SECTORS MATTER:
An International Study of Sector Skills and Productivity

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Foreword

In October 2002 the Department for Education and Skills formally launched Skills for Business (SfB), a new UK-wide network of employer-led Sector Skills Councils (SSCs), supported and directed by the Sector Skills Development Agency (SSDA). The purpose of SfB is to bring employers more centre stage in articulating their skill needs and delivering skills-based productivity improvements that can enhance UK competitiveness and the effectiveness of public services. The remit of the SSDA includes establishing and progressing the network of SSCs, supporting the SSCs in the development of their own capacity and providing a range of core services. Additionally the SSDA has responsibility for representing sectors not covered by an SSC and co-ordinating action on generic issues.

Research, and developing a sound evidence base, are central to the SSDA and to Skills for Business as a whole. It is crucial in: analysing productivity and skill needs; identifying priorities for action; and improving the evolving policy and skills agenda. It is vital that the SSDA research team works closely with partners already involved in skills and related research to generally drive up the quality of sectoral labour market analysis in the UK and to develop a more shared understanding of UK-wide sector priorities.

The SSDA is undertaking a variety of activities to develop the analytical capacity of the Network and enhance its evidence base. This involves: developing a substantial programme of new research and evaluation, including international research; synthesizing existing research; developing a common skills and labour market intelligence framework; taking part in partnership research projects across the UK; and setting up an expert panel drawing on the knowledge of leading academics, consultants and researchers in the field of labour market studies. Members of this panel will feed into specific research projects and peer review the outputs; be invited to participate in seminars and consultation events on specific research and policy issues; and will be asked to contribute to an annual research conference.

The SSDA takes the dissemination of research findings seriously. As such it has developed this dedicated research series to publish all research sponsored by the SSDA and results are being made available in both hard copy and electronically on the SSDA website.

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Executive Summary

Background

This report details the results of a project undertaken jointly by the Institute for Employment Studies (IES) and the Science Policy Research Unit (SPRU) for the Sector Skills Development Agency (SSDA). The project developed a range of skills indicators and calculated Total Factor Productivity (TFP) growth, which is a productivity measure that takes account of hours worked and capital input. This data was obtained for 23 sectors (plus the whole economy) across 16 Organisation of Economic Co-operation and Development (OECD) countries. By removing the country specific effects the impact of the skills indicators on TFP levels and growth at the sectoral level was examined.

Objectives

The project had four main objectives, these were:

- to undertake international productivity and skills analyses at a level of disaggregation as close to that of the SSDA's Sector Matrix as possible
- to provide and analyse internationally comparable productivity and skills profile data at the detailed sectoral level
- to examine the inter-relationships between skills and productivity at the detailed sectoral level
- to provide inputs to the sector level skills planning process led by the Sector Skills Councils.

Sectoral total factor productivity

The project used sectoral Total Factor Productivity (TFP) which is considered to be a more representative measure of underlying productivity than value added or labour productivity. This measure removes the distorting effects of hours worked and capital inputs and as such more accurately reflects the skills of those employed in the sector and how those skills are mobilised. TFP is often used in the same breath as innovation, as both cover technical, organisational, management and other changes that lead to productivity growth.

Why sectors matter

It is generally realised that different sectors have different skills demands, even if the exact nature of these differences are still poorly understood. This recognition underlies the rationale for the Sector Skills Councils and the development of sector skills strategies. The findings of this study reinforce the position that there is no single strategy that can be applied to all sectors, and that strategies *specific* to each sector are required.

The difficulties of sectoral analysis

Despite the recognition that there are wide differences between sectors, especially between manufacturing and service sectors, there is little empirical work that covers all the sectors in the economy. This is primarily due to data difficulties that include:

- changes in sectoral classifications
- a lack of international comparability, and
- a general problem with missing or incomplete data.

These problems mean that most of the standard econometric analytical approaches are problematic.

The approach used in this study necessarily therefore is an attempt to get round some of these problems. This means that when we examine the relationship between the sector and the human capital variables we are looking at the sector across all the countries, not simply for the UK or any other individual country. Despite these efforts there remain some limitations which need to be taken into account when interpreting the results. These largely relate to the quality and coverage of the underlying data which mean that panel data analysis techniques were not used.

International data sources

The study uses a range of international data sources. The OECD's STAN database and the Groningen 60 Industries database from the Groningen Growth and Development Centre are used for the economic data. The skills indicators data comes from the European Union's Labour Force Survey (LFS) and the US Current Population Survey (CPS). These databases were used to generate consistent sectoral level economic and skills data for the EU 15[1]

[1] The EU 15 are the 15 European Union members that predate the accession of countries in May 2004. As such, they are Belgium,

and the US covering ten years. Importantly, the sectoral information was the most detailed available.

Obtaining the sectoral impact

Only ten years of skills data were available from the Community Labour Force Survey and the US Current Population Survey. This especially, with some missing data is generally insufficient for the sort of analyses we needed to undertake. Therefore, we used a used a series of country and year dummies to take account of the variation due to these variables. This then meant that we were able to use the sectoral data from all the countries to look specifically at the sectoral effects. This effectively gave us up to 160 observations for each skill indicator, which allows robust analysis.

Main results

The exercise generated a large number of results, especially sector specific results, which are detailed in Chapters 3 and 6 of this report. However, there are a number of striking results which deserve to be brought to the fore.

Large differences between sectors

Perhaps most importantly, there are large and significant differences between the sectors. Essentially, this means that there are no simple one-size-fits-all solutions to sectoral skills issues. Although each sector is not necessarily unique, the differences in skill demand and utilisation are complex.

The UK has world beating sectors

In terms of Total Factor Productivity levels, the UK has some world beating sectors:

- Agriculture, hunting, forestry and fishing — second only to Japan.
- Manufacture of food, drink and tobacco — second only to Canada.
- Manufacture of furniture, jewellery, musical instruments, toys and miscellaneous products and recycling —first amongst the international competitors.
- Transport — second only to the United States.

Denmark, Germany, Greece, Spain, France, Ireland, Italy, Luxembourg, the Netherlands, Austria, Portugal, Finland, Sweden, and the UK.

Despite some relatively poor overall productivity comparisons it needs to be realised that some of the sectors in the UK economy are performing as well as or better than our competitors.

The UK has world lagging sectors

At the same time the UK has some sectors which have low levels of Total Factor Productivity which pull down the overall competitiveness of the country. These are:

- Wholesale, retail and car repairs — 14th out of 14 competitors.
- Financial services — 14th out of 15 competitors.
- Energy and chemicals —11th out of 16 competitors.
- Manufacture of transport equipment — 11th out of 16 competitors.

Importantly, it is possible for sectors, such as these, to be profitable and to even generate high levels of value added, but still be relatively unproductive in TFP terms. These sectors are simply not producing as much value added as their capital and labour inputs would suggest.

UK productivity a sectoral not a national problem

The UK comparative rankings in terms of both TFP levels and TFP growth range from the best of the comparative nations to the worst. This in turn means that most of the overall UK productivity position can be explained by the size of the high productivity and low productivity sectors. This suggests that the UK's productivity problem is not especially a national problem, but more a problem with a series of sectors.

Interaction between the skills indicators

There are high levels of overlap between many of the skills indicators that were used. Some of these were expected as a result of how the indicators were constructed. Others, such as the correlation between high-level education and training, although observed before were less expected. The extent of interactions between the indicators limited the number and nature of the variables included in the analysis. This in turn explains the absence of some variables that might be expected.

The importance of high-level education

High-level education is generally important for sustaining existing TFP levels. Interestingly, high-level education is important for high technology manufacturing and some, but not all, of the service sectors.

The importance of intermediate-level education

Intermediate-level education is more important to many sectors than high-level education. These intermediate-level skills were particularly important in lower technology manufacturing and service sectors involving personal service. This complex pattern with different outcomes for the differing levels of education may help explain some of the paradoxical results found for human capital in other econometric studies and case studies.

The role of training

Training generally has a large, significant and positive impact on TFP growth. However, there were some sectors where there was a small, but significant, negative association with TFP levels. Sectors where training is important also tend to be those where intermediate-level skills are important.

The role of managers

The role of managers appears to be very complex. For some sectors the proportion of the workforce who are managers is positively linked to TFP levels. However, for other sectors the relationship is negative. This suggests that the importance of managers is critically dependent on sector specific factors. This appears to include the skill mix of the workforce, as mangers were often important in sectors where intermediate-level skills were also important. The findings also lend support to the idea that managers have a greater role where strategy changes have to be made rapidly in response to changing demand.

The role of professionals

The role of professionals is less ambiguous than that of managers, generally professionals have a positive impact on TFP. However, there still remain some sectors where professionals appear to have an unclear impact on TFP.

The importance of ICT occupations

Information and Communication Technology (ICT) occupations have an impact beyond those sectors usually associated with ICT, such as the financial services. The impact was greatest in the services, but other sectors including some manufacturing sectors showed a large impact for ICT occupations.

1. Introduction

This report is based on research undertaken jointly by the Institute for Employment Studies (IES) and the Science Policy Research Unit (SPRU) for the Sector Skills Development Agency (SSDA). The objectives were to develop a wider range of sectoral level skills indicators as well as sectoral level productivity measures for a period of up to ten years covering the 15 EU countries and the USA. Given the limitations of internationally comparable data the aim was to use as similar as possible sectors as those used in the SSDA matrix. The data were to then be examined both descriptively and econometrically to determine the relative impact of each of the skills indicators. The report therefore covers both the descriptive and then the econometric analysis. This report also details the data collected, the sources and definitions used, and the outcomes of the econometric analysis.

1.1 Why sectors and skills indicators?

1.1.1 The importance of sectoral differences

It is widely recognised that different sectors have different skills requirements, not just in terms of sector specific skills but also in terms of the mix of skills levels and occupations. Indeed, it is these acknowledged differences that underlie the rationale for the SSDA and the Sector Skills Councils (Campbell and Garrett, 2004). However, much of the economic analysis that looks at the linkage between skills and productivity or economic growth tends to be economy wide or limited to the manufacturing sectors. The analyses that have been undertaken nevertheless do emphasise the wide disparities between the relative performance of UK sectors (Griffith *et al.*, 2003).

Similarly, the measures used for international comparisons of skills tend to be relatively broad brush in approach, which limits the scope for deriving policy messages. This project aimed to address these limitations by using a wide range of skills indicators and a more detailed and wider sectoral coverage than earlier studies, as well as a wider range of countries than often used. This approach revealed the large differences between the detailed sectors in terms of both productivity and skills profiles that are lost in aggregate studies.

1.1.2 The importance of innovation

Innovation and the associated Total Factor Productivity increases are critical for the UK's future economic growth and general well-being (HM Treasury, 2004). The term 'innovation' is used to describe a variety of linked concepts. At one end of the spectrum it is simply a synonym for Research and Development (R&D). It is also used to describe all the activities that enterprises can undertake to improve their productivity, so it can include R&D, purchasing of new technology, managerial or operational changes, advertising and other measures. Innovation has also been used to describe everything else that explains increases in output, apart from capital or labour inputs, in other words Total Factor Productivity (TFP). This means that the concept of 'innovation' includes increasing, or decreasing, human resource or skills inputs.

1.1.3 Total factor productivity

The concept of Total Factor Productivity can be traced back to Solow (1956). The idea developed out of the realisation that output depended upon other inputs apart from simply capital and labour. This can be expressed algebraically as:

$$\triangle Y = A(\triangle K, \triangle L, \text{residual})$$

Where $\triangle Y$ is change in real output (or growth), $\triangle K$ is change in physical capital, $\triangle L$ is change in labour input and A is a constant. The residual or the part of the growth in output that is not simply explained by change in capital and labour inputs is the Total Factor Productivity, and it is often referred to as technical change or innovation. Many variants of the equation have been used, with a wide range of factors introduced into the equations, in an attempt to explain the residuals (Hulten, 2000).

It is increasingly accepted that Total Factor Productivity is a preferred productivity measure to labour productivity as it opens up issues that are more closely aligned to policy issues (HM Treasury, 2004).

1.2 The project objectives

This study represents a detailed examination of Total Factor Productivity (TFP) at the sectoral level and its skills indicators determinates. More specifically the objectives were:

- to undertake international productivity and skills analyses at a level of disaggregation as close to that of the SSDA's Sector Matrix as possible

- to provide and analyse internationally comparable productivity and skills profile data at the detailed sectoral level
- to examine the inter-relationships between skills and productivity at the detailed sectoral level
- to provide inputs to the sector level skills planning process led by the Sector Skills Councils.

1.3 The economic and innovation indicators data

The economic data covering the European Union and the United States have been derived from international sources in order to minimise any potential problems of comparability. The main sources used were the OECD STAN database (OECD, 2002b) and the Groningen 60 industries database (Groningen Growth and Development Centre, 60-Industry Database http://www.ggdc.net). These were used to derive the following sectoral level economic data:

- outputs
- capital inflows
- number of employees
- hours worked.

These, along with a series of other assumptions (detailed in the Technical Annex), were used to calculate sectoral TFP for each of the 19 countries[1] covered for the years 1992 to 2000. This represents the longest available economic data time series for which the skills indicators were also available.

Other international sources, mainly the European Labour Force Survey, were used to develop the range of skills indicators. Due to the sources used this exercise only covered 16 countries, the EU 15 plus the USA. A number of potential indicators were examined and the following were found to generate robust enough indicators at the sectoral level for use. They were:

- R&D investments as a proportion of turnover
- people with high-level education as a proportion of employment
- people with intermediate-level education as a proportion of employment
- people receiving education or training in the last four weeks as a proportion of employment
- managers as a proportion of employment

[1] Data from Canada, Switzerland and Japan were added to the core of the EU15 and USA for the TFP Levels analysis.

- professionals as a proportion of employment
- technicians as a proportion of employment
- core HRSTC as a proportion of employment
- high qualified managers as a proportion of employment
- high qualified professionals as a proportion of employment
- those in SET occupations as a proportion of employment, and
- those in ICT occupations as a proportion of employment.

R&D investment was handled separately, as it is known that sectors benefit from R&D performed by other sectors and in other countries. This means that the remaining indicators are skills indicators and these were entered into an econometric model to determine their association with TFP levels and TFP growth.

1.4 Outline of the report

There are five remaining chapters in the main report:

- Data and Methodology — this chapter details data definitions and sources and outlines the econometric approach which is expanded upon in the Technical Annex.
- Skills Indicators — this chapter provides internationally comparable skills indicators and allows the UK's comparative position to be examined.
- TFP Growth and Levels — this chapter provides information on Total Factor Productivity levels and growth for the sectors and countries covered.
- Results by Skills Indicator — this chapter reports the results of the econometric exercise and starts to determine which indicator is the most useful.
- The Sectoral Pattern — this chapter provides detailed results along with brief commentary for each of the 23 sectors covered by the analysis.
- Conclusions — this chapter draws together the main results, the lessons and suggested policy conclusions that they imply.

Additionally, there is a Technical Annex aimed at those with more specialist knowledge that goes into greater detail covering the econometric methodology and provides some detailed results.

2. Data and Methodology

Two parallel data collation exercises, one covering the economic data and the other covering skills indicator data were analysed descriptively and then in a complex econometric model. This model involved a series of mathematical transformations to the data culminating in a series of regression analyses. This process enabled the relative impact of the various skills indicators on productivity to be examined.

Therefore, this chapter:

- outlines the economic and skills data and its collation
- outlines the collection and processing of the skills indicator data, and
- gives an overview of the econometric model that was used to derive the results presented later.

The definitions and sources of the skills indicators are covered in more detail in Chapter 3. The econometric model is also covered in much greater detail in the Technical Annex.

2.1 Economic data

The economic data comes from two international sources where great efforts have been made to ensure that the data is internationally comparable. These were:

- the OECD STAN database, and
- the Groningen 60 industries database.

These are detailed in turn below.

2.1.1 OECD STAN database

The Organisation for Economic Co-operation and Development (OECD) collate data using international classifications. One of their databases is the STructural ANalysis (or STAN) database (OECD, 2002). This database contains data on sectoral output levels, capital inputs, number of employees, hours worked and R&D expenditures.

2.1.2 Groningen 60 industry database

The Groningen Growth and Development Centre at the University of Groningen in the Netherlands has developed an enhanced version of the STAN database. This is the 60 Industry Database (GCDC, 2003). This provided more information for a number of variables in the STAN database, most notably sectoral hours worked data. Additionally, this database provided the sector and country specific deflators,[1] which were applied to the un-deflated variables in the STAN database such as sectoral R&D expenditures. Further details of the use of the STAN and Groningen databases can be found in the Technical Annex.

2.1.3 Production of total factor productivity data

The methodology used to construct sectoral Total Factor Productivity (TFP) data from the data in the STAN and Groningen 60 industry database is detailed in the Technical Annex. However, the approach centred on constructing capital stocks figures using the Permanent Inventory Method (PIM) (Evans *et al.*, 2004). The PIM method allows estimation of capital stocks from the much more easily measured capital investments. Each sector is assigned a mix of long-term capital stock (such as buildings) and short-term capital stock (such as computers) creating a sector specific depreciation rate. Then each year's capital investment plus the stock from the previous year is depreciated until the system stabilises and the capital stock is only based on depreciated investments. Despite the methods problems it is the recognised technique for generating capital stock figures and is widely used (Oulton, 2004). This method requires a long time series to generate reliable capital stock and in our case we used data from 1971 to 2001.

2.1.4 Sectoral classification used

The Eurostat data and the Groningen data use NACE (Nomenclature des Activités économiques dans la Communauté Européenne) (Eurostat, 1996) or ISIC (International Standard Industrial Classification) (UN, 2002). This meant that the data could be mapped onto the SSDA's Sector matrix as this is defined in terms of two digit UK SIC92 (Standard Industrial Classification 1992) (ONS, 1992) which at that level is equivalent to both NACE and ISIC. However, given the absence of very detailed four digit data it was impossible to utilise the SSC's sector footprints.

1 These deflators are used to take account of the differing inflation rates in each of the sectors and countries. Once the data is deflated any growth can be considered genuine underlying growth and not anything due to inflation.

The US Current Population Survey which was the source of the US skills data used the US SIC80 sectoral classification. This classification (recently replaced) has poor coverage of the services sectors and this meant that some compromises with the sectoral classification used had to be made. The benefits of including the US in the analysis was thought to outweigh any loss of detail due to this aggregation.

As the US classification does not distinguish between wholesale and retail it was necessary to aggregate three of the SSDA Sector Matrix sectors, into one sector . These were:

- SIC 50 – sale maintenance and repair of motor vehicles and fuel retail
- SIC 51 – wholesale trade
- SIC 52 – retail trade.

Similarly, it was necessary to aggregate many of the private sector service sectors into one sector including SIC 70, 71, 72, 73 and 74. This is an aggregate of three SSDA Sector Matrix sectors. Apart from these aggregations it was possible to collate detailed international economic and skills data covering 16 countries and economic data for a further three countries that map onto the SSDA Sector Matrix.

