Science, engineering and technology skills in the UK.

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Science, Engineering and Technology Skills in the UK

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Foreword

The skills of the workforce are critical for productivity and the long term prosperity of the UK. The ten-year science and innovation investment framework, published jointly by HM Treasury, DTI and DfES in 2004, acknowledges the importance of ensuring a healthy supply of people with science, engineering and technology (SET) skills if the UK is to improve upon its already strong science base. These skills will be vital in helping to achieve the ambition of making Britain the most attractive location in the world for science and innovation.

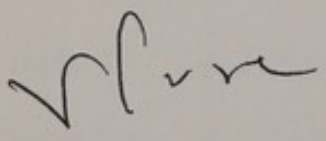
Concerns have been raised in a number of countries about the supply of SET skills. Given the importance attached to such skills in the ten-year framework, it is crucial that we monitor the market, both in terms of supply and demand, for people with SET skills.

The analysis presented in this paper brings together findings from a variety of data sources. It suggests that the supply of SET skills is quite strong. Substantial growth has occurred in the number graduating each year from higher education with SET degrees. However, there is some variation by subject. Particularly strong growth has been seen for computing and medical related subjects, but some declines are observed amongst engineering and physical sciences.

The labour market for people holding SET degrees would also appear to be healthy. SET graduates have high employment rates and have continued to receive a substantial wage premium for their skills. This suggests that the demand for such workers has kept pace with the expanding supply.

The focus of the paper is on degree level skills. However, as noted in the ten-year framework, the development of SET skills across the entire education system is important. Some analysis is therefore presented on GCSE and A level passes across a range of SET subjects. There is some concern that passes in SET subjects as a proportion of all A level passes has declined, particularly in mathematics.

Many of the policy initiatives in this area are new and there has been insufficient time to evaluate fully their impact on the science base. Gathering and presenting data on SET skills can only help this process of evaluation. There are likely to be many issues related to specific subjects and industrial sectors that remain undetected within this analysis. However, the material presented here provides a useful contribution to the evidence on SET skills.



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Executive summary and conclusions

Utilising the skills of scientists, engineers and technologists is important for innovation and Research and Development (R&D) activity. Evidence suggests that such activity exerts a significant impact on economic welfare. In 2004, the ten-year science and innovation investment framework outlined a vision for further improving the UK's already strong science base. It also set an ambition to increase total expenditure on R&D as a percentage of Gross Domestic Product (GDP) from the current value of 1.9 per cent to 2.5 per cent by 2014.

In meeting these ambitions, the ten-year framework recognises the need for a strong supply of individuals with qualifications in science, engineering and technology (SET). All parts of the education system have a role to play, from the Key Stages of compulsory education through to post-16/further education and higher education. The framework expects improvements in:

- The quality of science teaching in every school, college and university;
- The results for students studying science at GCSE level;
- The numbers choosing science, engineering and technology subjects in post-16 education and in higher education;
- The proportion of better qualified students pursuing R&D careers; and
- The proportion of ethnic minority and women participants studying SET subjects in higher education.

The Government has already introduced a range of policy initiatives to promote SET study and the framework intends to monitor progress on an annual basis. Concerns have frequently been raised within the UK, US and other OECD nations about the supply of SET skills and an apparent decline in interest to study these subjects. Given the importance attached to innovation policy, therefore, it is particularly important to monitor the market for SET skills, both in terms of demand and supply.

The analysis presented in this paper looks at recent trends in indicators relevant to the ten-year framework. A range of data sets are used and, where possible, definitions of SET are kept consistent. Data is presented on the supply of SET qualifications, with emphasis being attached to higher education, although some information on GCSE and A levels is also given. The way these qualifications are used in the labour market is then considered by analysing employment rates, wages, and industrial and occupational distributions of employment.

Trends in SET qualifications

There was a rapid expansion in higher education participation during the early 1990s that has subsequently slowed. This has led to a growth in the number of people being awarded degrees across most subject areas. The analysis of first degrees and doctorates reveals:

- In 2004 there were 2.1 million first degree graduates living in Britain with SET subjects. This is an increase of 57 per cent from the 1.3 million observed in 1997;
- A substantial growth of 49 per cent in first degrees in non-SET subjects also occurred over the same period;
- The number of new first degree graduations has risen substantially in computer sciences, subjects allied to medicine and biological sciences. Some declines in the absolute number of graduates however has been observed in engineering and technology, physical sciences and architecture; and
- There has been substantial growth in the number of doctorates awarded each year between 1997 and 2004. Two-thirds of PhDs are awarded in SET, although the growth rate has been higher for non-SET subjects.

SET graduates are disproportionately male, although the proportion of female graduates has risen from 27 per cent in 1997 to 36 per cent in 2004. Female representation is relatively strong in biology and medicine, but remains weak in engineering. Since 2001 there has also been a growth in the proportion of SET graduates from ethnic minority groups.

The growth in the numbers graduating with SET degrees may only be sustainable if sufficient numbers are acquiring SET qualifications at other levels. Statistics on entries and passes for A levels and GCSE show:

- The number of passes in A level SET subjects has remained fairly constant over the last ten years;
- Passes in SET as a proportion of all A level passes has declined, particularly in Mathematics; and
- The percentage of pupils achieving an A*–C pass in any science subject at GCSE has risen slightly from 47.6 per cent in 2001 to 48.2 per cent in 2004.

Labour market outcomes

Analysing the number of people holding SET qualifications provides an indication of the supply to the market. On these measures, the supply of these skills appears healthy. It is important, however, to understand the demand side by examining the way people with these skills are employed within the labour market. If the number of jobs requiring SET skills has not kept pace with supply,

this may be reflected in a range of labour market indicators such as wage returns, employment rates and vacancy data. It is found that:

- As with non-SET subjects, the wage gains associated with holding SET degrees have remained fairly constant over the last ten years;
- Employment, unemployment and inactivity rates of SET degree holders have not changed significantly since 1997, suggesting no emerging imbalances between demand and supply;
- Almost one-half of SET graduates work in occupational groups that are thought of as having the greatest requirement for SET skills. For medicine graduates, however, over 90 per cent work in SET occupations; and
- SET graduates work across a range of industrial sectors. However, they are particularly concentrated in health & social work and education.

Future scenarios and policy impact

Demand for higher level skills has been rising and is expected to continue. Recent forecasting work suggests that employment levels in SET occupational groups are expected to grow faster between 2004 and 2014 than the growth rate across all occupations. There will be considerable requirements for graduates in these occupations, not only to fill the predicted expansion in employment, but also to replace existing workers. If current trends continue, the supply of SET graduates would appear to be on course to maintain the contribution that graduates make to these occupations. However, the ambition to raise R&D expenditure is likely to generate an even larger requirement for SET graduates that is not factored into existing forecasting work. Further research may be needed to estimate the SET skill needs associated with increased R&D.

With the important role that SET skills play in the ten-year framework, it is necessary to continue to monitor the market for these skills, both in terms of supply and demand. A more detailed analysis than that presented here, by subject and sector, may also be required to understand specific areas of the market. Future work planned by DfES will study the demand and supply of people with SET qualifications in more depth and identify the areas of the market with the largest skill gaps.

Many of the policy interventions in this area, such as improving the attractiveness of research careers, are new and insufficient time has elapsed to gather evidence of their effectiveness. The collection and presentation of data on SET skills will make it easier to evaluate the impact of policy over time.

CHAPTER 1

Introduction

As one of the five drivers of productivity, innovation is considered crucial to economic growth and long-term prosperity. There are a number of ways of measuring innovation activity, though investment in Research and Development (R&D) has received considerable attention. The ten-year science and innovation investment framework set an objective to raise R&D expenditure from 1.9 per cent of Gross Domestic Product (GDP) to 2.5 per cent in 2014. Empirical evidence would appear to support the importance of R&D with studies finding the existence of both private and wider social returns to such investment.[1] As part of this research, it has been found that R&D provides a way for nations to catch-up with productivity leaders.[2]

The ten-year framework sets out a number of ways of strengthening the UK's science and innovation base. These include developing and maintaining research excellence in universities and improving the transfer of knowledge. One of the central themes of the framework is to ensure that the UK has a healthy supply of individuals with qualifications in science, engineering and technology (SET). This supply of skills, however, is not just about the numbers of people with such skills, but also raising the overall quality and participation amongst ethnic minorities and women. Although the emphasis is often placed on SET skills, the evidence suggests that a range of other skills such as management, communication and interpersonal skills also play an important role in innovation performance.[3]

The importance of SET skills for the ten-year framework inevitably raises questions about whether current trends are adequate and sustainable. Concerns are often raised about the supply of these skills, particularly amongst certain subject groups. Such concerns are not limited to the UK. In the US, the National Science Board is particularly concerned about possible shortages of SET personnel. In the 2004 indicators, they found a decline in the number of US citizens training to become SET personnel,[4] whilst the number of jobs requiring training in SET has continued to rise. And nor do they think it likely that a shortfall can continue to be made up by recruiting SET personnel from overseas – international competition for science and engineering skills is increasingly intense. So serious do they consider the situation that they state 'these trends threaten the economic welfare and security of our country'.

1 DTI Economics Paper No. 7 provides a summary of estimates.

2 Griffith et al. (2004).

3 Tether et al. (2005).

4 National Science Board (2004).

Any shortfalls in the supply of SET workers are, to an extent, likely to be corrected by the market mechanism. If demand for workers with these skills increases relative to supply, employment and wage rates for these workers would be expected to rise. This would then increase the incentive for individuals to invest in acquiring SET qualifications. In the short to medium run, however, supply may be slow to respond as it takes time for people to gain these qualifications.

The analysis in the remaining sections presents data on the supply of SET skills since the mid 1990s. Data constraints mean that the analysis has to focus on graduate level skills, although some information is reported for A levels. A distinction is made between the total number of SET graduates in the working age population and the number of people recently graduating with degrees in SET subjects. Box 1 provides a clearer definition of what is meant by SET skills.

Box 1: Definition of SET skills

SET skills are defined in terms of people holding qualifications in science, engineering and technology. Qualifications, however, are often argued to be an imperfect proxy for skills since many people will have developed a proficiency in SET in ways that are not captured through their formal qualifications. The main measure of SET skills used is the number of people holding first degrees and doctorates as their highest qualification. Definitions are kept as consistent as possible throughout and contains degree holders in the fields of medicine, dentistry, subjects allied to medicine (e.g. nursing and pharmacy), biological sciences, veterinary sciences, agricultural sciences, physical sciences (e.g. physics and chemistry), environmental sciences, mathematical and statistical sciences, computer sciences and ICT, engineering, technology, architecture, and building and planning.

Less data is available on the subjects studied for other qualifications e.g. National Vocational Qualifications (NVQs). The main exceptions are for GCSEs and A levels where subject specific information is available. Some analysis is therefore presented on A level entries and passes in biological sciences, chemistry, physics, mathematics, computer studies, ICT, and other sciences. Emphasis is placed on A levels since this represents the first opportunity for individuals to express a preference to study SET beyond compulsory schooling.

Analysis of a range of indicators provides some insight into the labour market for SET skills and relative changes in demand and supply in recent years. Here it often only becomes possible to look at data for those people employed in SET occupations. Although many workers employed as Science and Technology Professionals, for example, will hold qualifications in SET, it is not necessarily the case that all workers in that occupational group will. Examining employment and wage data for occupational groups is therefore an imperfect way of exploring the labour market for SET skills, but is often all that can be done with the available data. Box 2 presents more information on the way in which SET occupations are defined.

Box 2: Definition of SET occupations

The Standard Occupational Classification (SOC) 2000 provides a way of categorising individuals according to whether they work in SET or non-SET occupations. Being a member of a SET occupation, however, does not necessarily imply holding formal qualifications or having developed particular skills in science based work. In addition, many holders of SET qualifications will find employment in non-SET occupations. Analysing the labour market outcomes of SET occupations may still provide some useful information relating to the market for SET skills since these occupations are a natural employment opportunity for people with these skills. The occupations defined as being SET (except where otherwise stated) are science professionals, engineering professionals, ICT professionals, health professionals, scientific researchers, architects, town planners and surveyors, science and engineering technicians, draughtspersons and building inspectors, IT service delivery occupations, health associate professionals and therapists.

CHAPTER 2

Stocks and flows of SET qualifications

Science and technology is a crucial component of education, from the Key Stages that form the basis of compulsory schooling through to graduate and doctoral studies. Each of these educational stages are important for assessing the overall level of SET skills held within the UK and policies are in place to promote SET at all ages. A good starting point however in terms of the immediate impact on innovation performance and productivity is to examine graduate level qualifications. The **stock** of graduate skills is defined in terms of the number of individuals of working age[5] who hold degree level qualifications in SET subjects.

Even if the UK appeared as having a healthy stock of SET graduates, however, a longer term skill need may arise if fewer individuals are currently studying and obtaining degrees in SET subjects. It is therefore important to look at the **flow** of people being awarded SET degrees in order to obtain a picture of the nation's skills position. Although the analysis focuses on graduate level study, it is important to remember that the flow of individuals into university will depend partly on the popularity and attainment of SET during compulsory schooling and further education. It is particularly worthwhile to examine A levels since this represents a point at which pupils choose whether or not to continue studying SET and thus provide the natural pre-requisite for entry into university education.

Stocks of first degree graduates

Table 1 provides a measure of the stock of first degree holders within the working age population. There are currently around 2.1 million SET graduates living in Great Britain. This figure relates to those residing in Great Britain and therefore includes foreign nationals who may have obtained their SET degrees from another country. This measure of the stock has risen from 1.3 million in 1997, an increase of 57 per cent. These figures also relate to the number of SET graduates with a single subject degree. There are more individuals holding SET qualifications acquired from studying combined subject degrees. In 2004, an additional 500,000 degree holders held combined degrees where the main area of study was a SET subject, taking the total SET stock to 2.6 million.[6]

Table 1 reveals that there has also been a 49 per cent growth in the numbers holding degrees in other single subjects over the same period, increasing the

5 The working age population consists of men aged 16 to 64 and women aged 16 to 59.

6 The analysis presented in this paper concentrates on the stock of graduates of single subject degrees since detailed data on the subjects studied within combined degrees has only been collected from 2004 onwards in the Labour Force Survey.

stock from 1.8 million in 1997 to 2.7 million in 2004. This higher growth rate for SET compared to non-SET subjects suggests that the proportion of graduates with SET skills has risen very slightly, from 43 to 44 per cent.

