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Shaping Up For Innovation: Are we delivering the right skills for the 2020 knowledge economy?

A Knowledge Economy Programme Report

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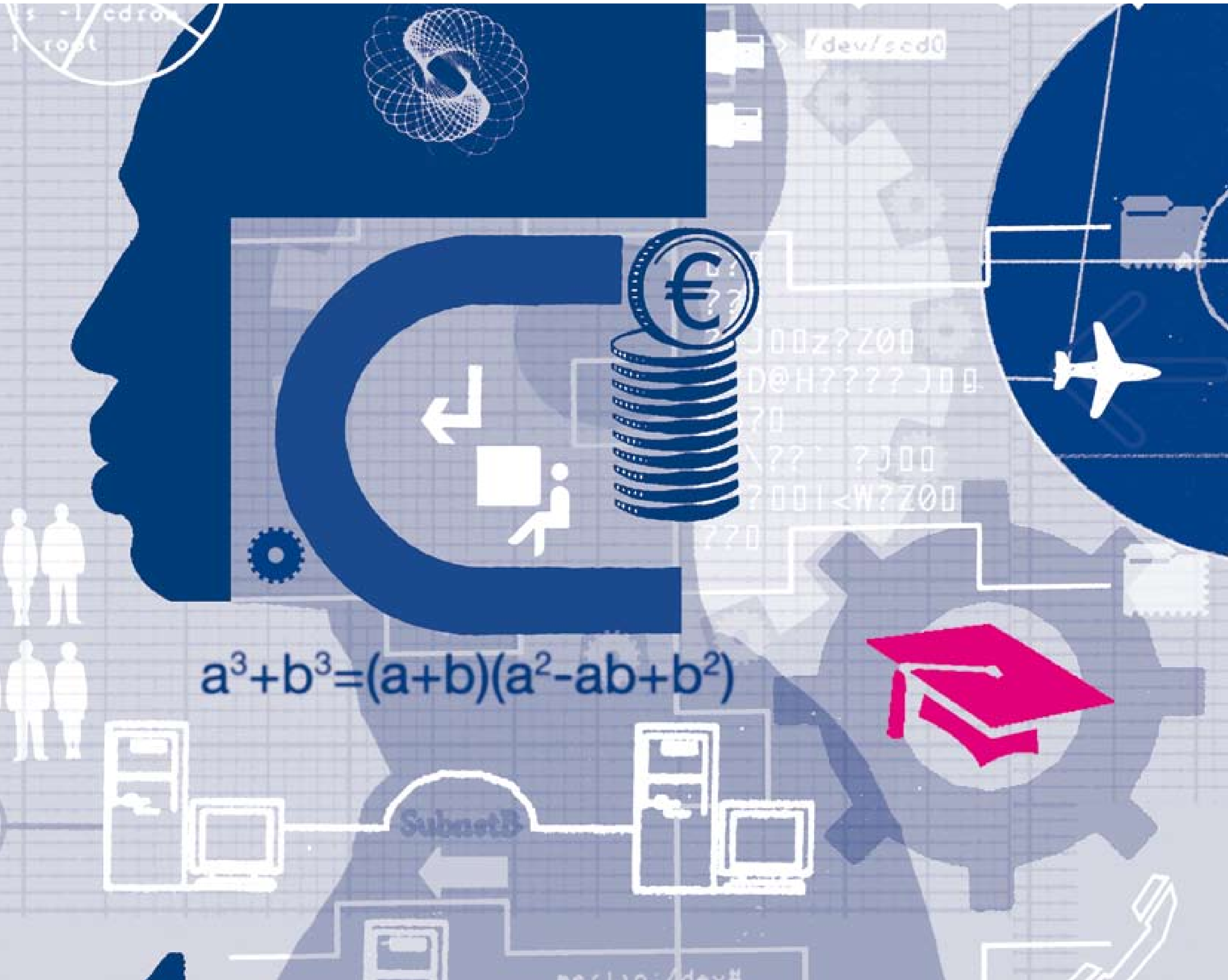

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Executive summary

This autumn the government will announce how heavily spending cuts will fall on each area of government support. This paper sets out clear evidence on why these savings must be made in ways which can sustain the recent expansion in higher education provision. The analysis focuses on what the 2020 knowledge economy needs from our higher education system and how scarce public funds can best be focused to deliver this.

Despite fears that higher education has expanded too rapidly in recent years, the paper demonstrates how the shift towards a knowledge intensive economy has increased the demand for highly skilled graduates in line with this increased supply. Given this evidence we can expect that the speed and strength of the UK's economic recovery will depend to a great extent on the developing and sustaining the skills of our workforce. Although graduate unemployment continues to create headlines, there is still a strong case for sustaining the recent expansion in higher education provision. Policy must focus on a broader understanding of the high-level skills that drive innovation and reform the funding of the sector so that it can deliver these in the context of public spending cuts.

The importance of graduates to the 2020 knowledge economy

Progress towards the knowledge economy is transforming the world of work. Knowledge intensive work depends on the use of 'tacit' knowledge that resides in people's minds in the form of expertise or experience, rather than being written down in manuals, guides lists and procedures. Productivity here depends on deriving value from intangible assets such as research and development, IT, branding and advertising, and organisational development. These activities depend heavily on the types of high-level skills often gained at universities – at its core, a degree reflects an ability to use tacit knowledge to assimilate, interpret and use a range of specialist information.

Much has been made in recent years of the idea that the expansion of higher education has been too fast, and that too many graduates are now entering 'non-graduate' jobs. However, evidence shows that graduates remain in strong demand in OECD member countries and a greater proportion are entering 'graduate' jobs in the UK. Furthermore, trends in the wage premium received by graduates certainly do not suggest that the UK has a long term over supply of graduates and there is little support for the argument that graduates are crowding out other occupations.

There also appears to be a concern that the recession has upset this balance within the labour market. Young people have certainly been disproportionately affected by the recession, and many graduates are struggling in the current labour market. However, the response of the economy to the recession has reinforced the need for a highly skilled workforce. As with previous recessions, the vast majority of jobs that were lost were in manual, unskilled and elementary occupations. It seems that rather than reducing the need for high-level skills, the recession is accelerating the long term process of structural change towards the knowledge economy.

The evidence presented here tells a clear story. Structural change in the economy is creating a strong and increasing need for more highly educated workers – a need to which the higher education sector had been responding well. While some topline indicators suggest this expansion has overshot labour market demand, a more considered analysis suggests that the need for highly skilled graduates has increased as a result of the recession. Young people and those who have lost their jobs have been quick to recognise the demand for skills in the economy and hence demand for university places has increased significantly in the past two years – demand that universities and higher education colleges have been unable to meet. Given this evidence, it is essential that this autumn's Comprehensive Spending Review provides the sector with the resources to sustain its excellence and continue providing the high skill hungry economy with the talent that it requires.

Delivering the right graduates for the knowledge economy

Successfully delivering the skills for the 2020 knowledge economy will depend not only on producing the right number of graduates, but also on the system supplying graduates with the right knowledge, competencies, and qualities. While this will in part depends on delivering graduates with the right professional skills (enough trained engineers, statisticians and lawyers for example), such a narrow focus would ignore the important feedback impacts of education. Education not only meets demand from the economy, but it also drives the economy by supporting innovation.

To date, public policy has focused on two responses to the vexed question of influencing the balance of subjects studied at university. The first has been the focus on 'economically valuable' degrees. However, developing policy actions from this has proved challenging. The other key area of attention has been STEM (Science, Technology, Engineering and Maths) subjects. These have a special role within innovation and they are particularly important to the processes of scaling up new knowledge to create products and services which are of value.

In response to pressure from perceived skills shortages, pressure from employers and the very low numbers of researchers within the labour force, the government has sought to boost the numbers of students studying STEM subjects. However, this numerically focused response reflects only a partial understanding of the skills issues and challenges that must be addressed.

The low numbers of researchers and the skills shortages in STEM subjects is puzzling when the proportion of the UK's graduates entering STEM courses is among the highest in the OECD, and the proportion of science graduates among 25-34 year olds in employment is also high by comparison with other developed economies. Also, significant effort has been made to increase uptake and attainment in STEM subjects. This has been increasing at all levels without alleviating perceived shortages.

Our analysis suggests that the key issues relate to the operation of demand for STEM graduates rather than the volume of their supply. Most importantly, it seems that either higher education institutions are not producing the quality of graduates demanded by employers or graduates do not perceive STEM careers to be attractive. For every two STEM graduates in the labour market, only one is in a STEM related occupation. This would be acceptable if those STEM graduates outside STEM professions were valued more highly than non-STEM graduates, but the available evidence suggests that they are not. Rectifying this situation will demand a focus on initiatives which can encourage STEM graduates into industry, action to strengthen the quality of STEM degrees and to boost industry and entrepreneurialism skills for graduates.

In addition, our analysis suggests limitations to the prioritisation of STEM skills as a proxy for the skills needed for innovation. STEM skills are important for product innovation and downstream processes, particularly in manufacturing industries. However, STEM skills alone are not enough, particularly in the case of process innovations. As we explain, innovation requires getting value out of invention. This requires important inputs from the creative industries such as advertising and design as well as good management, organisational expertise and outstanding leadership. If we are to have an innovation led skills system then we need to understand and recognise the skills that drive innovation.

The government should replace the current system of bids for an additional 10,000 STEM and other vulnerable subject places with a broader competition for additional places in courses that specialise in boosting innovation. It might be sensible to leave it to universities to innovate and to present bids defining what this means and how they can boost the innovative potential of their students, particularly improving interdisciplinary working between STEM subjects and creative subjects.

Finally, we need to engage employers as active participants in the skills system rather than leave them to be passive recipients of the outputs of higher education. Employers are vociferous in their opinions about lack of graduates in certain subjects and the 'employability' skills of others, but, in the main, are reluctant to contribute time or resources to higher education institutions that would improve outcomes for both students and employers alike.

Funding higher education

Despite its decreasing dependence on public resources, maintaining excellence and expanding higher education has required a significant investment from the government. Sustaining the expansion of provision at the rate seen in recent years and intervening to influence the mix of subjects studied at university would both be costly activities. These objectives contrast with the current financial situation facing the sector which has been targeted for cuts already by the government with further significant reductions likely.

Government spending on higher education in the UK is not out of line with most developed nations. Currently UK spending on higher education as a percentage of GDP is comparable to the EU average, but below the OECD figure. Spend per head on tertiary education in the UK is however above the OECD average. This spend per student is however dwarfed by the American figure. While UK institutions receive a higher proportion of their funding from private sources than their main EU competitors, we lag behind many of the larger OECD economies on this measure.

This strong growth in funding is unlikely to be sustained under current arrangements. Following the Chancellor's emergency budget in June, we can expect 25 per cent cuts across all non-ring fenced budgets in real terms over the course of the parliament. Commitments to protect spending on defence and school level education are likely to necessitate deeper cuts in budgets such as higher education funding with figures as high as 35 per cent being mentioned in the sector.[1]

Given this context, the final section of the report considers how well the three main options presented for reform would perform in the context of three overriding priorities for the higher education sector:

- Supporting the continued expansion of the higher education sector to serve the knowledge economy, while also maintaining teaching standards;

[1] 'The heat is on: official hints that cuts could rise to 35%', *Times Higher Education*, 12 August 2010. http://www.timeshighereducation.co.uk/story.asp?storycode=412956

- Maintaining access to higher education on the grounds of student ability; and
- Promoting competition within the sector.

Option 1 – an efficiency agenda should be viewed as the base case or minimum change scenario. This scenario could see per student funding levels return to the levels seen in the mid 1990s. With caps on student contributions fixed, success would depend on delivering higher education more cost effectively. Such an approach would certainly not provide any potential to expand provision and it is far from clear whether savings on this scale could be achieved without compromising teaching quality. The approach would also fix in the long term the income which universities can receive from students. This could impact negatively on competition as universities focus on competing in other areas where additional revenues can be derived.

Option 2 – increased student contributions would certainly allow for the continued expansion of higher education provision, without compromising teaching standards. Implemented in a way which promoted differential pricing of higher education, this could represent a particular boost for competition within the sector. It would also increase incentives to improve information about course content, quality and outcomes to justify the price and therefore improve student choice. There are concerns however that these reforms could hurt participation in higher education of students from lower socioeconomic backgrounds, particularly since implementation would be likely to necessitate reform of the student loans system.

Option 3 – a graduate tax offers the opportunity to pay for higher education based on the earnings of graduates. The conceptual strength is that the graduates who earn the highest salaries will contribute the most towards their education. This system would be unlikely to deter disadvantaged groups from accessing higher education, and if implemented in a decentralised form could drive competition between institutions based on how well they train their students. Unfortunately there are many technical obstacles. The most important of these relate to timing (how long it would take for tax receipts to replace current revenue sources), migration and international students (how a commitment to this tax could be ported across national borders).

The UK must retain its position as a world leader in higher education research and teaching but, in its expanded form, must continue to produce positive outcomes for students and employers alike. From this analysis it is clear that there is no perfect solution for reform. Pursuing a pure efficiency agenda is unlikely to allow the system to deliver sufficient numbers of graduates, with adequate quality training for the 2020 knowledge economy. Given the technical limitations of a graduate tax it is unlikely to be of a solution to current funding challenges, although it seems sensible to maintain the resolution of these issues as an aspiration for the future. It is clear therefore that there is only one viable option for reform of higher education funding – to increase tuition fees, and to reform the student loans system.

The road to recovery

In the wake of the deepest recession since the 1930s there is an urgent need to create conditions favourable for economic recovery and sustainable long term growth. Just as the economic recoveries of the 1980s and 1990s were led by the UK's knowledge intensive industries[2], the recovery from the latest recession will be dependent on the ability of our knowledge industries to raise productivity and create jobs through innovation, enterprise and creativity.[3]

This route to recovery will be reliant on the skills of our workforce, which are a key driver of productivity[4] and our main source of advantage in a global economy. More specifically, the knowledge economy requires a strong backbone of science, engineering and technology skills, world-class creative skills, and management and leadership that enables collaboration and innovation.

In response to the demands of globalisation and technology, the past thirty years has seen dramatic transformation in the educational profile of the workforce, significant occupational changes and a major shift in industrial structure.

Evidence suggests that these trends will continue. According to the UKCES report *Working Futures* released prior to the recession, there would be an estimated net growth of about 1.9 million jobs between 2007 and 2017 of which 1.1 million jobs will be in private knowledge intensive industries.[5,6] The recession may affect the number of jobs that are likely to be created[7] during this period, but the jobs created will still by-and-large be in private knowledge intensive industries, Indeed, the likely stagnation contraction in public sector employment means that jobs in private knowledge intensive industries will be the UK's main chance for recovery.[8]

The UK's economic future is thus dependent on its ability to continue its investment in and development of its skills base. As the UKCES's report *Skills for Jobs: Today and Tomorrow* concludes:

> *The development of high level skills as a more global commodity will continue to change the competitive paradigm of both developed and developing economies in sectors which export globally. The competitive advantage of developed economies will increasingly be*

[2] Brinkley, I. (2009), *Recession and Recovery*, The Work Foundation
[3] Brinkley, I. (2010), *Creativity, Innovation and Enterprise*, The Work Foundation
[4] *Skills for Growth*, BIS, (2009). Porter and Campbell eds (2005), *Skills and Economic Performance,* SSDA
[5] Banking and insurance, professional services, computing and related services, other business related services
[6] UKCES (2008), *Working Futures*
[7] UKCES will be providing updated projections in its 2011 Skills Audit
[8] See, *inter alia*, Brinkley, I., 2010, *op cit.*

> *increasingly be derived from the capacity to stimulate innovation and productivity growth and foster organisational agility, rather than from a simple price/quality trade-off. The policy implications arising from the pressures of globalisation are for a need to promote innovation, creativity and entrepreneurship, including a greater emphasis on lifelong learning. Achieving global competiveness is likely to require significant investment so governments may need to priorities funding, given likely cost constraints on policies to support innovation.*[9]

Despite the immediacy of the problem and the negative consequences of delayed action, our skills system and the debates that surround it progress at glacial speed, if at all. The 2003 skills White Paper identified almost exactly the same issues as the 2009 skills White Paper and the detailed analysis by the UK Commission for Employment and Skills in *Ambition 2020*. Lorna Unwin, Professor of Vocational Education at the Institute for Education, goes even further, noting the 'acute sense of *déjà-vu*' that 'permeates analyses of the labour market and skills' policies over the past 30 years'.[10] The issues that attract the most attention appear to be the most intractable, while definitions and consensus around ostensibly key concepts such as 'economically valuable skills' remain vague. The analytical focus on qualifications, occupations and sectors has also led to tunnel-vision about issues related to skills and the changing nature of work.

Getting this right is vital. While a high-skill, high-value added economy is the only option to remaining a prosperous nation in a global economy, post-recession austerity will require new choices and new approaches to achieve this future.

A call for action

Amongst the noise of the recession, and in the face of all evidence, higher education in the UK has become a cost to bear rather than an investment in our future and it is in danger of being perceived solely as a vocational mechanism rather than a route to self-fulfilment, active citizenship and personal growth. The new Liberal Conservative government's higher education plans are not yet in sight. The first coalition agreement of priorities refers only to Lord Browne's review on higher education funding and school reform to ensure greater choice. The subsequent *Programme for Government* provided few other clues other than a promise to create more

9 UKCES (2010), *Skills for Jobs: Today and Tomorrow – Evidence Report*
10 Unwin (2010), 'Learning and working from the MSC to New Labour: Young people, skills and employment, NIER, No. 212

places – among its first actions was cutting the planned increase in university places by 10,000 and making further cuts to university budgets.[11,12]

Cuts in higher education funding were announced by the previous administration totalling £915m. The Department for Business Innovation and Skills has been asked to make cuts of £836m this financial year and has passed on £200m of these onto university teaching. There has been no indication that higher education funding will be protected in this autumn's spending review which is expected to demand cuts of 25 per cent in non-ring fenced Departmental budgets in real terms over the course of the parliament.

While the current preoccupation with public sector cuts and taxes dominates the agenda, there is scant attention given to our economic future other than a firm belief that 'supply-side' policies will result in a blossoming of the private sector. By some measures, the UK is failing to keep up with its main competitors in building an innovation economy and the effects of disinvestment may be markedly apparent by 2020. In 1997, the year New Labour came into government, the UK made the fifth most patent applications in the world, by 2008 it had fallen to seventh.

To improve productivity, the UK must have a strong backbone of science, technology, engineering and mathematics (STEM) graduates working alongside other creative and innovative professionals in high performance workplaces. Between 2001/02 and 2007/08 universities saw an 18 per cent increase in applicants. However applications to study STEM subjects only increased by eight per cent – Engineering and Technology only five per cent. While STEM graduates are on the increase, the demands of the UK's knowledge economy are outstripping supply. It was projected that there would be an increase of 9.4 per cent in STEM related professions between 2007 and 2017. While this pre-recession forecast could potentially be reduced,[13] it is unlikely that it will do so significantly. Moreover, with one-half of STEM graduates going into non-STEM professions, the UK would require a 19 per cent increase in graduates to meet this demand – any difference needs to be made up from elsewhere.

However, there are reasons to be optimistic. As this paper highlights, there is a strong skills base that can, given the right conditions, institutions and frameworks, take advantage of the opportunities presented by likely growth in low carbon industries, high tech manufacturing, health care and the creative industries. This will be dependent upon a continued focus on

[11] Press Notice 4/10 Government announces £6.2bn of savings in 2010-11. http://www.hm-treasury.gov.uk/press_04_10.htm
[12] *The Coalition: our programme for government* (2010), HM Government
[13] A new forecast is due out from UKCES this year

fostering the conditions for innovation across the economy, within organisations, and within individuals.

These skills are essential to driving the innovation eco-system and innovation is at the heart of the UK's future knowledge economy. It is vital therefore that this autumn's Comprehensive Spending Review carefully considers how public resources can be best used to support the delivery of these skills.

This paper looks to offer an evidence base to respond to this question. It presents evidence relating to the delivery of the right number of graduates and support for the training of graduates with the right skills. There are clear conclusions on the first of these questions, however, our analysis highlights difficulties associated with identifying the skills which will promote innovation in the 2020 knowledge economy. The paper concludes with a look at future options for the funding of higher education.

1. Delivering enough graduates for the 2020 knowledge economy

This section reviews existing evidence on the demand for high level skills in the UK economy. It focuses on the implications of continued progress towards the knowledge economy, and the impact of the recent recession. The analysis also considers the current public policy context and stresses the need to maintain the recent expansion in the UK higher education.

1.1 Skills for the 2020 knowledge economy

The knowledge economy is a story of how new general purpose technologies have combined with intellectual and knowledge assets to transform our economy.[14]

The expansion of higher education has happened in parallel with a remarkable shift in the UK's industrial structure towards knowledge intensive industries and has been a key ingredient in retaining competitiveness in a global economy. Given some of the misconceptions[15] that still exist about the knowledge economy it is worth outlining its core components.[16] The shift is based on three key supply-side trends:

- **Increasing investment in intangibles** – There has been a fundamental shift in investment priorities towards the creation and exploitation of knowledge and other intangible assets such as research and development, IT, branding and advertising, and organisational development.[17]
- **Expansion of higher education** – Between 1970 and 2005 the proportion of the population with a graduate level education or above increased from 2 per cent to 20 per cent.
- **Technological development** – The rapid development of general purpose technologies (GPTs) such as the personal computer and the internet have had transformational impacts on the flow of global capital, the processing and communication of information and the development of organisational systems and processes.

This transition has been accompanied by important demand-side drivers:

- **Increasingly sophisticated consumer and business demand** – high value added knowledge intensive goods and services. Consumer services are increasingly personalised and the demand for experiential services has increased rapidly.

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[14] Brinkley, I. (2008), *The Knowledge Economy: How Knowledge is Reshaping the Economic Life of Nations*, The Work Foundation

[15] See, *inter alia,* UKCES, (2009) Skills for Jobs. UKCES, as outlined in *Skills for Jobs*, largely (mis)understands the knowledge economy as a transition to a service economy. See Skills for Jobs, p. 101

[16] For a more detailed overview of the knowledge economy see Ian Brinkley (2008), *The Knowledge Economy: How Knowledge is Reshaping the Economic Life of Nations*, The Work Foundation as well as related publications from the Knowledge Economy Programme available at www.theworkfoundation.com

[17] Brinkley, I. (2008), *The Knowledge Economy: How Knowledge is Reshaping the Economic Life of Nations*, The Work Foundation.

- **Collective consumption** – There has been increasing demand for publicly funded services in all OECD economies, particularly health and education.
- **Globalisation** has been a supply and demand side driver widening access to markets and speeding up the process on both sides.