This led to the 23 sector classification used in the analysis presented in this report, plus the whole economy. These sectors with their relevant SIC classifications were:

- agriculture, hunting, forestry and fishing — SIC 01, 02, 05
- mining and quarrying — SIC 10, 11, 12, 13, 14
- manufacture of food, drink and tobacco — SIC 15, 16
- manufacture of textiles and clothing — SIC 17, 18, 19
- manufacture of wood, pulp and paper products — SIC 20, 21
- publishing, printing and reproduction of media — SIC 22
- energy and chemicals — SIC 23, 24, 25, 26
- manufacture of basic metals and metal products — SIC 27, 28
- manufacture of machinery and equipment — SIC 29, 30, 31, 32, 33
- manufacture of transport equipment — SIC 34, 35
- manufacture of other products and recycling — SIC 36, 37
- electricity, gas and water supply — SIC40, 41
- construction — SIC 45
- wholesale, retail and car repairs — SIC 50, 51, 52
- hotels and restaurants — SIC 55

- transport — SIC 60, 61, 62, 63
- post and telecommunications — SIC 64
- financial services — SIC 65, 66, 67
- private sector professional services — SIC 70, 71, 72, 73, 74
- public administration and defence — SIC 75
- education — SIC 80
- health and social work — SIC 85
- other public and personal services — SIC 90, 91, 92 93.

2.1.5 Conversion of US data into international classifications

The US sectoral classifications were converted using the OECD methodology (Wyckoff, personal communication) which meant that the skills data derived from the CPS was consistent with the OECD derived economic data. The occupational classification was converted into ISCO using an SPSS version of a translation provide by Harry Ganzeboom (Ganzeboom *et al.*, 2003) produced by Paul Lambert. Where there were any remaining these were resolved by reference to the ICSO Manual (ILO, 1990).

2.2 Skills indicators

The primary objective of the project was to develop a range of country and sector level skills indicators and establish which ones were most clearly associated with Total Factor Productivity. The next section introduces the skills indicators selected for use in the modelling. Given the problems with the US sectoral classification some of the sectors in the SSDA skills matrix had to be aggregated These are defined more fully in Chapter 3 where the data is examined. Chapter 3 also defines a range of other skills indicators which were examined for inclusion in the modelling.

2.2.1 Educational attainment

The level of educational attainment is often taken as a useful proxy for skill levels. The modelling exercise used two levels: high-level educational attainment and intermediate-level educational attainment. These are defined in terms of the International Standard Classification of Educational Diplomas (ISCED) (UNESCO, 1997). They were expressed as a proportion of those in employment.

High-level educational attainment is defined as levels 5 and 6 of ISCED 97. ISCED level 5 is the first stage of tertiary education and level 6 is the second stage of tertiary education. In UK terms this is considered to include: HNDs, first degrees and all higher postgraduate qualifications.

Intermediate-level educational attainment is defined as levels 3 and 4 of ISCED 97. ISCED level 3 is entitled upper secondary education, while level 4 is called post-secondary non-tertiary education. In UK terms, this is problematic, as the boundary between ISCED level 2 and level 3 has yet to be fully determined. However, they have been taken to include 'A' levels and NVQ level 3 qualifications.

2.2.2 Training

Recent training is another indicator of skills acquisition. The question used across Europe is whether an individual has received education or training in the last four weeks (Eurostat, 2001). This is turned into an indicator by calculating the proportion of a sector's workforce that has received education or training in the last four weeks. Unfortunately, this indicator does not reflect either the relevance or intensity of the training. However, it does reflect the propensity of a sector to train and importantly the propensity to spread the training across the workforce, rather than simply concentrating it on a few individuals.

2.2.3 Occupational level

Another proxy for skill levels is the assumed skill level associated with various levels of occupations. The modelling exercise used two occupational groups defined in terms of the International Standard Classification of Occupations (ISCO) (ILO, 1990). These were:

- managers and senior administrators — ISCO level 1, and
- professionals — ISCO level 2.

These were again expressed as proportions of those in employment. The categories are defined in more detail with their UK parallels in Chapter 3.

2.2.4 ICT occupations

ICT occupations, or Information and Communications Technology occupations, are defined in terms of the following ISCO three digit categories:

- ISCO 213 — computing professionals
- ISCO 312 — computer associate professionals
- ISCO 313 — optical and electronic equipment operators
- ISCO 724 — electrical and electronic equipment mechanics and fitters.

This indicator is intended to be a proxy for ICT investment by the sectors. This was then expressed as a proportion of those in employment in the sector. As with the SET occupations more details of the source, and underlying logic behind, the ICT occupations indicator is contained in Chapter 3.

2.3 Total factor productivity

As explained in the introduction, Total Factor Productivity is the same as what remains of either productivity levels, or growth, once the impact of capital and labour inputs have been taken into account (Hulten, 2000). This is seen as a better overall measure of productivity than (the probably more easily understood) labour productivity (Islam, 1999 or O'Mahony, 2002).

2.3.1 TFP levels

TFP levels were calculated by comparing each country's TFP with the average for all the other countries. This has the advantage that the international comparisons are not dependent on a single country. These sorts of comparisons are dependent on the exchange rates used. Therefore, we used the OECD's Purchasing Power Parity exchange rates (Schreyer, Koechlin, 2002) rather than the more suspect[1] market exchange rates. The other downside of this averaging approach is that any error in one country can be transmitted to all the others. However, by including more countries in the analysis this potential negative impact can be minimised. This explains the addition of Canada, Norway and Japan to this part of the analysis. More details of the approach used are contained in Chapter 4 as well as the Technical Annex. Chapter 4 also contains a table showing how the UK's sectoral TFP levels rank compared with a range of international comparator countries in section 4.2.

2.4 Modelling

The Technical Annex explains the modelling in greater detail, and you are advised to read this annex should you want further information. This section simply highlights the main points of the approach used.

2.4.1 The national and other data problems

The initial analysis of the data showed that there was relatively little growth in many of the skills indicators. Similarly, most of the

[1] Market exchange rates can be influenced by policy and trader perceptions rather than simply reflecting the differing costs of products and services as reflected by Purchasing Power Parity exchange rates.

differences, as might be expected, were explained by the country. However, as we were trying to examine the influence of these skills indicators at the sectoral level it was necessary to take account of these country level fixed effects. This combined with the extent of missing data meant that certain panel analysis techniques could not be used.

The approach adopted was to include dummy values into the regressions. Dummy values were used where there were missing values to ensure that cases were not lost where there was missing data on one variable. Instrument variables, or country sector and year dummies, were also introduced to the regression to examine the fixed effects associated with these variables.

Then a range of regressions were run to find the best combination of variables in terms of policy relevance, explanatory power while at the same time minimising multi-collinearity. This led to two regressions being adopted. The first examined the variables at a national level, while the second more complex regression also looked at the impact at the sectoral level. The first regression and its outputs is described in more detail in Chapter 5. The second regression and its outputs is described in Chapter 6.

2.5 Chapter summary

This chapter introduced the main data sources used by both the descriptive and econometric analysis. Importantly, it explained why some of the SSDA Sector Matrix sectors had to be aggregated to incorporate the US data sources. It introduced the use of Total Factor Productivity as the preferred productivity measure. It also introduced the initial selection of skills indicators.

3. Skills Indicators

A total of 11 human capital and skills indicators were initially selected, following the testing of a wider range of indicators. These were:

- high-level qualifications
- medium or intermediate-level qualifications
- education or training in the last four weeks
- managerial occupations
- professional occupations
- technician or associate professional occupations
- HRSTC or core HRST
- high-qualified managers
- high-qualified professionals
- SET occupations
- ICT occupations.

The definition of each of these indicators is followed by a brief descriptive analysis of the available data. Usually, this consists of an examination of the UK comparative position and any notable international comparisons. Given the richness of this data there is further scope for a more comprehensive analysis.

3.1 High-level qualifications

The simplest skill based indicators refer to the highest level of education attained. International comparisons of educational attainment usually use ISCED 97 (UNESCO, 1997) as their basis. Using the ISCED 97 classification, high-level qualifications are defined as:

- ISCED 97 level 5
- ISCED 97 level 6.

In UK terms these are first degree and above qualifications or tertiary level qualifications. The numbers with a tertiary level qualification were then expressed as a proportion of those working in each sector.

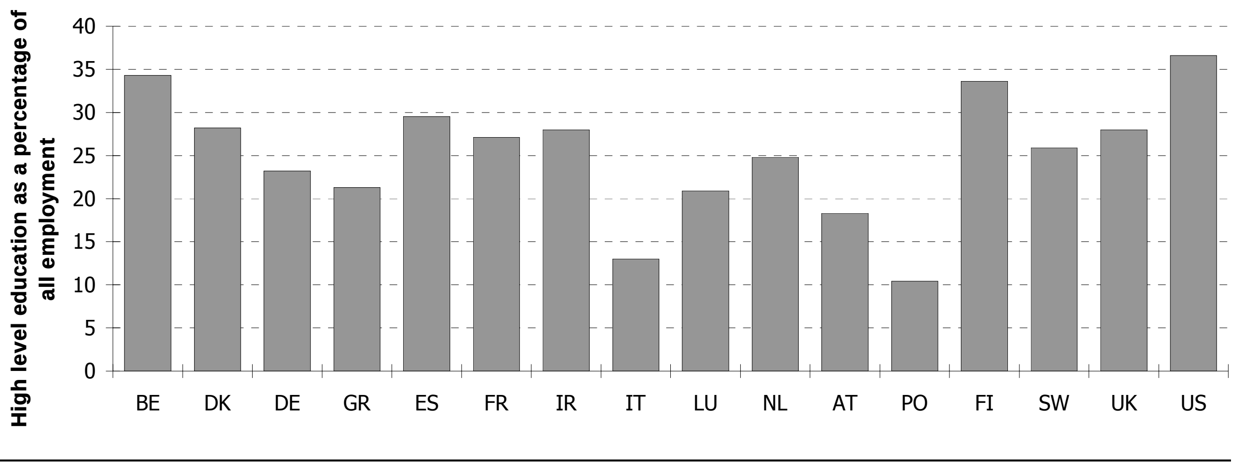
The advantage of this skills indicator is that the data is more readily available than some of the other indicators. Both the Eurostat Labour Force Survey (LFS) and the US Current Population Survey (CPS) contain variables that can be recoded into this classification. However, many of the EU countries had problems with the transition from the underlying ISCED 66 to ISCED 97 in 1997. This means that there are some lacunae and discontinuities in the data during this period.

As with some of the other indicators, there is no necessary relationship between graduates and innovative activity or increased productivity. However, this is a good measure of the quality of general human capital available to the sector. As such, this relates to the more general literature that examines the relationship between the quality of human capital and innovation (for example O'Mahony, Van Ark, 2002).

Looking at the total percentage of graduate level qualifications for all sectors shows that there is missing data for 1992 for all the EU countries except Italy. There is also a gap in the data in 1998 for Ireland, Luxembourg, Germany and the UK. Since this followed the introduction of ISCED 97, it is suggested that these countries were slow to adapt their national data to the new international standard. Also, the German data has missing observations for 1993 to 1994, as does the Netherlands' for the period 1993 to 1995 and 2003.

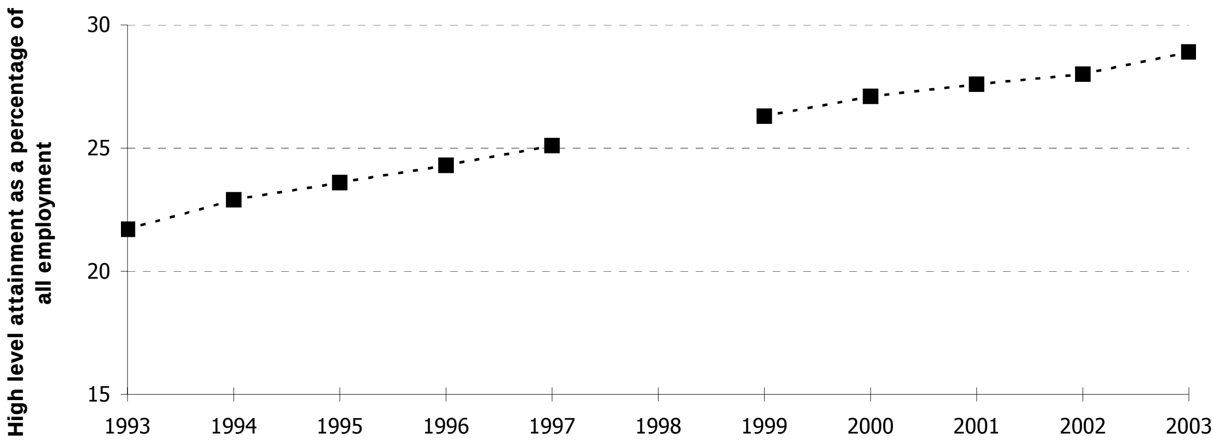
The highest concentration of graduate level qualifications is in the United States, at 36 per cent of the workforce, closely followed by Belgium and Finland both with about 34 per cent. Figure 3.1 also shows that the lowest proportion of tertiary qualified workers was in Portugal, at around ten per cent of the workforce.

Figure 3.1: High-level education as a percentage of all in employment by country, 2002



Source: IES/SPRU

Figure 3.2: UK high-level attainment as a percentage of all employment, 1993 to 2003



Source: IES/SPRU

The UK, as shown in Figure 3.2, had a steady and sustained growth in the highly qualified from about 22 per cent in 1993 to about 39 per cent in 2003.

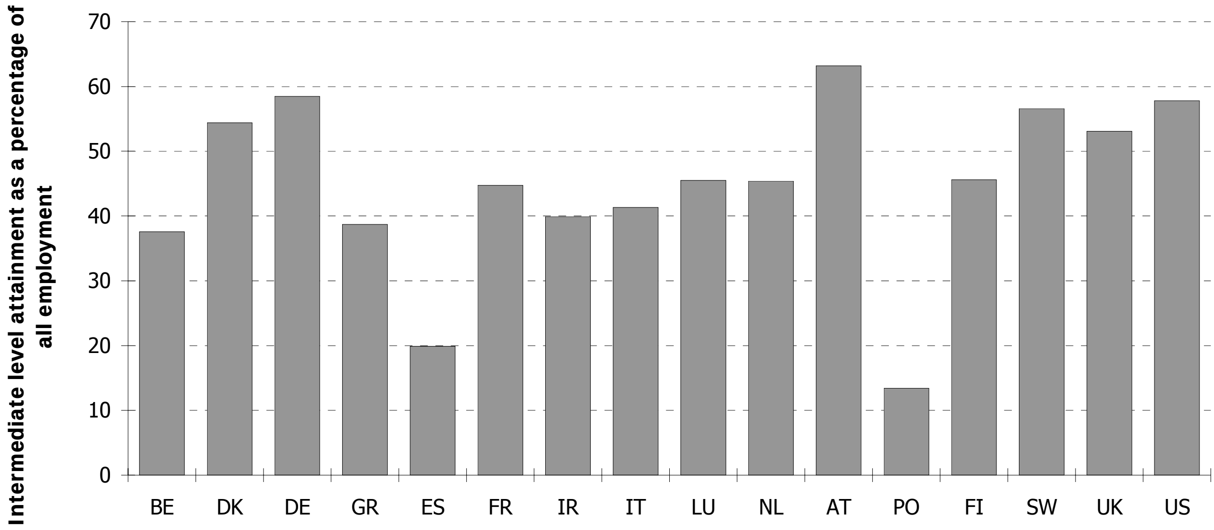
3.2 Intermediate-level qualifications

Some of the commentators on UK productivity suggest that the problem is a relative lack of intermediate-level skills compared with higher level skills (for instance Mason, 2001). Therefore, the impact of intermediate-level qualifications alone and in combination with higher level qualifications was examined. This indicator is also based on the ISCED classification, and defined in terms of ISCED 97 levels 3 and 4. The data was derived from Eurostat LFS and US CPS sources expressed as a proportion of the workforce in the sector.

The availability of data for this indicator was the same as described above (see high-level qualifications).

Figure 3.3 shows that the only country with more than 60 per cent of the workforce with intermediate-level qualifications was Austria. Below, but near to, 60 per cent were Germany, Denmark, Sweden and the UK. Although the UK has only had this position since 1999 when there was an increase of about 50 per cent compared to the early 90's, possibly explained by a change in definition). This probable definitional change also may explain why this pattern differs from that observed by others such as Murray and Steedman (1998). Spain and Portugal had respectively 20 per cent and below 20, thus showing the smallest proportion of the workforce with intermediate-level qualifications.

Figure 3.3: Intermediate-level attainment as a percentage of all employment by country, 2002



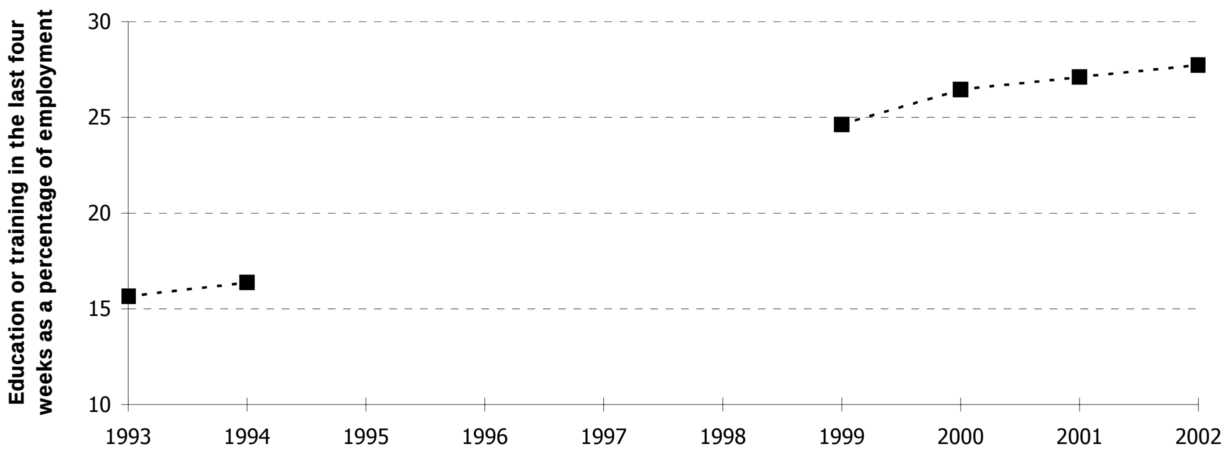
Source: IES/SPRU

A slightly positive trend was observed for Greece, Italy and Spain. For the rest of the countries the proportions were relatively stable over time.

