

2017 Knowledge Economy Report

Identifying our location. Defining our destination. Estimating our arrival.





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The future isn't as bright as it used to be

Northern Ireland is at a fork in the road. We either seriously invest in and build further on the foundations of a Knowledge Economy that has been established in the last few years, or we drift with small incremental progress but an overall economy that declines.

There was always going to come a moment when we, as a people, are tested to see if our actions mark the ambition of our vision. That moment is now.

Automation will either be a massive opportunity or a big threat to Northern Ireland. If we take the hard decisions now and back ourselves, we could become one of the top knowledge economies in the world, the benefits of which will flow to each and every citizen. It is up to each of us: business owners, entrepreneurs, government officials, elected officials, school principals and parents, to ask, 'Is what I am planning to do going to enable us to thrive in this new world'? The more of us who answer 'yes', the brighter our futures will be.

Steve Orr, Director



A true measure of progress. A stark reminder of where we are.

The Knowledge Economy is fundamental to the sustainable success of Northern Ireland. Not just heading towards 2030, but far beyond. It's an area we can excel in – we already do – and an ambition we can readily envisage.

That's why this report and index is a vital annual weather vane. It shows how we're performing against a set of standard Knowledge Economy metrics and just as importantly, how we measure up against the 11 other UK regions and Republic of Ireland. Setting the report in context is key to honestly appraising our competitiveness.

The criteria we use is based on the renowned San Diego CONNECT model – a proven indicator of tech economy vitality and progress. There are 25 indicators in our version, 21 of which have targets set. They are grouped under four pillars: Core Indicators; Investment; R&D and Innovation & Patent Activity.

We commission Ulster University's Economic Policy Centre to measure and produce this report, something we've been doing annually since 2013.

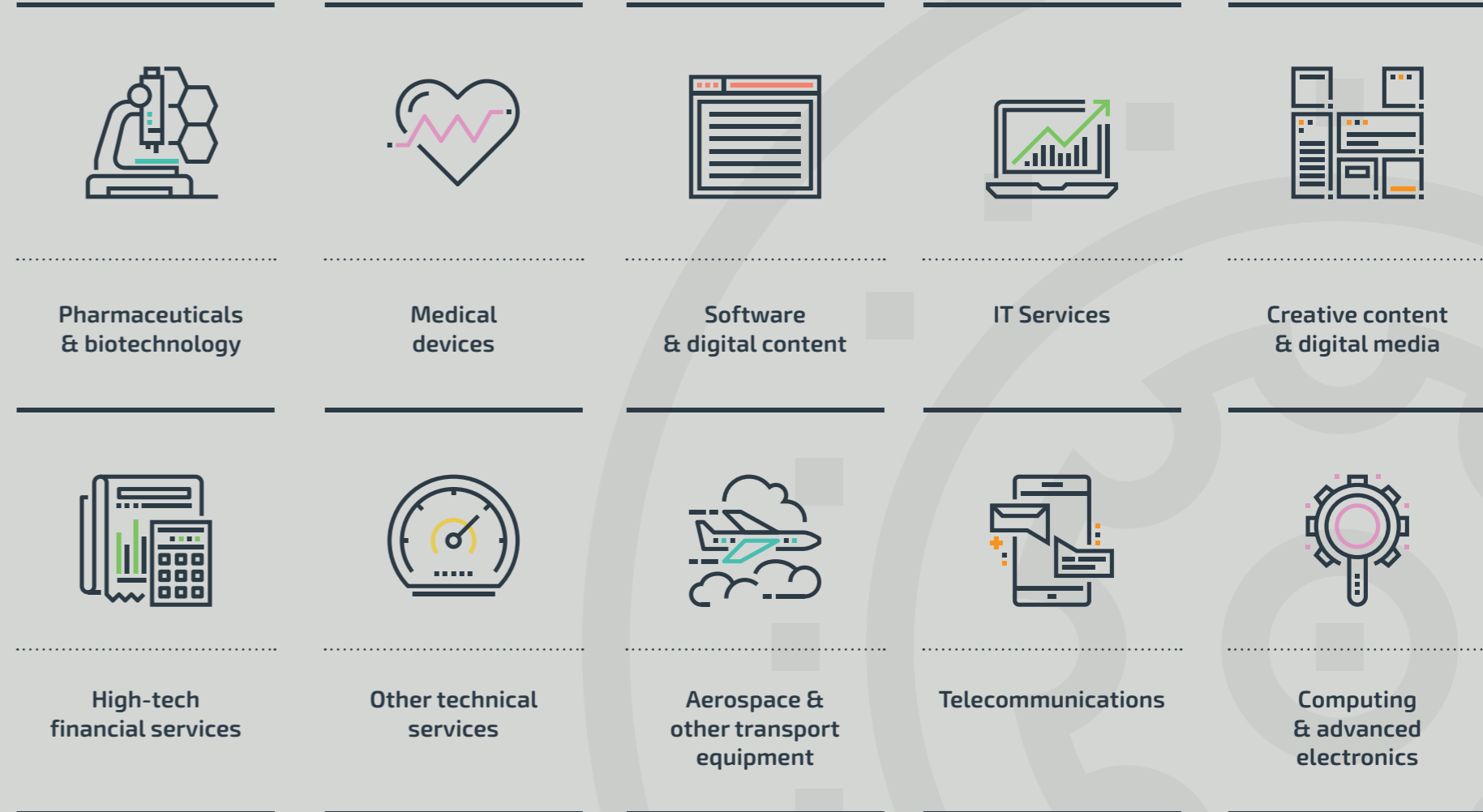
The Knowledge Economy matters to everyone in NI

Our Knowledge Economy is established and developed by individuals, companies and sectors that create and commercialise new ideas, technologies, processes and products to export around the world. To maintain their competitive advantage and stay at the forefront of their industry, they recruit highly skilled individuals, invest in R&D and nurture creativity.

This economic activity and the downstream effect it causes, increases the wealth and prosperity of many living here, not just those directly involved with the knowledge-based businesses.

The sectors

The industries we include in our index are knowledge-intensive and export-oriented. They represent the organisations with the greatest potential to sell high value goods and services globally.





How strong are our pillars?

Indicators ranked out of 13 include Republic of Ireland

Core indicators



- Remaining stable
- No improvement or decline in any of the eight ranking criteria
- Progress has slowed and all eight core indicators now underperforming

Core characteristics (CONNECT definition)	Regional ranking	Annual change in rank	Latest data
KE GVA, as a % of total	12/12	=	5.1%
KE employment, as % of total employment	10/12	=	4.6%
KE business stock, as a % of active enterprises	12/12	=	5.1%
KE business start ups as a % of active enterprises	12/12	=	0.7%
KE business deaths, as a % of active enterprises	12/12	=	0.4%
KE business churn rate, %	10/12	=	22%
KE median wage level, £	11/12	=	£28,798
KE wage premium (£)	11/12	=	£7,817

Investment



- Record improvement and highest ever average ranking
- Improved rank in four criteria
- No change in two criteria
- Now ranked first in two criteria
- Top five ranked in two others

Investment Activity	Regional ranking	Annual change in rank	Latest data
Private equity + VC investments (no. of companies)	7/12	^	63
No. of private equity inv' per 100,000 VAT registered bus'	3/12	^^	35
No. of venture capital inv' per 100,000 VAT registered bus'	1/13	=	76
Amount of VC investment, £m	5/13	^^	£14.8
No. of M&A and ECM deals per 100,000 VAT registered bus'	1/13	^^	342
Public listed companies: Market capitalisation per head	13/13	=	£629.2

R&D



- Research and development plateaus
- Skills and education fall behind
- Declined ranked in three criteria
- No change in two others

Research & Development Activity	Regional ranking	Annual change in rank	Latest data
R&D as % of workplace based GVA	4/13	^^	2.1%
Business Expenditure on R&D as % of workplace GVA	6/13	v	1.4%
Business R&D personnel as % of total employment	4/13	=	0.8%
No. of PhDs per million inhabitants	12/12	v	£241.7
HEI Research grants + contracts per 1,000 population	12/12	v	50
Science & tech' graduates (NVQ Level 4+) as % of workforce	12/12	=	6.1%
STEM Higher Education qualifiers (% total regional graduates)	11/12	=	23%

Innovation & Patent Activity



- Remains weak
- Improved ranking in one criterion
- No change in three others

Innovation & Patent Activity	Regional ranking	Annual change in rank	Latest data
% of firms stating that they are innovation active	11/12	^	45%
No. of patent applications per million inhabitants (to EPO)	10/12	=	42
No. of patent applications filed per million inhabitants (UK IPO)	12/12	=	84
No. of patents granted per million inhabitants (to UK IPO)	12/12	=	18



Doing great ahead of target on 7 indicators

- Highest number of employees (39,499)
- Highest number of business starts (400)
- Highest business stocks (2,905)
- Greatest ever number of private equity and VC investments (63)
- Highest number of VC investments per 100k businesses (76)
- Most active M&A (342)
- Highest PLC's market capitalisation per head (£629)
- Innovation active firms up to (45%)
- More EPO patents per million inhabitants than ever (42)
- Number of patents granted per million inhabitants by UK IPO (18)
- Best ever R&D employment (7,000)



Doing okay on target with 6 indicators

- Better performance in **two thirds** of the indicators versus last year
- But other regions improving too, hence no change in the majority of the league tables rankings
- Regional ranking improved in **six** indicators
- Investment activity is strong, ranked number **one** in **two** indicators and **third** in another. But investment values are very low compared to other regions



Doing poorly behind target on 8 indicators

- GVA has contracted since 2009
- Real GVA has contracted by **2.2%** since 2009
- Total NI economy grew by **1.8%**, resulting in the Knowledge Economy becoming relatively smaller
- GVA driven by employment, not productivity. And possibly through employment at the lower end of the wage scale
- Average wage reduced from **£29,391** to **£28,217** over the year
- Wage premiums are being squeezed
- Productivity premiums during 2014 and 2015 are at lowest levels
- R&D and BERD have declined marginally
- PhD numbers and research grants remain low
- Investment values remain relatively small, even with huge increases in activity
- Declining trends experienced in one third of the indicators
- Regional ranking declined in **three** cases



Note of caution

All eight core indicators are now underperforming and below the necessary trajectories set to meet our 2030 targets.

