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Department for Innovation, Universities & Skills

The Demand for STEM Graduates: some benchmark projections

Rob Wilson

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Acknowledgements

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Responsibility for the views expressed and any remaining errors lies solely with the author.

Summary

Aims

This report has two main objectives. The first is to develop and to present some benchmark projections of employment of people with graduate level qualifications in Science, Technology, Engineering and Mathematics (STEM) subjects. The second, is to use these results to provide a better understanding of 'demand-supply' issues for STEM personnel, While the prime focus is on demand, it is evident that the effects of demand and supply factors are difficult to isolate, as illustrated in the shift-share analysis conducted as part of the project.

Approach

The benchmark projections are generated using data from the Labour Force Survey (LFS). This extends previous work on the levels of qualifications held by those in employment, as published in *Working Futures.*[1] It does this by incorporating an additional dimension, highlighting the subject of qualifications for those qualified at degree level and above. The analysis assesses recent historical developments in the patterns of employment by the subject/discipline of qualifications held, and considers how these patterns might change over the next decade.

The analysis uses LFS data for 2001-2007, to explore the changing historical patterns of employment by discipline. Changes in shares qualified in the various disciplines distinguished within each qualification category are examined, with particular focus on NQF 4 and 5. This analysis is conducted separately for each occupational category, and also for separate sectors (at various levels of aggregation). These results are then used to develop benchmark projections.

The historical analysis of LFS data is combined with the latest *Working Futures* projections of employment by sector and occupation to develop some benchmark projections of "demand" (numbers in employment) for STEM disciplines.[2] As the most recent *Working Futures* results do not include explicit and detailed analysis of the demand for and supply of formal qualifications, the results are tied to a hybrid scenario, using projections of patterns in the levels of qualifications held from the previous round of *Working Futures*. The projections of shares of employment by discipline from the LFS were combined with projections of employment levels by qualification level, occupation and sector from this hybrid scenario.

Due to the limited sample size within the LFS, the data are quite sparse in places (especially at the most detailed level of aggregation by sector and occupation). Various procedures were developed to deal with gaps in the data (as described in Annex D of the main report). The initial analysis was undertaken at a detailed sectoral level, using the 67 industries distinguished in *Working Futures*. As the LFS results are not always robust at that detailed level they have subsequently been aggregated up to provide an analysis of historical data, focusing on patterns within 6 broad sectors. These broad sectors are defined in Annex B of the main report. Where no data were available the nearest equivalent information on qualification patterns was substituted. An RAS iterative procedure was developed to ensure consistency across the various dimensions of employment.[3]

A shift-share analysis, highlighting how demand patterns for STEM graduates are affected by both sectoral and occupational change is also presented.

1 Working Futures is a set of detailed employment forecasts produced on behalf of the LSC and UKCES. The present projections are linked to Working Futures 2007-17. The overall qualification patterns are based on an updated version of those produced for Working Futures 2004-2014, see Working Futures Qualifications Report at : http://www.ukces.org.uk/Default.aspx?page=28). The latest round of projections was completed without a full revision and reassessment of the qualification model developed in the 2004-2014 results. For further details of the results see the UKCSE website: http://www.ukces.org.uk/Default.aspx?page=28.

2 Strictly the results are the reflection of both supply and demand influences.

3 RAS is a well established procedure to develop 2 dimensional arrays consistent with target row and column vectors. IER has developed this to allow constraints across multiple dimensions.

Results

Current deployment of STEM graduates

Graduates and postgraduates account for just over 3 in 10 jobs across all sectors, but this ranges from over 5 in 10 in Non-marketed services (including education, health and public administration and defence), to not much more than 1 in 10 for the Construction sector.

Across all industries, people qualified at post graduate level in STEM subjects accounted for just under 3% of total employment in 2007. Those with a first degree in STEM subjects account for just over 8% of employment.

The analysis indicates that, while manufacturing has for many years been a major area of employment for STEM graduates and postgraduates, there is now a much larger number and share of such people employed in other sectors. In total, people qualified at post-graduate level in STEM subjects accounted for just over 2% of total manufacturing employment in 2007. ***Manufacturing*** now employs a smaller share of highly qualified people generally, although the patterns of change over time (in terms of the broad NQF categories) are very similar to those for all industries. However, the rate of growth of employment for STEM graduates is faster in manufacturing than elsewhere, despite the fact that overall employment prospects are poorer in this sector than for all industries and services.

The sector with the largest shares of people employed who are qualified in STEM subjects at first degree level or above is ***non-marketed services***. A large proportion of these are qualified in medicine (doctors and nurses, etc). Excluding those qualified in medicine, the ***business and other services*** sector accounts for even greater numbers of STEM graduates and postgraduates than the public sector. Its share has also been growing at very rapid rates, especially for those qualified in subjects such as mathematics and computing.

Significant numbers are also employed in **distribution & transport** (including hotels and restaurants). Indeed for all categories, except those qualified in engineering, the numbers employed in this sector are now much higher than in manufacturing. Finally, the **primary** sector (including utilities) and **construction** both employ significant numbers of STEM graduates and postgraduates. However, these are small compared to the numbers in other sectors. The largest groups involved in both cases are first degree graduates qualified in engineering.

Not surprisingly, people qualified in medicine account for a significant proportion of employment in the health service (and therefore in non-marketed services as a whole) but they are not very significant in other parts of the economy. People qualified in other STEM subjects currently feature most significantly in business & other services rather than in manufacturing or other more "traditional" parts of the economy. Significant numbers of people qualified in STEM subjects are still employed in areas such as engineering, the utilities, construction and transport, but their share of total numbers employed with such qualifications is falling.

The highest share of employment of postgraduates qualified in STEM subjects is still found in Primary & utilities, Manufacturing and Construction. These sectors also have the highest shares of first degree graduates employed in STEM subjects. However, the greatest **numbers** of STEM graduates and post-graduates are now employed in Business & other services and in Non-marketed services. More than 300 thousand STEM post-graduates were employed in these two sectors in 2007, while more than ¾ million STEM first degree graduates were employed in Business & other services alone.

STEM graduates and post-graduates are found to be most significantly represented in managerial, professional and associate professional occupations, although quite significant numbers are employed in lower level occupations.

Supply of those with STEM qualifications

In 2007, just under 1 million people in the working age population had STEM qualifications at NQF level 5 and just over 2 ½ million had STEM qualifications at NQF level 4. Of such postgraduates and graduates, the vast majority were economically active and in employment, with only very tiny numbers unemployed. This reflects the patterns for those qualified in other subjects as well. In contrast, a much higher percentage of people with qualifications lower than NQF level 4 are found to be economically inactive and/or unemployed. Those qualified in STEM subjects are marginally more likely to be economically active and in employment than graduates in other disciplines, although the differences are small.

Projections of numbers in employment

It is interesting to speculate about what the future demand for those with STEM qualifications might be if recent historical trends continue. This can be done by extrapolating the historical patterns observed in the LFS data and combining this information with detailed multi-sectoral occupational projections available from *Working Futures*. Some care should be taken when considering such "benchmark" projections for employment as presented here. They should be regarded as indicative, representing what might happen if past trends and current patterns of behaviour continue over the next decade. They should not be seen as inevitable but rather as likely outcomes if these assumptions hold true.

The projections are based on the *Working Futures* macroeconomic scenario which was developed in the first half of 2008 at a time of considerable economic uncertainty, with concerns about the impact on economic prospects of the "credit crunch" and rapidly rising commodity prices (especially for oil and food). Despite these uncertainties, and the deepening recession in the short term, the medium to long-term employment prospects for the UK remain quite bullish, with substantial employment growth expected, driven by rising population.

"Growth in employment is expected to be fastest for those qualified at the highest levels."

Growth in employment is expected to be fastest for those qualified at the highest levels, while the number of those in employment with no or few formal qualifications is projected to decline. With the main exception of medicine, the results generally suggest that the "demand" for those qualified in most STEM subjects will grow significantly faster than the average for all subject groups.[4] Employment shares for most STEM categories have been on a slightly rising trend for the past few years.

Such changing structural demand is also only part of the picture. The age profile of the STEM population means that there will also be a significant need to replace those leaving the STEM workforce (as older workers reach retirement age in the coming decade). This need to refresh talent (replacement demand) is at least as important as so called expansion demand arising from projected increases in employment levels for such workers.

The focus here is on employment. The impact of both demand and supply factors are reflected in the historical and projected estimates of employment by qualification level. Such limitations should be considered when looking at the projections. Employment levels by qualification may be interpreted as representing the revealed preferences of employers for certain types of labour as categorised by the qualifications they hold, but it is also clear that the changing patterns of supply, especially the strong trend towards undertaking and obtaining higher level qualifications, has driven up the average qualification levels of those in employment.

Shift-share analysis of projected changes

Projected changes in employment can be attributed to changing patterns of demand for skills within sectors, (by occupation and by qualification). Overall changes can be attributed to the following effects:

- Scale – changes expected to the overall scale of employment between 2007 and 2017;
- Industry – changes attributable to changes in industrial structure, holding all else equal;
- Occupation – changes attributable to changes in occupational structure, holding all else equal;

4 The projections of employment by discipline for various occupational and sectoral categories take no direct account of changes in the flows emerging from the educational system (i.e. the supply side). They therefore conflate both supply and demand influences. They indicate the numbers that might be expected if recent trends continue.

- Qualification – changes attributable to changes in qualification structure within occupations, holding all else equal
- Interaction – a residual term reflecting interactions across all three dimensions.

While there is some evidence of changing industry and occupational employment structures favouring certain STEM categories, these effects are quite modest compared with changes in the overall scale of employment and, more especially, the qualification effects observed.

"Many jobs are becoming more demanding in terms of qualifications needed."

The detailed analysis demonstrates qualification effects are much larger in magnitude than the scale of industry and occupation effects. Typically these are an order of magnitude larger in absolute terms. This suggests that the main factor driving the rising numbers of STEM (and other qualification categories) in employment is changing proportions qualified within particular sectors and occupations. This phenomenon can be seen as the consequence of both demand and supply factors. While the changes observed may be, in part demand driven, they are also heavily influenced by increases in supply. In particular, the very rapid increases in numbers of young people staying on into higher education and acquiring degree and postgraduate qualifications has clearly played a major part in these developments. However, there is also evidence that the nature of many jobs is changing and requirements for formal qualifications are rising. Many jobs are becoming more demanding in terms of qualifications needed. Moreover evidence on rates of return to higher level qualifications suggest that demand has more or less kept pace with the large increases in supply observed in recent years. All of this suggests that overall demand has kept up with supply of those with higher level (NQF4+ qualifications). Some of the most rapid increases are observed for *Biological sciences* at both graduate and post graduate levels. Many other STEM categories also show large qualification effects.

Potential for developing stock flow models

In addition to the LFS data exploited here, a huge amount of other information which focuses upon flows of people acquiring such qualifications is available. In principle, this presents the possibility of developing a much more sophisticated, more detailed, and in-depth analysis, including building a fully fledged stock-flow model of the supply of STEM personnel. In practice, however, there are a number of problems in obtaining consistent and comprehensive data.

At the broadest level, there is some evidence that the rapid increase observed in recent years in the supply of people moving into higher education may be slowing. The official measure of the Higher Education Initial Participation Rate (HEIRP) developed by ONS suggest that the proportion of young people going on to higher education may now have reached a plateau at around 40 per cent. Unfortunately the HEIRP is not available for particular subject categories, (although in principle such measures could be calculated).

There is also a considerable amount of other relevant data on flows, including the publications produced by UCAS, HESA and, HEFCE, as well as summary information assembled in many of the publications cited in detail in the main report (including the ETB's own Research Reports (ETB, 2006)). However this information is often not in a very useable format for developing sophisticated quantitative stock flow models. Problems of limited length of times series, lack of compatibility with other data sources, as well as lack of continuity over time mean that much of this information can only be used in a more qualitative fashion.

Despite these difficulties DTI (2006) developed a simple stock flow model to project the supply side. This involved projecting the number of STEM graduates for each subject grouping using Labour Force Survey data, focussing on individual year "cohorts". This appears to be similar to the detailed stock flow model developed by Wilson and Bosworth (2006) for all disciplines in the *Working Futures 2004-2014*. The DTI (2006) concludes that if current trends continue the supply of STEM graduates will be sufficient to meet demand. However, they suggest that the ambition to raise R&D expenditure in the UK could generate an even larger requirement for such graduates, which could cause some problems if supply is not also stimulated.

Measuring the imbalance between supply and demand for particular occupations or qualifications in more quantitative terms is, of course, much easier said than done. This has been extensively researched by the Migration Advisory Committee (MAC), and results for 3 digit occupational categories have been published (MAC, 2008).[5] This includes analysis of changing patterns of pay and other indicators such a skill shortage vacancies and unemployment rates from the LFS, as well as from other data sources.[6] The results presented by the MAC for STEM occupations suggest that demand and supply are currently broadly in balance, although there are a few occupations that are highlighted in the MAC's "shortage occupation list" and a number of other occupations that are "under review".[7]

Overview and implications

Given the importance of science, technology and engineering to economic growth and technological change, the falling shares of young people choosing to study STEM subjects has been of cause of concern. This is not just an issue in the UK but more generally across many other OECD countries.[8] Concerns in the UK about the numbers of young people following STEM educational routes through FE and HE, and onto science, engineering and technology occupations and careers, have been the subject of various official reports in recent years.[9]

"... the falling shares of young people choosing to study STEM subjects has been of cause of concern."

To address such concerns, it is helpful to examine, even if in a primarily qualitative fashion, how the projected trends in demand compare with what is happening on the supply side. This project has explored what the likely change in demand for such graduates might be, given a continuation of past trends in employment patterns using LFS data, and based on a detailed analysis of the longer-term prospects for the economy using multi-sectoral macroeconomic model.

The analysis focuses primarily on stocks of people in employment holding different types of qualifications. The analysis highlights the potential value of the LFS for measuring such historical changes and developing such projections of possible future changes in employment structure by discipline. Despite the problems which have been highlighted in the main report, the results provide some useful insights into possible developments and contribute to a better understanding of the overall demand/supply relationship for STEM personnel, currently and over the coming decade.

The results suggest that, apart from medicine, the demand for most STEM subjects is likely to grow faster than for other disciplines over the coming decade. The present analysis does not enable a direct comparison with likely supply. However, if recent trends of young people away from STEM subjects continue, these results suggest that companies and organisations dependent on high quality STEM personnel will find it increasingly difficult to find the skills that they will need to operate and compete successfully.

5 MAC (2008) "Skilled Shortage Sensible: The recommended shortage occupation lists for the UK and for Scotland. see: http://www.ukba.homeoffice.gov.uk/aboutus/workingwithus/indbodies/mac/macfirstshortagelist/
6 For example the Annual Survey of Hours and Earnings (ASHE) and the National Employer Skills Survey (NESS).
7 Op. cit.
8 Evolution of student interest in Science and Technology studies. Policy Report, OECD, May 2006: http://www.oecd.org/16/30/36645825.pdf
9 See the main report for a more detailed review of relevant recent reports and papers.

1. Aims

This report is part of a larger project which has two main aims:

1. to develop some benchmark projections of employment of people with graduate level qualifications in Science, Technology, Engineering and Mathematics (STEM) subjects;
2. to contribute to a chapter in the ETB *Engineering UK 2008* (in particular by providing a better understanding of demand supply issues for STEM personnel, based primarily on 1).

Ideally, the aim is to focus on the demand for such people although as the shift-share analysis presented below suggests it is quite difficult to separate out the effects of demand and supply factors. The shift share analysis highlights how employment patterns for STEM graduates and postgraduates are likely to be affected by both sectoral and occupational change (mainly demand side factors) and also qualification effects (which are a combination of both supply and demand). It is the latter effects which are dominant.

2. Approach

2.1 Benchmark projections

In order to produce the benchmark projections Labour Force Survey (LFS) data have been used to extend previous work on projections of employment by qualification level as published in *Working Futures.* [10] The main innovation is the use of the LFS to assess recent historical developments in the pattern of employment by subject/discipline for those qualified at degree level and above.

The LFS includes information on the subject of qualifications for those qualified at degree level and above (see Annex A for details). Although this is limited in value because of small sample sizes for a very detailed sectoral analysis, it can provide some useful insights into broad demand trends for STEM subjects.

The initial analysis has been undertaken at a detailed sectoral level, using the 67 industries distinguished in *Working Futures*. However, as anticipated in the original proposal the results are not always robust at that detailed level. They have been aggregated up here to provide an analysis of historical data, focusing on patterns within 6 broad sectors. At present these distinguish manufacturing and 5 other broad categories used in the *Working Futures* analysis. Much greater detail is available and other categories could be distinguished, including a composite "engineering" group as suggested in the original proposal. However, it is clear that manufacturing now accounts for a relatively small share of the total number of STEM graduates and post-graduates, so more detailed analysis may not be very productive.

"...Working Futures projections used to develop some benchmark projections of demand."

This historical analysis of the LFS data is combined with *Working Futures* projections to develop some benchmark projections of "demand" (employment).[11] *Working Futures 2004-2014* included an explicit and detailed analysis of the demand for and supply of formal qualifications.[12] *Working Futures 2007-2017* does not include this dimension. The results are therefore tied to a hybrid scenario, based upon projections of qualification patterns from *Working Futures 2004-2014*, combined with a sectoral and occupational employment scenario consistent with the current *Working Futures 2007-2017*.

Using the LFS data for 2001-2007, changing patterns of employment by discipline can be analysed and benchmark projections developed. Details of the methods used to do this are given in Annex D. Essentially, it involved examining the changing shares qualified in the various disciplines distinguished, within each qualification category (focusing on NQF 4 and 5). These are defined in Annex A, although they are aggregated here to 4 or 9 broad subject categories (again as defined in Annex A). This analysis was conducted separately for each occupational category and also for separate sectors (at various levels of aggregation).

10 See Working Futures Qualifications Report at : http://www.ukces.org.uk/Default.aspx?page=28)
11 Strictly the analysis is a mixture of supply and implied demand.
12 op cit.

Because of its limited sample size, the LFS data are quite sparse in places (at the most detailed level of aggregation by sector and occupation). Various procedures were developed to deal with gaps in the data (as described in Annex D). Where no data were available the nearest equivalent information on qualification patterns has been substituted.

The projections of shares of employment by discipline were then combined with *Working Futures 2007-2017* based projections of employment levels by broad qualification category, occupation and sector. This has been limited to an analysis by the 6 broad sectors defined in Annex B. An RAS iterative procedure has been developed to ensure consistency across the various dimensions of employment.[13]

The paper also includes a shift-share analysis, highlighting how demand patterns for STEM graduates are being affected by both sectoral and occupational change.

Section 4 explores the potential for a more detailed and in-depth analysis, drawing upon other data sources. This includes sketching out the potential for developing a full stock-flow model of STEM personnel.

