Science, Engineering & the Devolved Nations

Campaign for Science & Engineering in the UK

CaSE Policy Report **Number 11** **April 2011**

CaSE works to ensure that science and engineering are high on the political agenda and that the UK has: world-leading research and education; skilled and responsible scientists and engineers; and successful innovative business. CaSE is funded by individuals and organisational members from industry, learned societies, universities, and research charities.

Contents

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Why science & engineering?

Only by developing science and engineering can Scotland, Wales, and Northern Ireland continue the economic recovery, and secure their long-term prosperity.

Investment in science and engineering skills and research gives broad, and historically proven, economic returns over the short- and long-term[1]. Science, technology, engineering and mathematics (STEM) are vitally important to the UK's growth and economy, estimated to underly at least a quarter of the UK's gross domestic product[2]. Yet these sectors have not had the success or support that they should have had throughout the UK. Even while implementing austerity budgets, other countries, such as Germany, have increased their investment in research and innovation in order to support growth and rebalance the economy.

The devolved nations of the UK all govern in areas heavily influencing, or influenced by, science and engineering. These include:

- scientific analysis, advice and oversight in policy-making;
- education, from primary through to further and higher education;
- funding of research in universities and research institutes;
- policies supporting industry research and innovation.

Since the last elections, each nation has made improvements in these policy areas, with particular progress in scientific advice, data collection, and strategy.

It is essential that the incoming politicians and policy-makers build upon recent national strategies and reviews with real commitment to put science and engineering at the heart of their nation's growth and well-being.

The devolved Governments need to deliver strong and long-term policies to give aspiring and working scientists and engineers, and businesses, the confidence to locate their careers and investment in the UK. These policies need the high-level oversight of a Science Minister and financial support.

This report was produced in the run-up to the devolved elections of May 2011. It makes a series of recommendations for political parties campaigning for office and for the incoming assemblies and governments. CaSE has also produced recommendations targeted for each of the nations, and a more detailed background paper - all are available from the CaSE office or:

- www.sciencecampaign.org.uk.

By the time people cast their votes they must know how each party would respond to the challenges facing science and engineering. The public are increasingly interested in science and engineering, not least because of the vital role that these sectors should play in the economic recovery.

CaSE has written to the leaders of the main political parties asking them to state their policies on science and engineering. Their responses are published on the CaSE website, and are available from the office on request.

Prioritising Science & Engineering in Politics & Government

Every UK nation under-invests in research compared to competitor and collaborator countries (see Figure 1). Science and engineering need to be prioritised in the policies and expenditure of every nation to achieve the high-tech future and prosperity each strives for.

GOVERNANCE

- **Each nation should have a Minister with responsibility for science, engineering and innovation highlighted in his or her portfolio, who is included in the relevant high-level decision-making committees.**
- **All of the devolved nations have developed (or are developing) strategies for science, technology, engineering and mathematics (STEM) - all of the parties must commit to pursuing these agendas after the May 2011 elections.**
- **STEM policies need to be long-term, of the order of decades rather than years, as this is the time-frame in which research and innovation occur, external investment decisions are made, and careers are chosen and pursued.**

Currently, the Scottish Government names science as one of the ministerial responsibilities of the Cabinet Secretary for Education and Lifelong Learning, the Welsh Assembly Government has a Deputy Minister for Science, Innovation and Skills, and the Northern Ireland Executive does not name science, engineering or innovation as a specific ministerial responsibility.

A named Ministerial champion can ensure that policies affected by and affecting science and engineering are beneficial and coherent across departments. This appointment needs to be high level to signal to aspiring and working scientists and engineers, and investors, the priority that a Government places on science and engineering.

DEPARTMENTAL RESEARCH & DEVELOPMENT

- **Government departmental research and development (R&D) budgets need to be maintained to provide the evidence base for policy development and the effective delivery of public services. Recent cuts in departmental R&D spending should be reversed.**

Government departments must secure the evidence base for their policies by investing in research to develop new ideas and to evaluate policies already in place. It would be a false economy to cut the work that enables efficient and cost-effective policy-making. Given the importance of this investment, planned and past spending should be published more clearly and consistently than it is now to enable proper oversight.

SCIENCE & ENGINEERING ADVICE

- **All parties in Northern Ireland should commit to appointing a Chief Scientific Adviser and all parties in Wales and Scotland should commit to maintaining this position.**
- **The Chief Scientific Adviser should have explicit responsibility for engineering, be supported by a Scientific Advisory Committee, and have access to the relevant Minister and to the head of their national executive.**

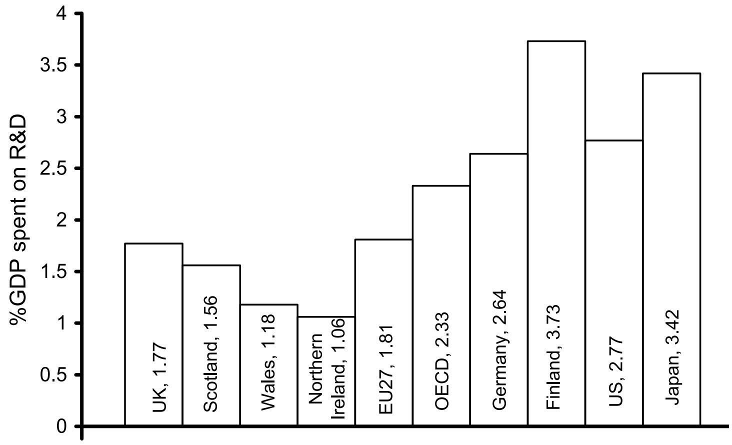
Virtually every area of policy-making requires or gains from science and engineering. The UK, Scotland and now Wales each have a Chief Scientific Adviser who oversees the advisory system to deliver the best possible scientific advice for policy development and delivery. This role can also encompass scanning for future risks and opportunities, supporting scientists and engineers in the civil service, and promoting STEM and the role of science in society and the wider knowledge economy.