Most developed nations and many developing nations aspire to create the conditions that ensure the transition towards a competitive knowledge economy. The primary aim of the European Union's Lisbon Strategy for Jobs and Growth was to make the European Union the most competitive knowledge based economy in the world.[18] Its successor strategy, EUROPE 2020, contains similar aspirations and objectives.[19]

A knowledge economy is not only a European and national aspiration. Cities and regions are becoming increasingly sophisticated in their understanding of how local business, labour markets and public institutions interact to drive knowledge intensive industrial growth. Cities that orientate themselves towards this goal and invest in the conditions that are favourable to this end have been more resilient to recession and more likely to enjoy a smoother and speedier return to growth.[20] The Work Foundation calls cities that match these criteria an Ideopolis – a sustainable knowledge city that drives growth in the wider city region.[21]

A highly skilled workforce is a pre-requisite for a knowledge economy and the expansion of higher education is necessary for the continued transition towards a knowledge economy.

Box 1: Knowledge intensive work and graduates

The Work Foundation's Knowledge Worker Survey studied the knowledge intensity of the activities of individual workers. This research highlights the central role of graduates within the knowledge economy workforce.

Knowledge intensive work can be most easily thought of as activities which depend on the use of high level 'tacit' knowledge that resides in people's minds in the form of expertise and/ or experience, rather than being written down (or codified) in manuals, guides, lists and procedures. Examples of knowledge intensive tasks include bespoke statistical analysis, system maintenance, graphic design or software design.

Cont.

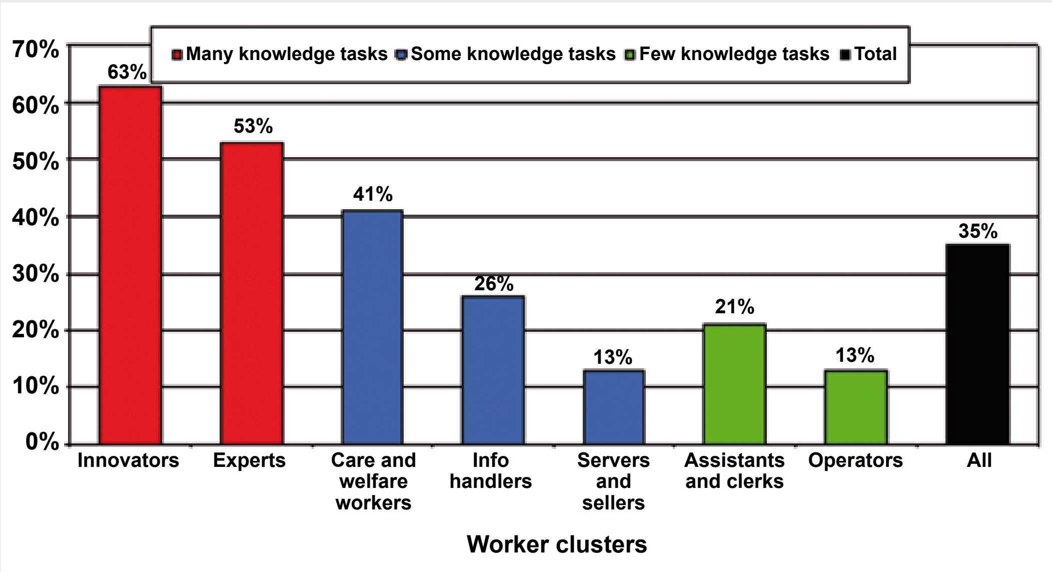
[18] Lisbon Strategy for Jobs and Growth (2000), http://europa.eu/legislation_summaries/employment_and_social_policy/community_employment_policies/c10241_en.htm
[19] EUROPE 2020 (2010) http://ec.europa.eu/eu2020/index_en.htm
[20] Lee (2010) *No City Left Behind*
[21] The Work Foundation (2008) *How can cities thrive in the changing economy?*

Cont.

Unlike previous research, which has looked to map knowledge workers based on their occupation or education attainment, the survey looked at the nature of individual tasks carried out by respondents – people were asked what they actually did at work and how often the performed certain tasks. Knowledge intensity was assessed based on the cognitive complexity of each.

As illustrated below, the composition of the two most knowledge intensive groups of individuals were found to be dominated by graduates. This highlights the importance of graduate skills for the knowledge economy.

Share of graduates by knowledge intensity of the job



Source: Brinkley, Fauth, Mahdon, Therodoropoulou (2009) Knowledge Workers and Knowledge Work

Box 2: Higher education, high-level skills and knowledge intensive work

Listed below are the definitions from the National Qualifications Framework for skill levels four and above. These represent the skills which higher education aims to impart, and the skills which are signalled by graduate qualifications.

Traditionally universities have been understood as equipping individuals for the world of work. They offer intellectual challenges, the pursuit of which leads to personal fulfilment and development. While qualifications are studied for and attained in specific subject areas, the notion of the high-level skills gained at university is a much broader concept.

They reflect an ability to use tacit knowledge to assimilate, interpret and use a range of specialist information to achieve desired objectives. For most graduates, the detail of the subjects learnt at university is of little practical relevance to their future professions – very few of last year's 25,000[22] historical and philosophical studies graduates will now be using the detailed information learned in these subjects in their work. However, it is the knowledge of how to to process, synthesise and communicate information developed in the pursuit of these details which is of future value.

In his recent speech on the future of higher education the Business Innovation and Skills Secretary Vincent Cable captured this notion:

> *'the greatest gifts bestowed by universities – learning how to learn, learning how to think; intellectual curiosity; the challenge and excitement of new ideas'*

These capacities are central to the notion of knowledge based work set out in Box 1 above – they relate to the ability to develop and to use knowledge. These skills are therefore central to the continued development of the knowledge economy.

Level 4 qualifications recognise specialist learning and involve detailed analysis of a high level of information and knowledge in an area of work or study.

Cont.

[22] HESA online statistics
http://www.hesa.ac.uk/index.php?option=com_datatables&Itemid=121&task=show_category&catdex=3

Cont.

Level 5 qualifications recognise the ability to increase the depth of knowledge and understanding of an area of work or study, to enable the formulation of solutions and responses to complex problems and situations.

Level 6 qualifications recognise a specialist high-level knowledge of an area of work or study to enable the use of an individual's own ideas and research in response to complex problems and situations.

Level 7 qualifications recognise highly developed and complex levels of knowledge which enable the development of in-depth and original responses to complicated and unpredictable problems and situations.

Level 8 qualifications recognise leading experts or practitioners in a particular field.

Source: http://www.tda.gov.uk/support/cdf/planner_guidance/qualification_levels.aspx

Private sector investment in people is also an important part of the education and training dimension. According to research by The Work Foundation, employer training accounted for 21 per cent of investment in intangibles in 2004.[23] The UK has, until this point, successfully up-skilled its workforce at the top of the spectrum to support and drive its knowledge economy.

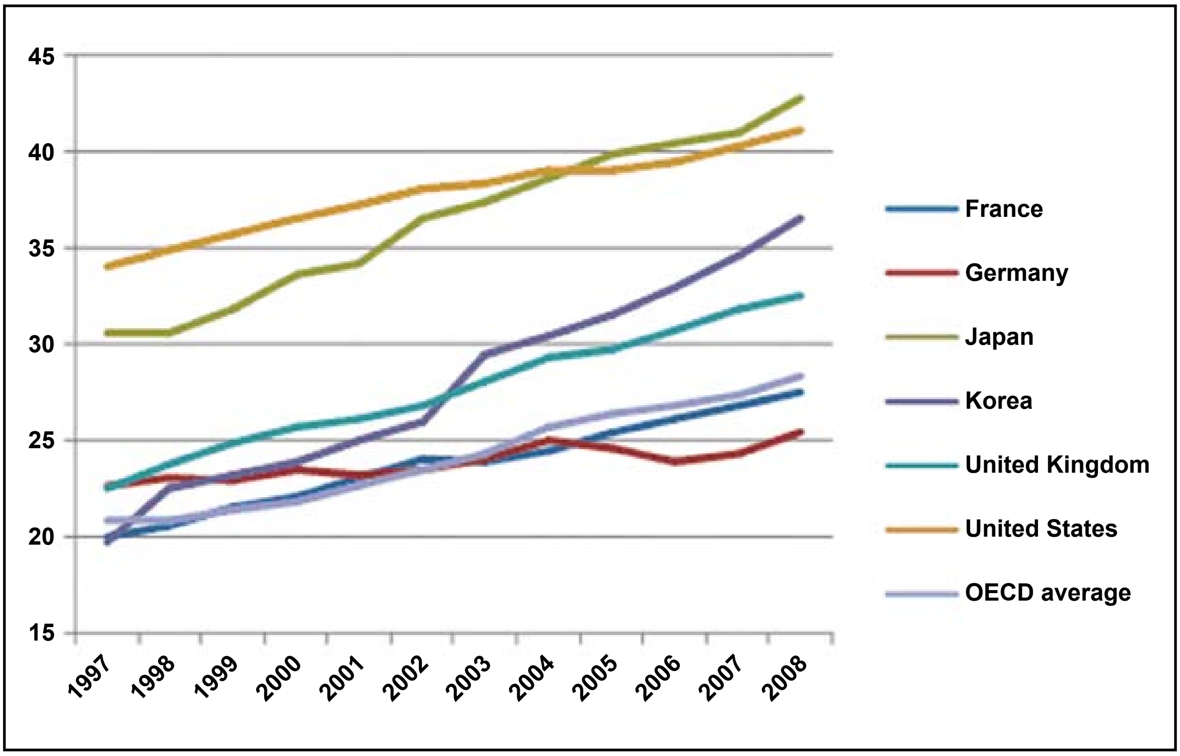
Our investment in human capital has increased significantly in the last thirty years. Prior to the 1980s, the UK had one of the lowest higher education participation rates in the OECD.[24] The Education Act of 1988 alongside other reforms has expanded access to higher education and created an unprecedented up-skilling of the population as the percentage of the labour force with university education leapt from below five per cent in 1980 to over 20 per cent thirty years later.[25] This drive to expand higher education peaked in 2008 with Labour's policy of aiming to get 50 per cent of young people to enter tertiary education and 75 per cent to enter post-secondary education.[26]

This trend has taken place in all industrialised nations. Across the OECD, an estimated 37 per cent of the 2006 age cohort completed tertiary education, an increase of 15 percentage points in

[23] Brinkley, I. (2008) op cit.
[24] Chevalier and Lindley (2007), Over-education and the Skills of UK Graduates
[25] Oversupply paper (longitudinal study)
[26] Leitch, 2006

the last eleven years.[27] As Figure 1 shows, there are significant variations in the rate of increase as well as the baseline of attainment across the OECD. Japan and the US stand out particularly in terms of the high proportion of graduates among 25-65 year olds, while Korea has increased its share in a short space of time to move ahead of the UK, Germany and France. While the UK appears to be unable to catch up to the US in this illustration, Figure 2, which looks only at those aged 25-34, shows quite a different picture. This illustration suggests that the UK has caught up significantly with the US in recent years as well as increasing at a rate above the OECD average.

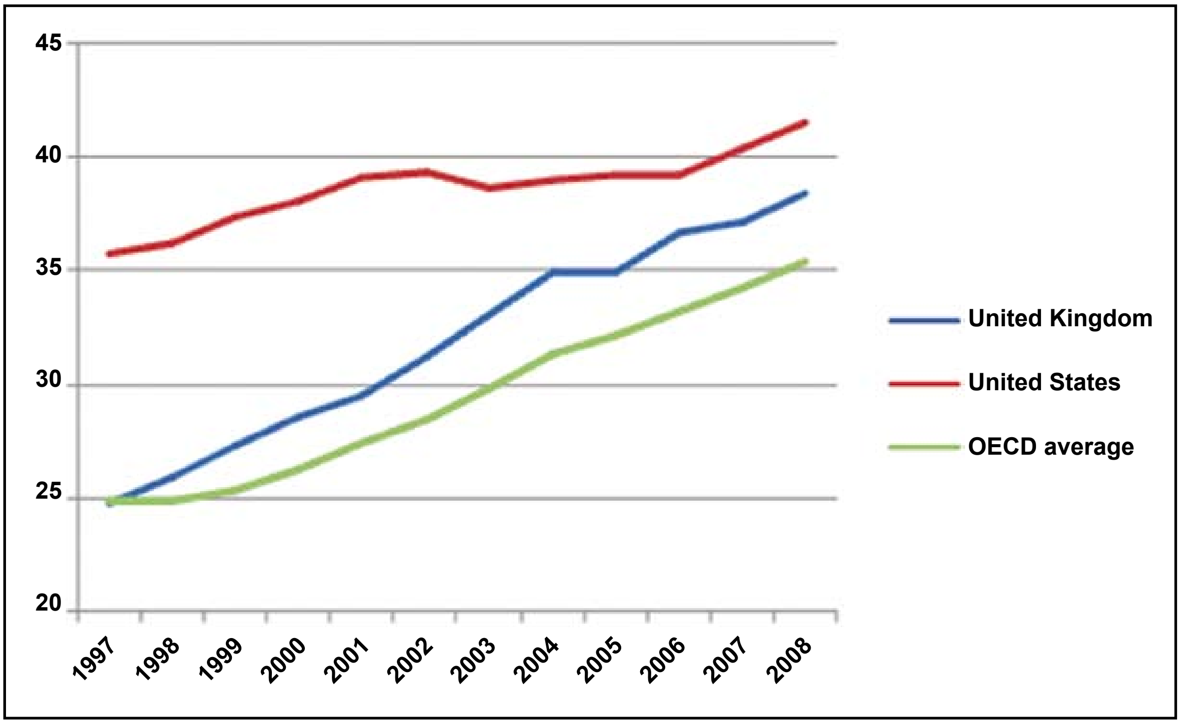
Figure 1: Tertiary attainment among 25-65 year olds in selected OECD countries



Source: OECD

[27] www.oecd.org. Among the 25 OECD countries with comparable data

Figure 2: Tertiary attainment among 25-34 year olds in US and UK



Source: OECD

1.2 Too rapid an expansion?

It is often claimed that higher education has expanded too quickly leading to adverse labour market outcomes. Perhaps first among these is the potential for polarisation between low-skilled and high-skilled labour. It is argued that this polarisation is compounded by the expanding graduate labour pool taking on non-graduate work and thus crowding out the market and making it harder for low and intermediate skilled labour to progress. Of secondary prominence is the fear that higher education is expanding at a rate that the labour market cannot absorb, and therefore more graduates would be over-qualified and either un- or under-employed.

These theories have not died away despite convincing evidence to the contrary. The Work Foundation's previous research on the knowledge economy found that supply and demand for graduates has largely remained in balance for the past decade evidenced by no deterioration in the relative labour market position or wage premium of graduates over non-graduates.[28] Overall, it found that the labour markets in transition towards a knowledge economy were hungry for high-skilled labour, the 'threat' of emerging economies is overblown, and the predicted polarisation had retarded in the decade between 1995 and 2005. Measured by wage returns

[28] Fauth and Brinkley, *op cit.*

and employment levels, the research found little support for the over-supply thesis, although it did produce some interesting conclusions about the type of jobs that graduates were doing. The authors found that more graduates were doing jobs that are not traditionally characterised as requiring graduate skills. This is referred to by various terms including ‘skill-mismatch’, ‘under-employment’, ‘over-qualification’. It is a complicated area as there is a distinction between objective and subjective definitions of this ‘over-qualification’ and, depending on which is used, different conclusions are arrived at about the significance of this problem.

While some commentators have voiced concern that too many graduates are entering non-graduate occupations, the evidence suggests little cause for alarm. Longitudinal research on graduate cohorts in the 1980s and 1990s has found little evidence that there were more under-employed graduates as a result of expansion[29] and recent research in the UK evidence suggests a trend of more graduates going into graduate jobs, particularly ‘modern’ and ‘new’ graduate occupations – see Figure 3.

Figure 3: Occupational destinations of graduates in the UK 2004 to 2008

Types of job	Examples	2004	2005	2006	2007	2008
Traditional graduate occupations	Solicitors, research scientists, architects, medical practitioners.	11.1%	11.2%	11.5%	11.7%	12.4%
Modern graduate occupations	Software programmers, journalists, primary school teachers.	12.3%	12.6%	13.1%	13.8%	13.7%
New graduate occupations	Marketing, management accountants, therapists and many forms of engineer.	14.9%	15.5%	16.0%	17.2%	16.6%
Niche graduate occupations	Nursing, retail managers, graphic designers.	22.7%	23.3%	23.7%	23.8%	23.0%
Non-graduate occupations	Any jobs that do not fall into the above categories.	39.1%	37.5%	35.6%	33.5%	34.3%
All		100%	100%	100%	100%	100%
Total in graduate occupations		**60.9%**	**62.5%**	**64.4%**	**66.5%**	**65.7%**

HESA (2009) accessible from – http://www.hecsu.ac.uk/graduate_market_trends_winter_09_what_do_graduates_do.htm

[29] Purcell (2004) *Seven Years On* http://www.hecsu.ac.uk/assets/assets/documents/seven_years_on.pdf

Looking at the occupations that graduates enter following graduation does highlight however that there are significant variations in outcomes by subject. For example, almost all medicine and dentistry graduates enter what The Work Foundation terms 'knowledge jobs' by occupation[30], while less than half of historical and philosophical studies graduates enter these occupations – see Figure 4.

Figure 4: 2007/08 UK graduate destinations by occupational category for those entering employment

	Knowledge workers	Non-knowledge workers
Medicine & dentistry	99.7%	0.2%
Veterinary science	94.0%	4.8%
Subjects allied to medicine	90.8%	9.2%
Architecture, building & planning	83.7%	16.2%
Engineering & technology	80.9%	19.2%
Education	78.7%	21.3%
Computer science	74.5%	25.4%
Mathematical sciences	72.3%	27.7%
Business & administrative studies	61.5%	38.5%
Physical sciences	61.0%	38.9%
Social studies	60.9%	39.1%
Creative arts & design	53.5%	46.5%
Biological sciences	52.8%	47.2%
Communications	52.1%	47.9%
Combined	49.4%	49.4%
Agriculture & related subjects	49.6%	49.6%
Languages	49.3%	50.7%
Law	48.9%	51.0%
Historical & philosophical studies	45.6%	54.4%
Total 2007/08	**65.3%**	**34.6%**
Total 2006/07	**66.8%**	**33.2%**
Total 2005/06	**64.4%**	**35.6%**

Source: HESA, The Work Foundation

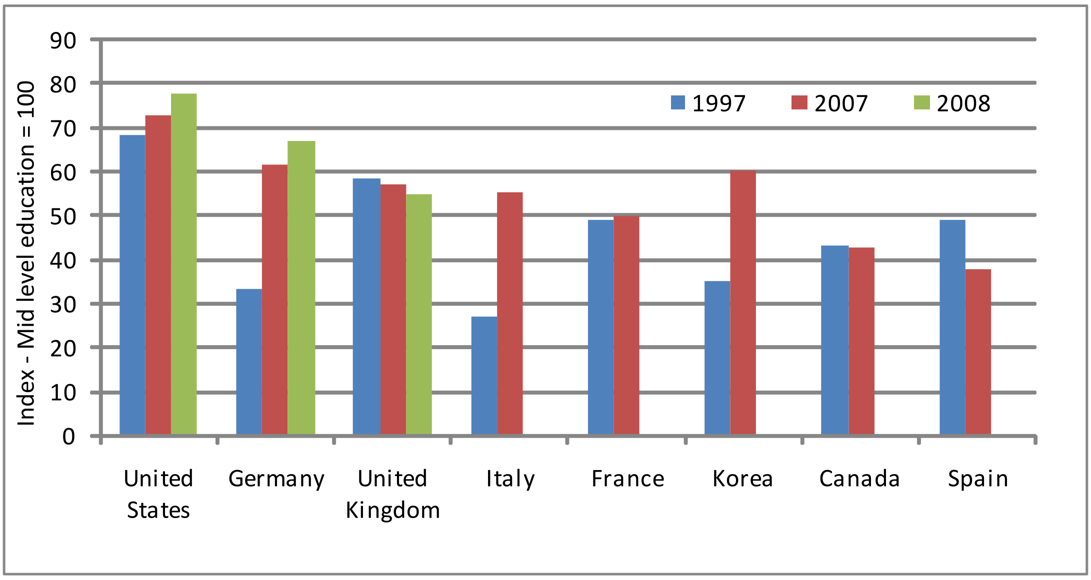
Note: Knowledge workers are those in the top three occupational categories (Managers and senior officials, professionals, associate professionals and skilled technicians)

30 The top three occupational categories (managers and senior professionals, professionals, and associate professionals and skilled technicians)

Across the OECD there seems to be evidence of strong, and in most cases expanding wage differentials between graduates and non-graduates (see Figure 5). This suggests that demand for graduate skills (perhaps most plausibly explained by the global expansion of the knowledge economy), is keeping pace with the global expansion in graduate labour supply.

This adds weight to the thesis set out above that demand for graduates will be sufficient to sustain recent increases in supply, since it suggests that our expanding demand is part of a global phenomenon. In addition, the global nature of these wage differentials suggests that global demand for high level skills remains high. This implies that a future UK labour force which is well equipped with these skills is likely to be well positioned to meet future demands.

Figure 5: Graduate earnings compared with non-graduates 1997-2007/08



Source: OECD 2010

Note: All figures show graduate earnings relative to those with a 'mid-level' education (better than basic schooling, less than degree or equivalent). 2008 data is only available for three countries. Data for Italy is 1998-2006

The Work Foundation's research on higher education expansion is supported by research published in 2007 by the OECD, which looked at the supposed problem of graduate over-supply and the possibilities of labour market crowding across industrialised countries. Given existing scepticism, its conclusions are worth quoting at length:

> *There is no evidence in the current data suggesting any crowding-out effects of lower-educated from higher-educated individuals. On the contrary, there seems to be positive employment effects for individuals with less education in countries expanding their tertiary education. Labour market outcomes for the upper secondary educated appears to be less influenced by the expansion of tertiary education, but there is no indication that tertiary educated individuals, on average, are displacing (crowding out) upper secondary educated individuals from the labour market. Similarly, the job market for the tertiary educated appears to be little influenced by the expansion of tertiary education….The earnings advantage (premium) for tertiary educated individuals in comparison with upper secondary educated individuals is still on the rise, which suggests that, on the whole, demand outstrips supply in most countries….it appears that the upper secondary educated have strengthened their labour market positions in countries expanding their tertiary education as unemployment rates and earnings have, on average, evolved in positive directions there….In conclusion, there is very little evidence to argue for an oversupply of higher educated individuals in the current dataset. Much of the results presented in this paper suggest that lower-educated individuals benefit from the expansion of tertiary education and that increasing levels of those with tertiary education in recent years have been absorbed by the labour market. In addition…the statistical analysis shows that the positive effects are more pronounced in recent periods. This suggests that, contradictory to any argument of a too rapid expansion of higher education, the benefits documented in this paper are largely driven by increases in higher education attainment in more recent years.*[31]

Migration cannot be omitted from this discussion as it has played a major role in meeting skills shortages in the labour market over the past decade. The previous government recognised that the top end of the labour market is highly mobile with intense competition for talent in some areas. Businesses therefore need flexible migration policies that enable them to meet key skills shortages and gaps and strengthen their international competitiveness. The UK higher education system for example has been unable to satisfy demand for STEM skills as the percentage of foreign born STEM graduates increased from 10 per cent to 15 per cent in a decade. The Australian style points based migration system introduced by the Labour Government reconciled the need to be seen to slow down inward migration while enabling UK businesses to have access to international talent and skills – it has therefore been unsurprising to note backlash from businesses towards the government's annual cap on non-EU migrants

[31] Hansson, B. (2007), 'Effects of Tertiary Expansion: Crowding-out effects and labour market matches for the higher educated', *OECD Education Working Papers*, No. 10, OECD Publishing. http://www.oecd-ilibrary.org/oecd/content/workingpaper/085513474523

and extra barriers for international students (who are predominantly studying in demand areas) to stay on and work in the UK.