2.2 Defining STEM

The individual subject areas are grouped within the report in the following ways:

- **Medicine** (1) Medicine and (2) Medical related subjects.
- **All other STEM** – (3) Biological sciences, (4) Agricultural sciences, (5)Physical/Environmental sciences, (6) Mathematical sciences and computing, (7) Engineering, and (8) Technology.
- **Other subjects** – All other subjects, LFS categories (9) - (18).

For this report **STEM** is defined as *Medicine plus All other STEM.*

13 RAS is a well established procedure to develop 2 dimensional arrays consistent with target row and column vectors. IER has developed this to allow constraints across multiple dimensions.

3. Results

3.1 Outline of the results

The following tables summarise the main results, beginning with a brief review of historical patterns of employment for STEM and other graduates, before presenting the "benchmark" projections. The latter should be regarded as indicative. They represent what might happen if past trends and current patterns of behaviour continue over the next few years. They should not be seen as inevitable but rather as likely outcomes if these assumptions hold true.

Both historical and projected estimates represent the impact of both demand and supply factors. The focus is on employment, which can be interpreted as representing the revealed preferences of employers for certain types of labour as categorised by the qualifications they hold. However, it is also clear that changing patterns of supply, especially the strong trend towards undertaking and obtaining higher level qualifications has driven up the average qualification levels of those in employment. While there have been some suggestions that this has resulted in over-qualification and excess supply, the evidence from both rates of return (which have held up well despite the huge increase in numbers supplied) and more detailed analyses of how people use their qualifications when in employment, suggests that the growth in supply has probably been matched by increased demand.

The projections are based on the *Working Future III* macroeconomic scenario. This was prepared in the first half of 2008 at a time of considerable economic uncertainty, with concerns about the impact on economic prospects of the "credit crunch" and rapidly rising commodity prices (especially for oil and food). Despite these uncertainties and a significant slowdown in economic growth (and possibly a deep recession) the medium term employment prospects for the UK remain quite bullish, with substantial employment growth expected, driven by rising population.

3.2 Historical qualification patterns

As noted in Section 2 the main data source on qualification patterns of those in employment is the LFS. This enables a picture to be drawn of changing employment patterns over the last few years. Changes in classification by sector and occupation prevent extending this back much before 2001. The main analysis focuses therefore on changes over a quite short period.

This section begins by focusing upon historical developments. Patterns of employment by qualification vary quite significantly by sector. Figure 1 compares 6 broad sectors, concentrating on broad qualification levels and for graduate (NQF4) and post-graduate (NQF5) qualifications, showing a breakdown for STEM and non-STEM subjects. Medicine has been separated out from the STEM subject group as a special case.

As shown in Figure 3.1, while graduates and postgraduates account for just over 3 in 10 jobs across all sectors, this ranges from over 5 in 10 in Non-marketed services (which includes education, health and public administration and defence), to not much more than 1 in 10 for the Construction sector.

"...roles in research and development being reclassified as services to business."

Medicine accounts for a significant proportion of employment in the health service (and therefore in non-marketed services) but is not very significant in other parts of the economy. People qualified in other STEM subjects feature most significantly in business & other services now, rather than in manufacturing or other parts of the economy. This reflects the continuing trends towards specialisation and lengthening of supply chains, with roles in research and development being separated out from traditional activities and being reclassified as services to business rather than core manufacturing activities. However, significant numbers of people qualified in STEM subjects are still employed in more traditional areas such as engineering, the utilities, construction and transport.

Figure 3.2 emphasises the importance of people with postgraduate level (NQF5) qualifications in STEM subjects employed in Primary & utilities, Manufacturing and Construction. It shows the shares of people with such qualifications as a proportion of all those with postgraduate level qualifications employed in that sector. Figure 3.3 shows the corresponding patterns for those qualified at first degree level. These show less marked differences across sectors.

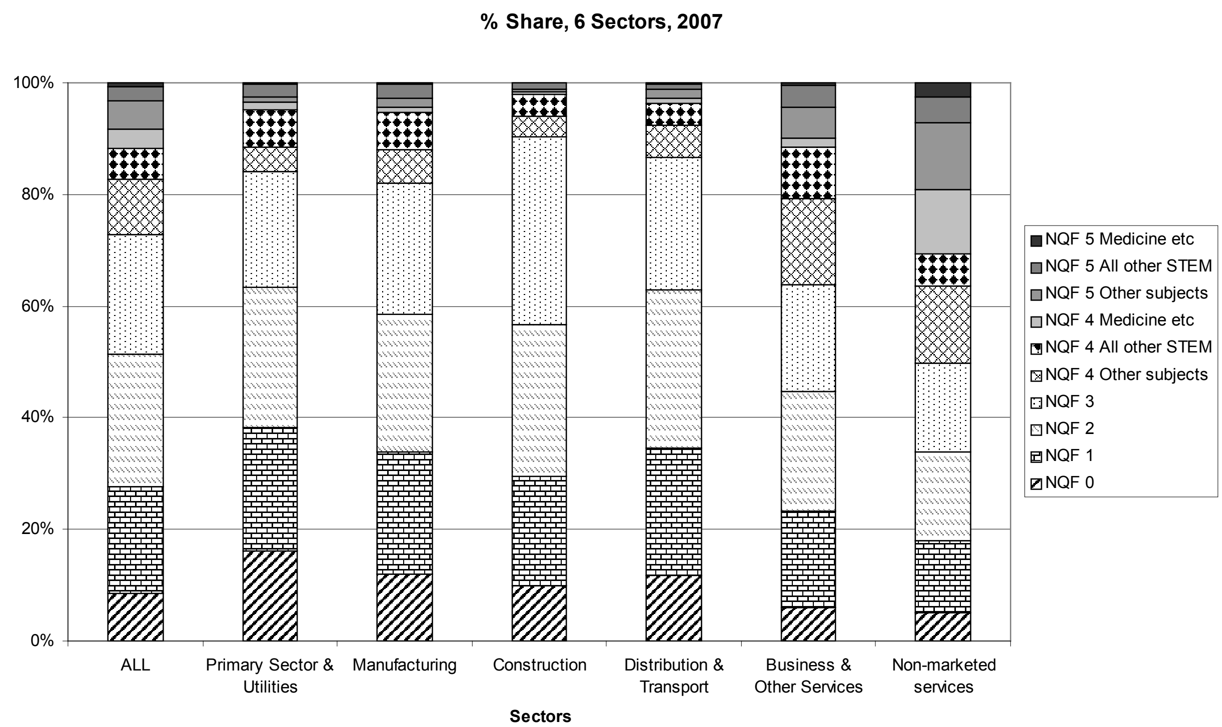
"Business & other services employs almost ¾ of a million people qualified in STEM subjects."

The growing significance of Business & other services and Non-marketed services as employers of STEM graduates (as well as other graduates and post-graduates) is further highlighted in Figures 3.4 and 3.5. For post-graduates these two sectors both employ around 250-300 thousand, which is 3 or 4 times more than any other sector. For first degree graduates, Business & other services stands out as the major employer. It employs almost ¾ of a million people qualified in STEM subjects other than medicine (not quite half the total). Figures 3.4a and 3.5a show the proportions that these represent of total employment in each sector. The intensity of such employment in some more traditional sectors (such as primary, manufacturing and construction industries) is higher than average.

It is clear that, despite some perceptions to the contrary, STEM graduates are not concentrated in the manufacturing and primary sectors. Many more STEM graduates and post-graduates now end up in jobs other sectors.

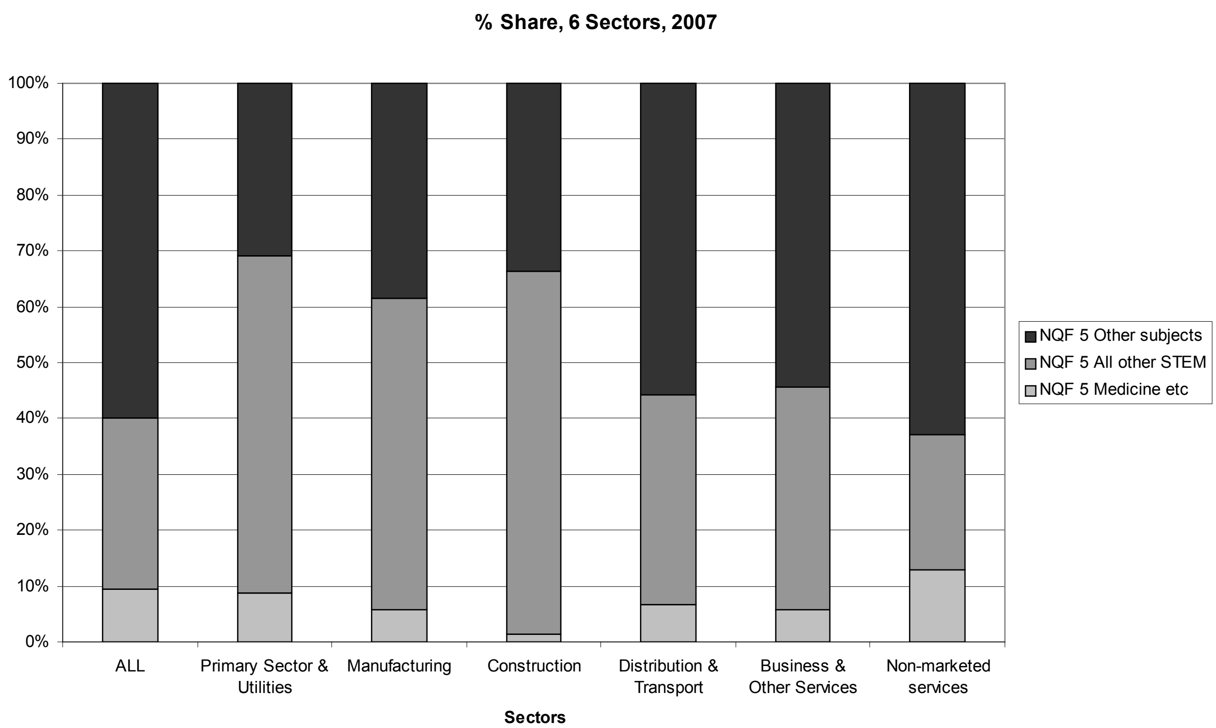
Figures 3.6 and 3.7 show how STEM graduates and post-graduates (as well as graduates in other disciplines) are deployed across different occupational categories. Managerial, professional and associate professional occupations are the most significant areas in which such people are employed, although quite significant numbers are employed in lower level qualifications.

Figure 3.1: Qualification Patterns within Broad Sectors



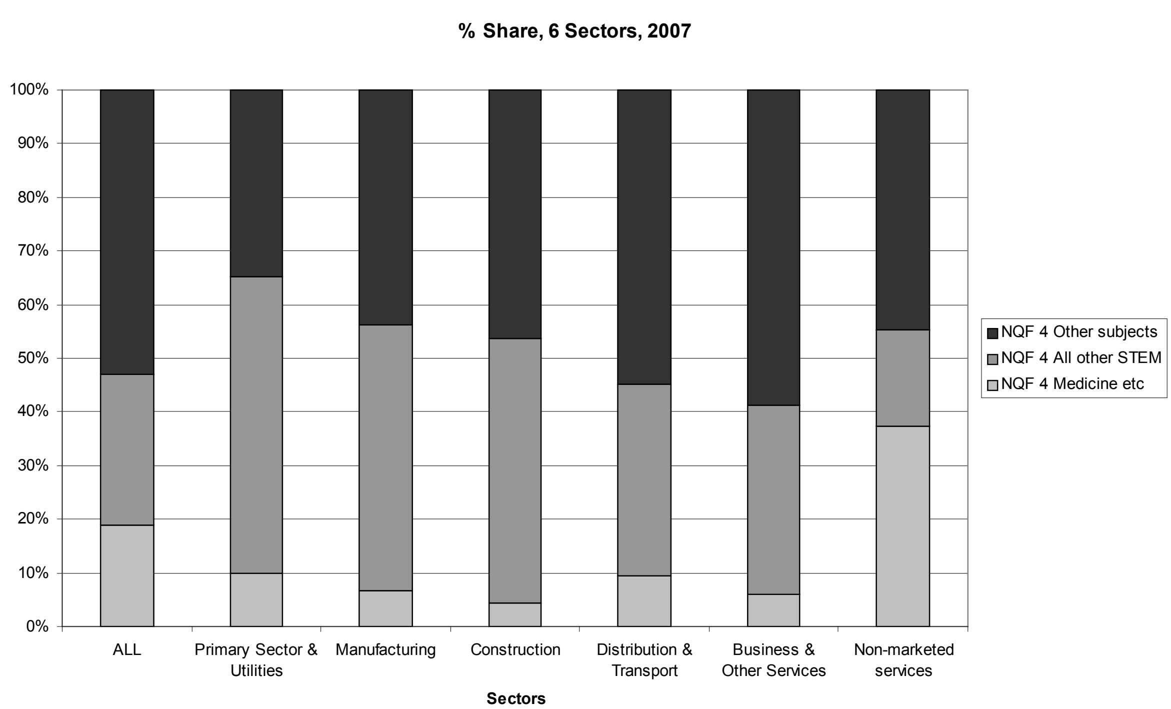
Source: *IER estimates based on the Labour Force Survey.*

Figure 3.2: Qualification patterns for post-graduates by sector



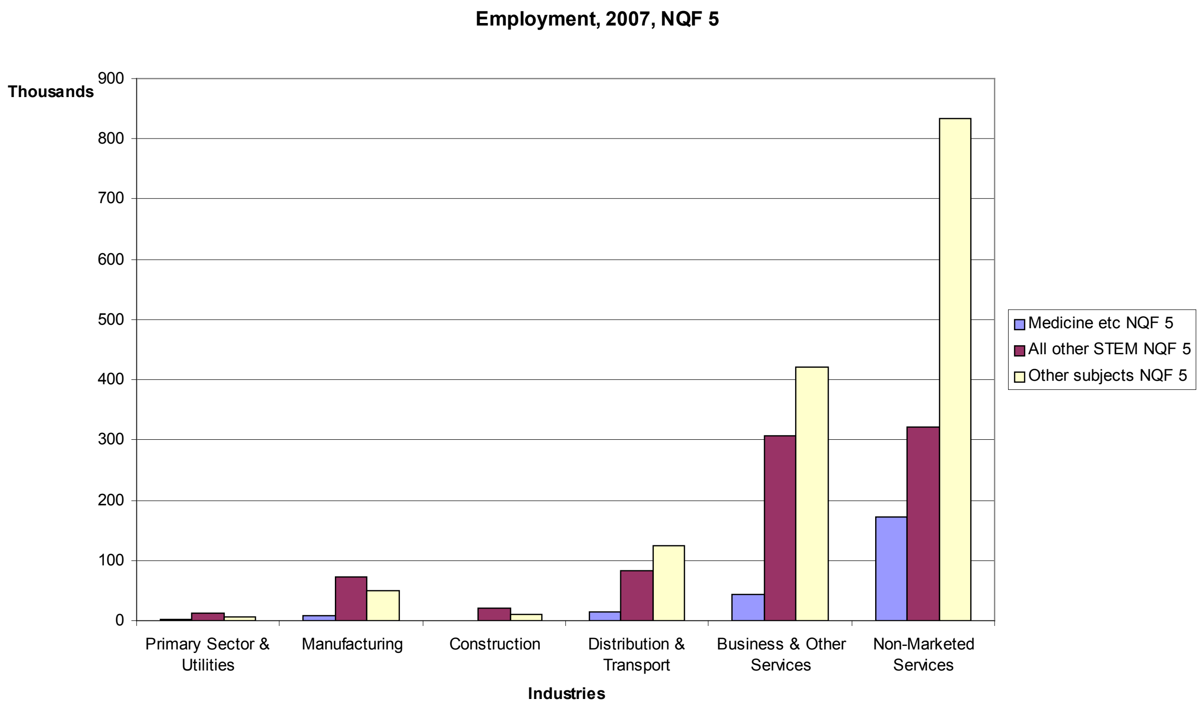
Source: *IER estimates based on the Labour Force Survey.*

Figure 3.3: Qualification patterns for first degree graduates by sector



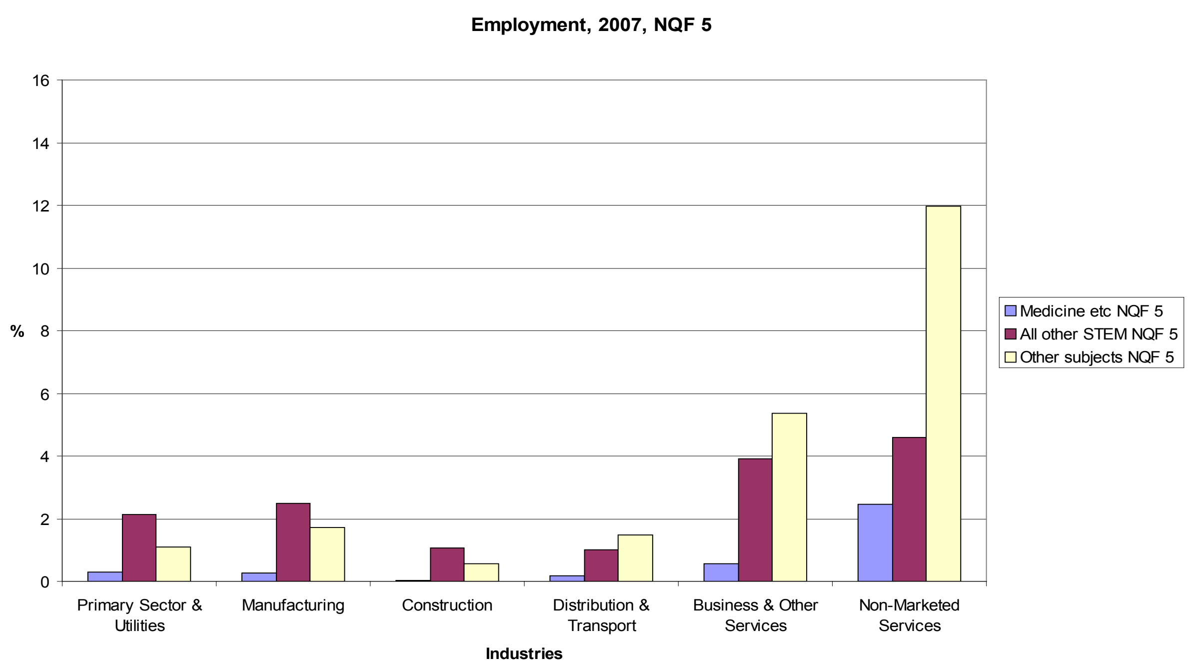
Source: *IER estimates based on the Labour Force Survey.*

