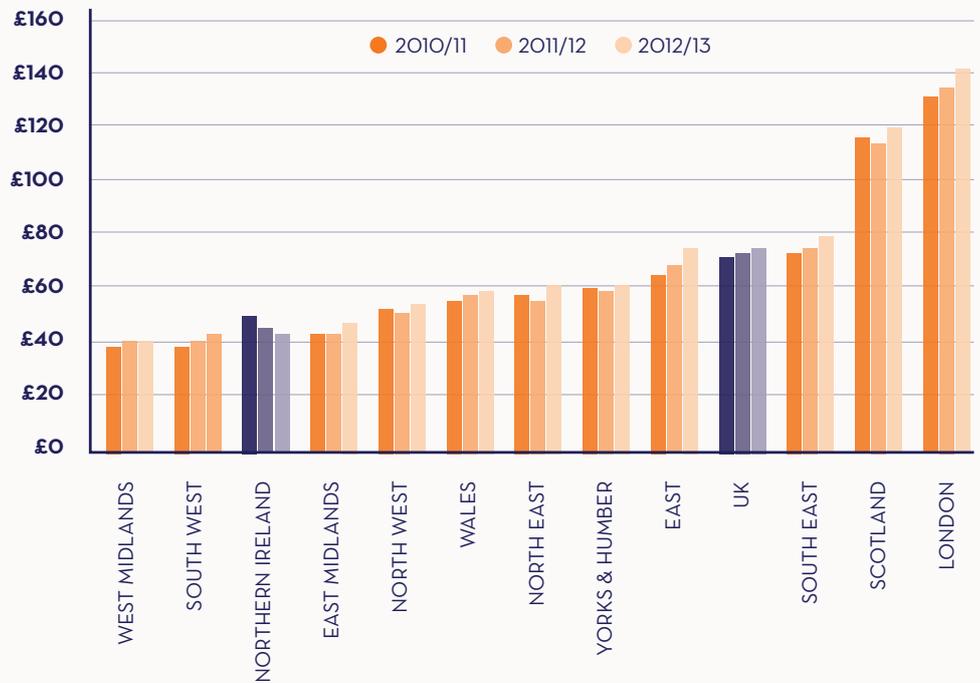
6.1.5 Research grants and contract values falling

London and Scotland dominate the UK regional picture, which is understandable due to the concentration of Higher Education Institutions located in each. Northern Ireland is below the UK average, and is the only region where the value of

research grants and contracts per 1000 inhabitants has fallen over the 3 year period, although it held onto the tenth place ranking. In absolute terms, the value of research grants and contracts fell from almost £89m in 2010/11 to £81m in 2012/13, providing some cause for concern.

FIGURE 6.5 VALUE OF RESEARCH GRANTS AND CONTRACTS PER 1,000 INHABITANTS

SOURCE: HIGHER EDUCATION INFORMATION DATABASE FOR INSTITUTIONS (HEIDI)



RESEARCH GRANTS IN TIMES OF AUSTERITY

In the current environment of austerity across the UK it is imperative that Northern Ireland considers both the impact and implications of austerity.

In this context, it means that all forms of Government income and expenditure must be considered in NI in order to make the best decisions for society. Funding for research must be considered in the context of all other Government expenditure and not just research or higher education expenditure.

It is recommended that NI and UK research grants, their funding, the potential for private sector top-ups and taking advantage of non-NI / UK sources is the subject of further research.

6.1.6 Science and technology graduates in the workforce proportionally low

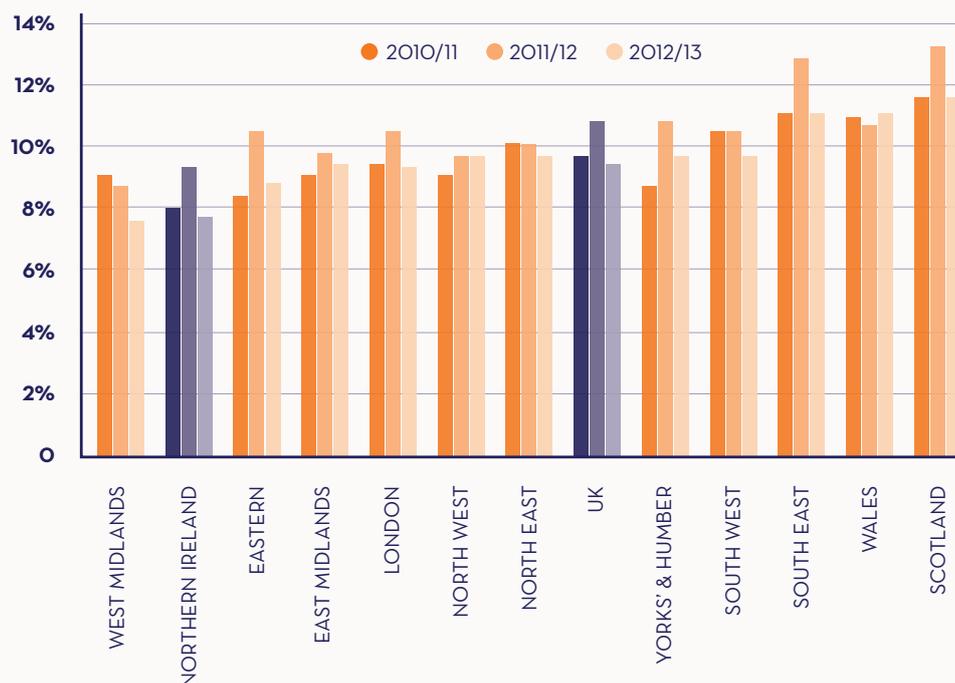
The supply of skilled labour is important to all economies but is particularly important to the Knowledge Economy. In 2013, the proportion of science and technology graduates in NI was 7.7% of workforce jobs, below the UK average of 9.6%. The

data is reasonably volatile for a number of the UK regions, as can be seen from the fluctuation in the NI data of one percentage point annually. However NI maintained its regional rankings of eleventh in 2013.

FIGURE 6.6 SCIENCE AND TECHNOLOGY GRADUATES AS A PROPORTION OF WORKFORCE JOBS

SOURCE: LABOUR FORCE SURVEY

NOTES: SCIENCE AND TECHNOLOGY INCLUDES BIOLOGICAL, VETERINARY, AGRICULTURAL AND PHYSICAL SCIENCES, MATHS AND COMPUTING, ENGINEERING AND TECHNOLOGY



6.1.7 R&D activity bolsters the Knowledge Economy Index

The R&D pillar of the KEI has performed well, with NI ranking eighth, on average. Levels of R&D and BERD as a proportion of GVA have stepped up significantly in recent years and continue to rise. Half of the indicators in this section have improved by two places.

The policy challenge for other elements of the KEI is to emulate the relative success of the R&D element of the Index and also to keep driving this element forward. It may also be expected that the relative success in this element of the Index should also raise the performance of other elements in future years.

TABLE 6.1 SUMMARY OF R&D ACTIVITY INDICATORS

R&D Activity	Previous Year	Latest Data	Regional Ranking	Progress since last year (ranking)	Year	Sources
R&D as % of workplace based GVA	1.8%	2.0%	5	▲ x2	2012	UK R&D Survey
Business Expenditure on R&D as % of workplace GVA	1.2%	1.4%	5	▲ x2	2012	UK R&D Survey
R&D personnel as % of total employment	1.0%	1.4%	11	▼ x2	2011	Eurostat
No. of PhDs per million inhabitants	282	314	6	▲ x2	2012/13	HEIDI
HEI Research grants and contracts per 1,000 population	£44.8	£44.4	10	...	2012/13	HEIDI
No. of science and tech' graduates (NVQ Level 4+) as % of workforce	9.0%	7.7%	11	...	2013	Labour Force Survey

Adoreboard

Knowledge is good. Understanding is better.

Without spending a lot of time, energy and effort you will never truly know if you are hitting the mark in achieving the kind of brand recognition that will drive maximum sales or reputation build.

That was before ADOREBOARD.

Adoreboard is a unique platform that measures how the world feels about your brand.

The brainchild of Chris Johnson, the company was set up in 2011 as a technology start up using academic research algorithms that elicit meaning and understanding from the emotions that people express online.

Adoreboard is VC backed through E-Synergy and Queens University Belfast, one of the UK leading research intensive universities, which is part of the Russell Group.

In 2014, Adoreboard was named as “best Technology Startup” 2014 by the influential body Silicon valley Global Leadership Forum (ITLG).

Dr Fergal Monaghan, the Chief Technology Officer for Adoreboard explains that the analysis produces a simple to understand Adorescore.

It is a stock index for emotional engagement. Just like a megapixel indicates the quality of an image, the adorescore allows any brand to understand its current real time emotional value. It does this by analysing over

60,000 online news sources...2 million articles....blogs, forums and online sites.

In September 2014 the company launched itself onto the world market and in just a couple of days was trending on product.hunt.com with thousands of hits worldwide.

Clients already include The Havas Group, SITA and The Conran Design Group with interest building from some of the world's biggest brand names.

7 INNOVATION AND PATENT ACTIVITY

As the final pillar of the KEI, innovation and patent activity provide an insight into the generation and commercial exploitation of new knowledge.