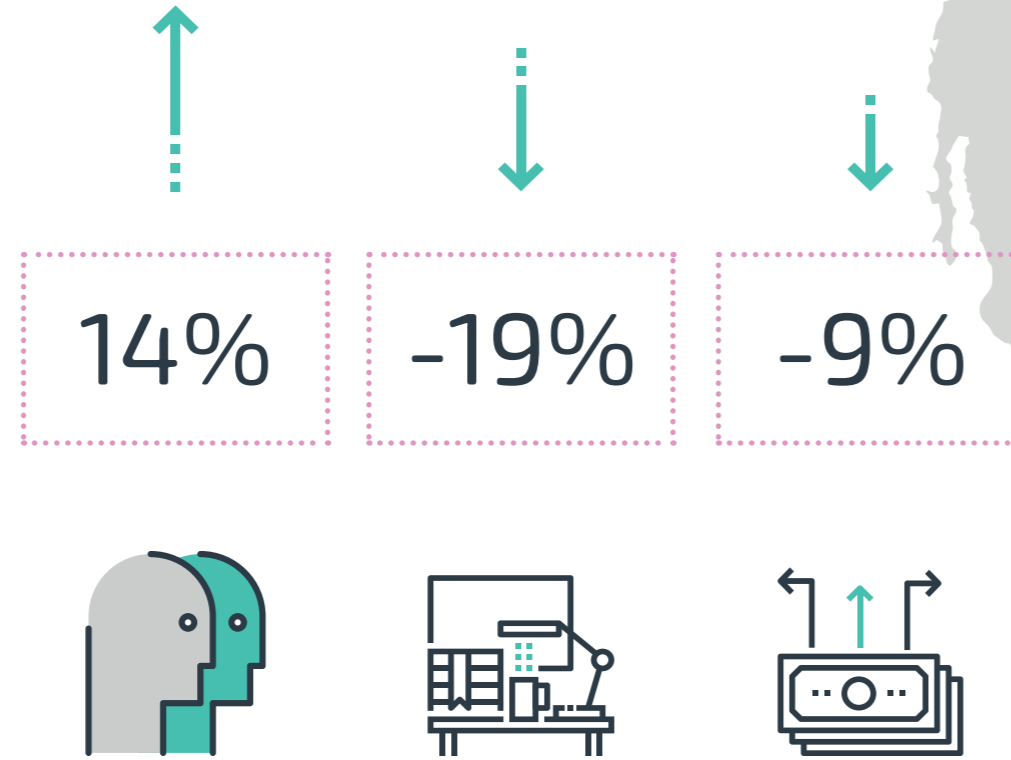
Knowledge Economy GVA, exports, productivity, business stock and average wage are all below target. As are the number of public listed companies, number of PhDs per annum and value of HEI research grants and contracts.

Braced for Brexit

Strong exports and GB sales are pivotal to positive economic outcomes for NI. In 2015, £4 out of every £5 of Knowledge Economy sales were generated outside the EU.

The Knowledge Economy accounts for 33% of NI exports, 80% of which are outside EU, where a strong North American market accounts for 56% of non-EU exports.

The composition of the Knowledge Economy export profile highlights potential for strong resilience to EU related uncertainty.



Employment increased by 14%, productivity declined by 19% and real GVA declined by 9% in the Knowledge Economy between 2013 and 2015.

Source: Northern Ireland Annual Business Inquiry (NI ABI)

North America
£1,106

Domestic
£957

Rest of World
exc. North America
£881

GB
£1,236

EU
£984

Knowledge Economy sales profile (£m), NI, 2015

Broad economy export measure, UUEPC. The BEE is based on ABI data and therefore excludes the Financial Services sector, including high tech financial services.

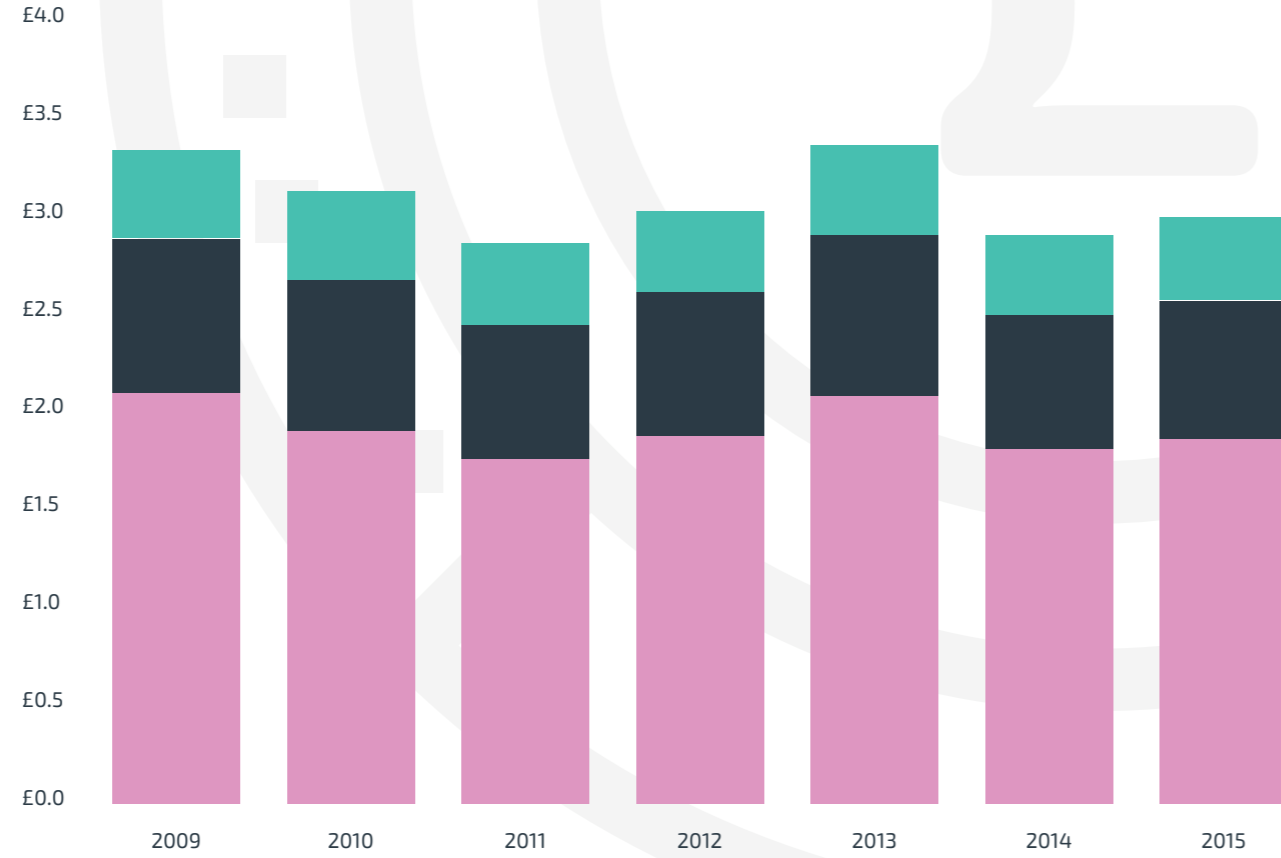


Wider impact of Knowledge Economy - GVA

£2.9bn

During 2015, the Knowledge Economy generated **£2.9bn** of direct, indirect and induced GVA. It now generates 8% of NI total GVA.