Figure 3.4: Deployment of post-graduates by sector



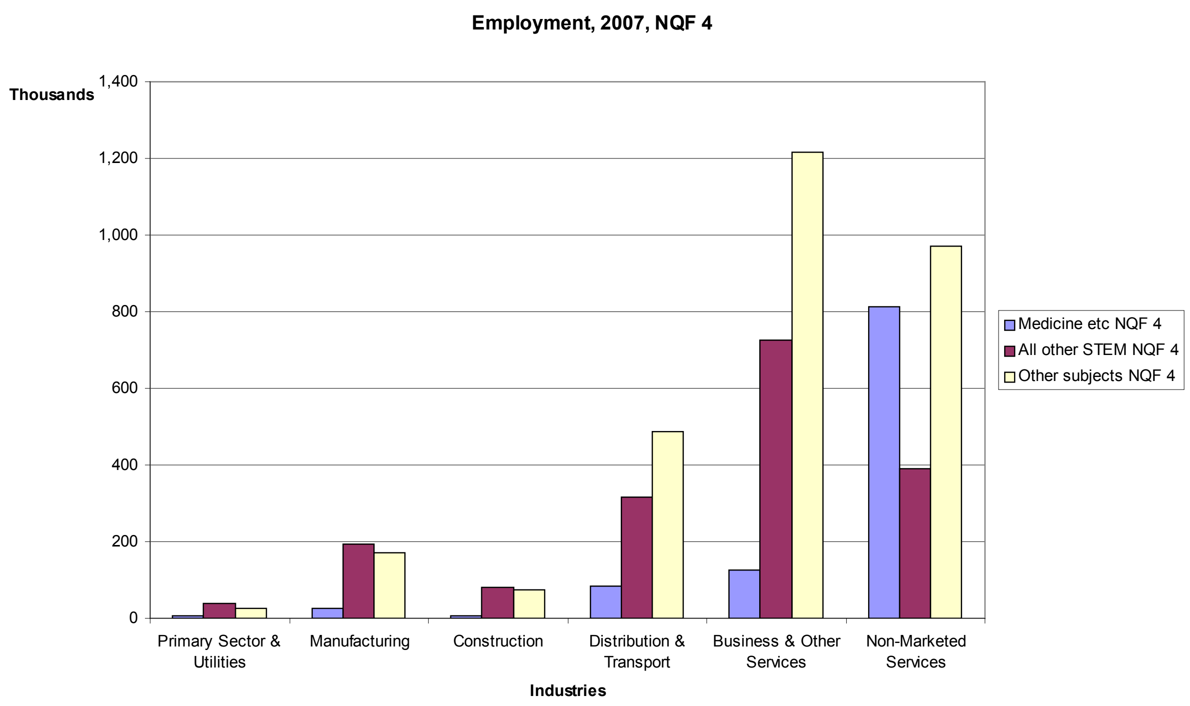
Source: *IER estimates based on the Labour Force Survey.*

Figure 3.4a: Deployment of post-graduates (% of total employment in the sector)



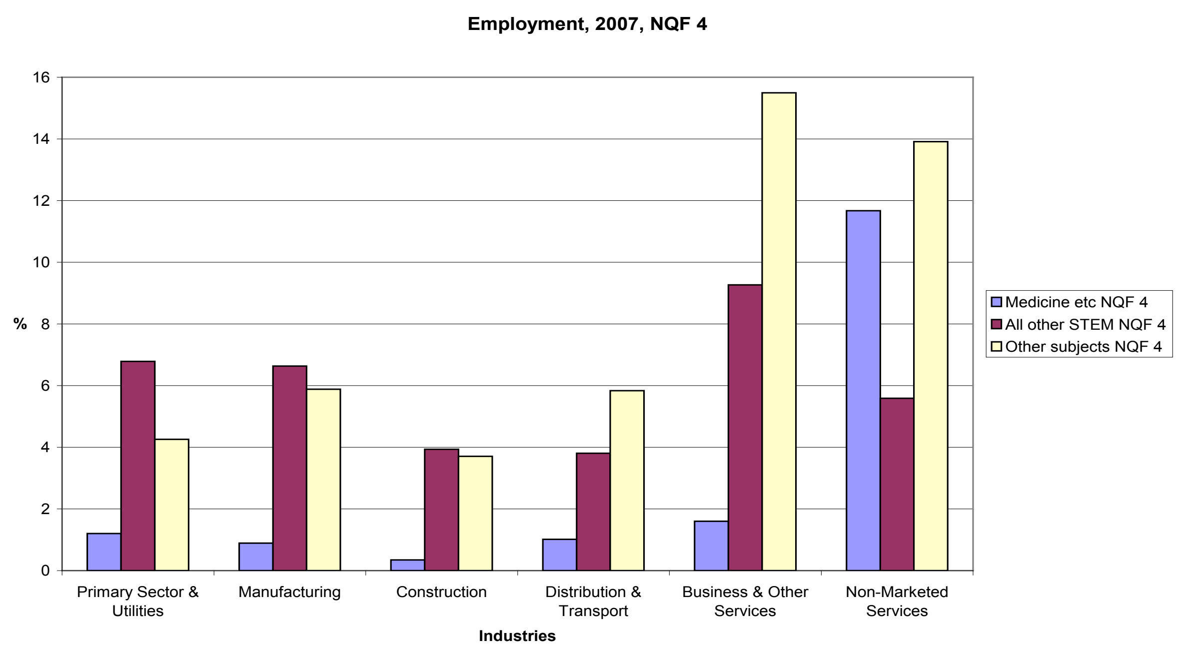
Source: *IER estimates based on the Labour Force Survey.*

Figure 3.5: Deployment of first degree graduates by sector



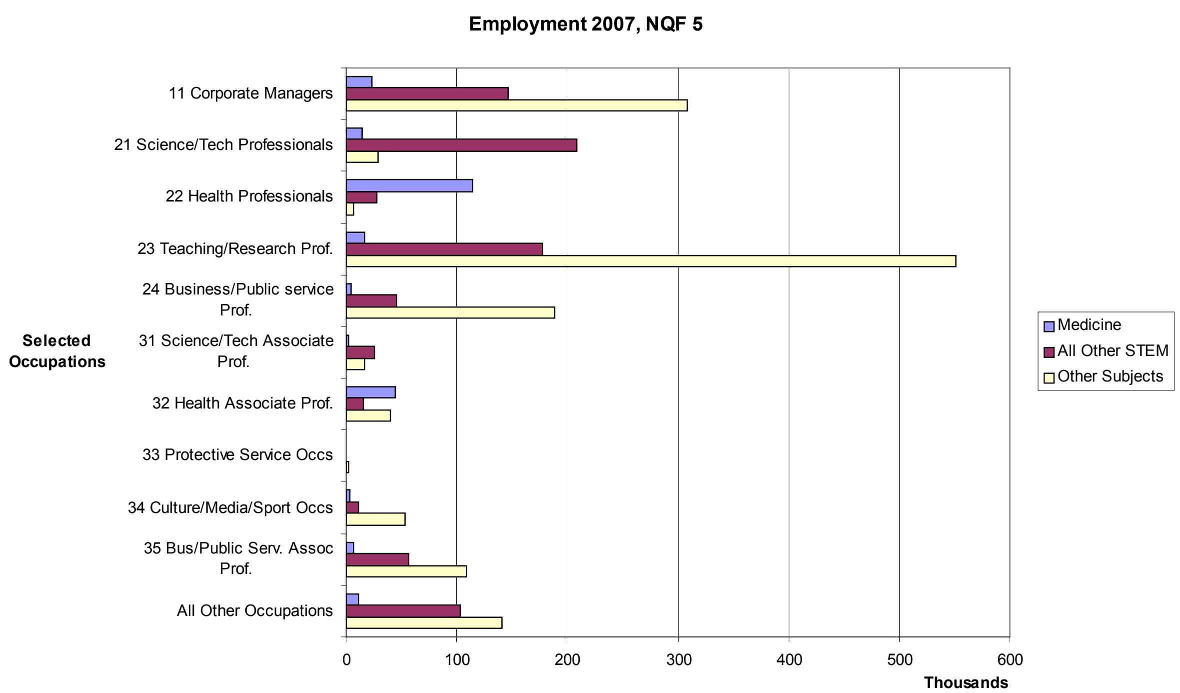
Source: *IER estimates based on the Labour Force Survey.*

Figure 3.5a: Deployment of first degree graduates (% of total employment in the sector)



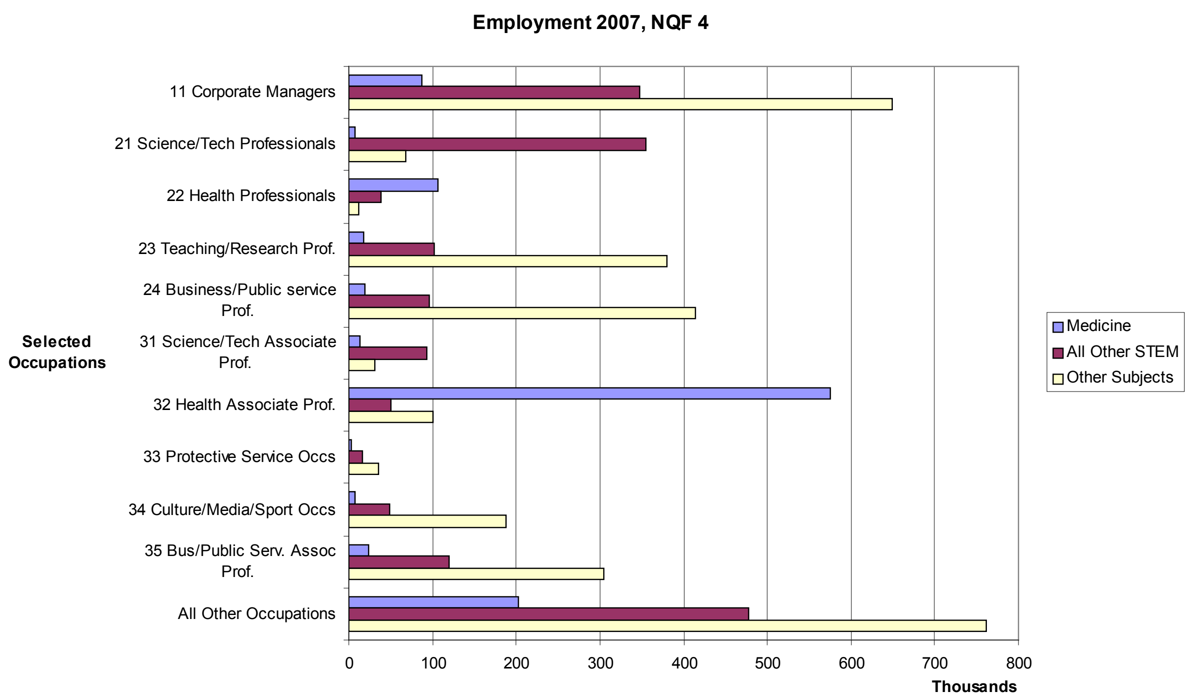
Source: *IER estimates based on the Labour Force Survey.*

Figure 3.6: Deployment of post graduates by selected occupations



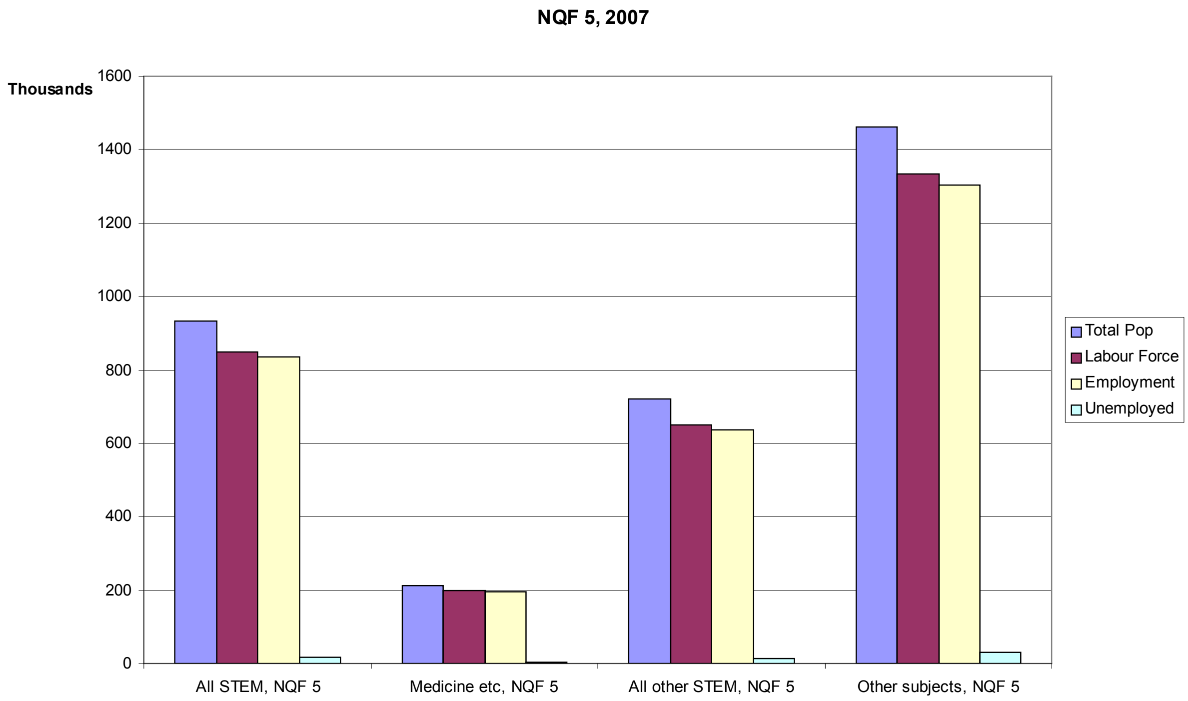
Source: *IER estimates based on the Labour Force Survey.*

Figure 3.7: Deployment of first degree graduates by selected occupations



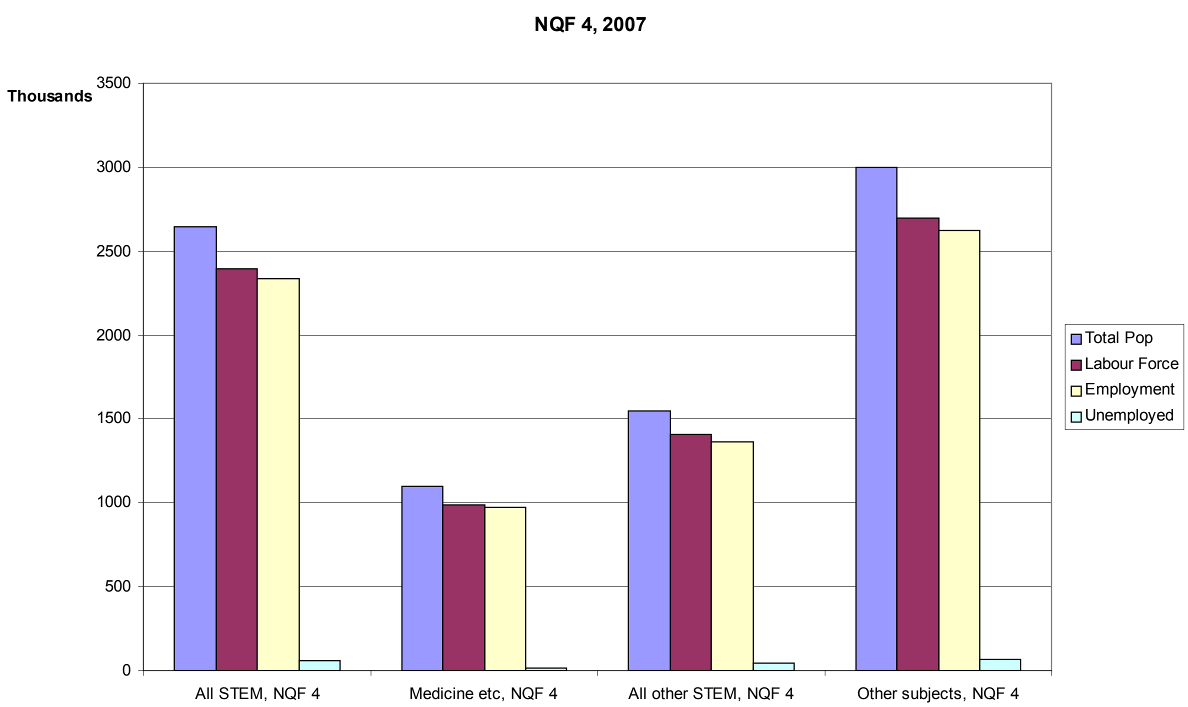
Source: *IER estimates based on the Labour Force Survey.*

Figure 3.8: Supply of those with post-graduate qualifications (NQF 5), 2007



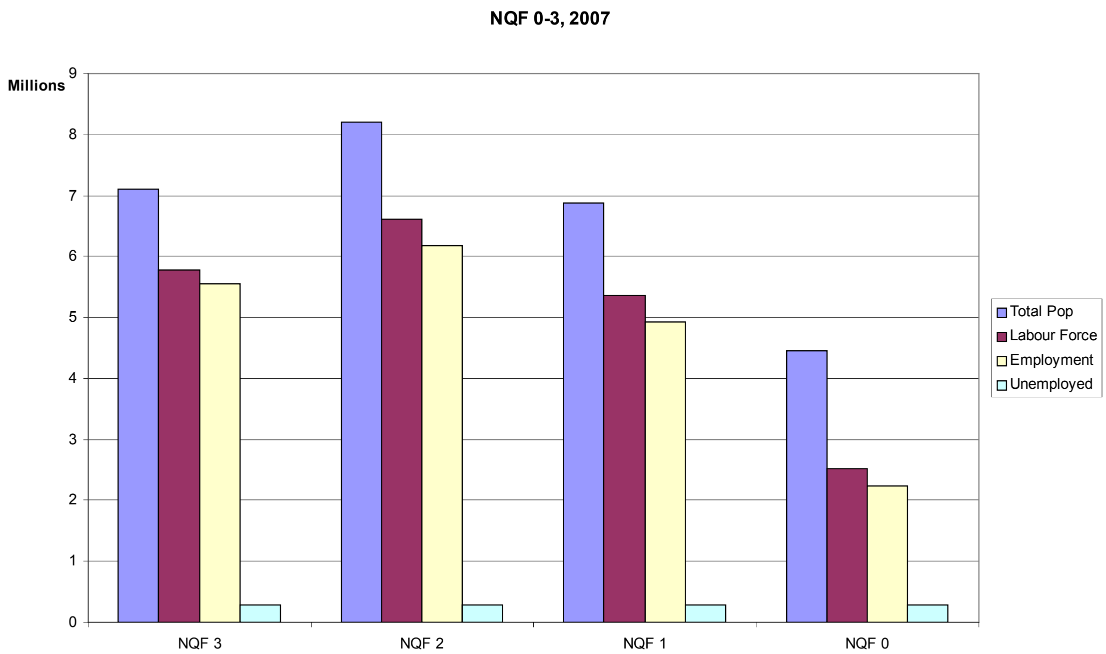
Source: IER estimates based on the Labour Force Survey.

Figure 3.9: Supply of those with graduate qualifications (NQF 4), 2007



Source: IER estimates based on the Labour Force Survey.

Figure 3.10: Supply of those with lower level qualifications (below NQF 4), 2007



Source: *IER estimates based on the Labour Force Survey.*

3.3 Comparisons with overall supply numbers

It is interesting to make some comparison with the overall numbers in the population and labour force that possess STEM qualifications. Based on the LFS the total numbers in the population and the economically active labour force holding particular types of qualification can be examined.