3.3 Education or training in last four weeks

This Eurostat variable is subtly different than the UK question, which asks about job related training in the last four weeks. The Eurostat variable counts any form of education or training, whether or not it is job related. As this is a Eurostat question there is no parallel in the US CPS questionnaire, and hence no comparable US data. Importantly, this only records the incidence of education or training and does not measure its intensity, quality or relevance. Figure 3.4 shows that there has been a steady growth in reported education and training in the last four weeks, with the incidence growing from about 16 per cent to above 27 per cent of the workforce

Figure 3.4: UK Education or training in the last four weeks as a percentage of employment

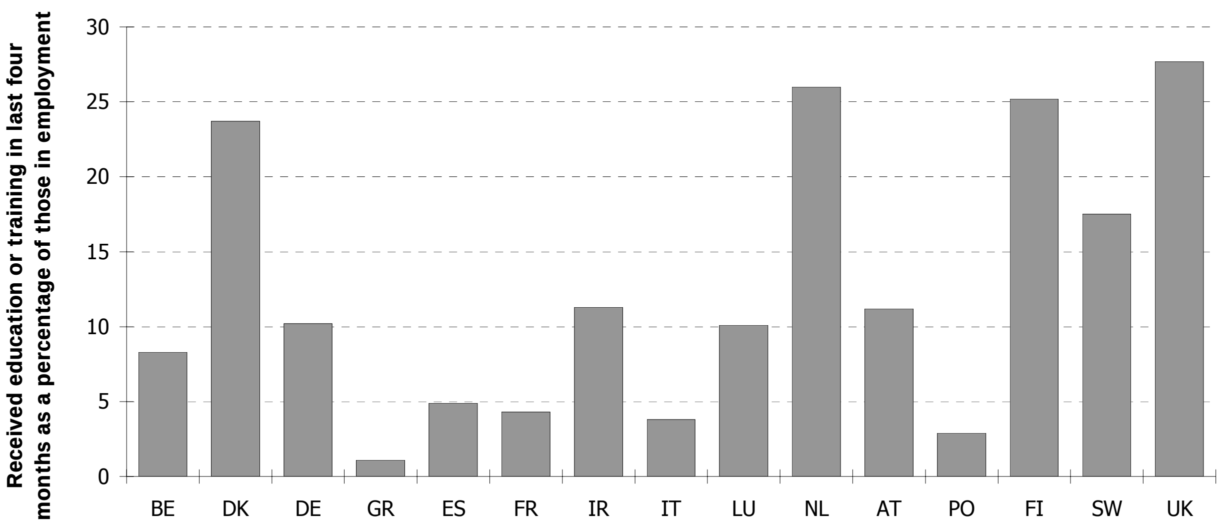


Source: IES/SPRU

Figure 3.5 shows the countries with an obvious focus on educating or training their workforce were: Denmark, Netherlands, Finland, the UK and Sweden. Around 25 per cent of the workforce in these countries reported receiving education or training in the last four weeks. At the bottom were Greece (one per cent) and Portugal (below three per cent).

Gaps in the data include 1992 for all the EU countries (except Italy), 2003 for Luxembourg and Netherlands, 1998 for Germany, Greece, Spain, France, Ireland, Italy, Luxembourg and the UK. France has no data for 2001 as well as the Netherlands for the period 1993 to 1995.

Figure 3.5: Education or training in the last four weeks as a percentage of those in employment, 2002



Source: IES/SPRU

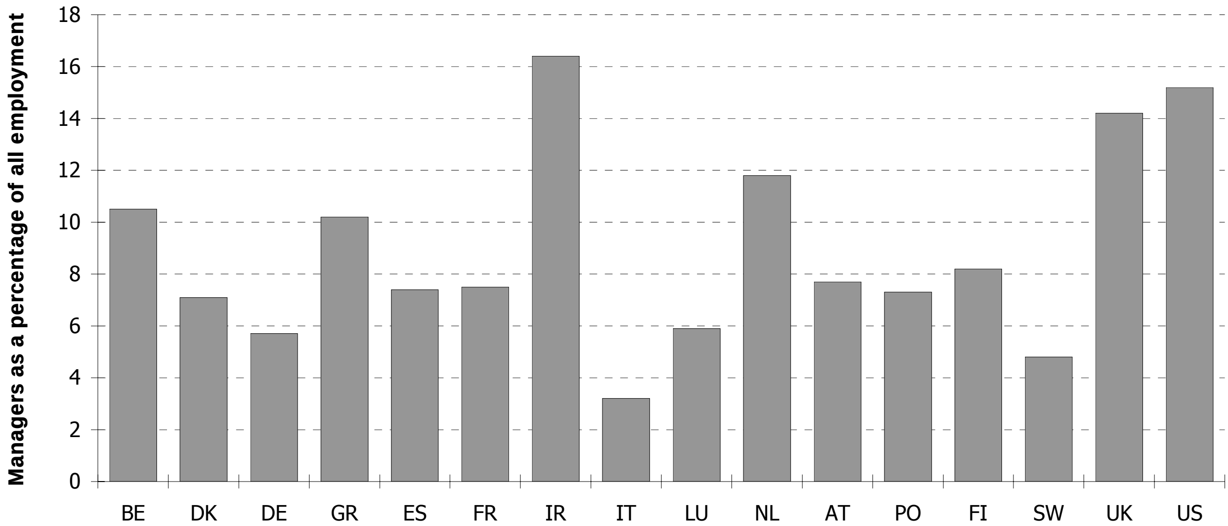
3.4 Managers

Managerial occupations are defined as those covered by ISCO Major Group 1. As with the HRST occupations, the data has been derived from the Eurostat LFS and the US CPS. As the UK occupational classification SOC2000 is designed to parallel the international ISCO classification, the ISCO Major Group 1 maps fairly closely onto UK equivalent SOC2000 Major Group 1.

Working with the Eurostat LFS data, we calculated the proportion of managerial occupations out of the total sectoral workforce for each of the 15 European countries for the period 1993-2003. Data on managers for 1992 is unavailable for all of the EU countries, with an exception of Italy. For Finland and Sweden data is available from 1997 and for Austria from 1995, due to their late accession to the EU. Similar calculations have been performed for the US based on the CPS.

The data shows a wide variation in the proportion of the workforce in managerial occupations, with Figure 3.6 showing a range from 16 per cent in Ireland to only three per cent in Italy. There may, in part, be an Anglo-Saxon culture at work here as, apart from Ireland, the other two economies with a high proportion of managers are the UK and the US. At the same time many jobs which are not strictly managerial have manager appended to the job title to concur greater status on the individual. However, since the underlying UK occupational data had the managerial definitions tightened up in 2000 and no corresponding drop was found in the Eurostat data this explanation is unlikely.

Figure 3.6: Managers as a percentage of all employment by country, 2002



Source: IES/SPRU

For most of the EU countries the percentages of managerial occupations seem to be stable over the years. This suggests that there are distinct national patterns of industrial organisation underlying the differences between the countries.

3.5 Professionals

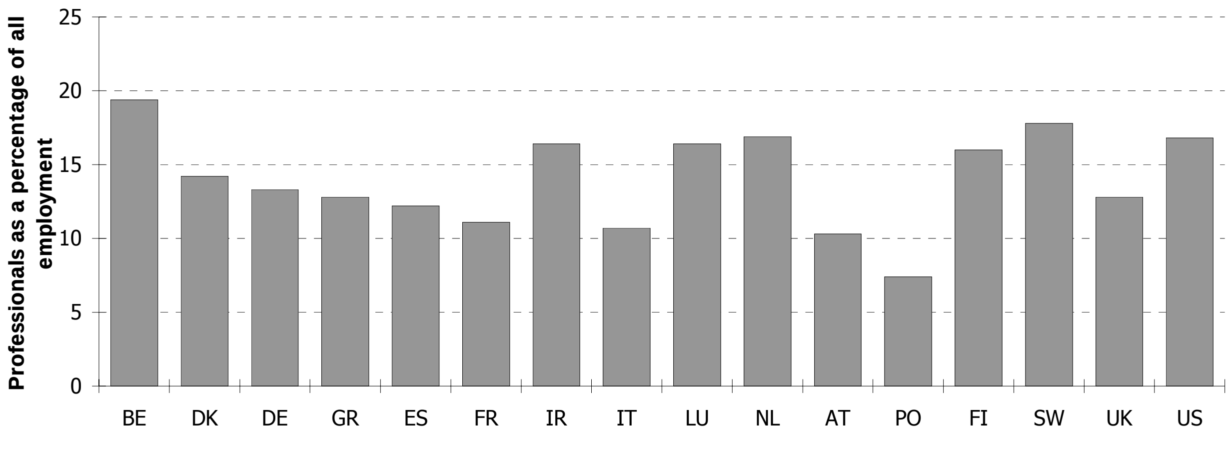
As with managerial occupations, the professional occupations are defined by ISCO, in this case major Group 2. The indicator is based on professional occupations as a proportion of the total sectoral workforce. As with the UK's SOC 2000, this major Group 2 includes scientists, engineers, medics, teachers, lawyers and other professionals. Again this data came from the Eurostat LFS and the US CPS.

The availability of data for the professional occupations using the LFS, is the same as described for managerial occupations. In addition, there is a gap in the data for Germany for the period 1993 to 1994.

After visually inspecting the data, we observe, for most of the countries, a relatively stable trend for the professional occupations as proportion of the sectoral workforce, and a slightly positive one for Germany, Greece, Spain, Italy, Luxembourg and Sweden.

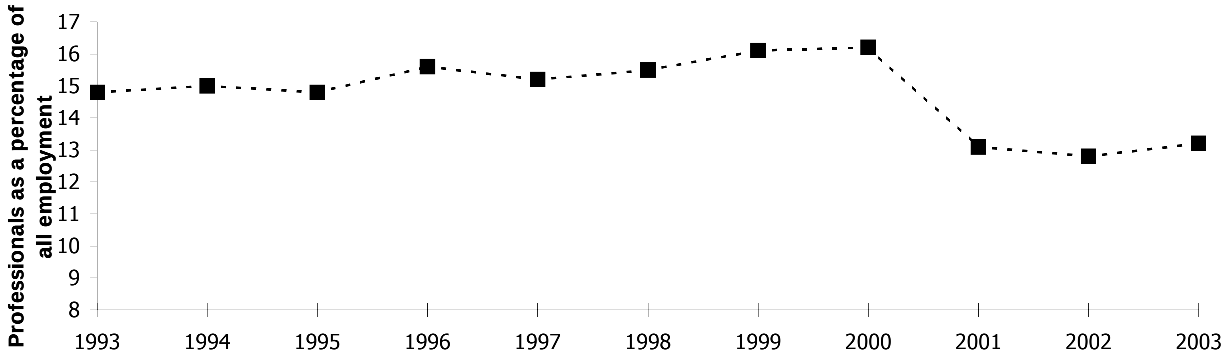
Figure 3.7 shows that the highest presence of professional occupations is observed in Belgium, around 19 per cent of the workforce in this category. A high concentration, around the 15 to 17 per cent mark, exists in Ireland, Luxembourg, Netherlands, Finland, Sweden and US. The smallest representation of the professional occupations is observed in Portugal, around seven per cent.

Figure 3.7: Professionals as a percentage of all employment by country, 2002



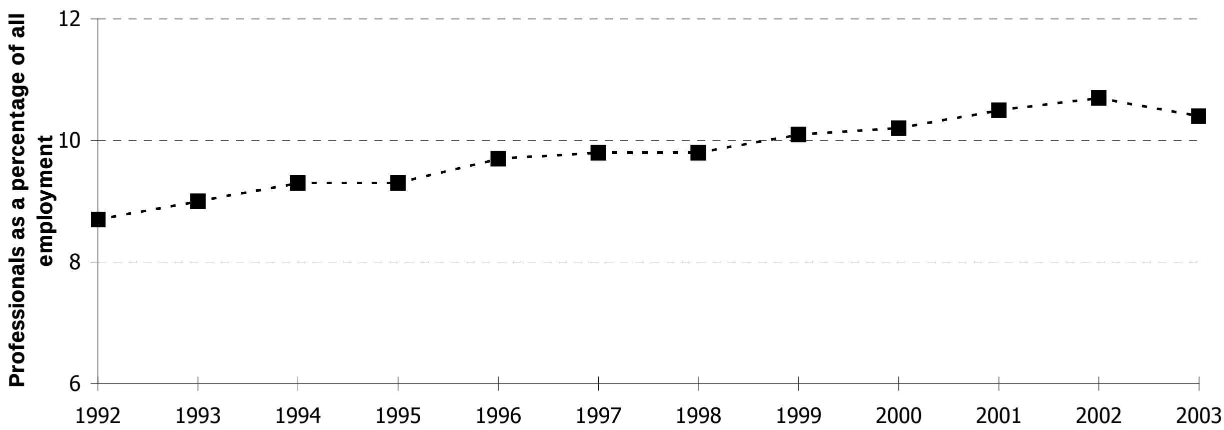
Source: IES/SPRU

Figure 3.8: UK professionals as a percentage of all employment, 1993 to 2003



Source: IES/SPRU

Figure 3.9: Italian professionals as a percentage of all employment, 1992 to 2003



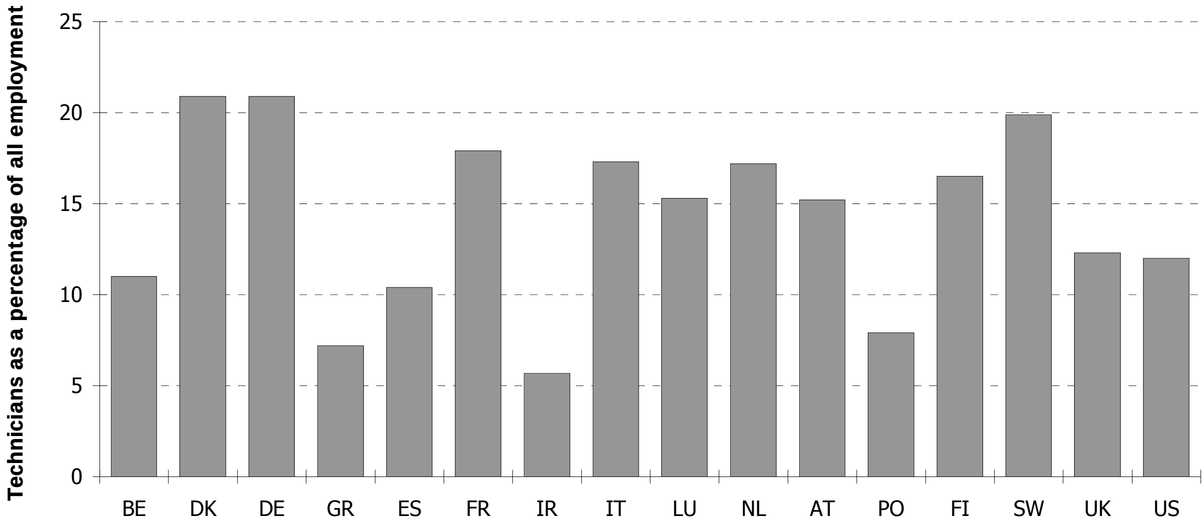
Source: IES/SPRU

Figure 3.8 shows a relatively static proportion of professionals at around 15 per cent for the UK, dropping to about 13 per cent in 2001. This drop is probably due to the introduction of SOC2000. Most of the other countries showed a similar slow upward trend. On the other hand, Figure 3.9 shows a gradual increase in the proportion of professionals in the Italian economy.

3.6 Technicians and associate professionals

Many commentators emphasise the importance of technicians for economic growth, especially the relative lack of technicians in the UK economy. This group is again defined in terms of ISCO in this case ISCO major Group 3. Figure 3.10 shows the wide variation in technician availability across Europe and the US.

Figure 3.10: Technicians and associate professionals as a percentage of all employment, 2002



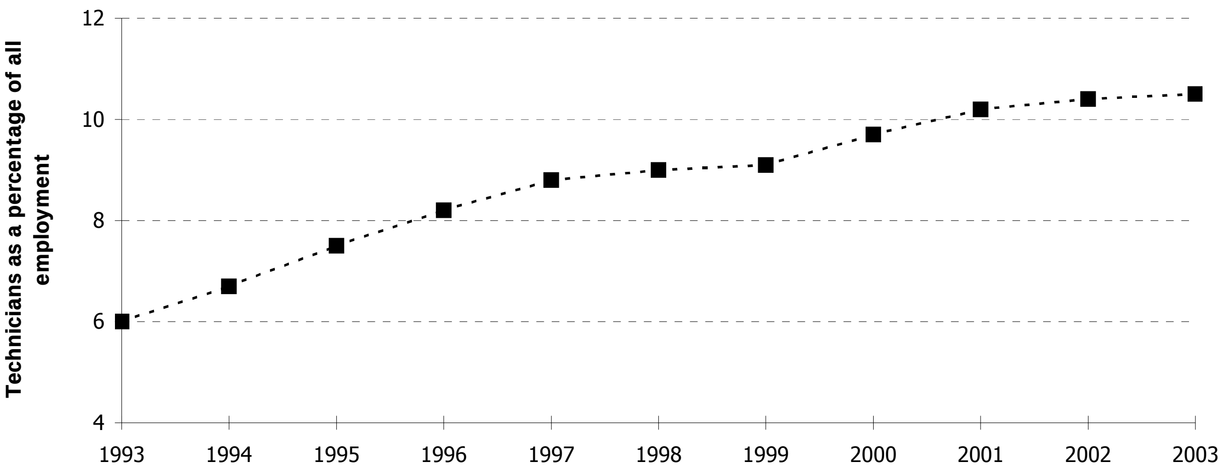
Source: IES/SPRU

Denmark, Germany and Sweden all show high-levels of technicians. At the other end of the scale Greece, Ireland and Portugal show figures of between five and seven per cent of their workforces.

Again, the pattern in terms of growth was very diverse, with some countries static and some countries showing strong growth in the proportion of the workforce recorded as technicians.

Figure 3.11 shows the strong Spanish growth from six per cent to over ten per cent of the workforce between 1993 and 2003.

Figure 3.11: Spanish technicians as a percentage of all employment, 1993 to 2003



Source: IES/SPRU

3.7 HRSTC or core HRST

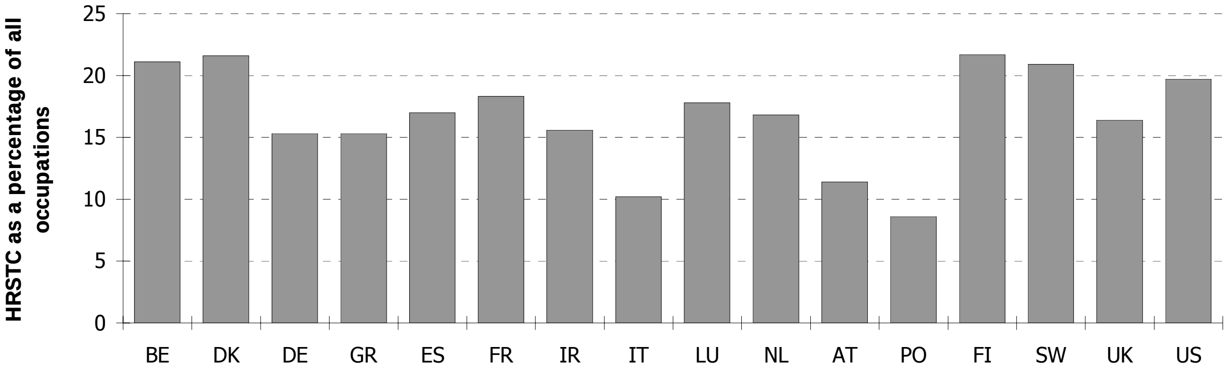
The OECD's Canberra Manual (OECD, 1995) has a range of definitions of what it terms *Human Resources for Science and Technology* or HRST. The manual uses a broad definition of Science and Technology, and the suggested definitions were largely driven by the available data at the time. The core approach used by the Canberra Manual is the intersection of occupational and educational definitions of HRST. One of the main dimensions used defines HRST as anyone in a professional or managerial occupation. That is, those in ISCO Major Group 1 and Group 2. The other dimension is high-level educational attainment (ISCED97 level 5 and level 6) or in UK terms 'graduates'.