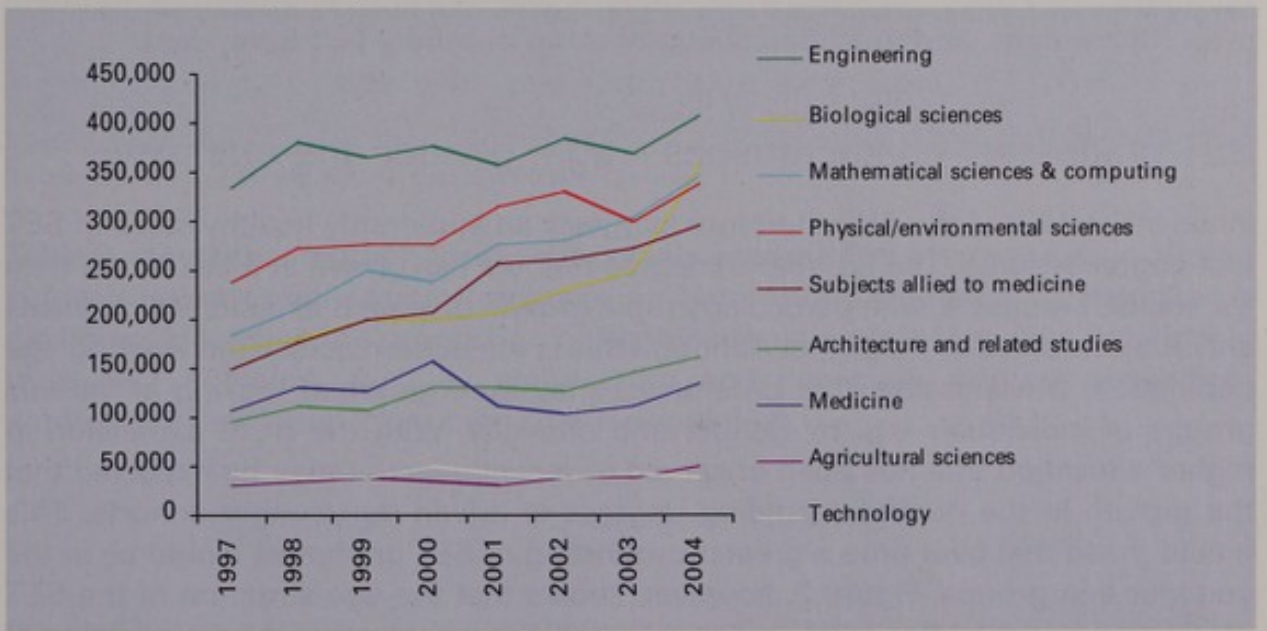
Table 1:
First degree graduates

		1997	2000	2004	% increase 1997-2004
SET subjects	Absolute number	1,350,000	1,669,000	2,123,000	57.2%
	As % of working age population	3.9%	4.8%	6.0%	
Non-SET subjects	Absolute number	1,788,000	2,189,000	2,670,000	49.3%
	As % of working age population	5.2%	6.3%	7.6%	

Source: Labour Force Survey, Autumn data, GB, single subject degrees and working age only (16-59/64)

There is earlier data from 1992 to 1996 on the number of graduates in SET subjects, although this is not directly comparable due to a change in the way degree subjects are coded in the Labour Force Survey in 1997. It suggests that the expansion of the SET graduate population has picked up pace in recent years.[7]

Figure 1:
SET graduates by subject



Source: Labour Force Survey, Autumn data, GB, single subject degrees and working age only

7 This data shows slower annual growth in numbers holding degrees from 1992 to 1996 – 11 per cent for SET graduates and 26 per cent for non-SET graduates.

Figure 1 plots the rise in the number of individuals holding first degrees reported in Table 1 in a range of SET subjects. The largest single subject grouping has historically been engineering. In recent years (1997 to 2004), the number of holders of biological sciences, subject allied to medicine (including pharmacy and nursing), and mathematical sciences & computing degrees has grown strongly, by 110 per cent, 98 per cent and 88 per cent respectively. The number of people with engineering degrees has risen more moderately, by 21 per cent to over 400,000. There are less than 50,000 individuals with technology degrees, with the latter group declining by 10% per cent over the period.

Where sample sizes allow, the Labour Force Survey can also provide information at more disaggregated subject groupings. Within biological sciences, it is the newer subjects that are driving the growth. Biology graduates have increased just 40 per cent, whereas microbiology graduates have increased by 111 per cent. Within subjects allied to medicine, nursing graduates have increased over threefold to reach 92,000. Within mathematical sciences and computing, it is the computing subjects that account for most of the growth, graduate numbers there having increased by 144 per cent compared to just 33 per cent for mathematics and statistics graduates. Chemistry and physics graduate numbers only grew by 24 per cent and 20 per cent respectively, whilst physical and environmental sciences graduates overall grew by 41 per cent. There is also a mixed picture within engineering. Production and manufacturing systems engineering graduate numbers grew by 45 per cent and civil engineering numbers by 44 per cent. Meanwhile, general and chemical engineering numbers grew 13 per cent, and mechanical engineering numbers just 5 per cent.[8]

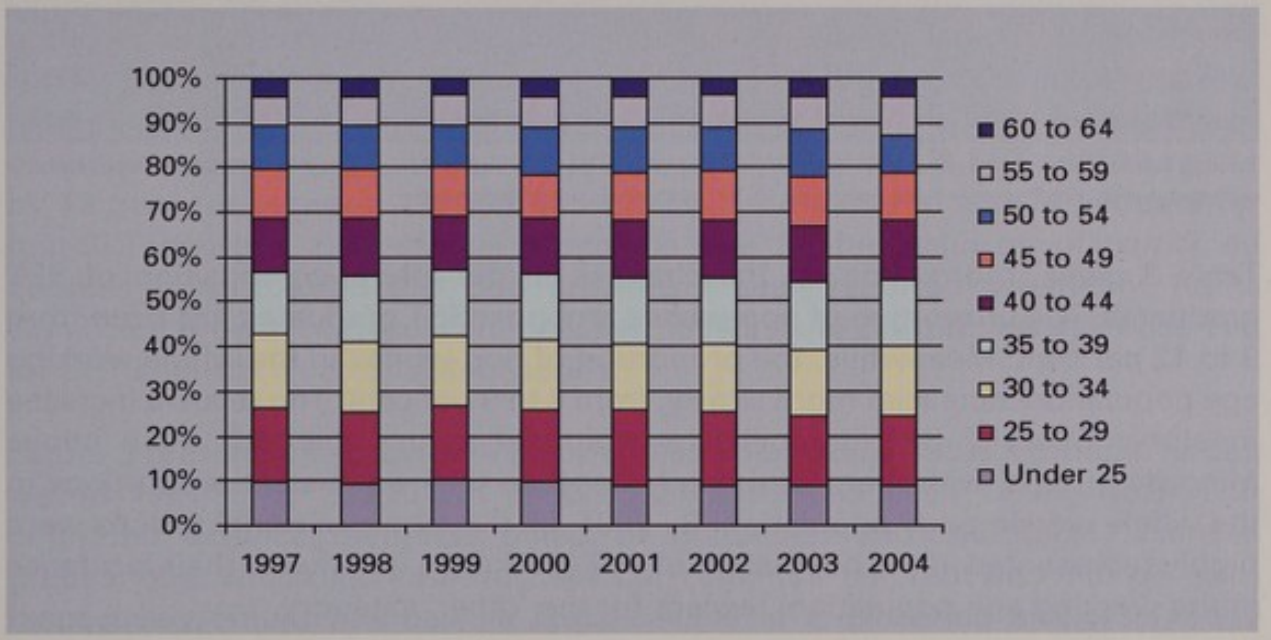
SET graduates' characteristics – age, gender and ethnicity

Initial inspection of the data therefore suggests an apparently healthy stock of SET first degree holders. The number of degree holders has grown at a faster rate than for non-SET subjects, with particularly rapid growth observed in biological sciences and subjects allied to medicine. Although this is the pattern across the working age population, it is possible that differences may emerge when looking at various groups of individuals e.g. by gender and ethnicity. With the rapid expansion in higher education that has been observed in recent years, it may be expected that the growth in the numbers holding degrees is driven by younger cohorts. This would mean that over time a greater proportion of SET graduates would be in the younger age groups. Figure 2, however, shows that the age structure of the SET graduate population has been reasonably stable in recent years. As a proportion of the total, most of the age bandings have only fluctuated slightly between 1997 and 2004 and within the margins expected from survey data. It may also be the case that only looking over a seven year period, combined with the relatively small turnover of the labour market in terms of those retiring and entering the labour market each year, there is insufficient time to detect any change to the age structure.

8 Source: Labour Force Survey, Autumn data, GB single subjects only and working age only. Growth factors for these more disaggregated subject groupings are biased slightly downwards, because there was also an increase in the numbers of graduates allocated to a major subject grouping, but not to a minor one.

The stability of the age structure reported in Figure 2 suggests there is little obvious reason for concern over a reduction in the population of SET graduates as a result of older cohorts retiring in the coming decades. A similar pattern holds across the nine SET subject groupings, but with some variation. For mathematical science and computing and biological sciences there are more graduates in the younger cohorts, whilst in engineering there are more people in the cohorts from 35 to 45 than in those below that age. This suggests that there is the prospect in 15 to 20 years' time of an absolute fall in the number of engineering graduates.

Figure 2:
SET graduates by age



Source: Labour Force Survey, Autumn data, GB working age only.

Table 2 shows that women form an increasing proportion of graduates in all SET subjects, except mathematical sciences and computing where their proportion is declining. However, the proportion of females remains disproportionately low in most SET subjects, such as architecture and especially engineering where women only make up 7 per cent of the population.

Table 2:
Female proportion of SET graduates by subject

	1997	2000	2004
Subjects allied to medicine	66%	70%	71%
Biological sciences	47%	47%	58%
Medicine	36%	38%	43%
Agricultural sciences	*	*	43%
Technology	*	24%	35%
Physical/environmental sciences	22%	24%	29%
Mathematical sciences & computing	27%	25%	25%
Architecture and related studies	18%	20%	21%
Engineering	4%	4%	7%
SET subjects	**27%**	**29%**	**36%**
Non-SET subjects	**49%**	**52%**	**53%**

Source: Labour Force Survey, Autumn data, GB, single subject degrees and working age only; * indicates results not reported due to small sample sizes (less than 10,000 individuals when weighted)

Table 3 gives information on the changes in the ethnic composition of SET graduates. The proportion of non-whites amongst SET graduates has risen from 9 to 12 per cent. Meanwhile, the proportion of non-whites in the whole working age population increased more slowly, from 8 to 9 per cent. The relative increase in ethnic minority SET graduates was spread across the four main ethnic minority groups, with them all rising faster than their equivalent proportions in the whole working age population. By 2004, all the ethnic minority groups were highly represented in the population of SET graduates (relative to their incidence in the working age population), except for the 'other' category.

Table 3:
SET graduates by ethnicity

Ethnicity	Population	2001	2004
White	SET graduates	90.7%	87.7%
	All of working age	91.6%	90.7%
Asian or Asian British	SET graduates	5.5%	6.6%
	All of working age	4.4%	4.5%
Black or Black British	SET graduates	1.6%	2.4%
	All of working age	2.1%	2.3%
Chinese	SET graduates	*	1.1%
	All of working age	0.4%	0.5%
Mixed	SET graduates	0.8%	1.1%
	All of working age	0.6%	0.8%
Other	SET graduates	1.0%	1.1%
	All of working age	0.9%	1.2%

Source: Labour Force Survey, Autumn data, GB, single subject degrees and working age only. * indicates results not reported due to small sample sizes (less than 10,000 individuals)

When analysing the nine SET subject groupings, sample sizes prevent disaggregation into each of the non-white groups identified in Table 3. Instead it is only possible to identify white and non-white groups. The pattern of relative over-representation of non-whites is most pronounced for medicine, followed by mathematical and computing science graduates. This group of individuals are also relatively under-represented amongst agricultural science graduates and technology graduates.[9]

Flows of first degree graduates

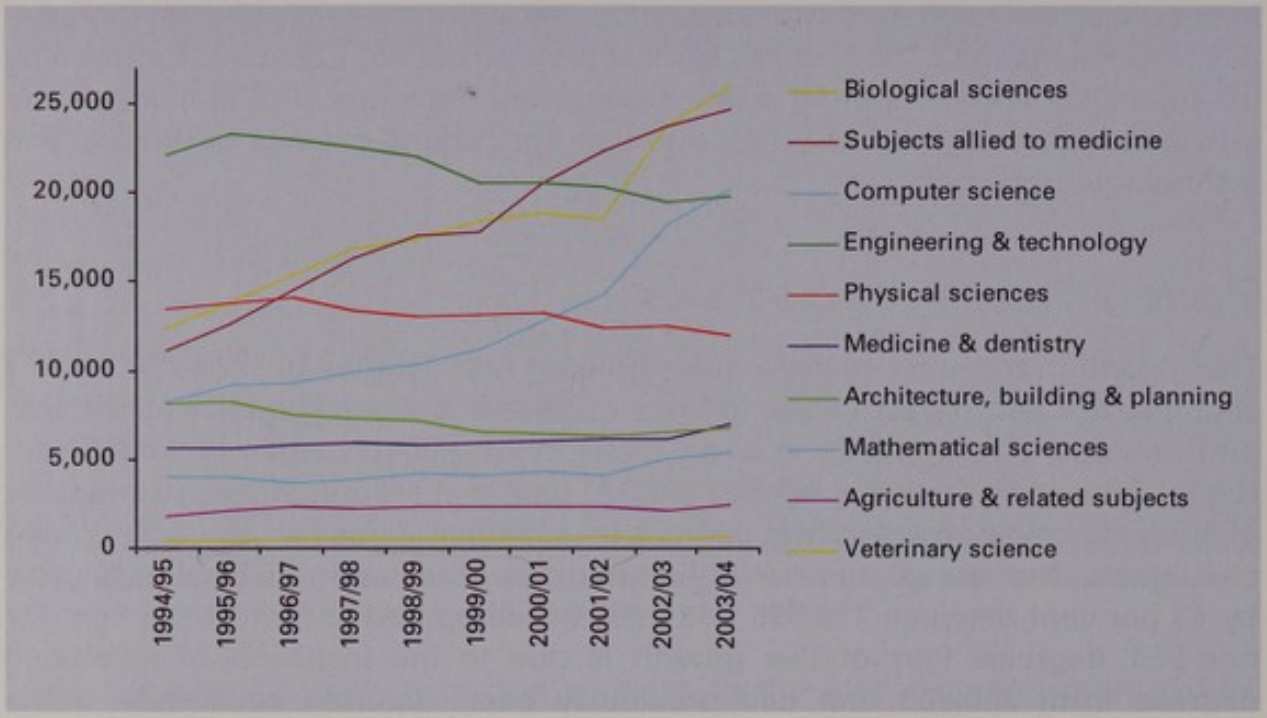
The growth in the stock of individuals holding first degrees provided in Table 1 captures the net impact of the inflows of people obtaining qualifications and outflows due to retirements. A direct measure of inflows can be obtained from Higher Education Statistics Agency (HESA) data that records the actual number of students being awarded first degrees in each year across an extensive range of subjects. The annual number of first degrees obtained in SET subjects grew by 43 per cent between 1994/95 and 2003/04, compared to just 11 per cent for non-SET degrees. Part of this growth is due to the inclusion of combined degrees from 2002/03 that had previously been reported separately, but a significant growth of 23 per cent between 1994/95 and 2001/02 was still observed for SET subjects as a consistent series.[10]

Figure 3 presents the growth in first degrees obtained by subject group over the period 1994/95 to 2003/04. It shows that there has been strong growth in computer science, subjects allied to medicine, and biological sciences graduations, which increased by 144 per cent, 123 per cent and 110 per cent respectively. There has been a large decline in engineering and technology graduations, down 2,000 absolutely or 10 per cent relatively, and likewise in physical sciences and architecture which both experienced falls of 1,500, or 11 per cent and 18 per cent respectively.

9 Source: Labour Force Survey, Autumn data, GB, singles subjects and working age only. Sample sizes too small to allow disaggregation into constituent non-white groups for nine SET subject groupings. For more information on SET skills and ethnicity see: IER (2005) at: http://www.royalsoc.ac.uk/downloaddoc.asp?id=1870.