“Innovative businesses are more productive and typically grow twice as fast as businesses that fail to innovate, and innovative economies are more competitive, respond better to change, and see higher returns on investment and increased living standards.”¹¹

InnovateUK, 2014

7.1.1 Innovation activity remains low

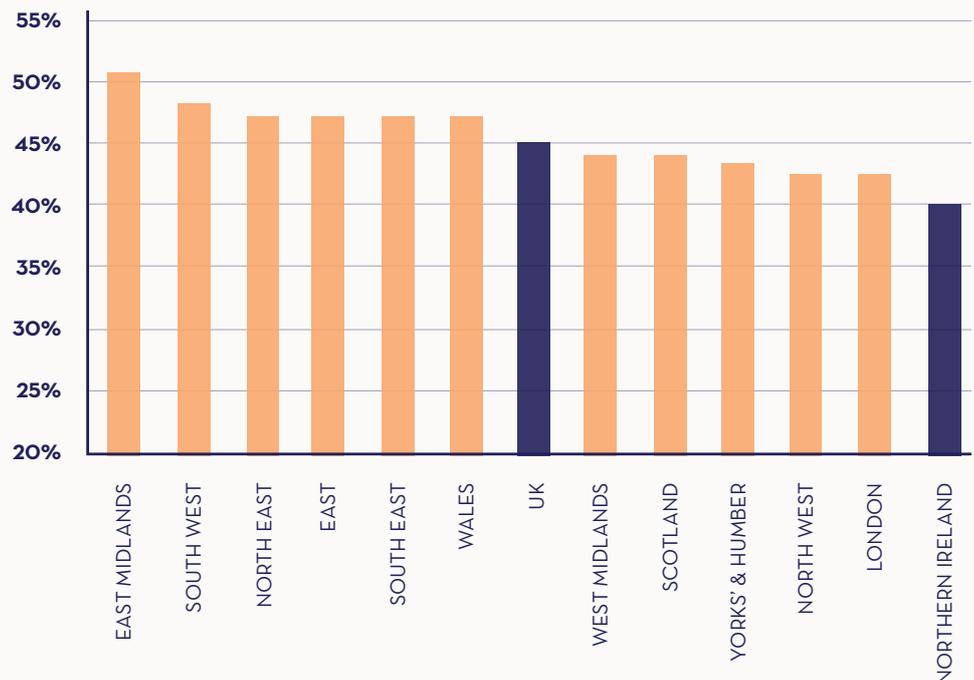
The 2012 UK innovation survey published by NISRA presents the data as an average over the three year period from

2010-2012. The latest available data shows that NI has the lowest proportion of businesses that are innovation active of the UK regions (40%), a full five percentage points lower than the

UK average. This is a disappointing performance as NI's regional ranking decreases from 11th in the previous survey, which covered 2008-10 to 12th.

FIGURE 7.1 PROPORTION OF ENTERPRISES THAT WERE INNOVATION ACTIVE, 2012

SOURCE: DETI, UK INNOVATION SURVEY



INVESTMENT ACTIVITY FLOURISHES IN THE NORTH EAST

Is being launched by NISP CONNECT and is supported by DETI and Invest NI. Those involved in the process will seek to translate NI's success in activity across the KEI pillars of innovation, R&D and investment into growing employment, businesses and exports to help deliver the ambitious NISP CONNECT 2030 targets and contribute towards the achievement of the DETI Innovation Strategy targets in 2025.

¹¹ <https://www.innovateuk.org/>

7.1.2 UK patent activity remains low relative to other regions

Applying for a patent makes an invention public and also offers protection at the same time. Measuring the number of patents granted helps to gauge a region's innovation activity and is reflective of its capacity to exploit knowledge and transform it into potential economic gains. However, in tough economic times patent budgets can become constrained and patent investment more selective.

NI and the North East of England are consistently the lowest ranked regions in terms of patent applications filed and granted

with the UK IPO. As with many of these types of indicators, the South Eastern corner of England ranks highest. What may be of more concern however, is NI's relatively low conversion ratio from applications filed to applications granted – an average of 7.6% compared to 16.4% in the UK.

It is perhaps surprising that NI's improving performance across the R&D indicators, especially in R&D as a % of GVA and BERD as a % of GVA do not seem to be feeding through to higher numbers of patent applications and higher conversion ratios. This may be explained by significant time lags in terms of bringing products to a market ready state.

TABLE 7.1 PATENT APPLICATIONS FILED AND GRANTED PER MILLION INHABITANTS, BY UK REGIONS 2012 - 2013

SOURCE: UK INTELLECTUAL PROPERTY OFFICE

Region	Applications Filed		Patents Granted	
South West	275	269	81	67
East	327	324	65	61
South East	349	344	75	53
London	335	344	50	46
West Midlands	210	219	41	36
Yorkshire & The Humber	201	193	36	33
North West	208	183	35	30
Scotland	182	176	37	28
Wales	175	182	36	27
East Midlands	199	171	30	26
North East	141	123	23	20
Northern Ireland	146	137	13	10
UK	254	248	49	41
UK % change		-2.6%		-17.1%
NI % change		-6.3%		-21.7%

7.1.3 European patent performance improves significantly

The OECD compiles data for patents and hi-tech patent applications with the European Patent office (EPO). The latest available information is for 2011, in which there is a significant decline for all of the UK regions. It would appear that this is a normal occurrence as more data for 2011 figures will be added as part of the next revision of the data and therefore the 2011 figures should be considered with caution. Nonetheless Northern

Ireland has performed well and managed to improve its regional ranking to 6th from the bottom of the table.

Ireland is much more productive than both the UK and NI in terms of patents filed per million inhabitants, reflecting the creative and dynamic nature of the activities undertaken by businesses and the impact of a relatively large pharmaceutical sector in the Republic.

TABLE 7.2 PATENT APPLICATIONS PER MILLION INHABITANTS, BY UK REGIONS 2009 - 2011

SOURCE: OECD, EPO PATENTS APPLICATIONS BY INVENTOR

	2009	2010	2011
East Midlands	82	82	55
South East	153	144	52
Ireland	78	70	51
South West	106	100	40
East	120	115	28
UK	86	84	28
North East	73	52	25
NI	38	33	20
West Midlands	61	71	19
Yorkshire and The Humber	44	50	19
Scotland	76	65	16
London	62	63	14
Wales	45	39	13
North West	55	60	11

7.1.4 Hi-tech European patent performance improves significantly

An important component of patent applications are those that are in the high technology field, potentially providing the most important safeguards to products and processes that could have

the greatest commercial potential. Ireland leads the way in this particular indicator for 2011, although it is generally only slightly ahead of the UK average. Once again, NI has improved its ranking from twelfth to sixth of the UK regions.sector in the Republic.

TABLE 7.3 HIGH TECHNOLOGY PATENT APPLICATIONS PER MILLION INHABITANTS, BY UK REGIONS 2005 - 2011

SOURCE: OECD, EPO PATENTS APPLICATIONS BY INVENTOR

	2009	2010	2011
Ireland	58	52	39
South East	89	80	31
East	84	83	15
South West	41	41	14
UK	45	44	12
London	44	45	8
Yorkshire and The Humber	20	25	8
NI	20	15	7
Scotland	46	35	7
East Midlands	26	21	7
North East	21	16	5
North West	18	20	4
Wales	26	23	4
West Midlands	28	34	4

7.1.5 Innovation and patent activity summary

NI's performance in the innovation and patent activity element of the KEI was historically the weakest of the four KEI areas but this is no longer the case as its average ranking has risen from twelfth to ninth out of the UK regions. Data for Ireland is included for two of the four indicators, both performing well underlining Ireland's reputation as an innovative and highly skilled nation.

It would be reasonable to expect that with the relative success of the R&D element of the index that some of the activity should begin to feed into the commercialisation of products and processes, which should then be reflected in the patent indicators.

TABLE 7.4 SUMMARY OF INNOVATION ACTIVITY INDICATORS

Innovation and Patent Activity	Previous Year	Latest Data	Regional Ranking	Progress since last year (ranking)	Year	Sources
% of firms stating that they are innovation active	40.0%	40.0%	12	...	2010-12	DETI UK Innovation Survey
No. of patent applications per million inhabitant (to EPO)	33	20	6	^ x6	2011	OECD
No. of high technology patents per million inhabitant (to EPO)	15	7	6	^ x6	2011	OECD
No. of patent applications filed per million inhabitant (to UK IPO)	146	137	11	...	2013	UK IPO
No. of patents granted per million inhabitant (to UK IPO)	49	41	12	...	2013	UK IPO

SolaForm

Established in 2013, Solaform Ltd is a spin-out from the University of Ulster led by Dr. Mervyn Smyth from the School of the Built Environment and Dominic McLarnon, from the University's Centre for Sustainable Technologies. The company's first product to be brought to market is the Solacatcher, a low-cost solar water-heating system designed specifically for domestic use.

The patented technology acts much like a thermos flask, enabling the collection of solar energy during the day and providing insulation to retain the stored heat for a prolonged period of time. The cost-effective technology has the potential to transform the solar water heating market. Complete system costs are estimated at as little as £700 in comparison to £4,000 for more traditional systems.

It began in 1995 when Mervyn embarked on a PhD in Solar Energy at the University of Ulster. Along the way he identified a gap in the market for solar thermal technology targeted at price sensitive

customers. On the back of the eco-friendly market trends and stricter renewable energy building regulations, he was confident his research could be commercialised. To take the project to the next stage, he contacted Dominic, an engineering consultant at the time, who helped to identify how best to leverage the research to spin out a company.