Figures 3.8-3.10 summarise the picture across all industries and occupations. Figure 3.8 shows the position for those with post-graduate level qualifications. In 2007 based on LFS data there were just under a million people in the population of working age with STEM qualifications at NQF level 5. Nearly all of these were economically active and only a very tiny number were unemployed. Those qualified in medicine accounted for just over a fifth of these. Post-graduates qualified in other subjects accounted for around 1.4 million people. Again most of these were economically active and in employment.

"...just over 2½ million people in the population of working age with STEM qualifications at NQF level 4."

Figures 3.9 shows the corresponding situation for those qualified at first degree level (NQF 4). In 2007 there were just over 2½ million people in the population of working age with STEM qualifications at NQF level 4. As for those with a post-graduate qualification nearly all of these were economically active and employed. Those qualified in medicine accounted for just over a million of these. Post-graduates qualified in other subjects accounted for around 1.4 million people. Again most of these were economically active and in employment.

Figure 3.10 completes the picture, illustrating the overall picture for those qualified at below NQF level 4. There is no breakdown by subject of qualification here. The most notable feature compared to the previous discussion is the much high percentage who are economically inactive and or unemployed. This is related positively and monotonically to the level of qualification held.

3.4 Projections of overall qualification levels

Tables 3.1 and 3.2 summarise the overall picture as far as numbers in employment by qualification are concerned. These are linked to the *Working Futures 2007-2017* scenario developed for LSC/ UKCES. This has yet to be finalised, so they should still be regarded as preliminary and may be subject to possible revision in light of the current economic climate and the implications this may have for the long term.

The qualification patterns are based on an updated version of those produced for *Working Futures 2004-2014*. However, this has been done without a full revision and reassessment of the qualification model, as this was not included in the *Working Futures 2007-2017* update.

The overall results in Table 3.1 (for total employment in all industries and services) paint a similar picture to that presented in *Working Futures 2004-2014*. The fastest growth in employment is expected to be for those qualified at the highest levels, while the number of those in employment with no or few formal qualifications is projected to decline.

"...the 'demand' for those qualified in STEM subjects will grow faster than the average for all subject groups."

As described in Section 2, using LFS data, changing patterns of employment by discipline have then been used to develop benchmark projections of numbers by discipline for various occupational and sectoral categories. It should be emphasised that such projections have their limitations. They take no direct account of changes in the flows emerging from the educational system (i.e. the supply side). They also conflate both supply as well as demand influences. They indicate the numbers that might be expected if recent trends continue (which as noted above have been driven by both demand and supply factors).

Other possibilities might also be considered in developing future scenarios. For example, projections could be developed holding shares within occupations constant at 2007 levels. The systems and procedures developed here enable such alternative scenarios to be explored, as well as the main benchmark scenario upon which this section focuses.

3.5 Projections by subject of qualification

Table 3.3 shows how the overall numbers employed by qualification category might be split by subject of qualification if recent trends continue. Figures 3.11 and 3.12 show the time series trends in employment shares of first degree STEM graduates and STEM post-graduates respectively, upon which the projections are based. Table 3.3 provides a summary across all industries and services. With the main exception of medicine, the results generally suggest that the "demand" for those qualified in STEM subjects will grow faster than the average for all subject groups.

Figures 3.13 and 3.14 provide a further summary of the results showing total requirements and replacement demands. These highlight that changing structural demand patterns as set out in Figures 3.11 and 3.12 are only part of the picture. The age profile of the STEM population means that there will also be a significant need to replace those leaving the STEM workforce (as older workers reach retirement age in the coming decade). This need to refresh talent is at least as important as so called expansion demands.

The results distinguish 9 subject categories highlighting the main STEM groups. The largest category however is other subjects, which includes humanities and social sciences. In total, across all industries, people qualified at post-graduate level in STEM subjects accounted for just under 3% of total employment in 2007. Other post-graduates account for a further 4%. Those with a first degree in STEM subjects account for just over 8% of employment, and other graduates for about 18% (including those whose subject of qualification is unknown). Those qualified below degree level account for the remaining 67% of those in employment.

Medicine accounts for almost half of the STEM category at first degree level. This subject category includes those doing many nursing courses, as well as those studying to become doctors.

Generally the STEM subjects are projected to see faster rates of growth than the average for all subjects over the decade to 2017. Notable exceptions are Medicine at graduate and post-graduate levels, Physical and environmental sciences and Engineering at 1st degree level.

Figure 3.11: Trends in STEM post-graduates (shares of total employment)

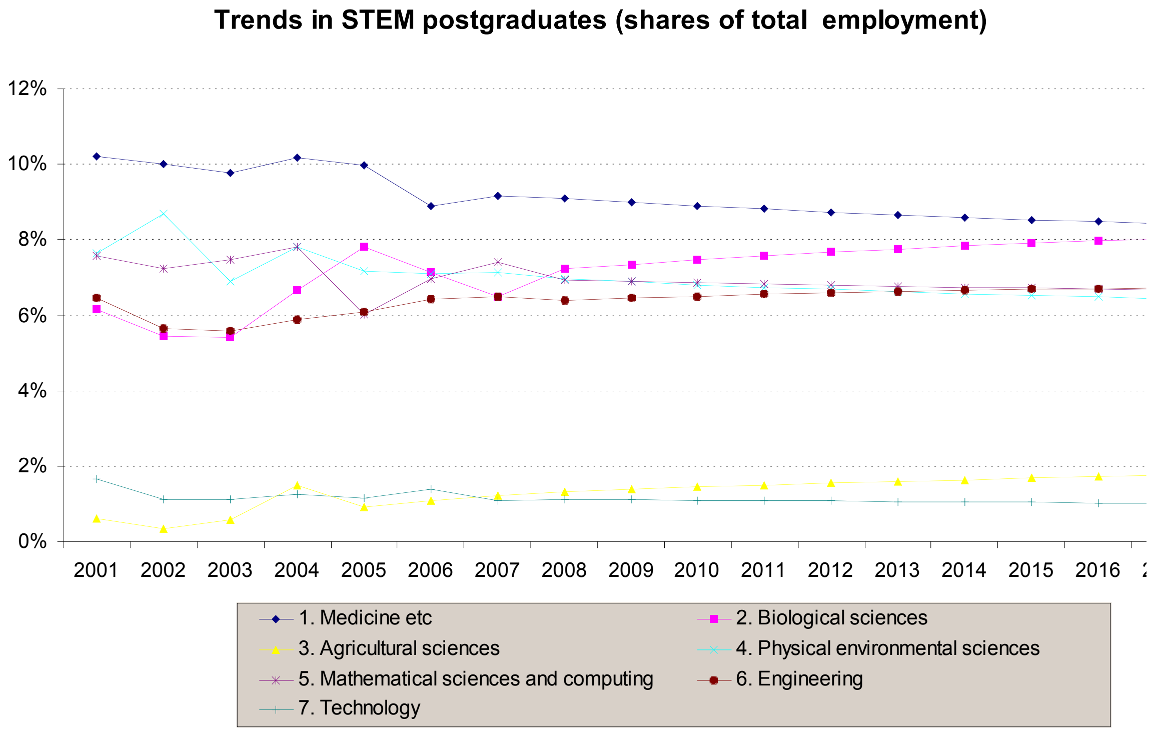


Figure 3.12: Trends in STEM First degree graduates (NQF 4), shares of total employment

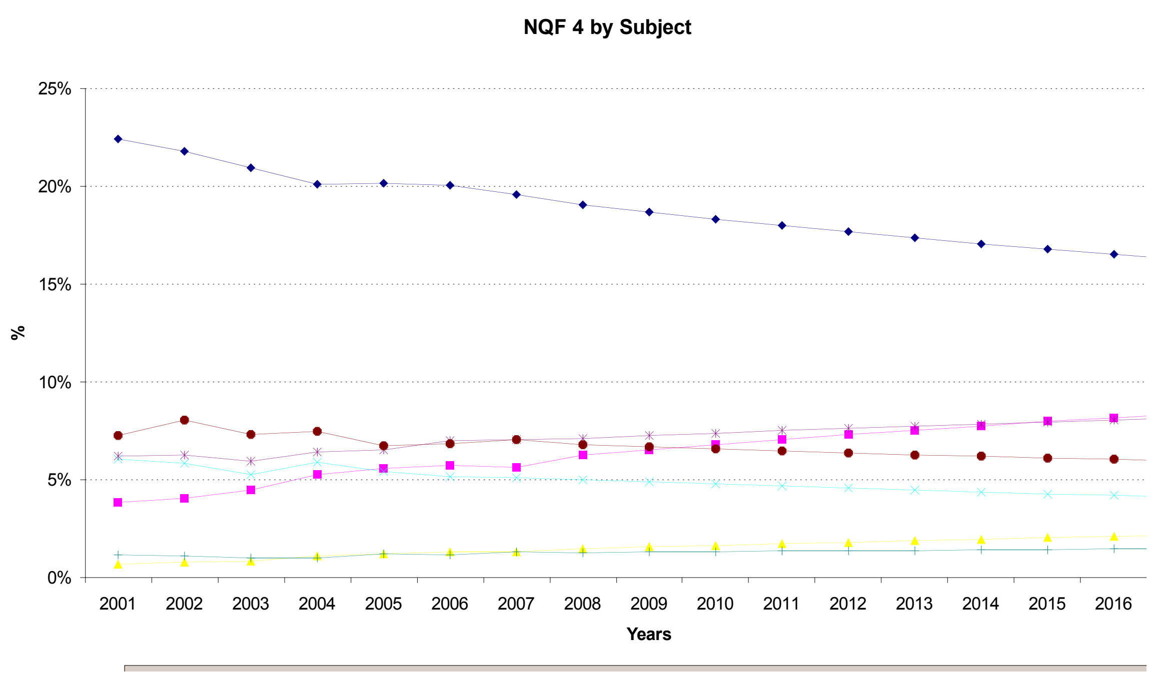


Figure 3.13: Projected changes in employment, STEM post-graduates (2007-2017) (%)

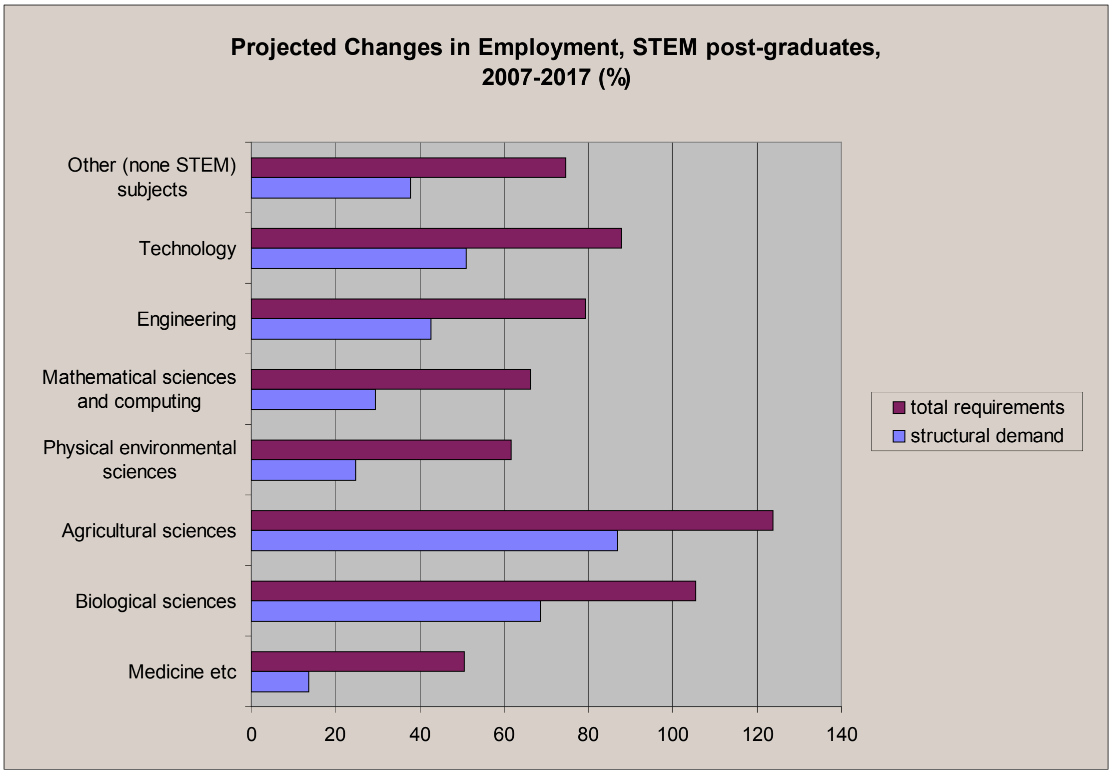
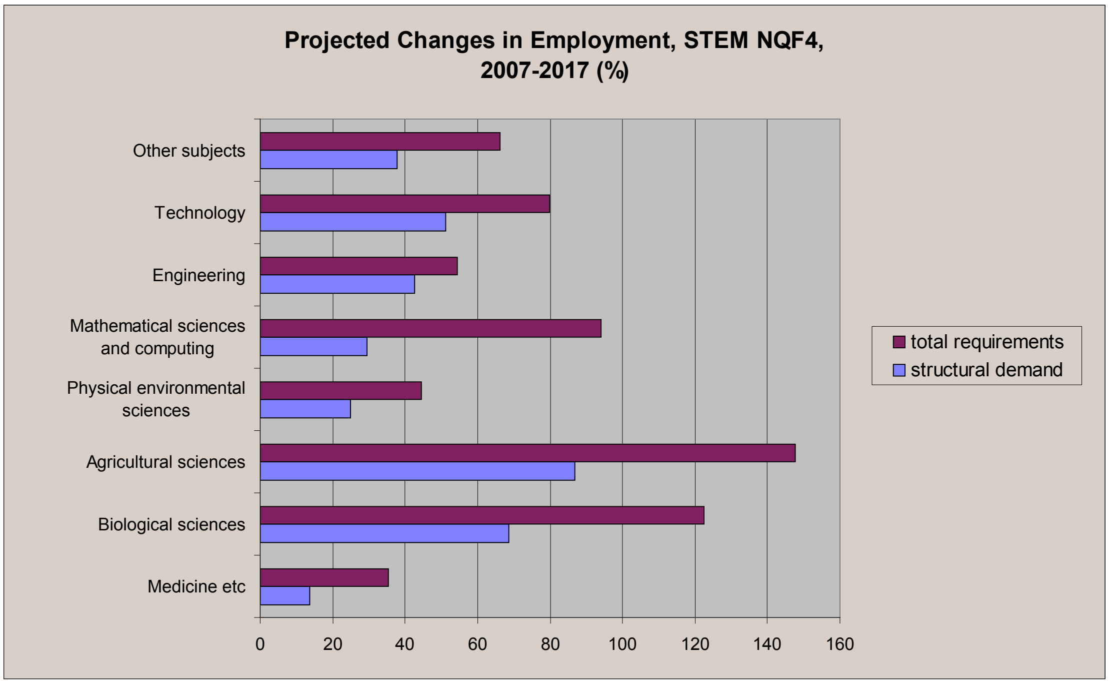


Figure 3.14: Projected changes in employment, STEM First degree graduates to (NQF 4), (2007-2017) (%)



3.6 Results for broad sectors

The results also cover each of the 6 broad sectors as defined in Annex B. The focus of discussion here is on manufacturing (Table 3.2b), although a complete set of results is presented for all 6 sectors. The focus on the manufacturing sector reflects the view that this is a key area for employment of those with STEM qualifications. As noted in Section 2 it is also possible to develop results for sub-sectors within manufacturing (although this is not attempted here, given that it is clear that the numbers involved would be relatively small). Breakdowns within some of the other broad sectors would be more robust.

It is clear that, while it may once have been the case that manufacturing was a major area of employment for STEM graduates and post-graduates, there is now a much larger number and share of such people employed in other sectors. This reflects the overall decline of the manufacturing sectors (especially in terms of employment). In part this has resulted from various activities being hived off from manufacturing and redefined as part of the service sector (such as research, design and development activities). The results show that ***manufacturing*** now employs a smaller share of highly qualified people generally, although the patterns of change over time (in terms of the broad NQF categories) are very similar to those for all industries.

The sector with the largest shares of people employed who are qualified in STEM subjects at first degree level or above is ***non-marketed services***. A large proportion of these are qualified in medicine (doctors and nurses, etc). Even if medicine is excluded from the picture, public administration and defence and education services employ large number of people qualified in other STEM subjects, and these numbers have (in most cases) been growing very rapidly in the last few years. A notable exception here is the numbers of first degree graduates qualified in engineering.

"...growing at very rapid rates, especially for those qualified in subjects such as mathematics and computing."

Ignoring those qualified in medicine, the ***business and other services*** sector accounts for even greater numbers of STEM graduates and post-graduates than the public sector. Its share has also been growing at very rapid rates, especially for those qualified in subjects such as mathematics and computing. Significant numbers are also employed in **distribution & transport** (which also includes hotels and restaurants). Indeed for all categories, except those qualified in engineering, the numbers employed in this sector are now much higher than in manufacturing.

Finally, the **primary** sector (including utilities) and construction both employ significant numbers of STEM graduates and post-graduates, but these are small compared to the other sectors. The largest groups involved in both cases are first degree graduates qualified in engineering.

Table 3.3b focuses on changing subject breakdowns within manufacturing. Tables 3.3a, and Tables 3c-f focus on the other broad sectors. Again the tables pick out 9 subject categories highlighting the main STEM groups. In all cases the largest category is other subjects, which includes humanities and social sciences. In total, people qualified at post-graduate level in STEM subjects accounted for just over 2% of total manufacturing employment in 2007. This is a smaller share of total employment than for all industries, but with a higher concentration of STEM subjects amongst the post-graduates that were employed. Similarly, those with a first degree in STEM subject account for around 6½ % of total employment but this is a larger proportion of the overall number of first degree graduates employed than is the case for all industries. Around 77% of all those employed in manufacturing are qualified below first degree level.

As for all industries, generally the STEM subjects are projected to see faster growth than average over the decade to 2017. Notable exceptions are Physical and environmental sciences. This subject category, along with a number of other STEM subjects, is "over-represented" in manufacturing (Table 3.4). This is despite the fact that this sector employs a smaller share of qualified people overall than the average for all industries and services. The rate of growth of employment for STEM graduates is faster in manufacturing despite the fact that overall employment prospects for the sector is less good than for all industries and services.

3.7 Shift-share analysis of projected changes

The projected changes can be attributed to changing patterns by sector, by occupation and by qualification. Even if the proportions of people with STEM qualifications in particular industries and occupations remained constant, structural changes within the economy, which are tending to favour certain sectors and occupations, would result in changes to the overall numbers of people with STEM qualifications employed.

