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The Supply of and Demand for High-Level STEM Skills

Executive Summary
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The Supply of and Demand for High-Level STEM Skills: Executive Summary

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Introduction

Science, technology, engineering and mathematics (STEM) skills are crucial to innovation and growth. **Studies have shown that innovation-active enterprises employ higher proportions of graduates in general and, in particular, a higher proportion of STEM graduates than their non-innovative counterparts (CIHE, 2007 p. 17).**

The report provides estimates of the supply of (employment plus an estimate of those seeking work in STEM occupations) and demand for (employment plus vacancies for STEM posts) STEM graduates. The results are primarily based on the Labour Force Survey, but many other sources of information are utilised.

The measures of supply and demand are brought together for the UK, at the national level for England, Scotland, Wales and Northern Ireland, and at the level of the nine planning regions for England. The study examines the estimated historical and projected market imbalances for STEM.

STEM Occupations and Sectors

Degrees are divided into:

- Medicine and related STEM (comprising Medicine and dentistry and Medical related subjects)
- Core STEM (comprising: Biological sciences; Agricultural sciences; Physical / environmental sciences; Mathematical sciences and computing; Engineering, Technology and Architecture)
- Non-STEM (all remaining subject areas)

The principal focus of the present study is on Core STEM, but comparisons are made with the other two degree groups and with non-graduates.

Medicine and related activities are separated from the rest of STEM because of: the extremely strong link between subject of degree and occupation and their tendency to dominate all other STEM jobs in the occupations and sectors where they are mainly located.

Occupations and sectors are classified as STEM by jointly examining their STEM densities (the share of the occupation's or the sector's total employment that comprises STEM graduates) and STEM proportions (the percentage of all STEM workers that are employed by that occupation or that sector).

Using LFS data to classify sectors and occupations into STEM, it was found that in 2011:

- Medicine and related STEM (Med STEM) occupations employ 65 per cent of Med STEM degree holders
- Core STEM occupations employ 40 per cent of Core STEM degree holders
- Med STEM sectors employ 60 per cent of Med STEM degree holders
- Core STEM sectors employ 45 per cent of Core STEM degree holders

Career Paths of New STEM Graduates

Evidence from HESA data does not point to major differences between STEM and non-STEM graduates in terms of their labour market status six months after graduation. Over the last ten years or so:

- newly qualified non-STEM were slightly more likely to be in employment than Core STEM, and slightly less hard hit by the recession
- Core STEM graduates are more likely be in education than both Med STEM and non-STEM graduates and the recession added a further incentive for this route

Data from the LFS suggests that a majority of new Med STEM graduates enter jobs in Medicine. In 2011,

- 58 per cent of employed new Med STEM graduates work in a Med STEM job in a Med STEM sector;
- 11 per cent work in non-STEM jobs in Med STEM sectors; and
- 23 per cent work in non-STEM jobs in non-STEM sectors.

Between 2001 and 2011, the proportion of graduates entering Medicine and related jobs in Medicine and related sectors increased.

LFS data on new graduates shows that in 2011:

- 16 per cent of employed new Core STEM graduates are working in Core STEM jobs in Core STEM sectors;
- 12 per cent are working in non-STEM jobs in Core STEM sectors;
- 6 per cent are working in STEM jobs in non-Core STEM sectors; and
- 66 per cent are working in a non-Core STEM job in a non-Core STEM sector (up from 52 per cent in 2001).

Thus, in 2011, only a third of new Core STEM graduates worked in either a Core STEM job or a Core STEM sector or both, which was down from 45 per cent in 2001. This drop is partly the result a change in occupational and sectoral classifications, but also reflects a general trend of dispersion of Core STEM workers from traditional Core STEM occupations and sectors, spreading out throughout the overall workforce. It may be the consequence of less demanding study programmes and the emergence of new subjects, such as sports science.

The recession is likely to have exacerbated this trend, forcing new graduates to take whatever jobs they could find. Several interviewees echoed the thoughts of an employer in the pharmaceutical sector, "With the economy in the current state, I'd imagine that graduates will take whatever they can get and hope that when the economy turns around, they can then start to get jobs that are better suited to their skills and qualifications".

However, STEM degree holders working in a non-STEM occupation may still be using their STEM skills. A representative from a chemical firm stated that, "Most of our sales and marketing people have chemistry degrees, and a few chemical engineers, because we sell business to business ... so they have to be able to understand the chemistry, and talk the same language as these people".

Many of the interviewees expressed concerns that difficulties in recruiting STEM graduates would become harder in the future when the economy picked up and that growth areas would require more STEM skills.