10 HESA published data provides an inconsistent time series due to the treatment of combined degrees, but consistent series are available on request from HESA directly. Also since 2000/01 qualifications awarded from 'dormant' status were included. The number of first degrees awarded rose by only 3 per cent as a result of this change, but much larger differences are observed for doctorates (22 per cent).

Figure 3:
SET first degrees obtained by subject



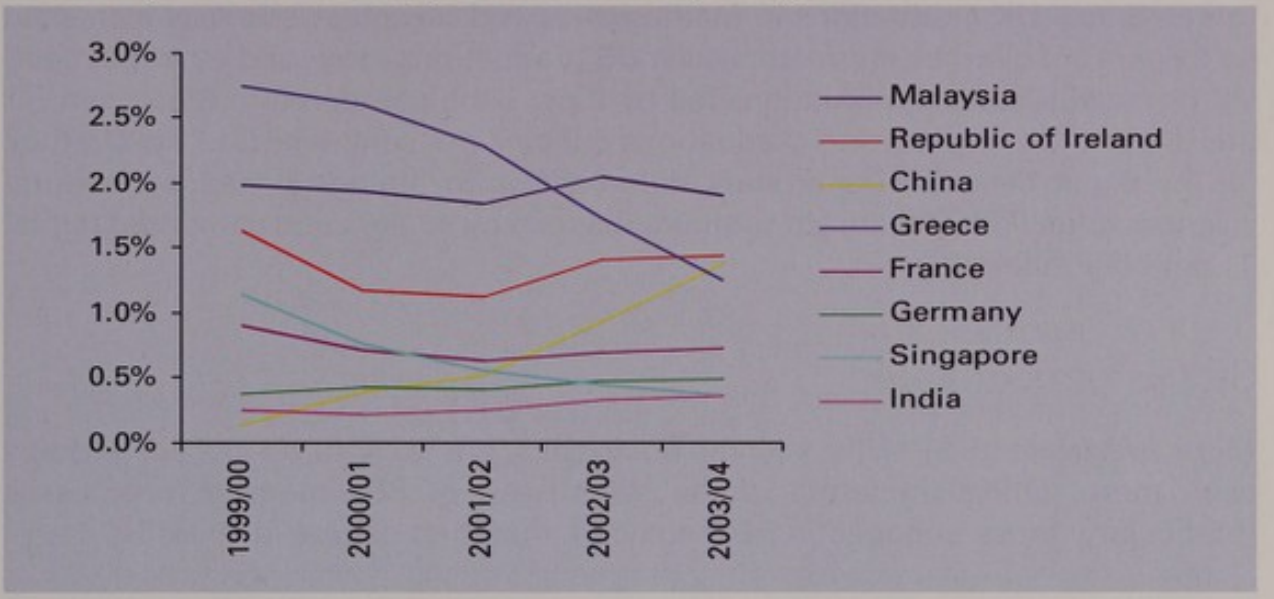
Source: Higher Education Statistics Agency. 2002/03 and 2003/04 data not directly comparable with previous years due to changes in the subject classification system and to the treatment of combined degrees.

HESA data also provides information on the nationality of graduates. The proportion of foreign nationals amongst new SET first degree graduates from UK Higher Education Institutions (HEIs) has been fairly constant over the last five years, at around 15 per cent, the same as non-SET subjects. This proportion varies dramatically by SET subject group, with 29 per cent of new engineering and technology graduates being foreign nationals, compared to just 8 per cent of new physical sciences graduates.[11] The countries these foreign nationals originate from have been changing significantly in recent years (Figure 4). Chinese nationals, who in 1999/00 accounted for just 0.1 per cent of SET graduates, made up 1.4 per cent by 2003/04. In contrast, the share of Greek nationals has declined from 2.7 to 1.3 per cent over the same period, going from the largest single source of foreign SET graduates to the fourth largest, after Malaysia, the Republic of Ireland and China.[12] The EU as a whole (excluding the UK) accounted for 7.2 per cent of new SET graduates in 2003/04, compared to 5.6 per cent in 1999/00.

11 These proportions of foreign nationals have remained fairly static since 1999/00. The recent growth in certain subjects reported in Figure 3 (e.g. computer science) therefore are not due to large rises in the number of foreign national graduates relative to UK graduates.

12 Data source is the Higher Education Statistics Agency plus DTI calculations. This data is based on the HESA nationality field, which is taken to be the country of legal nationality of the graduate. This is not a compulsory field, and the extent of its coverage varies by year and subject. For this reason, proportions of graduates from different countries are quoted rather than absolute numbers of graduates.

Figure 4:
Percentage of SET first degrees obtained by foreign nationals

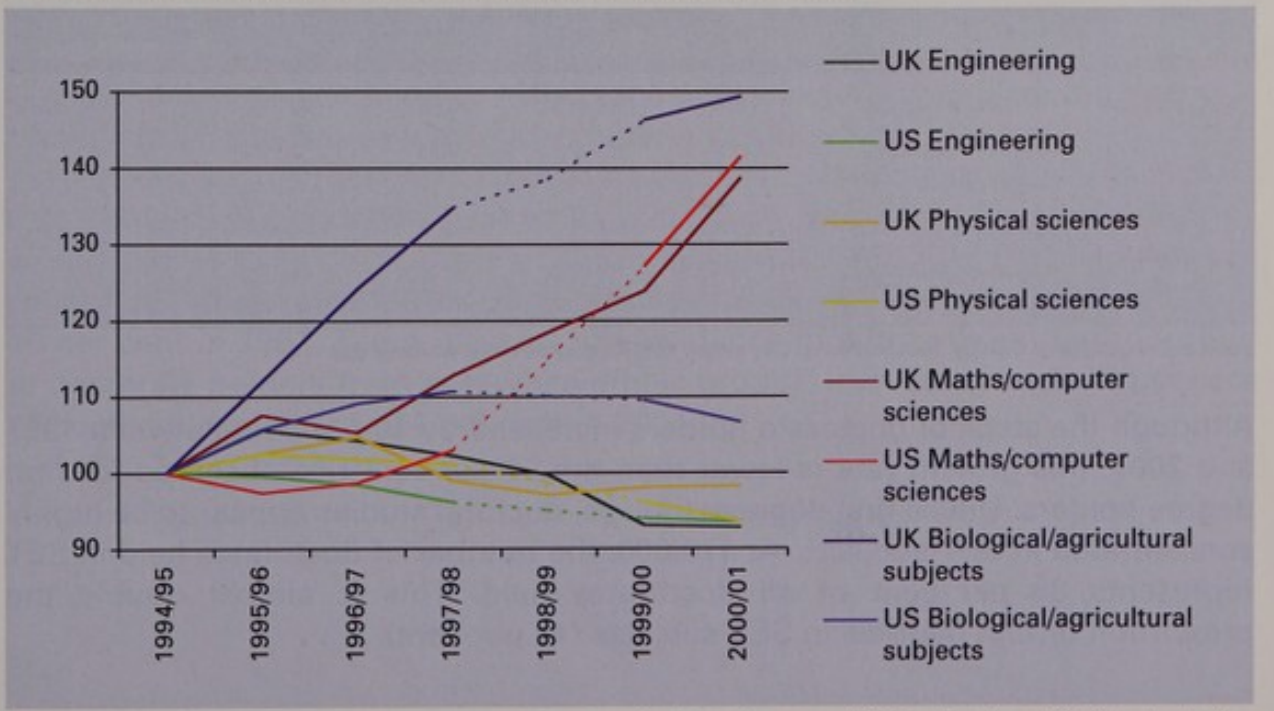


Source: Higher Education Statistics Agency

International comparisons

In the US, the National Science Foundation (NSF) provides data on graduations by SET degree subject, but uses slightly different definitions of SET subjects. Figure 5 compares this US data for 1994 to 2001 with that for the UK from the Higher Education Statistics Agency, for four main SET subject groupings that match up fairly closely.

Figure 5:
US and UK trends in SET graduations (1994/95 = 100)



Source: National Science Foundation, the Higher Education Statistics Agency and DTI calculations. US data missing for 1998/99. US data refers to bachelor's degrees and UK data to first degrees.

Figure 5 shows similar trends for the US and UK in mathematics and computer sciences (red lines), physical sciences (orange/yellow lines) and engineering (green lines). UK graduations in mathematics and computer sciences increased by 39 per cent over the six years, whilst US graduations increased by 41 per cent. UK physical sciences graduations fell by 2 per cent, compared to 6 per cent for the US; and UK engineering graduations fell by 7 per cent, whilst in the US they fell by 6 per cent. The only stark difference is in biological and agricultural sciences (blue lines) where UK graduations rose by 49 per cent, compared to just 11 per cent in the US.

Stocks of doctorates

More specialised SET skills, such as doctorates, are likely to be just as, perhaps even more, crucial in terms of the skills need of SET-intensive businesses (particularly those engaged in R&D activity), than first degree level skills.

Table 4 shows that between 1997 and 2004, there was a 40 per cent increase in the number of people of working age in Great Britain holding doctorates (PhDs) in SET subjects. This is comparable to the 37 per cent growth experienced in other subjects. As a proportion of the working age population, SET doctorate holders increased from 0.37 to 0.50 per cent. There is some volatility in the data series of the stock of doctorates, however, with the numbers rising to 1999, then dipping between 1999 and 2001, before increasing again. This may partly be a consequence of the relatively small number of doctorate holders interviewed within the Labour Force Survey.

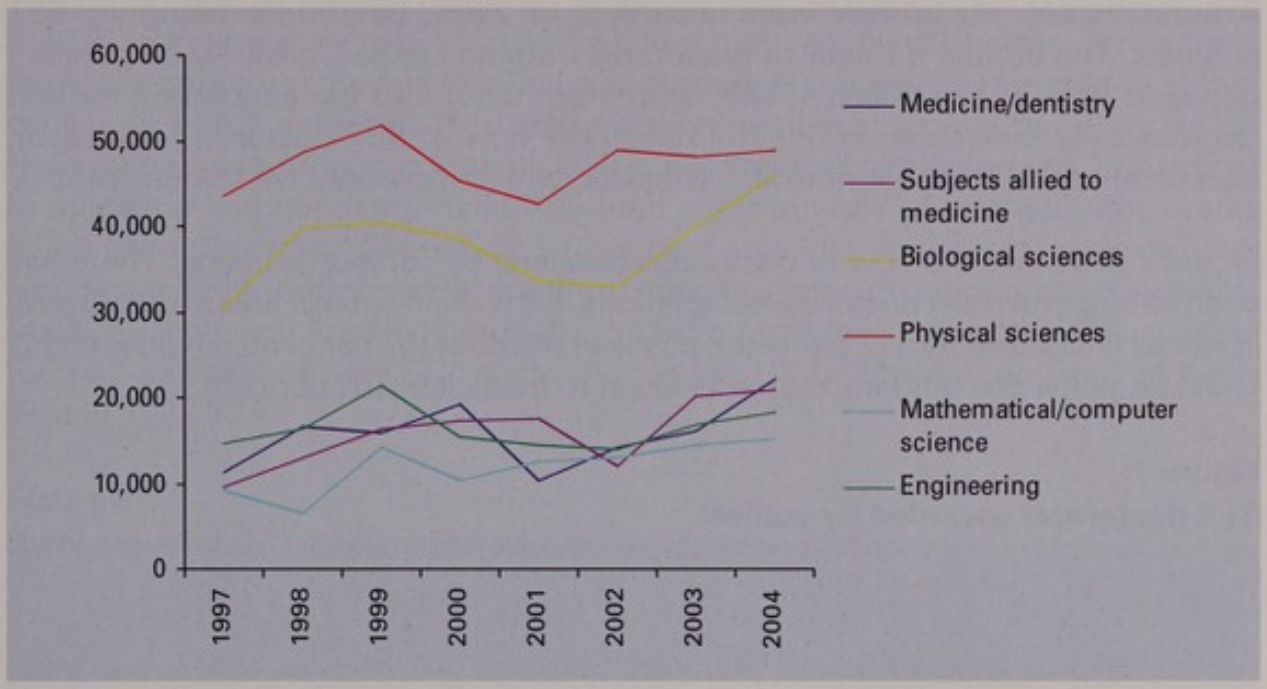
Table 4:
Holders of doctorates

		1997	1999	2001	2004	% increase 1997-2004
SET subjects	Absolute number	127,000	169,000	140,000	178,000	40.3%
	As % of working age population	0.37%	0.49%	0.41%	0.50%	
Non-SET subjects	Absolute number	33,000	43,000	43,000	46,000	37.4%
	As % of working age population	0.10%	0.13%	0.12%	0.13%	

Source: Labour Force Survey, Autumn data, GB, single subject degrees and working age only

Although the stock of doctorate holders increased by 40 per cent between 1997 and 2004, this growth rate is lower than the 57 per cent rise observed for first degree holders. Unlike first degrees though, doctoral studies appear to be highly concentrated in SET subjects. At 178,000, the number of doctorates held in SET represents 80 per cent of all doctorates held. This is almost double the proportion of first degrees in SET subjects (44 per cent).

Figure 6:
SET doctorate holders by subject



Source: Labour Force Survey, Autumn data, GB, single subject degrees and working age only. Agricultural sciences, technology and architecture/related subjects suppressed due to small sample sizes.

Figure 6 provides the subject breakdown for the stock of doctorates. The apparent fluctuation in the series may again be due to the small sample sizes obtained from survey data, which becomes more of an issue when analysing subject groupings. Even so, it may be seen that physical and biological sciences are the largest groups with around 95,000 of the total 178,000 doctorate holders being specialised in these two areas.

SET doctorate holders' characteristics – age, gender and ethnicity

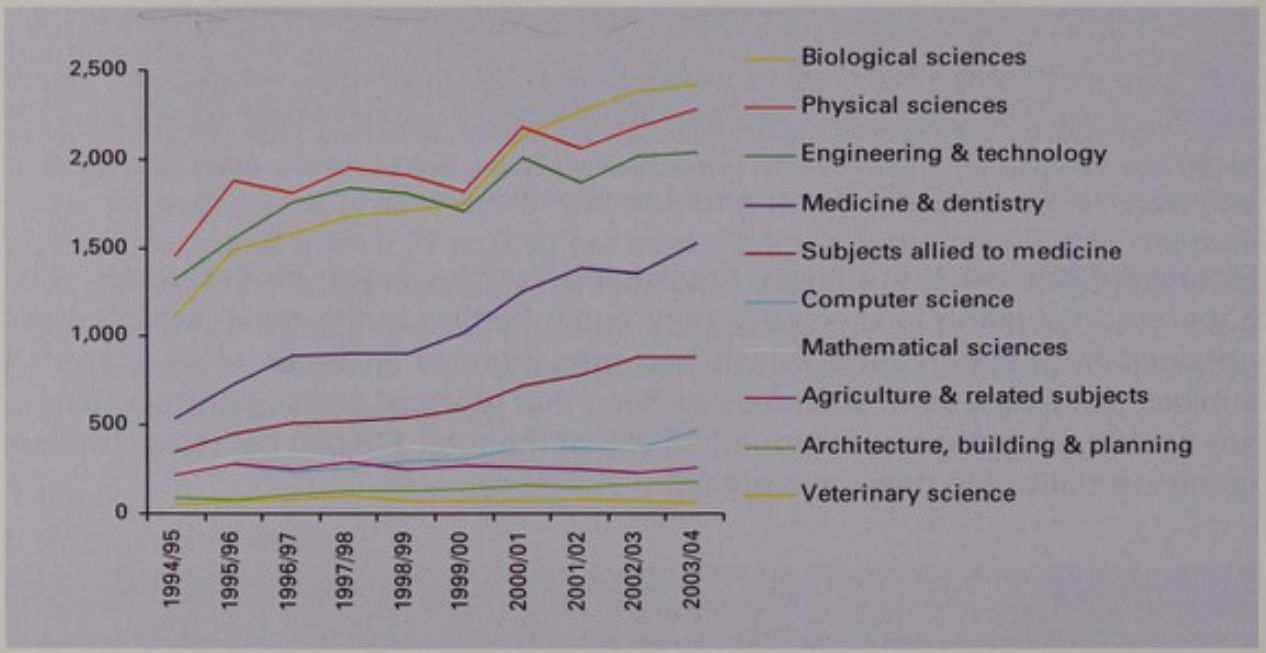
The limitations on the data with respect to doctorate holders means that providing full breakdowns by age, gender and ethnicity is less informative than that for first degree holders. As would be expected, a simple age analysis reveals that holders of doctorates tend to be older than first degree holders. Women would appear to be under-represented at this level of education with only 28 per cent of SET doctorate holders being female in 2004, although this has risen from 16 per cent in 1997. There is also some evidence of a growth in the proportion of doctorate holders from non-white ethnic groups, increasing from 10 per cent of doctorates in 1997 to 14 per cent in 2004.