■ Direct
■ Indirect
■ Induced



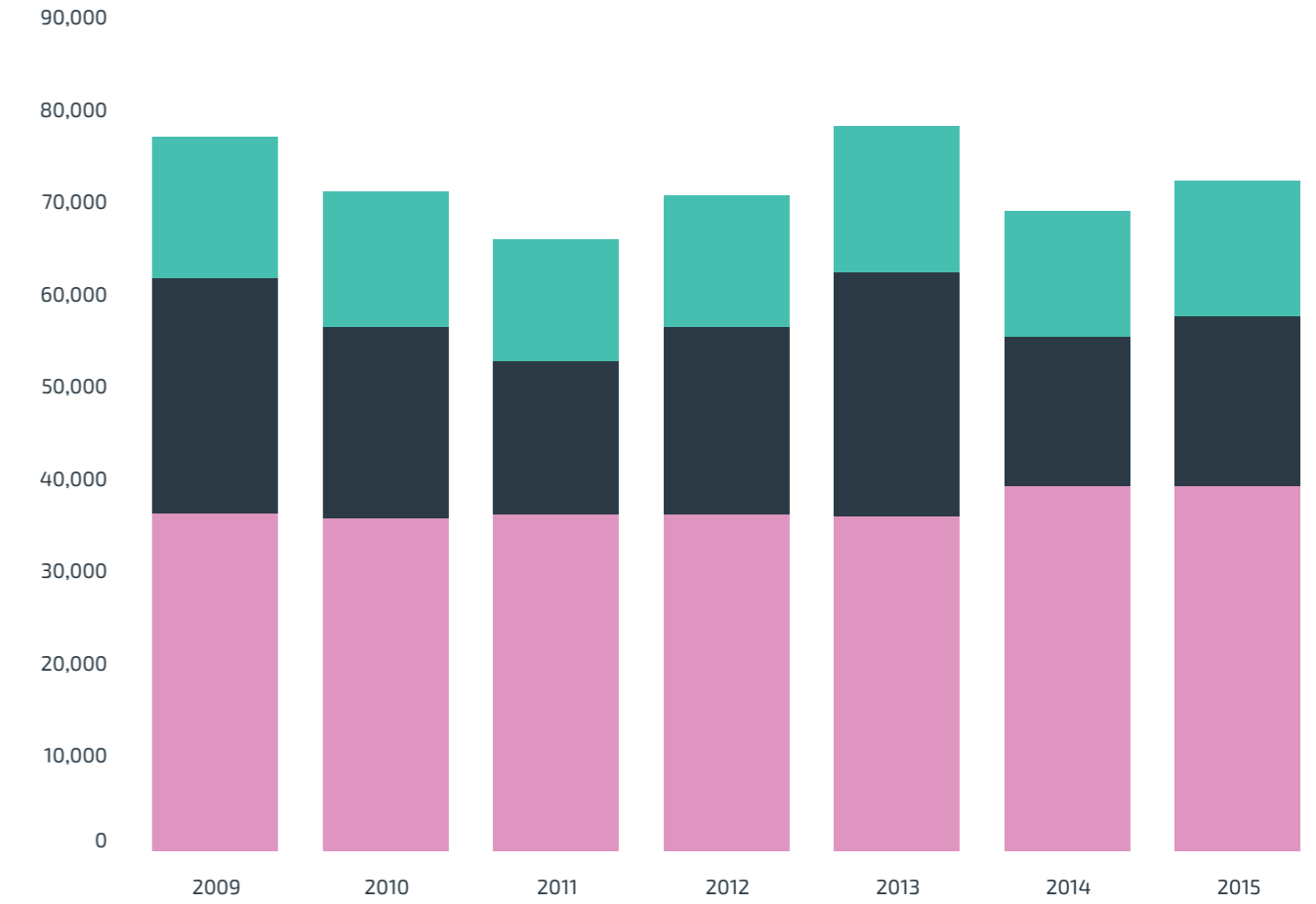
Wider impact of Knowledge Economy - Employment

72,000

The Knowledge Economy supported **72,000** direct, indirect and induced jobs in 2015, accounting for 8.4% of total NI employment.

Knowledge Economy employment remained stable over recent years. The changing sub-sectoral composition impacts on the indirect and induced effects.

■ Direct
■ Indirect
■ Induced





Knowledge Economy Activity Index

Economy growth

NI Knowledge Economy activity growth from 2009-12 was driven by strong performance in R&D indicators.

Over the past year, R&D and patent indicators declined marginally and skills and education indicators remain below their peaks, resulting in a levelling out in activity.

From 2014, NI growth was driven by a very strong performance in investment indicators.

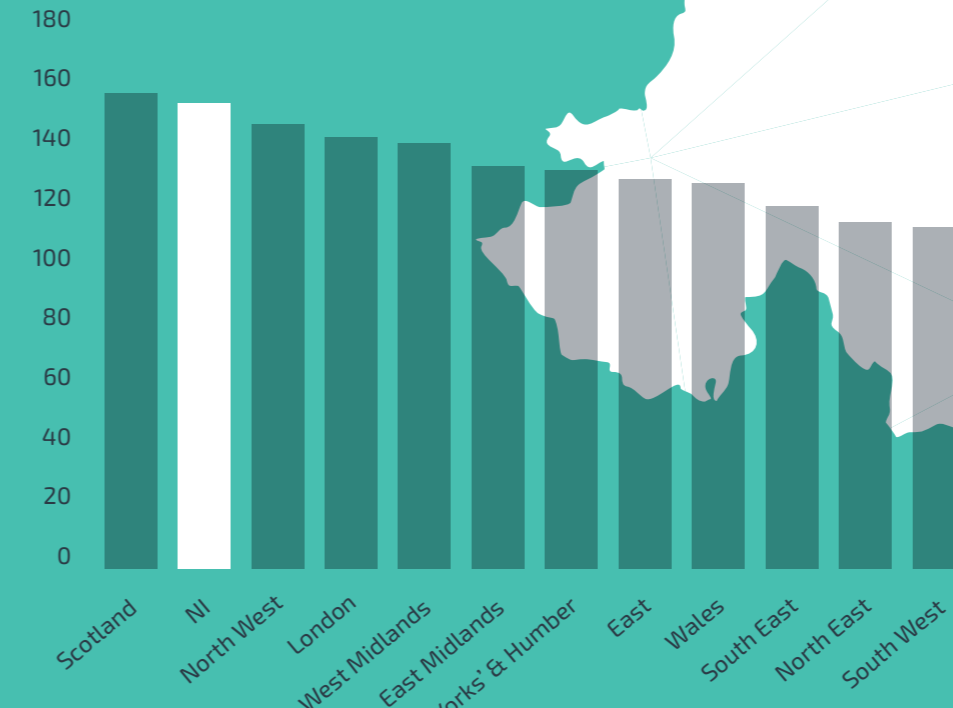
Knowledge Economy Activity Index (2009 = 100)



Growth by region

NI remains the second fastest growing region in terms of Knowledge Economy activity, closing in on Scotland.

Knowledge Economy Activity Index (2009 = 100)



 **Relative size**

NI Knowledge Economy Activity Index ranks NI 11th of the 12 UK regions.

The core strength of the UK Knowledge Economy is in the South East of England, while Scotland also performs well, largely due to its strong university base.