Eurostat subsequently has elaborated the definitions from the Canberra Manual, and has identified those that are both in ISCO Group 1 or Group 2 occupations as well as having high-level qualifications as HRSTC. This HRSTC category gets round many of the comparability problems of using only the one dimension, as it excludes unqualified professionals and technicians as well as graduates in non-graduate occupations.

Another advantage is that this data is more readily available than detailed ISCO data. Equally, sample surveys, such as the LFS, are more likely to generate reliable data for small sectors. The disadvantage is that it includes a wide range of managers and professionals who might not be involved in innovative activities.

Figure 3.12 shows that HRSTC occupations represent more than 20 per cent of the sectoral workforce in the following EU countries: Belgium, Denmark, Finland and Sweden. The majority of the rest of the EU countries have between 15 and 20 per cent of their workforce defined as HRSTC. The countries below 15 per cent are Italy, Austria and Portugal.

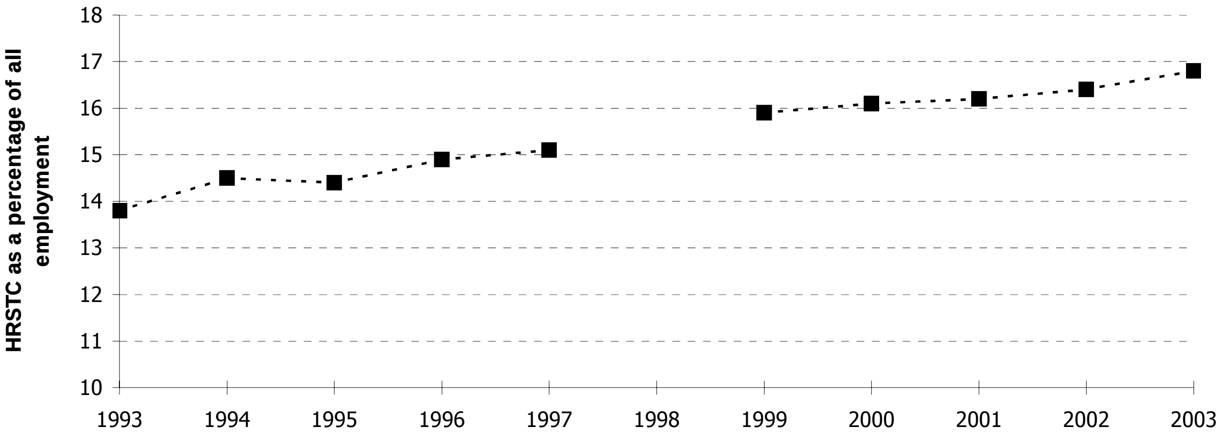
Figure 3.12: HRST as a percentage of all employment by country, 2002



Source: IES/SPRU

Figure 3.13 shows that in the UK there has been a steady growth in HRST from 14 per cent of the workforce in 1993 to 17 per cent in 2003.

Figure 3.13: UK HRSTC as a percentage of all employment, 1993 to 2003



Source: ISE/SPRU

3.8 SET occupations

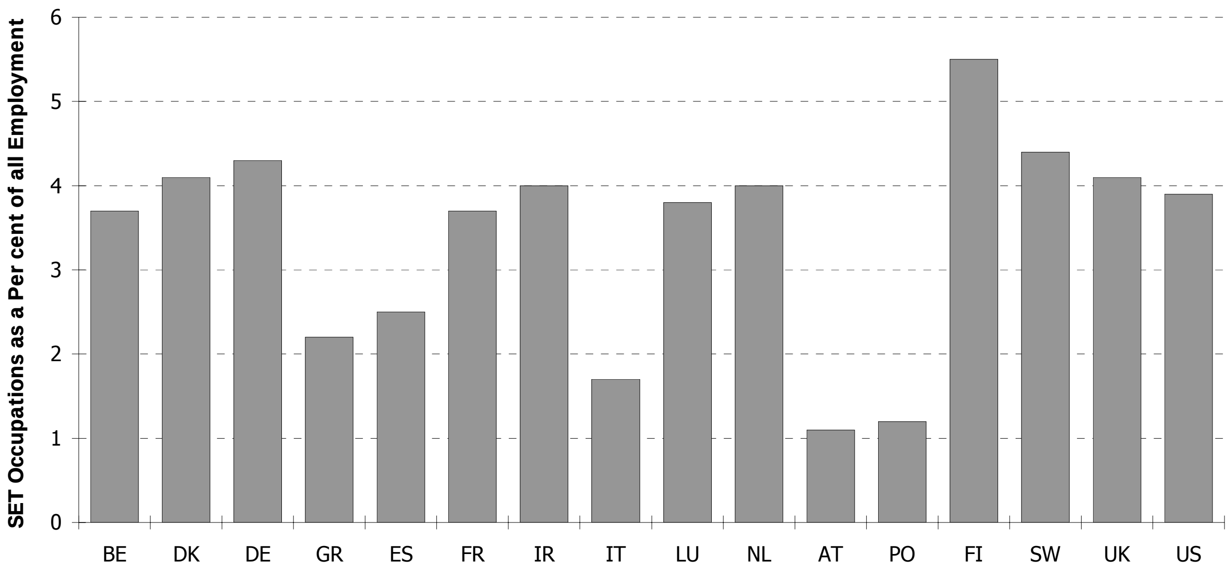
SET occupations are defined in terms of the International Standard Classification of Occupations (ISCO—88). An aggregate of the following ISCO minor groups was used to represent SET occupations:

- ISCO 211 — physicists, chemists and related professionals
- ISCO 212 — mathematicians, statisticians and related professionals
- ISCO 213 — computing professionals
- ISCO 214 — architects, engineers and related professionals

- ISCO 221 — life science professionals.

The advantage of using such an aggregate is that this allows the activity of scientists, engineers and technologists who are, and importantly who are not, engaged in R&D to be captured. This allows a broader scope of professional SET inputs to wealth creation to be captured. The disadvantage is that this sort of data comes from the Community Labour Force Survey, which is a sample survey. This means that the number of those in SET occupations in the smaller sectors can be subject to sampling error. Indeed, in many of the countries and sectors the numbers did not exceed the cut-off point below which numbers must be suppressed. However, using the aggregate meant that where the individual ISCO minor groups may have been below the national cut-off points, more often than not, it was possible to use the aggregate.

Figure 3.14: SET occupations as a percentage of all employment by country, 2002



Source: IES/SPRU

Figure 3.14 compares the proportion of the workforce in each of our countries in the SET occupations category, for the latest year, where we have data for all the countries. Examining these results from the Eurostat LFS data for all the sectors, it is clear that a relatively small proportion of the workforce is in SET occupations. The countries with above (and around) four per cent of their workforce in SET occupations are mainly northern European and include: Belgium, Denmark, Finland, Sweden, and the US. Austria and Portugal are the countries with the smallest proportions of the workforce in SET occupations at around one per cent.

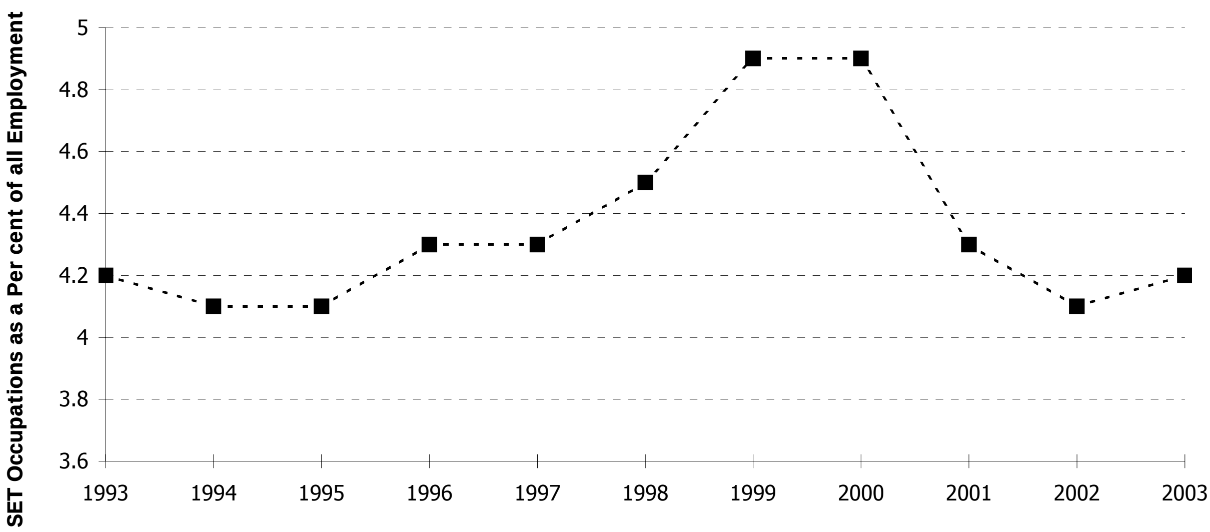
Data is not available for 1992 for any of the EU countries, except Italy. In addition, there is no data for Germany for 1993-94 period and no data for 2003 for Luxembourg and the Netherlands. Austria supplied data from 1995, and Finland and Sweden from 1997.

A positive trend is slightly visible for Finland, Denmark, Germany, Spain, Italy, Sweden, France and the UK. For the UK there is a dip from 2001, probably due to changes in the national occupational classification from SOC90 to SOC2000 and the rapid growth, and subsequent decline, in software professionals prior to the year 2000 (see Figure 3.15).

The data for the majority of the EU countries also shows a concentration of SET occupations in the following sectors (also shown in Figure 3.16 for the UK):

- Seven — Manufacture of coke, petrol, nuclear fuel, chemicals, rubber, plastics, glass, ceramics and cement.
- Nine — Manufacture of machinery, electrical and optical equipment.

Figure 3.15: UK SET occupations as a percentage of all employment 1993 to 2003

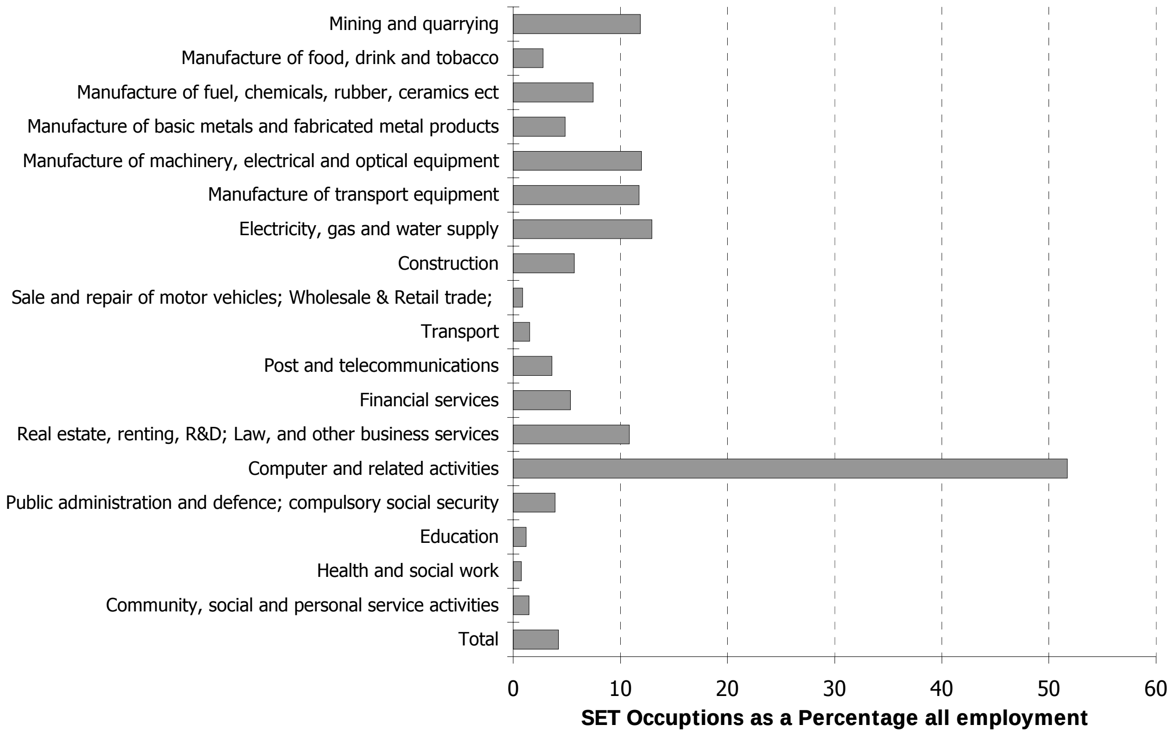


Source: IES/SPRU

- Twenty — Financial services.
- Twenty-two — Computer and related activities.
- Twenty-four — Public administration and defence; compulsory social security.

The inclusion of service sectors may be surprising, but it should be recognised that the SET occupations include computer professionals.

Figure 3.16: UK SET occupations 2003 by sector*



Note: *Missing sectors data suppressed due to too small values

Source: IES/SPRU

3.9 ICT occupations

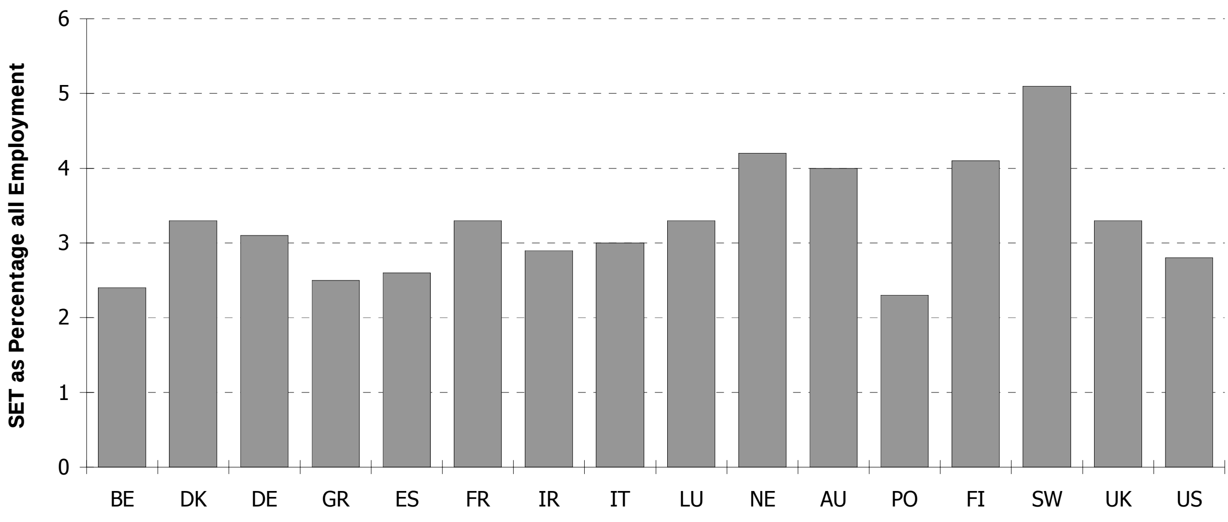
In a similar manner to SET occupations, ICT occupations (or Information and Communication Technology Occupations) are defined as an aggregate of Standard Occupational Classifications. As such ICT occupations are defined as:

- ISCO 213 — computing professionals.
- ISCO 312 — computer associate professionals.
- ISCO 313 — optical and electronic equipment operators.
- ISCO 724 — electrical and electronic equipment mechanics and fitters.

This aggregate provides a useful proxy for the level of ICT activity in a sector and the relative intensity of ICT. A lot of analyses have looked at the impact of ICT on productivity (van Ark *et al.*, 2003). However, the most useful measure that has been found for ICT activity has been ICT employment (van Ark, 2002).

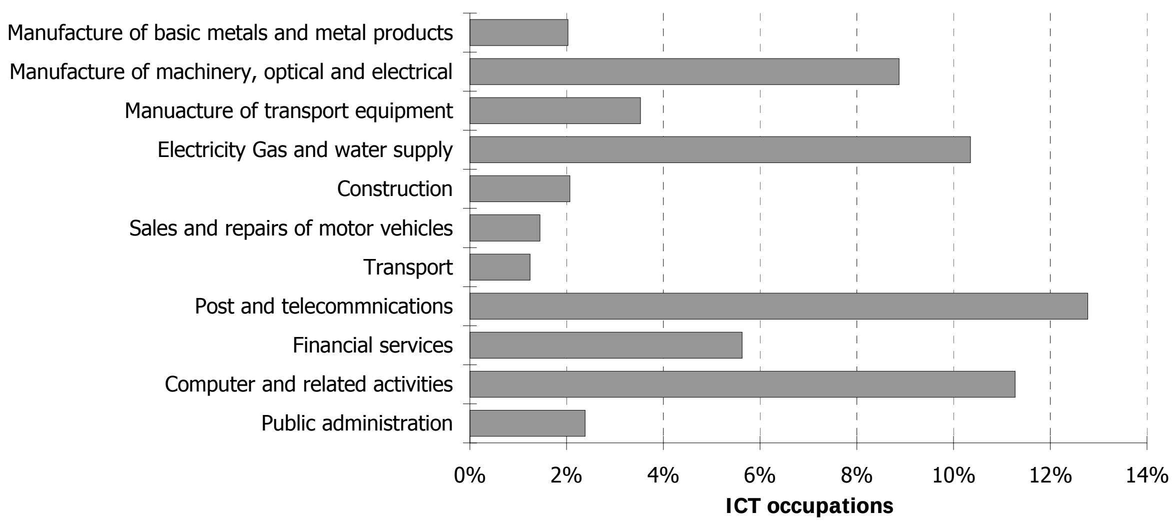
Figure 3.17 shows the proportion of the workforce in ICT occupations in each of the countries covered. This shows Sweden with the most, followed by the Netherlands, Finland and Austria, while Portugal reports the smallest proportion. The UK is in the second tier with Denmark France and Luxembourg.

Figure 3.17: ICT occupations as a percentage of all employment by country, 2002



Source: IES/SPRU

Figure 3.18: ICT occupations as a percentage of employment selected UK sectors, 2002



Source: IES/SPRU

When the sectoral breakdown is examined for the UK, as in Figure 3.18, the importance of the service sectors as employers of ICT workers becomes apparent. As might be expected the highest concentrations are found in the post and telecommunications sector as well as the computer and related activities sector.

3.10 Chapter summary

This chapter provided a necessarily brief descriptive analysis of the internationally comparable skills data for 16 countries. The UK's relative position will be examined again in Chapter 7. However, generally the UK is shown to be:

- not the best, but above average, in terms of high-level and intermediate-level skills as well as HRST and SET occupations
- about average in terms of professionals, technicians and ICT occupations, and
- apart from Ireland and the US the highest in terms of managers.

4. TFP Levels and Growth

4.1 Productivity and growth

It is now widely recognised that the main driver of economic growth is increasing productivity, which in part is driven by technical change, as well as organisation change and other factors. This chapter covers the choice of productivity measures and reports the relative international productivity levels by sector.