Flows of doctorates

Around 15,000 doctorates were awarded in 2004, two-thirds being in SET subjects. The annual number of doctorates obtained in SET grew by 88 per cent between 1994/95 and 2003/04. This is greater than the 43 per cent found for first degrees over the same period. The rise in the flow of SET doctorates, however, was smaller than that for non-SET subjects, which increased by 155 per cent.

Figure 7 describes the flow of doctorates obtained by subject grouping. There has been strong growth in doctorate completions in the main subject areas of biological sciences (increased by 117 per cent), physical sciences (57 per cent), engineering & technology (54 per cent) and subjects allied to medicine (151 per cent).

Figure 7:
SET doctorates awarded by subject

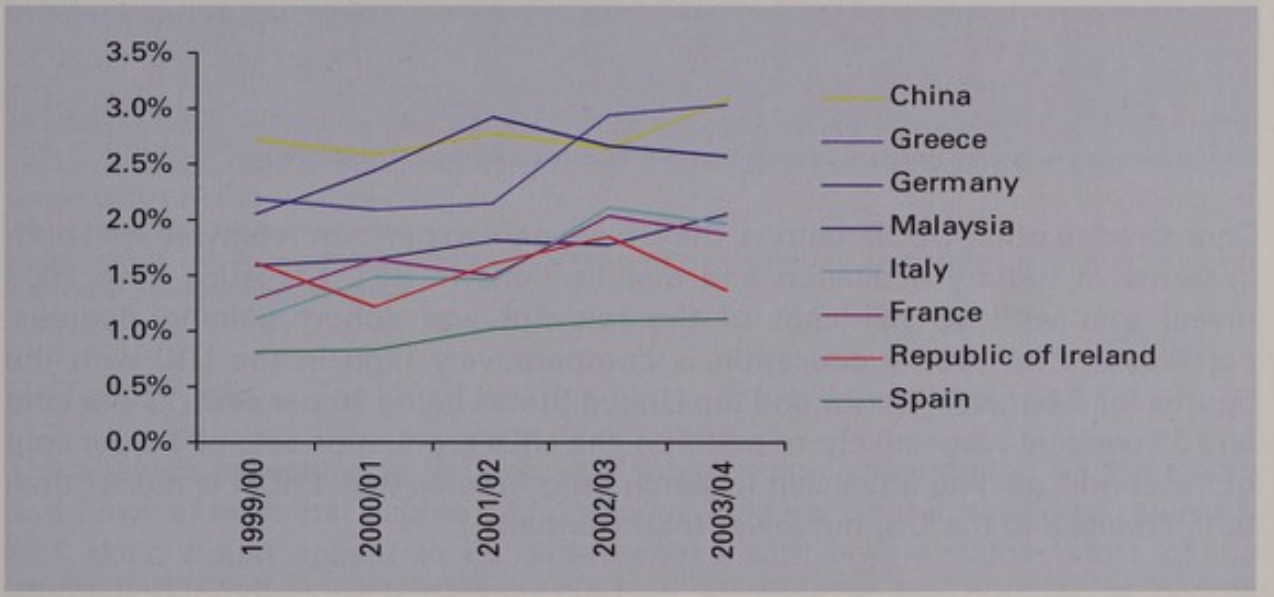


Source: Higher Education Statistics Agency. 2002/03 and 2003/04 data not directly comparable with previous years due to changes in the subject classification system and to the treatment of combined degrees.

Nationality of new SET PhD graduates

The proportion of foreign nationals amongst new SET doctorate completions in the UK is higher than that for new SET first degrees. Nevertheless, it has been fairly constant over the last five years at around 39 per cent, compared to 50 per cent in non-SET subjects. This proportion varies considerably by SET subject, from 60 per cent foreign nationals in engineering and technology to 26 per cent in medicine and dentistry. Relatively high contributions of new SET doctorates come from China and Greece, at 3.1 per cent and 3.0 per cent respectively, with significant contributions also coming from, in order of magnitude, Germany, Malaysia, Italy and France (Figure 8). The EU overall (excluding the UK) accounts for 14.7 per cent of new SET doctorates in the UK in 2003/04, up from 11.6 per cent in 1999/00.[13]

Figure 8:
Percentage of SET doctorates awarded to foreign nationals



Source: Higher Education Statistics Agency

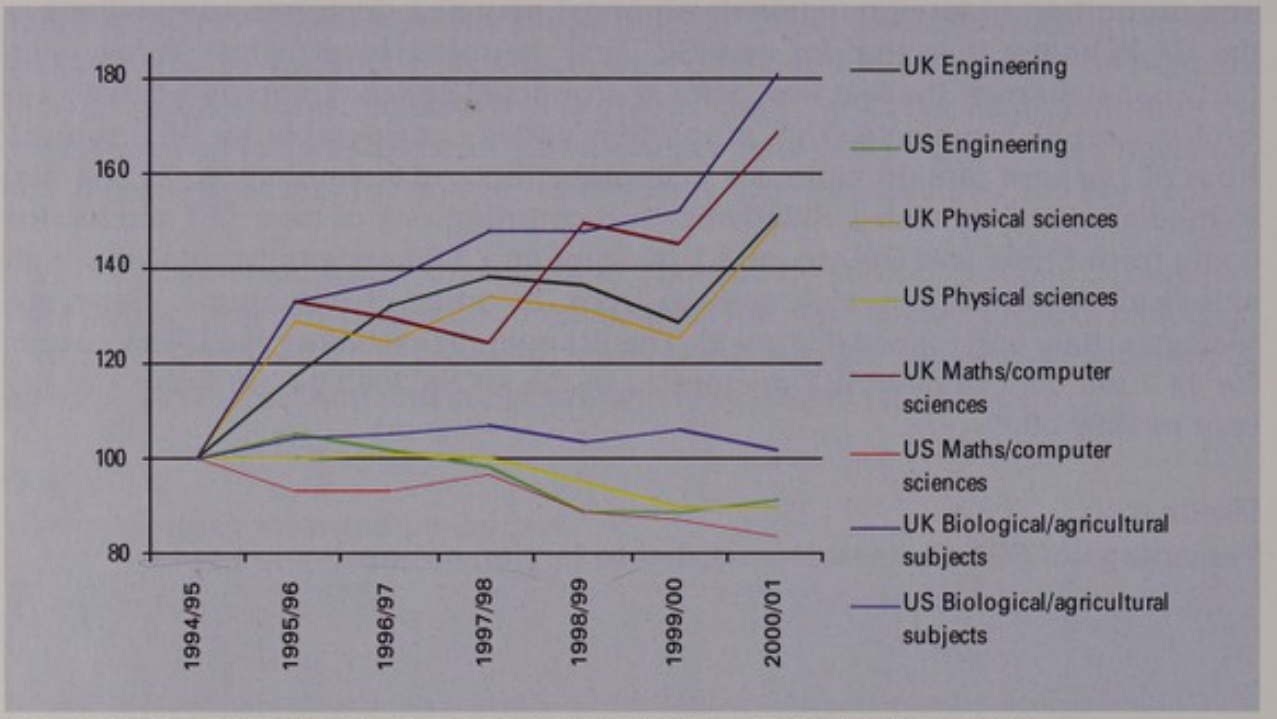
International comparison

The growth in SET[14] doctorate completions in each of the four SET categories in the UK in recent years has not been matched in the US, as shown in Figure 9. UK SET doctorate graduations increased by 61 per cent on average, whilst US SET doctorate graduations fell by 5 per cent. These changes are not explained by the US starting from a higher base in 1994/95; in fact, relative to their respective populations, the UK was nearly level with the US in new SET doctorate graduations in 1994/95 and had opened up a considerable gap by 2000/01.

13 See footnote 12.

14 Definitions as for first degree US-UK comparison above in Figure 5.

Figure 9:
US and UK trends in SET doctorate graduations (1994/95 = 100)



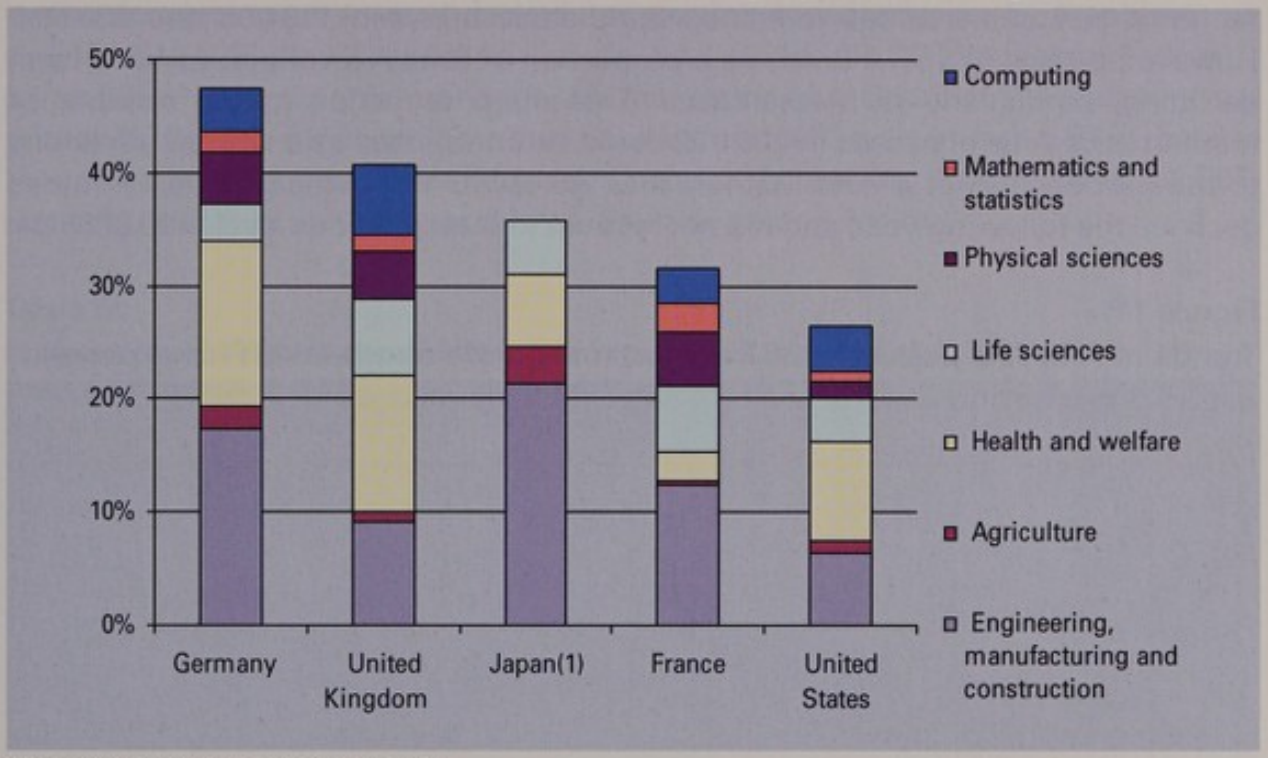
Source: National Science Foundation, the Higher Education Statistics Agency and DTI calculations.

Compared to other OECD nations, the UK appears to perform relatively well both in terms of tertiary education and qualifications in SET. Statistics from 2003 reveal that with 38 per cent of the relevant age cohort gaining degrees, participation in tertiary education is comparatively high in the UK, with the figures for Germany, France and the United States being 20 per cent, 27 per cent and 33 per cent respectively. In addition, the UK's graduation rate of 1.8 per cent of the cohort gaining advanced research programmes (e.g. PhDs) is higher than both France and the US, but lower than Germany.[15]

Figure 10 shows that 41 per cent of UK graduations were awarded in SET subjects. These figures relate to both bachelors degrees and PhDs (although only a small proportion of the total are PhDs). The UK has relatively high levels of computing and health and welfare degrees, but low levels of engineering, manufacturing and construction degrees. These findings support the view of a relative decline in the flow of engineering graduates in the UK suggested in Figure 3.

15 OECD Education at a Glance 2005.

Figure 10:
International comparison of SET graduates as a proportion of all graduates, 2003



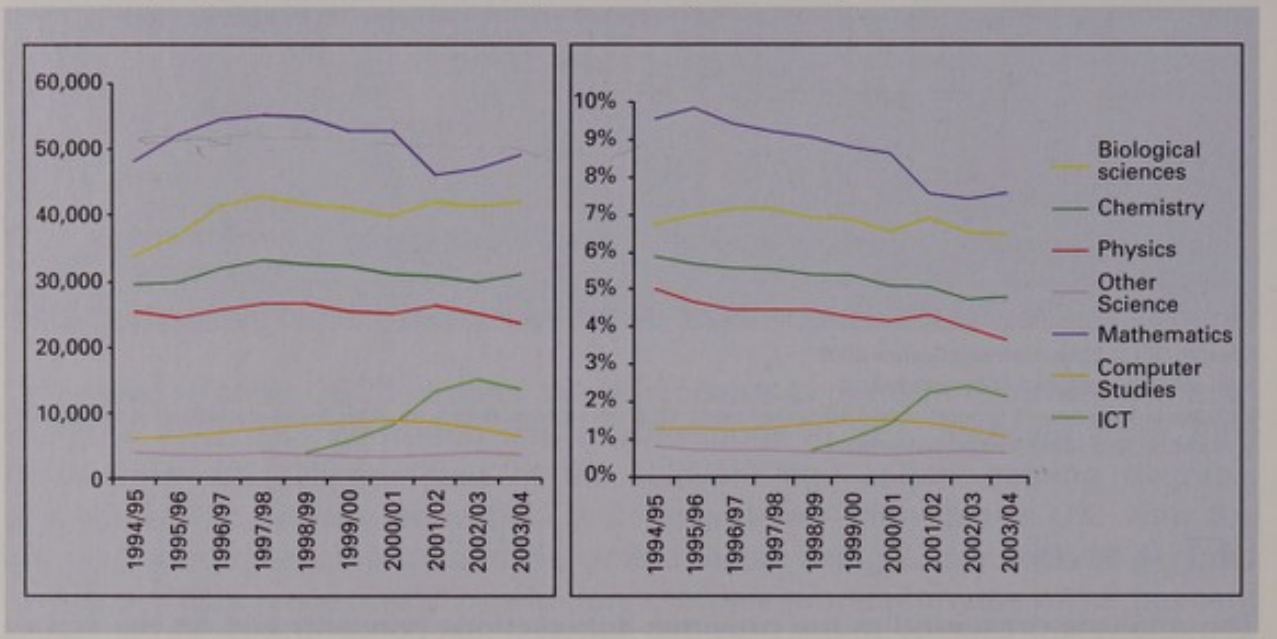
Source: OECD Education at a Glance 2005
1 All sciences included in life sciences.
Includes tertiary type-A programs and advanced research programmes. Refers to all students graduating in the country in question, including foreign nationals.