Some employers were optimistic that apprenticeships, which would eventually lead to a STEM degree, were the way to increase overall supply, to increase loyalty to the employer and create graduates with both STEM skills and a familiarity with the way business works. It was also pointed out that this route avoids the higher university tuition fees.

Careers of the Overall STEM Workforce

The share of employed Core STEM degree holders that work in Core STEM occupations declined between 2001 and 2010[1]. Although employment in Core STEM occupations grew faster than overall employment over this period, the increase in the supply of Core STEM degree holders was even larger, resulting in a declining share of the number of Core STEM degree holders working in Core STEM jobs. This may also be the result of new jobs and new sectors that require STEM skills that haven't been included in the definition of STEM, but are currently too small to be identified as STEM.

The likelihood that a Core STEM degree holder works in a Core STEM sector and/or occupation increases with age. In 2010:

- 63 per cent of employed Core STEM degree holders aged 55 to 59 worked in a Core STEM occupation compared with only 51 per cent of the overall STEM employment
- 48 per cent of those aged 50 to 54 who were employed and holding a Core STEM degree worked in a Core STEM sector, compared to 42 per cent of the overall Core STEM employment

While this may reflect career paths over time, it may also be because Core STEM sectors are more mature.

Scenarios based on Stock Flow Modelling

If the employment rate in 2020 rose to its 2007 value, there could be an additional 180,000 Core STEM degree holders in employment compared to a scenario based on the 2011 employment rates. While the difference between the employment rates (around 87 per cent for Core STEM in 2007 compared with 84 per cent in 2011) is small, it makes a large difference to Core STEM employment.

Increasing both the employment rates back to 2007 levels <u>and</u> the share of Core STEM graduates that work in Core STEM occupations to the 2001 levels of 60 per cent would lead to an additional 400,000 more Core STEM degree holders employed in Core STEM jobs in 2020 compared to a scenario based on the 2011 level of employment and level of STEM degree holders in STEM jobs.

[1] 2010 is used here as the occupational classification changes the occupational definitions in 2011.

There may well be a problem with individuals displaced from STEM occupations moving back into STEM if they have not kept pace with changes in science and technology. Several of the interviewees argued that shifts back into STEM jobs become difficult or impossible and this potential source of supply becomes lost. Seeing a similar problem in the USA, Hira (2009, p. 58) called for the Department of Labor to work with scientific and engineering professional associations to move towards the continuous education of STEM workers and the retraining of displaced mid-career STEM workers.

Retirement

Although the recession has slightly impacted on retirement trends, causing some older workers to retire when faced with redundancy, in general the inactivity rates have been decreasing for those aged 50 and over. In 2002, the inactivity rates for Core STEM degree holders aged 50-54, 55-60 and 60-64 were 11, 20 and 48 per cent, respectively. In 2011, the comparable inactivity rates were five, 18 and 47 per cent.

Stock flow scenarios comparing the supply of Core STEM degree holders based on current retirement rates with the supply based on a predicted future activity rates suggest that increases in retirement ages over current levels indicate the need for an additional 60,000 Core STEM degree holders in the work force in 2020. However, it is the inflow of new STEM graduates that is more likely to help ensure workers have knowledge of the latest science and technology – retaining older individuals does not do this.

Regional patterns

Commuting is especially important to London, the South East, the East of England and the East Midlands. In 2011, as a result of commuting:

- London has a net gain of 87,000 Core STEM workers;
- South East has a net loss of 50,000 Core STEM workers;
- East of England has a net loss 20,000 Core STEM workers; and
- East Midlands has a net loss of 22,000 Core STEM workers.

Interviews with STEM employers consistently indicate that London acts as a magnet to STEM workers at the expense of other parts of the country. Employers have pointed to difficulties hiring engineers, scientists and software developers with the right skills because their location is outside of London. Exceptions include pharmaceuticals, whose location is gravitating to Cambridge / Oxford, and engineering companies, whose head offices tend to be outside of London.

Trends based on the historical commuting patterns observed from 2001 to 2011, indicate that the net gain of workers by London will increase and there will be higher net losses in the South East, East of England and East Midlands.

Supply, Demand and Market Imbalances

Most of the effects of the recession on Core STEM supply have been on the newly graduated. For this group, there was a sharp rise in the inactivity rate following the onset of the recession after 2007. Many of these inactive new graduates remained in full-time education (see Section 3.3). However, the effect on Core STEM as a whole has been much more modest, with a rise of 2.7 percentage points in the rate of inactivity in the UK.

The baseline projections assume that these individuals will become part of the supply as the economy recovers as Core STEM degree holders in post graduate education graduate and enter the workforce and new graduates will become more likely to enter the workforce upon graduation rather continuing with their education as jobs become more available.