Migration of highly-skilled labour will need to continue to support the knowledge economy and particularly fill gaps in areas where we have either short term demands or difficulty creating long term supply.

Overall, the evidence presented here suggests that there is a need to sustain the long term expansion in higher education provision to support the continuing development of the knowledge economy. This need will be particularly pressing if in future we can not rely on immigration to plug gaps in our skills supply.

1.3 Recession and recovery – the impact on the demand for high level skills

There remains a concern that the recession will upset the balanced growth path of higher education – long term supply from higher education institutions seemed to be expanding in line with demand from the economy. There was, and still is, a significant amount of noise made about graduate unemployment and the possibility of a 'disillusioned generation'.[32] This was not without foundation, as the graduate unemployment rate increased during the recession[33] and many surveys suggested that the majority of large graduate employers were either freezing or reducing graduate intakes (see Figure 6), suggesting a potential oversupply.

Young people have certainly been disproportionately affected by the recession. The unemployment rate for 18-24 year olds increased by almost six percentage points between the first quarter of 2008 and the third quarter of 2009.[34] Young males and ethnic minorities were particularly vulnerable to the downturn. The group worst affected was young females aged 16-24 with no qualifications of whom 46 per cent were unemployed by February 2010, an increase of 18 percentage points.[35]

However, the impact of the recession on jobs has been smaller than could have perhaps been expected given the severity of this recession. This suggests that it may not be sensible to immediately scale back the expansion of higher education as a response to the recession. Job losses during this recession have been significantly lower than originally predicted and markedly lower than previous recessions. While the recessions in the 1980s and 1990s saw

[32] http://www.hrmagazine.co.uk/news/993480/Graduate-unemployment-creating-disillusioned-generation-employees-working-careers-unrelated-degree/
[33] There was a significant gender bias to this as well. According to an IPPR report, male graduates were markedly more likely to be unemployed (22 per cent) than female (13 per cent)
[34] Haver Analytics. Based on ILO measure
[35] IPPR (2010), *Colleges 2020*

Figure 6: Graduate unemployment in the recession

Measure	Details	Graduate unemployment in 2009
HESA	DLHE measures the destinations and outcomes of graduates one year from completion.	Unemployment among 2007/08 graduates was 8.4 per cent, up from 5.8 per cent from the previous year. Unemployment by subject ranged from 0.2 per cent (Medicine) to 14.3 per cent (Computer science).
Labour Force Survey	Labour Force Survey gathers quarterly data on the working age population.	9.4 per cent for those who received at least a Level 4 qualification in the past year.[36]
Employer Surveys	A number of surveys review yearly changes in graduate appointments in large companies.	In mid-June 2009 the CBI estimated that 38 per cent of employers had frozen graduate schemes, 10 per cent of these organisations were employing fewer graduates than the previous year and 5 per cent noted they would increase (CBI, 2009). A GRADirect survey the following month reported a similar number of employees hiring the same number of graduates (43 per cent) but over double the proportion said they would be increasing (12 per cent).

unemployment rise to over three million, unemployment during this recession has only reached 2.5m to May 2010.[37] At around 10 per cent, the youth unemployment rate has stayed below previous recessions in the 1980s (12 per cent) and the 1990s (13 per cent).[38]

There are numerous explanations for this unexpected result including 'labour hoarding', the value of workers as company assets because of their knowledge and relational capital, and better employer/employee negotiations to temporarily amend working practices and arrangements. Labour market data also suggests that more people are heading into education and training.[39] The recession has significantly increased applications to university in the UK but this has been met with relatively little increase in supply. There was a 31 per cent increase in the number of people unable to get into university courses for the 2009/10 academic year. Applications for the 2010/11 are said to have increased 16.5 per cent and, according to UCAS, an estimated 40,000 of these were unable to get places the previous year.

Perhaps surprisingly, it seems that the nature of the UK labour market's response to the recession may actually be increasing the need to expand higher education provision. The key similarity between this recession and its predecessors in the 1980s and 1990s is that the vast

[36] Estimate based on Labour Force Survey analysis in response to Parliamentary Question from the Rt Hon David Willetts. 10 Dec 2009
[37] IPPR (2010), *Colleges 2020*
[38] NIESR, 2010
[39] Brinkley, I., Comment on the Labour Market Statistics, The Work Foundation, May 2010.

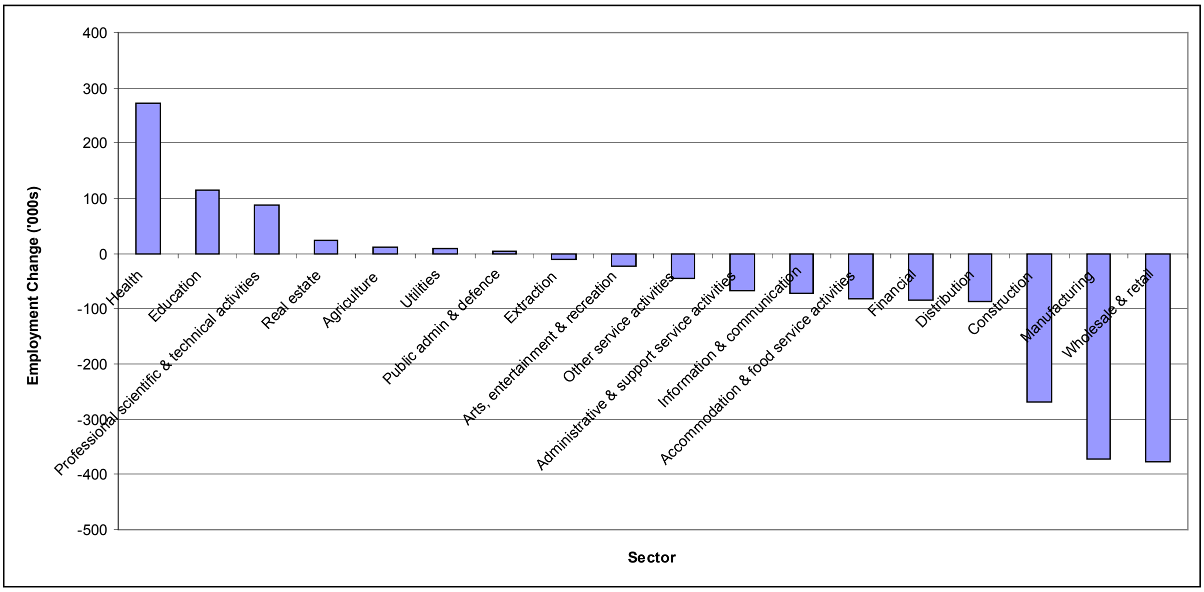
majority of jobs that were lost were in manual, unskilled and elementary occupations. The number of 'knowledge associated'[40] jobs actually increased between Q1 2008 and Q1 2010 – see Figure 7. On a sector basis, job losses have been in less knowledge intensive services, such as construction and distribution, and low to medium tech manufacturing – see Figure 8.[41]

Figure 7: Total employment change by occupation Q1 2008 to Q1 2010

	2008Q1	2010Q1	Change
Knowledge associated	12,675,710	12,705,290	29,580
Care and sales	4,558,550	4,685,435	126,885
Manual, admin and unskilled	12,175,740	11,411,765	-763,975

Source: ONS (2010) ELMR

Figure 8: Employment change by sector (Q2 2008 – Q2 2010)



Source: Labour Force Survey

This analysis suggests that the recession is accelerating the long term processes of structural change in the economy. This would imply that the recession is expanding the need for increased provision of higher level skills. The recession has also only served to reinforce the fact that the higher the level of qualification, the more likely a person is to be in employment and enjoy a

[40] The top three occupational categories – Managers and senior officials, professionals, skilled technicians and associate professionals. For more detailed coverage see Brinkley, I. (2009), *Recession and Recovery*, The Work Foundation

[41] Brinkley, I. (2009), *op cit*.

wage premium over those with lower qualifications. The evidence suggests that the main groups affected by this recession have been in low and intermediate skilled occupations.[42]

Taken together, this evidence suggests that despite the current obstacles faced by graduates entering the labour market, the recession has actually accelerated the process of structural change described above. This will result in a long-term increased need for higher education provision.

While many recent gradates are certainly struggling in the labour market, it is not sensible to adjust the long term capacity of our higher education system to deliver a workforce for the 2020 knowledge economy in order to respond to short term fluctuations in demand.

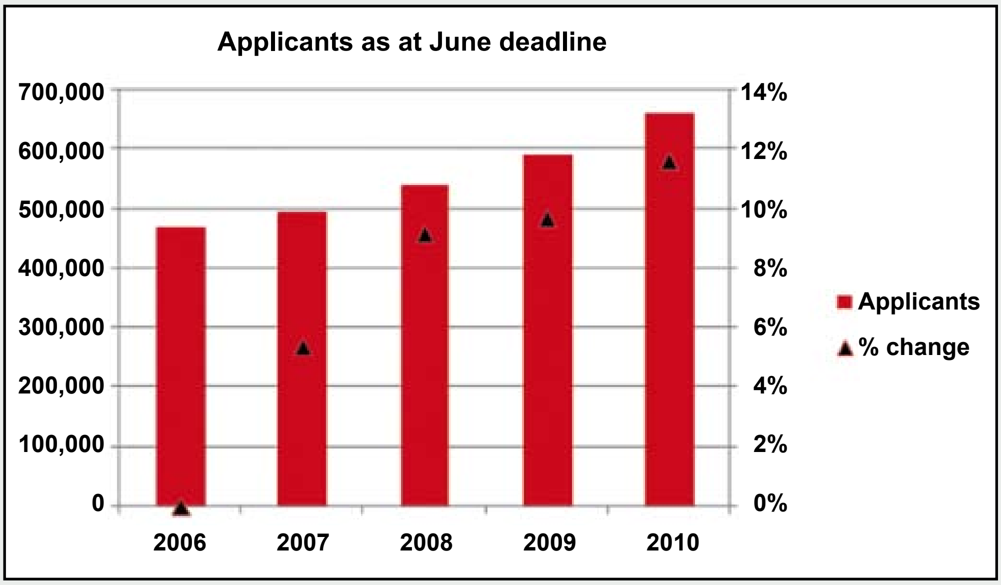
The evidence presented here tells a clear story. Structural change in the economy is creating a strong and increasing need for more highly educated workers – a need to which the higher education sector has been responding well. This need has been increased by the response of the labour market to the recession. Given this evidence, it is essential that this autumn's Comprehensive Spending Review is able to maintain the expansion in the graduate outputs from the higher education sector.

The next section considers the suitable focus for this provision.

[42] Brinkley, I. (2009), *Recession and Recovery to 2020,* The Work Foundation

Box 3: Increased demand for higher education in the recession

The recession has seen a strong expansion in the demand education and training. Labour Force Survey estimates show that the proportion of 18-24 year olds in full-time education has increased from 27 per cent in September-November 2007 to 32 per cent in March-May 2010.[43] The following figure illustrates the recent expansion in applications to British universities:



Source: UCAS Media Release 16 July 2010

As noted above, the effects of the recession has been felt particularly acutely by young people. Individuals are aware that they need stronger qualifications to compete in the current labour market – while the analysis above has highlighted the challenges facing recent graduates, they are faring much better than young people without degrees.[44] Prospective students may also hope that by the time they emerge from their studies that conditions will have improved. The government has stressed that there are other viable options to higher education such as apprenticeships, but based on the evidence it appears that these applicants are making a rational judgement in their best interest.

Rather than viewing the recession as causing a drop in the demand for graduates, it could perhaps be better seen as an opportunity to broaden access to higher education while demand remains particularly strong and alternative choices for those leaving school are limited.

Cont.

[43] ONS 2010 Labour Market Statistics

[44] For example the latest data from the Labour Force Survey (January-March 2010) show that the underpayment rate for graduates aged 20-24 is 11 per cent. This significantly lower than that of the whole age group (16 per cent)

Cont.

Indeed, there is a strong social case for immediately expanding provision. In The Work Foundation's recent report 'Hard Labour: Jobs, Unemployment and the recession', we set out the key negative physical, mental, social effects of unemployment. There is strong evidence that a period of unemployment near the start of an individual's career can be particularly damaging, with the psychological effects lasting for many years. Although, as we explore in detail in Section 3, current higher education funding arrangements mean that we can currently only expect a modest expansion in higher education in the short term.

Successfully delivering the skills for the 2020 knowledge economy will depend on supplying the right numbers of university graduates and also on the system supplying graduates with the right the specific qualities. The nature of the training offered within higher education and the subject areas where it is targeted will be of particular relevance.

There is a need to deliver a workforce with the right practical skills to work in the economy of the future – for example we need enough trained engineers, statisticians and researchers to respond to the future demands of the economy. However this view of education as meeting the needs of the economy denies the vitally important feedback impacts from education. As well as meeting demands from the economy, education also drives the economy, particularly through its relationship with innovation.

Box 4: Defining innovation

Innovation represents the creation and application of new knowledge. In the private sector this can be easily understood as the commercialisation of a new product or services to meet a market demand, or the creation and implementation of processes which improve the productivity of existing activities.

In this way innovation represents more than invention or discovery. It is a broader concept which depends on the ability to derive value from an invention. As Corado notes, "innovation goes beyond the upstream discovery of new inventions and technologies by scientists and engineers, beyond the creation of new ideas and designs by other workers, and beyond the turning of those inventions and ideas into new products and services. Inventions, ideas, new products, and new services are worthless without a downstream process that turns them into something that convinces people and firms to become customers.[45]

Innovation can therefore be thought of as comprising three distinct components, although interactions often complicate this picture making it challenging to separate:

- New knowledge creation – moments of innovative accident through which a new way of thinking about or doing something is created –a bright idea moment;
- Innovative accidents typically require a process of scaling up to a level at which they can be potentially useful; and
- These processes of innovation depend on upstream processes to support investment in innovation and downstream processes of selection and application before they can create benefits.

[45] Comment Submitted to the Advisory Committee on Measuring Innovation in the 21st Century Economy, Federal Reserve Board (2007)

As noted in Section 1, the notion of high level skills is a broad concept reflecting an individual's ability to use tacit knowledge to assimilate and interpret information. It seems sensible that these skills are of relevance for this innovation process – a topic explored in detail within this section.

To date, the public policy debate has concentrated on two responses to the question of influencing the balance of subjects studied at university – a focus on 'economically valuable' degrees and on STEM subjects (science, technology, engineering and maths) as a proxy for the skills for innovation. This section considers both of these responses in detail. It concludes by questioning whether this focus is adequate to support the innovation agenda demanded by continued progress towards the knowledge based economy.

Box 5: Higher education and the skills for innovation in context

This section focuses on the notion of the skills for innovation which can be imparted by the higher education system. This does however represent a limited understanding of the wider factors which drive innovation:

- Higher education represents only one component of the education system. This paper sets out the particular relevance of tertiary education for innovation, but this does not deny the importance of primary, secondary and more vocational forms of education in developing skills for innovation – Tether et al. (2005), for example, flag the importance of skills at all levels across the workforce for driving innovation;
- Education itself only represents one aspect of skills development. As with the development of any skills, an individual's skills for innovation will develop based on the full breath of their experiences and their innate capabilities;
- The impact of these skills depends on the operation of the wider innovation system. It will for example depend on how organisations and workplaces deploy these skills – how they demand high level skills and how they utilise and support the continued development of these skills. How different individuals interact, or the institutional composition of this system will also be of relevance.

This section does however present clear evidence on the importance of considering innovation within skills policy debates.

2.1 The 'economically valuable' degrees

Recently, the argument has been made about the need to identify which subjects are the most economically valuable in order to prioritise places and funding for higher education. For example, the UKCES report *Skills for Jobs* explains:

> *A further challenge, however, is ensuring we supply the 'right', economically valuable skills, which employers demand and which then can be effectively deployed in the workplace. Whilst overall returns to higher qualifications have held up (despite the recent growth in higher skills), there is substantial variation in experience by subject area. This raises questions about the provision currently supplied, and student choices.*[46]

The Leitch Review's focus on 'economically valuable skills', which are meant to offer 'real returns' for individuals by virtue of the fact that employers are prepared to pay higher wages for those skills, was supposed to improve the government's position in creating a 'clearer balance of financial responsibility' for higher education. Leitch was essentially saying that if there are increasing financial benefits to higher education for employers and individuals then they should bear more of the financial burden for this education. The latest higher education strategy *Higher Ambitions* reinforced this recommendation noting that the additional costs of our ambitions in Level 4 skills should largely be met by individuals and employers as they benefit most.[47] Although the Browne Review will report on this, there has not been much shift in the terms of the debate about the contribution of employers.

The term 'economically valuable' has also been interpreted in another way by UKCES in its 2010 Skills Audit for England.[48] It concludes that there needs to be a renewal to the commitment to 'economically valuable skills' referring to a list of the top ten sectors of 'economic significance' in 2007 and 2017, as outlined in Figure 9. In addition to having little consistency with the Leitch definition, this analysis assumes that the government are better able to determine which skills will be of use in the future than prospective students. This approach poses four serious problems:

- Firstly, our economy can no longer rely on a growth model based on the expansion of financial services and renting and real estate, currently ranked as first and third in 'economic significance' – given the events since the publication of these forecasts it is possible to question the sustainability of development based on these activities, and the suitability of using historical sectoral forecasts to plan future supply;

[46] UKCES (2010), *Skills for Jobs*.
[47] BIS (2009), *Higher Ambitions*, BIS
[48] UKCES (2010), *Skills for Jobs*.

- Secondly, these sectoral definitions are limiting and neglect significant areas of growth such as the creative industries (6.4 per cent of GDP) and the low carbon economy. As we noted within our recent paper *'Innovation, Creativity and Entrepreneurship in 2020'* our economy is seeing the rise of industrial groupings such as these which cut across traditional industrial classifications and boost demand for a broad range of skills;
- The economy will only see growth from private sector knowledge intensive industries. This has been the overall historical trend and the case in previous recoveries from recession; and
- The top 10 economically significant sectors in 2017 are predicted to be the same as the top 10 in 2007 – This is neither likely nor desirable.[49]

Figure 9: Current and future sectoral 'economic significance'[50]

	2007	2017
1	Financial services	Financial services
2	Business services	Business services
3	Renting and real estate	Renting and real estate
4	Computing	Computing
5	Health and social care	Health and social care
6	Retail	Retail
7	Post and telecoms	Post and telecoms
8	Electricity, gas and water	Electricity, gas and water
9	Construction	Construction
10	Transport equipment and manufacture	Transport equipment and manufacture

2.2 The special place of STEM in the 2020 knowledge economy

An important alternative interpretation of 'valuable skills' has been a focus on STEM subjects. This sub-section sets out the case for the promotion of STEM disciplines over other degrees. It also offers evidence on the current supply and demand for STEM graduates, the quality of this supply and the adequacy of current arrangements which promote and develop STEM skills.

As Section 1 highlights there has been a major transformation of the UK's industrial and occupational structure in the past thirty years as a result of technological change and globalisation. As this trend continues, it is predicted that the demand for high level STEM skills

[49] Hutton, W. (2010), *Landscape of Tough Times*, The Work Foundation
[50] UKCES (2010). Significance is based on an overall measure combining productivity and levels of employment. The 2017 figures are based on an analysis by IES undertaken prior to the recession

will increase further. The Institute for Employment Research projections for the UK Commission for Employment and Skills forecast growth of STEM occupations of 9.4 per cent by 2017. It found that due to the continued shift towards a knowledge intensive economy, demand for the share of the workforce with a Level 4 STEM qualification is projected to increase from 8.2 per cent in 2007 to 9.8 per cent in 2017.[51] A report on the demand for STEM graduates by (the then) Department for Innovation, University and Skills concluded:

> *...the demand for people with higher level STEM qualifications is likely to increase to some extent under most plausible futures. Hence the policies currently in operation to encourage take-up of scientific subjects are likely to be low risk provided that, in taking these subjects, people acquire the broader skills and experience that complements their technical knowledge and thus makes them attractive to employers.*[52]

STEM skills are also of importance beyond their sectoral relevance. There is a direct linkage between these skills and innovation. As noted above, innovation is increasingly important for value creation with the progress of the knowledge economy. This highlights the importance of the skills which support it.

STEM skills are certainly of particular relevance for innovation and the operation of STEM departments of universities is of central importance to the wider innovation system. There is a clear relevance of STEM skills to technical invention. As a report by the Brookings Institution concludes:

> *Ultimately, all increases in standards of living can be traced to discoveries of more valuable arrangements for the things in the earth's crust and atmosphere…No amount of savings and investment, no policy of macroeconomic fine-tuning, no set of tax and spending incentives can generate sustained economic growth unless it is accompanied by the countless large and small discoveries that are required to create more value from a fixed set of natural resources.*[53]

Looking at the notion of innovation set out above in Box 4 it is possible to see a clear link between STEM skills and innovation. It is not possible to identify specific skills which support innovative accidents – almost by definition these cannot be predicted, nor can the conditions which support them. It does however seem that STEM skills are of particular relevance for the

[51] IER, (2009) *Working Futures*
[52] DIUS (2009), The Demand for Science, Technology, Engineering and Mathematics (STEM) Skills
[53] Paul M. Romer and Zvi Griliches (1993), *Implementing a National Technology Strategy with Self-Organizing Industry Investment Boards*, Brookings Institution

process of scaling up new knowledge to create value. These skills are of relevance for product or technically oriented innovations. Here activity can be closely linked to the traditional notion of the invention and development process.

Box 6: Service innovation and STEM skills

The power of STEM skills for innovation in manufacturing is easily understandable. Here, tangible goods are produced or develop physically to be more highly valued than their predecessors. The role of scientific knowledge, R&D skills and other forms of STEM expertise are highly visible here. However, while an important part of the UK economy, manufacturing is responsible for only 11.6 per cent of UK GDP (Blue Book (2010)). The UK is primarily a service economy.

However, as highlighted within the recent paper from the Royal Society (2009) *Hidden wealth: the contribution of science to service sector innovation*, STEM skills are also of central importance to innovation in service sectors. They noted that:

- STEM capabilities are often internalised within many highly innovative service offers – a strong example of this would be the search algorithm which was the initial basis of Google's success;
- STEM skills are central to the infrastructure of highly innovative services – computing, communications, IT and database technology has enabled many areas of service innovation; and
- Service innovation often relies significantly on external STEM capabilities for innovation – compared to manufacturing, innovation in the service sector is often more open. It can often depend on bought-in expertise or technology, collaborations with suppliers, service users or consultants to solve challenges in innovative and competitive ways.