SET A levels

The analysis presented in the previous sub-sections concentrated on the stocks and flows of both first degree and doctorate holders. On the measures reported, SET skills would appear to be quite healthy with both a higher stock of the population holding such degrees and an increase in the number of people graduating each year. The extent to which this growth is sustainable however depends partly on the number of people gaining SET qualifications as a pre-requisite for higher education. Level 3 qualifications are likely to form the feeder population for both employment in technician-level SET jobs and for those who go on to study SET at degree level. Traditionally, A levels have formed the mode of entry to university and the subsequent analysis focuses on these qualifications. The analysis is also restricted to A levels since there is limited data available on the actual subjects studied by individuals for other Level 3 qualifications.

Figure 11 shows the trends in A level SET subjects since 1994/95. With the recent exception of ICT, the absolute numbers passing A levels (left-hand panel) across a range of SET subjects has remained fairly static between 1994/95 and 2003/04. However, passes in SET A levels as a proportion of total A level passes have been declining, particularly in Mathematics. The sharp reduction in the number of Mathematics A level passes in 2001/02 could be interpreted as a one-off effect due to the introduction of a new Mathematics AS level. Mathematics A level entries declined the following year, and did not recover to their previous level until 2003/04.

Figure 11:
Trends in A Levels passes in SET subjects, absolute number (left-hand panel) and as a proportion of all A level passes (right-hand panel)



Source: Department for Education and Skills, 16-18 year olds only

The relative decline in A level passes in SET subjects could be the result of a number of factors related to preferences for studying SET and perceptions over difficulty. Data on pass rates for different A level subjects suggest that SET A levels have become relatively more difficult. Pass rates for SET A levels have increased markedly, but not as much as they have in other subjects. SET A level pass rates were spread either side of the average pass rate for non-SET A levels in 1994/95 to 1999/00, but since 2001/02 SET pass rates have all been below the average rate for non-SET A levels.

Despite a lower pass rate, the proportion of people obtaining top grades is higher in SET subjects than non-SET subjects. Table 5 looks at the recent trends in the proportion of A level candidates getting top grades in SET subjects. It shows that a higher proportion get As and Bs in All SET subjects, but with particularly strong performance in Mathematics and Chemistry. However, top grades are much rarer in Computer Studies and ICT than in non-SET subjects. There is a steady upward trend for the proportion getting As and Bs in all SET subjects, and this upward trend is particularly strong for As.

Table 5:
Proportion of A level candidates gaining A or B grades by subject

Subject	2000/01	2001/02	2002/03	2003/04
Biological Sciences	38.4%	40.8%	42.4%	43.9%
Chemistry	47.9%	51.4%	53.4%	54.8%
Physics	44.6%	47.3%	48.4%	49.6%
Other Science	29.9%	38.1%	38.9%	41.8%
Mathematics	47.9%	58.3%	59.5%	61.0%
Computer Studies	22.0%	22.6%	30.0%	32.8%
ICT	#	#	20.8%	23.1%
All SET	**41.8%**	**45.7%**	**47.3%**	**49.5%**
All non-SET	**36.0%**	**40.9%**	**43.2%**	**44.1%**

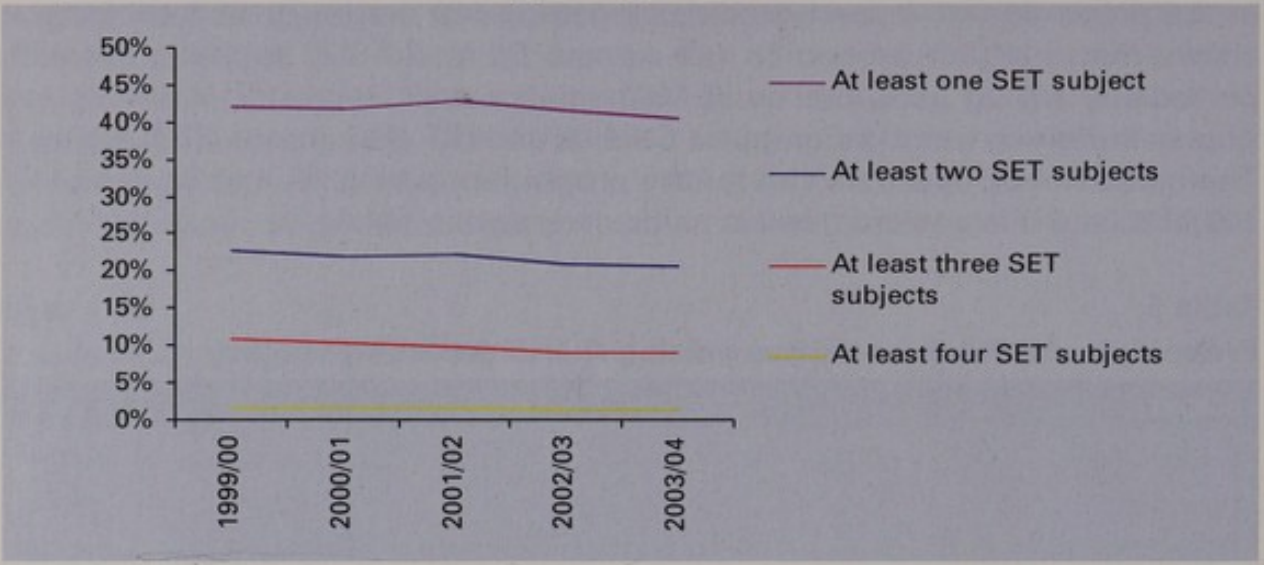
Source: Department for Education and Skills, England only, 16-18 year olds except 17-18 year olds for 2000/01.
# indicates data unavailable

The statistics looked at so far on A levels have been in terms of the number of total entries that have resulted in passes. The data can also be examined in terms of the proportion of A level students, and the proportion of the age cohort, who pass SET subjects. A similar story emerges from this version of the data, with gently declining proportions passing Mathematics, Biology, Chemistry, Physics and Computer Studies. For example, in 1999/00, 22 per cent of A level candidates (or 7 per cent of the age cohort), passed Mathematics, which had fallen to 19 per cent (6 per cent of the age cohort) by 2003/04.[16]

In 2003/04, 40 per cent of A level candidates passed at least one SET A level, or 13 per cent of the age cohort. This has changed little over the past five years, because the effect of falling entries for SET A levels has been balanced by the effect of increasing pass rates. 21 per cent of candidates in 2003/04 passed two or more A levels, and 9 per cent of candidates passed three or more A levels (Figure 12).

16 Source: Department for Education and Skills data on 17 year olds attempting and passing A levels.

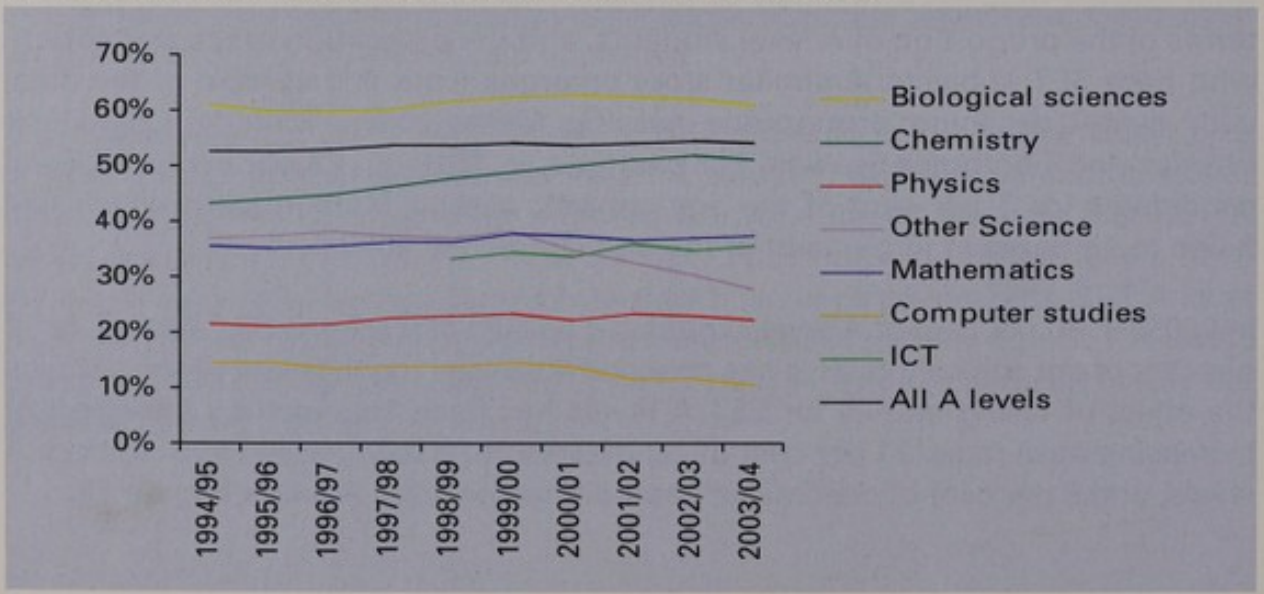
Figure 12:
Proportion of A level candidates passing SET A levels



Source: Department for Education and Skills. SET subjects are defined as those in Figure 10.

The young people passing A levels in SET subjects are still disproportionately male. Figure 13 shows that only amongst biological sciences passes is there an above average proportion of females. There has been an increasing proportion of Chemistry passes by young women and a decreasing proportion in other science A levels. Overall, this suggests there is still room for improvement in encouraging enough young women to take A levels in SET subjects.

Figure 13:
Percentage of females in A level passes in SET subjects



Source: Department for Education and Skills; 16-18 year olds only, England only.

The focus on A levels is of particular interest since it represents a point in the education system where individuals choose whether to continue studying SET. Part of the ten-year framework emphasises the desire to increase the numbers staying on to study SET in post-16 and higher education. Attainment at GCSE though remains crucial for developing SET skills and encouraging further study. There has been a gradual improvement in the percentage of pupils achieving A*-C GCSEs in any science, rising from 47.6 per cent in 2001 to 48.2 per cent in both 2003 and 2004.

CHAPTER 3

Labour market outcomes

By examining the stocks and flows of SET graduates, the analysis presented in section 2 may be interpreted as being more applicable to the supply side of the market for these skills. However, to a certain extent, the observed growth in the number of people holding these skills will also reflect changes in demand as individuals respond to the needs of the economy and invest in the skills yielding a promising return. It is likely that supply may be slow to adjust in the short to medium run and thus the responses to demand shocks may be prolonged. The recent boom and bust in ICT is an example of the extent to which the SET market may be susceptible to such shocks.

There are various indicators that may be used to assess the relative tightness of the labour market for people with SET qualifications. It is difficult to separate the demand and supply conditions within the market. Instead, by looking at the indicators over time, it is possible to make inferences concerning any apparent shifts in demand. For example, the stability in the wage returns received by university graduates over the last ten years indicates that despite the expansion in supply of graduates, there has been a corresponding rise in demand. Therefore, analysis of employment, unemployment and inactivity rates of those with SET qualifications, along with information on their relative wages, may offer some insight into the market conditions. Increases in the number of firms reporting hard-to-fill vacancies and skill shortages amongst SET occupational groups may also indicate the extent to which firms are able to recruit the workers they require.

Employment pattern of SET graduates

Data from the Labour Force Survey shows that, in 2004, 75 per cent of working age people were in employment with the remaining 4 per cent and 21 per cent being unemployed and inactive respectively (Table 6). Employment rates for all degree holders are higher, with 88 per cent of SET graduates in Great Britain being employed.

Table 6:
Labour market outcomes of graduates

Subject group	Employed	Unemployed	Inactive
All SET subjects	88.4%	2.3%	9.3%
All non-SET subjects	87.0%	2.7%	10.3%
All people	75.1%	3.8%	21.1%

Source: Labour Force Survey, Autumn 2004 data, GB, single subject degrees and working age only

There is some variation by subject, with 84 per cent of biological sciences graduates being in employment and 93 per cent of architects (Table 7). SET graduates, therefore, are characterised by a high propensity to be in employment.

Table 7:
Employment rates by SET subject

Subject group	Employment (per cent)
Medicine	91.0%
Subjects allied to medicine	92.1%
Biological sciences	84.4%
Agricultural sciences	85.7%
Physical/Environmental sciences	87.2%
Mathematical sciences & computing	88.2%
Engineering	87.7%
Technology	90.8%
Architecture and related studies	93.0%

Source: Labour Force Survey, Autumn 2004 data, GB, single subject degrees and working age only

Sample sizes are too small to allow the disaggregation of labour market outcomes of doctorates by the nine SET subject groupings. Overall though, holders of SET doctorates also appear to be in a relatively tight labour market with an employment rate of 92 per cent.

Analysis over the period 1997 to 2004 reveals no signs of sharp increases in employment rates or falls in unemployment that would indicate a tight labour market for SET graduates. The only subject group where the employment rate has risen consistently over the years looked at (indicating a consistently tightening labour market) is subjects allied to medicine. This includes a range of subjects such as nursing, midwifery and pharmacy. The occupations associated with these subjects are health associate professional occupations, and employment in them has been steadily increasing. This suggests that supply may be responding to increased demand, although other factors such as increasing female participation may also be involved.

Although a high proportion of SET graduates are in employment, it is important to examine the type of employment that they enter. In terms of the science and innovation agenda, the way that people with these skills are utilised in the labour market is important. Table 8 shows that 46 per cent of SET graduates are employed in SET occupations, 8 per cent in teaching and 45 per cent in other occupations. There is considerable variation across subject areas with 92 per cent of medicine graduates and 31 per cent of physical/environmental sciences graduates being employed in SET occupations.

Table 8:
Occupations of SET graduates

Subject group	SET occupation	Teaching	Other occupation
Medicine	92.3%	*	*
Medical related subjects	73.4%	*	24.2%
Biological sciences	32.6%	13.2%	54.3%
Agricultural sciences	*	*	74.7%
Physical/environmental sciences	31.3%	14.6%	54.0%
Mathematical sciences and computing	39.2%	13.7%	47.1%
Engineering	43.9%	3.2%	52.9%
Technology	*	*	62.7%
Architecture and related studies	51.3%	*	46.9%
All SET subjects	**46.3%**	**8.3%**	**45.4%**

Source: Labour Force Survey, Autumn 2004 data, GB, single subject degrees and working age only; * indicates results not reported due to small sample sizes

SET doctorate holders have a similar propensity to work in SET occupations (48 per cent), but many more of them work in teaching (17 per cent) than SET graduates in general. If these people are working in universities to teach, they are likely to be carrying out research as well, and hence working in a SET occupation, although it is not recorded as such. Again, there is a substantial proportion who work in occupations seemingly not directly related to their studies (35 per cent).