In September 2013 Dominic officially came on board Solaform Ltd as an Executive Director. With advice and support for the University's Office of Innovation, the company secured investment from the Ulster Innovation

Fund which helped fund the development of a prototype. After testing the market, the company is now seeking partners to further the commercial development of the Solacatcher through licensing or a joint venture arrangement.

SolaForm Ltd has been recognised as one of the leading tech companies to come out of Belfast in 2014 in a list compiled by The Observer. The future looks bright for this university spin-out with discussions already taking place with the local social housing market to supply the technology.

Oxford Economics, NISP CONNECT and key stakeholders developed targets for a range of Knowledge Economy indicators as part of the first phase of Knowledge Economy work in 2009. The objective of setting these targets was to help articulate what a successful Knowledge Economy would look like in 2030, help to calibrate the scale of the challenge and provide a framework against which progress could be measured. Now that NISP CONNECT is five years into the Knowledge Economy project, this is an appropriate time to assess progress towards these targets.

NI Executive's Innovation Strategy published a number of ambitious targets for the region to achieve by 2025, some based on the metrics defined in this Knowledge Economy Index. In 2012 NISP CONNECT members agreed a series of targets for Northern Ireland's knowledge economy by 2030, which, as an independent and largely private

sector-led team, are unsurprisingly more ambitious than those in the Innovation Strategy. When referenced the NISP CONNECT targets are intended to act as "stretch targets" if additional resource or initiatives are implemented.

If the targets are achieved by 2030 it is estimated that the growth of the

Knowledge Economy would create an extra 39,100 direct employee jobs and a further 22,500 jobs in the wider economy as businesses make purchases and staff spend wages. In total this would generate an extra £3 billion in direct Knowledge Economy GVA and an extra £5 billion in the economy as a whole.

8.1

ACCELERATED GROWTH NEEDED ON CORE TARGETS

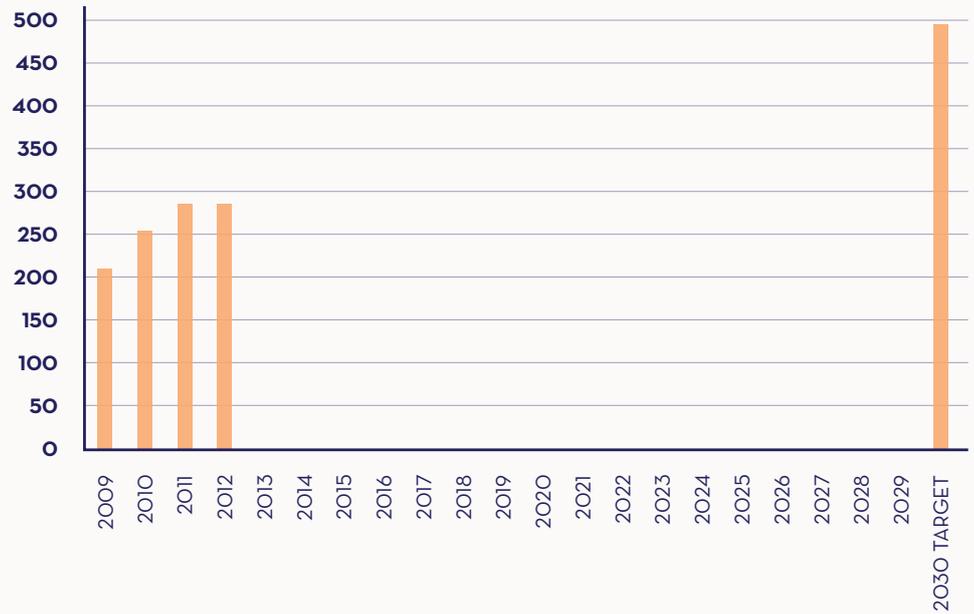
The latest data suggests that only one of the four core indicators (number of Knowledge Economy startups) is on track to meet its 2030 target.

The number of Knowledge Economy business startups grew reasonably rapidly until 2011, when growth plateaued at 295 startups. The picture is less positive for the other elements,

especially the Knowledge Economy average wage premium which has been following a negative trajectory since its peak in 2010. The average wage of workers in the Knowledge Economy is now £2,352 less than the overall NI average. It is possible that this lower average wage is due to a shift in the balance of power towards employers and away from employees following the recession or the jobs that have been created in the Knowledge Economy in recent years are graduate starter jobs and have therefore pulled the average down, or potentially a combination of both.

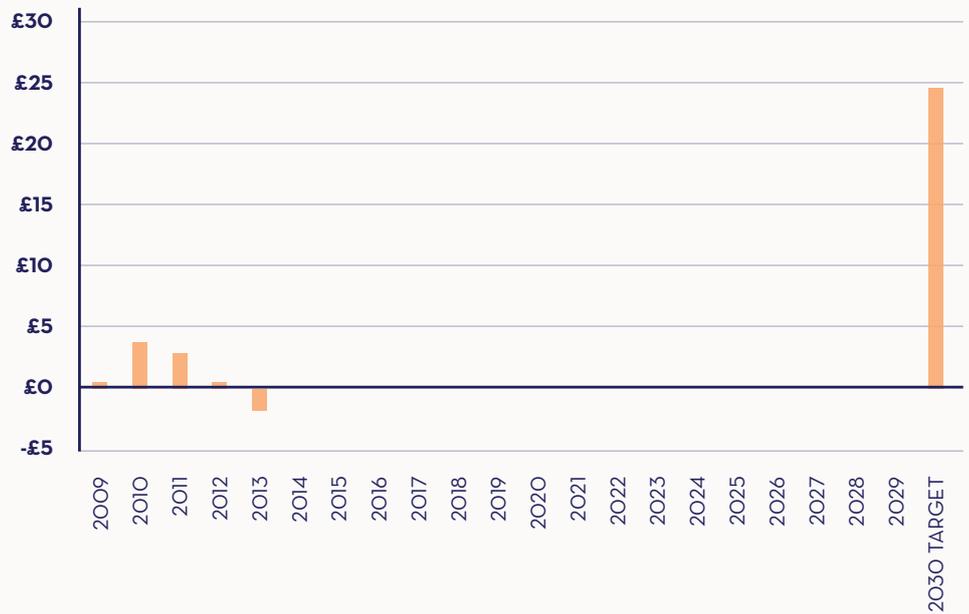
ON OR ABOVE TARGET

FIGURE 8.1 NUMBER OF KNOWLEDGE ECONOMY BUSINESS STARTUPS



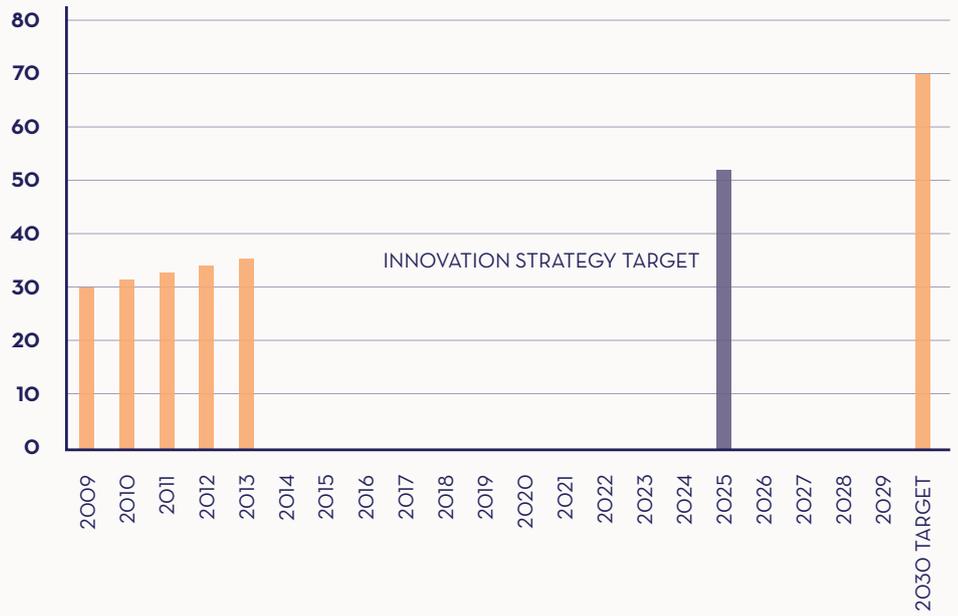
BELOW TARGET

FIGURE 8.2 KNOWLEDGE ECONOMY WAGE PREMIUM (£ x 1000)



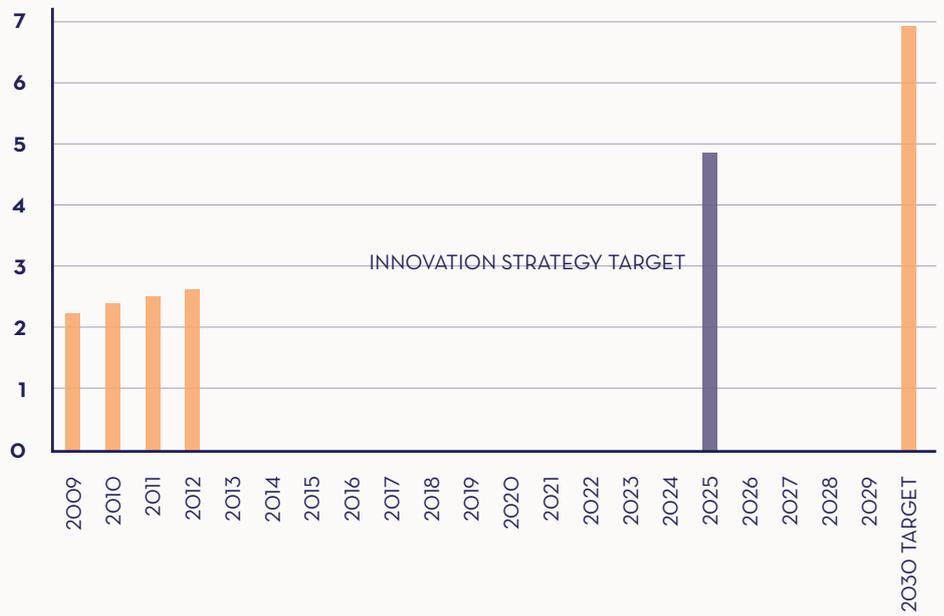
BELOW TARGET

FIGURE 8.3 KNOWLEDGE ECONOMY EMPLOYEES (x1000)