Table 3.4 presents a summary, showing how the overall changes can be attributed to the following effects:

- *Scale* - changes to the overall scale of employment between 2007 and 2017
- *Industry* - changes attributable to changes in industrial structure holding all else equal
- *Occupation* - changes attributable to changes in industrial structure holding all else equal
- *Qualification* - changes attributable to changes in industrial structure holding all else equal
- *Interaction* – a residual term reflecting interactions across all three dimensions.

If employment structure remained fixed as at 2007 each qualification category would have increased at the same rate (6.2 %). This is the so called ***"scale effect"***.

"Changing industry structure is projected to favour some qualification categories."

In practice, the rates differ for each category quite significantly. In part this is due to structural effects. Changing ***industry structure*** is projected to favour some qualification categories, most notably *Mathematical sciences and computing* at both graduate and post-graduate levels. This is about half the size of the scale effect. For most other STEM categories there are very modest positive effects, however for *Engineering* at both levels the impact is projected to be slightly negative. Generally non-STEM subjects are expected to do rather better. The industry effect is projected to be negative for all qualifications below NQF4.

Changes in ***occupational structure*** are projected to have a rather larger impact. As with the industry effect this is negative for all qualification categories below NQF4, but positive for all the NQF4 and NQF5 categories. For most of the STEM categories this is of a similar order of magnitude to the scale effect, especially at post-graduate level. At first degree level (NQF4) the effects for those qualified in *Biological sciences*, *Technology* and most especially *Agricultural sciences* are more modest. *Mathematical sciences and computing* shows the fastest increase due to occupational effects (at just under 9%).

Even this is dwarfed by the ***qualification effects***. Generally speaking these are much larger in magnitude than the scale, industry and occupation effects. This suggests that the main factor driving the numbers of STEM (and other qualification categories) in employment is changing proportions qualified within particular sectors and occupations. While the scale, occupation and industry effects can be regarded as essentially demand driven, this phenomenon can be seen as the consequence of both demand and supply factors. The very rapid increase in numbers of young people staying on into higher education and acquiring degree and post-graduate qualifications has clearly played a major part in this although there is also evidence that the nature of many jobs is changing and requirements for formal qualifications are rising. Some of the most rapid increases are observed for *Biological sciences* at both graduate and post-graduate levels. However may other STEM categories also show large qualification effects. The most notable exceptions are *Medicine* and *Engineering* at first degree level, although *Physical science* is also well below average at both NQF4 and NQF5 levels. All NQF categories below NQF4 show strong negative effects. The ***interaction effects*** are by comparison relatively modest. They show few systematic patterns across STEM or other qualification categories.

In conclusion, while there is some evidence of changing industry and occupational employment structures favouring certain STEM categories, these effects are modest compared with changes in the overall scale of employment and, more especially, the qualification effects observed (which are typically an order of magnitude larger in absolute terms). While these changes may be, in part demand driven, they are also heavily influenced by increases in supply.

Table 3.1 Implications for Qualifications

All industries

NQF category	Base year level 2007	Change 2007 - 2017	Projected level 2017	Total requirement 2007 - 2017
NQF 5	2,420,669	897,709	3,318,378	1,789,070
NQF 4	7,986,647	1,968,485	9,955,133	4,909,404
NQF 3	6,125,075	179,841	6,304,917	2,435,274
NQF 2	6,805,987	-169,232	6,636,754	2,336,932
NQF 1	5,422,300	-112,897	5,309,403	1,883,753
NQF 0	2,473,769	-814,580	1,659,188	96,334
total	31,234,447	1,949,326	33,183,774	13,450,768
	% share	**% change**	**% share**	**% of base year level**
NQF 5	7.7	37.1	10.0	73.9
NQF 4	25.6	24.6	30.0	61.5
NQF 3	19.6	2.9	19.0	39.8
NQF 2	21.8	-2.5	20.0	34.3
NQF 1	17.4	-2.1	16.0	34.7
NQF 0	7.9	-32.9	5.0	3.9
total	100.0	6.2	100.0	43.1

Source: *IER estimates based on Working Futures 2007-2017.*
Notes: Total requirement includes replacement needs, including losses due to retirements.

Table 3.2a Implications for Qualifications

Primary sector & utilities

NQF category	Base year level 2007	Change 2007 - 2017	Projected level 2017	Total requirement 2007 - 2017
NQF 5	23,760	-3,108	20,652	5,535
NQF 4	116,206	-10,623	105,583	31,647
NQF 3	122,024	-30,580	91,444	13,807
NQF 2	147,513	-24,745	122,768	28,913
NQF 1	129,126	-11,852	117,274	35,118
NQF 0	94,630	-48,986	45,644	-14,564
total	633,260	-129,894	503,366	100,455
	% share	**% change**	**% share**	**% of base year level**
NQF 5	3.8	-13.1	4.1	23.3
NQF 4	18.4	-9.1	21.0	27.2
NQF 3	19.3	-25.1	18.2	11.3
NQF 2	23.3	-16.8	24.4	19.6
NQF 1	20.4	-9.2	23.3	27.2
NQF 0	14.9	-51.8	9.1	-15.4
total	100.0	-20.5	100.0	15.9

Source: *IER estimates based on Working Futures 2007-2017.*
Notes: *Total requirement includes replacement needs, including losses due to retirements.*

Table 3.2b Implications for Qualifications

Manufacturing NQF category	Base year level 2007	Change 2007 - 2017	Projected level 2017	Total requirement 2007 - 2017
NQF 5	137,645	3,412	141,057	50,673
NQF 4	639,308	48,999	688,307	268,507
NQF 3	689,501	-170,672	518,828	66,069
NQF 2	720,669	-162,593	558,076	84,850
NQF 1	643,593	-72,035	571,558	148,944
NQF 0	350,603	-78,799	271,804	41,581
total	3,181,319	-431,688	2,749,631	660,625
	% share	**% change**	**% share**	**% of base year level**
NQF 5	4.3	2.5	5.1	36.8
NQF 4	20.1	7.7	25.0	42.0
NQF 3	21.7	-24.8	18.9	9.6
NQF 2	22.7	-22.6	20.3	11.8
NQF 1	20.2	-11.2	20.8	23.1
NQF 0	11.0	-22.5	9.9	11.9
total	100.0	-13.6	100.0	20.8

Source: *IER estimates based on Working Futures 2007-2017.*
Notes: *Total requirement includes replacement needs, including losses due to retirements*

Table 3.2c Implications for Qualifications

Construction NQF category	Base year level 2002	Change 2002 - 2012	Projected level 2012	Total requirement 2002 - 2012
NQF 5	38,700	12,652	51,352	25,167
NQF 4	310,458	99,878	410,336	200,278
NQF 3	685,766	6,676	692,442	228,448
NQF 2	550,029	7,294	557,323	185,170
NQF 1	398,375	151,207	549,581	280,038
NQF 0	203,247	-103,109	100,139	-37,380
total	2,186,574	174,599	2,361,173	881,722
	% share	**% change**	**% share**	**% of base year level**
NQF 5	1.8	32.7	2.2	65.0
NQF 4	14.2	32.2	17.4	64.5
NQF 3	31.4	1.0	29.3	33.3
NQF 2	25.2	1.3	23.6	33.7
NQF 1	18.2	38.0	23.3	70.3
NQF 0	9.3	-50.7	4.2	-18.4
total	100.0	8.0	100.0	40.3

Source: *IER estimates based on Working Futures 2007-2017.*
Notes: *Total requirement includes replacement needs, including losses due to retirements*

Table 3.2d Implications for Qualifications

Distribution & transport				
NQF category	**Base year level 2007**	**Change 2007 - 2017**	**Projected level 2017**	**Total requirement 2007 - 2017**
NQF 5	243,647	69,549	313,196	158,516
NQF 4	1,428,460	541,668	1,970,127	1,063,263
NQF 3	1,966,916	175,856	2,142,772	894,066
NQF 2	2,375,305	176,416	2,551,721	1,043,747
NQF 1	1,897,774	-19,823	1,877,952	673,140
NQF 0	968,721	-406,914	561,807	-53,190
total	8,880,824	536,752	9,417,575	3,779,542
	% share	**% change**	**% share**	**% of base year level**
NQF 5	2.7	28.5	3.3	65.1
NQF 4	16.1	37.9	20.9	74.4
NQF 3	22.1	8.9	22.8	45.5
NQF 2	26.7	7.4	27.1	43.9
NQF 1	21.4	-1.0	19.9	35.5
NQF 0	10.9	-42.0	6.0	-5.5
total	100.0	6.0	100.0	42.6

Source: IER estimates based on Working Futures 2007-2017.
Notes: Total requirement includes replacement needs, including losses due to retirements

Table 3.2e Implications for Qualifications

Business & other services				
NQF category	**Base year level 2007**	**Change 2007 - 2017**	**Projected level 2017**	**Total requirement 2007 - 2017**
NQF 5	795,011	230,256	1,025,266	520,745
NQF 4	2,775,465	882,156	3,657,621	1,896,286
NQF 3	1,489,158	183,819	1,672,978	727,945
NQF 2	1,690,539	104,080	1,794,619	721,788
NQF 1	1,355,736	142,991	1,498,728	638,365
NQF 0	467,016	-237,513	229,503	-66,869
total	8,572,926	1,305,789	9,878,715	4,438,260
	% share	**% change**	**% share**	**% of base year level**
NQF 5	9.3	29.0	10.4	65.5
NQF 4	32.4	31.8	37.0	68.3
NQF 3	17.4	12.3	16.9	48.9
NQF 2	19.7	6.2	18.2	42.7
NQF 1	15.8	10.5	15.2	47.1
NQF 0	5.4	-50.9	2.3	-14.3
total	100.0	15.2	100.0	51.8

Source: IER estimates based on Working Futures 2007-2017.
Notes: Total requirement includes replacement needs, including losses due to retirements

Table 3.2f Implications for Qualifications

Non-marketed services				
NQF category	**Base year level 2007**	**Change 2007 - 2017**	**Projected level 2017**	**Total requirement 2007 - 2017**
NQF 5	1,355,910	429,101	1,785,011	968,777
NQF 4	2,951,933	228,418	3,180,352	1,403,340
NQF 3	1,108,574	186,678	1,295,252	627,910
NQF 2	1,106,092	-5,526	1,100,566	434,718
NQF 1	900,361	-218,194	682,167	140,166
NQF 0	356,674	-126,708	229,966	15,255
total	7,779,544	493,769	8,273,314	3,590,165
	% share	**% change**	**% share**	**% of base year level**
NQF 5	17.4	31.6	21.6	71.4
NQF 4	37.9	7.7	38.4	47.5
NQF 3	14.2	16.8	15.7	56.6
NQF 2	14.2	-0.5	13.3	39.3
NQF 1	11.6	-24.2	8.2	15.6
NQF 0	4.6	-35.5	2.8	4.3
total	100.0	6.3	100.0	46.1

Source: IER estimates based on Working Futures 2007-2017.
Notes: Total requirement includes replacement needs, including losses due to retirements

Table 3.2g Implications for Qualifications SOC 1.1, Corporate managers

1.1 Corporate Managers				
2007	**Base year level 2007**	**Change 2007-2017**	**Projected level**	**Total requirement 2007-2017**
NQF 5	501,437	170,583	672,020	355,227
NQF 4	1,554,536	733,338	2,287,874	1,305,764
NQF 3	712,595	132,041	844,636	394,439
NQF 2	596,419	-33,640	562,779	185,979
NQF 1	392,061	-44,936	347,125	99,433
NQF 0	123,634	-123,634	0	-78,108
Total	***3,880,681***	***833,752***	***4,714,433***	2,262,733
	% share	**% change**	**% share**	**% of base year level**
NQF 5	12.9	34.0	14.3	70.8
NQF 4	40.1	47.2	48.5	84.0
NQF 3	18.4	18.5	17.9	55.4
NQF 2	15.4	-5.6	11.9	31.2
NQF 1	10.1	-11.5	7.4	25.4
NQF 0	3.2	-100.0	0.0	-63.2
Total	***100.0***	***21.5***	***100.0***	***58.3***

Source: *IER estimates based on Working Futures 2007-2017.*
Notes: *Total requirement includes replacement needs, including losses due to retirements*
Tables analogous to 3.2g are also available for all other occupations

Table 3.3 Implications for Qualification Subjects

All industries NQF category	Base year level 2007	Change 2007 - 2017	Projected level 2017	Total requirement 2007 - 2017
NQF 5	2,420,669	897,709	3,318,378	1,789,070
Medicine etc	*221,196*	*30,426*	*251,622*	*111,877*
Biological sciences	*154,219*	*105,934*	*260,153*	*162,722*
Agricultural sciences	*29,513*	*25,658*	*55,172*	*36,526*
Physical environmental sciences	*171,169*	*42,598*	*213,767*	*105,627*
Mathematical sciences and computing	*179,114*	*52,748*	*231,862*	*118,703*
Engineering	*163,866*	*69,734*	*233,600*	*130,075*
Technology	*26,120*	*13,347*	*39,467*	*22,965*
Other subjects	*1,408,522*	*531,935*	*1,940,457*	*1,050,594*
No subject	*66,950*	*25,328*	*92,278*	*49,981*
NQF 4	7,986,647	1,968,485	9,955,133	4,909,404
Medicine etc	*1,028,827*	*-13,739*	1,015,088	*365,106*
Biological sciences	*305,383*	*261,564*	566,947	*374,015*
Agricultural sciences	*70,312*	*77,964*	148,275	*103,855*
Physical environmental sciences	*283,839*	*22,070*	305,910	*126,588*
Mathematical sciences and computing	*399,527*	*228,836*	628,362	*375,953*
Engineering	*403,940*	*71,134*	475,074	*219,877*
Technology	*74,903*	*32,290*	107,193	*59,871*
Other subjects	*2,895,859*	*846,875*	3,742,734	*1,913,215*
No subject	*2,524,058*	*441,491*	2,965,549	*1,370,924*
NQF 3	6,125,075	179,841	6,304,917	*2,435,274*
NQF 2	6,805,987	-169,232	6,636,754	*2,336,932*
NQF 1	5,422,300	-112,897	5,309,403	*1,883,753*
NQF 0	2,473,769	-814,580	1,659,188	*96,334*
total	31,234,447	1,949,326	33,183,774	13,450,768
	% share	**% change**	**% share**	**% of base year level**
NQF 5	7.7	37.1	10.0	73.9
Medicine etc	*0.71*	*13.76*	*0.76*	*50.58*
Biological sciences	*0.49*	*68.69*	*0.78*	*105.51*
Agricultural sciences	*0.09*	*86.94*	*0.17*	*123.76*
Physical environmental sciences	*0.55*	*24.89*	*0.64*	*61.71*
Mathematical sciences and computing	*0.57*	*29.45*	*0.70*	*66.27*
Engineering	*0.52*	*42.56*	*0.70*	*79.38*
Technology	*0.08*	*51.10*	*0.12*	*87.92*
Other subjects	*4.51*	*37.77*	*5.85*	*74.59*
No subject	*0.21*	*37.83*	*0.28*	*74.65*
NQF 4	25.6	24.6	30.0	61.5
Medicine etc	*3.29*	*-1.34*	*3.06*	*35.49*
Biological sciences	*0.98*	*85.65*	*1.71*	*122.47*
Agricultural sciences	*0.23*	*110.88*	*0.45*	*147.71*
Physical environmental sciences	*0.91*	*7.78*	*0.92*	*44.60*
Mathematical sciences and computing	*1.28*	*57.28*	*1.89*	*94.10*
Engineering	*1.29*	*17.61*	*1.43*	*54.43*
Technology	*0.24*	*43.11*	*0.32*	*79.93*
Other subjects	*9.27*	*29.24*	*11.28*	*66.07*
No subject	*8.08*	*17.49*	*8.94*	*54.31*
NQF 3	19.6	2.9	19.0	39.8
NQF 2	21.8	-2.5	20.0	34.3
NQF 1	17.4	-2.1	16.0	34.7
NQF 0	7.9	-32.9	5.0	3.9
total	100.0	6.2	100.0	43.1

Source: *IER estimates based on Working Futures 2007-2017.*
Notes: *Total requirement includes replacement needs, including losses d ue to retirements*

Table 3.3a Implications for Qualification Subjects

Primary sector & utilities NQF category	Base year level 2007	Change 2007 - 2017	Projected level 2017	Total requirement 2007 - 2017
NQF 5	23,760	-3,108	20,652	5,535
Medicine etc	*1,819*	*1,876*	*3,696*	*2,538*
Biological sciences	*1,951*	*-1,007*	*945*	*-297*
Agricultural sciences	*2,265*	*-747*	*1,518*	*77*
Physical environmental sciences	*3,904*	*-1,448*	*2,456*	*-28*
Mathematical sciences and computing	*1,268*	*248*	*1,516*	*710*
Engineering	*2,707*	*-1,381*	*1,326*	*-396*
Technology	*445*	*-181*	*264*	*-19*
Other subjects	*6,397*	*-165*	*6,232*	*2,162*
No subject	*3,003*	*-303*	*2,700*	*789*
NQF 4	116,206	-10,623	105,583	31,647
Medicine etc	*7,053*	*-1,437*	5,616	*1,128*
Biological sciences	*5,301*	*-1,761*	3,540	*167*
Agricultural sciences	*9,426*	*128*	9,554	*3,556*
Physical environmental sciences	*4,258*	*-1,014*	3,244	*535*
Mathematical sciences and computing	*5,686*	*-145*	5,541	*1,924*
Engineering	*12,115*	*45*	12,160	*4,452*
Technology	*2,961*	*-202*	2,758	*875*
Other subjects	*24,933*	*157*	25,090	*9,226*
No subject	*44,473*	*-6,393*	38,080	*9,784*
NQF 3	122,024	-30,580	91,444	*13,807*
NQF 2	147,513	-24,745	122,768	*28,913*
NQF 1	129,126	-11,852	117,274	*35,118*
NQF 0	94,630	-48,986	45,644	*-14,564*
total	633,260	-129,894	503,366	100,455
	% share	**% change**	**% share**	**% of base year level**
NQF 5	3.8	-13.1	4.1	23.3
Medicine etc	*0.29*	*103.12*	*0.73*	*139.49*
Biological sciences	*0.31*	*-51.59*	*0.19*	*-15.22*
Agricultural sciences	*0.36*	*-32.99*	*0.30*	*3.38*
Physical environmental sciences	*0.62*	*-37.10*	*0.49*	*-0.72*
Mathematical sciences and computing	*0.20*	*19.60*	*0.30*	*55.97*
Engineering	*0.43*	*-51.01*	*0.26*	*-14.64*
Technology	*0.07*	*-40.63*	*0.05*	*-4.26*
Other subjects	*1.01*	*-2.58*	*1.24*	*33.80*
No subject	*0.47*	*-10.10*	*0.54*	*26.27*
NQF 4	18.4	-9.1	21.0	27.2
Medicine etc	*1.11*	*-20.38*	*1.12*	*16.00*
Biological sciences	*0.84*	*-33.22*	*0.70*	*3.15*
Agricultural sciences	*1.49*	*1.35*	*1.90*	*37.73*
Physical environmental sciences	*0.67*	*-23.81*	*0.64*	*12.56*
Mathematical sciences and computing	*0.90*	*-2.54*	*1.10*	*33.83*
Engineering	*1.91*	*0.37*	*2.42*	*36.74*
Technology	*0.47*	*-6.83*	*0.55*	*29.54*
Other subjects	*3.94*	*0.63*	*4.98*	*37.00*
No subject	*7.02*	*-14.38*	*7.56*	*22.00*
NQF 3	19.3	-25.1	18.2	11.3
NQF 2	23.3	-16.8	24.4	19.6
NQF 1	20.4	-9.2	23.3	27.2
NQF 0	14.9	-51.8	9.1	-15.4
total	100.0	-20.5	100.0	15.9