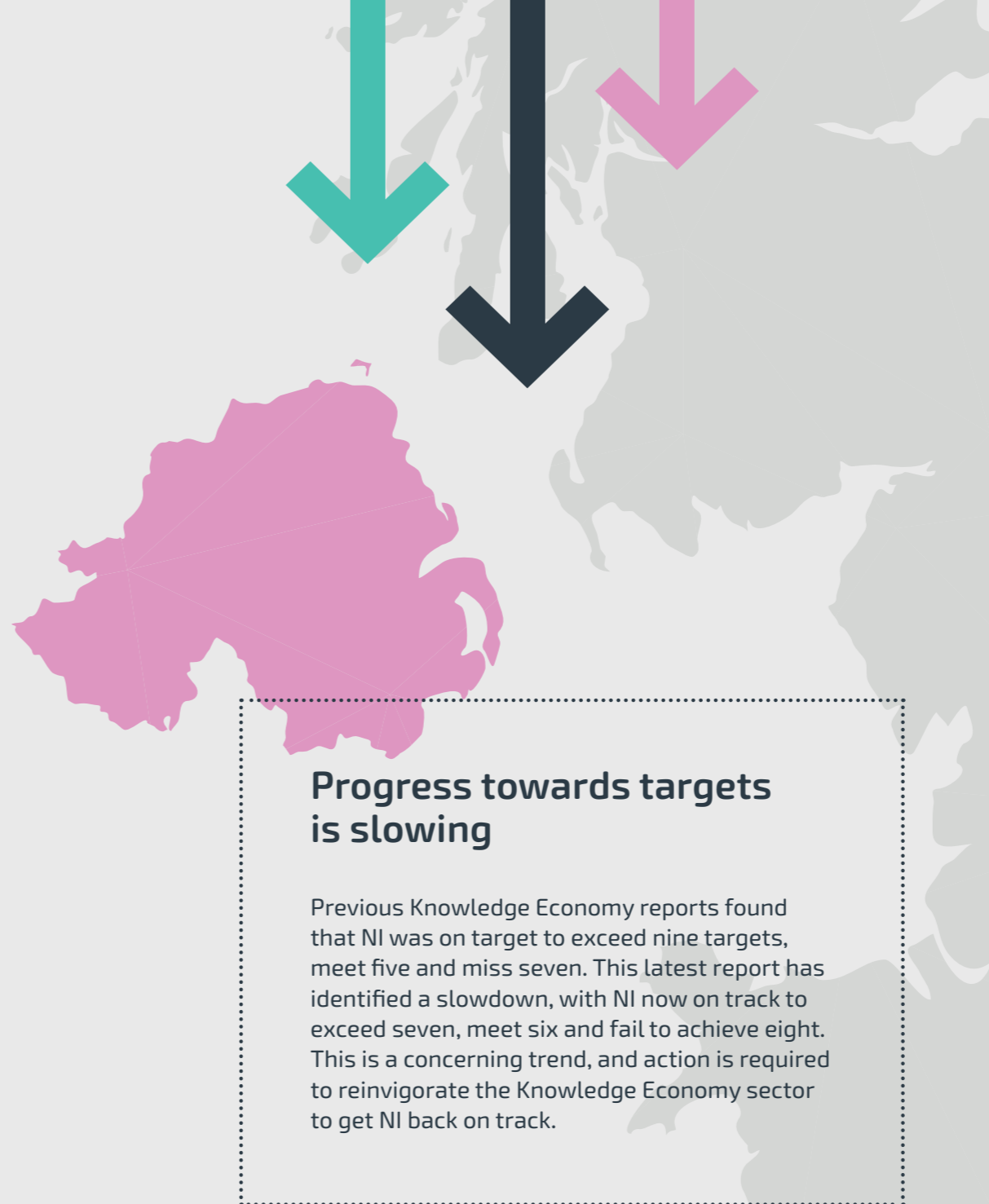
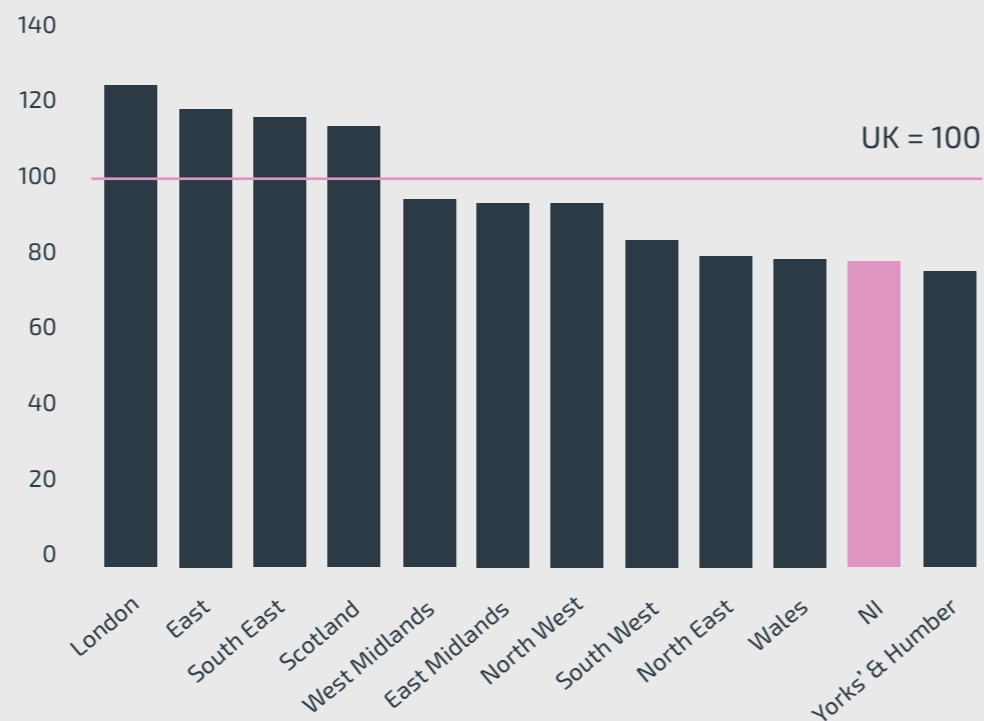
NI Knowledge Economy Activity remains 20% below the UK average.

Scotland's relatively more rapid growth was driven by business stocks; private equity and M&A activity; Innovation; R&D activity; but mostly by skills and education activity (PhD's awarded, research contracts & STEM employees).

In contrast, NI's growth is driven by a flurry of investment activity in recent years.

NI Knowledge Economy Activity remains 20% below the UK average.

Knowledge Economy Activity Index (2009 = 100)



Progress towards targets is slowing

Previous Knowledge Economy reports found that NI was on target to exceed nine targets, meet five and miss seven. This latest report has identified a slowdown, with NI now on track to exceed seven, meet six and fail to achieve eight. This is a concerning trend, and action is required to reinvigorate the Knowledge Economy sector to get NI back on track.

2016 Tracker

The previous Knowledge Economy report found that NI was on target to exceed nine targets, meet five and miss seven.



2017 Tracker

This latest report has identified a slow down, with NI now on track to exceed seven, meet six and fail to achieve eight.



Translating activity into outcomes

The NI Knowledge Economy is very successful in generating additional activity across a range of indicators – particularly in investment and R&D. However, the growth in activity has not yet translated into growth in economic outcomes in terms of productivity, wages and GVA. Translating activity into tangible economy outcomes that benefit society is the key challenge for the Knowledge Economy.



Reinvigorating the Knowledge Economy

Action is required across all of the Knowledge Economy pillars, either to maintain performance in the case of investment, build on R&D strengths or kick-start innovation and patent activity.



Educating for the Knowledge Economy of the future

NI's education system – from primary through secondary and on to tertiary education must be aligned to the requirements of the increasingly knowledge intensive economy.

The economy is changing. That is nothing new. New technologies replace the old, new occupations and jobs are created and others disappear. It is essential that NI considers the sort of education system required for the economy of 2030 – a time when today's primary school children are embarking on their careers. It will be important for the Government, the private sector and philanthropists to ensure that appropriate funding is available for education at all three levels. Equipping our children with the skills that will help them in the future is one of the most important things we can do for them.



Boosting innovation and patent activity

NI's performance in innovation and patent activity, whilst improving, has not been rapid enough to move up the regional rankings. This is the weakest activity pillar of the report, with all four indicators ranked 9th to 12th of the UK regions. This has been consistent since 2009. In order to grow the Knowledge Economy, NI's innovation and patent performance needs to improve.



Building on the R&D base

NI's R&D performance was strong from 2009 – 12 but has since levelled out. Indeed, the most recent data shows a decline in BERD and the total value of R&D. Whilst more local SME's are investing in R&D, the impact of a small number of large FDI players can have a negative impact.

NI must build on the existing R&D base to maintain and improve its position. Diversification of the base to include more local enterprises and SME's is welcome and should be encouraged in the future.



Maintaining investment performance

NI's investment performance has surged ahead in recent years with a flurry of investments. Maintaining the level of activity is key, as the North East, North West and Yorkshire and the Humber all experienced investment booms that dissipated after a couple of years. NI has been successful with both private and public-sector investments fuelling the success. Investment values remain relatively small and hopefully as the sector matures, deal sizes will begin to increase. It's worth mentioning the £20M of venture capital injected into NI tech companies through Catalyst Inc research programs. However, when put into context with c.£740M worth of VC raised for Knowledge Economy businesses in the Republic of Ireland during the same period, NI needs to maintain both a high number and high level of investment if it is to keep pace.

Automation and the NI Economy

How a perceived threat could be a real opportunity.

Change is inevitable, but are its consequences?

The automation or mechanisation of jobs traditionally performed by humans is nothing new.

As far back as 1589, William Lee's revolutionary knitting machine was turned down for a patent by Queen Elizabeth 1st. She declared 'it would assuredly bring to them (the hand knitters) ruin by depriving them of employment thus making them beggars'. Her reasoning was sound, but as we'll discover, unnecessarily cautious.

Automation then, as now, did not result in mass unemployment, or an increase in the number of beggars on our streets.

It was a similar perceived threat that concerned the horse breeders and farriers of Henry Ford's 1920s America. Their worries, as it transpired were more justified. Automation has been good for society, but inevitably, there are some sections that lose out.

What we're faced with now is the next leap forward in tech development. Where Queen Elizabeth had an automated knitting machine, we have Artificial Intelligence, blockchain, Big Data and the Internet of Things. The technology has moved on, but the fear of it remains exactly the same.



Three key facts

1. Automation replaces jobs, but it also creates new occupations – many of which haven't even been thought of yet.
2. Workers whose jobs become automated need to reskill or face economic hardship. Older workers and those with low educational attainment are most at risk.
3. The economics of supply and demand will create opportunity. Humans have insatiable appetites for more things to do, buy and see. Automation will increase this appetite by making goods more affordable, stimulating higher consumption, which in turn will increase the number of jobs and opportunities.

Automation is a job creation machine



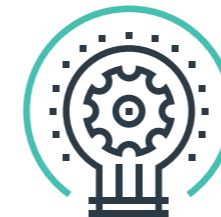
In 2001 - 2015
800,000 UK jobs lost to automation
3,500,00 UK jobs created by automation

'Brawn to Brains', Deloitte, Osbourne & Frey, 2015



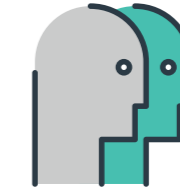
2.6 jobs created (24M) for every **1** lost

Pélessié Du Rausas et al. 2011



By 2030, an estimated **5%** of all UK jobs (**1.9M**) will be related to robotics

PWC, Will robots steal our jobs?, 2017



Digital technology has made self-employment a credible option for many workers

Citi: Global Perspectives & Solutions, 2017



App development accounts for **750,000** jobs in USA, **0.5%** of the entire working population. Apple's app store only opened in 2008.