BELOW TARGET

FIGURE 8.4 NUMBER OF KNOWLEDGE ECONOMY BUSINESSES (x1000)



8.2

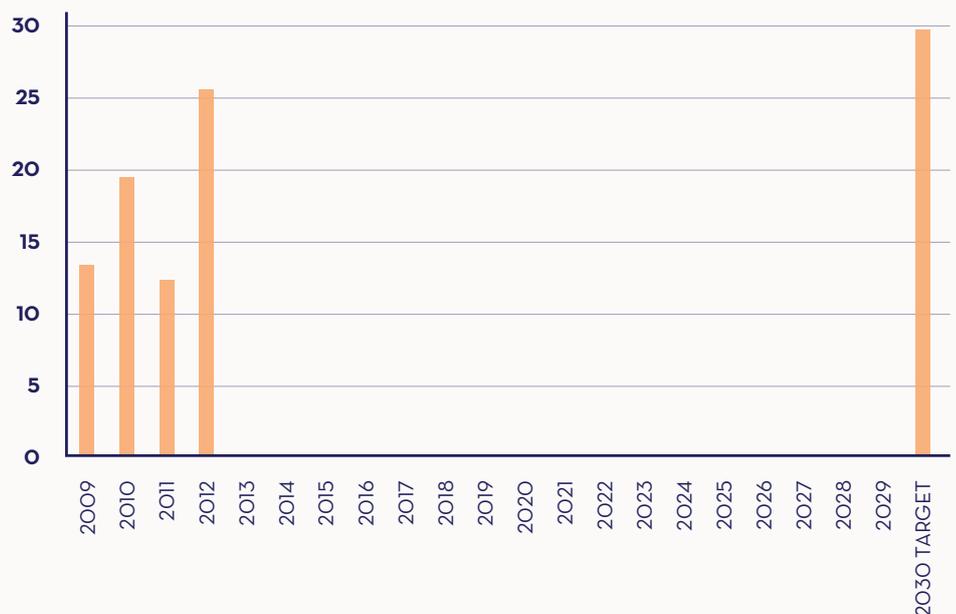
A MIXED PERFORMANCE IN INVESTMENT ACTIVITY

The performance of indicators within this element is broadly positive, with three out of five above the target trajectories. 2012 was an excellent year in terms of the number of private equity and venture capital investments (100% and 140% growth respectively), as well as for the number of M&A and ECM deals (58% growth), all of which are well ahead of their target trajectory at this stage.

In contrast, the value of these VC investments has not been able to match 2011's successes and has fallen behind the required growth rate. 2011 included a single, large deal which accounted for the large jump in value of VC deals from £5m to £20m and should be considered as an outlier, suggesting VC investment is now at the same level as at the 2009 base level of £2m. The number of public listed companies has also failed to achieve sufficient growth in the past 5 years with only one more PLC than in 2009, making it increasingly difficult to achieve the CONNECT target of 24 public listed companies by 2030.

ON OR ABOVE TARGET

FIGURE 8.5 NUMBER OF PRIVATE EQUITY INVESTMENTS



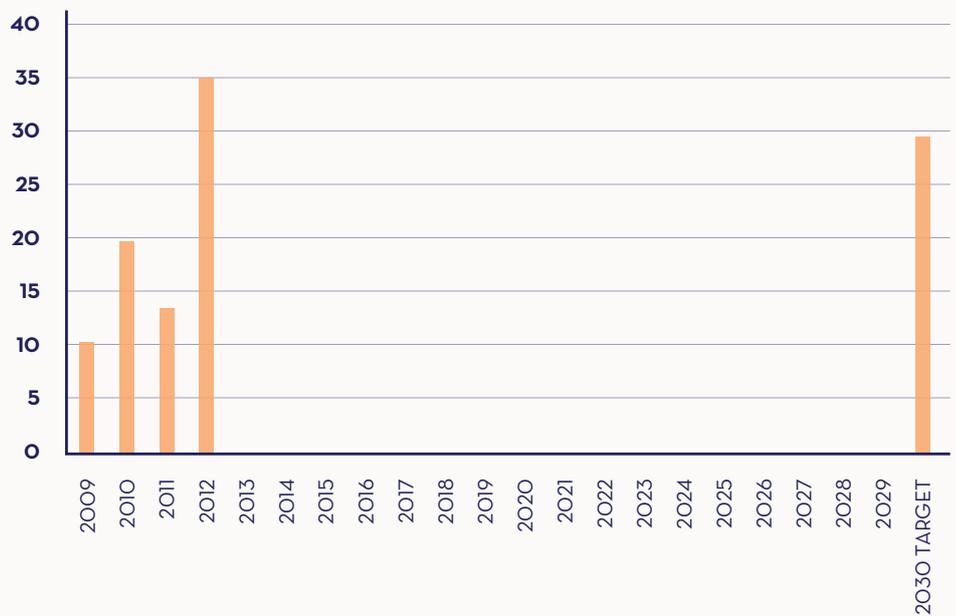
ON OR ABOVE TARGET

FIGURE 8.6 NUMBER OF M&A AND ECM DEALS



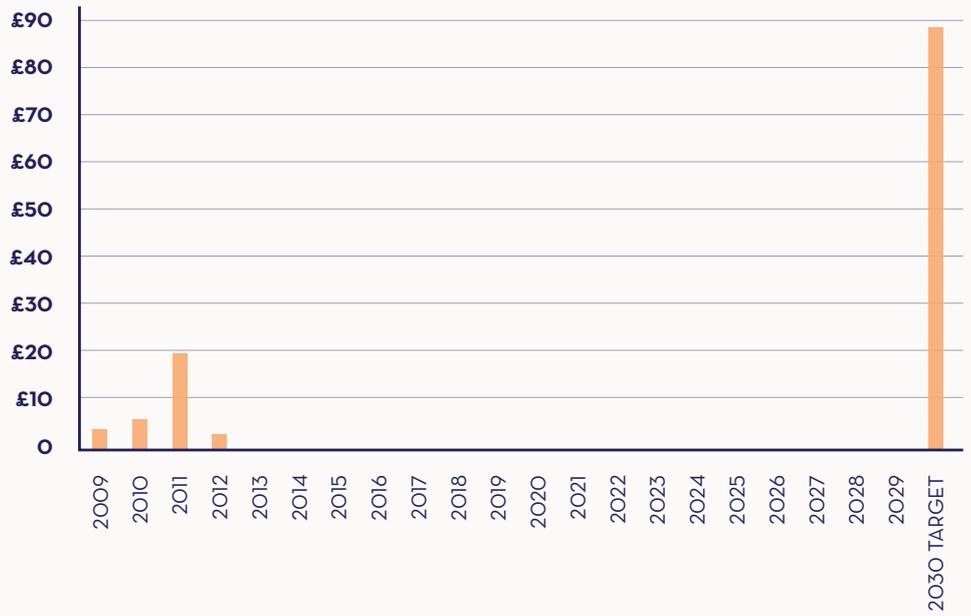
ON OR ABOVE TARGET

FIGURE 8.7 NUMBER OF VENTURE CAPITAL INVESTMENTS



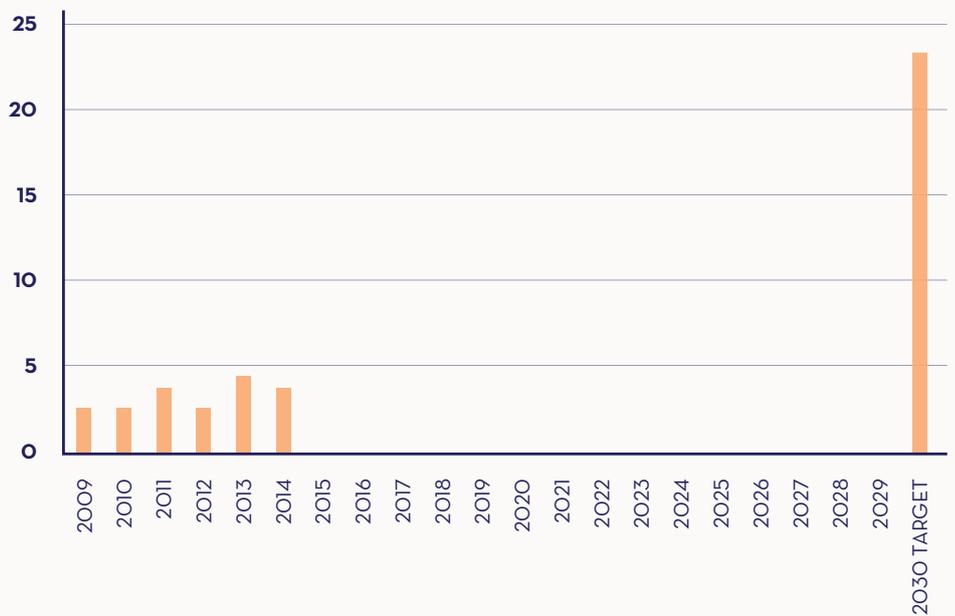
BELOW TARGET

FIGURE 8.8 VALUE OF VC INVESTMENT (£M)