Source: *IER estimates based on Working Futures 2007-2017.*
Notes: Total requirement includes replacement needs, including losses due to retirements

Table 3.3b Implications for Qualification Subjects

Manufacturing NQF category	Base year level 2007	Change 2007 - 2017	Projected level 2017	Total requirement 2007 - 2017
NQF 5	137,645	3,412	141,057	50,673
Medicine etc	*7,509*	*-1,075*	*6,434*	*1,503*
Biological sciences	*7,583*	*-3,190*	*4,393*	*-586*
Agricultural sciences	*1,938*	*538*	*2,475*	*1,203*
Physical environmental sciences	*23,375*	*-3,946*	*19,429*	*4,080*
Mathematical sciences and computing	*9,539*	*381*	*9,920*	*3,656*
Engineering	*26,927*	*4,571*	*31,497*	*13,816*
Technology	*3,490*	*641*	*4,131*	*1,839*
Other subjects	*50,118*	*7,205*	*57,323*	*24,413*
No subject	*7,166*	*-1,712*	*5,454*	*748*
NQF 4	639,308	48,999	688,307	268,507
Medicine etc	*26,171*	*9,934*	36,106	*18,920*
Biological sciences	*32,983*	*16,495*	49,478	*27,820*
Agricultural sciences	*12,039*	*96*	12,135	*4,230*
Physical environmental sciences	*33,838*	*9,560*	43,398	*21,178*
Mathematical sciences and computing	*30,440*	*23,764*	54,204	*34,216*
Engineering	*72,562*	*7,596*	80,158	*32,510*
Technology	*12,401*	*7,643*	20,044	*11,901*
Other subjects	*172,265*	*2,283*	174,548	*61,431*
No subject	*246,610*	*-28,373*	218,237	*56,301*
NQF 3	689,501	-170,672	518,828	*66,069*
NQF 2	720,669	-162,593	558,076	*84,850*
NQF 1	643,593	-72,035	571,558	*148,944*
NQF 0	350,603	-78,799	271,804	*41,581*
total	3,181,319	-431,688	2,749,631	660,625
	% share	**% change**	**% share**	**% of base year level**
NQF 5	4.3	2.5	5.1	36.8
Medicine etc	*0.24*	*-14.31*	*0.23*	*20.02*
Biological sciences	*0.24*	*-42.07*	*0.16*	*-7.73*
Agricultural sciences	*0.06*	*27.76*	*0.09*	*62.09*
Physical environmental sciences	*0.73*	*-16.88*	*0.71*	*17.45*
Mathematical sciences and computing	*0.30*	*3.99*	*0.36*	*38.33*
Engineering	*0.85*	*16.97*	*1.15*	*51.31*
Technology	*0.11*	*18.37*	*0.15*	*52.70*
Other subjects	*1.58*	*14.38*	*2.08*	*48.71*
No subject	*0.23*	*-23.90*	*0.20*	*10.44*
NQF 4	20.1	7.7	25.0	42.0
Medicine etc	*0.82*	*37.96*	*1.31*	*72.29*
Biological sciences	*1.04*	*50.01*	*1.80*	*84.35*
Agricultural sciences	*0.38*	*0.80*	*0.44*	*35.13*
Physical environmental sciences	*1.06*	*28.25*	*1.58*	*62.59*
Mathematical sciences and computing	*0.96*	*78.07*	*1.97*	*112.40*
Engineering	*2.28*	*10.47*	*2.92*	*44.80*
Technology	*0.39*	*61.64*	*0.73*	*95.97*
Other subjects	*5.41*	*1.33*	*6.35*	*35.66*
No subject	*7.75*	*-11.51*	*7.94*	*22.83*
NQF 3	21.7	-24.8	18.9	9.6
NQF 2	22.7	-22.6	20.3	11.8
NQF 1	20.2	-11.2	20.8	23.1
NQF 0	11.0	-22.5	9.9	11.9
total	100.0	-13.6	100.0	20.8

Source: *IER estimates based on Working Futures 2007-2017.*
Notes: *Total requirement includes replacement needs, including losses due to retirements*

Table 3.3c Implications for Qualification Subjects

Construction NQF category	Base year level 2007	Change 2007 - 2017	Projected level 2017	Total requirement 2007 - 2017
NQF 5	38,700	12,652	51,352	25,167
Medicine etc	*473*	*68*	*541*	*221*
Biological sciences	*1,932*	*-478*	*1,454*	*147*
Agricultural sciences	*1,382*	*256*	*1,638*	*703*
Physical environmental sciences	*4,347*	*184*	*4,531*	*1,590*
Mathematical sciences and computing	*2,705*	*362*	*3,067*	*1,236*
Engineering	*9,933*	*4,720*	*14,653*	*7,932*
Technology	*1,466*	*-310*	*1,156*	*164*
Other subjects	*11,251*	*5,991*	*17,242*	*9,630*
No subject	*5,210*	*1,859*	*7,069*	*3,544*
NQF 4	310,458	99,878	410,336	200,278
Medicine etc	*7,063*	*3,904*	10,967	*6,188*
Biological sciences	*9,796*	*4,802*	14,599	*7,971*
Agricultural sciences	*4,015*	325	4,341	*1,624*
Physical environmental sciences	*7,538*	-1,756	5,781	*681*
Mathematical sciences and computing	*13,400*	*1,464*	14,864	*5,798*
Engineering	*41,965*	*-12,426*	29,539	*1,145*
Technology	*3,320*	*-1,067*	2,253	*7*
Other subjects	*75,388*	*32,497*	107,884	*56,877*
No subject	*147,973*	*72,134*	220,107	*119,988*
NQF 3	685,766	6,676	692,442	*228,448*
NQF 2	550,029	7,294	557,323	*185,170*
NQF 1	398,375	151,207	549,581	*280,038*
NQF 0	203,247	-103,109	100,139	*-37,380*
total	2,186,574	174,599	2,361,173	881,722

	% share	% change	% share	% of base year level
NQF 5	1.8	32.7	2.2	65.0
Medicine etc	*0.02*	*14.35*	*0.02*	*46.69*
Biological sciences	*0.09*	*-24.74*	*0.06*	*7.60*
Agricultural sciences	*0.06*	*18.53*	*0.07*	*50.87*
Physical environmental sciences	*0.20*	*4.24*	*0.19*	*36.58*
Mathematical sciences and computing	*0.12*	*13.37*	*0.13*	*45.71*
Engineering	*0.45*	*47.52*	*0.62*	*79.85*
Technology	*0.07*	*-21.14*	*0.05*	*11.20*
Other subjects	*0.51*	*53.25*	*0.73*	*85.59*
No subject	*0.24*	*35.69*	*0.30*	*68.03*
NQF 4	14.2	32.2	17.4	64.5
Medicine etc	*0.32*	*55.28*	*0.46*	*87.62*
Biological sciences	*0.45*	*49.02*	*0.62*	*81.36*
Agricultural sciences	*0.18*	*8.10*	*0.18*	*40.44*
Physical environmental sciences	*0.34*	*-23.30*	*0.24*	*9.04*
Mathematical sciences and computing	*0.61*	*10.93*	*0.63*	*43.27*
Engineering	*1.92*	*-29.61*	*1.25*	*2.73*
Technology	*0.15*	*-32.14*	*0.10*	*0.20*
Other subjects	*3.45*	*43.11*	*4.57*	*75.45*
No subject	*6.77*	*48.75*	*9.32*	*81.09*
NQF 3	31.4	1.0	29.3	33.3
NQF 2	25.2	1.3	23.6	33.7
NQF 1	18.2	38.0	23.3	70.3
NQF 0	9.3	-50.7	4.2	-18.4
total	100.0	8.0	100.0	40.3

Source: *IER estimates based on Working Futures 2007-2017.*
Notes: *Total requirement includes replacement needs, including losses due to retirements*

Table 3.3d Implications for Qualification Subjects

Distribution & transport NQF category	Base year level 2007	Change 2007 - 2017	Projected level 2017	Total requirement 2007 - 2017
NQF 5	243,647	69,549	313,196	158,516
Medicine etc	*15,132*	*-3,319*	*11,812*	*2,206*
Biological sciences	*13,354*	*6,558*	*19,912*	*11,434*
Agricultural sciences	*6,999*	*-427*	*6,572*	*2,129*
Physical environmental sciences	*18,987*	*-8,254*	*10,732*	*-1,322*
Mathematical sciences and computing	*16,810*	*3,994*	*20,804*	*10,132*
Engineering	*22,275*	*6,259*	*28,534*	*14,393*
Technology	*4,839*	*-1,488*	*3,351*	*279*
Other subjects	*124,460*	*54,732*	*179,192*	*100,178*
No subject	*20,793*	*11,494*	*32,287*	*19,086*
NQF 4	1,428,460	541,668	1,970,127	1,063,263
Medicine etc	*84,488*	*1,790*	86,278	*32,640*
Biological sciences	*60,810*	*50,397*	111,207	*72,601*
Agricultural sciences	*28,123*	*18,637*	46,760	*28,906*
Physical environmental sciences	*53,164*	*-4,388*	48,776	*15,024*
Mathematical sciences and computing	*79,612*	*39,035*	118,647	*68,105*
Engineering	*70,874*	*5,590*	76,464	*31,470*
Technology	*23,878*	*26,985*	50,862	*35,704*
Other subjects	*485,524*	*226,662*	712,186	*403,949*
No subject	*541,986*	*176,960*	718,946	*374,864*
NQF 3	1,966,916	175,856	2,142,772	*894,066*
NQF 2	2,375,305	176,416	2,551,721	*1,043,747*
NQF 1	1,897,774	-19,823	1,877,952	*673,140*
NQF 0	968,721	-406,914	561,807	*-53,190*
total	8,880,824	536,752	9,417,575	3,779,542

	% share	% change	% share	% of base year level
NQF 5	2.7	28.5	3.3	65.1
Medicine etc	*0.17*	*-21.94*	*0.13*	*14.58*
Biological sciences	*0.15*	*49.11*	*0.21*	*85.62*
Agricultural sciences	*0.08*	*-6.10*	*0.07*	*30.42*
Physical environmental sciences	*0.21*	*-43.47*	*0.11*	*-6.96*
Mathematical sciences and computing	*0.19*	*23.76*	*0.22*	*60.28*
Engineering	*0.25*	*28.10*	*0.30*	*64.61*
Technology	*0.05*	*-30.74*	*0.04*	*5.77*
Other subjects	*1.40*	*43.98*	*1.90*	*80.49*
No subject	*0.23*	*55.28*	*0.34*	*91.79*
NQF 4	16.1	37.9	20.9	74.4
Medicine etc	*0.95*	*2.12*	*0.92*	*38.63*
Biological sciences	*0.68*	*82.88*	*1.18*	*119.39*
Agricultural sciences	*0.32*	*66.27*	*0.50*	*102.78*
Physical environmental sciences	*0.60*	*-8.25*	*0.52*	*28.26*
Mathematical sciences and computing	*0.90*	*49.03*	*1.26*	*85.55*
Engineering	*0.80*	*7.89*	*0.81*	*44.40*
Technology	*0.27*	*113.01*	*0.54*	*149.53*
Other subjects	*5.47*	*46.68*	*7.56*	*83.20*
No subject	*6.10*	*32.65*	*7.63*	*69.16*
NQF 3	22.1	8.9	22.8	45.5
NQF 2	26.7	7.4	27.1	43.9
NQF 1	21.4	-1.0	19.9	35.5
NQF 0	10.9	-42.0	6.0	-5.5
total	100.0	6.0	100.0	42.6

Source: *IER estimates based on Working Futures 2007-2017.*
Notes: Total requirement includes replacement needs, including losses due to retirements

Table 3.3e Implications for Qualification Subjects

Business & other services NQF category	Base year level 2007	Change 2007 - 2017	Projected level 2017	Total requirement 2007 - 2017
NQF 5	795,011	230,256	1,025,266	520,745
Medicine etc	*44,098*	*8,910*	*53,007*	*25,022*
Biological sciences	*40,839*	*26,414*	*67,253*	*41,336*
Agricultural sciences	*11,947*	*3,965*	*15,912*	*8,331*
Physical environmental sciences	*66,561*	*2,603*	*69,164*	*26,924*
Mathematical sciences and computing	*113,271*	*28,072*	*141,343*	*69,460*
Engineering	*58,521*	*20,720*	*79,242*	*42,104*
Technology	*16,467*	*96*	*16,563*	*6,113*
Other subjects	*420,184*	*136,639*	*556,823*	*290,171*
No subject	*23,122*	*2,836*	*25,958*	*11,285*
NQF 4	2,775,465	882,156	3,657,621	1,896,286
Medicine etc	*125,335*	*21,963*	147,298	*67,760*
Biological sciences	*119,951*	*101,879*	221,830	*145,708*
Agricultural sciences	*33,138*	*10,024*	43,162	*22,132*
Physical environmental sciences	*124,260*	*42,521*	166,781	*87,924*
Mathematical sciences and computing	*248,939*	*179,111*	428,050	*270,071*
Engineering	*160,032*	*8,467*	168,500	*66,942*
Technology	*40,598*	*32,886*	73,485	*47,721*
Other subjects	*1,215,237*	*352,807*	1,568,044	*796,844*
No subject	*707,975*	*132,497*	840,472	*391,185*
NQF 3	1,489,158	183,819	1,672,978	*727,945*
NQF 2	1,690,539	104,080	1,794,619	*721,788*
NQF 1	1,355,736	142,991	1,498,728	*638,365*
NQF 0	467,016	-237,513	229,503	*-66,869*
total	8,572,926	1,305,789	9,878,715	4,438,260
	% share	**% change**	**% share**	**% of base year level**
NQF 5	9.3	29.0	10.4	65.5
Medicine etc	*0.51*	*20.20*	*0.54*	*56.74*
Biological sciences	*0.48*	*64.68*	*0.68*	*101.22*
Agricultural sciences	*0.14*	*33.19*	*0.16*	*69.73*
Physical environmental sciences	*0.78*	*3.91*	*0.70*	*40.45*
Mathematical sciences and computing	*1.32*	*24.78*	*1.43*	*61.32*
Engineering	*0.68*	*35.41*	*0.80*	*71.95*
Technology	*0.19*	*0.58*	*0.17*	*37.12*
Other subjects	*4.90*	*32.52*	*5.64*	*69.06*
No subject	*0.27*	*12.27*	*0.26*	*48.81*
NQF 4	32.4	31.8	37.0	68.3
Medicine etc	*1.46*	*17.52*	*1.49*	*54.06*
Biological sciences	*1.40*	*84.93*	*2.25*	*121.47*
Agricultural sciences	*0.39*	*30.25*	*0.44*	*66.79*
Physical environmental sciences	*1.45*	*34.22*	*1.69*	*70.76*
Mathematical sciences and computing	*2.90*	*71.95*	*4.33*	*108.49*
Engineering	*1.87*	*5.29*	*1.71*	*41.83*
Technology	*0.47*	*81.00*	*0.74*	*117.54*
Other subjects	*14.18*	*29.03*	*15.87*	*65.57*
No subject	*8.26*	*18.71*	*8.51*	*55.25*
NQF 3	17.4	12.3	16.9	48.9
NQF 2	19.7	6.2	18.2	42.7
NQF 1	15.8	10.5	15.2	47.1
NQF 0	5.4	-50.9	2.3	-14.3
total	100.0	15.2	100.0	51.8

Source: *IER estimates based on Working Futures 2007-2017.*
Notes: Total requirement includes replacement needs, including losses due to retirements

Table 3.3f Implications for Qualification Subjects

Non-marketed services NQF category	Base year level 2007	Change 2007 - 2017	Projected level 2017	Total requirement 2007 - 2017
NQF 5	1,355,910	429,101	1,785,011	968,777
Medicine etc	*171,903*	*12,591*	*184,494*	*81,012*
Biological sciences	*107,793*	*66,957*	*174,751*	*109,861*
Agricultural sciences	*15,742*	*11,482*	*27,224*	*17,748*
Physical environmental sciences	*77,682*	*21,735*	*99,417*	*52,654*
Mathematical sciences and computing	*71,830*	*10,388*	*82,219*	*38,978*
Engineering	*34,865*	*11,999*	*46,864*	*25,876*
Technology	*13,227*	*6,176*	*19,403*	*11,440*
Other subjects	*834,160*	*270,505*	*1,104,665*	*602,516*
No subject	*28,708*	*17,267*	*45,975*	*28,693*
NQF 4	2,951,933	228,418	3,180,352	1,403,340
Medicine etc	*813,820*	*-31,805*	782,015	*292,110*
Biological sciences	*121,805*	*84,450*	206,254	*132,930*
Agricultural sciences	*24,601*	*22,437*	47,037	*32,228*
Physical environmental sciences	*81,889*	*-1,670*	80,219	*30,923*
Mathematical sciences and computing	*85,427*	*20,465*	105,892	*54,466*
Engineering	*49,976*	*-10,847*	39,129	*9,044*
Technology	*26,058*	*4,823*	30,881	*15,194*
Other subjects	*970,100*	*185,824*	1,155,924	*571,941*
No subject	*778,258*	*-45,258*	733,001	*264,503*
NQF 3	1,108,574	186,678	1,295,252	*627,910*
NQF 2	1,106,092	-5,526	1,100,566	*434,718*
NQF 1	900,361	-218,194	682,167	*140,166*
NQF 0	356,674	-126,708	229,966	*15,255*
total	7,779,544	493,769	8,273,314	3,590,165
	% share	**% change**	**% share**	**% of base year level**
NQF 5	17.4	31.6	21.6	71.4
Medicine etc	*2.21*	*7.32*	*2.23*	*47.13*
Biological sciences	*1.39*	*62.12*	*2.11*	*101.92*
Agricultural sciences	*0.20*	*72.94*	*0.33*	*112.74*
Physical environmental sciences	*1.00*	*27.98*	*1.20*	*67.78*
Mathematical sciences and computing	*0.92*	*14.46*	*0.99*	*54.26*
Engineering	*0.45*	*34.42*	*0.57*	*74.22*
Technology	*0.17*	*46.69*	*0.23*	*86.49*
Other subjects	*10.72*	*32.43*	*13.35*	*72.23*
No subject	*0.37*	*60.15*	*0.56*	*99.95*
NQF 4	37.9	7.7	38.4	47.5
Medicine etc	*10.46*	*-3.91*	*9.45*	*35.89*
Biological sciences	*1.57*	*69.33*	*2.49*	*109.13*
Agricultural sciences	*0.32*	*91.21*	*0.57*	*131.01*
Physical environmental sciences	*1.05*	*-2.04*	*0.97*	*37.76*
Mathematical sciences and computing	*1.10*	*23.96*	*1.28*	*63.76*
Engineering	*0.64*	*-21.70*	*0.47*	*18.10*
Technology	*0.33*	*18.51*	*0.37*	*58.31*
Other subjects	*12.47*	*19.16*	*13.97*	*58.96*
No subject	*10.00*	*-5.82*	*8.86*	*33.99*
NQF 3	14.2	16.8	15.7	56.6
NQF 2	14.2	-0.5	13.3	39.3
NQF 1	11.6	-24.2	8.2	15.6
NQF 0	4.6	-35.5	2.8	4.3
total	100.0	6.3	100.0	46.1