4.2 Why TFP?

Measures of productivity constitute core indicators for the analysis and prospects of economic growth (HM Treasury, 2004). There are many different approaches towards productivity measurement and their calculation and interpretation needs careful consideration, in particular when international comparisons are involved (OECDa, 2001). In the following we consider labour productivity and Total Factor Productivity (TFP).

First, labour productivity is defined as the ratio of output to labour, where both the numerator and the denominator can be measured in different ways. For example output can be measured as gross output (the sum of the company sales at the industry level) or as value added. The latter requires information on the value of intermediate inputs. However, as the OECD Productivity Manual put it, the advantage of the value added based measure of productivity is that it permits:

> *'… analysis of micro-macro links, such as the industry contribution to economy-wide labour, productivity and economic growth. At the aggregate level, value-added based labour productivity forms a direct link to a widely used measure of living standards, income per capita. Productivity translates directly into living standards, by adjusting for changing working hours, unemployment, labour force participation rates and demographic changes'* (OECD, 2001a, p. 14).

Likewise, labour can be measured in several ways. Perhaps the simplest measure of labour is the total number of employees in a given industry, but this requires controls for both country and industry differences in the use of labour by counting hours worked rather than simply using labour as a mere head count.

Labour productivity is a partial measure because it leaves out a host of factors that may influence productivity, such as capital inputs, intermediate inputs and the use of energy. Despite the immediacy and simplicity of labour productivity computations, it is often preferred to compute TFP.

The Total Factor Productivity (TFP) approach to economic analysis has a long history (Hulten, 2000), and underlies many empirical analyses of economic growth (for instance, O'Mahony, 2002). The ultimate basis for TFP analysis is the neo-classical growth model of Solow (1956). Solow expressed growth as a function of capital and labour and the residual.

$\triangle Y = A(\triangle K, \triangle L, \text{residual})$

Where $\triangle Y$ is change in real output (or growth), $\triangle K$ is change in physical capital, $\triangle L$ is change in labour input and A is a constant. The residual, or the part of the growth in output, that is not explained by changes in capital and labour inputs is the Total Factor Productivity. It is often also referred to as technical change or innovation. Since 1956, a number of additional factors have been introduced into the equation in an effort to reduce the unexplained residual. These have included the quality of human capital (Engelbrecht, 1997), the level of business confidence, hours worked, and most often R&D spending (Hall, Mairesse, 1995) or (Coe, Helpman, 1995). Wide ranges of analyses have been carried out using both national and international data.

4.2.1 R&D and spillovers

A particular focus of the literature has been the impact of R&D spending, and the way the benefits of R&D spending by one sector, or country, spills over into other sectors and countries (Grilliches, 1998 or Cohen, Leveinthal, 1989). Companies, sectors and countries can benefit from R&D spending elsewhere, either by emulating or licensing the results of the R&D, or as a consequence of purchasing products which contain the results of the R&D (Wilson, 2001). In general, these mechanisms whereby others appropriate R&D inputs, are termed 'spillovers'. This ability for competitors to appropriate the results of R&D is seen as an explanation of sub—optimal levels of R&D investment and a rationale for public support, through the university system (Romer, 2000) and otherwise for R&D (Griffiths, 2000).

An approach based on Griffiths *et al.* (2000) was initially attempted to generate data on R&D intensities and the potential for spillovers. However, the extent of missing R&D expenditure data generally and almost total absence of R&D data in some of the service sectors meant that R&D intensities and spillovers were excluded from the final analysis.

4.3 Problems with missing data

An exercise such as this is fraught with problems of missing data. In part this is because some countries simply do not collect the necessary data. Where they do collect the data sometimes the classifications used mean that it cannot be reported in terms of the international classifications. With the economic data where we have missing data from years between known data we interpolated the data. However, in no cases was the data extrapolated either backwards or forwards. Despite these efforts there was so little economic data from three of the countries, they were effectively dropped from the subsequent analysis. These were:

- Ireland
- Greece
- Portugal.

Other countries had problems with the skills indicators data. For instance Austria, Sweden and Finland joined the EU during the 1990s which meant that they generally only had five years of data. Most countries, apart from Italy, did not adopt the sectoral classification NACE Rev 1 for their Labour Force Surveys until 1993 or later. This meant that we had no usable data from these countries from the years before the full adoption of NACE Rev 1. Other countries had problems with the occupational classification ISCO or the educational attainment classification ISCED all leading to missing data. Finally, as the Labour Force Surveys are sample surveys small values are unreliable and the various national surveys have different values below which it is necessary to not use the data. However, it should be noted that we used some values, which were possible to impute from two larger and thus legitimate values. As already mentioned the absence of R&D expenditure data from many of the service sectors meant that reluctantly this, and derived R&D spillover data, was dropped from the analysis.

4.4 UK sectoral TFP levels ranked internationally

Table 4.1 is based on the series of sector specific tables in Chapter 6, which indicate the actual relative levels, and shows the UK ranking in terms of Total Factor Productivity (TFP) levels compared with a range of international competitors. This shows that the UK has a number of high TFP sectors. These were:

- Agriculture, hunting, forestry and fishing — second only to Japan.
- Manufacture of food, drink and tobacco — second only to Canada.

- Manufacture of other products and recycling — first amongst the international competitors.
- Transport — second only to the United States.

These sectors do a lot to help keep the UK's overall total factor productivity in contention with our international competitors. However, there are also a number of sectors which are significantly low in the international ranking. These sectors are:

- Wholesale, retail and car repairs — 14th out of 14 competitors.
- Financial services — 14th out of 15 competitors.
- Energy and chemicals —11th out of 16 competitors.
- Manufacture of transport equipment — 11th out of 16 competitors.

Table 4.1: UK international ranking in terms of TFP level

	UK TFP level rank	Number of countries
Agriculture, hunting, forestry and fishing	2	15
Mining and quarrying	9	15
Manufacture of food, drink and tobacco	2	16
Manufacture of textiles and clothing	5	15
Manufacture of wood. pulp and paper products	10	16
Publishing, printing and reproduction of media	3	12
Energy and chemicals	11	16
Manufacture of basic metals and metal products	5	16
Manufacture of machinery and equipment	5	16
Manufacture of transport equipment	11	16
Manufacture of other products and recycling	1	15
Electricity, gas and water supply	5	16
Construction	8	15
Wholesale, retail and car repairs	14	14
Hotels and Restaurants	9	14
Transport	2	11
Post and telecommunications	9	11
Financial services	14	15
Private sector professional services	2	14
Public administration and defence	2=	14
Education	13	14
Health and social work	13	14
Other public and personal services	14	14

Source: IES/SPRU Model

Not only do these sectors drag down the overall productivity of the UK, equally the range of values indicates that productivity is less of a structural UK issue but a sectoral level problem. If all the UK sectors had similar relative TFP levels this would suggest a generic national productivity problem. However, as there is a wide range of relative TFP levels this suggests that the UK overall productivity problems were due to specific UK problems with the performance of some sectors. This in turn suggests that the issues need to be addressed at the sectoral level. Chapter 6 of this report provides detailed analyses of the linkages between the range of skills indicators and sectoral TFP levels as well as TFP growth. As such this begins to provide an answer to why there is such a range in the productivity rankings between the sectors.

4.5 UK sectoral TFP growth ranked internationally

TFP growth is different from TFP levels as this is more about the level of dynamism in the sectoral economy than the relative success of the sector. It is also easier to sustain a high growth rate from a low level than from a high level. However, growth rates, especially those based on relatively short time series such as those used here are very influenced by short-term business cycles. Although it should be acknowledged that part of the process of generating these figures involved an attempt to take business cycles into account. Despite this, given their susceptibility to short term influences much less emphasis is placed on TFP growth rates than TFP levels in the subsequent analysis.

Both of these features of TFP growth are illustrated in Table 4.2 which shows the ranking amongst our international competitors of the UK TFP growth rates.

As with the TFP levels this shows a mixed picture with some sectors performing well and other performing poorly. Generally, reflecting the problem of growing from a high level, those sectors which had high relative TFP levels tend to have low TFP growth rates and vice versa. However, the following sectors have comparatively high TFP growth rates:

- Manufacture of transport equipment — ranked second.
- Financial services — ranked second.
- Energy and chemicals — ranked third.

There were also some UK sectors which have comparatively low TFP growth rates:

- Manufacture of basic metals and metal products — UK ranked 11th out of 16 competitor countries.
- Manufacture of other products and recycling — UK ranked 12th out of 15 competitor countries.

Table 4.2: UK international ranking in terms of TFP growth

	UK TFP growth rank	Number of countries
Agriculture, hunting, forestry and fishing	10	15
Mining and quarrying	4	15
Manufacture of food, drink and tobacco	7	16
Manufacture of textiles and clothing	10	15
Manufacture of wood. pulp and paper products	10	16
Publishing, printing and reproduction of media	6	12
Energy and chemicals	3	16
Manufacture of basic metals and metal products	11	16
Manufacture of machinery and equipment	4	16
Manufacture of transport equipment	2	16
Manufacture of other products and recycling	12	15
Electricity, gas and water supply	9	16
Construction	13	15
Wholesale, retail and car repairs	10	14
Hotels and restaurants	14	14
Transport	5	11
Post and telecommunications	8	11
Financial services	2	15
Private sector professional services	13	14
Public administration and defence	11	14
Education	9	14
Health and social work	3=	14
Other public and personal services	8	14

Source: SPRU/IES Model

- Construction — UK ranked 13th out of 15 competitor countries.

Again this wide variation in the UK's sectoral ranking in terms of TFP growth suggests that the UK's productivity problem is as much a sectoral problem as a national problem.

4.6 Chapter summary

This chapter provided an examination of how the UK's relative Total Factor Productivity levels were calculated and looked at the UK's relative rankings.

5. Results by Skills Indicator

This chapter presents the results of the econometric analysis by skills indicator. The analysis uses data from all the available countries, and after controlling for country looks at the relationships between skills indicator and TFP productivity levels. The first section provides guidance on interpreting the results in this chapter and the next. Then the chapter works its way through the skills indicators in the following sequence:

- Educational high- and intermediate-level educational attainment.
- Impact of training.
- Impact of occupational level.
- Impact of specific occupations.

5.1 Interpreting the regression outputs

This chapter provides the results of a regression examining the linkages between the skills indicators and TFP levels. Importantly, this is based on data from all the sectors and all the countries. The national aspect of the data having been removed using a set of country dummy variables. This provides a wealth of observations with (on average) the regression based on about 2,000 cases. The next sections provide more background and give some information on how to interpret these regression results.

5.1.1 Results for TFP levels

The concept of TFP levels is expanded upon and how this can be interpreted is explained in the box below:

TFP levels

Total Factor Productivity (TFP) levels allow cross country comparisons and refer to national levels of productivity expressed as a proportion of the average level of all the countries. Therefore, a country with above average TFP levels will have a figure above one, and those with a below average level will have figures below one. Due to the method used to calculate the TFP levels, any positive linkage of a skills indicator with TFP levels indicates that the indicator is important for sustaining the current levels of TFP.

5.1.2 Interpreting the regression output

The tables in this chapter presenting the results of the regressions need interpreting with care. There are three indicators that need to be understood in order to interpret them, these are the:

- regression coefficients
- significance of the standard errors
- R-square.

Each of these outputs are explained below and detail is given on how they should be interpreted. It is important to realise that the interpretation of regression outputs involves all three of these indicators.

Regression coefficients

The regression coefficients measure the slope of the regression line and represent the size of the relationship between the skills indicator and either the TFP levels or TFP growth. They can be interpreted relatively easily, if the coefficient is X then if the skills variable changes by one per cent then the TFP levels or TFP growth are also predicted to change by X per cent.

Since the skills variables, as entered in to the regressions, are expressed as proportions, rather than percentages, this means that a one per cent change in any of the indicators are predicted to cause a percentage change of the same size as the coefficient on the levels or growth. A very important aspect of their interpretation is whether the regression coefficients are positive or negative reflecting positive or negative relationships.

Significance of the standard error

The significance measures the statistical significance of the standard error and as such is a measure of the strength of the statistical evidence for the coefficient.

The standard error is a measure of extent to which the data fits the regression line. Or more properly the significance measures the probability of the results being due to chance. As such the significance of the standard error is a measure of how well either TFP levels or TFP growth are explained by the skills indicators. One asterisk represents a one-in-ten chance, or ten per cent, that the results are not due to chance. Two asterisks means that there is a one in every 20, or five per cent, chance that the results are not due to chance. Three asterisks means that there is a one in 100, or one per cent, chance that the result is not due to chance.

R-square

The R-square represents the amount of variance in the model predicted by the variables. It is a standard measure of how much of the dependent variable is explained by the variables in the regression. Therefore, it represents the extent to which the variation in the skills variable explains the variation in either the TFP growth or TFP levels. The values of R-square cannot exceed one, and figures close to one indicate a better fit.

5.1.3 Interaction between human capital variables

Many of the human capital indicators are correlated with each other. Since some are functions of each other, such as the high qualified professional and HRST, this is to be expected. However, there are other more subtle correlations with high-level qualifications correlated with professionals and technicians. This actually causes a number of potential problems with the econometric technique. These correlations introduce what is known as collinearity into the regression. In practice, this has limited the type and extent of analyses that have been possible with the data.

Table 5.1 and Table 5.2 show the correlation matrix between the human capital indicators. Some of these correlation coefficients are very high. For instance there is a correlation coefficient of 0.8750 between the percentage of employees in a sector with high-level education and the percentage of employees in a sector in professional occupations. This is in part to be expected, as it is assumed that those in professional occupations will also have a high-level education.

Table 5.1: Correlation between human capital variables

	High-level	Intermediate	Low-level	HRSTC	SET occupations	ICT occupations
High-level	1					
Intermediate	0.6013	1				
Low-level	0.2523	0.4584	1			
HRSTC	0.9258	0.4312	0.1509	1		
SET occupations	0.6059	0.4739	0.2153	0.5384	1	
ICT occupations	0.4110	0.4643	0.2721	0.3429	0.6108	1
Technicians	0.6909	0.6464	0.2754	0.6609	0.4937	0.4584
Professionals	0.8348	0.3555	0.0825	0.9288	0.4218	0.2483
Managers	0.4511	0.5822	0.3783	0.2786	0.3338	0.2410
Training	0.5347	0.5849	0.2582	0.4733	0.3636	0.3104
High managers	0.6236	0.4650	0.1701	0.4847	0.4325	0.2960
High professionals	0.8337	0.3362	0.1194	0.9369	0.4735	0.2795
R&D expenditure	0.1906	0.4213	0.1551	0.0692	0.2576	0.1807

Source: IES/SPRU Model

Table 5.2: Correlation between human capital variables (continued)

	Technicians	Professionals	Managers	Training	High managers	High professionals	R&D expenditure
High-level							
Intermediate							
Low-level							
HRSTC							
SET occupations							
ICT occupations							
Technicians	1						
Professionals	0.5454	1					
Managers	0.3754	0.2604	1				
Training	0.5206	0.4072	0.4008	1			
High managers	0.3908	0.4446	0.5077	0.2983	1		
High professionals	0.5233	0.9369	0.2168	0.4167	0.2825	1	
R&D expenditure	0.2004	0.0281	0.2286	0.2142	0.1578	0.0291	1

Source: IES/SPRU Model

Other relatively high correlations are also to an extent structural. For instance there is a negative correlation between the percentage with high-level education and the percentage with low-level qualifications. Since these two groups are alternatives this pattern is also to be expected. Other high correlations are a result of how the indicator is specified. The example here is HRSTC or the highly qualified professionals and high-level education. As HRSTC and highly qualified professionals both contain high-level education in their definition, they can be expected to correlate with it.

There are also some more interesting correlations such as the 0.4108 coefficient between training and highly qualified managers or the negative correlation of -0.4903 between training and low levels of educational attainment. However, regardless of the explanation of the correlations they pose potential problems for standard regression techniques. The use of specific techniques such as 'robust' regression and the careful selection of included variables minimised these problems.

5.1.4 Variance inflation factors

One way of addressing the issue of correlation between the explanatory variables is to know its extent. A relatively simple approach is to calculate the Variance Inflation Factor (VIF) for each regression. The VIF measures the impact of collinearity between the variables in the regression on the precision of the estimates generated. In practice a mean VIF greater than 10 is felt to indicate too much collinearity (Chatterjee *et al.*, 2000).

5.1.5 Other potential methodologies

There are a range of sophisticated regression techniques that can address both the collinearity and other problems with the data such as endogeneity. These are largely variants of panel analysis techniques. However, we found that the human capital indicators changed very slowly with time. This is in the nature of these sorts of variables, which are usually only changed by younger more qualified people entering a sector and older less qualified people leaving the sector. This in turn means that many of the panel analysis techniques that use rates of change, or first differences, are less applicable. Equally, the extent of missing values in the data also precludes many of these advanced techniques. There is a case, and this is explored in section 7.2.1, for spending further time imputing missing values and undertaking some forms of panel analysis, however this is beyond the scope of the present study.

5.1.6 Dummy values and instrument variables

As already mentioned the extent of missing values was problematic. Where legitimate and possible to do so, attempts to address the problem were made by imputing values. The main approach used to address this problem was the inclusion of dummy variables. This effectively meant that cases were not dropped where there was missing data on one variable. This maximised the use of all the available data and to an extent controlled for the missing values.

Similar dummy variables, or instrument variables, were used to control for the fixed effects potentially introduced by countries, sectors or years. These instrument variables also allowed the residual impacts of countries, sectors and years to be examined.

5.2 The indicators regression

5.2.1 The formulation

By using dummy variables it was possible to enter a range of variables and examine their interactions with countries and sectors. However, the main focus of this regression was the relationship between the human capital variables and TFP levels. The regression described in Chapter 6 focused on the sector specific impact of these human capital variables.

5.2.2 Variables included in the regression

The following variables were included in the regression:

- High-level education — the proportion of the workforce with high-level educational qualifications

- Intermediate education — the proportion of the workforce with intermediate-level educational qualification
- Managers — the proportion of the workforce in ISCO level 1, or managerial, type occupations
- Training – the proportion of the workforce reporting education or training in the last four weeks
- ICT occupations — the proportion of the workforce Information and Communication Technology related occupations
- Professionals — the proportion of the workforce in ISCO level 2, or professional, occupations
- Country dummies — these are included to assess and to an extent deal with any country level fixed effects
- Sector dummies — as with the country dummies these are included to assess and counter any sector level fixed effects
- Year dummies — again these are included to examine and counter any fixed effects due to the year the data comes from
- Missing values dummies — these are included to examine the impact of missing values and to ensure that cases are included even if they are missing some variables.

5.2.3 Variables excluded from the analysis

A range of variables were examined for inclusion in the model, but were dropped for a range of reasons. These were:

- Low-level education — once high-level and intermediate-level education were included this variable was essentially redundant and when its inclusion was tested it tended to introduce multi-collinearity.
- Research and Development (R&D) expenditure — this has relatively high correlations with a range of other included variables and as such tended to generate more multi-collinearity than its explanatory power justified. At the same time there was a lot of R&D expenditure data that was missing especially in the service sectors which provided another reason for its exclusion.
- SET occupations — these are all professional occupations and as such are highly correlated with the proportion of the workforce in professional occupations. Therefore, when it was tested it introduced a lot of multi-collinearity.
- Highly qualified managers — this as it represents the intersection of high-level education and managers is understandably correlated with both of these groups. These correlations as would be expected generated multi-collinearity when introduced.