This represents an example of the complex boundary between manufacturing and service activities. The notion of manu-services (discussed in detail within The Work Foundation report *Manufacturing and the Knowledge Economy,* (Brinkley 2009)) explains how the knowledge economy can derive value from service activities related to manufacturing.

Here, the technical application of service processes is key to innovation. Success must depend on individuals who have technical skills as well as the ability to fully integrate themselves into the most creative of environments.

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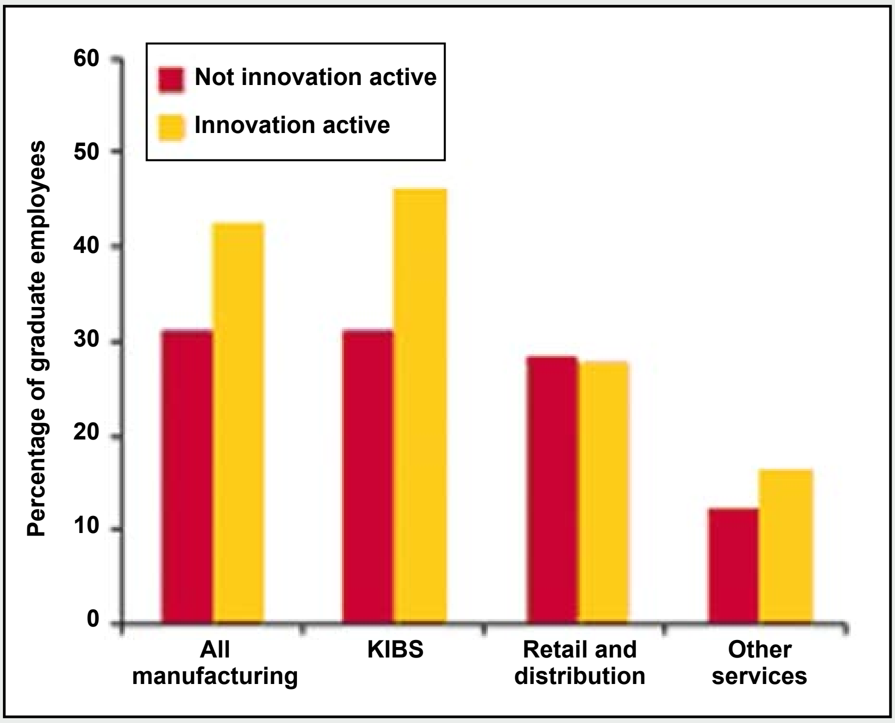
Analysis of the UK Innovation Survey (2007) supports this position. It shows that innovation-active firms engaged in both manufacturing and knowledge-intensive business service industries employ higher proportions of graduates with science or engineering degrees than their non innovation-active equivalents. This suggests that these skills are of particular relevance for innovation in both sectors.

Percentage of graduate employees with a science or engineering degree in innovation active/non active firms by sector



Source: RSA (2009)

2.1.1 Science, technology and innovation and the role of government

Historically a strong case has been made for public investment in science and technology research as well as facilitating the transfer of knowledge. A number of studies, including one by Grillches in 1992, have found that since 'knowledge' is a 'non-rival good'[54], the returns to the stock of R&D knowledge is higher at the aggregate level than at the organisational level.[55] This means that the production of knowledge produces positive externalities, which benefit parties other than the producer or investor. These externalities of research are often termed 'spill-overs' and it is suggested that without government intervention companies will not invest at an optimum level since they do not receive the full benefits of their investment. In recognition of this, most governments invest a significant proportion of tax receipts in HE research and teaching as well as providing tax credits to incentivise private sector investment in R&D. Knowledge transfer is also a key area of government intervention due to, *inter alia*, co-ordination failures.

The case for additional investment in STEM skills rests on similar foundations. Given their relevance for the creation of new knowledge – a process from which individuals will not capture the full benefits. As with the creation of knowledge itself this suggests that there may be grounds for government intervention to promote STEM skills training over other subjects.

As technological innovation was identified as a key driver of economic productivity, significant attention has been given to the processes, policies and people that enable innovation to happen. The government has a vital role in ensuring that the quantity and quality of skills entering the labour market are sufficient to drive innovation and that there is a significant investment in research and development, particularly through higher education mechanisms. Governments are increasingly also playing important roles in supporting and co-ordinating innovation 'eco-systems' through enabling knowledge transfer between public research and private sector businesses.

The focus on people has, to date, mainly focused on supporting and developing the cadre of STEM graduates to ensure that the right skills are available to adopt, adapt and evolve new technologies. Government plays a significant role in higher education in the UK, which is still largely publicly funded, although UK higher education institutions (HEIs) receive a reasonable share of their income from private sources in comparison to other EU countries.[56] While there is a current focus on 'STEM' graduates, the next chapter examines the need for other skills to be supported in order to drive innovation.

[54] A good or service is non-rival if its consumption does not decrease the quantity of the good available
[55] Grillches (1992) The Search for R&D Spillovers
[56] See for example, *Education at a Glance,* OECD, 2009

Science, technology and innovation policy in the UK is largely the domain of the Department for Business, Innovation and Skills with support from HM Treasury on tax policies and the Department for Education on the pipeline for STEM skills. The Science and Innovation Framework (SIF), to encourage R&D investment between 2004 and 2014, and the Technology Strategy, to deliver maximum benefit from the research through knowledge transfer, are core strategies in this area. The government white paper *Innovation Nation* set out the national strategy for innovation in the UK and the previous government's industrial strategy *New Industries, New Jobs*[57] was heavily orientated towards industries built on science and technology such as advanced manufacturing and pharmaceuticals.

All these strategies have highlighted the need to improve the UK's science, technology, engineering and maths skills base, without which the UK will not be able to deliver on these strategies and meet its economic ambitions.[58] The need for investment in our science and technology skills and education has also been the topic of discussion in a number of significant government reviews from the Roberts Review on science and engineering education in 2002[59], to the Leitch Review on skills in 2006 to the Sainsbury Review on innovation in 2007[60] – see Figure 10.

Figure 10: Government reviews on STEM skills

Roberts Review (2002)	Fewer students choosing to study some science and engineering disciplines. Attractive opportunities outside of research and development are decreasing the number of STEM graduates going into industry.
Leitch Review (2006)	Focus on 'economically valuable skills that provide 'real returns' to individuals and employers, such as STEM skills.
Sainsbury Review (2007)	The lack of suitably qualified and competent teachers in STEM subjects as a key barrier to encouraging and sustaining uptake in these subjects.

The current Liberal Conservative programme for government includes a commitment to consider the implementation of the Dyson Review, which aims to make the UK the leading hi-tech exporter in Europe.[61] More specifically, the Review's proposals include the need for:

[57] The active industrial strategy proposed by BIS under Lord Mandelson is unlikely to be taken forward in the same way by the current coalition government
[58] http://news.bbc.co.uk/nol/shared/bsp/hi/pdfs/science_innovation_120704.pdf
[59] http://www.hm-treasury.gov.uk/ent_res_roberts.htm
[60] http://www.bis.gov.uk/assets/biscore/corporate/migratedD/ec_group/20-08-SC_b
[61] J. Dyson (2010), *Ingenious Britain*

- Cultural change to develop high esteem for science and engineering, including a major national prize scheme for engineering and commitments to 'grands projets' such as high speed rail and nuclear power to demonstrate the government's ambitions for the country.
- Changes at university level to encourage more young people to choose science and engineering degrees, including: industry scholarships for engineers, where the costs of bursaries to students are shared between industry and government; greater freedom for universities, for example to develop shorter courses where appropriate, or more vocational degrees.

The next sub-section examines the supply and demand for STEM skills with a view to understanding the appropriateness and likely effectiveness of such proposals.

2.2.2 Meeting the STEM needs of the 2020 knowledge economy

While government strategies and reviews have long recognised the importance of STEM skills to innovation and hence global competitiveness, there has been relatively little impact on our science and technology human resources. Internationally our stock of science and technology 'researchers'[62] is proportionally lower than all the UK's major competitors and as a proportion of the total workforce saw only negligible growth between 1995 and 2005 – see Figure 11. Furthermore, according to the OECD *Technology and Industry Scoreboard 2009*, the only countries that saw slower growth in the proportion of researchers in the workforce during this period were Slovakia, Switzerland, Poland and the Russian Federation.[63]

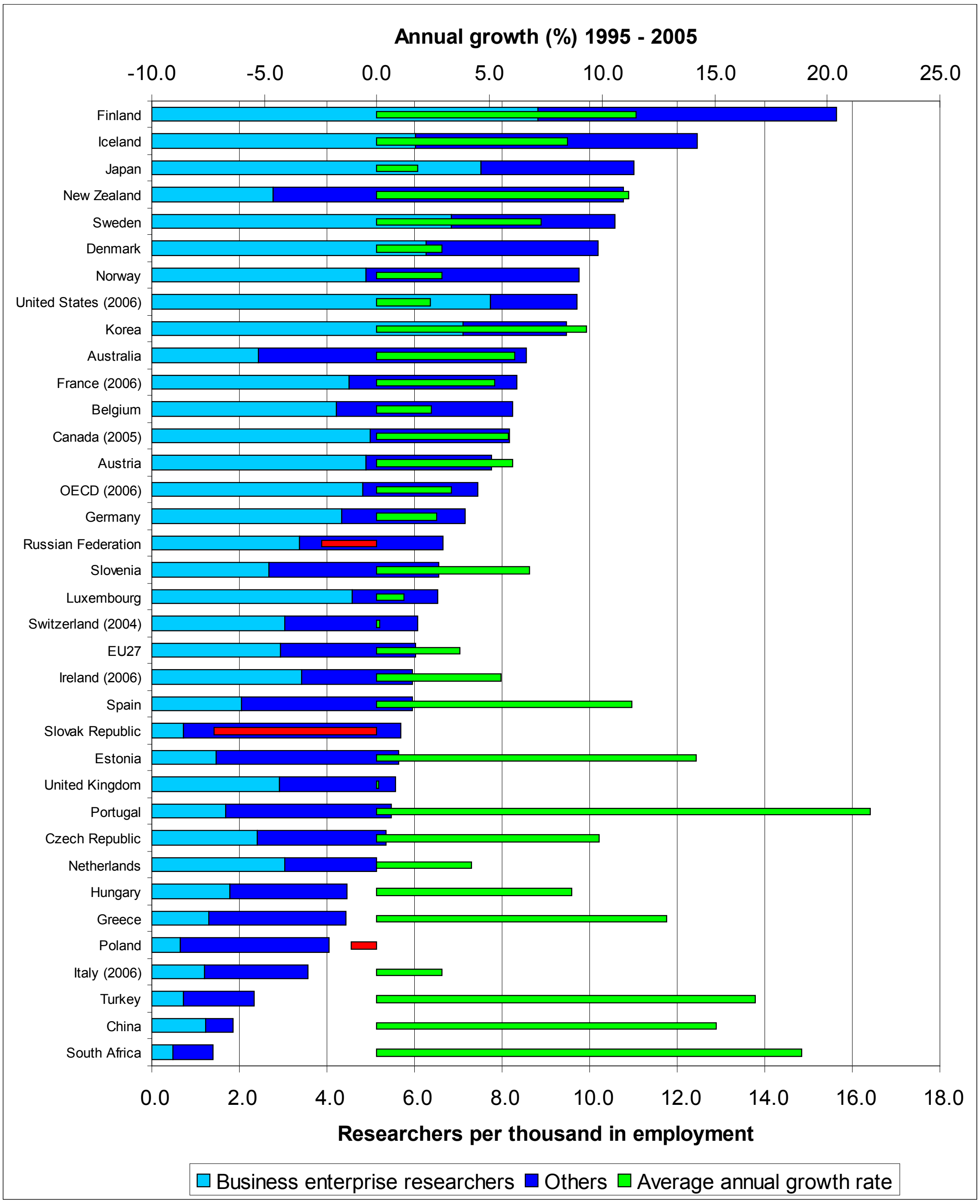
In this section we set out evidence which shows that this situation is puzzling since:

- The proportion of the UK's graduates entering science, technology, engineering and maths courses is among the highest in the OECD, and the proportion of science graduates among 25-34 year olds in employment is also high;
- Significant effort and progress has been made since the Roberts Review to increase interest, uptake and attainment in STEM subjects;
- Enrolment and attainment in STEM subjects has risen at all levels of education over the past ten years – see Figure 12; [64] and
- Proportionally fewer people take STEM subjects at tertiary level in many countries, the US being a notable example, but have a greater proportion of researchers in their labour market.

[62] OECD definition – see Figure 11
[63] Annual Innovation Report, BIS, 2009.
[64] These figures are for what the OECD terms 'tertiary type-A level' which refers to theoretical (university) rather than vocational higher education (college)

The following sub-sections unpick whether these issues with STEM relate to its supply from UK institutions, demand, or aspects of the quality of STEM provision or indeed a combination of these factors.

Figure 11: Researchers per thousand in employment (2007)



Source: OECD, Technology and Industry Scoreboard 2009

Note: The OECD defines 'researchers' as professionals engaged in the conception and creation of new knowledge, products, processes, methods and systems and are involved directly in the management of projects. The count below is expressed in terms of full-time equivalent researchers (FTE)

STEM supply – not necessarily a cause for concern

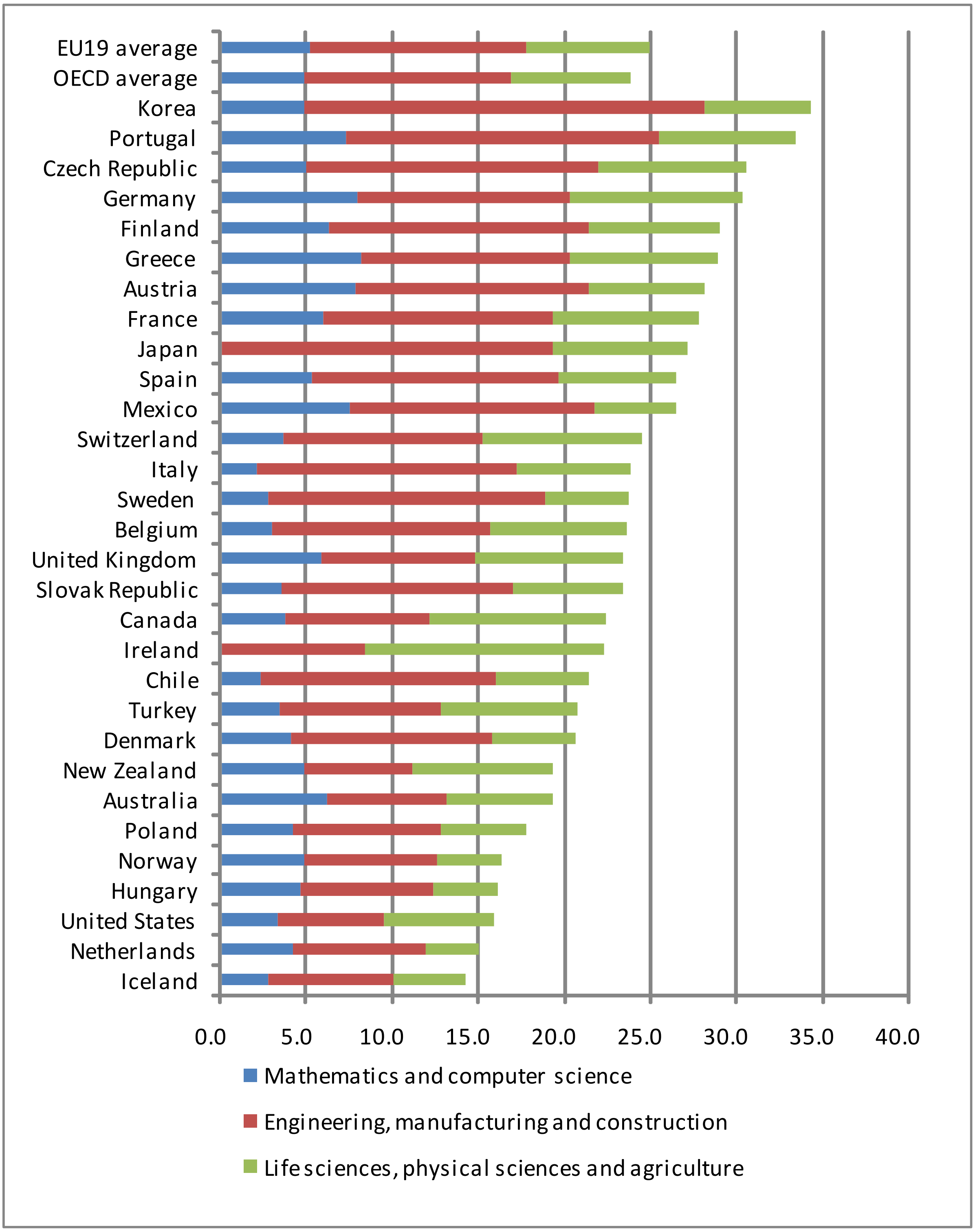
An inadequate supply of STEM graduates is frequently cited as an important issue holding back the economic development of a number of industries, particularly high tech manufacturing. There are particular concerns about the quantity of science, technology, engineering and maths (STEM) graduates being produced in the UK. The CBI report *Stronger together: businesses and universities in turbulent times* forecasts that over 750,000 new jobs requiring STEM skills are likely to be needed over the next five years alone.[65] EngineeringUK, a trade body, believes the country faces a chronic shortage of engineers[66] and the British Chamber of Commerce's publication *Growing pains: what is* holding *SMEs back* highlights the proportion of students studying STEM as a problem. A recent survey by the CBI and vocational qualification body EDI found that nearly half of the 694 organisations surveyed were struggling to recruit employees with STEM skills and expect the situation to get worse in the next three years.[67] The majority of respondents to the survey suggest that more needs to be done to promote these subjects in school and ensure that capable students study all three science subjects at GCSE.[68]

While there is evidence of an increase in STEM subject uptake at secondary and tertiary level[69], the Royal Society's report *The Scientific Century* (2010) emphasises that our investment in science and technology is falling behind our competitors at the risk of losing talent abroad and ultimately economic prosperity.[70] The Society argues that without continued investment, Britain potentially faces a situation similar to that which confronted the scientific community in the mid-1980s when year-on-year cuts had major impacts on facilities and infrastructure, destroyed morale, drove top scientists abroad and ultimately affected the nation's ability to remain at the leading edge of the technological and scientific frontier.[71] In response, the organisation 'Save British Science' was created by 1,500 scientists and engineers to meet the objective of its name.

The teaching of STEM subjects in university departments represents an important component of this investment. However, these reactions do not necessarily fit the evidence on STEM supply. From an international perspective, the UK is in the middle of the pack, in terms of the proportion of undergraduates taking STEM subjects at tertiary level. As Figure 12 shows, the UK is marginally below the OECD and EU19 averages on this measure which is a consequence of a significantly lower proportion of students in engineering subjects. Figure 13 also illustrates that science graduates are a particular strength for the UK workforce aged 25-24. This suggests that the STEM graduate problem may not simply be a supply issue.

[65] CBI (2009), *Stronger together: businesses and universities in turbulent times*
[66] Engineering and Technology Board's Engineering UK series
[67] http://www.guardian.co.uk/education/2010/may/18/skills-shortage-worsens
[68] See SQW Consulting (2009) *Demand for subjects and skills in English HE* for a recent review of this evidence base
[69] See for example DIUS (2009), *Demand for STEM graduates*, and BIS, Annual Innovation Report 2009
[70] Royal Society (2010), *The Scientific Century: securing our future prosperity*, Royal Society
[71] Royal Society (2010), op cit.