Citi: Global Perspectives & Solutions, 2017



By 2030, up to **9% (3.3M)** of all labour demand could be in occupations created by automation that don't yet exist

McKinsey Global Institute, 2017



21st century skills will be in demand (teaching, social perceptiveness, service orientation, persuasion) and higher-order cognitive skills (such as complex problem solving, originality and fluency of ideas)

Pearson, NESTA & Oxford Martin, 2017



Jobs that might be impacted by automation

47%

Up to 47% of all US jobs are at high risk of disappearing over the next two decades

Osborne & Frey, 2015

375m

375m jobs displaced globally by automation

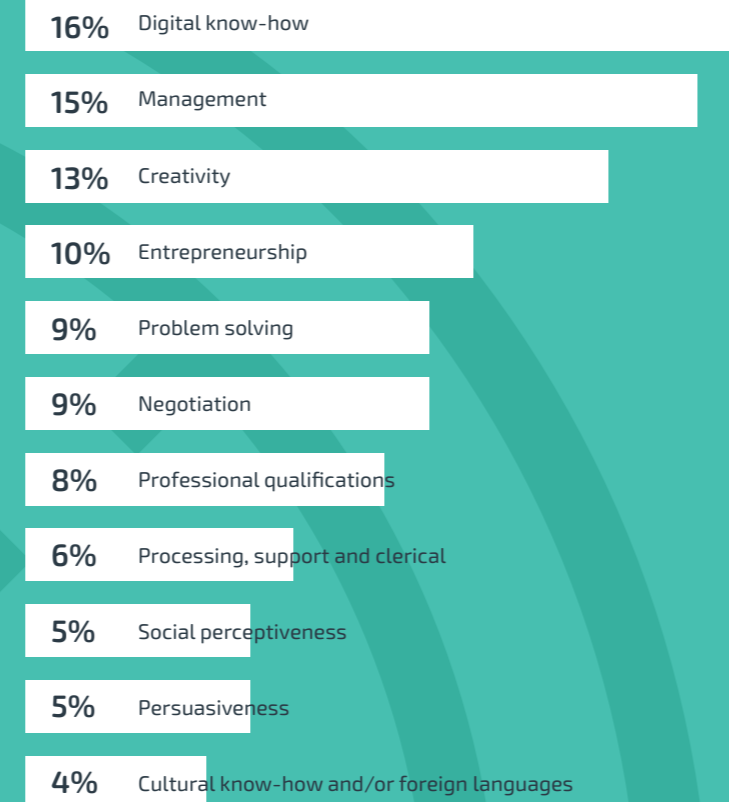
McKinsey, 2017

15m

15m UK jobs at risk due to automation

Bank of England, Andy Haldane, 2015

Skills required by businesses and public sector organisations



Source: Deloitte survey of 100 businesses, 2014



Jobs at risk from automation

Occupations with the largest growth or decline since 2001

Occupations with largest fall in employment	Probability of automation (%)	Change in jobs by occupation ('000s)	Occupations with the greatest rise in employment	Probability of automation (%)	Change in jobs by occupation ('000s)
Personal assistants and other secretaries	85	-204	Care workers and home carers	50	271
Typists and related keyboard occupations	99	-108	Teaching assistants	56	235
Bank and post office clerks	98	-83	Nurses	1	186
Retail cashiers and check-out operators	97	-72	Secondary education teaching professionals	1	131
Shopkeepers and proprietors, wholesale and retail	16	-69	Sales accounts and business development managers	16	122
Postal workers, mail sorters, messengers and couriers	80	-65	Business and financial project management professionals	11	115
Assemblers (electrical and electronic products)	94	-60	Teaching and other educational professionals n.e.c	1	113
Business sales executives	60	-58	Primary and nursery education teaching professionals	56	110
Metal machining setters and setter-operators	79	-51	Chefs	57	103
Sewing machinists	89	-47	Property, housing and estate managers	25	101

Source: Frey and Osborne, Deloitte analysis 2015.



Risks and opportunities for NI

Given NI's relatively lower productivity within sectors and the composition of the workforce, it's logical to conclude it is at greater risk from automation than other UK regions.

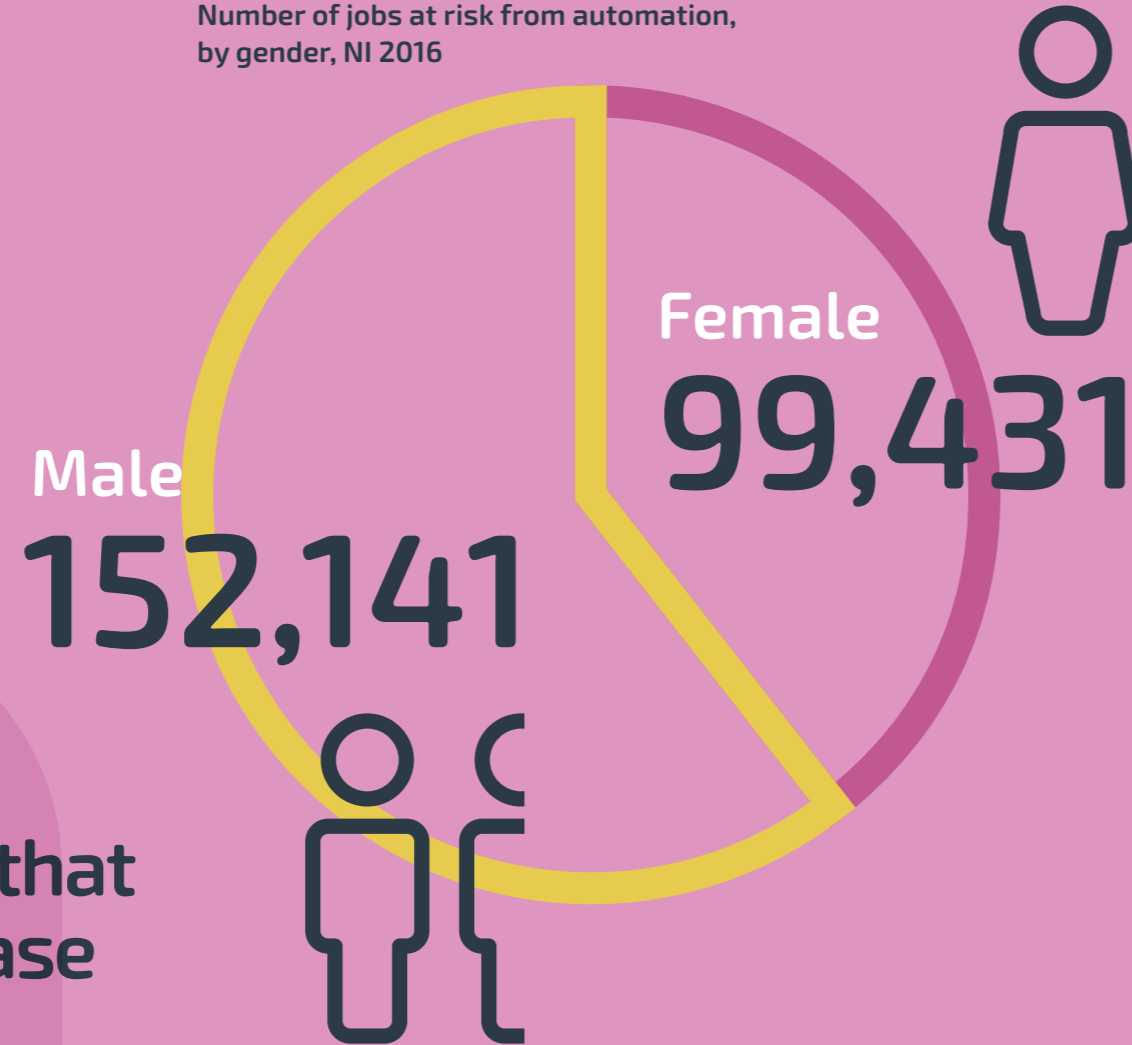
Using Osborne & Frey data and applying it to NI occupational structure, the number of NI jobs at risk by 2030 is 50% (423,000), compared to 35% for the rest of the UK.

Source: Deloitte 'Agiletown: the relentless march of technology and London's response', November 2014

However, Deloitte, Osborne & Frey estimate that between 2011-15, automation provided a c£3bn boost to the NI economy as well as more than 100,000 jobs in net terms.