BELOW TARGET

FIGURE 8.9 NUMBER OF LISTED COMPANIES



8.3

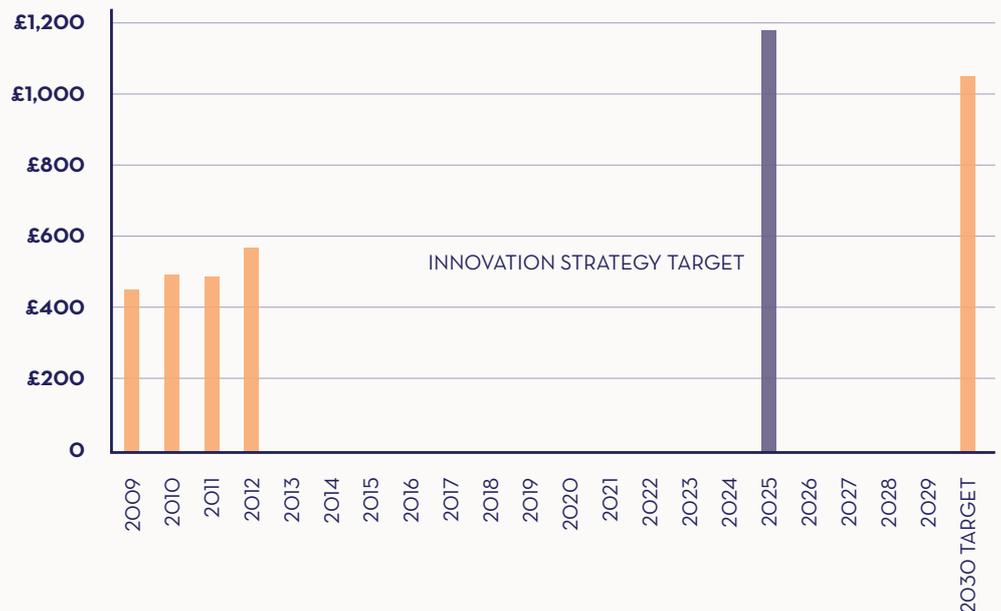
PROGRESS IN R&D ACTIVITY

Three of the six elements of the R&D forecasts are on, or ahead of the required trajectory to meet the 2030 targets. R&D expenditure and the number of PhDs awarded are ahead of the required trajectory and as inputs, or activity targets, it is hoped that the outcome of these activities will lead to greater employment, profitability and wages in the Knowledge Economy in future years, helping to achieve some of the core targets.

The value of research grants and contract values has been in decline since the base year of 2009 and the number of science and technology graduates has also performed poorly. The science and technology graduate figures are from the Labour Force Survey and have been volatile. The LFS is the only source of this data but suffers as a result of small sample sizes. Eurostat data on the number of R&D personnel for 2011 does not align well with other R&D indicators for the same period as it shows the number of R&D employees falling by around half.

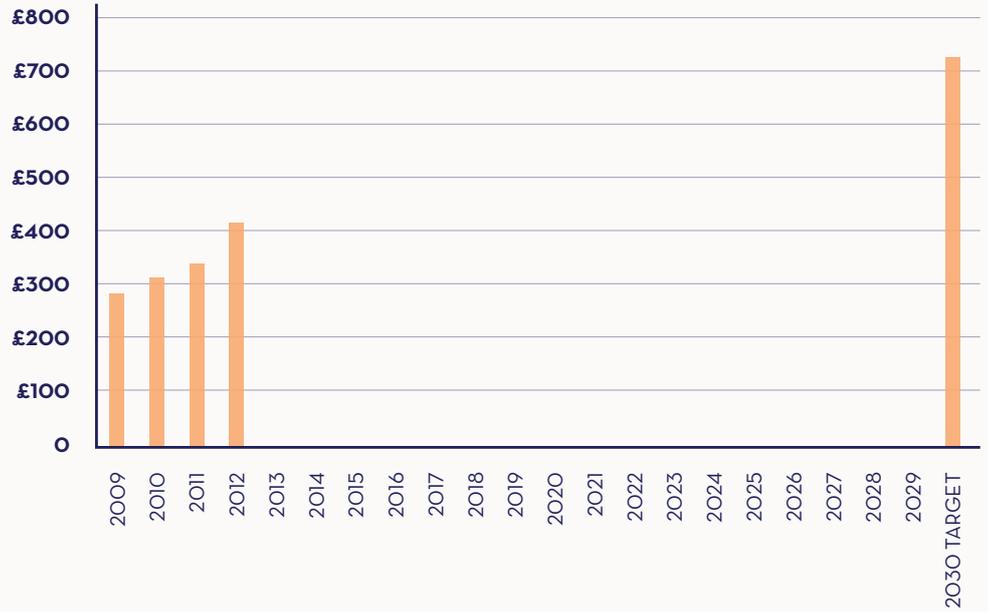
ON OR ABOVE TARGET

FIGURE 8.10 TOTAL EXPENDITURE ON R&D (£M)



ON OR ABOVE TARGET

FIGURE 8.11 TOTAL BUSINESS EXPENDITURE ON R&D (£M)



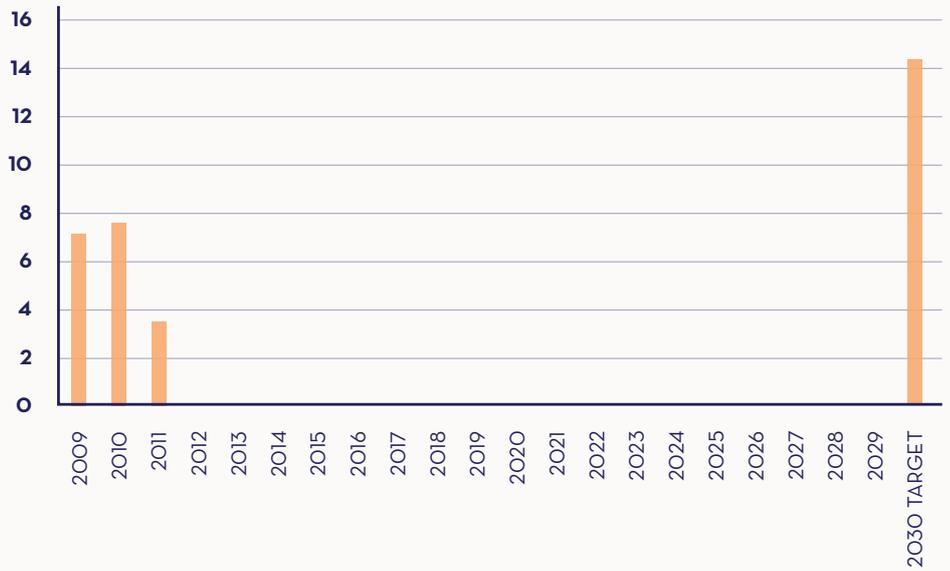
ON OR ABOVE TARGET

FIGURE 8.12 NUMBER OF PHD'S AWARDED



BELOW TARGET

FIGURE 8.13
R&D PERSONNEL
(x1000)



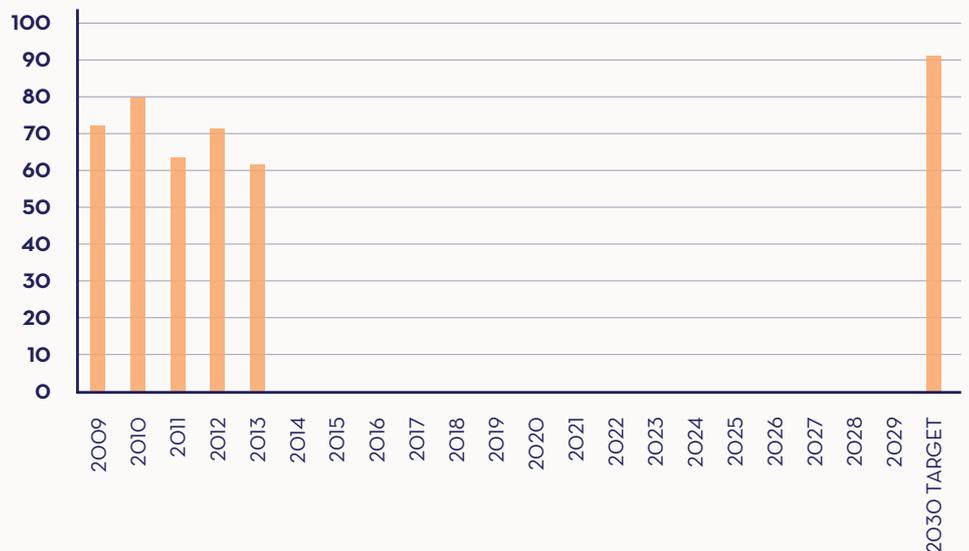
BELOW TARGET

FIGURE 8.14 VALUE OF
RESEARCH GRANTS AND
CONTRACTS



BELOW TARGET

FIGURE 8.15 NUMBER
OF SCIENCE AND
TECHNOLOGY
GRADUATES (x1000)