SCRUTINY & INTEREST

- **Each of the national assemblies should have a specified committee that is responsible for ensuring that current and future policies affecting, and affected by, science and engineering are duly scrutinised.**

None of the devolved nations has a dedicated committee for the scrutiny of science and engineering. The number of elected representatives in each of the nations may limit the viability of a dedicated committee; if one is not possible then oversight should be clearly designated to a specific committee. This would guard against policy areas falling between gaps of oversight and help policy coherence. It also enables interest and expertise to be built up over time.

Figure 1. Total investment in R&D as a percentage of Gross Domestic Product (GDP), 2009 (but see footnote[3])



STEM Education for All & Teaching Expertise

■ **All students need the STEM skills necessary to thrive in our modern world. In order to meet future skills needs, it is essential that more students study STEM to a higher level.**

The UK's competitive future lies in high-skill sectors which need the support of a correspondingly highly-skilled workforce. The demand for STEM skills is expected to grow faster than that of other sectors, so the future STEM workforce will be vital to sustain the economic recovery. Over nine out of ten UK businesses employ people with STEM skills, but two thirds of all employers report difficulty recruiting enough of these workers, particularly with higher skills levels[4].

TEACHING

■ **All secondary schools should have teachers with specialist knowledge in each of biology, physics and chemistry, and sufficient teachers to meet student need in mathematics.**

■ **There is a shortage of specialist teachers of physics, chemistry, and mathematics in Wales and Northern Ireland - recruitment targets should be set for teacher training in these subjects and financial incentives used to help meet them.**

■ **All primary schools should have at least one teacher with relevant graduate-level qualifications or additional training in mathematics and science.**

■ **Measures should be taken to get teachers into the schools where they are most needed.**

The quality of science teaching relates to teachers' qualifications, with a better match improving standards and achievement[5],[6]. Unfortunately, many schools have difficulty recruiting teachers with a background in physics, mathematics and chemistry. Just 14% of registered teachers in Northern Ireland have STEM degrees and less than a quarter of these work in primary schools; 70% of schools in Northern Ireland are non-selective, but only about a third of secondary physics teachers work in them[7]. In 2010, across the 222 secondary schools in Wales, there were 158 registered teachers of physics trained in the subject, compared with 198 physics teachers without such training (and 50 whose training was unknown)[8].

In order to teach students older than 14 years in Scotland, teachers need to have studied their subject for two years at degree level. Survey data suggest that there might have been some difficulty recruiting STEM teachers in the past[9],[10]. However, there is little to suggest the presence of current shortages.

Throughout the UK, primary school teachers are generalists and many lack confidence teaching science. The UK government recently acknowledged that all English primary schools should have a mathematics specialist[11]. This goal should be extended to the devolved nations and include science teachers[12]. Students start to develop subject preferences and career aspirations in primary school and it is vital that their teachers are confident and inspiring[13].

Much has been done in recent years to try to address teacher shortages, including financial incentives, additional training routes, and recruitment targets. These should operate at primary as well as secondary level.

Teaching in a Different Language

■ **Research should be commissioned in Wales (and, to a lesser extent, Northern Ireland) to determine the impact of requirements to teach science and mathematics in a language other than English.**

In Scotland 0.4% of students received all or some of their curriculum in Scots Gaelic, most of them at primary school[14]. About one in ten schools in Northern Ireland are Irish medium and there are moves to provide more materials to promote STEM in them (although English is encouraged for at least part of the curriculum)[15].

The issue is much more prominent in Wales - with a quarter of secondary schools teaching in Welsh for at least half their lessons. Unfortunately, it is hard to find specialist teachers able to teach science and mathematics in the Welsh language. For instance, fewer than 15% of newly qualified physics teachers are able to teach in Welsh[16].

Continuing Professional Development

■ **All teachers should be entitled to funded, subject-specific Continuing Professional Development (CPD). Courses should be available for teachers without a background in physics, chemistry and mathematics to develop their skills and confidence, and also for primary school teachers seeking to develop a specialism in science or mathematics.**

STEM teachers need CPD to keep up to date with advances in their fields. It can also improve practical teaching and is hoped to improve retention. Courses for teachers to develop a STEM specialism have the potential to break the vicious cycle of there being too few specialist teachers to inspire students to go on to further study and then enter the graduate pool from which future teachers are recruited.

Secondary Education

SECONDARY QUALIFICATIONS

■ Wales and Northern Ireland must ensure that all schools give students the opportunity to study three separate science GCSEs and that uptake of STEM subjects improves post-16.
■ Northern Ireland needs to urgently revise its curriculum to require all students to study mathematics and science until the age of 16.

In England, Wales and Northern Ireland, most students progressing to higher education (HE) study GCSEs up until 16 and then take AS levels followed by A levels. Although students who study two combined science GCSEs can progress to study science A levels, pupils that study three separate biology, physics and chemistry GCSEs ("triple science") are more likely to study and do well later at science A levels[17]. It is estimated that over 40% of schools in Wales do not offer the separate sciences at GCSE (30% in England)[18].