In 2017, PWC estimated that automation could increase NI output (GVA) by 5.4%

Number of jobs at risk from automation, by gender, NI 2016



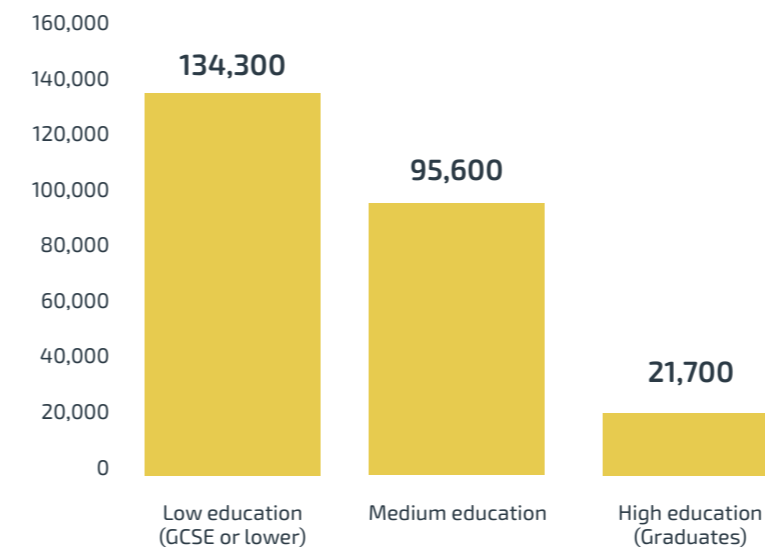
Risks and opportunities for NI

Number of jobs in NI that might be created by automation by 2030

Research base	%	Number
Pélessié Du Rausas	2.6 jobs are created for every job lost	595,000 (using 27% average of jobs at risk)
PWC	5%	43,000
McKinsey Global Institute	8% - 9%	68,000 - 76,000
Average	28%	236,000
Range	5% - 70%	43,000 - 595,000

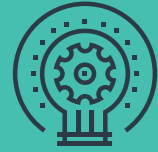
Sources: Various & UUEPC analysis

Number of jobs at risk from automation, by education level NI 2016



Numbers of jobs that are at risk of automation in NI by 2030, by occupation





1. Historical perspectives provide some comfort

Technological progress has been feared as a risk to employment for more than four centuries. Economists, policy makers and Governments used to (and some still do) worry about mass technological unemployment and the potential impact on society. So far, those concerns have proven to be unfounded at a macro level. But if your job is automated away then certain challenges are likely unless you can reskill.

Automation increases productivity and that reduces average prices, making goods and services more affordable and freeing up cash for other purchases, promoting consumption. Demand increases for these products (Say's law) and our quality of life and average income increases. Automation has been good for society in general, but at a micro level there are losers and policy needs to consider the best options.



2. Jobs are at risk, but others will be created

Research estimates that a significant proportion of occupations are at risk of being replaced, or partially replaced by automation over the next two decades. The jobs most at risk are generally (but not all) lower skilled and routine. However, more and more non-routine and cognitive occupations are being replaced. The jobs that are least at risk of being replaced are those that require dexterity, softer "people skills", creativity, digital knowhow, persuasion, creativity, strategic thought and leadership.

At the opposite end of the spectrum, lower skilled jobs that require more human interaction and dexterity are more difficult to replace. Therefore, mid-level skills in the labour market will face some challenges as machine operatives, accounting technicians and paralegals, to name but a few are subject to the forces of automation.

Published research estimates a large range of jobs are at risk from automation (10%- 47%) and similarly, a large range of jobs might be created (5%- 65%). It is easier to identify existing jobs that are at risk though, than those that do not exist and so, forecasting the number of jobs that might be created is more challenging.



3. NI is more at risk than the UK average, but opportunities abound

At an NI level, a greater proportion of jobs are at risk from automation, given the sectoral and occupational composition of the economy. Applying UK based research to NI suggests that up to 50% of jobs could be impacted over the next two decades, but an even larger range of jobs might be created (5% to 70%).



4. Planning for the future is key

Society is on the cusp of another technological disruption, where big data, blockchain and IoT change how we live our lives. The world is changing, and although NI has no control over the pace of that change it must plan the journey along the road ahead. We need to think, act and educate now for the economy of the 2030's and beyond or risk being left behind as the rest of the UK and the world embraces the opportunities automation will undoubtedly bring. Doing that could result in a net gain in the number of jobs available rather than the reduction most people fear.



A vital sector of the NI economy

The Knowledge Economy generates significant income from sales outside NI, helping to grow the economy and create skilled, well paid and highly productive employment opportunities.

It is a sector that helps to close the productivity gap with the rest of the UK and generates income for the region. A growing Knowledge Economy will help to rebalance the NI economy toward greater private sector activity.

Creating jobs across the region

The majority of companies in the sector are clustered in and around Belfast, while a North West Knowledge Economy hub also exists in Derry/Londonderry. Whilst the majority of the firms are located in and around the cities and along motorway corridors, there is also a spread across rural areas, providing employment opportunities and helping to promote regional growth.

Wider economic impacts

The downstream effects generate one additional job in the wider economy for every Knowledge Economy job – in shops, trades, logistics and restaurants. For every ten jobs that are created in the Knowledge Economy another nine are created elsewhere.

Insulating against Brexit

Four fifths of local Knowledge Economy sales are to NI, GB and the rest of the world excluding the EU. This means that the Knowledge Economy is uniquely positioned to grow its existing export sales base outside the EU and is well insulated from some of the Brexit trade risk. However, the sector is dependent on highly skilled individuals, who are often internationally mobile. The detail of the emerging deal between the UK and EU is limited, but access to appropriately skilled labour is essential for the sector.

11 of the 25 indicators saw record highs over the last year

Record performances

11 of the 25 indicators saw record highs over the last year, including employment, business stocks and business starts. This is particularly encouraging as it is evident that there are more opportunities and activity within certain areas of the sector than ever before.

Investment surges ahead

The number of investments continues to grow and this pillar is the strongest element of the Knowledge Economy report. NI is the top ranked region for two indicators and is third in another. Indeed, it performs ahead of the UK and Irish averages in most indicators.

But progress is slowing

The record highs in an NI context are set against other regions that are also trying to boost their performance and NI has struggled to move up the regional rankings.

Productivity has been declining, reducing employers' ability to pay higher wages and resulting in lower profits for Knowledge Economy enterprises. Knowledge Economy GVA is lower now than it was in 2009, which is concerning. Nine of the indicators declined over the most recent year and progress towards the aspirational targets has slowed.

Reinvigoration is required in the Knowledge Economy if it is to achieve the ambitions set for 2030.





Why our Knowledge Economy matters

- Employs one in twelve people directly or indirectly
- 81% of all Knowledge Economy sales are outside NI
- Productivity levels on average since 2009 are close to one third higher than the economy-wide average
- Salaries are 45% above NI average
- The downstream effects of the Knowledge Economy are seen in how companies and employees spend their earnings. Higher wages mean more disposable income
- For every person employed in the Knowledge Economy nearly one more full-time job will be created elsewhere in different sectors. And for every pound generated, an additional 61 pence will be created elsewhere

Rebalance public/private sector employment levels

A larger Knowledge Economy will help to rebalance the NI economy towards higher productivity private sectors that generate wealth from outside NI and sustain highly paid jobs

More public service funding

Increased levels of economic activity will result in a broader tax base, which can then be used to fund public services

Happiness and wellbeing

New ideas and knowledge unlock amazing opportunities, resulting in improved economic wellbeing and increased quality of life

Downstream spending

The wider impact of the Knowledge Economy is felt through the supply chain purchases made by these companies (the indirect effects) and through the expenditure of employees' wages earned from Knowledge Economy companies

More competitive. More attractive.

A healthy Knowledge Economy boosts the competitiveness of NI, making it more attractive to inward investors

Inspires a generation

It inspires the kids of today by giving them ambition for tomorrow

Values a wider range of skills

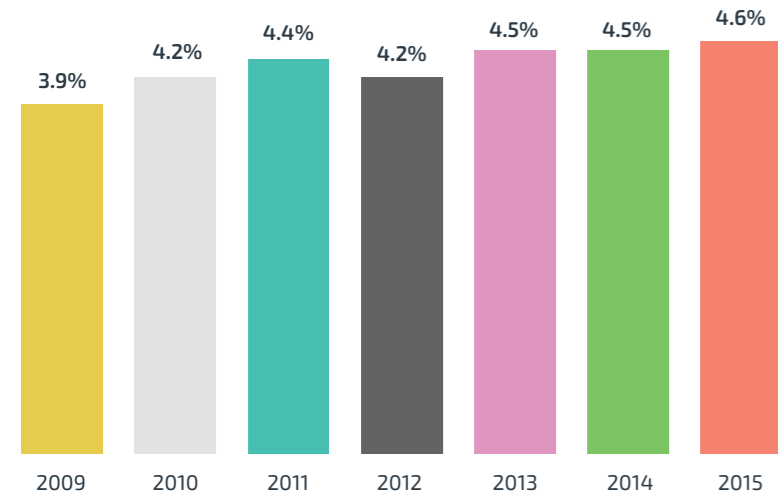
The Knowledge Economy values creativity and design, not just ingenuity and technical savvy



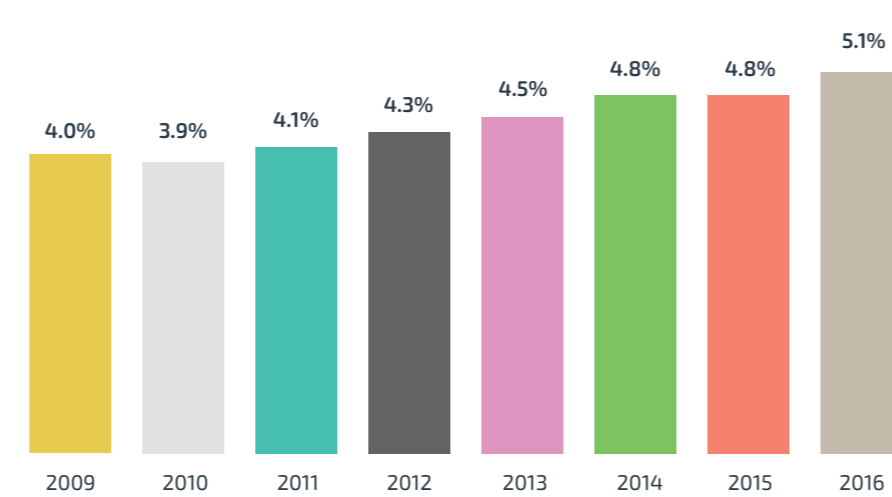


Key indicator trends

Knowledge Economy employment
(% of total workforce)