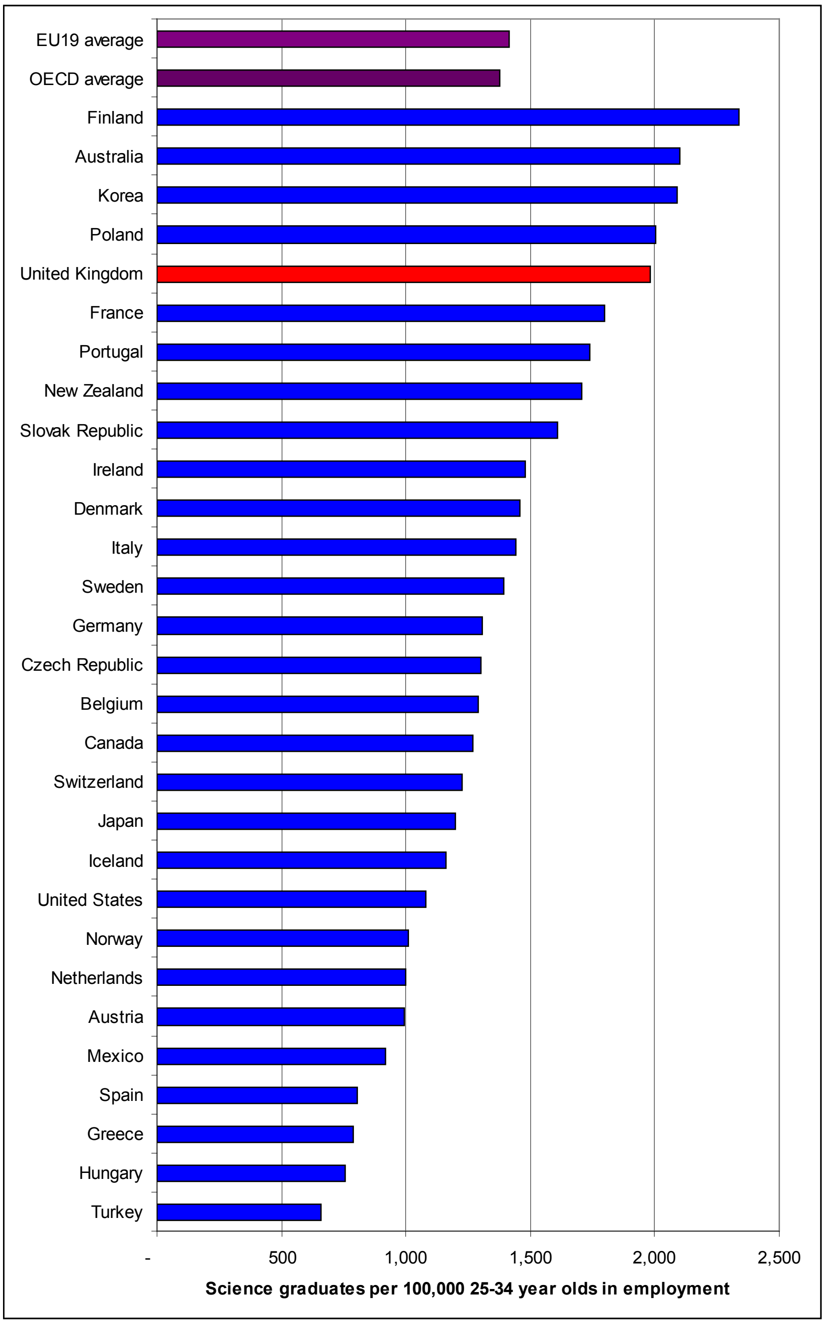
Figure 12: Percentage of tertiary graduates by field of education (2008)



Source: OECD

Note: These figures are for what the OECD terms 'tertiary type-A level' which refers to theoretical (university) rather than vocational higher education (college)

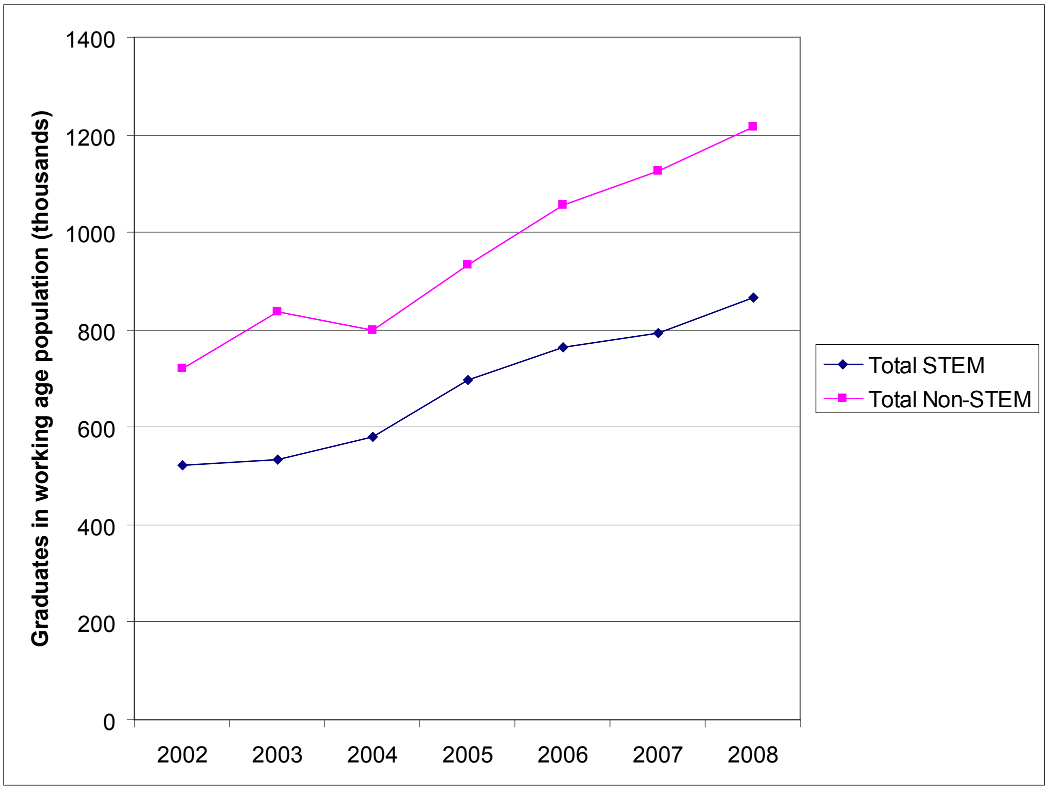
Figure 13: Science graduates among 25-34 year-olds in employment (2007)



Source: OECD, 2009

It is also interesting to note that the recent expansion in STEM graduates supply does not appear to have impacted on the perceived challenge facing recruiters. On some indicators, programmes and projects to increase the uptake of STEM subjects at secondary school and universities, such as STEMNET[72], appear to have had the desired effect. BIS's 2009 *Annual Innovation Report* highlights that entries by pupils in STEM subjects at A-level have increased 9.7 per cent since 2000, first degree graduates in STEM subjects increased 15 per cent from 2002/03 to 2008/09, and PhD graduates in STEM subjects increased by 19 per cent during the same period.[73] Figure 14 below illustrates the pace at which the numbers of STEM graduates in the working age population have increased in recent years.

Figure 14: STEM and non-STEM graduates in the working age population



Source: DIUS

It is worth highlighting however, that increases in STEM numbers also need to be viewed in relation to other subjects as the expansion of higher education has increased numbers across the board. Indeed, none of the core STEM subjects are among the five undergraduate courses with the largest increases in full time numbers between 1997 and 2008 – nursing, business and management, law, psychology, English.[74] Among post-graduate courses, computer science had

[72] http://www.stemnet.org.uk/
[73] BIS (2009), *Annual Innovation Report*.
[74] HESA online statistics http://www.hesa.ac.uk/index.php?option=com_datatables&Itemid=121&task=show_category&catdex=3

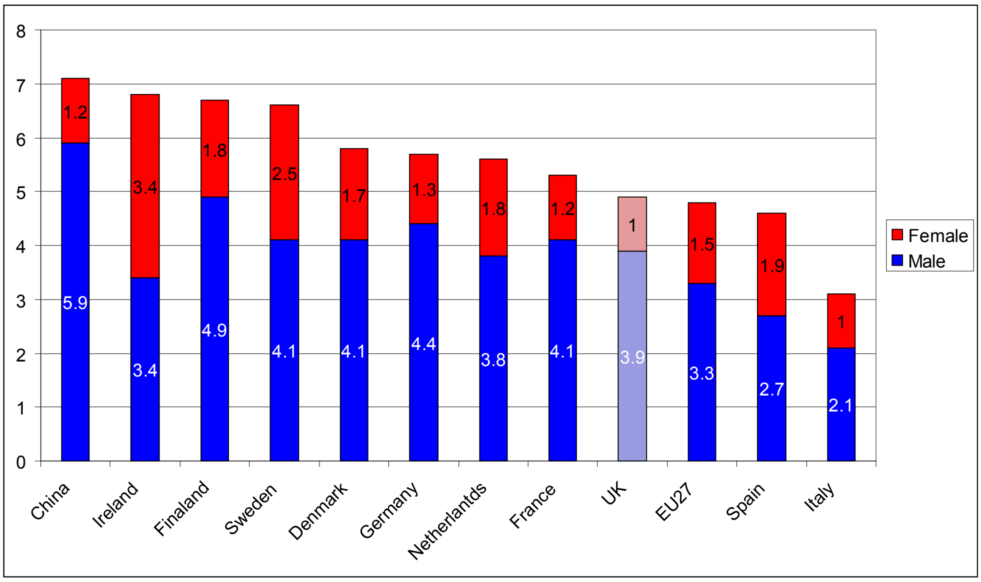
the second largest increase during this period but the other four were non-STEM disciplines – business and management, law, teacher training and psychology. Similarly DIUS found that while A-level entries had increased in STEM subjects, they had failed to keep up with the overall numbers taking A-level subjects so in actuality there has been a relative decline.[75]

2.2.3 STEM demand – STEM graduates and STEM industries

Despite the evidence that suggests significant future demand for STEM skills in the workforce, the data on recent STEM graduates and those already in the workforce suggests that there may be some issues affecting the operation of demand for STEM graduates from STEM industries.

The strong and expanding STEM graduate supply described above does not appear to be translating into employment in STEM industries – we seem to have a workforce with science degrees, rather than a strong science and engineering workforce.

Figure 15: Breakdown of scientists and engineers, 25-64 years old, by sex, as a percentage of the total labour force, EU-27 and selected countries 2006



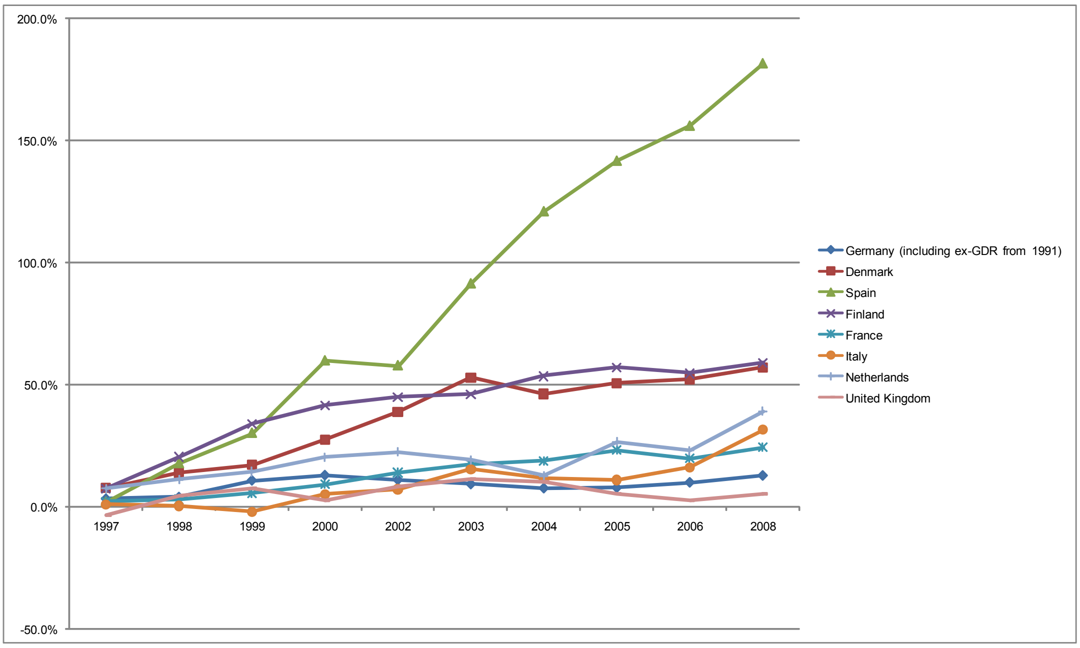
Source: Eurostat

Figure 15 highlights that the UK is only marginally above the EU-27 average in terms of scientists and engineers in the 25-64 year old labour force. There is a distinct gender bias to this problem – according to Eurostat analysis 47.9 per cent of the UK's potential science and technology human resources are female, but only 20.4 per cent are in S&T industry.

[75] DIUS (2009) *The Demand for STEM Graduates: some benchmark projections*

Similarly, the expansion in STEM graduates (Figure 14 above) has resulted in only incremental growth in our research and development population. Between 1996 and 2008, the number of full-time equivalent employees in research and development occupations in the UK increased by only 5.4 per cent. Large European economies including Germany (12.8 per cent), France (24.3 per cent), Italy (31.5 per cent) and Spain (181.6 per cent) have all seen significantly greater increases in their research and development population. Major economies in Asia are increasing at an ever faster pace – see Figure 16.

Figure 16: Growth in R&D personnel in selected EU countries (FTEs) 1996=100



Source: Eurostat

This picture concurs with a detailed analysis of the demand for STEM skills in the UK by the (then) Department of Innovation, Universities and Skills (DIUS). It found that just over a half of STEM graduates in the labour market are in non-STEM occupations[76], nine per cent work in

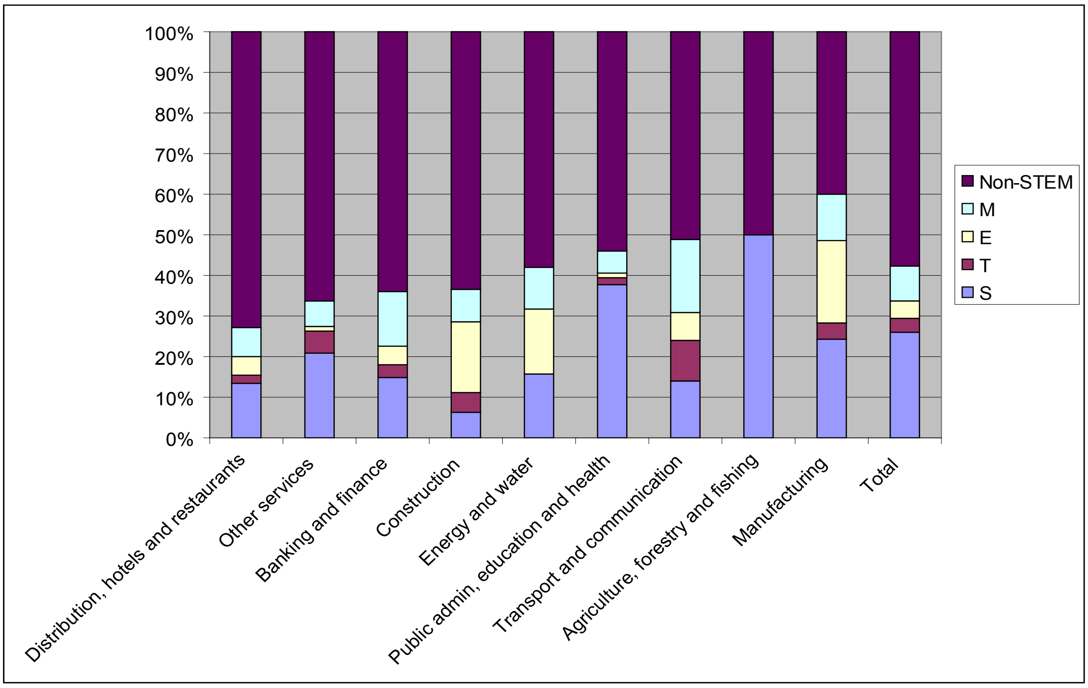
[76] DIUS developed a list of STEM occupations based on four-digit Standard Occupation Codes. While they acknowledge that this represents an arbitrary definition the low proportion of non-STEM graduates found in STEM occupations was noted as offering credibility to the classification:

i. managers in construction (1122), mining and energy (1123), IT (1136), R&D (1137), health services (1181), pharmacy (1182), healthcare practice (1183), farming (1211), natural environment (1212);
ii. chemists (2111), biologists (2112), physicists/mathematicians (2113),engineers (2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129), IT professionals (2131), software professionals (2132), medical occupations (2211), other medical professionals (2212), pharmacists (2213), opticians (2214), dentists (2215), veterinarians (2216), scientific researchers (2321), statisticians (24234), actuaries (24235), architects (24310); and
iii. technicians (3111, 3112, 3113, 3114, 3115, 3119, 3121), draughtspersons (2113), other medical associate professionals (3214, 3215, 3216, 3217, 3218, 3221, 3222, 3223, 32290, 32292, 32293).

Financial occupations were defined as: Financial institution managers (1151), Chartered and certified accountants (2421), Management accountants (2422), Management consultants, actuaries, economists and statisticians (2423), Finance and investment analysts (3534), Taxation experts (3535), Financial and accounting technicians (3537) teaching and between four and eight per cent work in finance leaving between 34 to 38 per cent of STEM graduates in non-STEM related occupations. This explains the apparent contradiction between the persistently low stocks of scientists and engineers in the UK compared to its EU and international competitors and the comparatively high number of science graduates among the 25 – 34 year old working age population.

The fact that STEM graduates are in jobs outside of STEM professions is not in and of itself detrimental and, as Figure 157 illustrates, STEM graduates span the entire range of industrial sectors.

Figure 17: Proportion of graduates with STEM skills by industry (as proportion of total graduates)



Source: LFS, Q1, 2009

The aggregate data analysed by HESE and presented in Figure 18, identifies a strong wage advantage for students from many STEM subjects. This strength holds even once the highly paid medical students are removed from the sample.

Figure 18: Imputed salary of graduates three-and-a-half years after graduation

Subject	Mean simulated salary six months after graduation	Mean simulated salary three and a half years after graduation
Chemistry	£16,339	£22,512
Physics, astronomy	£15,666	£24,759
Engineering	£17,981	£26,006
Mathematical sciences	£16,348	£25,757
Land-based studies	£14,007	£21,615
Modern foreign languages	£14,787	£26,823
Psychology	£13,345	£21,391
Sociology, social policy and anthropology	£14,908	£23,050
Medicine	£29,260	£40,078
Anatomy and physiology	£16,488	£22,973
Biosciences	£14,070	£21,382
Nursing	£19,052	£23,749
Pharmacy and pharmacology	£15,162	£28,683
Health studies	£16,505	£24,357
Sports science	£14,495	£23,220
Architecture, building and planning	£16,965	£26,873
Other physical sciences	£14,311	£23,055
ITS and computer software engineering	£16,731	£25,631
Business and management	£15,456	£23,552
Finance and accounting	£15,620	£24,673
Humanities and language-based studies	£14,509	£23,979
Geography	£14,989	£22,667
Education	£16,486	£22,963
Design and creative arts	£13,151	£21,788
Media studies	£13,358	£21,187
Combined	£13,545	£22,912
STEM	**£17,086**	**£25,699**
STEM Excluding Medicine	**£16,157**	**£24,602**
All	**£15,514**	**£24,091**

Source: HEFCE (2008) Graduates and their early careers

Note: Data drawn from survey of the 2002-03 graduating class

However, while it is argued that STEM graduates are ‘economically valuable’ in non-STEM professions, the evidence, at least measured by wages, does not support this contention. The DIUS report on STEM demand found that, controlling for a range of factors associated with earnings[77], STEM graduates only enjoy a wage premium in science or finance related occupations.[78] This lack of premium suggests that STEM skills are not particularly valued in non-STEM occupations. This large deadweight factor potentially undermines the notion of public support for STEM training. This is a particular issue given the higher cost of offering many STEM courses – a topic explored in detail in Section 3 below.

The DIUS report concluded that ‘…the most likely explanation is some kind of mismatch between the type of skills STEM graduates have, and the type of skills sought in science occupations.’[79] This analysis also implies that STEM graduates aren’t necessarily in non-STEM jobs because of better remuneration since, apart from the small minority entering the finance sector, they are earning less outside of science, engineering and technology roles. This issue of quality is also explored in detail below.

As well as not entering STEM industries, comparatively few engineering and technology graduates progress into further research degrees such as Masters and Doctorates.[80] The majority (57.7 per cent) that do go on to do PhDs are foreign born students, as are a significant minority (44.9 per cent) of Masters students. Engineering UK notes:

> *The implications for the UK economy, it’s businesses, and the education system, are as yet unknown nevertheless unforeseen erosion of UK’s technological competitiveness must not be overlooked.*

It is also possible that organisations employing STEM graduates outside of STEM occupations are not making the most of their skills. Ng argues that insufficient application of STEM tools and processes in service innovation are often due to poor understanding of their application, a lack of understanding of their application and less interaction with universities – more ambitiously the author argues that ‘service’ needs to develop into a discipline in its own right and the service sector needs a ‘paradigmatic shift from a product-centric industrial era mindset’.[81]

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[77] Prior attainment, institution studied at, gender, ethnicity, socio-economic status and age
[78] DIUS (2009), *The Demand for Science, Technology, Engineering and Mathematics (STEM) Skills*.
[79] DIUS (2009), op cit.
[80] Engineering UK (2009), *Where do Engineering and Technology Graduates go?*
[81] Ng, I (2008), ‘Service Innovation and role of Science, Technology, Engineering and Maths: Ten Challenges for Industry, Academia and Government’, White paper, Centre for Service Research. http://www.eric.exeter.ac.uk/exeter/bitstream/10036/48254/1/serviceinnovation_whitepaper_a4.pdf

Finally, data on the immediate prospects for STEM graduates also provides a picture that does not support the consensus that STEM skills are in demand – or at least the STEM skills that are being produced by UK HEIs. Figure 19 highlights a mixed picture across the board with respect to the relative outcomes of STEM subject graduates relative to other non-STEM graduates. The table outlines the six possible paths for graduates post-graduation and indicates in green or orange whether graduates from that discipline were above or below the average for the cohort. In terms of employment in the UK, the top performers are all medically related followed by education graduates. The other two STEM subjects that had an above average employment rate, engineering & technology and computer science, were only marginally above average at 59.6 per cent and 62.4 per cent respectively and also had above average 'assumed' unemployment. According to the data from HESA, graduates from STEM subjects had an above average unemployment rate with the exception of medically related subjects and biological sciences.

The HESA figures also show that a significant minority of graduates in key demand areas such as physical sciences and engineering are taking up employment opportunities overseas. Apart from those graduates with language degrees, engineering and technology graduates are the most likely to head abroad for employment with 4.5 per cent of all graduates choosing this route. This could be due to better opportunities or reflect the significant number of non-UK domiciled students in many STEM disciplines.[82]

[82] International students are significantly more likely to be in STEM subjects such as engineering and technology, where international students comprise 30 per cent of total enrolments. Computer science (20 per cent) and mathematical sciences (18 per cent) also contain an above average proportion of international students

Figure 19: Destinations of 2007/08 higher education leavers in the UK

	UK employment only	Overseas employment only	Combination of employment and study	Further study only	Not available for employment	Assumed to be unemployed	Others
Medicine & dentistry	88.6%	0.1%	5.7%	4.9%	0.3%	0.2%	0.2%
Education	74.7%	1.3%	7.7%	9.9%	2.4%	3.2%	0.8%
Subjects allied to medicine	76.3%	1.1%	7.3%	8.1%	2.0%	4.4%	0.7%
Veterinary science	80.6%	3.1%	3.1%	4.1%	3.1%	5.1%	1.0%
Law	33.0%	1.6%	10.2%	44.5%	4.0%	5.6%	1.2%
Combined	55.0%	1.6%	6.2%	20.9%	7.0%	7.8%	0.8%
Biological sciences	55.0%	2.0%	8.1%	21.2%	4.9%	7.8%	1.1%
Social studies	58.7%	2.6%	7.9%	16.2%	5.2%	8.1%	1.2%
Agriculture & related subjects	62.8%	3.2%	8.2%	11.4%	5.4%	8.2%	1.3%
Mathematical sciences	44.2%	2.1%	14.0%	25.1%	5.0%	8.5%	1.2%
Languages	50.1%	5.4%	7.1%	22.9%	4.8%	8.5%	1.2%
Physical sciences	46.3%	2.8%	6.3%	28.8%	5.2%	9.4%	1.3%
Business & administrative studies	58.8%	3.5%	10.4%	11.3%	5.0%	9.5%	1.5%
Engineering & technology	59.6%	4.5%	6.1%	14.6%	3.7%	10.0%	1.5%
Historical & philosophical studies	49.9%	2.5%	7.3%	24.1%	4.9%	10.0%	1.2%
Architecture, building & planning	56.3%	3.4%	11.3%	13.3%	3.9%	10.5%	1.4%
Creative arts & design	63.8%	2.3%	6.3%	10.7%	4.0%	11.2%	1.8%
Mass communications & documentation	68.5%	2.0%	3.9%	7.2%	4.7%	12.2%	1.7%
Computer science	62.4%	2.3%	4.4%	12.1%	2.9%	14.3%	1.6%
2007/08 Total	**59.4%**	**2.6%**	**7.6%**	**16.6%**	**4.1%**	**8.4%**	**1.3%**
2006/07 Total	**61.2%**	**2.6%**	**8.7%**	**16.3%**	**4.3%**	**5.8%**	**1.2%**
2005/06 Total	**60.7%**	**2.7%**	**8.4%**	**16.1%**	**4.6%**	**6.4%**	**1.2%**

The evidence presented here appears to highlight a paradox. We seem to have a high reported demand for STEM graduates which is thought not to be met by current supply. This is surprising given that we have a strong and expanding supply of graduates from these subjects. Demand does not seem to be attracting a high proportion of these graduates into what we might expect to be STEM professions, despite a clear wage premium. Given this context the high apparent unemployment rate for STEM graduates is perplexing. The implication is that any further increases in the supply of STEM graduates may not resolve this issue. This suggests that either something is holding back individuals from entering these professions, or higher education institutions are not producing the STEM graduates which meet the needs of business.