Maintained schools in Wales and Scotland follow a nationally-specified curriculum which includes mathematics and science. Since 2007-08, Northern Ireland has not required students to study mathematics or science after the age of 14 years. Thus students can take no STEM, or a choice of one, two or three of biology, physics and chemistry GCSEs. There is already a worrying impact upon results, with entries into single science GCSE increasing[19]. This pattern needs to be monitored and there is an urgent need to introduce a requirement for all students to study science and mathematics qualifications post-14.

There is also a striking inequity in performance in Northern Ireland (where 67 of 226 schools are selective). Only a third of non-selective schools enter students into physics A level, whereas all selective schools do so[20]. Just 47 schools produced 70% of all STEM A levels and they were all selective[21].

The Scottish education system is distinct. Most students take intermediate and standard qualifications prior to the age of 16. These will soon be replaced under the Curriculum for Excellence, with new National 4 and 5 qualifications. These new qualifications must not lead to lower take-up or a narrowing of STEM subjects. Most students take Highers and Advanced Highers post-16. It is possible but not usual to progress to HE after taking Highers (at age 17), with many Scottish degrees lasting four years. Alternatively, students can study Advanced Highers at school, sometimes enabling them to skip the first year of HE[22].

INTERNATIONAL COMPARISONS

■ The UK needs to improve its mathematics and science performance and post-16 uptake. Wales needs to make these improvements an absolute priority, and Northern Ireland must work harder for its lower-performing students.
■ Scottish STEM students fare better than the rest of the UK, but less well in international comparisons, with a possible downward trend; the new curriculum and qualifications need careful monitoring.

International scores for 15-year-olds in mathematics and science show the relative strength and weaknesses across the UK (see Table 4). Only Scotland also took part in PISA 2003, in which it scored significantly higher than in 2009 in maths (25 points)[23].

Table 1. PISA scores, 2009 (standard deviation in parentheses)[24]

	Mathematics	Science
OECD average	496	501
England	493 (SD=87)	515 (SD=99)
Scotland	499 (SD=93)	514 (SD=96)
Wales	472 (SD=82)	496 (SD=95)
Northern Ireland	492 (SD=89)	511 (SD=103)
Finland	541	554
Germany	513	520
US	487	502
Japan	529	539

Northern Ireland had the greatest difference between the low- and high-performers in science in PISA 2006 and the spread of attainment was also greater than that of the UK as a whole in mathematics.

Boys significantly out-perform girls in every UK nation in mathematics, and in science in Wales. This gender pattern is not true of all countries sampled. In all UK nations for post-16 study, female students showed a stronger preference for biological sciences, but males are more likely to study physics and mathematics.

A recent comparison of 24 countries found that England, Wales and Northern Ireland are the only ones in which fewer than 20% of students study mathematics at upper secondary (typically post-16) level (not counting retakes of GCSEs etc.). The figure is nearer half for Scotland, but still below average. Three quarters of the countries surveyed, but none of those in the UK, had compulsory mathematics for at least some students at upper secondary level[25].

Accessing Further & Higher Education; Improving Diversity

VOCATIONAL TRAINING & APPRENTICESHIPS

■ Scotland needs to sustain its support for apprenticeships, while Northern Ireland and Wales need to increase provision and help more small businesses to participate.

There is a wide range of vocational qualifications, often delivered in Further Education (FE) colleges, many of which can lead to HE. National Vocational Qualifications (NVQs) and Apprenticeships in England, Wales and Northern Ireland, along with Scottish Vocational Qualifications (SVQs), provide work-based learning in a range of industry and employment sectors, including engineering. Foundation degrees also offer vocational education, equivalent to the first two years of an Honours course. Vocational qualifications are currently under review by the UK Government and in Northern Ireland; they do need rationalisation.

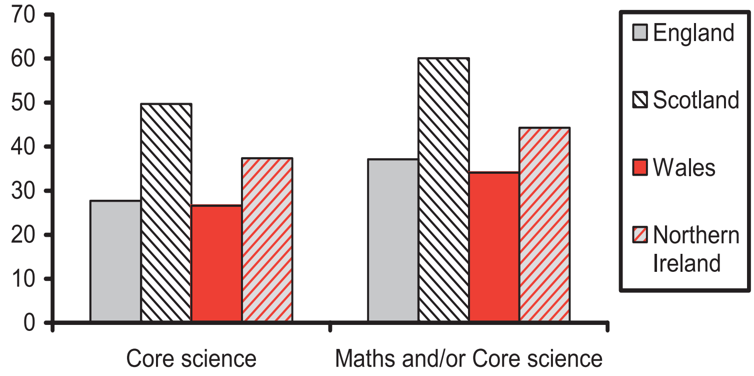
Scotland has increased its provision of apprenticeships and achieved an impressive rise in female uptake. Wales needs to move its successful pilot programmes into full provision with the necessary number of placements. Business representatives have urged Northern Ireland to set better targets and provide more support (including funding) for apprenticeships[26]. The large proportion of small businesses in this nation may limit placement availability as businesses struggle to find the necessary time and money.

ACCESSING HIGHER EDUCATION

■ The number of students studying STEM at higher levels depends upon supply. All secondary school students should have access to the necessary courses, including physics and mathematics A level, and be given high quality career advice. A more progressive approach could increase the breadth of post-16 study or introduce compulsory elements (e.g., maths).

Recent analyses examined the size of the pool of students who could potentially study STEM post-18, illustrated in Figure 2[27]. The stronger performance of Scottish students probably reflects their typically broader range of study at Highers. Worryingly, the proportion of students taking core science appears stable in Scotland and Northern Ireland, but declined in England and Wales from 2005 to 2009, widening the gap between them and the other nations.