- Highly qualified professions — as with the highly qualified managers this variable is already highly correlated with other variables, and as such were excluded.

5.3 Indicator regression results

Overall 2,148 cases were included in the regression. This is less than the theoretical 2,691 cases (23 sectors by 13 countries by nine years). However, cases were dropped where we did not have data for TFP levels and/or high-level and intermediate-level education. Since TFP level was our dependent variable this was logical. High-level and intermediate-level education were also selected as necessary variables, as previous work in this area has shown the importance of these variables (Sianesi, Van Reenen, 2000). Dropping these cases meant that we lost 13 per cent of our theoretical maximum. However, we also lost a large proportion of the cases with missing values and thus improved the reliability of the analysis at little loss to the number of cases.

Table 5.3: Indicator level regression results

Variable	Coefficient	Standard errors	VIF
High-level education	0.367	[0.112]***	16.65
Intermediate-level education	0.173	[0.076]**	5.99
Training in last 4 weeks	-0.007	[0.149]	7.93
Missing training values	0.007	[0.042]	6.37
Managers	0.121	[0.123]	3.62
Missing manager values	0.059	[0.049]	4.06
ICT occupations	0.645	[0.553]	3.29
Missing ICT values	0.065	[0.041]	2.29
Professionals	-0.086	[0.085]	9.08
Missing professional values	-0.121	[0.046]***	4.03
1992 year dummy	0.157	[0.049]***	1.27
1993 year dummy	0.056	[0.027]**	1.69
1994 year dummy	0.046	[0.028]*	1.68
1995 year dummy	0.018	[0.025]	2.04
1996 year dummy	0.021	[0.022]	1.90
1997 year dummy	0.011	[0.021]	1.82
1998 year dummy	0.008	[0.021]	1.71
1999 year dummy	0.005	[0.021]	1.73
2000 year dummy	0.003	[0.021]	1.75
Belgium dummy	-0.001	[0.050]	3.89
Denmark dummy	-0.057	[0.043]	3.16
Germany dummy	-0.066	[0.045]	2.82
Spain dummy	-0.047	[0.054]	5.30

Variable	Coefficient	Standard errors	VIF
France dummy	0.047	[0.049]	4.52
Italy dummy	0.060	[0.051]	5.33
Luxembourg dummy	0.139	[0.052]***	3.58
Netherlands dummy	-0.007	[0.047]	1.95
Austria dummy	-0.045	[0.047]	3.30
Finland dummy	-0.120	[0.043]***	2.61
Sweden dummy	-0.047	[0.045]	2.22
US dummy	-0.005	[0.052]	4.77
Mining & quarrying dummy	-0.029	[0.056]	1.09
Food, drink & tobacco dummy	0.104	[0.041]**	2.20
Textiles & clothing dummy	0.003	[0.040]	1.87
Wood, pulp & paper dummy	0.142	[0.066]**	1.54
Publishing & printing dummy	0.069	[0.044]	1.63
Energy & chemicals dummy	0.007	[0.044]	2.64
Metals & metal products dummy	0.000	[0.041]	2.36
Machinery & equipment dummy	0.038	[0.069]	3.83
Transport equipment dummy	0.079	[0.046]*	1.92
Furniture & other products dummy	0.079	[0.040]**	1.53
Electricity, gas & water dummy	-0.020	[0.088]	1.65
Construction dummy	0.065	[0.041]	3.00
Wholesale & retail dummy	0.035	[0.040]	6.26
Hotels & restaurants dummy	0.096	[0.046]**	2.41
Transport dummy	0.081	[0.040]**	1.97
Post & telecoms dummy	0.035	[0.068]	1.64
Financial services dummy	0.032	[0.062]	3.64
Professional private services dummy	-0.098	[0.079]	8.18
Public admin & defence dummy	0.007	[0.046]	4.32
Education dummy	-0.038	[0.071]	11.40
Health & social work dummy	0.027	[0.050]	11.55
Community & other services dummy	0.017	[0.047]	2.88
Constant	0.786	[0.078]***	---
Observations	2,148	---	---
R-squared	0.151	---	---
Mean VIF	---	---	3.81

Standard errors in brackets; * significant at 10%; ** significant at 5%; *** significant at 1%.

Source: IES/SPRU Model

Table 5.3 presents:

- the regression coefficients which are a measure of the size of the interaction

- the standard error which measure how well the data fits the regression line
- the significance of the standard error with one asterisk representing a one-in-ten chance, two asterisks a one-in-fifty chance and three asterisks a one-in-a hundred chance that the result is not due to chance
- the Variance Inflation Factor (VIF) which measures the impact of the variable on the overall variance and by implication the extent of multi-collinearity
- the number of observations used in the regression, and
- the R-squared which is a measure of how much of the variation in the TFP level is explained by the skills indicator.

Overall, the R-square of 0.151 was obtained with a mean VIF of 3.81. The R-square suggests that only about 15 per cent of the variance in TFP levels has been explained by the included variables. This is not a particularly high R-square, but is typical of this sort of data. Perhaps more importantly the mean VIF is well below the suggested maximum of ten which means that problems due to multi-collinearity were avoided due to the selection of variables included in the analysis. The constant has a large coefficient and a significant standard error indicating that there remain other factors which have not been included in the analysis.

The results for each of the variables are discussed in turn below:

- High-level education — this has a relatively large coefficient and a significant standard error, which emphasises the importance of this sort of education for productivity found in previous international comparisons (for example: De La Fuente, Doménech, 2002). The high Variance Inflation Factor (VIF) indicates that part of the coefficient may be due to correlations with other factors such as professionals and training.
- Intermediate education — this has a smaller coefficient and the standard error while still significant is less so than the one for high-level education. Again this result is consistent with previous national comparisons and sector level case studies which both emphasise the importance of this level of education for firm level productivity (Mason, 2001).
- Training in last four weeks — this has a small negative coefficient, but the standard error is not significant. Although, the lack of significance suggests not too much weight should be put on this negative result it is perhaps perplexing. In part an explanation can be derived from the high correlation between training and high-level education which in turn suggests that much of the benefits of training are being picked up by the high-level education variable.

- Managers — this has a small positive coefficient but the standard error is not significant. This suggests that at an all sector level any impacts of managers are clouded by the other variables.
- ICT Occupations — as with managers this has a small positive coefficient and a non-significant standard error. As before this suggests that at the all sector level the impact of ICT is not clear.
- Professionals — this has a small negative coefficient but the standard error is not significant. Importantly, the missing values dummy for professionals is also negative and in this case the standard error is significant. This suggests that there might be problems interpreting the results for this variable due to the pattern of missing values.
- Country dummies — only two country dummies are significant: Luxembourg has a large significant positive coefficient suggesting that some unobserved factors give Luxembourg a high TFP level. Conversely, Finland has a significant negative coefficient suggesting that factors not included in the regression cause a lower than expected TFP level.
- Sector dummies — some of the sectors have significant standard errors suggesting un-examined sector specific effects. However, none of the associated coefficients are particularly large which suggests that this should not cause concern for this all sector analysis.
- Year dummies — the standard errors for 1992 and 1993 are significant probably reflecting the greater extent of missing values in these years as various countries adopted the international classifications at different speeds.

The following chapter, Chapter 6, provides a more detailed sector by sector analysis of the impact of these variables.

5.4 Chapter summary

This chapter examined the interaction of a range of skills indicators with national TFP levels. The chapter introduced the interpretation of the regression outputs used. This showed that at this level of aggregation there was a high level of correlation between many of the measures. At the same time the only significant results to emerge were a linkage with intermediate-level skills and a stronger one with high-level skills.

6. Sectoral Patterns

This chapter presents the results of the econometric analysis by sector. Importantly, it needs to be realised that these results reflect the common sectoral aspects across the 16 countries included in the analysis. The regression used is detailed in the Technical Annex, however it included the same variables as used in Chapter 5. Those were:

- high-level education
- intermediate-level education
- education or training in the last four weeks
- ICT occupations
- management, and
- professionals.

All of these variables for each sector, plus the following were entered into the regression:

- dummy variables, where there were missing values
- country dummies
- year dummies for 1992 to 2002, and
- sector dummies.

Overall, there were 2,148 observations. This is as with the previous regression is less than the theoretical 2,691cases (23 sectors by 13 countries by nine years). However, as with the previous regression in Chapter 5 cases were excluded where we did not have data for TFP levels and/or high-level and intermediate-level education.

The regression had an R-square of 0.43 and a mean VIF of 21.65. The R-square is more than adequate for this sort of regression. However, the mean VIF is high, indicating multi-collinearity due to correlations between the variables in the regression. In part the high R-square can be attributed to this multi-collinearity. The standard assumption is that the cut-off point is a mean VIF of about ten (Chatterjee *et al.*, 2000), therefore a potential word of caution needs to be taken on board with these results. However, this probably means that the coefficients are slightly inflated, the pattern and relative strengths of the relationships are unaffected.

The country, sector and year dummies are explored later, however the regression output, which is displayed in full in Table A2 in the Technical Annex, is split up into its sectoral components for convenience below. The sectors used were defined in Section 2.1.4, but for the reader's convenience, they have been defined again at the beginning of each section.

An important feature about the sectoral regression results reported here is that they represent a pooled result over the period covered (1992 to 2002), and also over the countries covered. The remaining national and year contributions are given by the country and year dummies at the end of this chapter.

6.1 Agriculture, hunting, forestry and fishing

6.1.1 Definition of the sector

The agriculture, hunting, forestry and fishing sector is defined in terms of the following SIC codes:

- SIC 01 — agriculture, hunting and related activities
- SIC 02 — forestry, logging and related activities
- SIC 05 — fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing.

6.1.2 Mean TFP levels and growth in agriculture

The first thing to notice in Table 6.1 is that there is no data for Spain; this is due to missing output data in the STAN database. Apart from Japan, the UK has the highest TFP level for agriculture. This indicates that UK agriculture is highly productive given levels of capital and labour inputs.

Table 6.1: Mean TFP levels and growth in agriculture by country

	TFP levels	TFP growth
Austria	0.386	0.048
Belgium	1.122	0.029
Canada	1.298	0.027
Denmark	0.790	0.026
Finland	0.761	0.045
France	1.141	0.007
Germany	0.906	0.029
Italy	1.138	0.024
Japan	1.686	0.014
Luxembourg	0.729	0.045
Netherlands	1.072	0.011
Norway	0.822	0.022
Spain	–	–
Sweden	1.301	0.003
United Kingdom	1.310	0.021
United States	1.264	0.018

Source: IES/SPRU Model

6.1.3 Results for TFP levels in agriculture

Given that the UK has relatively high TFP levels for the agriculture sector, the factors that are associated with high TFP levels are important (Table 6.1).

Table 6.2 shows that high-level skills are important with a coefficient of 2.365. This indicates that a one per cent increase in employees in agriculture with high-level educational attainment is associated with a 2.4 per cent growth in TFP levels. The most important group of workers in the sector appear to be ICT workers, as a one per cent increase in this group is associated with a 43 per cent increase in TFP levels. This seems a very large figure and obviously has its limits as also suggested by the high standard error. One suggested explanation is that ICT has a bigger impact on TFP levels in sectors where only a few countries have used ICT. This suggests that sectors where ICT use is the norm it has less potential to generate differential performance. The relatively low significance and the large standard error for ICT supports this explanation. Finally, the sector dummy was not reported, as all other sectors have been judged against the agriculture sector.

Table 6.2: TFP levels and skills indicators in agriculture internationally

Indicator	Coefficient	Standard errors	Significance
High-level education	2.365	1.237	*
Intermediate-level education	-0.254	0.258	
Training in the last 4 weeks	0.602	0.494	
ICT occupations	42.707	22.471	*
Managers	0.265	0.217	
Professionals	-2.791	4.733	
Sector dummy	--	--	--

Source: IES/SPRU Model

6.2 Mining and quarrying

6.2.1 Definition of the sector

The mining and quarrying sector is defined in terms of the following SIC codes:

- SIC 10 — mining of coal and lignite; extraction of peat
- SIC 11 — extraction of crude petroleum and natural gas; services activities incidental to oil and gas extraction including surveying
- SIC 12 — mining of uranium and thorium ores
- SIC 13 — mining of metal ores
- SIC 14 — other mining and quarrying.

6.2.2 Mean TFP levels and growth in mining and quarrying

Table 6.3 shows that the UK has a below average TFP level in the mining and quarrying sector. The TFP growth rate for the UK is also the lowest for all the countries. Since the figures have been deflated, this indicates that TFP growth in this sector in the UK has barely exceeded inflation. Given that North Sea oil and gas is still relatively important to the UK economy this is potentially a problem. Italy has the highest TFP level for all the countries under consideration. While Belgium had the highest TFP growth rates and the second highest TFP levels, Norway and Denmark, also both with significant North Sea oil and gas operations showed negative TFP growth rates, suggesting general problems in this area.

Table 6.3: Mean TFP levels and growth in mining and quarrying

	TFP levels	TFP growth
Austria	0.972	0.033
Belgium	1.123	0.059
Canada	0.733	-0.006
Denmark	0.734	-0.048
Finland	0.646	0.030
France	--	--
Germany	0.729	0.021
Italy	1.239	-0.022
Japan	1.019	0.047
Luxembourg	0.933	-0.023
Netherlands	2.062	0.016
Norway	0.682	-0.041
Spain	1.113	0.054
Sweden	1.056	0.005
United Kingdom	0.923	0.040
United States	0.681	0.037

Source: IES/SPRU Model

6.2.3 Results for TFP levels and skills indicators

In terms of TFP levels, ICT occupations had the highest coefficient at 3.7, followed by high-level education (see Table 6.4). Although, none of the standard errors were particularly significant so some caution is needed. This suggests that to sustain TFP levels in the mining and quarrying sector requires ICT and highly educated people. This in turn suggests that mining and quarrying should not been seen as a low skill sector. It is possible that the UK has seen the sector as low skill and this explains the UK's relatively poor showing of the sector internationally.

Table 6.4: TFP levels and skills indicators in mining and quarrying internationally

Indicator	Coefficient	Standard errors	Significance
High-level education	0.150	0.4516	
Intermediate-level education	-0.193	0.139	
Training in the last 4 weeks	0.646	0.540	
ICT occupations	3.668	2.361	
Managers	-0.442	0.864	
Professionals	-0.415	0.949	
Sector dummy	0.105	0.141	

Source: IES/SPRU Model

6.3 Manufacture of food, drink and tobacco

6.3.1 Definition of the sector

The manufacture of food, drink and tobacco sector is defined in terms of the following SIC codes:

- SIC 15: manufacture of food products and beverages
- SIC 16: manufacture of tobacco products.

6.3.2 TFP levels and growth in food drink and tobacco

Apart from Canada, the UK had the highest TFP levels in the food, drink and tobacco sector. However, Austria and Finland had the highest TFP growth. Since the Netherlands also had the third highest TFP level, their growth rate suggests that they may overtake the UK soon (Table 6.5).

Table 6.5: TFP levels and growth in food, drink and tobacco by country

	TFP levels	TFP growth
Austria	0.920	0.030
Belgium	1.025	0.006
Canada	1.372	-0.001
Denmark	0.882	0.010
Finland	0.874	0.028
France	0.991	0.006
Germany	0.790	0.011
Italy	0.976	-0.008
Japan	1.180	-0.003
Luxembourg	0.785	-0.019
Netherlands	1.123	0.021
Norway	0.929	-0.001
Spain	1.172	-0.029
Sweden	0.886	0.013
United Kingdom	1.210	0.006
United States	1.206	-0.014

Source: IES/SPRU Model

Table 6.6: TFP levels and skills indicators in food drink and tobacco internationally

Indicator	Coefficient	Standard errors	Significance
High-level education	-0.095	0.421	
Intermediate-level education	0.055	0.134	
Training in the last 4 weeks	0.829	0.263	***
ICT occupations	0.312	2.520	
Managers	2.689	0.527	***
Professionals	-0.091	1.392	
Sector dummy	-0.031	0.124	

Source: IES/SPRU Model

6.3.3 Results for TFP levels and skills indicators

The two highly significant regression results for the food drink and tobacco sector are a positive linkage between both training and managers with TFP levels (Table 6.6). None of the other variables have particularly large coefficients and the sector dummy has a very small coefficient. Overall, this suggests that internationally the combination of training and management generates higher levels of TFP in this sector.

6.4 Manufacture of textiles and clothing

6.4.1 Definition of the sector

The manufacturing of textiles and clothing sector is defined in terms of the following SIC codes:

- SIC 17 — manufacture of textiles
- SIC 18 — manufacture of wearing apparel; dressing and dyeing of furs
- SIC 19 — tanning and dressing of leather, manufacture of luggage, handbags, saddlery, harness and footwear.

6.4.2 TFP levels and growth in textiles and clothing

The UK's TFP levels in the textiles and clothing sector are above average, but behind those of France and three other countries. Similarly, the UK's TFP growth figures for this sector are not impressive in comparison with our international competitors. Denmark, followed by Belgium Sweden and Norway, had the highest TFP growth figures (Table 6.7).

Table 6.7: TFP levels and growth in textiles and clothing by country

	TFP levels	TFP growth
Austria	0.980	0.031
Belgium	0.926	0.037
Canada	1.039	0.009
Denmark	0.895	0.041
Finland	0.932	0.033
France	1.206	0.019
Germany	1.003	0.030
Italy	1.006	0.010
Japan	--	--
Luxembourg	1.168	0.007
Netherlands	1.069	0.032
Norway	0.914	0.032
Spain	0.938	-0.003
Sweden	0.835	0.033
United Kingdom	1.031	0.020
United States	0.928	0.025

Source: IES/SPRU Model

6.4.3 Results for TFP levels and skills indicators

The most significant result for the textiles and clothing industry is the positive impact of intermediate-level education (Table 6.8). ICT occupations, training and professionals also had positive coefficients, but were not significant. Presumably, because high-level education displaces those with intermediate-level education it has a negative coefficient. However, this negative coefficient for high-level education, along with the negative coefficient for managers, was not significant.

Table 6.8: TFP levels and skills indicators in textiles and clothing internationally

Indicator	Coefficient	Standard errors	Significance
High-level education	-0.360	0.555	
Intermediate-level education	0.605	0.135	***
Training in the last 4 weeks	1.303	0.538	
ICT occupations	1.819	1.573	
Managers	-0.061	0.570	
Professionals	1.099	1.258	
Sector dummy	-0.155	0.100	

Source: IES/SPRU Model

6.5 Manufacture of wood, pulp and paper products

6.5.1 Definition of the sector

The manufacture of wood, pulp and paper products sector is defined in terms of the following SIC codes:

- SIC 20 – manufacture of wood and products of wood and cork, except furniture
- SIC 21 – manufacture of pulp, paper and paper products.