8.4

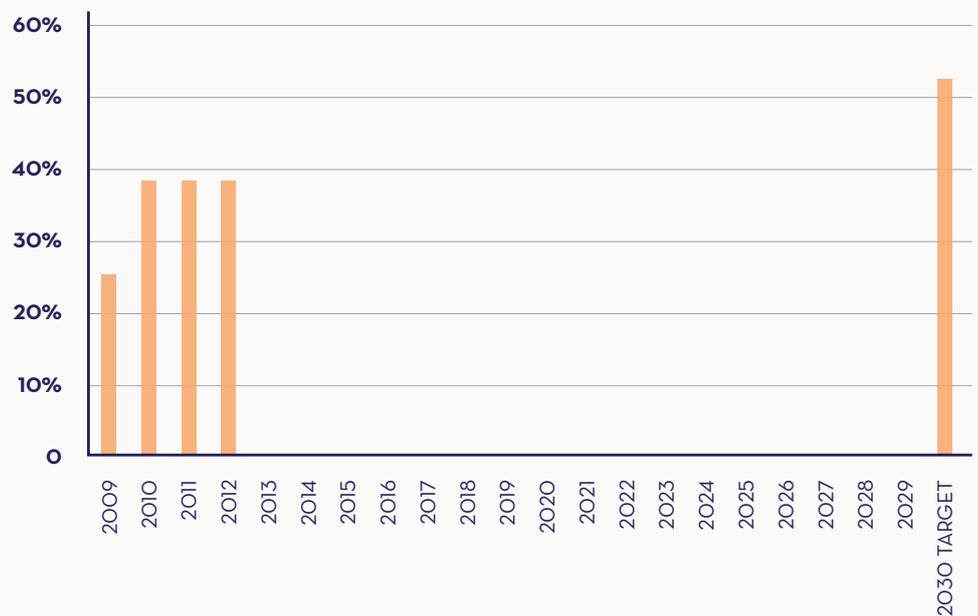
PROGRESS TO BE MADE ON INNOVATION & PATENT ACTIVITY

Innovation and patent has performed less well, with only one indicator (innovation active firms) above the target trajectory. In contrast, progress towards meeting patent

and hi-tech patents has not been close to the level required to stay on the required trajectory.

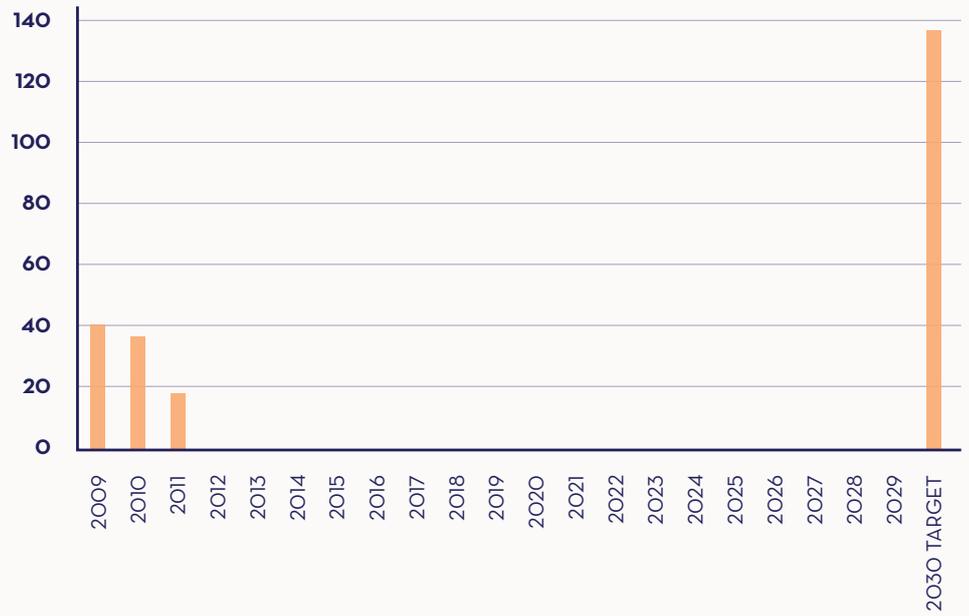
ON OR ABOVE TARGET

FIGURE 8.16 PROPORTION OF INNOVATION ACTIVE FIRMS



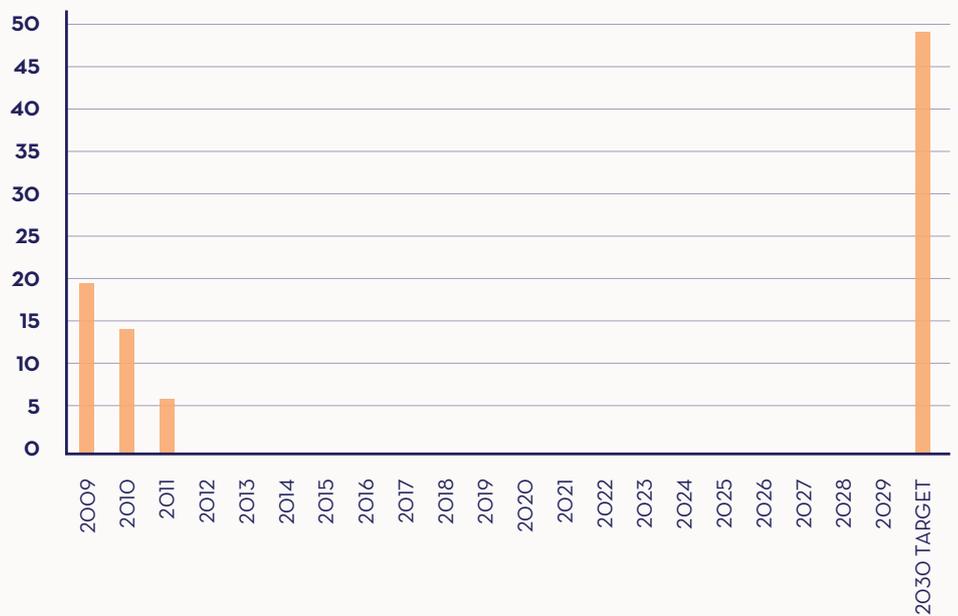
BELOW TARGET

FIGURE 8.17 NUMBER OF PATENT APPLICATIONS PER MILLION INHABITANTS



BELOW TARGET

FIGURE 8.18 NUMBER OF HI-TECH PATENT APPLICATIONS PER MILLION INHABITANTS



8.5

FOCUSING ON THE PRIZE - 2030 TARGETS

The key benefit of target setting is the realism that it brings to setting the scale of the challenge and also helping to focus minds throughout the journey.

It is worth re-emphasising that a transformation along the lines of the Executive's Innovation Strategy and NISP CONNECT vision in Northern Ireland would have a profound impact on the economy. There would be more job opportunities available across the economy and rates of economic growth would surpass that experienced during the last boom.

The good news is that six indicators are more than ten per cent above the required trajectory and three are broadly on target.

Unfortunately, even at this early stage, half of the indicators are more than ten per cent below the trajectory that is required to meet NI's 2030 target. The overall sense the data brings is that "more" and "better" will need to be the focus for the Knowledge Economy stakeholders, businesses and policymakers, if NI is to keep on track to meet the targets.

Employment, wages, business stock, number of listed companies, value of venture capital deals, research contracts, science and technology graduates and patents are all indicators which fall short at the moment. The challenge is to identify policy improvements and actions that can be taken by the private sector to achieve these aims.

Get Invited

– University of Ulster

A student spin-out from the University of Ulster, Get Invited is the next generation of online ticketing software. It provides event organisers with online registration, smartphone ticketing, social media monitoring and post-event analysis.

The web platform began as a Masters project between students Kyle Gawley and David Turner under the supervision of Christopher Murphy, senior lecturer in interactive design. As a regular expert speaker at digital industry conferences, Christopher identified common frustrations among organisers when it came to online sales and event management capabilities. He encouraged his students to develop a more advanced, user-friendly model as part of their Masters' practical assignment and as a result, Get Invited was born.

While competing solutions focus solely on ticketing, Get Invited offers an end-to-end solution for event organisers to manage the full lifecycle of their event online. The social timeline tracks online conversations about an event from all major social networks. It provides detailed analytics so an event organiser can see who's attending their events and also what they are saying about the event. Attendees can benefit as well; Get Invited provides an attendee online community

which offers an environment for people to connect and discover new events through their network.

On completion of the Masters, the students joined forces with lecturer Christopher to take the project to the next level and develop a real start-up venture with commercial viability. Over a period of four months the team developed the prototype into a fully functioning digital platform. The first test of commercial viability was as official ticketing partner for the university's annual Ulster Festival of Art and Design in February 2013 which was a huge success.

With support to develop a business plan and on-going advice from the university's Office of Innovation, Get Invited closed an initial venture capital seed round in November 2013 which allowed the appointment of a lead designer.

The official commercial launch took place in February 2014 and the company is already gaining significant traction in

both the UK and international markets. In April 2014, Get Invited recruited a dedicated marketing manager. Soon after, it was shortlisted onto the 500 Startups Accelerator programme in Silicon Valley which is designed to take promising tech start-ups to the next level.

A key success includes a ticketing deal with 'The Web Is' conference in Cardiff which saw Get Invited process over £1m in ticket sales. More recently, the company was awarded a contract with the prestigious LAUNCH Festival in San Francisco, which is celebration of technology startups, products and services.