Figure 2. The percentage of the post-16 student cohort studying at pre-university level (i) core science or (ii) mathematics and/or core science, 2009.



Over the 1990s, the popularity of mathematics and physics declined, but this trend reversed in recent years. Between 2005 and 2009, mathematics entries rose by 40% in England, 4% in Scotland, 46% in Wales, and 22% in Northern Ireland. Over the same period, physics entries rose by 6% in England and Wales, 4% in Scotland, but little in Northern Ireland. Worryingly, the proportions of institutions entering students into physics and mathematics decreased in each of the nations. This may reflect the shortage of specialist teachers in these areas.

DIVERSITY IN SCIENCE AND ENGINEERING

■ Every nation should have a funded plan to improve diversity in STEM - for equality, to make the most efficient use of resources, and to harness the widest innovative potential to advance research and support growth.
■ Strategies to improve uptake of STEM subjects may be most beneficial and cost-effective if they are targeted at under-represented groups.

Distinct groups of people are under-represented in certain areas of STEM such as women, people from certain ethnic minority groups or socially-disadvantaged backgrounds, and disabled people. This represents an enormous loss of potential in terms of the sheer numbers of scientists and engineers there could be. Innovation is also enhanced by having a wide range of perspectives, so limiting participation affects innovative potential. It is also a waste of investment. For example, only 30% of women with STEM degrees are employed in STEM compared with 50% of men[28]. Unfortunately, the UK government has dramatically cut funding for the UK Resource Centre for Women in SET. Each nation needs to articulate its own plans and funding to improve diversity, across all under-represented groups.

Higher Education - Performance & Funding

■ All UK nations need to train more STEM graduates and postgraduates to meet skills needs.

Scotland has 14 universities, including 5 in the top 200 in the world[29], and 5 other HE institutions. Wales has 11 HE institutions, with plans to rationalise them to 6. Northern Ireland has 2 universities and 2 HE colleges. They all also have a branch of the Open University.

Over all subjects, Scotland and Wales award more undergraduate and graduate degrees than expected for their populations, but fewer other HE qualifications (e.g., Foundation degrees). Northern Ireland has a lower share than would be expected, partly because of a low cap on student numbers. It has many students studying abroad; unfortunately, about a quarter of such STEM students do not return to work in Northern Ireland, and the Government is developing scholarships to attract them back[30].

Figure 3. Percentage of undergraduate degrees awarded in broad or core STEM subjects, shown by nation (2009)[31]

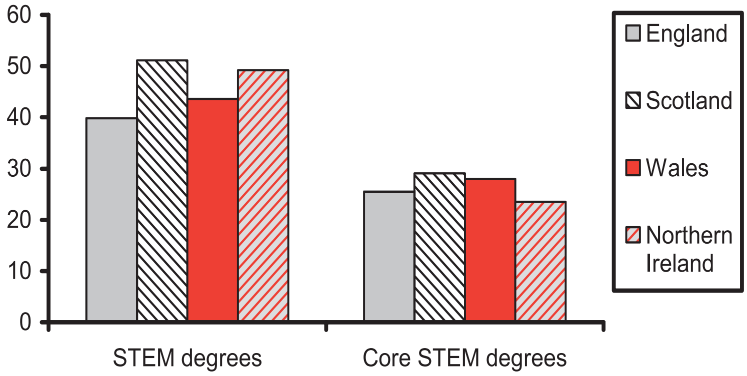


Figure 3 shows that about half of degrees in 2009 were in STEM subjects in Scotland and Northern Ireland, compared with about 40% in Wales and England. The numbers are lower for core STEM subjects. Women are heavily over-represented in subjects allied to medicine but under-represented in computing, engineering and mathematics.

FUNDING

■ All political parties need to give a realistic explanation of how they will fund higher education in a sustainable and internationally competitive way, without risking departmental or course closures in STEM.
■ If different student fees are charged for different courses they must not discourage students from STEM.
■ Groups of students already under-represented must not be less able or inclined to study STEM because of new funding arrangements.

The organisation and funding of FE and HE is changing across the UK. It may take many years for the new systems to stabilise. Universities receive public funding for teaching - this is currently either being cut or at risk of being cut, sometimes dramatically, in each of the UK nations. Compared to other countries, the UK has not been investing heavily in HE, and has a smaller public contribution. In 2007, the UK as a whole spent a total of 1.3% of GDP on HE, about half (0.7% of GDP) was from public funds[32]. The European average was 1.3% of GDP, with 1.1% from public funds, and the OECD average was 1.5% of GDP with 1% from public funds. Historically, funding has been higher in Scotland, than Wales, and in Wales than Northern Ireland (see Figure 4).

Universities also charge tuition fees directly to their students - there are loans available to cover these fees and some bursaries available to offset them. In 2010-11, universities in England and Northern Ireland charged a tuition fee of £3,000 to all UK students. Scottish universities did not charge Scottish students, but charged students from other UK nations less than £2,000 a year. Welsh universities charged Welsh students just over £1,000 a year, and UK students from other nations, £3,000 a year.

Tuition fees may rise dramatically for many students, up to £9,000, and universities can vary them across subjects. Variable subject fees would be likely to affect student choice of what to study, and must not work against the need to increase uptake of strategic STEM subjects. Higher fees must not increase the under-representation of students from certain ethnic minorities or from socially-disadvantaged backgrounds[33].

Scotland seems unlikely to introduce fees, but it must make up the relative loss of teaching income that will occur, estimated to be between about £100m and £200m.