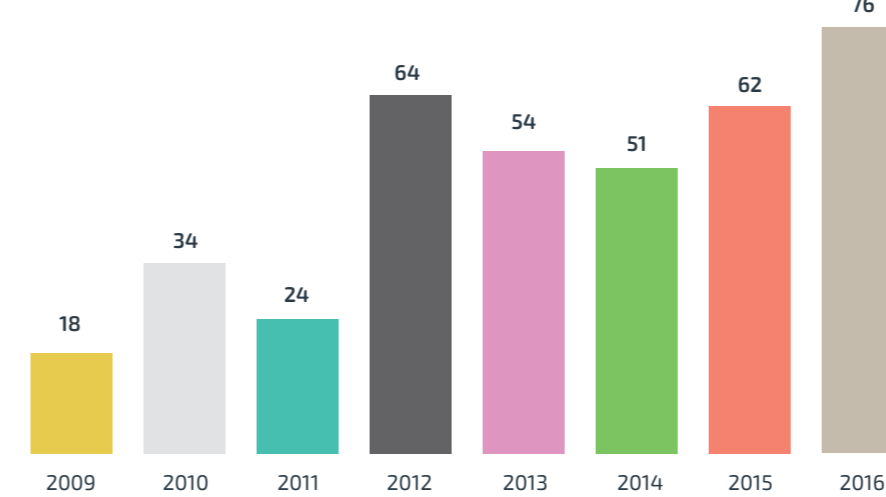


Knowledge Economy businesses
(% of total active enterprises)

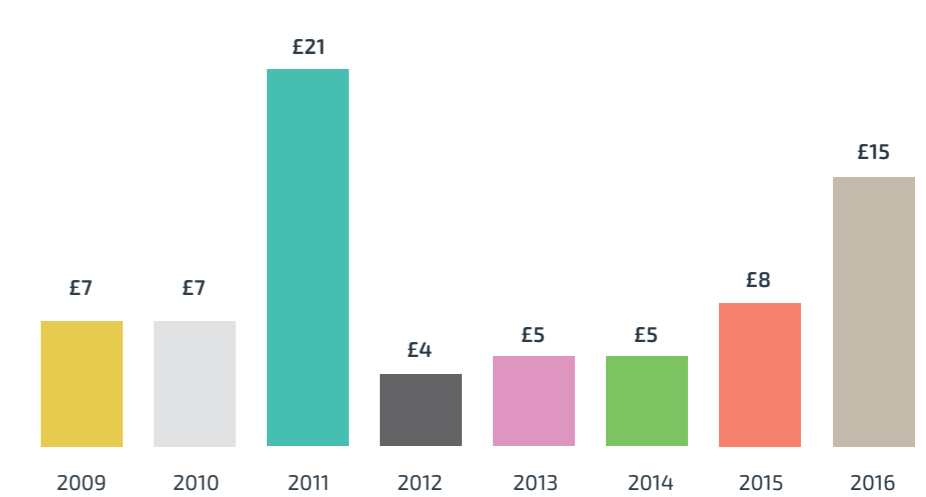


Key indicator trends

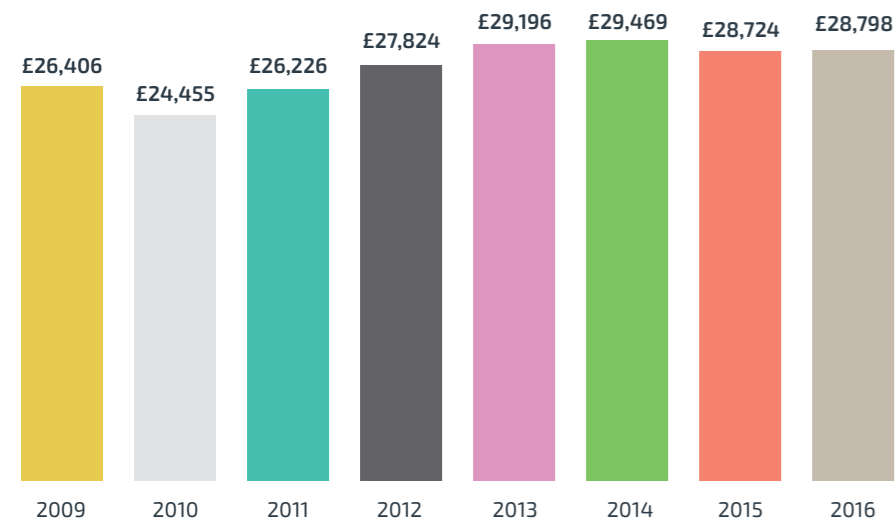
Number of venture capital investments
(per 100,000 active enterprises)



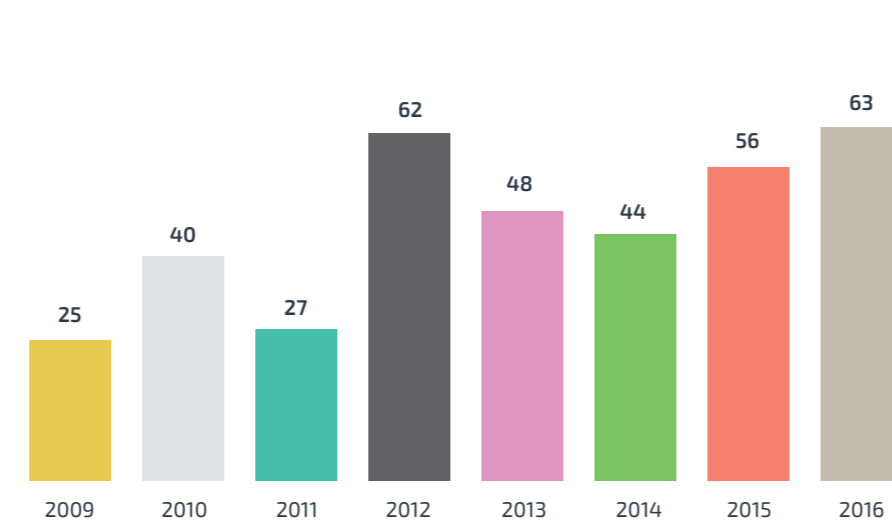
Amount of venture capital invested in
(£m)



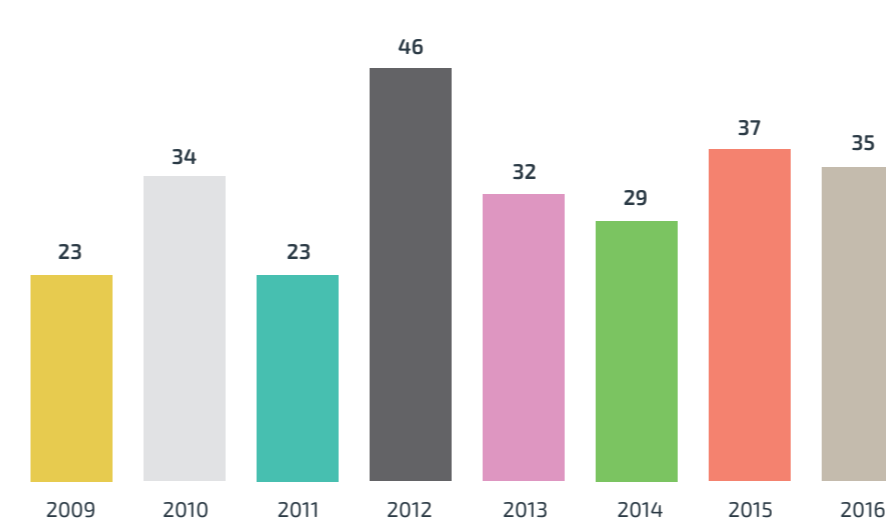
Knowledge Economy average annual wage (£)



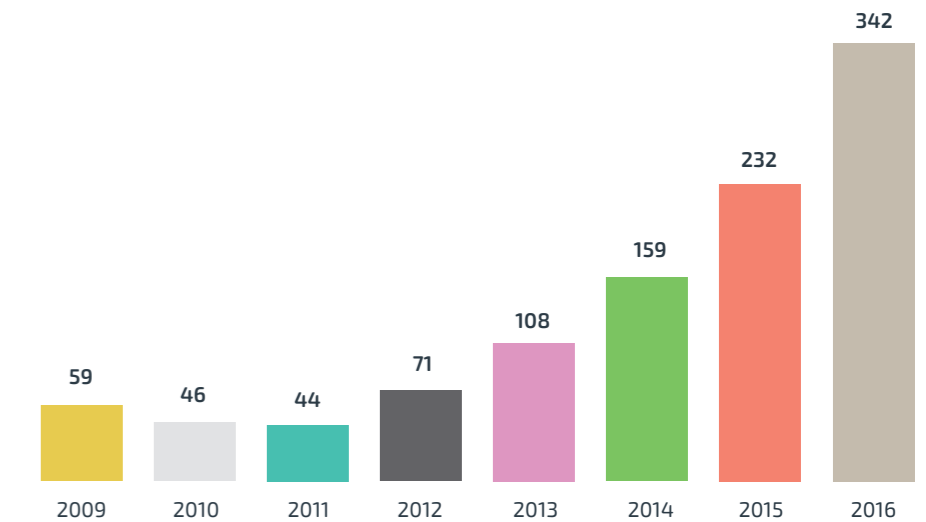
Number of private equity and venture capital investments
(number of companies)