Estimates of vacancy ratios (the number of vacancies divided by employment) do not suggest a higher vacancy rate for Core STEM vacancies (in all occupations) or for vacancies in STEM occupations only.

For instance, in 2007 the overall vacancy ratio for England was 2.6 but only 2.4 for Core STEM vacancies (in all occupations) and 2.7 for Core STEM occupations as a group. However, there are a few Core STEM occupations that do have higher than average vacancy rates (e.g. Engineering Professions had a vacancy rate of 4.5 in East of England and Architects had a vacancy rate of 6.4 in England).

Supply and demand calculations for 2020 under both the "2007" (pre-recession) and "2011" (recession) scenarios do not suggest an overall shortage of STEM graduates (in terms of numbers) in most regions or nations of the UK.

However the baseline "2007 scenario" predicts a few shortages such as: 7,000 Med STEM graduates in the UK, 2,000 Core STEM graduates in Scotland, and 1,500 Core STEM graduates in the South East. Under the less optimistic, 2011 scenario there is no overall predicted shortage.

This result needs to be interpreted with care. In particular, it does not mean there will be no shortages at all – as different disciplines will differ and employers can be looking for very specific areas of knowledge and expertise, for example:

- One interviewee noted that, "Companies like JLR are looking for electrical engineers but cannot find them as they have been 'taken up' by the power and energy industries: that's a specific skill but it's at quite a high level".
- A representative of one of the major engineering companies noted, "For mechanical engineering, I would agree [there is no shortage]. However, for electrical / electronics, there are simply not enough graduates with the right degree and employers are trying to recruit from a small pool of those with the right degree content (i.e. higher-voltage direct current is a pre-requisite for the transmission and distribution industry: there the supply of graduates is inadequate)".

It became clear from a number of the interviews that recruitment of certain types of Core STEM took place from a restricted number of universities – those that gave a rigorous foundation in the disciplines required. In order to cut costs, some universities have cut back on the equipment and laboratories, which has led to graduates with less hands-on experience.

Projected Core STEM unemployment per vacancy based upon the high ("2007") scenario is close to unity (1.4) in 2020, a surplus of only one Core STEM degree holder per 100 STEM employees (broadly the same as the market for non-STEM). At this stage, specific shortages being experienced at the present will begin to evolve into more general shortages. The market for Med STEM is projected to be even tighter, while the market for non-graduates will still be fairly slack.

The results, however, are very sensitive to changes in demand, for example, based upon the "2007" scenario in 2020:

- A Core STEM vacancy rate of about four per cent produces an approximate balance between supply and demand for England as a whole.
- Increasing the vacancy ratios from those obtained by the proportional method to those obtained by regression analysis results in a shortage of 95,000 Core STEM degree holders in the UK.
- Rebalancing the economy towards manufacturing which results in a one per cent higher demand for STEM in 2020 would result in a small shortage of Core STEM under the 2007 scenario.

Under the prolonged recession (2011 scenario) there is still an excess of Core STEM supply. The same trends hold out for the four nations and the nine English planning regions, using the regression vacancy densities gives a shortage of Core STEM under the 2007 scenario but not under the 2011 scenario.

Core STEM vacancies are more likely to be hard-to-fill. Vacancies for Core STEM are more likely to be hard-to-fill than the vacancies overall and a return to 2007 vacancy rates suggest that there will be problems with Core STEM recruitment.

- Before the recession, 34 per cent of Core STEM vacancies in England were hard-to-fill, compared with 30 per cent of all vacancies and 27 per cent for non-graduates.
- After the recession, 26 per cent of Core STEM vacancies in England were hard-to-fill, compared with 22 per cent of overall vacancies and 18 per cent for non-graduates.

There are important differences with hard-to-fill vacancies across the regions and the cross-regional patterns seem sensitive to the overall level of economic activity.

These findings, along with the results of the interviews, are largely consistent with those of specific recruitment difficulties in some STEM-related sectors where employers report insufficient UK candidates of suitable quality.[2] The interviews also confirmed another earlier finding that, while in some instances these difficulties relate to the lack of applicants with suitable STEM skills, they may also result from “broader concerns about a lack of well-rounded candidates with technical skills, broader competencies, such as mathematical capability, and practical work experience”.[3]

[2] In particular, the biosciences, engineering and IT of the quality they are seeking” (BIS, 2009 p. 4).
[3] BIS (2009, p. 4).

Executive Summaries present the key findings of the research produced by the UK Commission for Employment and Skills. More detailed analytical results are presented in Evidence Reports.

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