INTERNATIONAL STUDENTS

■ Specific strategies should be developed to promote universities more effectively overseas and attract more international students.

Across the UK, international students help build global networks and collaborations, and many stay on as part of the UK workforce or take their experience and contacts on to benefit other nations (building up their ties with the UK). International students also support UK universities and the wider economy through fee income and living expenses. Non-EU students spent £1.9bn across the UK in 2008/09, £128m in Scotland (6.7% of the UK total), £51m (2.7% of UK) in Wales and £12m (0.6% of UK) in Northern Ireland[34].

The Research Base - Performance & Devolved Public Funding

■ **Scotland has a strong research base, but must continue to prioritise research spending in order to keep up with the many other countries increasing their investment in R&D.**
■ **Wales and Northern Ireland have weaker research performance and must invest more in a strategic way to build up their collaborative mass.**

Research carried out in universities and research institutes is referred to as the "research base". It is dependent on education policies to deliver skilled researchers and on public funding to enable a core mass of research to be performed and infrastructure to be maintained.

Table 2. The numbers of publications, citations, and citations per paper (2000-2010), increase in each of these measures from 2000-2004 to 2006-2010, and overall rank for citation/paper (% of UK total in parentheses)[35].

	England	Scotland	Wales	Northern Ireland
Papers (000s) (%UK total)	679 (82%)	106 (13%)	36 (4.3%)	17 (2.1%)
% increase in papers	7.7	6.8	13.2	7.4
Citations (%UK total)	9,979 (82%)	1,622 (13%)	435 (3.6%)	202 (1.6%)
%increase in citations	42	41	59	58
Citation/paper	14.7	15.3	12.2	11.6
%increase citation/paper	32	32	41	47
Rank for citation/paper	6	5	16	19

Table 2 shows measures of productivity of the research base, including the number of publications and citations referring to those publications. Citations per paper can indicate impact and quality of the research.

Scotland performs very well on research productivity and impact. It has high impact in agriculture, biological sciences, physics and space science, but less strong in chemistry, social sciences, geosciences, and engineering[36].

Over all nations, Wales ranks 16th for citation rate per paper, and its productivity is about where it should be, or just below, in terms of UK population share. Its performance is increasing on both these measures. It has high impact in plant and animal science, does well in computer sciences, and highly productive in social sciences, psychology and psychiatry[37].

Northern Ireland also has a large range in its productivity and impact across disciplines; it has high impact in chemistry and geoscience, but weak in mathematics. While coming from a relatively low base of paper publication in 2000-04, it increased its publication rate by 7% and its citation rate per paper by an impressive 47%, by 2006-10[38].

DEVOLVED FUNDING: THE BLOCK GRANT

■ **The research base can leverage public investment into it by drawing in skills from overseas and funds from other sources.**
■ **Scotland needs to keep up its strong investment to maintain its success in winning external funding.**
■ **Wales and Northern Ireland do not secure their proportionate share of competitive funding and must invest more and develop critical mass in order to do so. Northern Ireland especially needs to build up research mass through collaboration including with overseas researchers and businesses.**

Public funding for the research base is delivered by a dual support system of: (i) a block grant given by each nation and (ii) competitively awarded grants from the UK-wide Research Councils. Additional public funds can be won from other sources. Insufficient core funding for a solid base of infrastructure and skills makes it hard to win competitive funding. Thus even a relatively small disadvantage in devolved public-funding can create a much larger disadvantage in total research funds.

The block grants that universities receive for research depend on a number of factors - some of this funding is directed towards knowledge transfer but most is quality related (QR) funding, allocated on the basis of prior performance. The key data for the QR distribution are the size of research groups and the quality of work as judged by the Research Assessment Exercise (RAE) conducted jointly across the UK. The RAE is to be replaced by the Research Excellence Framework, which takes into account the impact as well as the quality of research. The RAE ranks research on the basis of its originality, significance and rigour as unclassfied or one of:

4* - world-leading;
3* - internationally excellent;
2* - internationally recognised;
1* - nationally recognised.

The 2008 RAE classified 18% of research submitted from England as world-leading, compared with 15% for Scotland, and 14% for Wales[39]. Half of the assessed research in Northern Ireland was 3* or 4* and both universities improved their performance from the RAE 2001[40]. The amount and distribution of QR money is determined within each nation.

Comparable data, illustrated in Figure 4, includes support for charitable investment in research and for post-graduate research training. In 2009-10, England spent £1,515m in these areas , Scotland spent £240.5m, Wales spent £83.2m , and Northern Ireland spent £53.9m[41,42].

Competitive Funding of the Research Base. Key STEM Comparisons

RESEARCH COUNCIL FUNDING

The UK Government sets a Science Budget that funds the Research Councils for studentships, research projects, and national research facilities. Funding is allocated by peer review and is highly competitive. The October 2010 Spending Review froze the Science Budget in cash terms; with the impact of inflation, these funds will become yet more precious. In December, it was announced that the Research Councils' capital funding, used to maintain infrastructure and fund new builds, would be approximately halved[43].

The pattern of Research Council funding has been fairly stable. In 2009-10, Scotland received £348m, Wales, £78m and Northern Ireland, £24m[44]. Some of the geographic distribution reflects the location of public Research Institutes (with none in Northern Ireland.)