Get Invited is a perfect example of how Northern Ireland's knowledge economy is being driven by entrepreneurial graduates from the University of Ulster.

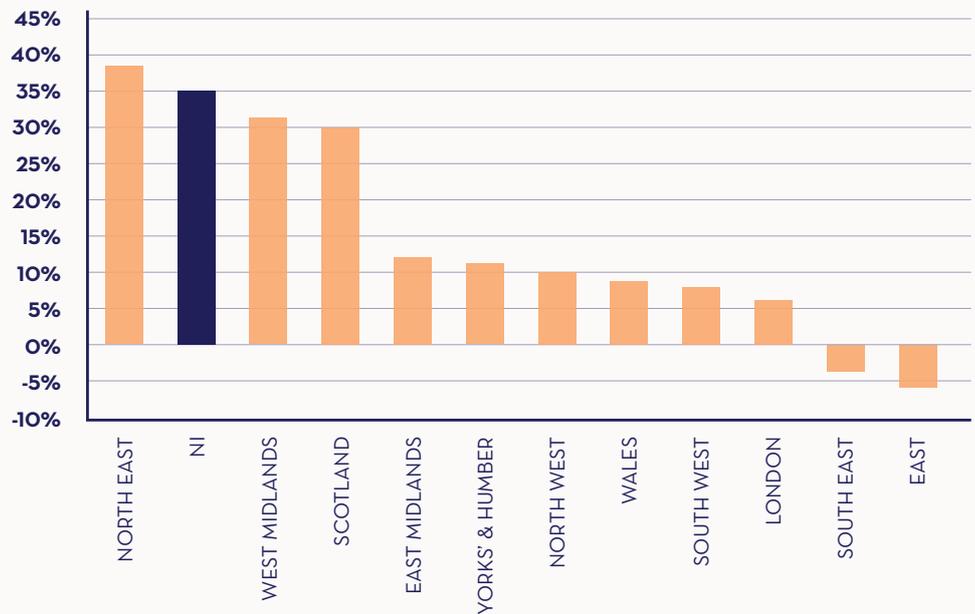
9.1 OVERARCHING SUMMARY

The Knowledge Economy is an important and growing component of the NI economy. Companies within the Knowledge Economy invest in research, development, innovation, creativity and sales & marketing.

This allows them to compete internationally resulting in a range of highly skilled and well paid employment opportunities being provided in NI generating income in the form of exports.

FIGURE 9.1 GROWTH IN KNOWLEDGE ECONOMY INDEX, UK REGIONS, 2009-2014

SOURCE: NICEP



The 2014 KEI research found that the NI Knowledge Economy performed very well in some areas and underperformed in others. There were positive findings to report in terms of increasing activity in the R&D, investment and innovation pillars, with the result that in overall terms the NI Knowledge Economy

was the second fastest growing of the UK regions as illustrated in figure 9.1. As a result, NI is now ranked 10th largest of the UK Knowledge Economies, having moved up from 12th in 2009 when the KEI project was launched.

FIGURE 9.2 NI AND UK KNOWLEDGE ECONOMY INDICES, 2009 - 2014 (2009=100)

SOURCE: NICEP
NOTE: 2014 is a forecast



Growing the Knowledge Economy by more than a third over a five year period and outpacing other UK regions is an excellent performance for NI. The increases in activity are encouraging in each of the innovation, R&D and investment pillars of the index, which drive the overall improvement in the KEI. However, the increases in activity have not yet fed through to a significant improvement in employment, wage levels, businesses stocks and startups and based on current trends, NI is not on target to meet

half of the very challenging 2030 targets that were set for the Knowledge Economy by NISP CONNECT.

In conclusion, 2014 has been a year of very good progress in many areas. The vision for the Knowledge Economy of the future is set, but in order to attain it, efforts must be intensified in a number of areas.

9.2

PROGRESS IN KEY INDICATORS

Progress has been varied with increasing levels of activity in investment, R&D and innovation pillars of the KEI. However,

these improvements have yet to feed through to the core metrics.

TABLE 9.1 SUMMARY OF KNOWLEDGE ECONOMY INDICATORS

Knowledge Economy - Core characteristics (CONNECT definition)	Previous Year	Latest Data	Regional Ranking	Progress since last year (ranking)	Year	Sources
KE employment, as % of total employment	4.2%	4.3%	11	▼	2013	COE/BRES
KE businesses, as % of total business stock	4.2%	4.4%	12	...	2012	IDBR
KE Business start ups per 100,000 population*	16	16	12	...	2012	IDBR/NOMIS
Science and Tech' employees average wage level	£27,608	£25,475	12	...	2013	Labour Force Survey
Investment Activity	Previous Year	Latest Data	Regional Ranking	Progress since last year (ranking)	Year	Sources
No. of private equity and VC investments (no. of companies)	17	38	10	▲ x2	2012	BVCA, IVCA, InvestNI
No. of private equity inv' per 100,000 VAT registered businesses	30	67	2	▲ x3	2012	BVCA, IVCA, InvestNI
No. of venture capital inv' per 100,000 VAT registered businesses	25	63	2	▲ x1	2012	BVCA, IVCA, InvestNI
Amount of VC investment, £M	£21	£4	12	▼ x8	2012	BVCA, IVCA, InvestNI
No. of M&A and ECM deals per 100,000 VAT registered businesses	71	113	11	▲ x1	2013	Experian Corpfin
Public listed companies: Market capitalisation per head	£248	£282	10*	...	2014	London Stock Exchange
R&D Activity	Previous Year	Latest Data	Regional Ranking	Progress since last year (ranking)	Year	Sources
R&D as % of workplace based GVA	1.8%	2.0%	5	▲ x2	2012	UK R&D Survey
Business Expenditure on R&D as % of workplace GVA	1.2%	1.4%	5	▲ x2	2012	UK R&D Survey
R&D personnel as % of total employment	1.0%	1.4%	11	▼ x2	2011	Eurostat
No. of PhDs per million inhabitants	282	314	6	▲ x2	2012/13	HEIDI
HEI Research grants and contracts per 1,000 population	£44.8	£44.4	10	...	2012/13	HEIDI
No. of science and tech' graduates (NVQ Level 4+) as % of workforce	9.0%	7.7%	11	...	2013	Labour Force Survey
Innovation and Patent Activity	Previous Year	Latest Data	Regional Ranking	Progress since last year (ranking)	Year	Sources
% of firms stating that they are innovation active	40.0%	40.0%	12	...	2010-12	DETI UK Innovation Survey
No. of patent applications per million inhabitant (to EPO)	33	20	6	▲ x6	2011	OECD
No. of high technology patents per million inhabitant (to EPO)	15	7	6	▲ x6	2011	OECD
No. of patent applications filed per million inhabitant (to UK IPO)	146	137	11	...	2013	UK IPO
No. of patents granted per million inhabitant (to UK IPO)	49	41	12	...	2013	UK IPO

NOTE: * LONDON STOCK EXCHANGES DEFINITION OF UK REGIONS INCLUDES 10 RATHER THAN 12 REGIONS.

The bullets below provide an overview of how NI performed within the Knowledge Economy indicators.

Core metrics

This element of the KEI performed poorly over the last year. Regional rankings are in the main static at 12th out of the 12 UK regions and disappointingly Knowledge Economy employment as a proportion of total slipped by one place to 11th.

Investment activity

Increased activity is evident in this element of the index as a large amount of small deals have taken place. Whilst the total value of deals remains reasonably low in a historical context, the increased levels of activity are encouraging.

R&D and research activity

R&D expenditure and BERD as a percentage of GVA are at or above the UK level, which is an impressive performance for NI and the numbers of PhDs awarded continue to increase. This is the strongest of the KEI pillars and the challenge is now for NI to reach standards of international excellence.

Innovation and patent activity

Innovation activity performed less well with NI slipping back to 12th in the league table. However, a stronger performance in terms of European patents to mid-table helped to improve the performance of this element of the KEI.

9.3

BUILDING AN EVIDENCE BASE FOR COMPANIES AND POLICY

The research has presented a number of areas where additional research would be of benefit in terms of increasing the level of understanding of the sector, filling important gaps in the data and bringing forward additional evidence that will help grow the Knowledge Economy.

The key recommendations, outlined in detail earlier in the report are;

Policy remarks

9.3.1 Innovation into action

Innovation into action is being launched by NISP CONNECT and is supported by DETI and Invest NI. Those involved in the process will seek to translate NI's success in activity across the KEI pillars of innovation, R&D and investment into growing employment, businesses and exports to help deliver the ambitious NISP CONNECT 2030 targets and contribute towards the achievement of the DETI Innovation Strategy targets in 2025.

9.3.2 R&D - focussing internationally

NI is successful in that it has caught up to and exceeded the UK average level in R&D as a % of GVA and Business Expenditure on R&D as a % of GVA. Businesses, academics and policymakers should be congratulated for this achievement. NI's vision for R&D should now become international, promoting R&D activity

and implement policies that will broaden the R&D base and continue NI's success.

9.3.3 Boosting research grants

If NI is to grow the R&D base and meet the NISP CONNECT target for the Knowledge Economy, funding for research grants should become a higher priority, which may be a challenge in times of austerity.

Research suggestions

9.3.4 Supply chain and downstream effects

The KEI focuses on measuring and reporting the direct economic impact of the Knowledge Economy in NI. It is important to consider the downstream effects, which based on US research may be more significant for the sector than other elements of the economy. This research should be taken forward during 2015, using primary data collected for this specific purpose or by using NISRA's forthcoming supply use tables.