2.2.4 STEM Quality

It has been suggested that the reason why STEM graduates are not meeting business demand relates to the quality of the graduates. It seems that businesses are demanding not only more graduates but better quality graduates in STEM subjects – either in terms of their intellectual calibre, their knowledge and expertise of STEM areas or their cultural capital and wider skills such as team working, communication skills, leadership potential and business acumen.[83] The CBI's 2008 education survey found that 42 per cent of employers believe the quality of graduates is a major barrier to STEM recruitment.[84] Technical and practical skills are the main concern, but there are also significant worries about the lack of transferable skills in areas such as problem solving, commercial awareness, team working and communication.

With STEM graduates working in positions throughout the value chain and in inter-disciplinary teams, these skills are increasingly in demand and increasingly under-supplied. A report by DIUS on the demand for STEM graduates found that recruitment difficulties were more often related to 'broader concerns about a lack of well rounded candidates'.[85] With respect to those in post-graduate training, the Roberts' Review concluded that:

> *… the training elements of a PhD – particularly training in transferable skills – need to be strengthened considerably. In particular, the review recommends that HEFCE and the Research Councils … should make all funding related to PhD students conditional on students' training meeting stringent minimum standards. These minimum standards should include the provision of at least two weeks' dedicated training a year, principally in transferable skills, for which additional funding should be provided and over which the student should be given some control.*[86]

[83] HEFCE (2010), *Strategically Important and Vulnerable Subjects*
[84] CBI (2008), *Taking Stock: CBI education and skills survey*
[85] http://www.bis.gov.uk/assets/biscore/corporate/migratedD/publications/D/Demand_for_STEM_Skills
[86] Roberts, 2002

The demand for these skills is only likely to increase. Changes in the workplace mean that the range of skills required has shifted in content, complexity and distribution. HEFCE noted that the globalisation of production and research is requiring employees to work together in new ways. This is raising the importance of employees' 'soft' skills and adaptability.[87]

A significant change for STEM graduates is the prevalence and level of interdisciplinary work that takes place. While inter-disciplinary working between professions such as architecture and engineering have been common place for many years, there is now much greater collaboration between a range of disciplines in both academia and professional workplaces.[88] This shift requires not only specific skills related to communication, team-working and problem-solving but also greater understanding and empathy for different points of view.

2.3 A wider understanding of the skills for innovation?

Analysis suggests that in addition to the issues with STEM set out in Section 2.2 above, the concept is not totally synonymous with the notion of the skills for innovation demanded by the 2020 knowledge economy. This section suggests that the grouping of STEM subjects is artificial. It includes unlikely candidates which detract from the power of the concept, and excludes a number of areas of education which may be of relevance to a broad appreciation of the skills for innovation.

This section makes the case for a more balanced focus on the skills for innovation.

The limitations of an aggregate STEM focus

The attention paid to the total number of STEM graduates is perhaps misplaced. There are concerns that the overall STEM increases in higher education mask decline in key areas. The inclusion of 'biological sciences', including psychology and sports science are perceived to have artificially inflated numbers, particularly given the increases in these disciplines.[89] Even when these changes are accounted for, the stagnation of maths and chemistry graduates and the historical decline in physics are masked by marked increases in medicine. At undergraduate level a 34 per cent increase in medicine and dentistry between 2002/03 and 2006/07 masks significant declines in chemistry (down 11 per cent) and computer science (down 10 per cent).[90]

[87] HEFCE (2010) *Strategically Important and Vulnerable Subjects*
[88] Royal Society, (2010), *op cit.*
[89] Analysis by DIUS of the occupations of STEM graduates three and a half years after grduation identified very low proportions Sports Science (1 per cent) and Psychology (23 per cent) students entering STEM related careers (49 per cent average). This suggests that these courses are distinct from other STEM subjects, and should not necessarily be grouped togehter.
[90] Ibid

Other reports have also highlighted problems with the official statistics on STEM supply and relying on an aggregate analysis across all STEM disciplines. In addition to the aforementioned masking of decreases by surging numbers in psychology, forensic science and sports science, the Royal Society's report, *A degree of concern?* (2006) found that increases in biology and mathematics were 'apparent rather than real' since they are the result of changes to the way in which students doing combined degrees are classified.[91] Far from being a negligible difference, the report's revised analysis of HESA statistics found that, accounting for these changes, the reported 35 per cent increase in mathematics graduates between 1995/06 and 2004/05 was only 7.4 per cent. Similarly, the reported 12.8 per cent increase in biology graduates fell to 1.7 per cent when these factors were taken into account.

Related to this issue with STEM graduate numbers, the headline STEM A-level numbers are also potentially misleading. As BIS's predecessor DIUS found, while A-level entries had increased in STEM subjects there has also been a stagnation of entries into key STEM subjects such as chemistry and maths and an absolute decline in physics entries, from 28,400 in 1996[92] to 23,932 in 2007.[93]

Other key skills for innovation

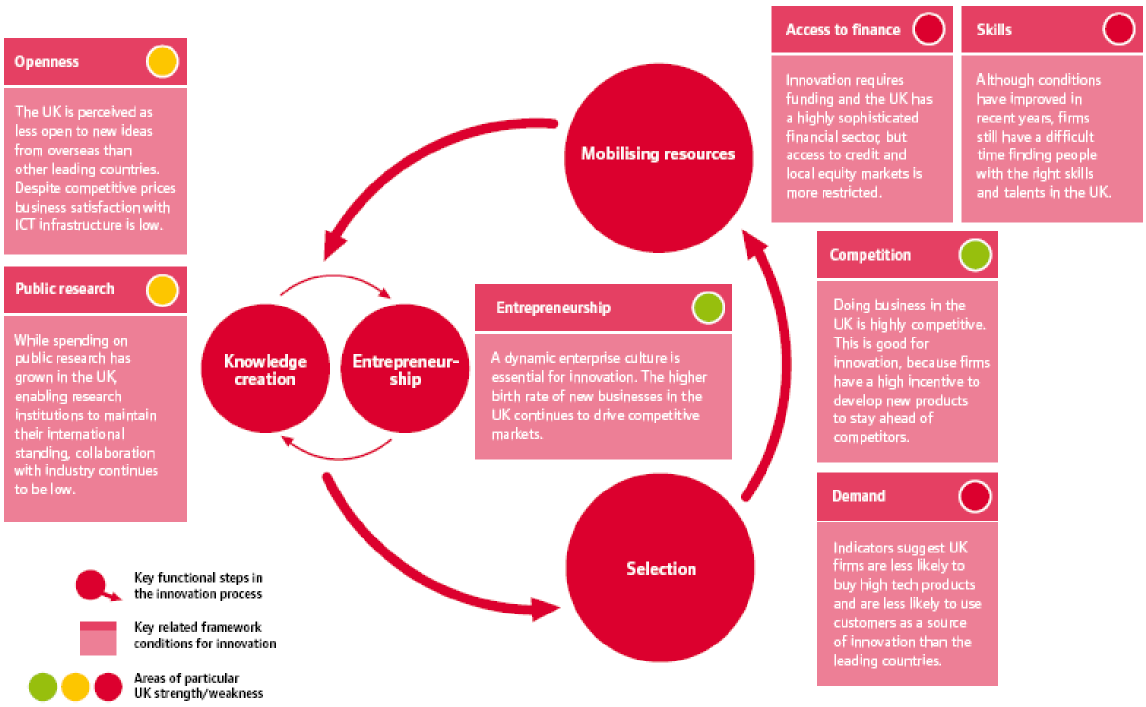
The key weakness with targeting support for STEM skills is that they are only of particular relevance for a sub-set of the full innovation process. As set out within Box 4, innovation is a broad process which depends not only on the creation and development of knowledge, but also on the application of this knowledge to create benefits – most commonly understood in terms of financial returns. This depends on upstream and downstream processes which support investment in innovation and the downstream process of new product selection, often performed within markets. This idea is perhaps most easily understood when viewing innovation as the product of a system.

Such a system can perhaps most readily be understood based on the notion of the building blocks of knowledge creation, entrepreneurship, the selection of potential innovations and the mobilisation of resources to support the process. Investments in intangible assets represent inputs into this system, and innovation its self is the output. The efficiency of the system (its ability to generate innovations from investment) is determined by the condition of the system – how the building blocks operate, and how they link and interact with each other.

[91] http://royalsociety.org/A-degree-of-concern-First-degrees-in-science-technology-and-mathematics/
[92] The longer term decline is even more dramatic – in 1983 over 53,000 students took A level physics
[93] DIUS, (2009) The Demand for STEM Graduates

Work by NESTA (2009) identifies a number of the factors which together determine the condition of the system. Figure 20 illustrates such a system and presents their analysis of these conditions for the UK.

Figure 20: The Innovation System



Source: Adapted from NESTA (2009)

As noted above, STEM skills are of particular relevance in the creation of new knowledge and technical scaling of this associated with product based innovations. However, these skills are not necessarily of direct relevance for the up-stream processes of identifying needs and mobilising resources to invest in such gaps. STEM skills are equally not necessarily direct relevance for the down-stream process of entrepreneurship and engaging with markets.

Innovation depends as much on the strengths of the links of the system, as on the creation and development of new knowledge. Viewed from this perspective, the role for STEM skills within innovation becomes less apparent. The recent case study analysis of innovation in public services from NESTA illustrates this well[94]. The research presents examples of radical process innovations. Consistently success was dependent on openness, communication, cooperation,

[94] Gillinson, Horne and Baeck (2010) *Radical Efficiency: Different, better, lower cost public services*

partnership, empathy between producers and consumers, an ability to lean from feedback and careful risk management, rather than some form of technical excellence.

Unfortunately very little research has been conducted to date into what these additional skills for innovation might be. The broad notion of innovative capacity is presumably a highly personal characteristic. It seems plausible that it will depend on an individual's knowledge of subjects developed the full range of their academic, professional and personal experience and will be conditioned by the unique ways in which individuals approach questions and challenges. Some important discussions in this area include the Work of Gardner as reflected within his book *Five Minds for the Future,* Dan Pink's work *A Whole New World* and the extensive literature on soft skills.[95]

However, this work has struggled to precisely define how to inculcate these capacities within individuals beyond the need to raise education levels in general. They offer very little in the way of insights into whether it is possible to set up public policy structures which support such development, particularly at the tertiary level – the focus of this paper.

We have however identified a number of skills which are of relevance for these up and downstream innovation activities which are broader than STEM:

- **Design skills** –The Cox Review defined design as shaping 'ideas to become practical and attractive propositions for users or customers'. This is of clear relevance for innovation since it depends on new knowledge being translated into a form in which it is of maximum value to business and consumers;

- **Commercial skills** – If innovation depends on the understanding of how products will sit within and can lead to the development of new markets, then understanding how business and markets operate will be of particular relevance; and

- **Communication Skills** – The ability to transmit information, thoughts or opinions is of clear relevance for all aspects of innovation. It is important for example to an individual's ability to work collaboratively on research, for their ability to sustain networks, vital for market development and marketing activities, and of relevance for attracting funding. Humanities courses which have an explicit focus on communication, may therefore be of great relevance for supporting innovation.

[95] Please see Tether et al. (2005) A Literature Review on Skills and Innovation. How Does Successful Innovation Impact on the Demand for Skills and How Do Skills Drive Innovation? for a review of thought in this area. Accessible at http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file11008.pdf

The relevance of these skills for innovation undermines the notion that STEM subjects are of particularly special relevance. This suggest that such skills may also be subject to the positive spillover effects described for STEM skills in Section 2.2.1. This analysis suggests that a broader focus is required on what the skills for innovation are, and how they are supported by the government.

Box 7: Innovation – dependent on the renaissance man, or a renaissance society?

The breadth of skills with particular relevance for innovation gives rise to an important, and often overlooked question – does innovation depend on the skills of individuals or the mix of skills in society?

- Will the 2020 economy demand a group of innovators who have mastered the full breath of these innovation skills? The archetypal renaissance man would perhaps be Leonardo da Vinci – an individual renown as a 'painter, sculptor, engineer, astronomer, anatomist, biologist, geologist, physicist, architect, philosopher, humanist'.[96] Many argue that technological fusion and an increased place for co-operation across industries and technological boundaries is changing the demand for skills towards workers with broader, less specialised or multi-disciplinary skills.[97] This notion would match closely to the idea of a renaissance man who is capable of excellence across a range of disciplines. If this is the case then it is essential that our education system which encourages individuals to develop detailed knowledge of diverse areas; or
- Can innovation depend on the interaction, co-operation and relationships between individuals with these skills in society? By building on the capacities of many individuals it is perhaps possible for the total knowledge driving an innovation to be deeper and more detailed. If this is of relevance for innovation then the nature of society will play a major role in determining the innovative capacity – innovation policy should perhaps consider promoting initiatives such as the greater interaction between different professional bodies.

However, it seems highly unlikely that there is a single answer to this question. A balance between these two notions would be very difficult for government to prescribe, and would in any case depend on individual personal characteristics. The challenge for policymakers must be to construct a system in which individuals can develop a broad range of skills, and a society which promotes the effective sharing of knowledge.

[96] Johnston and Walker Smith (2003). *Life Is Not Work, Work Is Not Life: Simple Reminders for Finding Balance in a 24-7 World*
[97] See for example, Kodama (1992) *Technology Fusion and the New Research and Development*

2.4 Reflections and discussion

The evidence presented in this report paints a clear picture about the future needs of graduates for the 2020 knowledge economy. Unfortunately, evidence on any direction that public policy should try to exert on the nature of this supply is more complicated to interpret. Translating notions of 'economically valuable' degrees into policy has proved challenging.

The analysis has confirmed the relevance of STEM training for the 2020 knowledge economy. However, in contrast to well publicised claims of some employers, the evidence presented within this paper suggests that the issues with STEM skills are more subtle than a straightforward issue of under supply. It seems that the key challenges for STEM is to stimulate effective demand to ensure that individuals are attracted to STEM professions, and to promote the quality of STEM training.

This could be achieved through:

- Policy encouraging STEM graduates into industry could be productive:
    - Using nudges that have been successful in encouraging graduates into teaching – eg lower interest loans;
    - Tax breaks for small firms – for example, investment in STEM human capital qualifies as R&D spend;
    - Changing workplace image and reality – attracting more females into STEM professions, flexible working practices;
    - Employer engagement and investment – need to continue the efforts to improve this led by UKCES. The benefits of employer involvement are staggering, a one unit increase in employer involvement increases graduate employability by 25 per cent.

- Industry and entrepreneurialism skills:
    - Support for applied advanced research degrees in technology innovation centres similar to those at French Carnot Institutes, which host 6,500 PhD researchers, and the Fraunhofer Institute, which has a Masters Programme for individuals with five years industry experience;
    - Continuing support for University Enterprise Networks – regionally based networks led by the National Council of Graduate Entrepreneurship and BIS.

- Focus on increasing quality of STEM degrees:
    - More funding per person through industry sponsored places;
    - Greater interdisciplinary working to be encouraged within STEM courses.

In addition, our analysis suggests limitations to the prioritisation of STEM skills as a proxy for the skills for innovation. STEM skills include a range of activities which would not typically be thought of as particularly relevant for innovation. A focus on STEM skills also excludes a number of areas of training which are potentially of special relevance. Instead we need a broader understanding of the high level skills for innovation.

The government should replace the current system of bids for an additional 10,000 STEM and other vulnerable subject places with a broader competition for additional places in courses that specialise in boosting the innovative stock of the economy. It might be sensible to leave it to universities to innovate and to present bids defining what this means and how they can boost the innovative potential of their students.

3. Funding higher education

Sections 1 and 2 above set out the importance of sustaining the recent expansion in higher education and stress the rationale for government support to influence the mix of subjects studied at university in order to promote innovation. However higher education represents a major draw on public resources. In this time of public sector funding austerity, such monies are increasingly viewed as unsustainable and any expansion in funding seems unlikely.

The Secretary of State for Business Innovation and Skills (BIS), Vincent Cable has emphasised the strain which the funding system is currently under strain. BIS has already been asked to make financial savings of £836m in the current financial year. The department has asked universities to contribute £200m towards these,[98] on top of cuts of £915m announced in January by the former Secretary of State, Peter Mandelson.[99]

Following the Chancellor's emergency budget in June, we can now expect spending cuts of 25 per cent across all non-ring fenced departments within the life of this parliament. Budget for front line health and education (primary and secondary) services has been safeguarded, and it is understood that spending on defence and primary and secondary education will not be cut to the same extent. The safeguarding of some areas will necessitate deeper cuts in others and there has been no indication that higher education will be protected.[100] Indeed we have been led to believe that we can expect major reform of higher education funding following the publication of the Browne Review of higher education funding and student finance.

This section details the current funding regime for higher education and explores in detail what is driving change. It concludes by considering the likely implications of the three main options for reform, focusing in particular on how well they can help the sector to meet the future needs of the economy set out in Sections 1 and 2 above.

3.1 Public skills policy and the Leitch review

As set out above, in a competitive and globalised economy, the UK has increasingly relied on the knowledge and skills of its workforce for increased productivity and competitive advantage, rather than its physical assets. It is well established and widely understood that individuals and businesses in the UK enhance their productivity and achieve significant rates of return by investing in skills.[101] Past governments have demonstrated an awareness of this imperative and

98 http://www.hefce.ac.uk/pubs/circlets/2010/cl14_10/
99 http://www.guardian.co.uk/education/2010/jan/25/universities-david-lammy-cuts
100 In a recent speech on higher education Vince Cable confirmed that 'no one should be under any illusion that there will be any other than deep cuts in government spending on universities.' http://nds.coi.gov.uk/content/Detail.aspx?NewsAreaID=2&ReleaseID=414467 It has also been reported that the Cabinet Office have told all Vice Chancellors to prepare for spending cuts of 35 per cent http://www.timeshighereducation.co.uk/story.asp?sectioncode=26&storycode=412956&c=2
101 For example, over their working life a university graduate will earn, on average, comfortably over £100,000 more than an individual whose highest qualification is 2 or more A-levels (BIS, 2009)

aimed to create a skills system in the UK that works for individuals, employers and providers alike. The Leitch Review of Skills published in 2006, has been a significant influence of the current course of government activity and many of its recommendations have shaped the UK's ambitions.[102]

As section 1.3 notes, the recession has created, highlighted and exacerbated a number of labour market trends and challenges that require thoughtful and careful responses. In addition, the UK continues to grapple with historic and often seemingly intractable skills problems. Despite recognition that investment in skills will guarantee sustainable international competitiveness, the UK places well below many countries in the OECD, particularly in intermediate levels of skills, and in many cases the gap is widening.[103] The UKCES's report *Ambition 2020* highlights the key challenges to the current UK employment and skills system[104]. While none of these are particularly new, they are worth detailing:

- **Mismatches between jobs and skills:** The supply of skills is not aligned to the labour market, creating skill shortages and skill gaps. Skills shortages and gaps also pose potential barriers to sustained growth in our knowledge intensive growth industries including low carbon industries, high-tech manufacturing, pharmaceuticals and the creative industries.

- **Employer ambition:** UKCES argues that it is not enough to simply raise skill levels and align the skills with the skill requirements. To retain international competitiveness, the UK needs an economy that drives a higher demand for skills. It operates on the principle that skills are a 'derived demand' dependent on the shape and level of economic activity. Skills utilisation is also vital to enhancing productivity. Effective leadership and management supported by 'high performance working practices' is vital to making the most of the talent available.

- **Complexity of the skills system:** The current skills system is unwieldy. According to UKCES we face a 'policy gap', a 'policy to practice gap' and a 'measurement gap'. *Ambition 2020* proposes a new strategic framework for thinking and action on the skills and employment agenda.

[102] Leitch, S. (2006), *Leitch Review of Skills*
[103] The UKCES report *Ambition 2020* provides a good overview of the skills challenges across the population
[104] UKCES (2009), *Ambition 2020*, UKCES

Our interest is in the shape of the knowledge economy of 2020 and it is a year that is particularly relevant to the skills agenda in the UK. The ambitions set out by the Leitch Review were to be achieved by 2020 and the likely successor to the Lisbon strategy for jobs and growth, EUROPE 2020[105], will also focus on achieving its goals by 2020. The Leitch Review's goals were ambitious. It recommended that the UK aim to move to the top quartile of OECD performers by 2020 in functional literacy and numeracy, basic skills, intermediate skills and high-level skills. To achieve this ambition in higher skills, 40 per cent of the adult population needed to attain Level 4 (degree level or above) qualifications from a baseline of 29 per cent in 2005.

Anticipated progress towards the targets is mixed and there is particular concern about failure to improve low and intermediate skill levels. *Ambition 2020*, the UK UKCES review of progress towards the Leitch ambitions, predicts that the UK will exceed the high skill target with 42 per cent of the adult population having Level 4 qualifications by 2020. The UK is no longer on track to meet basic literacy and numeracy ambitions. [106] Performance as measured by international benchmarking in these areas has fallen. UKCES is not optimistic about the UK's ability to reach Leitch's ambitions in low-level and intermediate skills; it predicts that the UK will slip from 19th to 20th in the OECD by 2020 in low-level skills (percentage of population qualified to at least Level 2) and remain 21st in intermediate skills (Level 3 qualifications).

Prior to the recession there were already concerns that the expansion of higher education has led to under-employment among graduates, a reduction in the quality of education, and a reduction in the value of university education in the labour market. This concern has been compounded by the difficulty in financing the level of higher education expansion advocated by the Leitch Review. As a result of the record budget deficit, universities have already been subject to cuts prompting a negative reaction from higher education institutions and their representatives. While these cuts were not directed at research funding, it is argued that the continued expansion of higher education and further education, in line with the ambitions of the Leitch Review, cannot be the full responsibility of the government. As the Department for Business, Innovation and Skills' report notes:

> *Universities have enjoyed a benign financial climate over recent years. Growth based so heavily on state funding cannot continue and this confronts government and universities with a series of challenges. Maintaining excellence in both teaching and research is key. We recognise that per capita funding is important but also that in the current circumstances maintaining that level through public expenditure alone will be extremely difficult. That is*

[105] http://ec.europa.eu/eu2020/.

[106] The UK is no longer on track to meet its functional literacy target of 95 per cent by 2020. Current trajectories suggest they will fall one percentage point short of the numeracy target of 90 per cent

why the development of a diverse set of funding streams is important if the quality of higher education is to be maintained and improved.[107]

3.2 Higher education funding in 2010

The funding of universities is highly complex and is often misunderstood. Complexity comes from the fact that, despite perceptions, universities operate independently of government and are technically not considered to be part of the public sector. Predominantly incorporated as charities, they draw funding from private sources as well as from a number of different public sector funds.