CHARITABLE FUNDING

■ **All political parties should commit to continue to cover the indirect costs of charitably-funded research to encourage this investment stream.**

In 2009-10, charities invested well over £1.2bn in research. The distribution of charity funding won by HE is shown in Figure 4[46]. All of the UK nations encourage charitable support for research by allocating funding to cover indirect costs, like new builds, libraries and staff training. Although some charities do make discrete grants in these areas, blanket support for them falls outside charitable objectives. If public money did not cover this element, then universities would lose out financially when they accept charitable funding. If one nation delivered less support, then it would probably draw in less charitable-funding, and if this support weakened across the UK, then it might affect how charities spend their funds[45]. The different nations have different ways of managing the charity support element, but they aim to be consistent with each other.

BUSINESS FUNDING

■ **Universities should work to understand business needs and ensure that they are well represented in their governance.**

Industry funds some research in universities: in 2008-09, Scotland received £66m (21% of UK total), Wales £13.7m (4.4%) and Northern Ireland, £3.4m (1.1%)[47]. Universities can also collaborate with industry for certain funds (e.g., from the Technology Strategy Board, see page 11). The extent to which universities can draw in private investment may reflect their access to business expertise. In 2007-08, 37% of governors of HE institutions in England had a commercial background, compared with 34% in Scotland, 31% in Wales, and 21% in Northern Ireland[47]. Better communication between academia and industry should also facilitate innovation.

EUROPEAN FUNDING

As of March 2010, the UK had attracted €1,834m or 14% of the total Framework Programme 7 budget: 75% of this went into education institutions, 20% to business, 3% to other public bodies and 1% to research organisations[48].

KEY COMPARISONS - Figure 4

Inspection of Figure 4 shows that Scotland invests well above its population share in HE teaching and in the research base. It has a quantifiably excellent research base (e.g., as measured by citation rates or top ranking universities), and secures a high rate of competitive funding from the UK Research Councils, research charities and the EU. This extra income more than covers the higher rate of public investment. Scotland's relative weakness is in business R&D. Scotland's current HE review considers reorganising the research base, but strategies should focus on areas with a stronger need for improvement, such as increasing industry R&D.

Wales invests in HE at a proportionate rate for its population (although it has a high rate of participation), with public research funding slightly lower than might be expected. Unfortunately, it struggles to win its share of competitive funding and it has a relatively low level of private R&D investment. Strategies to improve R&D investment and innovation in Wales aim to build collaborative partnerships to create critical mass, but should start by increasing public investment in teaching and R&D.

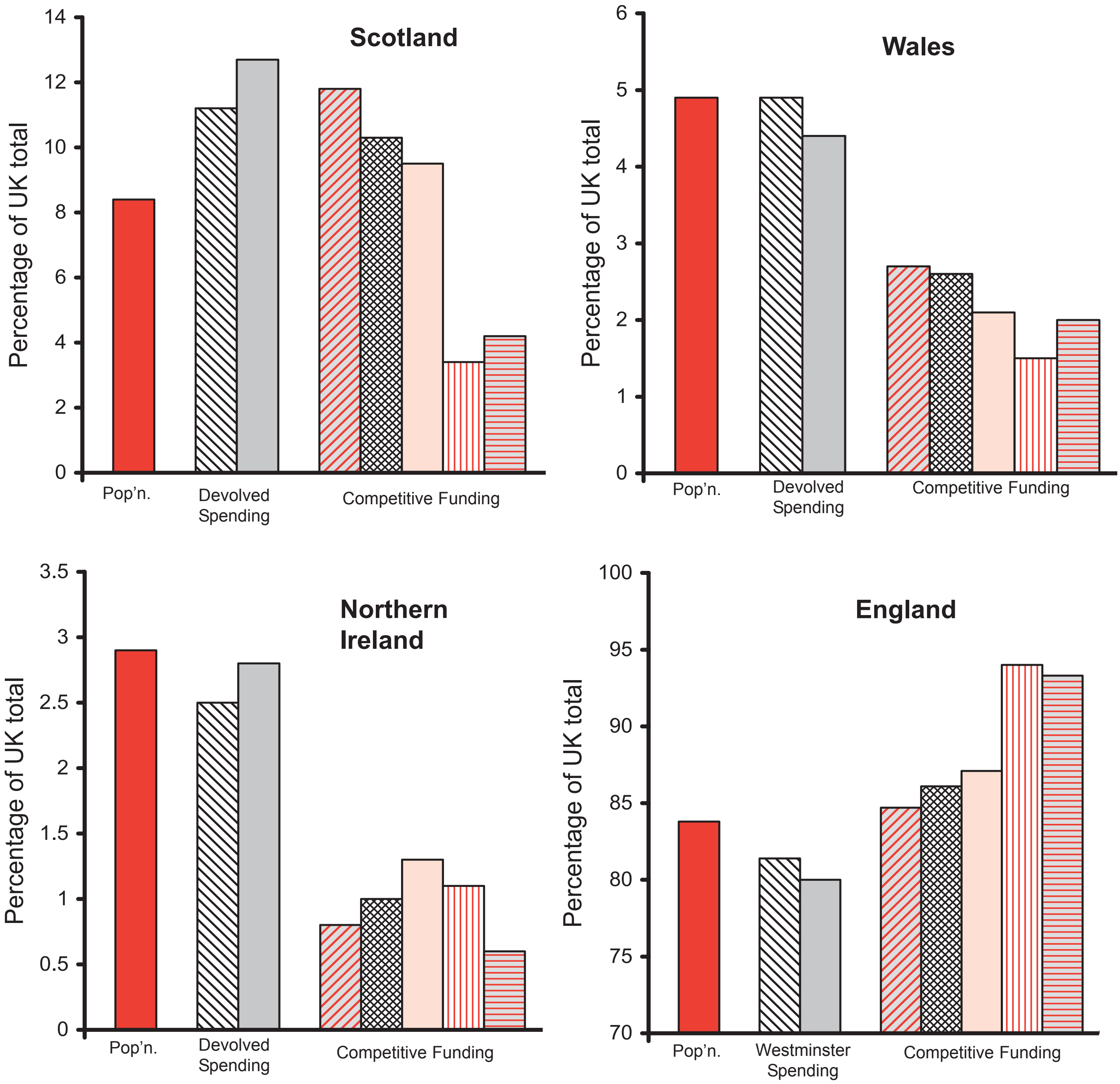
Northern Ireland invests in HE and research at a level slightly below that expected for its population. Its small and geographically isolated research base, combined with the funding shortfall, make it unsurprising that it wins only a small share of competitive research funding. It also has low levels of private investment in R&D, possibly reflecting its high number of smaller businesses. Northern Ireland's new STEM policy work needs to be accompanied by significant investment and the building of research partnerships, including with the Republic of Ireland. Recent plans to increase employer engagement with HE should help to identify and address skills gaps and might also bring in more private funding.