9.3.5 North East employment and investment - further research required

KE employment in the North East fell by a fifth from 2011-13. Over the same period, the North East also benefitted from large increases in investment activity which led to it being the fastest growing Knowledge Economy in the UK. It is recommended that further investigation is carried out on the data for the North East of England to identify the reasons for the employment declines and also to consider how, if and when increased investment activity might lead to better outcomes for the core metrics in the region.

Investment activity in the North East of England far outstrips the next best performing region (NI). Whilst the NI performance is prodigious in terms of activity, the North East of England is still more than sixty per cent ahead of NI. The North East should be considered as a potential case study for further research to help to understand the driving factors behind its success and their applicability to NI.

9.3.6 Matched study with San Diego

Given the genesis of the programme in San Diego, a matched firms study would be particularly valuable for NI in order to understand differences in management practices, behaviours and cultures that are prevalent, how companies here may adopt better practices for greater economic benefit and how policy may be formed in order to help such companies grow in the Knowledge Economy in NI.

9.4

MOVING IN THE RIGHT DIRECTION

Over the past year, the Knowledge Economy in NI has made good progress in a number of areas. The newly developed regional KEI's confirm this, as NI is the second fastest growing region in the UK.

The regional indices provide an additional perspective on the overall health of the sector and should be widely used in the development and measurement of innovation oriented strategies.

It is important also to acknowledge that this is a dynamic environment as all UK regions are striving to grow their knowledge economies, increase employment and productivity and increase overall standards of living. Employment in the Knowledge Economy now makes up 4.3% of total employment compared to 3.7% in 2009, which is a significant improvement. However, the NI Knowledge Economy must continue to strive not just to be average, but to continue to grow more rapidly if it is to deliver on the aspirations set out in the Executive's Innovation Strategy and NISP CONNECT targets.

Improving data

9.3.7 Venture capital – time for an official survey

There is no single source that captures and reports on all venture capital activity for NI which presents significant issues in terms of measuring activity and developing effective policies. NICEP's recommendation is an annual Venture Capital and Private Equity survey or census should be carried out.

9.3.8 Wage data – more access to official data and research required

The wage information used within the index is from the Labour Force Survey and is based on a reasonably small sample.

It is recommended that the Annual Survey of Hours and Earnings and Destination of Leavers from Higher Education surveys are reviewed, along with any other potential data sources that may provide a more complete perspective on wages paid to Knowledge Economy employees.

There are a significant number of challenges that NI must overcome on the road to delivering these aspirations. Northern Ireland is still one of the smallest Knowledge Economies in the UK, innovation remains low, there are issues with VC and wage data and progress toward half on the targets is below the required trajectory.

NI can learn from other regions, but must also play to our natural strengths in terms of the data, behaviours and cultures that are at play in the Knowledge Economy in NI. With the level of success in the R&D, NI will now need to work out how it forges ahead of UK levels and therefore, following others is no longer an option in this arena. Further research should be commissioned to fully understand how the Knowledge Economy impacts on the wider economy in NI and also carry out the complementary research on a region that NI may aspire towards, such as San Diego.

In summary, the Knowledge Economy is a vibrant and vital sector of the NI economy, providing highly skilled and well-paid jobs, exporting across the globe and helping to deliver on many of the Programme for Government, MATRIX and Innovation Strategy targets.

Write to read

– Gareth Reid

A revolutionary new App has been created by 16-year-old schoolboy Gareth Reid. The 'Write to Read' mobile app can photograph text and display it on screen in a font which has been proven to improve the comprehension and retention of people with dyslexia. The font helps make letters more distinct from each other.

Celebrated as the 'Belfast Boy Wonder', Gareth is representative of a new breed of young entrepreneurs who embrace the concept of commercialising their inventions. He is certainly hoping his mobile app for dyslexic people will join the ejector seat, the pneumatic tyre and the portable defibrillator as one of Northern Ireland's best inventions. Already an award winner the school boy has just completed his GCSEs and is one of 12 finalists in the Northern Ireland Science Park's Connect Invent 2014 contest.

The invention has received interest from the Police Service of Northern Ireland, Disability Action and Northern Ireland

firm, Core Systems, which makes software for use in prisons where many inmates have literacy problems. Describing his motivation to bring the App to market Gareth said: "I started to look into the problems that dyslexic people faced and found out that some fonts were much easier for them to read than others. "Common problems include rotation of letters, where a 'p' might turn into 'd' and confusion between letters like 'i' and 'j' or 'h' and 'n'. "I experimented with making some letters bold, or tipping them to change their height and width to differentiate them from other letters." In-depth research indicates there were much fewer errors when the text was converted into the new font." Invent

2014 Panel Judge Andy Hopper from Cambridge University was so impressed that he said he hoped Gareth would study at Cambridge soon.

In the meantime he is concentrating on getting his exams and playing his part in representing the most inspiration of our young people as part of the NISP CONNECT Generation Innovation project. Gen I is providing a supportive environment for young entrepreneurs like Gareth to be confident in their ideas, get support from successful peers and realise that success is primarily in motivation and confidence. However as international interest in his invention picks up Gareth may find himself just a little distracted.

CONNECT DEFINITION

Sector	SIC 2007 Definition	
Medical Devices	26511 MF of electronic instruments & appliances for measuring, navigation, except industrial	32500 MF of medical and dental instruments and supplies
	26513 MF of non-elect' instruments & appliances for measuring, testing and navigation, except industrial	72190 Other research and experimental development on natural sciences and engineering
	26600 MF of irradiation, electromedical and electrotherapeutic equipment	74202 Other specialist photography
	26701 MF of optical precision instruments	
Pharma / Biotechnology	21100 MF of basic pharmaceutical products	72110 Research and experimental development on biotechnology
	21200 MF of pharmaceutical preparations	
IT services	62020 Computer programming, consultancy and related activities	62090 Other information technology and computed service activities
	62030 Computer facilities management	63110 Data processing, hosting and related activities
Communications	26301 MF of telegraph and telephone apparatus and equipment	61900 Other telecommunications activities
	26309 Manu of communications equipment	
Computing and advanced electronics	26200 MF of computers and peripheral equipment	27110 MF of electric motors, generators, transformers and electricity distribution and control apparatus
	26512 MF of electronic industrial process control equipment	27200 MF of batteries and accumulators
	26110 MF of electronic components and boards	27310 MF of fibre optic cables
	26400 MF of consumer electronics	27900 MF of other electrical equipment
	26512 MF of electronic industrial process control equipment	
Other technical consultancy services	71121 Engineering design activities for industrial process and production	74100 Specialised design activities
	71122 Engineering related scientific and technical consulting activities	74901 Environmental consulting activities
	71200 Technical testing and analysis	
Aerospace & Transport	28110 MF of engines and turbines, except aircraft, vehicle and cycle engines	28131 MF of pumps
	28120 MF of fluid power equipment	28132 MF compressors
Creative Content	28150 MF of bearings, gears, gearing and driving elements	30400 MF of military fighting vehicles
	29100 MF of motor vehicles	59111 Motion picture production activities
	29201 MF of bodies	59112 Video production activities
	29202 MF of trailers and semi trailers	59113 Television programme production activities
	29310 MF of electrical and electronic equipment for motor vehicles	59120 Motion picture, video and television post production activities
	29320 MF of other parts and accessories for motor vehicles	59200 Sound recording and music publishing activities
	30110 Building of ships and floating structures	18201 Reproduction of sound recording
	30120 Building of pleasure and sporting boats	18202 Reproduction of video recording
	30200 MF of railway locos	18203 Reproduction of computer media
	30300 MF of air and spacecraft and related machinery	
Software	58210 Publishing of computer games	62012 Business and domestic software development
	58290 Other software publishing	63120 Web portals
	62011 Computer programming activities	

A programme of the Northern Ireland Science Park, NISP CONNECT is modelled on and supported by the successful CONNECT non-profit organisation in San Diego, which was originally part of the University of California, San Diego.

CONNECT sets out to bring aspiring science and technology entrepreneurs and experienced business people together through a set of tried and tested initiatives to engage and educate. CONNECT recognises that the way to overcome the entrepreneurial challenge in economies like Northern Ireland's is to:

- Give the most promising would be entrepreneur's pro bono training and mentoring from successful business people and already successful entrepreneurs.
- Increase public policy advocacy.
- Attract international risk capital.
- Open up international markets.
- Research and experiment to find brand new ways to develop the Knowledge Economy.

CONNECT's philosophy is that although the strongest political support is needed, the private sector must lead – and independent funding from philanthropy, membership, sponsorship and appropriate contracts is paramount.

This commitment of independent time and resource enables NISP CONNECT to perform vital activities, organising events and forums to bring together all the players in the innovation ecosystem. The knowledge flows, high levels of trust, collaborative capacity and nimbleness needed in entrepreneurial ventures are significantly enabled by this combination of geographic propinquity and boundary-spanning activities.

APPENDIX C: KNOWLEDGE ECONOMY INDEX WEIGHTS

The Knowledge Economy Index is a composite index in that includes all twenty one of the indicators that are listed in table 1. It is calculated using the weighted average growth rate of each of the indicators from 2009. The weights for each of the 21 indicators are detailed below.

Section	Weight
Knowledge Economy - Core characteristics (CONNECT definition)	40%
Investment Activity	20%
R&D and Research Activity	20%
Innovation and Patent Activity	20%