***Spending on higher education institution*s**

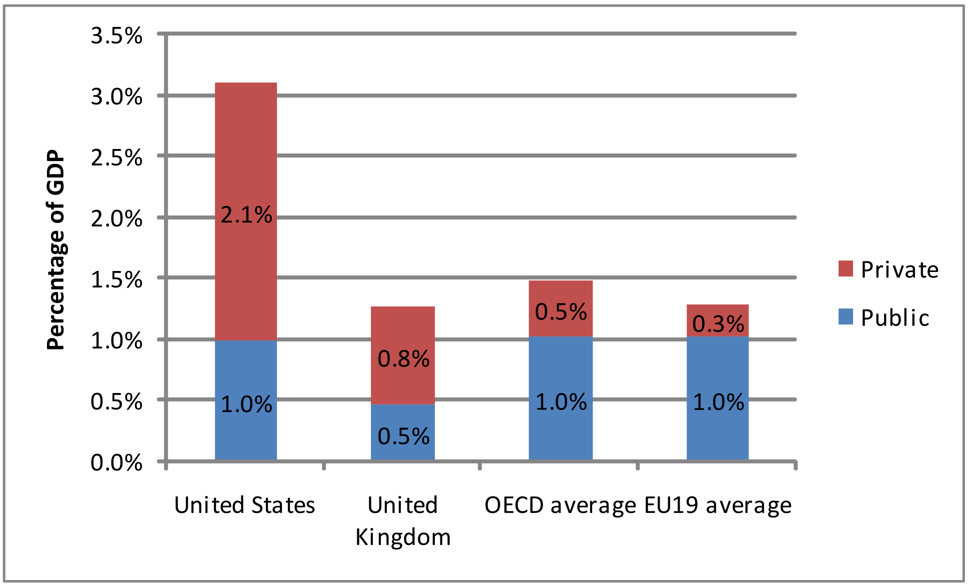
As a proportion of GDP, the UK currently spends the same on higher education institutions as a percentage of GDP as the EU19 average, but slightly below the OECD average – see Figure 21. Compared to our main EU competitors (including France and Germany), the UK receives a greater proportion of funding from private sources, but lags behind many of the larger OECD economies, including the United States, Korea, Canada, Japan and Australia. Overall UK higher education institutions receive slightly less from private sources as a percentage of GDP than the OECD average (0.5 per cent) and is significantly less than the United States (1.9 per cent).[108]

Many universities have aggressively chased international students to increase revenue and the UK is currently responsible for 12 per cent of the international student market, second only to the US. As Figure 22 shows, fees from overseas students comprise eight per cent of higher education income, four times the amount derived from postgraduate fees.

The accompanying investment in our universities to achieve this expansion, particularly in research and development, has assured and extended the UK's international competitiveness, placing four universities in the top ten higher education institutions in the world according to the QS World University rankings.[109] As noted earlier, the quality of the higher education sector, alongside active marketing, has also led to a significant increase in the number of non-UK domiciled students attending universities in the UK. While there are legitimate concerns about higher education funding in the UK, spend per head on tertiary education in the UK is higher than the OECD average and between 1995 and 2007 increased by 48 per cent. This increase was driven however by the one off increase in the cap on tuition fees at the end of this period. The increase between 1995 and 2005 was only 15 per cent. However, as Figure 23 shows, the US has sustained a comparable rate of increase from a much higher base. In 2007 expenditure stood at US $27,000 per student.[110]

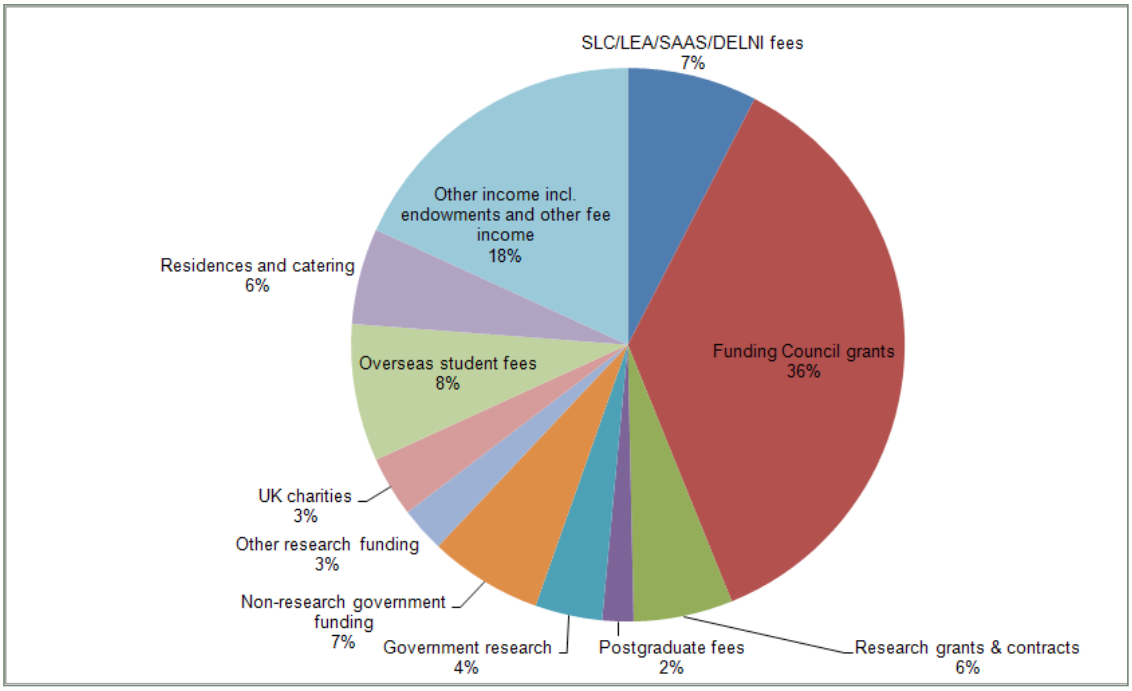
[107] http://www.bis.gov.uk/wp-content/uploads/publications/Higher-Ambitions-Summary.pdf
[108] OECD, Education at a Glance, 2009
[109] http://www.topuniversities.com/university-rankings/world-university-rankings/2010/results/
[110] In 2000 prices adjusted for purchase parity across the OECD

Figure 21: Expenditure on tertiary educational institutions as a percentage of GDP, by source of fund and level of education (2007)



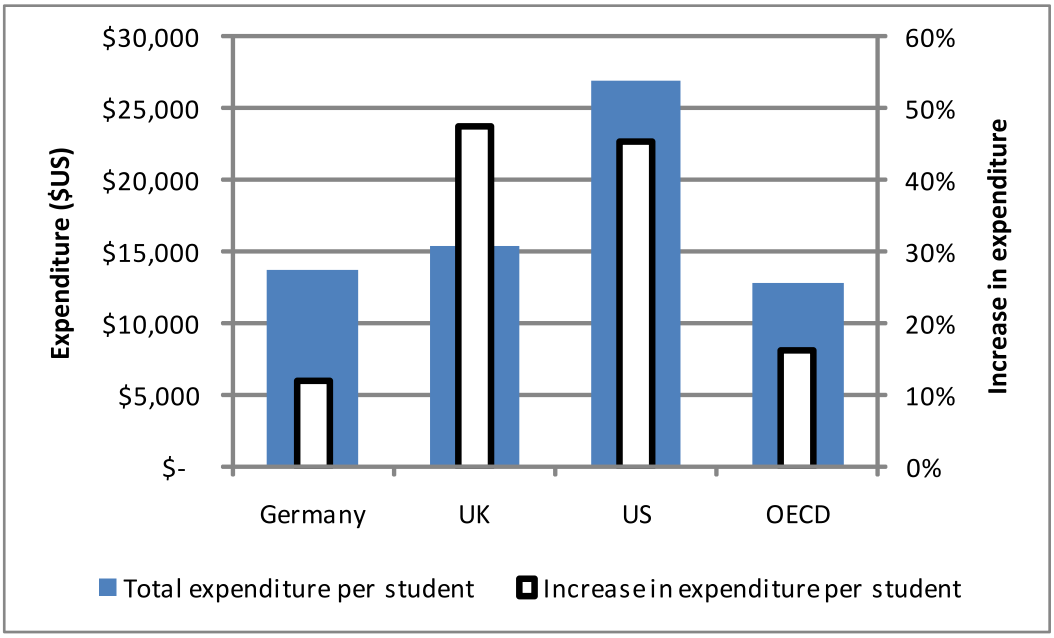
Source: OECD, Education at a Glance, 2010

Figure 22: Sources of finance for UK universities and colleges in 2007-08



Source: HESA Finance Record 2007-08

Figure 23: Expenditure on tertiary education in Germany, UK and US (per student and increase per student between 1995 and 2007)



Source: OECD

Note: Expenditure in 2000 US$ adjusted by purchase parity

Pressure on the higher education system has been identified as coming from new challenges facing higher education institutions, placing new demands on resources. The review of higher education finance and pay data conducted by the Unions and the University and Colleges Employers Association noted that:

> *New challenges and opportunities have arisen, including students from a much wider range of backgrounds; new teaching and learning methods and technologies; greater expectations from employers, students, and government; and a more complex and costly operating environment, including greater domestic and international competition. Institutions now have to invest more, and they have a lower proportion of secure public funding, and more contract and commercial income which incurs higher risk and costs of marketing, tendering and negotiation.*
>
> Joint Negotiating Committee for Higher Education Staff (2010)

The stabilisation of the unit of resource for teaching, reform of public research funding, new capital grant schemes, and the introduction of variable student tuition fees seem to have improved the finances of the sector. However, the review concluded that higher education institutions are not achieving surpluses which can support the investment required to achieve long term sustainability.

Funding for higher education teaching

In 2010/11 the Higher Education Funding Council will allocate £4.7bn as a teaching grant. These funds are predominately allocated based on the number of students attending an institution, with an allowance made for the costs of delivering certain courses:

Box 8: Differential public higher education funding – teaching

Currently an allowance is made in HEFCE funding reflecting the fact that teaching different subjects requires different levels of resource:

Group	Description	Cost weight	2010/11 grant
A	The clinical stages of medicine and dentistry courses and veterinary science	4.0	£15,804
B	Laboratory-based subjects (science, pre-clinical stages of medicine and dentistry, engineering and technology)	1.7	£6,717
C	Subjects with a studio, laboratory of fieldwork element	1.3	£5,136
D	All other subjects	1.0	£3,951

Source: HEFCE 2010

In addition, HEFCE support and promote the delivery of a number of 'Strategically Important and Vulnerable Subjects' – broadly interpreted as STEM subjects and modern foreign languages.

Since most STEM courses fall into categories A-C in the table above, the funding system already supports these courses more strongly than others. In addition, the 'University Modernisation Fund' includes a £250m funding pot to expand higher education provision by 10,000 additional places in institutions which were able to focus more on these strategically important and vulnerable subjects. HEFCE noted that the cap on student admissions was preventing some universities from expanding their provision of these 'Strategically Important and Vulnerable subjects' beyond this additional 10,000.[111]

Cont.

[111] HEFCE (2009) Strategically Important and Vulnerable Subjects

Cont.

Finally, HEFCE also allocate approximately 15 per cent of their teaching grant through a number of smaller funds. The most important of these cover widening participation, foundation degrees, support to part time undergraduates, accelerated and intensive provision, old and historic buildings and institution specific cots.

Student contributions make up the remainder of teaching funding. These are currently capped at £3,225[112] for full-time undergraduate students in 2010/11. Institutions are free to set any tariff for students from outside of the EU. Through this, higher education has become a major export industry for the UK, generating £5.3bn export earnings in 2007/08.[113]

Box 9: Private returns to higher education

The debate on who should pay for higher education has a long history. The idea of a graduate premium was central to the case for the introduction of higher education fees in 1998 and their increase in 2006. This premium reflects the additional wage which a graduate can command as a result of their degree during their working life. A range of estimates for this have been offered in recent years:

- One of the highest was presented by the Blair government when advocating the introduction of tuition fees – £400,000;[114]
- Lord Browne recently estimated the premium at £100,000 after tax, a figure recently cited by the Secretary of State for BIS; and
- In a recent detailed examination of the topic Universities UK produced an average figure of £160,000, but offered a breakdown between different disciplines. The wage premium from different disciplines varied from £340,000 for medicine to £34,000 from arts.

It is worth noting however, that these are average figures. The marginal benefits to individuals and society (the benefits gained from having one more graduate) may be smaller. However, as noted above, the expanding demand for graduates in the workforce suggests that this effect may not dominate the substantial gains.

[112] These are currently paid directly to universities from in the form of a loan from the Student Loans Company. This is repayable from the student once their annual income exceeds £15,000, with deductions from salaries of 9 per cent of earnings over this threshold. Any outstanding amounts are written off after 25 years
[113] Universities UK (2009), 'The impact of universities on the UK economy: fourth report'
[114] http://news.bbc.co.uk/1/hi/education/6369107.stm

These funding provisions have established a predominantly demand-led system with teaching grants expanding in line with growing student numbers. As noted above, university application numbers have risen strongly as a reaction to the recession. However in the current public financial position, the funding system is unable to respond to this change. Student number control limits are now in place which limit the number of students which universities can accept on full time undergraduate and PGCE courses – fixing them at 2008/09 levels.[115]

3.3 2020 higher education funding priorities

As set out above, there is a strong need to continue to expand higher education provision over the coming decade. Given the current funding system, this would represent a major call on public finances. If expansion were to focus on the expensive to teach STEM courses, then it would represent a particularly costly ask for the government.

The current funding context is creating an urgent need for action. It has been predicted that 170,000 prospective undergraduate students will fail to secure a higher education place this year compared with 100,000 who are rejected in a normal year for failing to get the necessary grades.[116] The lecturers' union claimed the unprecedented demand would create a 'lost generation' of students.[117] The situation is certainly not desirable if it results in able students being denied the opportunity to invest in their skills, while less able students in past and future cohorts are supported. If the long term aim is to expand higher education provision, this can not be a sustainable position.

The public debate has focused on three main options for reform – realising cost savings within higher education institutions, increasing student contributions and the idea of a graduates tax. The higher education system, and the challenges facing it are highly complex. The introduction of these reforms will have far reaching impacts on this system. In order to unpick and better understand these, this section sets out three broad priorities for the higher education system. The implications of the options for reform are considered against each.

Principles for higher education reform

- Capacity to support the continued expansion of the higher education sector in order to meet the needs of the 2020 knowledge economy, while also sustaining high standards of teaching;
- Continuing to support access to higher education on the grounds of student academic ability and merit rather than socio-economic background; and

[115] Although, as noted above 10,000 additional places have been made available in specific subjects
[116] http://www.guardian.co.uk/education/2010/jul/16/university-places-cuts-cap
[117] http://www.ucu.org.uk/index.cfm?articleid=4749&from=4725

- Promoting competition between institutions in order to maintain standards and to drive long term efficiency. Related to this is a need to consider how alternative funding options will impact on the balance between different types of higher education institutions.

Option 1: An efficiency agenda
This option should be viewed as a base case, or minimum change scenario. It would depend on maintaining the current funding structures and the real level of student contributions, and current student number control limits – there would be no increase in higher education provision. Success would come from higher education institutions responding to public spending cuts through major efficiency savings and the continued development of alternative sources of funding.

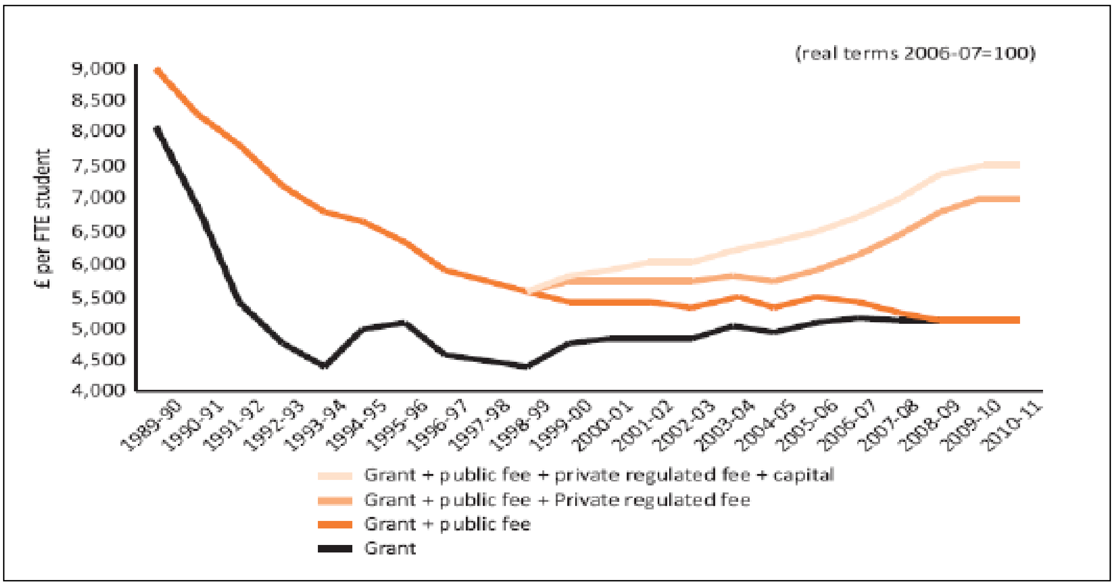
However, finding savings on the scale required[118] is likely to represent a major challenge. The contentious nature of the cuts made by the previous administration highlights the scale of the task. The cut of £915m represents only six per cent of the total public support given to Universities[119]. Figure 23 below illustrates the recovery in student funding seen in the higher education sector since 1997/98 – a time perceived by many in the industry as a crisis point. Cuts of 35 per cent in the teaching grant would reduce per student funding by £1,750 – returning it to its level in the mid 1990s.

The National Audit Office's recent report on the Treasury's cross government Value for Money Savings program highlights the difficulty of achieving sustainable pure efficiency savings which do not impact on service quality – this is a concern since this programme was targeting a much lower level of savings than is likely to be required of the higher education sector.[120]

Rather than looking for pure efficiency gains it seems likely that in order to meet cuts in the public subsidy universities would also need to implement changes as divisive as two year degrees, or increased distance learning. However, these two widely cited responses will be challenging to implement. Two year degrees, for example, are thought to limit the potential for the cross subsidisation of research and teaching activities (something which is understood as key to attracting high quality teaching staff) and HEFCE report particularly low demand for two

[118] It is difficult to predict this scale in advance of the spending review, however it is plausible that teaching funds could be cut in line with non-ring fenced departmental expenditure by 25 per cent.
[119] HESA Financial Record 2007/08
[120] They reported that cuts of £35bn (3 per cent of budgets) were unlikely to be met. The majority of the claimed efficiency savings that they examined were found not to fairly represent sustainable savings. NAO (2010) Progress with VFM savings and lessons for cost reduction programmes

Figure 23: Government's planned unit of funding for teaching



Source: Policy Exchange (2010) More Fees Please

Note: Data from HEFCE

year courses.[121] Highly visible cost savings such as increased distance learning may become harder to justify if students see themselves as increasingly responsible for funding their higher education provision. Increased distance learning could also put at risk the quality of the personal interaction between students and academic experts which is understood to be central to teaching excellence in the UK system.[122]

This option would cap the long term revenue that universities raise from teaching. This could lead to an increased reliance on expansion of non-teaching related private sources of revenue into universities to complement teaching revenues. This is likely to be something which the elite research universities will find easiest to achieve. Such pressures will increase competition between universities for these funds. This may come at the expense of their focus on teaching excellence if those revenues come to represent a smaller share of their income.

Overall, this option offers limited potential to expand higher education provision over the coming decade. Given the likely scale of pure efficiency savings, public spending cuts of as much as 35 per cent would put the system under considerable strain.

[121] http://www.hefce.ac.uk/Pubs/rdreports/2006/rd01_06/rd01_06.pdf
[122] For example the report by JM Consulting (2008) The sustainability of learning and teaching in English higher education, prepared for HEFCE and the Financial Sustainability Group concluded that this interaction was 'the critical distinctive feature' of UK universities

This measured reform of higher education would be unlikely to impact directly on the accessibility of universities from students of different backgrounds. There is a risk however, that these reforms could impact negatively on competition between institutions for students.

Option 2: Increased student contributions

The second commonly citied proposal is to raise, or at the extreme, to remove the current cap of £3,225 on student contributions towards tuition fees. This is an argument advocated most strongly by many of the most respected universities with the strongest brands. The Russell Group of leading research universities make the case for these particularly strongly within their submission to the Browne Review.

Such action could certainly dramatically expand the funds available for higher education teaching. This could allow an expansion in provision from current public funding, while also maintaining the quality of teaching. It could also promote the differential pricing of provision, see Box 10.

Box 10: Differential pricing of higher education

The reform of the fees system in 2006 was intended to introduce a variable system within which different institutions, and potentially departments or courses, could charge different tuition fees. As well as allowing universities to raise additional revenues from private sources, the reform was intended to support the development of a stronger market within the sector.

It is certainly clear that within the current system that different institutions deliver very different products. Students are able to derive different returns from studying at different institutions – the White Paper which promoted top up fees in 2003 reported a ‘44 percentage point difference in average returns between graduates from institutions at the two extremes of the graduate pay scale’. [123] Recent analysis by Chevalier and Conlon found a wage premium of 10 per cent associated with graduation from a prestigious Russell Group university as opposed to a modern university.[124] This research is particularly significant since the analysis controlled for the family background of students – the wage premium is directly a result of attending these universities rather than a product of a different mix of students.

Cont.

[123] DfES (2003) The future of higher education

[124] Chevalier and Conlon (2003) Does it pay to go to a prestigious university? Centre for the Economics of Education, LSE

Cont.

Greater variation in fees would allow universities to occupy different positions within the higher education market. Differential pricing could also strengthen universities to improve the services they offer – with variable fees, strengthening brands could be translated directly into higher fees and larger margins.

However, with the exception of Greenwich University, all full-time undergraduate courses currently cost the same. It is widely believed that the implementation of variable fees was blocked by the establishment of too low a cap on student contributions. A substantial increase in this cap could promote the development of differential pricing within the sector.

Unfortunately for the government, if increased fees were matched by increased caps on student loans, then this could represent a significant cost. Analysis conducted by the Institute for Fiscal Studies (2010) *Future arrangements for funding higher education* found that the zero real interest rate and 25 year write-off term on student loans implies a subsidy of 23 per cent. This calculation is based on an analysis of the future earning potential of the 2011 higher education intake and predicts that every £1 loaned will cost the government 23 pence. For the average current debt this equates to £4,800. An increase in average tuition fees to £5,000 could increase government costs to £6,900 per graduate. If the government wanted to avoid this implicit subsidy from the loan system while also increasing fees to £5,000 then the IFS calculate an increase in the real interest rate charged on these loans to four per cent would be required.