England invests in HE teaching and research at lower rates than might be expected for its population. However, it wins a large amount of competitive funding, possibly because it enables many research centres to get well above critical mass.

Key STEM Comparisons

Figure 4.
Percentage of the UK total for key STEM statistics for each of the UK nations. Population is presented first to provide a baseline, with other funding grouped as devolved spending, and competitive funding for R&D from public & private sources.[50]

- Population (2009)
- HE Teaching Grant (2010-11)
- Quality Related Research Grant (2009-10)
- Research Council Funding (2008-09)
- Competitive Funds from Charity to HE (2008-09)
- EU Framework 7 to HE and business (up to 2010)
- Business Enterprise R&D (2008)
- Technology Strategy Board (2007-11)



Industry & Innovation

■ Business investment in R&D is low in the UK compared to other countries, and this is particularly true of the devolved nations. Governments must actively and urgently improve this situation. Industry needs skilled graduates, a strong public research base, and a stable research environment to invest in.
■ Smaller nations struggle to match the pool of talent coming from FE and HE to local business needs. Governments may need to balance supply and demand for skills. They also have a role in facilitating communication between educators and employers, especially when there are many small businesses.

Industry investment in R&D is vital for nations to fully exploit the fruit of their research, yielding beneficial products, services, employment and manufacturing. The gains that private companies reap from their investment in R&D are estimated to be about half of the gains that spillover to other private companies and wider society from that R&D[51]. Direct support, regulation and incentives to enhance private R&D investment are thus well justified.

Overall, the UK has a low level of Business and Enterprise investment in R&D (BERD; see Figure 5). The UK Government has argued that this is, in part, because of the profile of the economy. More than four fifths of UK industry sales occur in sectors that are low or very low investors in R&D, like oil and gas. Obviously the same argument can be applied to the devolved nations. But we also know that public investment encourages private investment and governments have a very important role to play in building up public spending, making sure that the right skills are available and creating a facilitatory policy environment for innovation[52]. New attempts to rebalance the economy prompted by the recent financial crisis should actively encourage a broader range of industries and investment in R&D.

Figure 5. BERD as a percentage of GDP (2008)[53]

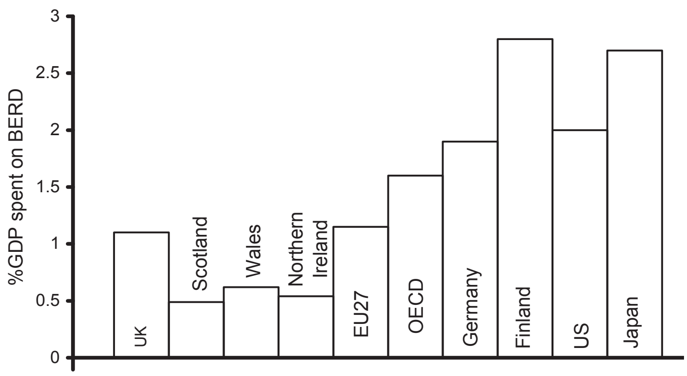


Table 3 shows the pattern of BERD and industry employment across the UK in 2008 and European funding of commercial work. Businesses in the devolved nations receive a share of European funding that corresponds with their level of BERD.

Table 3. People employed in industry, BERD, and BERD per head, for 2008, and Financial Contribution from Framework Programme 7 until March 2010 (€m), shown by UK nation[54].

	England	Scotland	Wales	Northern Ireland
People employed in industry R&D	139,000	7,000	3,000	4,000
BERD (£m)	14,935	547	243	171
BERD (£/per head)	290	106	81	96
European funding €m (%UK total)	€340.8 (93.8%)	€13.2 (3.6%)	€4.5 (1.2%)	€4.7 (1.3%)

In Scotland, BERD totals £547m and is strongest in chemicals (£160m), electrical machinery (£109m) and services (£92m), with other spending in mechanical engineering (£19m) and extractive industries (£34m). European economic analyses identified Eastern Scotland and the Highlands as specialised in agriculture, North Eastern Scotland to be specialised in industry and agriculture and South Western Scotland to be balanced across services, industry and agriculture[55]. Scottish industries fund a relatively high proportion of their R&D (£66m) in universities[56], perhaps reflecting the strength of the research base. Such outsourcing is a model which many sectors are moving to and it is likely to become an increasingly important source of university income.

BERD in Wales totals £243m and is spread across the chemicals (£38m), mechanical engineering (£23m), electrical machinery (£50m) and services (£47m) sectors. European economic analyses identified Wales as specialised in agriculture.