6.5.2 TFP levels and growth in wood, pulp and paper products

The UK had below average TFP levels for the wood, pulp and paper products sector. Surprisingly, perhaps, Denmark had the highest TFP levels. The UK also had relatively poor TFP growth rates. Canada had the highest TFP growth rates in the sector, while Luxembourg showed a declining TFP growth rate (Table 6.9).

Table 6.9: Mean TFP levels and growth in wood, pulp and paper products by country

	TFP levels	TFP growth
Austria	0.836	0.015
Belgium	0.936	0.011
Canada	0.482	0.042
Denmark	1.872	0.004
Finland	1.130	0.027
France	1.051	0.023
Germany	0.898	0.018
Italy	0.846	0.000
Japan	1.223	0.014
Luxembourg	0.753	-0.078
Netherlands	1.042	0.012
Norway	1.009	0.034
Spain	1.027	-0.032
Sweden	1.201	-0.004
United Kingdom	0.968	0.009
United States	1.326	0.001

Source: IES/SPRU Model

Table 6.10: TFP levels and skills indicators in wood, pulp and paper products internationally

Indicator	Coefficient	Standard errors	Significance
High-level education	1.900	0.695	***
Intermediate-level education	0.567	0.183	***
Training in the last 4 weeks	2.351	1.361	*
ICT occupations	-9.965	8.743	
Managers	-0.936	1.183	
Professionals	-5.306	3.199	*
Sector dummy	-0.060	0.157	

Source: IES/SPRU Model

6.5.3 Results for TFP levels and skills indicators

Both high-level and intermediate-level education have positive and significant linkages to TFP levels in the wood, pulp and paper products sector (Table 6.10). However, the largest positive coefficient was associated with training in the last four weeks, but this was less significant. Both professionals and ICT occupations had relatively large negative coefficients, but these were not significant.

6.6 Publishing, printing and reproduction of media

6.6.1 Definition of the sector

The publishing, printing and reproduction of media sector is defined in terms of the following SIC code:

- SIC 22: publishing, printing and reproduction of recorded media.

6.6.2 TFP levels and growth in publishing *etc*

In the publishing, printing and reproduction of recorded media the UK is second only to the USA in terms of TFP levels. However, the TFP growth rates in the UK are moderate compared with some other countries, although they are positive which is more than can be said for most countries (Table 6.11).

Table 6.11: Mean TFP levels and growth in publishing and printing by country

	TFP levels	TFP growth
Austria	1.070	0.022
Belgium	0.977	0.017
Canada	.	.
Denmark	.	.
Finland	0.926	0.021
France	1.228	-0.005
Germany	0.964	-0.008
Italy	1.007	-0.001
Japan	.	.
Luxembourg	.	.
Netherlands	1.069	0.013
Norway	1.032	-0.017
Spain	1.060	-0.040
Sweden	0.875	0.034
United Kingdom	1.163	0.002
United States	1.167	-0.019

Source: IES/SPRU Model

6.6.3 Results for TFP levels and skills indicators

The largest positive coefficient, which was also significant, in the printing and publishing sector was for ICT occupations (Table 6.12). Intermediate-level education, training in the last four weeks and mangers were also positive and significant. A suggestion that this sector may have too many graduates comes from the significant negative coefficient associated with high-level education.

Table 6.12: TFP levels and skills indicators in printing and publishing internationally

Indicator	Coefficient	Standard errors	Significance
High-level education	-0.434	0.201	**
Intermediate-level education	0.555	0.140	***
Training in the last 4 weeks	0.634	0.183	***
ICT occupations	2.863	1.300	**
Managers	0.793	0.313	**
Professionals	-0.148	0.302	
Sector dummy	-0.075	0.120	

Source: IES/SPRU Model

6.7 Energy and chemicals

6.7.1 Definition of the sector

The energy and chemicals sector is defined in terms of the following SIC codes:

- SIC 23: manufacture of coke, refined petroleum products and nuclear fuel
- SIC 24: manufacture of chemicals
- SIC 25: manufacture of rubber and plastic products
- SIC 26: manufacture of other non-metallic mineral products.

6.7.2 TFP levels and growth in energy & chemicals

The UK's energy and chemicals sector has a below average TFP level. However, Japan has a vastly greater TFP level of 4.1 and if this was excluded it is highly likely that the UK would be at or slightly above average (Table 6.13).

Table 6.13: Mean TFP levels and growth in energy and chemicals by country

	TFP levels	TFP growth
Austria	0.906	0.029
Belgium	1.157	0.009
Canada	1.016	0.015
Denmark	0.840	0.014
Finland	0.830	0.014
France	1.090	0.014
Germany	0.886	0.017
Italy	1.062	-0.009
Japan	4.144	0.039
Luxembourg	0.827	0.019
Netherlands	0.999	0.014
Norway	0.952	0.000
Spain	1.044	-0.020
Sweden	1.023	-0.001
United Kingdom	0.920	0.023
United States	1.126	0.011

Source: IES/SPRU Model

Table 6.14: TFP levels and skills indicators in energy and chemicals internationally

Indicator	Coefficient	Standard errors	Significance
High-level education	0.090	0.311	
Intermediate-level education	0.375	0.135	***
Training in the last 4 weeks	-0.210	0.207	
ICT occupations	-4.331	1.454	***
Managers	1.484	0.463	***
Professionals	-0.744	0.816	
Sector dummy	0.031	0.124	

Source: IES/SPRU Model

6.7.3 Results for TFP levels and skills indicators

The largest significant positive coefficient in the energy and chemicals sector was associated with managers (Table 6.14).

The other positive and significant coefficient was for intermediate-level education. Importantly, the largest significant coefficient was negative and associated with ICT occupations.

6.8 Manufacture of basic metals and metal products

6.8.1 Definition of the sector

The manufacture of basic metals and metal products sector is defined in terms of the following SIC codes:

- SIC 27 — manufacture of basic metals
- SIC 28 — manufacture of fabricated metal products, except machinery and equipment.

6.8.2 TFP levels and growth in metals and parts

The UK has above average TFP levels in the basic metals and metal products sector. However, the UK is behind Norway, which has the highest levels, as well as Belgium, the USA and France.

In terms of TFP growth the UK ranked ninth out of 16 (Table 6.15).

Table 6.15: Mean TFP levels and growth in metals and fabricated metal parts by country

	TFP levels	TFP growth
Austria	0.906	0.030
Belgium	1.155	0.018
Canada	1.046	0.014
Denmark	0.850	0.004
Finland	0.904	0.016
France	1.133	0.007
Germany	0.905	0.016
Italy	0.902	0.011
Japan	0.932	0.016
Luxembourg	0.901	0.050
Netherlands	1.006	0.014
Norway	1.216	0.018
Spain	0.878	-0.008
Sweden	1.034	0.003
United Kingdom	1.102	0.011
United States	1.144	0.015

Source: IES/SPRU Model

6.8.3 Results for TFP levels and skills indicators

As with many of the other mature manufacturing sectors metals and fabricated parts generates significant positive coefficients for mangers and intermediate-level education (Table 6.16). The other significant coefficient was the sector dummy. This suggests that there remains another factor that explains high-levels of TFP for this sector that has not been included in the regression.

Table 6.16: TFP levels and skills indicators in metals and fabricated parts internationally

Indicator	Coefficient	Standard errors	Significance
High-level education	0.082	0.302	
Intermediate-level education	0.741	0.106	***
Training in the last 4 weeks	-0.243	0.298	
ICT occupations	-0.173	0.816	
Managers	1.530	0.505	***
Professionals	-1.255	0.985	
Sector dummy	-0.226	0.104	**

Source: IES/SPRU Model

6.9 Manufacture of machinery electrical and optical equipment

6.9.1 Definition of the sector

The manufacture of machinery and equipment sector is defined in terms of the following SIC codes:

- SIC 29 — manufacture of machinery and equipment not elsewhere classified
- SIC 30 — manufacture of office machinery and computers
- SIC 31 — manufacture of electrical machinery and apparatus not elsewhere classified
- SIC 32 — manufacture of radio, television and communication equipment and apparatus
- SIC 33 — manufacture of medicinal, precision and optical instruments, watches and clocks.

6.9.2 TFP levels and growth in machinery, electrical and optical equipment

Table 6.17: Mean TFP levels and growth in machinery, electrical and optical equipment

	TFP levels	TFP growth
Austria	0.963	0.072
Belgium	1.143	0.068
Canada	0.944	0.018
Denmark	0.868	0.031
Finland	0.951	0.029
France	1.179	0.053
Germany	1.064	0.056
Italy	1.060	0.027
Japan	0.675	0.039
Luxembourg	0.858	0.028
Netherlands	0.882	0.052
Norway	0.920	0.015
Spain	1.154	0.031
Sweden	0.915	0.027
United Kingdom	1.089	0.064
United States	1.313	0.089

Source: IES/SPRU Model

In the machinery, electrical and optical equipment sector, the USA has the highest TFP levels. The UK is ranked fifth, behind the USA France, Spain and Belgium. However, the UK is ranked third in terms of TFP growth, behind the USA and Austria (Table 6.17).

6.9.3 Results for TFP levels and skills indicators

In the machinery, electrical and optical equipment sector the largest significant positive coefficient is associated with high-level education (Table 6.18). Managers also have a significant positive coefficient as well as intermediate-level education. However, both training and the sector dummy had negative significant coefficients. This suggests that training has a negative impact in this sector. This is possibly because training is given predominantly to those with high and intermediate-level education and its positive impact is therefore explained by level of education.

Table 6.18: TFP levels and skills indicators in machinery, electrical and optical equipment

Indicator	Coefficient	Standard errors	Significance
High-level education	1.156	0.294	***
Intermediate-level education	0.918	0.214	***
Training in the last 4 weeks	-1.243	0.344	***
ICT occupations	0.598	0.513	
Managers	1.492	0.686	**
Professionals	0.112	0.569	
Sector dummy	-0.514	0.162	***

Source: IES/SPRU Model

The negative coefficient for the sector dummy suggests that a negative and unknown factor was not in the regression.

6.10 Manufacture of transport equipment

6.10.1 Definition of the sector

The manufacture of transport equipment is defined in terms of the following SIC codes:

- SIC 34 — Manufacture of motor vehicles, trailers and semi-trailers.
- SIC 35 — Manufacture of other transport equipment.

6.10.2 TFP levels and growth in transport equipment

In the manufacture of transport equipment sector, the UK was below average in terms of TFP levels. However, in terms of TFP growth, the UK was second only to Japan (Table 6.19).

Table 6.19: Mean TFP levels and growth in manufacture of transport equipment by country

	TFP levels	TFP growth
Austria	0.961	0.025
Belgium	1.292	0.016
Canada	1.252	0.007
Denmark	0.697	0.007
Finland	0.884	0.026
France	1.078	0.034
Germany	1.102	0.004
Italy	0.977	0.015
Japan	0.911	0.044
Luxembourg	0.715	0.013
Netherlands	0.674	0.034
Norway	1.016	-0.003
Spain	1.050	0.023
Sweden	1.061	-0.004
United Kingdom	0.916	0.037
United States	1.463	0.009

Source: IES/SPRU Model

6.10.3 Results for TFP levels and skills indicators

The largest positive coefficient in the transport equipment manufacturing sector is associated with intermediate-level education (Table 6.20). The other factor significantly and positively associated with TFP levels in this sector are professionals. Interestingly, training again has a significant but negative coefficient in this sector. Another explanation in addition to those advanced before may be that training is remedial and countries with a poor TFP record may be investing in training in an effort to improve the situation.

Table 6.20: TFP levels and skills indicators in manufacture of transport equipment

Indicator	Coefficient	Standard errors	Significance
High-level education	0.201	0.270	
Intermediate-level education	0.762	0.109	***
Training in the last 4 weeks	-0.950	0.272	***
ICT occupations	-0.874	0.896	
Managers	-0.353	0.646	
Professionals	1.392	0.630	**
Sector dummy	-0.130	0.117	

Source: IES/SPRU Model

6.11 Manufacture of other products and recycling

6.11.1 Definition of the sector

The manufacture of other products and recycling is defined in terms of the following SIC codes:

- SIC 36 — Manufacture of furniture, manufacturing not elsewhere specified.
- SIC 37 — Recycling.

6.11.2 TFP levels and growth in other products and recycling

In the manufacture of other products and recycling sector, the UK has the highest TFP level of all the countries covered. With lower TFP levels than the UK, but above average, they were, in sequence: the USA; Canada; France; Norway; Germany and Spain. All of the other countries had below average TFP levels. Despite the high ranking for the UK in terms of TFP levels, the UK had a negative TFP growth over the period in question (Table 6.21).

Table 6.21: Mean TFP levels and growth in other products and recycling by country

	TFP levels	TFP growth
Austria	0.904	0.023
Belgium	0.924	0.014
Canada	1.156	-0.010
Denmark	0.958	-0.008
Finland	0.921	0.021
France	1.114	0.011
Germany	1.070	0.005
Italy	0.965	0.001
Japan	.	.
Luxembourg	0.976	0.013
Netherlands	0.985	0.012
Norway	1.106	-0.011
Spain	1.031	-0.020
Sweden	0.582	0.032
United Kingdom	1.238	-0.009
United States	1.207	0.011

Source: IES/SPRU Model

Table 6.22: TFP levels and skills indicators in other products and recycling internationally

Indicator	Coefficient	Standard errors	Significance
High-level education	0.214	0.344	
Intermediate-level education	0.466	0.110	***
Training in the last 4 weeks	-0.095	0.345	
ICT occupations	4.073	1.995	**
Managers	1.448	0.448	***
Professionals	0.870	1.366	
Sector dummy	-0.150	0.108	

Source: IES/SPRU Model

6.11.3 Results for TFP levels and skills indicators

The largest significant and positive coefficient in the other products and recycling is associated with managers (Table 6.22). The other positive and significant coefficients are associated with intermediate-level education and managers.

6.12 Electricity, gas and water supply

6.12.1 Definition of the sector

The electricity, gas and water supply sector is defined in terms of the following SIC codes:

- SIC 40 — Electricity, gas, steam, and hot water supply.
- SIC 41 — Collection, purification and distribution of water.

6.12.2 TFP levels and growth in electricity, gas *etc*

In the electricity, gas and water supply sector, the UK is ranked fifth, behind, in order, Spain, Belgium, Italy and Norway. However, in terms of TFP growth the UK is ranked ninth. Norway with its hydroelectric potential is ranked first, followed by France with its large nuclear electric capacity (Table 6.23).

Table 6.23: Mean TFP levels and growth in electricity, gas and water supply by country

	TFP levels	TFP growth
Austria	0.919	0.028
Belgium	1.334	0.024
Canada	0.958	0.023
Denmark	0.957	-0.014
Finland	0.849	0.019
France	0.922	0.029
Germany	0.846	0.020
Italy	1.173	-0.008
Japan	0.789	-0.001
Luxembourg	0.893	0.013
Netherlands	1.015	-0.001
Norway	1.079	0.035
Spain	1.492	-0.051
Sweden	1.044	0.005
United Kingdom	1.070	0.011
United States	1.062	0.000

Source: IES/SPRU Model

6.12.3 Results for TFP levels and skills indicators

The only significant coefficient in the electricity, gas and water supply sector is associated with high-level education (Table 6.24). The other coefficients are relatively small and not significant.

Table 6.24: TFP levels and skills indicators in electricity, gas and water supply

Indicator	Coefficient	Standard errors	Significance
High-level education	0.724	0.218	***
Intermediate-level education	-0.161	0.216	
Training in the last 4 weeks	0.002	0.209	
ICT occupations	0.193	0.264	
Managers	-0.310	0.490	
Professionals	0.279	0.451	
Sector dummy	0.114	0.150	

Source: IES/SPRU Model

6.13 Construction

6.13.1 Definition of the sector

The construction sector is defined in terms of the following SIC code:

- SIC 45 – Construction.

6.13.2 TFP levels and growth in construction

The UK has an above average TFP level in the Construction sector, however, it is still ranked eighth out of 16 countries. Germany, then the USA, had the highest TFP levels in this sector. This possibly reflects the UK's TFP level ranking, the UK had negative TFP growth over the period covered (Table 6.25).

Table 6.25: Mean TFP levels and growth in construction by country

	TFP levels	TFP growth
Austria	1.021	0.015
Belgium	1.069	0.005
Canada	1.090	-0.009
Denmark	0.813	0.002
Finland	0.788	0.001
France	1.053	0.009
Germany	1.201	0.005
Italy	1.041	-0.006
Japan	0.868	0.018
Luxembourg	1.010	0.007
Netherlands	1.119	-0.021
Norway	1.009	-0.001
Spain	.	.
Sweden	0.870	-0.003
United Kingdom	1.038	-0.008
United States	1.155	-0.006

Source: IES/SPRU Model

Table 6.26: TFP levels and skills indicators in construction internationally

Indicator	Coefficient	Standard errors	Significance
High-level education	-0.533	0.356	
Intermediate-level education	0.410	0.100	***
Training in the last 4 weeks	-0.313	0.318	
ICT occupations	-1.714	0.690	**
Managers	0.215	0.437	
Professionals	2.967	1.141	***
Sector dummy	0.036	0.104	

Source: IES/SPRU Model

6.13.3 Results for TFP levels and skills indicators

Professionals appear to make the most important and significant contribution to TFP levels in the construction sector (Table 6.26). At the same time intermediate-level skills are also important and make a contribution to TFP levels. Interestingly, ICT occupations are associated with a significant but negative coefficient suggesting that ICT has a negative impact on TFP levels in the sector.

6.14 Wholesale, retail and car repairs

6.14.1 Definition of the sector

The wholesale, retail and car repairs sector is defined in terms of the following SIC codes:

- SIC 50 — Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel.
- SIC 51 — Wholesale trade and commission trade, except of motor vehicles and motorcycles.
- SIC 52 — Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods.

6.14.2 TFP levels and growth in wholesale, retail *etc*

The UK has a below average TFP level in the wholesale, retail and car repair sector. Indeed, it has the lowest TFP level for all the 14 countries for which we have data. At the same time, the UK has a relatively low, but still positive, TFP growth in this sector (Table 6.27).

Table 6.27: Mean TFP levels and growth in wholesale, retail and car repairs by country

	TFP levels	TFP growth
Austria	1.049	0.007
Belgium	1.193	-0.009
Canada	0.903	0.005
Denmark	0.997	0.003
Finland	0.849	0.011
France	1.033	0.008
Germany	1.022	0.007
Italy	1.282	-0.016
Japan	.	.
Luxembourg	1.194	0.008
Netherlands	1.073	0.002
Norway	0.951	0.036
Spain	.	.
Sweden	0.880	0.011
United Kingdom	0.814	0.003
United States	0.960	0.012

Source: IES/SPRU Model

6.14.3 Results for TFP levels and skills indicators

There are no significant results for this sector (Table 6.28). However, the largest positive coefficient is for professionals and there are negative coefficients for high-level education, ICT occupations and managers.

Table 6.28: TFP levels and skills indicators in wholesale, retail and car repairs internationally

Indicator	Coefficient	Standard errors	Significance
High-level education	-0.393	0.242	
Intermediate-level education	0.162	0.101	
Training in the last 4 weeks	0.215	0.152	
ICT occupations	-0.769	1.776	
Managers	-0.302	0.228	
Professionals	1.624	1.228	
Sector dummy	0.163	0.109	

Source: IES/SPRU Model

6.15 Hotels and restaurants

6.15.1 Definition of the sector

The Hotels and restaurants sector is defined in terms of a single two digit SIC classification. That is:

- SIC 55 — Hotels and restaurants.