Given that students from more affluent families would be more able to pay tuition fees up-front, it does seem likely that a substantial increase in interest charged would disproportionally impact on students from less privileged backgrounds as these students would be more likely to rely on the loan system. Any reductions in the subsidies offered through student loans system would fall most heavily on the lowest paid graduates. Under current arrangements, their loans take the longest to pay off, so an increase in interest charges would have the greatest impact.[125] The text box below highlights the potential scale of debt, and crucially the time that it would take graduates to re-pay this.

[125] It is worth noting that recent proposals, such as only increasing the interest rates charged on student loans for high earning graduates, do offer opportunities for progressive reform. See for example – http://www.ft.com/cms/s/0/881ad75c-bb8c-11df-89b6-00144feab49a.html?ftcamp=rss

Box 11: The scale of debt – a worked example

Exceptionally large debts could be racked up by students if tuition fees were substantially increased. Analysis conducted by the British Medical Association has assessed the potential debt implications of student fees increasing to £15,000p.a. – (a figure lower than the current public contribution to medicine courses).

Medical students could expect to rack up debts of £90,000 for their studies. Despite the fact that medicine is understood to be a well remunerated profession, based on current salary scales and likely progression paths, the BMA have estimate that it could take doctors over 31 years to pay off a debt on this scale.[126]

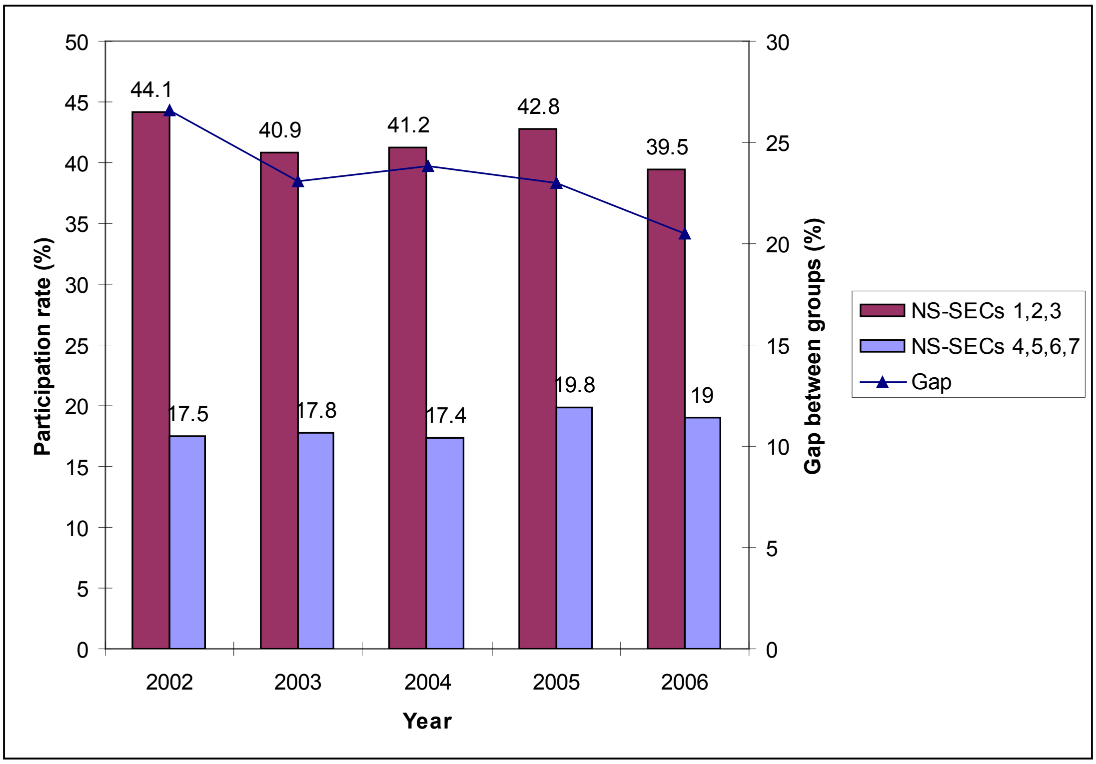
Crucially, there is a risk that this debt could deter individuals from pursuing poorly remunerated careers. In the case of medical students this might be in medical research. The impact of dramatically increased student debt on poorly remunerated, but socially valuable professions such as social work could be particularly severe.

While there has been a marked expansion in higher education participation and funding, there are well-founded concerns that access to higher education in the UK is still significantly dependent on socio-economic status and therefore institutionalising inequality. As Figure 24 illustrates, this inequality has decreased over time but is still significant. The body responsible for promoting fair access to higher education (the OFA), have voiced particular concern that 'Fair access to the most selective institutions appears to have continued to move more slowly than access to the sector as a whole.'[127]

The more up to date data on applications to higher education institutions presented in Figure 25 suggests that there was little change in the mix of applicants between 2003 and 2008.

[126] BMA Submission to the Independent Review of Higher Education Funding and Student Finance: call for proposals. Calculation based on current student loan repayment terms (9 percent of income in excess of £15,000).
[127] OFA (2010) Submission to the Independent Review of Higher Education Funding and Student Finance

Figure 24: Higher education rates by socio-economic class for young people aged 18–30



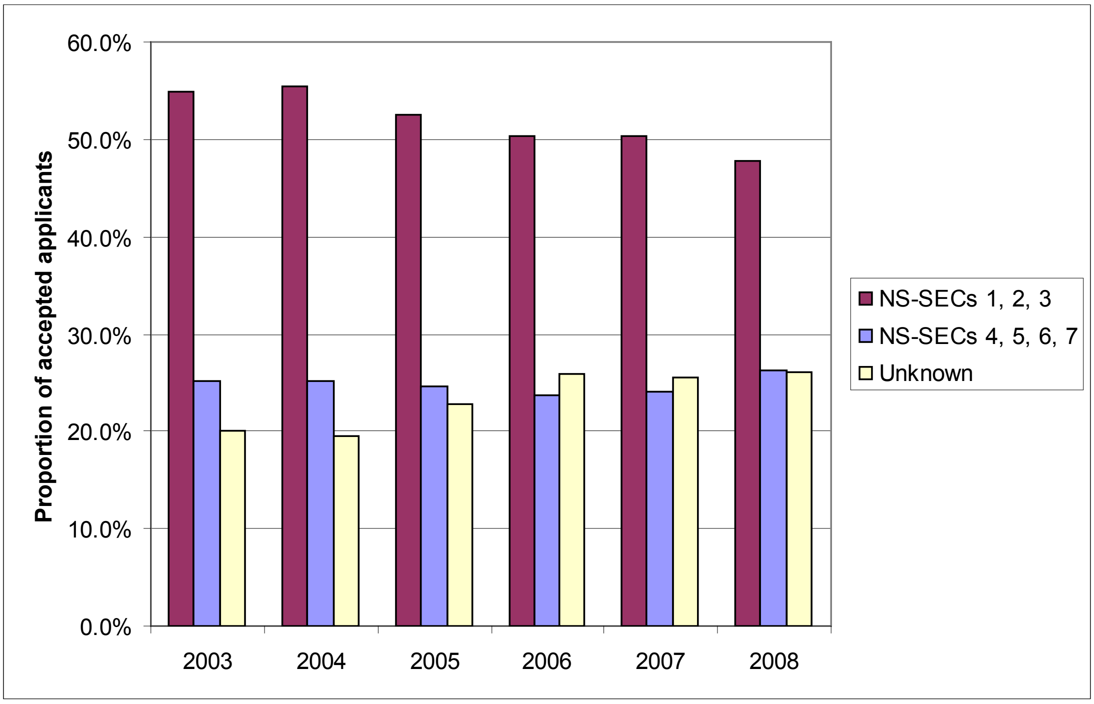
Source: DIUS, 2008

Note:The figure shows the Full-Time Young Participation by Socio-Economic Class (FYPSEC) measure

Despite the significant expansion of higher education, the proportion of young people going on to post-compulsory education has, alarmingly, remained static at 75 per cent over the past ten years, exacerbating social mobility issues.[128] While this paper is not able to address the failure to tackle this problem in the detail it requires, the UK economy will not reach its full potential until this begins to change. The most recent results from the international benchmarking studies on numeracy[129] and literacy[130] suggest that this educational division is widening and has led to a decrease in the UK's average scores in both areas.

[128] Unwin (2010), *op cit*.
[129] Trends in International Mathematics and Science Study, 2007. http://timss.bc.edu/TIMSS2007/index.html
[130] Progress in International Reading and Literacy Study, 2006. http://timss.bc.edu/pirls2006/index.html

Figure 25: Proportion of accepted applicants by socio-economic class



Source: UCAS

The link between participation and socio-economic background is highly complex. Poor A-level attainment from lower socio-economic groups is understood to be the primary bar on access to higher education. However, results at 18 do not necessarily reflect the potential academic ability of students. They are strongly influenced by socio-economic background.[131] A discussion of the balance of responsibility between schools, universities and society in supporting the development of this potential is beyond the scope of this paper. However, it is important that any reform of higher education funding does not exacerbate current weaknesses in the system.

Survey evidence confirms that the costs of going to university and the fear of debt represents a major deterrent from entering higher education.[132] A recent review conducted by London South Bank University concluded that the 'consensus in research that debt aversion for non-traditional students is a factor that deters entry into higher education'.[133] While a direct link between increasing fees, socio-economic class and participation has proved challenging to establish statistically[134], it does seem sensible that a substantial increase in the up-front private costs of

[131] IFS (2010) Widening Participation in Higher Education: Analysis using Linked Administrative Data
[132] See for example HESCU (2009) *Futuretrack* http://www.hecsu.ac.uk/hecsu.rd/documents/FUTURETRACK/FT_Stage2_Nov09_links.pdf
[133] London South Bank University, Healthcare Student Support Systems, A Review of the Literature, 2009.
[134] See for example IFS analysis – http://www.ifs.org.uk/docs/fees_review.ppt

higher education could exacerbate these issues. If an increase in fees necessitated reform and retrenchment of the generous student loan system, then this could have a double deterrent effect on students from the most deprived backgrounds.

Box 12: Competition, elitism and higher education funding

The current cap on higher education fees for domestic students moderates the impact of competition between higher education intuitions. There is concern that progress towards a more pure market system could concentrate resources in the hands of a few highly successful organisations at the expense of the wider system.

Oxford University and Oxford Brookes currently charge undergraduate full-time students the same fees. Given their close location, it seems sensible that their costs such as staff and premises could perhaps be comparable in the long term (although the two universities do focus on different areas and pursue different teaching models). Their very different brands and histories however, could allow Oxford University to charge substantially higher fees than Oxford Brookes in an unregulated system.

De-regulation could therefore contribute to the continued development of international centres of excellence – successful universities could charge higher fees, reinforcing their advantages. Such intuitions can represent a major positive for the UK economy. They can derive strong revenues from international students and can attract leading edge thinkers in technologically advanced areas. As we have seen in the recent Work Foundation report *Anchoring Growth: The role of 'Anchor Institutions' in the regeneration of UK cities* strong academic intuitions can play a major role in local economic development.

However, there is a risk that by drawing in additional teaching funding, as well as research resources, such institutions may develop at the expense of the quality of education offered in the wider system.

A comparison of international standing of universities in the UK and Germany suggests that given constrained resources, nations may be faced with a choice between a few star performers and depth in higher education provision.

The table below illustrates that compared to the UK, Germany has few top flight universities, but still maintains a strong population of top 500 institutions:

Cont.

Cont.

	QS world university rankings[134]		Webometrics ranking of world universities[135]		ARWU Rankings[136]	
	Top 100	Top 500	Top 100	Top 500	Top 20	Top 500
UK	18	53	5	34	2	38
Germany	4	41	0	50	0	39

Any reform of the funding of higher education teaching must remain aware of its likely impacts on such balance, and rest on a vision for how a future higher education system should be structured.

It is often argued that the introduction of tuition fees has promoted competition between UK higher education institutions. It seems that the act of handing over money (or in the case of current student loan arrangements signing over funds) has turned students into consumers of higher education as well as pupils. While the effects of this change on the behaviour of higher education institutions is hard to capture, strong anecdotal evidence shows universities are actively competing on their commitments to respond to student demands.

Increasing the scale of student contributions to higher education could potentially promote this empowerment and competition between higher education institutions. This effect would be particularly strong if accompanied by differential pricing in higher education (see Box 10).

It is worth flagging up/highlighting/emphasising however, that the purchase of higher education services remains a highly complex transaction. The material to be studied, the facilities available, the attitudes of staff and the reputation of the institution held by employers, and the earnings of recent graduates for example are all central aspects of the decision making process, but are all highly intangible and challenging to establish in advance. This complicates processes of competition, a situation which is exacerbated by the limited availability of data on these points. If the market for higher education is to be developed under this model, then we would support recent demands for clearer and simpler information on these areas.

[135] http://www.topuniversities.com/university-rankings/world-university-rankings/2010/results
[136] http://www.webometrics.info/rank_by_country_select.asp?cont=europe
[137] http://www.arwu.org/ARWUStatistics2010.jsp

Overall the option has significant potential to support the continued development and expansion of higher education provision within the UK. However, any increases in fees are likely to demand substantial increases in public spending to fund student loans. If this system is also reformed, then the impacts could be particularly negative for both those from lower socio-economic backgrounds and those who intend to peruse poorly remunerated careers.

The move towards more pure market competition within higher education an opportunity, but could demand more careful management, and potentially could necessitate greater government involvement in the operation of the higher education sector.

Option 3: A graduate tax

The final, and perhaps most controversial, proposed option for reform would be to replace the current system of loans with an additional income tax of graduates. As with current loan repayments, this would represent a progressive tap on graduate earnings. The charge would also be limited to a definite period (perhaps 25 years). However, the amount to be paid by graduates would not be capped. It would be limited only by earnings. There is clear potential for such a system to raise additional revenue, allowing for the long term expansion of higher education.[138]

The conceptual strength of this reform would be the creation of some form of link between the costs of and the benefits received from higher education. Graduates who earn the highest salaries will contribute the most. Graduates from prestigious universities who are interested in pursuing poorly remunerated careers which may have wider social benefits would not be asked to make such a contribution.

There is a strong efficiency argument for such a tax. Only those students who judge that they will derive a long term benefit from higher education will expose themselves to the tax. This may, for example, encourage students to pursue courses most likely to support their future earnings potential. This effect could help the public sector to maximise its return on its investment in tertiary education.

To date, very little research has been conducted on the likely implications of graduate taxes on access to university. It is particularly difficult to compare the different psychological deterrent between a future tax such as this and commitments to repay a debt based on income. The fact

[138] The NUS have produced a costed proposal with the additional tax varying from 0.3 per cent of income for the lowest quintile of earners to 2.5 per cent for the highest. Their calculations show such a tax raising £15bn within 15 years

that prospective students sight fear of debt as a major deterrent from entering higher education, rather than concern about the future tax rates for high earners is a potential cause for optimism. However, these responses may be a function of current student finance arrangements.

It seems sensible that this tax would have the greatest deterrent effect on those who perceive their future earning potential to be the highest. This could deter some of the prospective students with the brightest futures from entering the British higher education system. It is worth noting however, that this group of students is likely to be very different to the groups from lower socio-economic backgrounds discussed above as being poorly served by current provision. Indeed, the sense of fairness offered by paying for education based on future income could potentially be most attractive to individuals from deprived backgrounds who might otherwise be put off higher education.

The implications of a graduate tax on competition between higher education institutions have been the subject of intense media debate this summer. Concern has been expressed that a centralised new tax on graduates could impact negatively on competition by breaking the link between student contributions and individual universities. The fear that revenue raised from such a tax would not be hypotocated potentially putting the long term funding of higher education establishments at risk.

Speaking on the BBC programme Newsnight on the 15 July 2010, the Business Secretary did stress however his interest in a decentralised graduate contribution. Under such a scheme graduate taxes could be transferred to the university where the individual studied. This could create a new form of competition. Universities would in effect be taking an equity stake in the careers of all of their students. They would have a direct interest in the outcomes of the education they offer.

The critical weakness of this option for higher education funding reform are however technical rather than conceptual. It will take many years before receipts could replace current revenues from fees as subsequent cohorts enter the labour market. This is a particular issue given the strength of the government’s commitment to rapidly cut public spending. One alternative would be for universities to raise funds immediately by privately capitalising the likely future revenue from this tax on graduates – perhaps by selling some form of graduate income bonds.

The current highly internationalised nature of the UK’s higher education system and the high mobility of graduates also presents technical challenges. The most commonly cited of these

Box 13: Illustrating the risks of designing a graduate tax

This new form of competition might present a number of risks. The following questions would present challenges for the design of a graduate tax:

- Would universities be incentivised to create individuals who go on to be steady earners in middle ranking jobs rather than nurturing the bright sparks who might be responsible for taking radically different perspectives and through this driving innovation?
- How would such a change impact on university activities which focus on developing the social skills of its students – is education more than delivering high earning individuals?
- If socio-economic background is still a strong predictor of future earnings, regardless of education, then would universities increasingly focus on social elites?
- Given that the lifetime earnings of men are higher than those of women, would universities focus admissions on men?

is the fear that graduates from British universities might leave the country to avoid the tax. Under the current loan system if a graduate emigrates, payments are expected by international transfer, rather than through deductions from salaries. While a debt is readily definable and can be ported across national borders, a higher education tax would require integration into international tax systems. Remedying this would demand major treaty reform if it were to be implemented across the EU. It is worth noting however, that the scale of the proposed graduate tax is likely to be modest compared to recent changes in tax rates for high earners.

This emigration issue is a particular concern for EU students originating from outside of the UK. Under the terms of the Maastricht treaty these students must be offered the same support as domestic. However, a much smaller proportion of these students can be expected to remain within the UK. Under tax arrangements far fewer would contribute towards the costs of their education.

Finally under a graduate tax scheme a number of other technical issues could arise. Three of these are detailed below. While each raise many questions, they could all potentially demand greater intervention from the government:

- Students from outside the EU would not necessarily be covered by a graduate tax system. This could further increase the relative value of revenues from these students compared to domestic since their fees would be paid in advance. This could affect the balance between how universities look to recruit foreign and domestic students;
- The tax could create an incentive for certain prestigious and perhaps business-oriented universities to opt out of the public system. Such institutions would perhaps then become totally inaccessible to those from all by the most privileged backgrounds; and
- The tax could impact strongly on the mix of courses offered by universities. If certain humanities subjects seem to have low financial returns, then higher education institutions might be dissuaded from offering such courses.

3.4 Reflections

It is clear from this analysis that there is no one single perfect reform that could succeed in supporting the required expansion in higher education, promote fair access to higher education and sustain competition within the sector.

<u>On option 1 – an efficiency agenda:</u>
While efficiency savings will be demanded across all publically funded activities, there are major risks associated with the first pure efficiency focused option. It offers very limited potential to support the expansion of higher education. Achieving savings on the level discussed is also highly likely to impact negatively on the quality of teaching.

Given this and the current state of public finances, it does seem inevitable that additional resources will be needed from private sources. This conclusion agrees with the view of both the current coalition government and the previous Labour administration:

> *'What we have is an urgent problem. Like the wider public sector, universities are going to have to ask how they can do more for less. There will probably be less public funding per student; quite possibly fewer students coming straight from school to do 3 year degrees; greater contributions from graduates; more targeted research funding. Perhaps all of these.'*
>
> Vince Cable, Higher Education Speech, 15t July 2010

> *'Universities have enjoyed a benign financial climate over recent years. Growth based so heavily on state funding cannot continue and this presents government and universities with a series of challenges. Maintaining excellence in both teaching and research is key. We recognise that per capita funding is important but also that in the current circumstances*

> *maintaining that level through public expenditure alone will be extremely difficult. That is why the development of a diverse set of funding streams is important if the quality of higher education is to meet new expectations.'*
>
> BIS (2009) Higher Ambitions

This will demand the pursuit of either the second and third options for reform.

On option 2 –increased student contributions:
Higher student fees offer an opportunity to raise additional revenues and to expand higher education provision while maintaining the quality of teaching. It also seems sensible that this could promote greater competition within the sector.
Any increase in fees will represent a major draw on public resources as borrowing for student loans will increase and the associated public subsidy will be more costly. If this reform is to be cost-neutral, major reform of the student loan system will also be required.

The key concern with this option is the risk that it may detrimentally impact on the accessibility of the most prestigious higher education institutions. This is a particular risk if student loans are also reformed. An expansion in student debts could also impact on the choices of graduates in the labour market, deterring them for pursuing less financially rewarding careers.

On option 3 – a graduate tax:
The third option seems to offer a panacea. It sets out a vision of a higher education system which is funded in a very sensible way – it is paid for by those who benefit the most from it, in a way which is unlikely to deter the groups who have historically struggled to gain access to higher education. It also offers prospects for strong competition between institutions on the fundamental output of their training.

Unfortunately the conceptual beauty of this option is contrasted by significant technical challenges. This suggests that this option appears to be only aspirational at present.

This paper sets out a clear evidence base on the importance of graduates to the 2020 knowledge economy. The analysis shows that recent increases in higher education provision have been matched by an expanding demand for graduates. The continued development of the knowledge economy will be heavily dependant on sustaining this expansion over the coming decade. The response of the labour market to the recession has perhaps surprisingly, highlighted the importance of maintaining the output from the higher education sector.

The future of the knowledge economy will also depend on higher education institutions equipping individuals with the skills which will drive the innovation which the future knowledge economy will rely on. The main way in which governments have sought to influence teaching within higher education in recent years has been by making additional resources available to expand the numbers of undergraduate students studying STEM subjects.

Our analysis suggests however that this attention on the supply of STEM graduates may be misplaced. Perhaps the greatest challenges facing STEM provision seem to be in how individuals progress into the labour market. Of greatest concern is that it seems as though universities are not delivering STEM graduates with the qualities demanded by employers. Rectifying this will demand a focus on initiatives which can encourage STEM graduates into industry, action to strengthen the quality of STEM degrees and to boost industry and entrepreneurialism skills for graduates.

The paper has also made a clear case for a broader interpretation of how the government can support the development of skills for innovation within the economy. While STEM skills are of great relevance here, they exclude a number of areas of training which are also potentially of special relevance. We have, for example, established why skills linked to design, communication and business studies could be of particular relevance for innovation. Given this, the government should replace the current system of bids for an additional 10,000 STEM and other vulnerable subject places with a broader competition for additional places in courses that specialise in boosting the innovative stock of the economy. It might be sensible to leave it to universities to innovate and to present bids defining what this means and how they can boost the innovative potential of their students.

Finally, it is now clear that we can expect the Comprehensive Spending Review to demand deep cuts in higher education funding budgets. This will drive change within the sector, and this paper makes the case for substantial reform of higher education funding. There is a need for urgent action to safeguard the health of the higher education system if it is to continue to play its vitally important role within the developing knowledge economy. This is a particular issue if it is to sustain its recent expansion and continue to focus on many of the expensive-to-teach areas discussed above.

The analysis highlights the risks associated with limited reform or focusing solely on an efficiency agenda approach. It seems however that there is only one viable option for the sector – to increase tuition fees, and to reform the student loans system.

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