BERD spending in Northern Ireland totals £171m, mostly on chemicals (£16m), electrical machinery (£22m), services (77m), and mechanical engineering (£21m). European economic analyses identified Northern Ireland to be specialised in agriculture. The recent Northern Ireland STEM consultation emphasised the lead that business has to take in building up STEM skills. This sort of work will be vital to growing high-tech industry in Northern Ireland, but should not be seen as a replacement for public involvement, investment and leadership.

FACILITATING INNOVATION

■ **The devolved Governments must continue to invest in knowledge transfer activities to drive innovation and to develop and implement strategies to enhance their ability to win UK-wide research and innovation funding.**

The 2006 European Innovation Scoreboard broke down performance on 25 innovation indicators by region. The performance of England's nine regions ranked 12th-78th, Wales ranked 80th, with Scotland at 89th, and Northern Ireland at 113th. Clearly, there is plenty of scope for all of the UK nations to improve.

Each UK nation targets funding to support knowledge exchange and innovation. Scottish universities receive a lump sum to support knowledge exchange and additional funding based on prior performance. A further fund of £3.8 million delivers project funding in key industry sectors identified in the Scottish Government's economic strategy[57].

Much recent policy development in Wales has aimed to increase BERD and help economic renewal, with a recent publication stating that *"Wales must move towards a more R&D intensive and knowledge-based economy where the right conditions exist for innovation to flourish."*[58] The goals of this work are to build academic capacity in key business sectors, encourage collaboration to win more research contracts, and promote the importance of BERD. Business support in Wales will be more targeted and educators have been asked to ensure that skills needs will be met. This cohesive approach to research, and the skills it depends upon, with the goal of building high-tech growth lays important ground for Wales' future and must come with longterm financial backing.

In Northern Ireland, knowledge transfer is funded through a HE innovation fund[59]. Activities must take account of departmental strategic priorities and reflect the Northern Ireland National Innovation Strategy. There is also an HE and FE collaboration fund to coordinate the knowledge transfer needs of businesses. The Northern Ireland Executive set up a Science Industry Panel (MATRIX) in 2007 to develop policies to promote an innovation-based economy. It identified five key STEM sectors with recommendations for maximising the commercialisation opportunities within them. It also recommended the now ongoing establishment of "Industry led Innovation Communities" involving business and academia[60]. The current review of HE aims to increase knowledge exchange.

The Technology Strategy Board promotes innovation through collaborative projects and knowledge transfer activities, linking business, universities and government in strategic areas. It is funded by the UK government and industry. Table 4 and Figure 4 show that the devolved nations receive much less funding than their share by population, with Scotland faring better than Wales, and Northern Ireland, less so. The strong Scottish research base does less well than might be expected, possibly because of limited industry partners.

Table 4. Distribution of funding from Technology Strategy Board from 2007 to current[61].

	England	Scotland	Wales	Northern Ireland
Grants to HE	£248m	£14.4m	£14.2m	£1m
Grants to industry	£778m	£31.5m	£7.1m	£6m
Total	£1,027m	£45.9m	£21.3m	£7m

POLICIES TO PROMOTE INNOVATION

■ **Governments should do more to benefit businesses through their public-sector procurement and investment strategies.**
■ **Research in industry and the research base should be facilitated through supportive policy-making, such as by streamlining research approval times with the NHS.**

The devolved nations can directly support businesses through public-sector procurement, worth £220bn across the UK. Governments can also help develop venture capital funds to support innovative start-ups[62].

Other areas of public policy can promote innovation throughout the research base and in business. The National Health Service has great potential to facilitate research. Recent steps have aimed to improve the NHS as an academic and business partner, yet a recent report identified unnecessary bureaucracy, delays, and complexity. For instance, it can take nearly two years to go from funding a research proposal to recruiting the first patient into clinical trials[63].

Scotland's strength in health research is supported by a new initiative coordinated across the nation. NHS Research Scotland, which ensures fast approval times for research. This approach is being cited as the benchmark for other parts of the UK[64]. In addition, a new electronic record system is streamlining researcher access to patient records. To maximise the potential of medical research, regulation needs to be coordinated across the UK.

Core Recommendations

The parties will make their own commitments to science and engineering - but the arguments are so strong that there should be agreement on a core set of policies across the parties and nations. Such consistency should also deliver some stability in policy-making, providing a more attractive environment for scientists, engineers and investors.

- **All governments should prioritise science and engineering with a long-term strategy and the appointment of a dedicated Minister to oversee it.**
- **Governments need to invest in research for policy-making and have a Chief Scientific Advisor to lead a robust system of science and engineering advice.**
- **Policies and actions affecting and affected by science and engineering should be scrutinised by a specified committee.**
- **All school students should have access to a rich science and mathematics curriculum taught by teachers with the relevant expertise.**
- **Reforms to higher education must not jeopardise our research and economic future by deterring students from taking STEM subjects.**
- **Governments must invest money and policy-development into the research base to be nationally and internally competitive in quality and the ability to win external research funds.**
- **Governments must create much more attractive policy environments, alongside an excellent skills and research base, to secure more business investment in research and development.**

For more information, please visit the CaSE website (or contact the CaSE office) where you can read the letters CaSE wrote to the leaders of the political parties running for election in 2011, the responses that we have received, and other relevant documents:

Background paper
- **Science, Engineering & the Devolved Elections, 2011.**

Targeted Recommendations
- **Voting for Science and Engineering in Scotland.**
- **Voting for Science and Engineering in Wales.**
- **Voting for Science and Engineering in Northern Ireland.**

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