Source: *IER estimates based on Working Futures 2007-2017.*
Notes: *Total requirement includes replacement needs, including losses due to retirements*

Table 3.3g Implications for Qualification Subjects, SOC 1.1, Corporate managers

11 Corporate Managers 2007	Base year level 2007	Change 2007-2017	Projected level 2017	Total requirement 2007-2017
NQF 5	501,437	170,583	672,020	355,227
Medicine etc	23,703	-1,430	22,272	7,298
Biological sciences	20,707	11,400	32,107	19,025
Agricultural sciences	8,340	6,335	14,675	9,406
Physical environmental sciences	40,542	4,988	45,530	19,916
Mathematical sciences and computing	46,896	-434	46,462	16,835
Engineering	26,015	14,901	40,916	24,480
Technology	3,624	-599	3,025	735
Other subjects	308,630	122,433	431,064	236,080
No subject	22,978	12,991	35,968	21,452
NQF 4	1,554,536	701,888	2,256,424	1,274,314
Medicine etc	87,584	25,099	112,683	57,350
Biological sciences	54,338	59,476	113,814	79,485
Agricultural sciences	13,292	8,065	21,357	12,959
Physical environmental sciences	66,240	3,219	69,459	27,611
Mathematical sciences and computing	91,808	66,612	158,419	100,418
Engineering	110,560	1,537	112,096	42,248
Technology	11,817	13,415	25,232	17,766
Other subjects	649,025	392,605	1,041,629	631,595
No subject	469,873	131,861	601,735	304,883
NQF 3	712,595	132,041	844,636	394,439
NQF 2	596,419	-33,640	562,779	185,979
NQF 1	392,061	-44,936	347,125	99,433
NQF 0	123,634	-123,634	0	-78,108
Total	*3,880,681*	*802,302*	*4,682,983*	*2,231,283*

	% share	% change	% share	% of base year level
NQF 5	12.9	34.0	14.4	70.8
Medicine etc	0.6	-6.0	0.5	30.8
Biological sciences	0.5	55.1	0.7	91.9
Agricultural sciences	0.2	76.0	0.3	112.8
Physical environmental sciences	1.0	12.3	1.0	49.1
Mathematical sciences and computing	1.2	-0.9	1.0	35.9
Engineering	0.7	57.3	0.9	94.1
Technology	0.1	-16.5	0.1	20.3
Other subjects	8.0	39.7	9.2	76.5
No subject	0.6	56.5	0.8	93.4
NQF 4	40.1	45.2	48.2	82.0
Medicine etc	2.3	28.7	2.4	65.5
Biological sciences	1.4	109.5	2.4	146.3
Agricultural sciences	0.3	60.7	0.5	97.5
Physical environmental sciences	1.7	4.9	1.5	41.7
Mathematical sciences and computing	2.4	72.6	3.4	109.4
Engineering	2.8	1.4	2.4	38.2
Technology	0.3	113.5	0.5	150.3
Other subjects	16.7	60.5	22.2	97.3
No subject	12.1	28.1	12.8	64.9
NQF 3	18.4	18.5	18.0	55.4
NQF 2	15.4	-5.6	12.0	31.2
NQF 1	10.1	-11.5	7.4	25.4
NQF 0	3.2	-100.0	0.0	-63.2
Total	*100.0*	*20.7*	*100.0*	*57.5*

Source: *IER estimates based on Working Futures 2007-2017.*
Notes: Total requirement includes replacement needs, including losses due to retirements
Tables analogous to 3.3g are also available for all other occupations.

Table 3.4: Shift-share analysis of projected change

						000s
Summary	net effects		(summed over all occupations and industries)			
2007-2017						mutiple
	net	scale	industry	occupation	qualification	interaction
NQF5, Medicine etc	55	13	2	11	34	-5
NQF5, Biological sciences	119	9	1	11	90	7
NQF5, Agricultural sciences	21	2	0	2	16	1
NQF5, Physical environmental sciences	39	10	0	12	24	-8
NQF5, Mathematical sciences and computing	74	12	6	16	52	-12
NQF5, Engineering	70	8	0	10	51	2
NQF5, Technology	11	2	1	2	7	-1
NQF5, Other subjects	675	78	21	105	492	-21
NQF5, No subject	45	5	0	2	33	5
NQF4, Medicine etc	34	65	5	57	-25	-67
NQF4, Biological sciences	261	22	3	15	197	24
NQF4, Agricultural sciences	53	7	-2	0	38	9
NQF4, Physical environmental sciences	45	19	3	16	22	-15
NQF4, Mathematical sciences and computing	263	29	14	30	193	-3
NQF4, Engineering	3	25	-2	27	-18	-29
NQF4, Technology	71	7	0	4	53	7
NQF4, Other subjects	813	183	66	187	519	-142
NQF4, No subject	350	151	6	76	164	-47
NQF3, all subjects	-157	410	-25	-105	-467	30
NQF2, all subjects	2	417	-20	-156	-342	103
NQF1, all subjects	143	322	-32	-192	-147	192
NQF0 (no qualifications)	-1,040	155	-49	-130	-985	-31
QualtotOcc	1,949	1,949	0	0	0	0

						% of base year
						mutiple
	net	scale	industry	occupation	qualification	interaction
NQF5, Medicine etc	26.6	6.2	0.8	5.3	16.7	-2.5
NQF5, Biological sciences	78.9	6.2	1.0	7.3	59.9	4.6
NQF5, Agricultural sciences	63.1	6.2	0.2	6.3	46.8	3.5
NQF5, Physical environmental sciences	23.7	6.2	0.3	7.5	14.3	-4.7
NQF5, Mathematical sciences and computing	40.2	6.2	3.5	8.7	28.0	-6.3
NQF5, Engineering	53.6	6.2	-0.3	7.5	39.0	1.2
NQF5, Technology	30.6	6.2	1.7	6.4	20.0	-3.8
NQF5, Other subjects	54.1	6.2	1.7	8.4	39.4	-1.7
NQF5, No subject	59.4	6.2	-0.1	3.2	43.8	6.2
NQF4, Medicine etc	3.3	6.2	0.4	5.5	-2.4	-6.5
NQF4, Biological sciences	75.4	6.2	0.8	4.4	57.0	6.9
NQF4, Agricultural sciences	47.8	6.2	-1.5	0.2	34.2	8.6
NQF4, Physical environmental sciences	14.9	6.2	1.1	5.3	7.1	-4.9
NQF4, Mathematical sciences and computing	56.8	6.2	3.1	6.4	41.7	-0.6
NQF4, Engineering	0.8	6.2	-0.5	6.8	-4.5	-7.2
NQF4, Technology	65.7	6.2	0.4	3.5	48.9	6.6
NQF4, Other subjects	27.7	6.2	2.3	6.4	17.7	-4.8
NQF4, No subject	14.5	6.2	0.2	3.2	6.8	-1.9
NQF3, all subjects	-2.4	6.2	-0.4	-1.6	-7.1	0.5
NQF2, all subjects	0.0	6.2	-0.3	-2.3	-5.1	1.5
NQF1, all subjects	2.8	6.2	-0.6	-3.7	-2.9	3.7
NQF0 (no qualifications)	-42.0	6.2	-2.0	-5.3	-39.7	-1.3
QualtotOcc	6.2	6.2	0.0	0.0	0.0	0.0

4. Overview and Implications

4.1 Taking stock

This project has demonstrated the potential value of the LFS for measuring historical changes and developing projections of possible future changes in employment structure by discipline. The analysis based on LFS data focuses primarily on stocks of people holding different types of qualifications.

It has also highlighted a number of problems related to data and interpretation. Despite these problems, these results have been tailored to provide some input into a chapter of the latest ETB annual 'flagship' publication *Engineering UK 2008*. This will aim to contribute to a better understanding of the overall demand/supply relationship for STEM personnel. Although it is not able to address directly questions such as "how many engineers/technicians are we short of in the UK". It does focus attention on where such personnel are currently employed and the likely prospects employment in these areas over the next 10 years or so.

"...contribute to a better understanding of the overall demand/supply relationship for STEM personnel."

It is possible to address in a more qualitative fashion how these projected trends compare with what is happening on the supply side, including concerns about the numbers of young people following STEM educational routes through FE and HE and on into science, engineering and technology occupations and careers. This has been the subject of various official reports in recent years, as summarised below.

Measuring the imbalance between supply and demand for particular occupations or qualifications in more quantitative terms is much easier said than done. This has been extensively researched by the Migration Advisory Committee (MAC), and results for 3 digit occupational categories have been published (MAC, 2008).[14] This includes analysis of changing patterns of pay and other indicators such a skill shortage vacancies and unemployment rates from the LFS, as well as from other data sources.[15] The results presented by the MAC for STEM occupations suggest that demand and supply are currently broadly in balance, although there are a few occupations that are highlighted in the MAC's "shortage occupation list" and a number of other occupations that are "under review".[16]

4.2 Review of other recent research

The Roberts Report (Roberts, 2002)) highlighted the importance of those qualified in STEM subjects to the UK economy as a key element in the R&D, innovation, education triangle. It argued that while the UK has a relatively large number of students studying STEM subjects, this is due to increases in those studying IT and biological sciences rather than mathematics, engineering, and the physical sciences, and that this is a source of concern. It identified a number of issues in schools, further and higher education which need to be addressed if an adequate supply of scientists and engineers is to be maintained (both in terms of quality and quantity).

A number of other reports published within the last few years have reached a generally similar conclusion. In *A Higher Degree of Concern* and the earlier *A Degree of Concern* reports the Royal Society (2006 and 2008) provide a statistical review of trends in this general area. They argue that, in the context of an increasingly competitive and inter-connected global economy, the Higher Education system underpins the UK's economic performance. HE needs to equip students with the knowledge, skills and aptitudes to compete with the best in the world, while at the same time underpinning much of the nation's R&D activity.

While they recognise that in many respects the UK is performing quite well in this regard, they identify a number of weaknesses, especially in the area of STEM subjects, with more needing to be done to encourage more (and more able) students to chose core STEM subjects, and to raise the status of higher degree courses in this area. The Royal Society reports also recognise that demand for and supply of STEM graduates are both intimately linked and that there is a need to encourage virtuous circles, where supply encourages demand and demand stimulates supply.

14 MAC (2008) "Skilled Shortage Sensible: The recommended shortage occupation lists for the UK and Scotland." : http://www.ukba.homeoffice.gov.uk/aboutus/workingwithus/indbodies/mac/macfirstshortagelist/

15 For example the Annual Survey of Hours and Earnings (ASHE) and the National Employer Skills Survey (NESS).

16 Op. cit.

Links between industry and universities are also a key area where more emphasis is needed to strengthen collaboration and ties.

"...measures are needed to enhance the teaching and learning of STEM subjects."

In the Ten-year Science and Innovation Investment Framework Annual Report 2005 (a joint Treasury, DTI, DfES publication) it is argued that, in an increasingly knowledge-driven global economy, science and innovation are a crucial element in ensuring the UK's long-term competitiveness. Across the world, economic activity is shifting towards innovation and knowledge intensive industries. Many emerging economies, such as India and China are moving their production activities up the value chain and competing directly with economies like the UK in many areas of economic activity. Investment in STEM personnel is seen as a key element in any strategy to meet these competitive pressures. The UK has a good record in this area with the UK maintaining its position as second only to the US in global research excellence (as measured by citations), and with a science base amongst the most productive among G8 nations. However, the report identifies a number of areas of concern relating to the supply of, and demand for, STEM graduates. It argues that a range of measures are needed to enhance the teaching and learning of STEM subjects and to boost the recruitment and retention of science teachers and researchers, in order to encourage more students to follow such course of study, and to thereby underpin the future needs of the science base and the economy for people qualified in these areas.

The subsequent reports published in 2006 and 2007 by the Treasury reinforce those messages. In the 2006 report it is argued that government policies are beginning to have a positive impact on the quality and quantity of STEM learning at all levels of the education system. In particular, the supply of school teachers in relevant areas has improved. The package of further measures (mainly in the area of schools policy) announced in Science and Innovation Investment Framework 2004-2014: Next Steps are expected to reinforce this. The 2007 report emphasises that these signs of progress are continuing.

Similarly, DfES (2006) concludes that the UK's stock of science and engineering graduates compares well internationally, and that the quality of STEM graduates as measured by prior qualifications of entrants is rising. Quoting the OECD it argues that the international comparative picture has shown some signs of improvement in terms of the stock of STEM skills. Based on an analysis linked to Working Futures 2004-2014, demand for such skills is expected to rise.

The DfES (2006) report also highlights that for many STEM graduates there is evidence of significant financial returns to investment in such qualifications. This draws upon an earlier study by PricewaterhouseCoopers (2005), carried out on behalf of the RSC and IoP. This study carried out a detailed analysis for many STEM subjects. Its main findings were that over a working life, the average graduate will earn around 23% more than someone holding two or more 'A' levels. However, engineering, chemistry and physics graduates (as well as those studying medicine) will earn on average over 30% more.

In 2008 DIUS presented a consultation document on the use of higher education at work, which focuses on STEM graduates. The document involved consulting with employers, learners and higher education providers on what is needed to equip the workforce with the skills required for an innovative and competitive economy. More than 200 written responses were obtained from a wide range of stakeholders including employers, providers and other representative bodies such as Sector Skills Councils and Professional Bodies. Smith (2008) also focuses on the role of STEM graduates in the supply chain.

The recent report by Lord Sainsbury (2007) argues that the UK is now quite well placed to take advantage of the new markets being opened up by globalisation. The UK's record of scientific innovation, the rapid growth of high-technology manufacturing and knowledge-intensive sectors present a generally positive picture. Knowledge transfer from universities to industry and commerce has increased significantly and this is resulting in high-technology clusters around many world-class research universities. However sustaining this will require a major campaign to improve the quality and quantity of science teaching in schools and universities, and thereby continue to raise the number of young people studying STEM subjects. Sainsbury also calls for improvements to careers advice, and a range of other initiatives to inspire more young people to take up careers in science and engineering.

Halkett (2007) emphasises that scientific research often lays the groundwork for innovations and significant new products and processes. UK science policy is focused on:

- increasing R&D spending;
- driving up the number STEM graduates; and
- translating the knowledge generated into commercial value.

But this may not be enough. Greater priority needs to be attached to innovation policy which focuses on not only the ability to generate new knowledge, but also to identify, adapt and use that knowledge (and knowledge generated elsewhere) for commercial gain. There are also concerns about the mix of STEM graduates being produced, with insufficient emphasis on core science and engineering subjects. The linear model (of universities doing research and industry applying the results) needs to be replaced by a model which recognises the need for much closer collaboration with flows of people and ideas moving in both directions.

In a general review of science, engineering and technology skills in the UK, The DTI (2006) reinforces the view that if the Government's ambitions for UK plc are to be realised, then there will be a need for a strong supply of individuals with qualifications in science, engineering and technology. All parts of the education system have a role to play in this from the Key Stages of compulsory education, through to post-16, further education and higher education.

"There are also concerns about the mix of STEM graduates being produced..."

The DTI report highlights the rapid growth in supply numbers, which it notes have increased at a rate slightly higher than the average for all subjects but that recent increases have been concentrated in computer sciences, and subjects allied to medicine and biological science rather than in engineering and technology, physical sciences and architecture.

The DTI report also explores the demand for higher level STEM skills focusing upon the growth in certain occupational groups in the *Working Futures 2004-2014* projections. It argues that these groups are expected to grow faster between 2004 and 2014 than the growth rate across all occupations. As a consequence there will be considerable requirements for graduates in STEM subjects if current patterns of employment within occupations continue (not only to fill the predicted expansion in employment, but also to replace existing workers, so called replacement demand).

4.3 Potential for developing stock flow models

There is also a huge amount of other information available which focuses upon flows of people acquiring such qualifications. In principle, this opens up the possibility of developing a much more sophisticated, more detailed, and in-depth analysis, including building a fully fledged stock-flow model of STEM personnel. In practice, there are a number of problems in obtaining consistent and comprehensive data, and what follows is more of a rough sketch than a complete picture.

For example, at the broadest level, there is some evidence that the rapid increase in the supply of people moving into higher education observed in recent years may be slowing. The latest DIUS/ONS press release on participation rates in higher education (DIUS, 2008), suggests that the Higher Education Initial Participation Rate (HEIRP) fell to 40% in 2008 compared with 42% the previous year. The HEIPR measures the participation of those aged 17-30. Unfortunately this is not available for particular subject categories, although in principle such measures could be calculated.

There is a considerable amount of other relevant data on flows, including the publications produced by UCAS, HESA and, HEFCE, as well as summary information assembled in many of the publications already cited (including the ETB's own Research Reports (ETB, 2006)). However this information is often not in a very useable format for developing sophisticated stock flow models, with problems of limited length of times series, lack of compatibility with other data sources, as well as lack of continuity over time.

The DTI (2006) developed a stock flow model to project the supply side. This involved projecting the number of STEM graduates for each subject grouping using Labour Force Survey data, focusing on individual year "cohorts". The population in each year was then estimated at each age by taking the population one year earlier who were 1 year younger and adjusting it by a factor to account for immigration and mortality rates. Trends in the flows of new graduates was estimated by extrapolating linear trends from HESA graduation data 1994/95 to 2001/02), and these new graduates were assigned to each year cohort in accordance with the average age distribution of graduates observed in the LFS for the previous four years. Adjustments were then made to account for the proportion who will be economically active. This method is similar to the procedure developed by Wilson and Bosworth (2006) to produce projections for all subject categories in *Working Futures 2004-2014*.

Using this approach the DTI (2006) concluded that if current trends continue the supply of STEM graduates will be sufficient to meet demand. However, they suggest that the ambition to raise R&D expenditure in the UK could generate an even larger requirement for such graduates.

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Annex A: LFS subject classifications

There are number of variables in the LFS that distinguish subject of qualification.
There is also a variable, HIGHO, which gives the level of a higher degree.

Single subject (SNGDEG) has about 900 subjects distinguished.
Combined subject (CMBDEG) has 18 subject categories for each of the (up to) 12 subjects studied.