SET graduates are employed in significant numbers across a wide variety of industrial sectors, as described in Table 9. Around 21 per cent of SET graduates work in health and social work. SET graduates also make up around 13 per cent of all employment in this sector. Graduates constitute the largest share of employment in research and development services, at 39 per cent. However, only 2 per cent of all SET graduates are employed in research and development services. There will be many more graduates working on R&D in firms whose activity is ascribed to other sectors within the industrial classification. There will also be many individuals who do not hold SET degrees engaged in R&D across all industrial sectors.

Table 9:
SET graduate employment by sector

Industry (two-digit SIC)	SET graduates:		
	Number	As a proportion of all SET graduate employment	As a proportion of sector employment
73:research,development	35,000	1.9%	38.9%
72:computer,related activities	127,000	6.8%	25.1%
11:oil,gas extractn etc (not surveying)	12,000	0.7%	22.7%
24:chemicals,chemical products man.	57,000	3.0%	20.4%
30:office mach,computer manufacture	14,000	0.8%	18.7%
41:water collection,purif.,supply etc	11,000	0.6%	18.7%
32:radio,tv,communication eqt man.	12,000	0.7%	13.9%
85:health,social work	392,000	20.9%	12.5%
33:medical,precision,optical eqt man.	14,000	0.7%	12.0%
35:other transport eqt manufacture	25,000	1.3%	11.9%
80:educ	248,000	13.2%	10.4%
74:other business activities	190,000	10.1%	9.9%
70:real estate activities	39,000	2.1%	9.8%
91:activ. of membership organisations	18,000	1.0%	9.2%
75:public admin,defence,social security	125,000	6.6%	6.8%
65:financl intermed (not insur.,pensn.)	44,000	2.4%	6.4%
29:mach,eqt manufacture	21,000	1.1%	5.9%
34:motor veh,trailer,etc manufacture	15,000	0.8%	5.8%
67:other financial (not insur.,pensn.)	19,000	1.0%	5.3%
28:fabric-metal prod (not mach,eqt) man	17,000	0.9%	5.0%
Total	**1,876,000**	**100.0%**	**7.1%**

Source: Labour Force Survey, Autumn 2004 data, GB, single subject degrees and working age only. Excludes sectors where SET graduate sample sizes are too small, and nine sectors with low proportions of SET graduates.

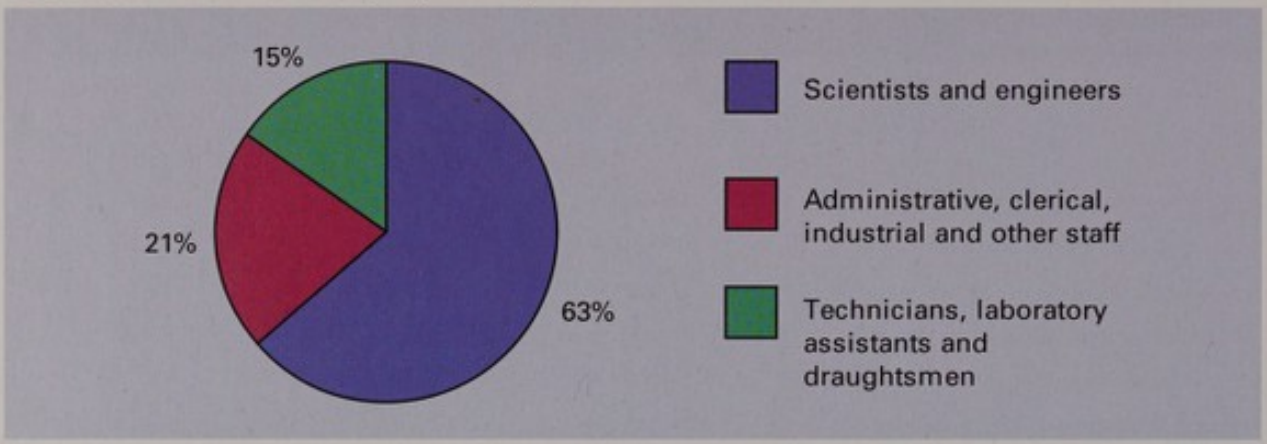
As part of the ambition to raise total R&D to 2.5 per cent of GDP, the ten-year framework outlines that business investment in R&D should increase from 1.2 per cent of GDP to 1.7 per cent. The Business Enterprise R&D (BERD) survey 2004 provides data on known R&D performers across all industrial sectors and their expenditure on such activity in UK business.[17] In 2004, £13.5 billion (or 1.1 per cent of GDP) was spent on R&D, employing 163,000 individuals.[18] There has been a gradual increase in the contribution scientists and engineers make to total employment, rising to 63 per cent in 2004 (Figure 14).[19]

17 This is a performance measure. It excludes expenditure financed by UK businesses that is performed overseas and in other sectors of the economy (e.g. higher education, government departments/agencies, private non-profit organisations). But it does include Business R&D performed in the UK that is financed by other sectors e.g. Government.

18 R&D employment is the number of people working on R&D in business, regardless of the industrial code.

19 Scientists and engineers are defined not by qualification or occupational code, but as being professionals engaged in the conception or creation of new knowledge, products, methods and systems. Technicians are defined as qualified personnel who participate in R&D projects by performing scientific and technical tasks, normally under the supervision of professional scientists and engineers.

Figure 14:
Breakdown of R&D employment, 2004



Source: BERD survey. Numbers do not sum to 100% due to rounding

In addition to presenting the proportion of SET graduates who are employed in SET occupations, it would be useful to analyse the outcomes of those holding SET skills at Level 3 or trade apprenticeship. Unfortunately, subject specific data is not available that allows those with SET Level 3 qualifications to be identified. Table 10 simply presents the occupational groups that all those whose highest qualification is either a Level 3 or trade apprenticeship are employed in. Since 2001, employment of those with Level 3 qualifications in SET occupations has fallen by 12 per cent (399,000 to 351,000). Their employment in SET occupations relative to all other occupational groups has fallen from 6.7 per cent to 5.9 per cent. All that is observed here is the outcome in terms of employment and it is difficult to determine whether this decline is a demand or supply effect.

Table 10:
Employment of those whose highest qualification is at level 3 or a trade apprenticeship, by occupation

Occupational group	2001	2002	2003	2004
SET occupations	399,000	394,000	353,000	351,000
Teaching	27,000	25,000	25,000	29,000
Other occupations	5,523,000	5,655,000	5,679,000	5,554,000
Proportion in SET occupations	6.7%	6.5%	5.8%	5.9%

Source: Labour Force Survey, Autumn data, GB, single subject degrees and working age only

Another indicator of labour market shortage is a high level of vacancies, particularly ones which are hard-to-fill. For SET occupations the incidence of hard-to-fill vacancies relative to employment is slightly below the average for all occupations (1.1 per cent of employment[20] compared to 1.2 per cent). However, the incidence is above average in three particular SET occupations: architects/town planners/ surveyors (3.3 per cent), draughtspersons/building inspectors (2.5 per cent) and health associate professionals (1.9 per cent).

Wages of SET workers

One of the key indicators relating to the utilisation of skills in the labour market relates to the impact on productivity. Typically, wages have been used as a proxy for productivity if workers are paid a salary that reflects their marginal product. There is a substantial literature estimating the returns to education, which is measured as the additional wages received by a worker holding a certain level of qualification.[21] The existence of high returns to a degree is likely to signal to individuals the relative value of graduates to the labour market and raise the incentive to invest in such qualifications. Changes in these returns over time may also be used to assess the impact of demand and supply conditions within the market.

Table 11 presents estimates of the returns to a range of degree subjects at four points in time. Each percentage in the table represents the extra earnings someone holding a degree in a particular subject receives relative to an individual with similar personal characteristics but who only holds two A levels as their highest level of attainment (Level 3). For example, a medicine graduate in 2002 earns 29 per cent more than someone with similar characteristics but who only holds A levels. Sizeable returns are also found to exist for engineering, maths and computing studies. In general, the returns to degrees have remained fairly stable suggesting that there has been an increase in demand at the same time as the expansion in the numbers holding degrees. Biological sciences tend to be associated with a relatively low rate of return, although it has remained stable over time. The return to architecture appears to have declined during the period where the number holding these degrees has risen (Figure 1) and the employment rate has been high (Table 7).

20 Results from the National Employer Skills Survey 2003, which asks employers if they have any vacancies, and then if any of those vacancies are hard-to-fill.

21 Dickerson (2005).

Table 11:
The return to degrees by subject relative to holding 2+ A levels

Subject group		1993	1996	1999	2002
SET subjects	Medicine	24%	22%	27%	29%
	Engineering	19%	20%	23%	26%
	Maths	23%	25%	26%	25%
	Computing	24%	21%	29%	24%
	Physical science	18%	12%	14%	16%
	Biological science	9%	9%	7%	11%
	Architecture	16%	8%	10%	10%
	Agricultural science	15%	12%	7%	2%
Non-SET subjects	Law	32%	24%	39%	31%
	Business	31%	22%	22%	25%
	Education	24%	20%	18%	17%
	Social science	10%	15%	11%	13%
	Languages	18%	13%	8%	8%
	Librarian	*	*	*	*
	Arts & Humanities	9%	*	*	*

Source: McIntosh, chapter 8 of *What's the good of education? The economics of education in the UK*, eds. Steve Machin and Anna Vignoles, 2005. * indicates a return not significantly different from zero.

The rates of return analysis estimates the additional wages received by an individual holding a SET degree. It is an average estimate in the sense that it does not specifically examine the wages of SET degree holders working in SET occupations, where it may be expected that their skills are most relevant. Table 12 presents some data showing the mean gross weekly wages of both SET and non-SET degree holders by their occupational group. There is some evidence in 2004 of a higher wage being obtained if those with SET skills are employed in SET occupations.

Table 12:
Gross weekly earnings for SET and non-SET graduates, 2001 and 2004

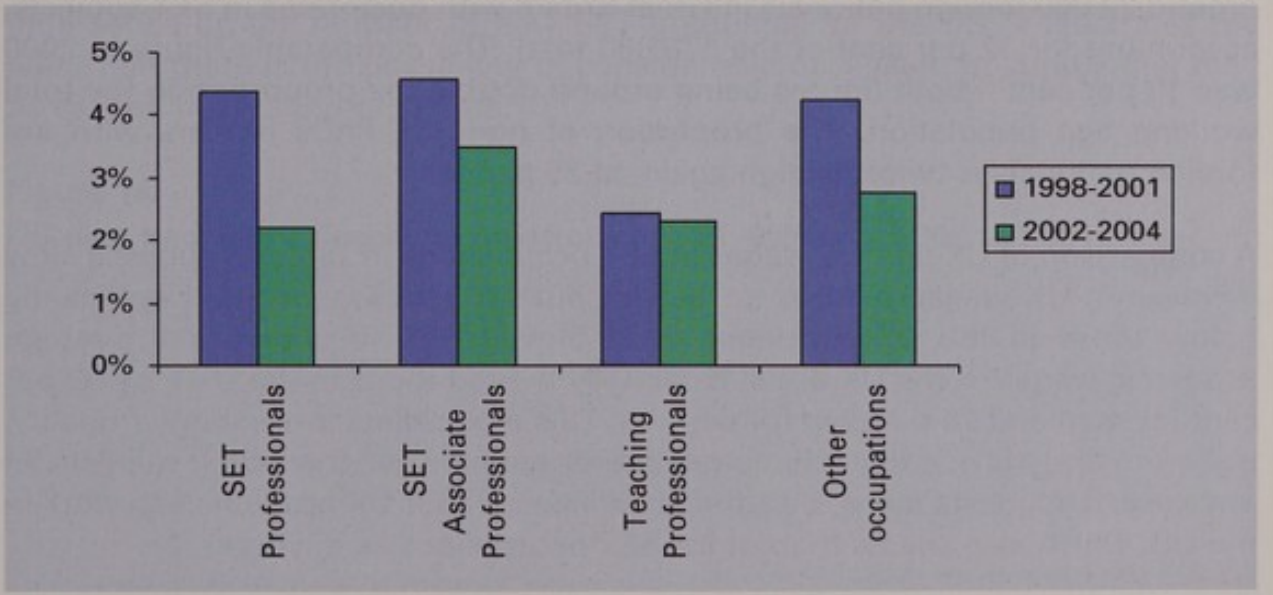
		Occupation		
	Degree subject	SET Occupations	Teaching	Other Occupations
2004	SET	£640	£582	£610
	Non-SET	£464	£536	£573
2001	SET	£578	£542	£605
	Non-SET	£476	£470	£547

Source: Labour Force Survey 2001 and 2004

Another indicator of the market conditions for SET skills is the growth in wages. For this, data is examined from the Annual Survey of Hours and Earnings (ASHE), which is a more reliable source of wage data than the Labour Force Survey.[22] Since ASHE does not enable the identification of SET degree holders, the analysis looks at those employed in SET occupations.

A rapid expansion in demand may be expected to lead to high rates of wage growth as firms compete for individuals possessing these skills. Figure 15 suggests that there has been a slight decline in the rate of wage growth amongst SET professional and associate professional occupations. For both these groups and teaching professionals, the annual rate of real wage growth would appear to have slowed over the period 2002-2004 compared with 1998-2001. This would suggest a slight loosening of the market with the possibility that supply has risen faster than demand. The pattern of declining wage growth in SET occupations, however, is consistent with that observed in all other occupational groups.

Figure 15:
Average annual real wage growth in SET and non-SET occupations, 1998 to 2004



Source: Wages from Annual Survey of Hours and Earnings and inflation from National Statistics. Break in series due to change of occupational codings from 2001 to 2002.

Changes in the coding of occupations to the SOC 2000 classification mean that comparisons of occupational wage data over a long period of time should be treated with caution. Amongst SET occupations, however, since 2002 there has been substantial variation in the growth of wages. Quantity surveyors and scientific researchers have seen their real wages rise by around 10 per cent annually, while both architects and IT professionals have seen annual falls of around 10 per cent.

22 Wage data for workers is only recorded in their first and fifth interviews within the Labour Force Survey.

International movements of SET personnel

National-level imbalances in the supply and demand for SET workers can be alleviated by international labour flows. This may be more important in the short-term where domestic supply may adjust slowly. According to Marey et al. 'often, international labour mobility is a less costly alternative to domestic policy adjustments.'[23]

In 2004, 6.9 per cent of SET graduates resident in Great Britain were foreign nationals, up from 4.1 per cent in 1997. The proportion of all those of working age who are foreign nationals was similar, rising from 4.7 to 6.4 per cent, suggesting that the SET market is only marginally more likely to attract foreign nationals than average. This incidence of foreign nationals varies by degree subject. The proportion of medical degree holders who are foreign nationals has increased dramatically, reaching 17 per cent in 2004, compared to just 5 per cent in physical and environmental sciences.[24]

The picture for SET PhD holders is somewhat different. In 2004, there were around 22,000 foreign nationals in Great Britain with doctorates in SET subjects, accounting for 12 per cent of the 178,000 total. The comparable figure in 2000 was 10 per cent – both figures being around double the proportion in the total working age population. The proportion of non-SET PhDs holders who are foreign nationals is twice as high again, at 25 per cent.