Number of private equity investments
(per 100,000 active enterprises)



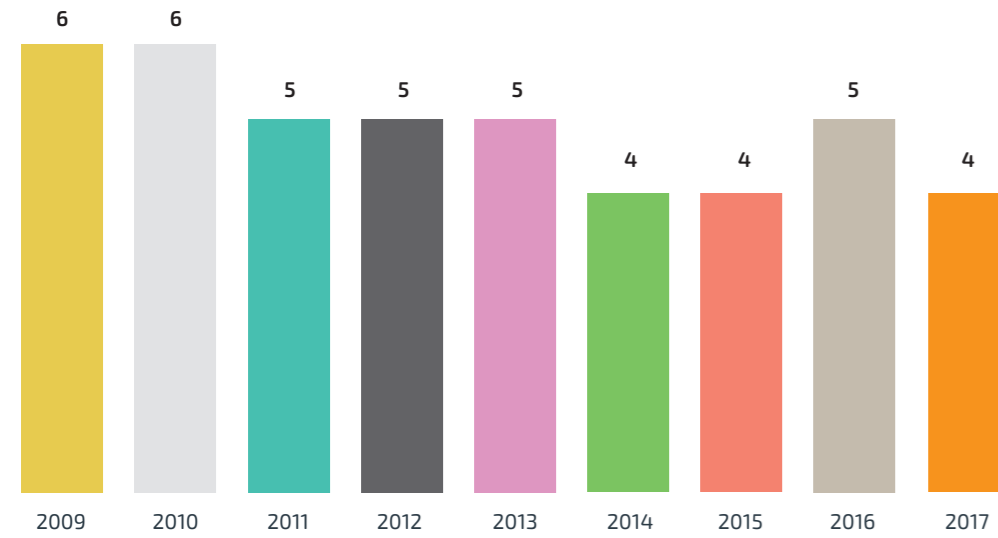
Number of M&A and ECM deals
(per 100,000 active enterprises)



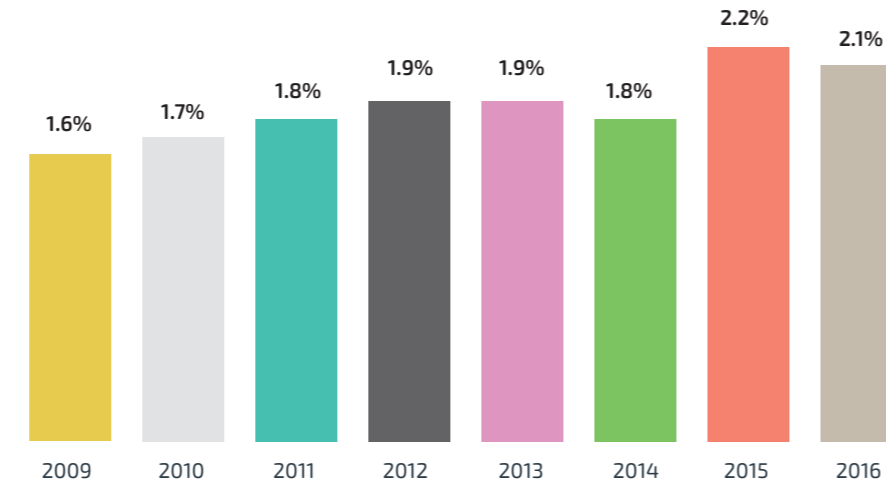


Key indicator trends

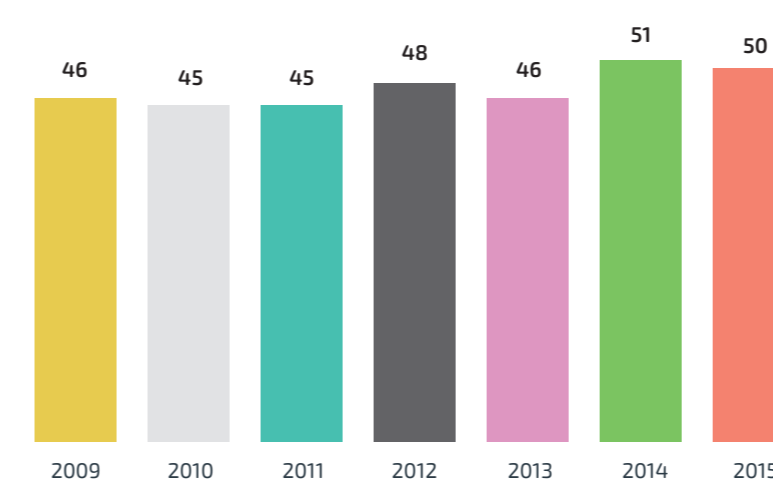
Number of Public listed companies (% of workplace GVA)



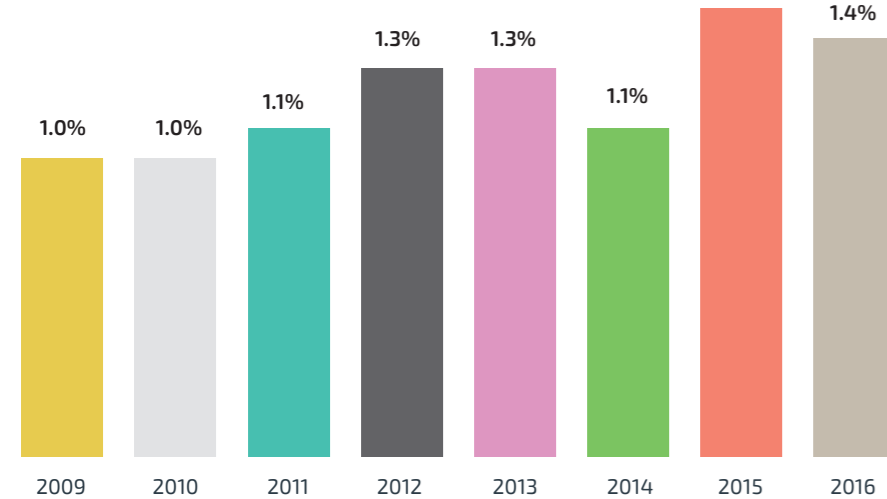
Research and Development (% of workplace based GVA)



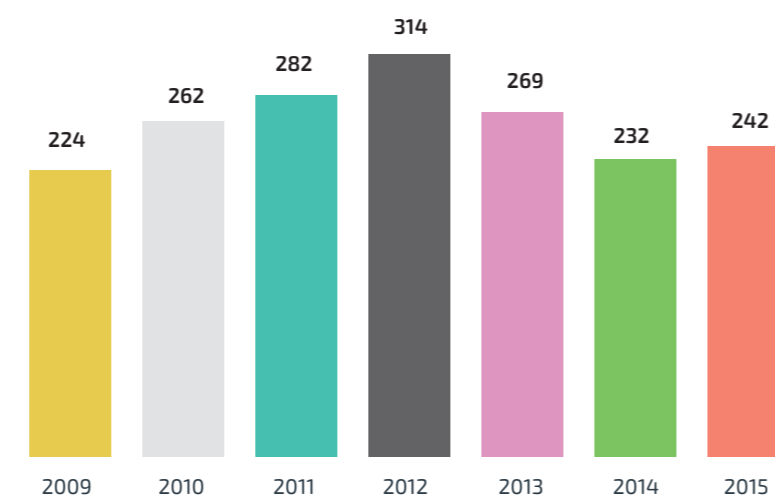
HEI research grants and contracts (per 1,000 population)



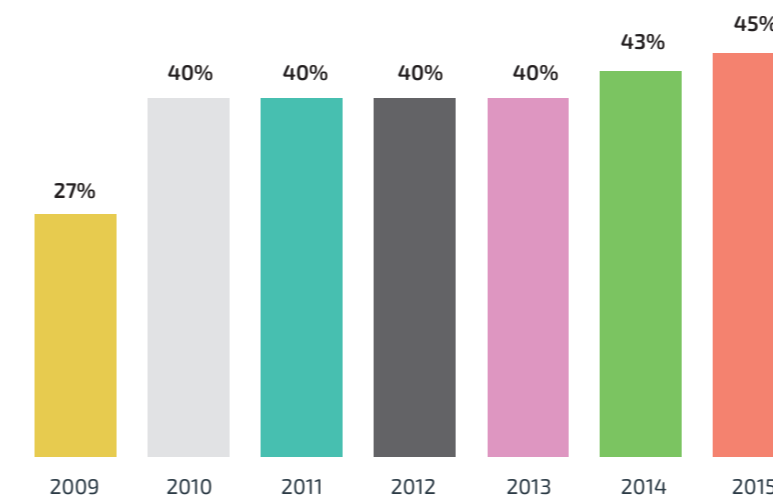
Business Expenditure on Research & Development (% of workplace GVA)



Number of PhDs (per million population)



Firms stating that they are innovation active (% of total)





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