There may be some ambiguity regarding subject in the case of the Single subject variable (SNGDEG), if the person has a higher degree. Generally this will relate to the highest qualification held.

The details of the precise subjects covered are given in the LFS documentation classifications.pdf (page 112). The subject breakdown is extremely detailed and enables precise identification of STEM categories.

The variable SNGDEG is documented in the LFS documentation variabledetails2007.pdf (page 277).

SNGDEG - Subject of single subject degree
(1 to 19.9.9) Code for title of degree
FREQUENCY: Each quarter from Summer 97
COVERAGE: Applies to all respondents who have a degree qualification or a nursing/medical qualification (Summer 97 to Winter 03: DEGREE = 1, 2 or 3 OR QUALS = 8; From Spring 04: DEGREE4
= RESPONSE OR QUALS4 = 8).
NOTES: SNGDEG was introduced from Summer 97 which allows analysis of degree subject at far greater detail than SUBJCT1. In Spring 04 the coding frame was up-dated to reflect changes in subjects. LFS User Guide Volume 5 (LFS Classifications) gives a complete breakdown of codes.

CMBDEG(01-12) - Subject areas of combined subject degree
(1) Medicine
(2) Medical related subjects
(3) Biological sciences
(4) Agricultural sciences
(5) Physical/environmental sciences
(6) Mathematical sciences and computing
(7) Engineering
(8) Technology
(9) Architecture and related subjects
(10) Social sciences
(11) Business and financial studies
(12) Librarianship and information studies
(13) Linguistics, English, Celtic, ancient
(14) European languages
(15) Other languages
(16) Humanities
(17) Arts
(18) Education
FREQUENCY: Each quarter from Summer 97
COVERAGE: Applies to all respondents who have a degree in a combined subject (SINCOM ≠ 1).
NOTES: From Summer 97 to Autumn 98 this variable was called CMBDEG (01-18) and respondents could give up to 18 subject areas in a combined degree. From Winter 98 onwards the LFS records up to 12 subject areas in a combined degree. In SuperCROSS an additional variable called CMBDEGM is available. See note on page 2 of the LFS documentation for more information on SuperCROSS variables.

CMBMAIN - Main subject area studied in qualification

(1) Medicine
(2) Medical related subjects
(3) Biological sciences
(4) Agricultural sciences
(5) Physical/environmental sciences
(6) Mathematical sciences and computing
(7) Engineering
(8) Technology
(9) Architecture and related subjects
(10) Social sciences
(11) Business and financial studies
(12) Librarianship and information studies
(13) Linguistics, English, Celtic, ancient
(14) European languages
(15) Other languages
(16) Humanities
(17) Arts
(18) Education
FREQUENCY: Each quarter from Spring 03
COVERAGE: Applies to all respondents whose degree or nursing/medical qualification is in a combined subject in more than one subject area (SINCOM=3).
NOTES: Eurostat now requires that a main subject area be recorded for most qualifications, including combined degrees. Currently the LFS records up to 12 subject areas in a combined degree at question CMBDEG.

CMBMAIN records the main subject of a combined degree.

The individual subject areas are grouped within the report in the following ways:

- **Medicine** (1) Medicine and (2) Medical related subjects.
- **All other STEM** – (3) Biological sciences, (4) Agricultural sciences, (5)Physical/Environmental sciences, (6) Mathematical sciences and computing, (7) Engineering, and (8) Technology.
- **Other subjects** – All other subjects, LFS categories (9) - (18).

For this report **STEM** is defined as *Medicine plus All other STEM*.

Annex B: Sectoral definitions

The present paper focuses on the 6 broad sectors defined in Table B.1. This table also illustrates some other commonly used groupings

The *Working Futures* results use up to 67 industry categories. The analysis of the LFS data has been conducted initially at that level. These categories can be aggregated up in various ways. Table B.2 illustrate how these are defined in terms of the 2003 SIC.

Table B.1: Broad Sectors, Sector Matrix, Industries and RMDM Industries

Broad Sector Industries	25 / 27 industries[a]	R M D M
1. Primary sector and utilities	1. Agriculture, etc	1
	2. Mining & quarrying	2-4
	Electricity, gas & water[a]	22-24
2. Manufacturing	3. Food, drink and tobacco	5
	4. Textiles and clothing	6
	5. Wood, pulp & paper	7
	Printing & publishing[a]	8
	6. Chemicals, non-metallic min. prods.	9-12
	7. Metals and metal goods	13-15
	8. Machinery, electrical & optical eq.	16-18
	9. Transport Equipment	19-20
	10. Other manufacturing & recycling	21
3. Construction	11. Construction	25
4. Distribution, transport etc.	12. Sale & maintenance of motors	26 (part)
	13. Wholesale distribution	26 (part)
	14. Retailing	27
	15. Hotels & restaurants	28
	16. Transport	29-31
	17. Communications	32
5. Business and other services	18. Financial services	33,34
	19. Professional services	36 (part)
	20. Computing services	35
	21. Other business services	37 (+part of 36)
	25. Other services	41
6. Non-marketed services	22. Public administration & defence	38
	23. Education services	39
	24. Health & social work	40

Note: (a) Most of these sectors are identical to the 27 categories in Table A.3. The exceptions are industries 2 and 5, which are aggregates of 2 such categories.

Table B.2: Detailed Industries (Ind67)[17]

Ind67	Ind67 name	SIC2003	SAM41 (MDM)	25 industries
1	Agriculture	01	1	1
2	Forestry	02	1	1
3	Fishing	05	1	1
4	Coal mining	10	2	2
5	Oil and gas	11	3	2
6	Uranium mining	12	3	2
7	Metal ores	13	4	2
8	Other mining	14	4	2
9	Food	15.1-15.8	5	3
10	Drink	15.9	5	3
11	Tobacco	16	5	3
12	Textiles	17	6	4
13	Clothing	18	6	4
14	Leather	19	6	4
15	Wood and wood products	20	7	5
16	Paper and paper products	21	7	5
17	Publishing and printing	22	8	5
18	Manufactured fuels	23	9	6
19	Pharmaceuticals	24.4	10	6
20	Chemicals nes	24 (ex 24.4)	11	6
21	Rubber and plastics	25	12	6
22	Non-metallic mineral products	26	13	6
23	Basic metals	27	14	7
24	Metal goods	28	15	7
25	Mechanical engineering	29	16	8
26	Computers and office machinery	30	17	8
27	Electrical engineering	31	18	8
28	TV and radio	32	17	8
29	Instruments	33	18	8
30	Motor vehicles	34	19	9
31	Aerospace	35.3	20	9
32	Other transport equipment	35 (ex 35.3)	20	9
33	Manufacturing nes	36	21	10
34	Recycling	37	21	10
35	Electricity	40.1	22	2
36	Gas supply	40.2, 40.3	23	2
37	Water supply	41	24	2
38	Construction	45	25	11
39	Sale and maintenance of motor vehicles	50	26	12
40	Distribution nes	51	26	12
41	Retailing nes	52	27	14
42	Hotels and catering	55	28	15
43	Rail transport	60.1	29	15
44	Other land transport	60.2, 60.3	29	15
45	Water transport	61	30	15
46	Air transport	62	31	15
47	Other transport services	63	29	15
48	Post and courier services	64.1	32	16
49	Telecommunications	64.2	32	16
50	Banking and finance	65	33	18
51	Insurance	66	34	18
52	Financial support services	67	33	18
53	Real estate	70	36	19
54	Renting of goods	71	36	19
55	Computing services	72	35	20
56	Research and development	73	36	19
57	Professional services nes	74.1-74.4	36	21
58	Other business services	74.5-74.8	37	21
59	Public administration and defence	75	38	22
60	Education	80	39	23
61	Health and social work	85	40	24
62	Waste disposal	90	41	25
63	Membership organisations	91	41	25
64	Culture and sport	92	41	25
65	Other services	93	41	25
66	Private household	95	41	25
67	Extra-territorial organisations	99	41	25

17 They are abbreviated from the full names used by ONS.

Annex C: Qualifications data from the LFS

C.1 General issues in measuring qualifications

Estimating the proportion of the population qualified at different levels using LFS data is not as straightforward a task as it might at first appear. Results can differ depending on a number of factors, including:

1. The vintage of the data set (ONS release different versions, incorporating corrections and adjustments based on other data to benchmark the numbers more robustly);
2. There are also different versions of the LFS available at the same time which can contain different information. (Government Departments get uncensored access to the data while public versions of the data set have various information suppressed because of concerns about confidentiality and data protection issues);
3. The coverage over time (The LFS is conducted quarterly, using an overlapping sample. There are some differences in the information collected in each quarter. Quarters can be combined together to create an annual average but this requires careful treatment to avoid double counting of some individuals due to the same individual being questioned in subsequent quarters);
4. There are a number of slightly different questions relating to qualifications (resulting in a choice of possible variables in the final survey results);
5. The allocation of individual qualifications to NQF levels is not straightforward. The mapping is complicated by the need to recognise that in some cases only a proportion of individuals have achieved the threshold levels to move them up from one NQF level to the next (depending on grades achieved, etc). This information is not available in the LFS and an apportionment based on other information is needed. This requires a procedure to randomly select and allocate individual cases which can lead to sampling variation of estimates taken from the LFS, separate from the normal statistical variation. This approach is necessary in a number of situations, as described in more detail in the following section.
6. The LFS is a complex survey and routing through the questionnaire can affect the number of missing cases. The proportions with different qualifications can be affected by this. Unless this routing is dealt with in precisely the same way when interrogating the survey slightly different results can be obtained.
7. However the issue of routing is dealt with there are always a significant number of cases missing. In addition, in a significant number of cases the individual responds that they "Don't know" the qualifications they hold. These types of problems can be dealt with in various different ways. One possibility is to assume that such cases all have the same probabilities of holding qualifications as the population as a whole. Another is to assume that those who don't know have no qualifications. A third possibility is to allocate them all to a residual category. This can lead to quite different outcomes.
8. Variations can also arise because of the use of a different population (for example excluding all above the official retirement age).
9. Differences can also arise because of the focus sometimes on the highest qualification held as opposed to all qualifications held.

Unless all of these factors are common then two independent interrogations of the LFS can lead to very different outcomes. Without very detailed documentation on how data were extracted and estimates made it is often not possible to exactly replicate results produced previously.

C.2 Specific procedures, assumptions and choices adopted for the analysis

(Numbering corresponds to the previous section)

1. The LFS data used for *Working Futures 2004-2014* were re-weighted in April/May 2004. A new rebasing has taken place subsequently.

3. IER generally use quarters 1 and 5 combined. This ensures that there is no overlap within a year but it does mean a 50% overlap with the prior and following year. Estimates for successive years will therefore include some element of overlap.

From 2006 estimates have been for the calendar year. Earlier years are based on seasonal quarters (where the "last" (so called winter) quarter related to December, January & February, etc). This introduces a slight discontinuity with earlier years.

5. Allocation to NQF level. There are four qualifications where the allocation to NQF level depends on the number of qualifications held by the individual (LFS variable name given in parenthesis) :

- A-Level (LFS variable numal) – available1993 to date
- SCE higher or equivalent (numsce) – 1997 to 2005
- A/S level or equivalent (numas) - 1995 to date
- GCSE grade A-C or equivalent (numol, numol4, numol5) - 1994 to date

Where this information is not available an apportionment is done (see below).

Many people when surveyed report that they do not know how precisely many qualifications they hold. These cases are split in the same proportion as those who do know. This can produce different results depending on which other variables are included in the process.

There are three cases where the allocation to NQF splits a qualification category. These are allocated by a fixed proportion (based on information supplied by DfES):

- Scottish CSYS: 2/3 NQF3 1/3 NQF2
- Trade apprenticeship: 1/2 NQF3 1/2 NQF2
- Other qualifications & Don't know: 0.1 NQF3 0.35 NQF2 0.45 NQF1

In addition the qualifications such as A-level above are split in fixed proportions in the years where information on the number of qualifications held is not available.

7. "Don't know" is treated as "Other qualifications".

8. There is no qualification information (i.e. it is missing) for anyone over retirement age (59/64) unless they are in employment.

If other variables are used this can also complicate things. For example the 'where resident one year ago' variable (gorone) is available for the 1st quarter only.

9. IER normally use the 'Highest qualification' held variable. SCOTVEC modules are less than 'NQF1' and are included in 'NQF1 or less'. In some cases these may be treated as no qualifications.

C.3 Definitions of NQF levels

Qualifications are defined by reference to the National Qualifications Framework. This is the framework into which all QCA-accredited qualifications fit. The framework has six levels and three categories for types of qualification. The three categories of qualifications are general, vocationally-related and occupational. The different levels are:

- NFQ 0 (Entry and none)
- NFQ 1 (Foundation)
- NFQ 2 (Intermediate)
- NFQ 3 (Advanced)
- NFQ 4 (Degree level or equivalent)
- NFQ 5 (Postgraduate level)

Levels 4 and 5 relate to higher level qualifications (e.g. degrees and other higher level awards at Levels 4 and 5). Entry Level is defined as being pre-Level 1 and is aimed at those learners who are not yet able to attain a Level 1 qualification. These include academic as well as vocational qualifications. For brevity the five levels are referred to as NQF 1-5. In addition a 6th category for those with no formal qualifications is defined, NQF 0. For most purposes, the focus is upon the highest qualification held. Further details of the qualifications included within each NQF category are given in the *Working Futures Qualifications Technical Report,* (Wilson and Bosworth, 2006).

For further details see the separate technical document Wilson (2008).

Annex D: Developing the projections of changes in qualification patterns by discipline

Summary

The purpose of this annex is to outline the procedures developed to project future patterns of STEM (Science, Technology, Engineering and Mathematics) and others subjects, broken down by discipline.

In the course of the project a series of Excel Workbooks have been developed which contain the basic data and develop the projections. These contain much more detailed information and allow many more different analyses than it is possible to present in this report. They include:

- **etbdataPT NEW.xls** - basic LFS data in the form of a large pivot table allowing analyses over multiple dimensions;
- **6UKSTEM.xls** - Working Futures based projections;
- **shiftshare RAW.xls** - shift-share analysis of projections;
- **6 Sectors Implications for Qualification.xls** - main tables and charts as used in the report.

Note that some of the files (especially the pivot tables) are very large (c. 50 megabytes).

Process

The starting point is an Excel pivot table 'ETBData.xls', containing data covering the following dimensions:

- **Years** - historical data for 2001 to 2007;
- **Industries** – data for the 67 sectors used in *Working Futures*
- **Occupations** – data for 25 occupational groups and at the 3-digit level;
- **Qualification level** – aggregated to the 6 levels of the National Qualification Framework (NQF) – no qualifications and NQF1-6;
- **Discipline** (*NB* - NQF 4 & 5 only) – for 7 STEM qualifications and Other Subjects;
- **Other dimensions** – for example, economic activity (employed, unemployed, etc.), gender and age.

These data form the basis for the projections of shares by discipline within each NQF category (4 & 5 only). The analysis has been conducted at various different levels of sectoral aggregation and also distinguishes the 25 SOC sub-major groups.

Each projection is based on a number of steps. Each step in the process is carried out in a separate sheet within Excel, allowing easy viewing and more straightforward troubleshooting should an error occur. The processing steps are as follows:

1. **Table** – The initial table is copied using data from the ETBData.xls excel file into this sheet.
2. **Interpolation** – The data is placed into another sheet, where certain missing data is interpolated using a macro (see 'Macros' below).
3. **Extrapolating** – Further missing cells are filled in this process using the 'FORECAST' function (if necessary).
4. **Forecast Function** – using historical data worked on in previous sheets, projections can be made for 2008-2017 using linear forecasting.
5. **Non-Negative** – When projections show negative output it is necessary to force a constraint to make these numbers non-negative. This worksheet, therefore, uses an excel 'IF' statement to substitute any negative numbers from the projections.
6. **Sum to total** – It is necessary for each breakdown to sum up to its total in the process of calculating the shares. If for any reason there is missing data and values don't meet the overall total, then it's essential to obligate the numbers to tally up to each total.
7. **Proportions** – Shares are worked out and forecasts, as proportions, are shown in their simplest form against historical or other projected values.
8. The projected shares are then linked into the *Working Futures* workbooks, to produce numbers by qualification and discipline.

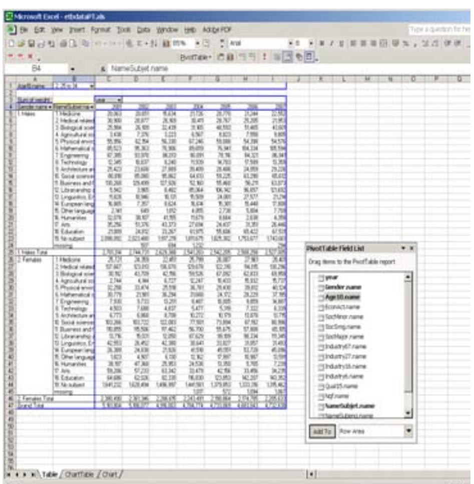
Files

All files are saved within 'N:\Projects\Working Futures\STEM\'

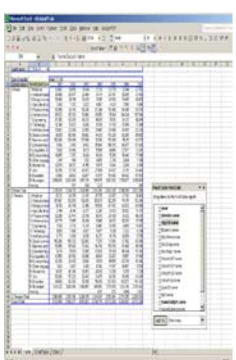
- **Occs, Sector, subj NQF5.xls -** Occupation and subject qualification, broken down by sector (NQF 4 – Employed/Self Employed)
- **Occs, Sector, subj NQF5.xls -** Occupation and subject qualification, broken down by sector (NQF 5 – Employed/Self Employed)
- **Sector NQF4 and 5.xls -** Occupation and subject qualification, all sectors (NQF 4 – Employed/ Self Employed and NQF 5 - Employed/Self Employed)

Pivot Tables

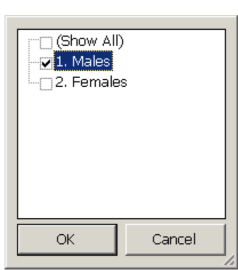
The pivot table (as used within ETBData.xls), creates an interactive summary from the thousands of records within the data set. Pivot tables can be manipulated to quickly rearrange the information to suit specific requirements. When the pivot table area is selected/active, the user is able to double click or drag a field from the 'field list' onto the pivot table area (see examples below), the pivot table will update accordingly. Pivot tables have a variety of different functions, including (among others) the ability to automatically sort, count, and total data stored in one table or spreadsheet, they are also very useful for the creation of cross tabs.



Pivot Table – Area into which fields can be dragged onto. Specific fields can also be selected, (for example, the age range can be set to certain age groups).



Pivot Table Field List – fields can be selected (double clicked) or dragged onto the active pivot table area. The main fields include: Industry (4 separate aggregations – Industry 67, 27, 16 and 6), Occupations (SocMajor, SocSmg), Qualifications (Qual15), Qualification Subject (SubQual), Qual15 (detailed NQF qualification breakdown).



Single clicking on the field button (within the active pivot table area) enables the user to select more specific data ranges.

For further details see the separate technical document Wilson (2008)

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