A comparison of UK and US wages in SET occupations in Table 13 shows a slow increase in UK wages relative to the US, but with UK wages still significantly below those in the US. Evidence from Stevens (2004) shows that average academic wages in the UK are substantially behind those in the US – by 32 per cent for men and 25 per cent for women. This may reflect lower worker quality, but more likely is due to institutional differences between the labour markets. In any case, it suggests there is a significant incentive for UK academics to work in the US, which also seems to exist for SET occupations as a whole.

Table 13:
Comparison of UK and US trends in nominal wages in SET occupations

Occupational group	1998	1999	2000	2001	2002	2003	2004
US SET occupations in PPP £s	£29,500	£31,400	£32,700	£33,500	£34,500	£35,900	£37,000
UK SET occupations	£20,200	£21,500	£22,500	£23,900	£25,500	£26,200	£28,000
UK/US	68%	68%	69%	71%	74%	73%	76%

Sources: ASHE wage data, OECD and US Bureau of Labor Statistics. Comparability is limited as the US data, UK data 1998-2001 and UK data 2002-2003 are all based on different occupational codings, which are matched up as well as possible.

23 Marey et al. (2001).

24 Statistics on foreign nationals from Labour Force Survey, Autumn 2004, resident in Great Britain, working age and single subject degree holders only.

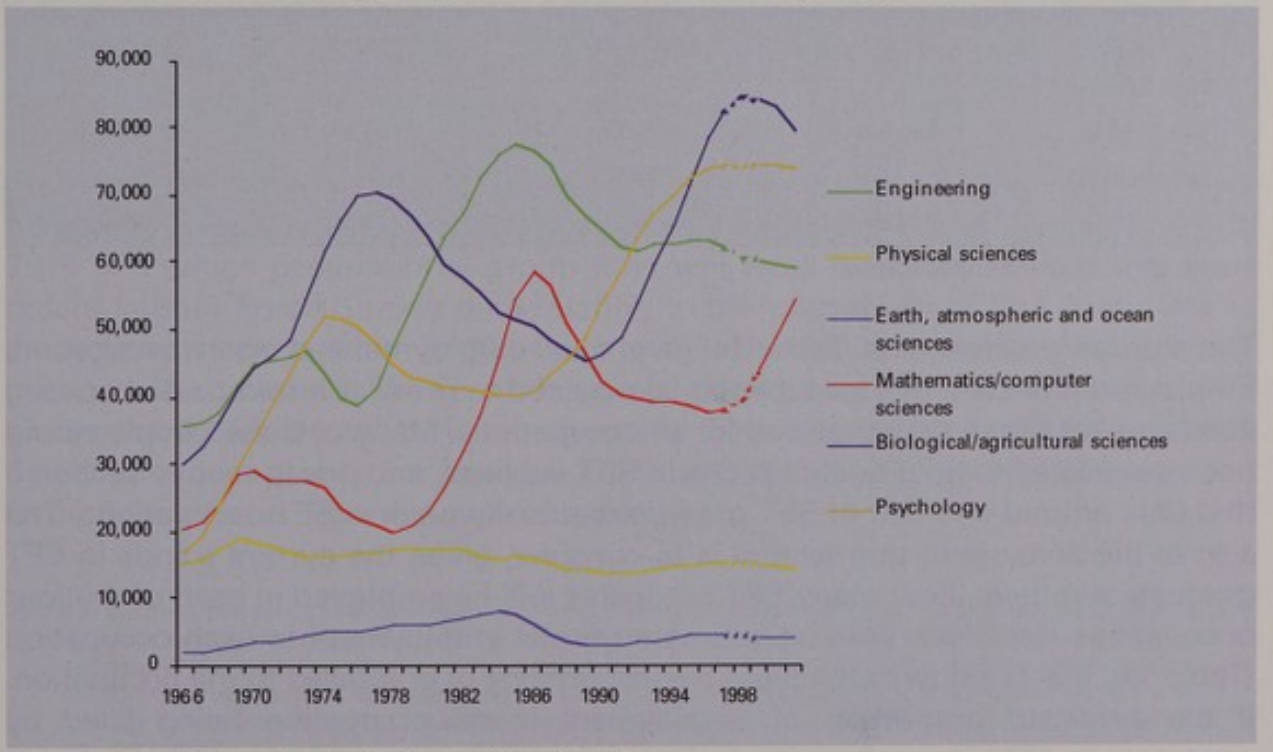
CHAPTER 4

Future scenarios

The previous section concentrated on the current state of the labour market for SET graduates and any changes that have occurred since the late 1990s. Despite the rapid expansion in both the stock and flow of SET degree holders, basic labour market indicators do not reveal an excess supply, suggesting that demand for these skills has kept pace. Given the policy emphasis placed on SET skills within the ten-year science and innovation framework, it is useful to consider forecasts of the employment pattern for SET workers over the next decade.

Robust projections of future employment levels are difficult to derive. Most forecasting models are based on the assumption that, to a large extent, current trends in demand and supply will continue. The validity of this assumption is clearly questionable in an economy subject to both internal and external shocks. Cycles of demand and supply make it difficult to predict the labour market at a specific date in the future. As an example, Figure 16 presents a relatively long time series on the number of new SET graduates for the US. It illustrates the point that there is the possibility of considerable oscillation in supply that may be caused by a range of factors.[25]

Figure 16:
US new bachelor's degree graduations in SET subjects, 1966 to 2001



Source: National Science Foundation. Data missing for 1999.

25 US population has been increasing over time (OECD data), so the cyclical nature of graduations is unlikely to be due to demographics (OECD data available at http://www.oecd.org/dataoecd/62/38/35267227.pdf).

Despite the inevitable errors associated with much forecasting work, such models do provide a baseline view of the world and provide a picture of how the market may look if broad trends continue. More subjective alterations may then be factored in if certain scenarios are considered likely or if particular policies are anticipated to have a significant impact.

Through the Sector Skills Development Agency (SSDA), the UK has developed a methodology for deriving detailed projections of employment across regions and industrial sectors. Using a Keynesian approach to modelling demand, a large simultaneous equation system is solved that yields estimates of total output and employment within industrial sectors and regions that may then be summed to give UK values. Further modelling work then takes these estimates of employment and forecasts the breakdown into occupational groups based on historical information on the occupational composition of the workforce. Table 14 presents the latest estimates available (for 2014) on the employment levels within each of the main SET occupational groups.

Table 14:
Projected employment in SET occupations in 2014

Science and Technology Professionals (SOC code 21)	Health Professionals (SOC code 22)	Science and Technology Associate Professionals (SOC code 31)	Health Associate Professionals (SOC code 32)	All other occupations (All other SOC)
2004 (baseline)				
947,000	277,000	593,000	1,045,000	26,449,000
2014 (forecast)				
1,121,000	360,000	666,000	1,122,000	27,314,000
Change (%)				
18%	12%	30%	7%	4%

Source: SSDA Working Futures 2 (2006)

The figures presented in Table 14 give total employment in each occupation. Employment in each SET occupation is expected to grow at a faster rate between 2004 and 2014 than that expected for all occupations. Many of these people would not be expected to hold qualifications in SET subjects, and it was seen in section 3 that only around one-half of SET graduates actually work in SET occupations. The aim of the analysis in this section is to consider, given the current trends in SET graduate numbers, how many SET graduates will be employed in each of the four occupations identified. With an estimate of total employment in each occupation (Table 14), it is possible to measure the importance of graduates to the occupation. If the predicted proportion of employment in an occupation being filled by graduates in 2014 is much higher or lower than that observed in recent years, this may suggest a substantial shift in either demand or supply is occurring.

The first stage of this analysis requires projecting the number of SET graduates for each subject grouping in 2014. The starting point was the 2004 Labour Force Survey, breaking down SET graduates into individual year cohorts. The population in 2005 was then estimated at each age by taking (1) – the population one year younger in 2004 and multiplying it by a factor to account for immigration and mortality rates, and (2) – the projected 2005 flow of new SET graduates (by extrapolating linear trends from the HESA graduation data 1994/95 to 2001/02). These new graduates were assigned to each year cohort in accordance with the average age distribution of graduates observed in the previous four years of LFS. An analogous process was repeated for 2006 and each year up to 2014. The projected stock of all SET graduates in 2014 is presented in Table 15, along with the projection for each subject.

Table 15:
Projected supply of SET graduates in 2014 by subject

Subject group	2004 total population	2014 total population	Percentage change 2004 to 2014
Medicine	138,000	203,000	46.7%
Subjects allied to medicine	302,000	641,000	112.5%
Biological sciences	364,000	643,000	76.7%
Agricultural sciences	50,000	78,000	57.6%
Physical/environmental sciences	345,000	456,000	32.2%
Mathematical sciences and computing	346,000	588,000	70.1%
Engineering & Technology	454,000	617,000	36.1%
All SET subjects	**1,997,000**	**3,226,000**	**61.5%**

Source: DTI calculations; numbers may not add due to rounding

From the estimates of the total number of people holding SET degrees, it is then necessary to calculate how many of these are expected to be in employment in 2014 and which occupational group they will work in. These are derived from recent Labour Force Survey data relating to the proportion of SET graduates in employment and assuming that the trend in the movement into occupational groups will continue.[26] The second row of Table 16 predicts that of the 3,226,000 graduates, 2,658,000 will be in employment. Row 3 then provides the breakdown by occupational group. For example, 17% of those in employment are expected to be Science and Technology Professionals.

26 It is assumed that the 2014 employment rates in each subject by age match those of 2004 for all SET graduates by age. 2004 employment rates by age are taken from the Labour Force Survey, except at the upper and lower extremes of the age range where sample sizes were too small to use LFS estimates. At these age extremes, employment rates for 2014 were arbitrarily chosen. By estimating employment rates by age and multiplying them by the population, we are effectively incorporating retirements (as well as other forms of inactivity) into our model.

The distribution of SET graduates (together and by subject) across the different occupational groupings was estimated by looking at the available Labour Force Survey data from 2001 to 2004 and using them to estimate the proportions that will pertain in 2014.

Marey et al. (2001) assume for their forecasts that the distributions of research scientists and engineers across sectors remain constant into the future. We could have analogously assumed that the distribution of SET graduates across occupational groups remains constant, but since we have 2001-2003 data as well as 2004 data, it is useful to use all the data available. These are arbitrary assumptions and hence sensitivity analysis follows.

With 17% of the 2,658,000 graduates being Science and Technology Professionals, this gives an estimate of 452,000 graduates being employed in this occupation (row 4). Total employment in this occupation is forecasted to be 1,121,000 (row 1). This suggests that SET employment as a proportion of all employment in 2014 is projected to be 40.3 per cent (row 5) if the current trends in the supply of graduates continues.

It is useful to then compare this estimate of the proportion of graduates amongst Science and Technology Professionals in 2014 with the actual proportions observed in the years 2001 to 2004 (rows 6-9). If the 2014 proportion was considerably below the values observed in recent years, this may suggest an undersupply, or shortage of SET graduates for this occupational group. Alternatively, if the 2014 proportion was much larger than the recent values, this may suggest an oversupply of graduates.

The proportions presented in rows 6-9 suggest a gradual rise in the importance of SET graduates to Science and Technology Professionals. The 40.3 per cent share estimated for 2014 appears compatible with recent values. This gives the impression that the current trend in the supply of graduates will be sufficient to meet the growing needs of this occupation.

The remaining columns present the analysis for the remaining occupational groups. It is only for Health Professionals that the 2014 share of graduates (88.6 per cent) appears much larger than recent values. This could be an indication of oversupply, although it should be noted that there has also been considerable growth in the proportion of workers in this occupation holding SET degrees between 2001 and 2004.

Science and Technology Associate Professionals are the only group for which the predicted 2014 share is lower than that of recent values, although the difference is only marginal. Overall though, there is little evidence presented in Table 16 to indicate that the current trends in SET graduate supply will generate any shortages or surpluses; the 2014 estimates do not significantly alter the proportion of workers holding these degrees beyond what would be expected given recent values relating to these shares.

Table 16:
Projected employment outcomes for all SET graduates in 2014

	Science and Technology Professionals	Health Professionals	Science and Technology Associate Professionals	Health Associate Professionals	All other Occupations
Total projected employment	1,121,000	360,000	666,000	1,122,000	27,314,000
Projected population of SET graduates (supply trend)	3,226,000, of which 2,658,000 in employment				
Projected distribution of SET graduates across occupational groups based on 2001-2004	17%	12%	3%	11%	57%
SET employment in this occupation if supply trends continue	452,000	319,000	80,000	292,000	1,515,000
Which would be this percentage of all employment in this occupational group:	40.3%	88.6%	12.0%	26.1%	5.5%
Compared to this in 2004	38.4%	73.8%	12.2%	17.2%	3.5%
This in 2003	34.7%	68.1%	12.8%	13.2%	3.4%
This in 2002	36.1%	68.6%	12.1%	13.0%	3.4%
This in 2001	36.0%	63.5%	12.3%	13.3%	3.3%

Source: SSDA Working Futures 2 (row 1) and DTI calculations. Numbers may not add due to rounding.

A number of assumptions relating to demand and supply trends have to made when producing these estimates which means that the findings need to be treated with caution. Even if the market were heading towards excess supply or demand, it is unlikely that such movements would continue unchecked. Wages would be likely to adjust to correct for such imbalances, although imperfections in the speed of this adjustment process and other factors may create difficulties in the short to medium term.

Sensitivity analysis suggests that the results in Table 16 are not very sensitive to the assumed employment rate. Even if the 2014 SET graduate employment rate is way below that of 87.4 per cent in 2004, at say 78 per cent, there are no more indications of shortages of SET graduates. The higher the employment rate (and lower inactivity rate) used in the analysis, the more likely it is SET graduates will be looking to move into SET occupations.

However, the analysis indicates the results are very sensitive to the choice of proportions of SET graduates working in each occupational group in 2014. Around 21 per cent of SET graduates currently work in Science and Technology Professional occupations. If a significantly lower proportion did so in 2014, then there could be a shortage of SET graduates for these occupations. The same is true for SET graduates in Health Professional occupations. If only around 7 per cent wished to work in these occupations in 2014 compared to the current 12 per cent, there could be shortages in 2014. However, if similar or higher proportions of SET graduates were to work in these occupations in 2014 relative to 2004, then there could be excess supply of SET graduates.

Forecasts of qualifications in SET occupations

The previous analysis used projections of total employment in each SET occupation and then assessed whether the current trends in SET graduations would generate an increasing or decreasing share of this employment being taken by graduates. Recent forecasting work produced for the SSDA also produces estimates of the number of people expected to hold each of the levels of qualification. Table 17 presents estimates of the demand for degree-level qualifications for the four SET occupations.

Table 17:
Incremental demand for degrees ('000s) between 2004 and 2014 by occupation

	Higher degree	First Degree or equivalent
All Occupations	2,133	2,725
Science/Technology Professionals	145	191
Health Professionals	112	45
Science/Technology Associate Professionals	28	76
Health Associate Professionals	82	257
Other	1,766	2,156

Incremental demand is expansion plus replacement demand
Source: Working Futures 2

These are estimates of total demand and include two specific components. The first is replacement demand where new degree holders will be required as existing workers in an occupation retire and are replaced by new workers. The second is expansion demand which occurs when the number of people employed in the occupation in 2014 exceeds that of 2004, which generates a change in the number of degree holders required. Across all occupations it may be seen that almost 5 million degree holders will be needed to meet replacement and expansion demand. Within Science and Technology Professionals, 336,000 degrees will be required, and amongst Health Associate Professionals the figure is 339,000.

These figures provide an indication of the magnitude of the requirements for degree-level qualifications within SET occupations over the next decade. They do not, however, necessarily relate to demand for SET degrees since all subjects are covered in the forecasts. Further disaggregation of this broad estimate into specific subjects would possibly reveal variation in the demand for particular subjects.

Increasing R&D as a proportion of GDP

In 2000, the Lisbon agenda for economic reform in the EU was launched, with the aim of making the EU 'the most competitive and dynamic knowledge-driven economy by 2010'. A cornerstone of this agenda was a commitment to enhancing innovation, concisely defined as 'the successful production, assimilation and exploitation of novelty in the economic and social spheres'.[27] A key plank of this commitment was the introduction of a target to increase R&D expenditure as a proportion of the EU's Gross Domestic Product (GDP) to 3 per cent by 2010. The UK recognises the importance of innovation, including that driven by R&D, for productivity growth. The ten-year science and innovation investment framework, launched in 2004, describes the UK Government's ambitions for the UK science base and raising total R&D expenditure to 2.5 per cent of GDP by 2014.

Increasing the UK's R&D is likely to require additional SET skills beyond those identified within the models that forecast the employment and attainment levels within the SET occupational groups. The specific impact that such a target has on R&D activity and the corresponding effect on SET employment is not formally modelled. The estimates of the changes to employment and demand for graduates reported in Tables 16 and 17 are therefore likely to be lower bound estimates. Meeting the R&D target is likely to require more researchers and thus graduates in SET subjects.

UK policy

Theory suggests that there are likely to be significant spillover effects associated with R&D, leading to sub-optimal levels of investment by firms. This form of market failure may be corrected by policies that provide some form of incentive to promote R&D. Evidence demonstrates a link between R&D and productivity, which is likely to generate a long term increase in economic welfare. An OECD study finds that a 1 per cent rise in public R&D increases total factor productivity by 0.17 per cent.[28] In addition, Griffith et al. (2004) present evidence for the positive impact that R&D has on total factor productivity and how part of the return arises when R&D is performed in sectors which are not considered leading edge in terms of existing productivity levels.

27 European Commission (2003).

28 OECD (2001).

The ten-year science and innovation investment framework provides the broad range of initiatives in place to improve the science base and raise R&D expenditure. Part of this framework identifies the supply of scientists and engineers as being important for the science base and R&D. Before the 2004 framework, Professor Sir Gareth Roberts published a review of the supply of scientists and engineers in 2002.[29] In the final report, he suggested that securing a strong future supply of scientists and engineers (for R&D) would require co-ordinated action from government, employers and universities. There would be two main aspects to this action. First, it would be necessary to ensure a strong supply of students at every stage of the education system both able and willing to study and work in science and engineering. Second, it would be necessary to ensure individuals gaining graduate and postgraduate qualifications in science and engineering subjects are given attractive options to work in both university and private sector R&D.

There is a potential role here for Government in influencing how many students study SET subjects at all levels, through the provision of sufficiently attractive opportunities to study such subjects, and making sure that courses are sufficiently responsive to employers' changing requirements. Also, government may have a role in improving the public's understanding and perception of careers in science and engineering. However, the review was clear that the ultimate responsibility for providing scientists and engineers with employment opportunities in R&D that are competitive with other sources of employment open to scientists and engineers, lies with employers.

The government has taken a series of actions in line with the recommendations of the Roberts Review, in order to help secure the future supply of SET personnel. One of the main policy themes centres on improving the attractiveness of research careers. After decades of no real growth in PhD stipends, the research councils are set to increase these awards to a minimum of £12,000 in 2005/06 (see Box 3). In addition, there is to be an improvement in the professional training accompanying research degrees, particularly in areas such as communication, teamworking and business awareness. Universities' HEFCE and Research Council funding will be dependent on meeting high quality minimum training requirements in doctorate programs.

29 Roberts (2002), available at: http://www.hm-treasury.gov.uk./Documents/Enterprise_and_Productivity/Research_and_Enterprise/ent_res_roberts.cfm.

Box 3: PhD stipends

PhD stipends were unchanged in real terms from 1966 to 1998. As relative demand to employ workers with graduate level skills increased, graduate salaries rose dramatically. The relative value of PhD stipends therefore eroded.

Recognising this fact, minimum research council stipends have now been increased from £6,455 in 1998/99 to a planned minimum of £12,000 in 2005/06, with extra funds available for higher stipends in areas of shortage expected to lead to an average stipend of £13,000 by that point.

An individual's decision to study for a PhD is likely to be based on a range of both monetary and non monetary factors. The value of the stipend relative to what could be earned in the labour market will inform this decision. A direct comparison is difficult since PhD stipends are not taxable, unlike the wages received in employment. Comparing the stipend to gross wages therefore understates the true value of a PhD. Looking at how the value of the stipend relative to gross wages has changed over time, however, does give some indication of whether studying for a doctorate has become more or less attractive.

The table below shows that the value of the stipend relative to gross earnings has risen over the last four years, from 36 per cent to 52 per cent. It would appear therefore that the option of studying a PhD has become more appealing when looking at this simple financial measure. It is important to note, however, that stipends are not usually a PhD student's only source of income as they often receive an income from tutoring.

	2001/02	2002/03	2003/04	2004/05
Minimum PhD stipend	£7,500	£8,000	£9,000	£10,500
Mean wage of SET graduates graduating in last two years	£20,600	£20,900	£20,900	£20,100
Minimum stipend/wage of SET graduates in last two years	36%	38%	43%	52%

Sources: Minimum PhD stipend data from Research Councils UK and wage data from Labour Force Survey

For holders of doctorates, steps have also been taken to encourage careers in research. Average postdoctoral salaries are set to have increased by £4,000 by 2005/06 along with the introduction of new academic and teaching fellowships. There should also be more emphasis on the training requirements of postdoctoral fellows in the human resource plans of HEIs.

Further study has also been encouraged with the Prime Minister's announcement in 2003 of a £10m initiative to bring high quality doctorate students from overseas to top UK universities to study science. The 2006 Dorothy Hodgkin Postgraduate Awards will offer 80 scholarships to students from India, China, Hong Kong, Russia and the developing world to study PhDs in the UK.[30]

30 See www.ost.gov.uk/research/funding_schemes.htm.

Changes have also been made that make it easier for foreign SET personnel to work in the UK. Permits now last for five years instead of four and there is a new entitlement for foreign students beginning or continuing courses in SET subjects to work in the UK for one year following graduation from a UK institution. Alterations to the Highly Skilled Migration Scheme are also designed to attract skilled labour.

Additional funds have also been made available to improving science and engineering laboratories in schools, colleges and universities. Importance is also being attached to modernising the curricula at all levels to develop practical understanding of science and to help students engage with matters of topical interest, such as GM foods. There is a recognition for improved communication between HEIs and business to ensure curricula reflect business needs. Entrepreneurship is being encouraged amongst students through the funding of Science Enterprise Centres in universities. These centres are for undergraduates and postgraduates to develop their entrepreneurship skills through the development of project proposals, business plans and even business start-ups. They also involve the development of new degree programs.

At roughly the same time as Sir Gareth Roberts was producing his report, Baroness Susan Greenfield was specifically looking at the issues facing women in acquiring SET qualifications and their employment prospects. This report was published in November 2002 and led to the production of a new Government Strategy for Women in SET. A key part of this strategy was the setting up of a dedicated delivery agent, and in September 2004, the Government launched the new Resource Centre for Women in SET, committing a total of £6.9m from 2004-2008.[31] The Government has also set up an independent group to monitor the progress it makes in making science and technology more attractive to women.

Monitoring and evaluation

Accompanying the ten-year science and innovation framework is a full set of indicators for which progress will be monitored. An annual report is to be published each year summarising key progress against these indicators.[32] Since the framework was only published in 2004, some of these indicators are yet to be fully developed and much of the data pre-dates the framework.

31 www.setwomenresource.og.uk.

32 The ten-year science & innovation investment framework annual report 2005.

Work on evaluating the market for scientist, engineers and technologists continues and will feature in the annual reports from 2006. A range of data sets, including information collected by HESA and the Learning and Skills Council's National Employers Skill Survey will inform this process. The DfES is leading on producing further detailed analysis of the supply and demand for people holding SET qualifications, along with identifying the specific areas with the greatest skill deficiencies. This piece of research is likely to offer further recommendations for Government and other organisations.

There is other ongoing research that examines some of the subject and sector specific issues that are not addressed within this report. Work by the Engineering and Technology Board uses similar data but focuses on the qualifications and labour market outcomes of engineers.[33] A recent report published by The Association of the British Pharmaceutical Industry presents some evidence on the current and future skill needs of the sector.[34]

With the importance SET skills are believed to have for innovation and productivity, many countries have expressed concern over the stock and flow of such skills within the labour market. Some countries report a declining enrolment or graduation in SET. Policy initiatives in place across OECD members follow similar themes to those described above for the UK – encouraging interest in SET during schooling, increasing support for those interested in research careers, attracting foreign talent, and raising participation in SET amongst women. There remains, however, a general lack of evaluation evidence regarding the impact that such schemes have on participation in SET.

33 Engineering UK 2005, ETB.

34 Sustaining the Skills Pipeline in the Pharmaceutical and Biopharmaceutical Industries, ABPI, 2005.

Annex

Additional tables on the number of individuals holding SET degrees

Table 1 presents the finding that the number of individuals in the working age population had increased from 1.3 million in 1997 to 2.1 million in 2004. Figure 1 provides a graphical representation of degree holders across the range of SET subjects, but for further information, the numbers holding these degrees is given in Table 18.

Table 18: Numbers of SET graduates by subject

	1997	1998	1999	2000	2001	2002	2003	2004
Engineering	335,000	383,000	365,000	379,000	359,000	387,000	370,000	407,000
Biological sciences	170,000	179,000	200,000	199,000	209,000	229,000	250,000	359,000
Mathematical sciences & computing	184,000	211,000	252,000	238,000	278,000	282,000	305,000	345,000
Physical/environmental sciences	239,000	272,000	278,000	277,000	316,000	330,000	299,000	338,000
Subjects allied to medicine	149,000	176,000	201,000	207,000	256,000	263,000	273,000	295,000
Architecture and related studies	97,000	111,000	106,000	131,000	129,000	127,000	146,000	160,000
Medicine	105,000	131,000	126,000	156,000	110,000	104,000	113,000	133,000
Agricultural sciences	28,000	36,000	36,000	34,000	28,000	36,000	38,000	48,000
Technology	43,000	37,000	39,000	47,000	43,000	38,000	42,000	38,000
All SET subjects	**1,350,000**	**1,536,000**	**1,603,000**	**1,669,000**	**1,729,000**	**1,797,000**	**1,837,000**	**2,123,000**

Source: Labour Force Survey, Autumn data, GB, single subject degrees and working age only (16-59/64). Numbers rounded to nearest 1,000.

Using HESA data, Figure 3 illustrates the number of first degrees awarded in SET subjects from 1994/95 to 2003/04. Table 19 reports that almost 125,000 first degrees were awarded in 2003/04 along with the underlying data for each subject.

Table 19: Numbers of SET first degrees by subject

	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04
Biological sciences	12,380	13,800	15,365	16,885	17,360	18,450	18,890	18,495	23,725	25,955
Subjects allied to medicine	11,105	12,630	14,515	16,285	17,595	17,790	20,505	22,330	23,665	24,715
Computer science	8,275	9,210	9,295	9,990	10,380	11,210	12,825	14,300	18,240	20,205
Engineering & technology	22,085	23,320	23,015	22,575	22,010	20,550	20,495	20,285	19,455	19,780
Physical sciences	13,440	13,785	14,070	13,295	13,055	13,180	13,205	12,415	12,480	11,995
Medicine & dentistry	5,620	5,630	5,800	5,900	5,840	5,970	6,065	6,130	6,175	7,005
Architecture, building and planning	8,165	8,285	7,480	7,275	7,225	6,590	6,460	6,390	6,555	6,735
Mathematical sciences	4,070	4,070	3,705	3,940	4,250	4,090	4,295	4,130	5,100	5,395
Agriculture and related subjects	1,830	2,110	2,275	2,265	2,330	2,340	2,325	2,350	2,150	2,415
Veterinary science	470	460	520	495	530	550	580	620	560	660
All SET subjects	**87,435**	**93,300**	**96,045**	**98,900**	**100,570**	**100,720**	**105,645**	**107,445**	**118,105**	**124,860**

Source: Higher Education Statistics Agency. 2002/03 and 2003/04 data are not directly comparable with previous years due to changes in the subject classification system and to the treatment of combined degrees. Numbers rounded to nearest 5.

For doctorates, analysis of the Labour Force Survey revealed that in 2004 there were 178,000 people of working age in Britain with a PhD. Figure 6 plots the number of doctorate holders by subject since 1997. Table 20 presents the estimates of the number of people specialised in each subject.

Table 20: Numbers of SET doctorate holders by subject

	1997	1998	1999	2000	2001	2002	2003	2004
Medicine/dentistry	11,000	17,000	16,000	19,000	10,000	14,000	16,000	22,000
Subjects allied to medicine	10,000	13,000	16,000	17,000	18,000	12,000	20,000	21,000
Biological sciences	30,000	40,000	41,000	38,000	34,000	33,000	40,000	46,000
Physical sciences	44,000	49,000	52,000	45,000	43,000	49,000	48,000	49,000
Mathematical/computer science	9,000	6,000	14,000	10,000	12,000	13,000	15,000	15,000
Engineering	15,000	16,000	22,000	15,000	15,000	14,000	17,000	18,000
All SET subjects	**119,000**	**141,000**	**161,000**	**146,000**	**132,000**	**135,000**	**156,000**	**172,000**

Source: Labour Force Survey, Autumn data, GB, single subject degrees and working age only. Agricultural sciences, technology and architecture related subjects are excluded from All SET subjects due to small sample sizes. Thus the total is 6,000 lower than that in Table 4.

Finally, Table 21 provides an alternative presentation of the HESA data relating to the number of SET doctorates awarded each year since 1994/95.

Table 21 Numbers of SET doctorates awarded

	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04
Biological sciences	1,115	1,485	1,580	1,675	1,705	1,750	2,130	2,270	2,375	2,415
Physical sciences	1,455	1,875	1,810	1,950	1,910	1,820	2,180	2,060	2,180	2,280
Engineering and technology	1,325	1,555	1,755	1,835	1,805	1,710	2,010	1,865	2,020	2,040
Medicine and dentistry	545	730	900	905	905	1,020	1,255	1,385	1,360	1,530
Subjects allied to medicine	350	455	515	525	545	590	720	780	885	880
Computer science	220	280	240	265	300	310	385	370	375	470
Mathematical sciences	230	320	345	300	380	350	380	390	370	415
Agriculture and related subjects	215	285	245	290	255	270	265	255	230	260
Architecture, building and planning	95	80	110	135	130	140	165	150	175	185
Veterinary science	55	65	80	105	70	70	70	85	70	60
All SET subjects	**5,610**	**7,130**	**7,580**	**7,985**	**8,010**	**8,030**	**9,560**	**9,610**	**10,040**	**10,535**

Source: Higher Education Statistics Agency. 2002/03 and 2003/04 data are not directly comparable with previous years due to changes in the subject classification system and to the treatment of combined degrees.

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