6.15.2 TFP levels and growth in hotels and restaurants

The UK has one of the lower comparative TFP levels for the hotels and restaurants sector (Table 6.29). The UK's TFP levels in this sector are comparable with Canada, Finland, Germany, and Sweden. However, Italy and then France and the Netherlands have much higher relative TFP levels.

Table 6.29: Mean TFP levels and growth in hotels and restaurants by country

	TFP levels	TFP growth
Austria	0.059	0.001
Belgium	0.993	0.005
Canada	0.779	-0.003
Denmark	1.070	-0.011
Finland	0.766	0.012
France	1.351	-0.021
Germany	0.757	-0.016
Italy	1.762	-0.024
Japan	.	.
Luxembourg	1.109	-0.013
Netherlands	1.351	-0.018
Norway	1.183	-0.012
Spain	.	-
Sweden	0.796	-0.003
United Kingdom	0.794	-0.037
United States	0.881	-0.014

Source: IES/SPRU Model

Table 6.30: TFP levels and skills indicators in hotels and restaurants internationally

Indicator	Coefficient	Standard errors	Significance
High-level education	-2.197	0.441	***
Intermediate-level education	-0.352	0.158	**
Training in the last 4 weeks	0.378	0.198	*
ICT occupations	10.262	6.758	
Managers	-0.179	0.171	
Professionals	1.626	2.492	
Sector dummy	0.577	0.117	***

Source: IES/SPRU Model

6.15.3 Results for TFP levels and skills indicators

The largest significant coefficient is a negative one for high-level education (Table 6.30). This suggests that the hotels and restaurants sector may be over supplied with graduates and that they are displacing other skills. Interestingly, there is a very large, but insignificant, coefficient for ICT occupations. This suggests that in a few countries ICT has made an important contribution to TFP levels. Finally, there is a significant positive coefficient for the sector dummy. This suggests that there is some other factor that was not included in the regression that determines TFP levels in this sector.

6.16 Transport

6.16.1 Definition of the sector

The transport sector is defined in terms of the following SIC codes:

- SIC 60 — Land transport; transport via pipelines.
- SIC 61 — Water transport.
- SIC 62 — Air transport.
- SIC 63 — Supporting and auxiliary transport activities not elsewhere specified.

6.16.2 TFP levels and TFP growth in transport

In terms of TFP levels for the transport sector of the 11 countries, for which we have data, the UK is ranked number two behind the USA. However, the UK's position is less impressive when TFP growth for the transport sector is examined. In terms of TFP growth Germany and then Austria are the highest with the UK coming in at sixth equal with France (Table 6.31).

Table 6.31: Mean TFP levels and growth in transport by country

	TFP levels	TFP growth
Austria	0.911	0.011
Belgium	.	.
Canada	1.030	-0.010
Denmark	0.941	-0.003
Finland	0.993	0.009
France	1.045	0.005
Germany	0.955	0.012
Italy	.	.
Japan	.	.
Luxembourg	.	.
Netherlands	1.036	0.008
Norway	0.975	-0.006
Spain	.	.
Sweden	0.852	-0.004
United Kingdom	1.108	0.005
United States	1.166	0.001

Source: IES/SPRU Model

6.16.3 Results for TFP levels and skills indicators

The only positive significant coefficient in the transport sector is associated with managers (Table 6.32). This suggests that internationally in this sector mangers make an important contribution to TFP levels. There is also a suggestion that professionals have a negative impact on TFP levels with a slightly significant negative coefficient.

Table 6.32: TFP levels and skills indicators in transport internationally

Indicator	Coefficient	Standard errors	Significance
High-level education	0.057	0.240	
Intermediate-level education	-0.001	0.108	
Training in the last 4 weeks	-0.064	0.266	
ICT occupations	1.653	2.655	
Managers	1.536	0.313	***
Professionals	-1.801	1.039	*
Sector dummy	0.168	0.140	

Source: IES/SPRU Model

6.17 Post and telecommunications

6.17.1 Definition of the sector

The post and telecommunications sector is defined in terms of the following SIC code:

- SIC 64 — Post and telecommunications.

6.17.2 TFP levels and growth in post and telecoms

The UK had a well below average TFP level in the post and telecommunications sector. Indeed, the UK ranked only ninth out of the 11 countries for which we have data. Even in terms of TFP growth, the UK only manages tenth out of 11. This maybe reflects a tight regulatory regime or equally possibly this reflects poor productivity in the postal sub-sector (Table 6.33).

Table 6.33: Mean TFP levels and growth in post and telecommunications by country

	TFP levels	TFP growth
Austria	1.122	0.019
Belgium	.	.
Canada	1.060	-0.005
Denmark	0.989	0.024
Finland	0.882	0.023
France	1.197	0.036
Germany	1.646	0.082
Italy	.	.
Japan	.	.
Luxembourg	.	.
Netherlands	1.178	-0.044
Norway	0.747	0.044
Spain	.	.
Sweden	0.902	0.029
United Kingdom	0.894	0.012
United States	1.123	0.002

Source: IES/SPRU Model

Table 6.34: TFP levels and skills indicators in post and telecommunications internationally

Indicator	Coefficient	Standard errors	Significance
High-level education	-0.622	0.304	**
Intermediate-level education	-0.465	0.299	**
Training in the last 4 weeks	-0.230	0.171	
ICT occupations	1.206	0.392	***
Managers	1.536	0.313	***
Professionals	2.075	0.793	***
Sector dummy	0.589	0.165	***

Source: IES/SPRU Model

6.17.3 Results for TFP levels and skills indicators

The regression suggests that professionals make a large and significant contribution to TFP levels in the post and telecommunications sector (Table 6.34). Other significant positive contributions appear to come from managers and ICT occupations. High-level education and intermediate-level education also appears to have relatively significant negative impacts on TFP levels.

6.18 Financial services

6.18.1 Definition of the sector

The financial services sector is defined in terms of the following SIC codes:

- SIC 65: Financial intermediation, except insurance and pension funding.
- SIC 66: Insurance and pension funding, except compulsory social security.
- SIC 67: Activities auxiliary to financial intermediation.

6.18.2 TFP growth and levels in financial services

The UK's financial services sector has a very low level of TFP compared the other OECD countries included in the analysis. The UK's TFP level of 0.68 suggests that it is about 32 per cent worse than the average. Given the size of this sector in the UK, both in terms of employment and in terms of turnover, this low TFP level will be bringing the UK's overall TFP level down significantly. Only Canada's smaller financial services sector has a worse TFP level. A more positive picture for the UK emerges from the TFP growth data. Here the UK has the second highest TFP growth rate, behind only Japan (Table 6.35).

Table 6.35: Mean TFP levels and growth in financial services by country

	TFP levels	TFP growth
Austria	1.239	-0.002
Belgium	0.879	0.011
Canada	0.610	-0.012
Denmark	1.192	0.003
Finland	1.044	0.017
France	0.926	-0.008
Germany	1.025	0.008
Italy	1.624	-0.003
Japan	0.947	0.038
Luxembourg	1.492	-0.034
Netherlands	0.700	-0.026
Norway	1.086	-0.016
Spain	.	.
Sweden	1.260	0.002
United Kingdom	0.686	0.024
United States	0.854	-0.014

Source: IES/SPRU Model

6.18.3 Results for TFP levels and skills indicators

Overall, there were only two significant coefficients for the financial services sector and TFP levels (Table 6.36). These were a relatively large negative coefficient associated with managers. This may reflect job-title inflation in the sector with more people described as managers when they are not actually performing a managerial function. However, equally there could be too many managers displacing other more productive inputs. There was also a significant positive coefficient associated with the sector dummy. As before this probably indicates that some other important sector specific factor has not been included in the regression.

Table 6.36: TFP levels and skills indicators in financial services internationally

Indicator	Coefficient	Standard errors	Significance
High-level education	0.157	0.283	
Intermediate-level education	-0.041	0.284	
Training in the last 4 weeks	0.366	0.226	
ICT occupations	-2.694	1.754	
Managers	-2.236	0.342	***
Professionals	-0.569	0.543	
Sector dummy	0.650	0.255	***

Source: IES/SPRU Model

6.19 Private sector professional services

6.19.1 Definition of the sector

The private sector professional services sector is defined in terms of the following SIC codes:

- SIC 70 — Real estate activities.
- SIC 71 — Renting of machinery and equipment without operator and of personal and household goods.
- SIC 72 — Computer and related activities.
- SIC 73 — Research and development.
- SIC 74 — Other business activities.

6.19.2 TFP levels and growth in private sector professional services

Table 6.37 shows that the UK has a relatively high TFP level of 2.24 in the private sector professional services sector, just behind Canada and just ahead of the USA. Austria at 0.58 and Finland at 0.59 on the other hand have strikingly low comparative TFP levels in this sector. Interestingly, all the countries for which we have data show negative TFP growth for this sector.

Table 6.37: Mean TFP levels and growth in private sector professional services by country

	TFP levels	TFP growth
Austria	0.578	-0.031
Belgium	0.866	-0.006
Canada	2.244	-0.021
Denmark	0.879	-0.030
Finland	0.593	-0.021
France	0.849	-0.016
Germany	0.759	-0.024
Italy	0.900	-0.036
Japan	.	.
Luxembourg	0.983	-0.025
Netherlands	0.607	-0.036
Norway	0.787	-0.024
Spain	.	.
Sweden	1.014	-0.007
United Kingdom	2.240	-0.063
United States	2.012	-0.037

Source: IES/SPRU Model

Table 6.38: TFP levels and skills indicators in private sector professional services

Indicator	Coefficient	Standard errors	Significance
High-level education	0.116	0.874	
Intermediate-level education	-0.123	0.795	
Training in the last 4 weeks	-0.119	0.542	
ICT occupations	1.732	0.654	***
Managers	4.238	1.189	***
Professionals	-1.255	0.439	***
Sector dummy	0.040	0.602	

Source: IES/SPRU Model

6.19.3 Results for TFP levels and skills indicators

Managers generate a relatively large significant positive coefficient with TFP levels in the private sector professional services sector (Table 6.38). ICT occupations are also associated with a positive significant coefficient, suggesting that the sector benefits from ICT. However, professionals are associated with a significant negative coefficient suggesting that either there are too many professionals and they are displacing other more productive inputs or that they have a negative impact on TFP in the sector.

6.20 Public administration and defence

6.20.1 Definition of the sector

The Public Administration and Defence sector is defined in terms of the following SIC code:

- SIC 75 – Public administration and defence, compulsory social security.

6.20.2 TFP levels and growth in public administration

The TFP figures suggest that the UK has a relatively high TFP level in the public administration and defence sector (Table 6.39). Indeed the UK is second only to the United States amongst our comparator countries. These levels also appear to be relatively stable with generally low TFP growth rates across the board.

Table 6.39: Mean TFP levels and growth in public administration and defence by country

	TFP levels	TFP growth
Austria	1.088	0.018
Belgium	0.954	0.008
Canada	1.003	0.010
Denmark	0.949	0.010
Finland	0.746	0.005
France	0.934	0.006
Germany	0.951	0.018
Italy	0.980	0.014
Japan	-	-
Luxembourg	1.124	-0.010
Netherlands	1.146	0.010
Norway	0.755	0.010
Spain	-	-
Sweden	0.966	-0.024
United Kingdom	1.146	0.000
United States	1.349	-0.011

Source: IES/SPRU Model

6.20.3 Results for TFP levels and skills indicators

Looking at the significant coefficients in the public administration and defence sector suggests that professionals make the largest contribution to TFP levels (Table 6.40). There is a similarly significant but smaller contribution from intermediate-level education. While the significant sector dummy again suggests that we have omitted an important and sector specific factor from the regression.

Table 6.40: TFP levels and skills indicators in public administration and defence

Indicator	Coefficient	Standard errors	Significance
High-level education	0.133	0.168	
Intermediate-level education	0.555	0.175	***
Training in the last 4 weeks	-0.246	0.174	
ICT occupations	0.691	1.430	
Managers	0.433	0.327	
Professionals	1.664	0.260	***
Sector dummy	-0.370	0.140	***

Source: IES/SPRU Model

6.21 Education

6.21.1 Definition of the sector

The Education sector is simply defined in terms of the following SIC code:

- SIC 80 – Education.

6.21.2 TFP levels and growth in education

The UK's TFP level is one of the lowest, with only Denmark with a lower TFP level (Table 6.41). The picture is not helped by the TFP growth rates as the UK also has a strong negative growth rate. This of course may be due to measurement problems in terms of the level of the sectors outputs and there are recognised problems with this measurement in the UK public sectors (Allsopp, 2004).

Table 6.41: Mean TFP levels and growth in education by country

	TFP levels	TFP growth
Austria	1.091	0.000
Belgium	1.077	0.014
Canada	1.001	-0.011
Denmark	0.790	0.008
Finland	1.197	-0.004
France	1.075	0.004
Germany	0.986	0.007
Italy	1.082	-0.004
Japan	-	-
Luxembourg	1.359	-0.004
Netherlands	1.137	0.000
Norway	0.818	0.003
Spain	-	-
Sweden	0.826	0.021
United Kingdom	0.810	-0.003
United States	0.889	-0.004

Source: IES/SPRU Model

Table 6.42: TFP levels and skills indicators in education

Indicator	Coefficient	Standard errors	Significance
High-level education	1.520	0.280	***
Intermediate-level education	0.783	0.283	***
Training in the last 4 weeks	0.222	0.205	
ICT occupations	-7.445	4.422	*
Managers	-1.464	1.052	
Professionals	-0.164	0.087	
Sector dummy	0.848	0.251	***

Source: IES/SPRU Model

6.21.3 Results for TFP levels and skills indicators

High-level education and intermediate-level education both have positive and significant coefficients with TFP levels in the education sector (Table 6.42). Although, there was also a positive and significant coefficient for the sector dummy.

6.22 Health and social work

6.22.1 Definition of the sector

The Health and Social Work sector is defined in terms of the following SIC code:

- SIC 85 – Health and social work.

6.22.2 TFP levels and growth in health and social work

Apart from Norway the UK has the lowest TFP level in the heath and social work sector compared with our international comparators (Table 6.43).

On the positive side the TFP growth rate is the fourth highest suggesting that the UK's TFP level position will improve.

Table 6.43: Mean TFP levels and growth in health and social work by country

	TFP levels	TFP growth
Austria	1.021	-0.011
Belgium	0.918	0.010
Canada	0.938	-0.009
Denmark	1.021	0.003
Finland	0.882	-0.002
France	1.032	0.000
Germany	0.883	-0.002
Italy	1.254	-0.009
Japan	-	-
Luxembourg	1.159	0.013
Netherlands	1.047	-0.008
Norway	0.813	-0.003
Spain	-	-
Sweden	0.934	0.039
United Kingdom	0.838	0.010
United States	1.339	-0.018

Source: IES/SPRU Model

6.22.3 Results for TFP levels and skills indicators

The coefficients for high-level and intermediate-level education are positive and significant, indicating there contribution to TFP levels in the health and social work sector (Table 6.44). However, there is a negative and significant coefficient for professionals, which suggests that this group may be squeezing out more productive groups from the sector. Finally, the slightly significant sector dummy suggests that there are sector specific factors that we have not included in the analysis.

Table 6.44: TFP levels and skills indicators in health and social work

Indicator	Coefficient	Standard errors	Significance
High-level education	0.570	0.207	***
Intermediate-level education	0.732	0.153	***
Training in the last 4 weeks	-0.085	0.169	
ICT occupations	5.376	2.839	*
Managers	0.550	0.614	
Professionals	-0.400	0.119	***
Sector dummy	-0.256	0.135	*

Source: IES/SPRU Model

6.23 Other public and personal services

6.23.1 Definition of the sector

The other public and personal services sector is defined in terms of the following SIC codes:

- SIC 90 – Sewage and refuse disposal, sanitation and similar activities.
- SIC 91 – Activities of membership organisations not elsewhere specified.
- SIC 92 – Recreational, cultural and sporting activities.
- SIC 93 – Other service activities.

6.23.2 TFP levels and growth in other public sector

The UK has the lowest relative TFP levels compared with the other countries (Table 6.45). Even when the TFP growth rates are examined the UK's position still looks poor.

Table 6.45: Mean TFP levels and growth in other public and personal services by country

	TFP levels	TFP growth
Austria	0.984	-0.005
Belgium	0.890	0.011
Canada	0.895	-0.016
Denmark	0.980	-0.005
Finland	0.903	-0.001
France	0.789	-0.027
Germany	1.072	-0.002
Italy	1.425	-0.024
Japan	-	-
Luxembourg	1.043	-0.046
Netherlands	0.982	0.028
Norway	0.999	-0.005
Spain	-	-
Sweden	1.215	-0.042
United Kingdom	0.697	-0.013
United States	1.264	-0.015

Source: IES/SPRU Model

Table 6.46: TFP levels and skills indicators in other public and personal services

Indicator	Coefficient	Standard errors	Significance
High-level education	0.153	0.356	
Intermediate-level education	0.618	0.196	***
Training in the last 4 weeks	0.053	0.233	
ICT occupations	-3.964	2.109	*
Managers	-2.025	0.702	***
Professionals	0.624	0.561	
Sector dummy	0.016	0.161	

Source: IES/SPRU Model

6.23.3 Results for TFP levels and skills indicators

In this sector intermediate-level skills are associated with the only significant positive coefficient with TFP levels (Table 6.46). Managers are associated with a relatively large and significant negative coefficient which suggests they maybe displacing other occupations that are more productive. ICT occupations are also associated with a larger, but not significant, negative coefficient. This suggests that ICT has not been particularly successful in this sector.

6.24 Country dummies

The country and year dummies are important both for the process of determining the sectoral results and equally they are important as results in their own right. The inclusion of the dummies in the regression to an extent allowed these variables to be controlled for. As such, they gave increased explanatory power to the sectoral results. However, an examination of the results for the dummies allows an examination of whether or not there was significant influence on the other results from these variables.

The country dummies were included as instrument variables as it was known *a priori* that there were distinct national effects on TFP levels. By using the UK as the base for this the country dummies also illustrate the UK's relative position in terms of the other countries. Importantly, this relative position is independent of differences between sector mix and employment shares between the countries. This produces a slightly different ranking than that usually used which looks at the relative TFP levels for the whole economy given the differing sectoral specialisations of each country.

This suggests that Luxembourg has a large and significantly higher residual TFP level than the UK (Table 6.47). Italy, Spain and France also had significant positive coefficients, again suggesting that, all other things being equal, they had higher TFP

Table 6.47: TFP levels and country dummies

	Coefficient	Standard errors	Significance
Belgium country dummy	0.076	0.042	*
Denmark country dummy	-0.049	0.041	
Germany country dummy	-0.060	0.041	
Spain country dummy	0.096	0.046	**
France country dummy	0.084	0.050	*
Italy country dummy	0.110	0.044	**
Luxembourg country dummy	0.214	0.047	***
Netherlands country dummy	-0.044	0.046	
Austria country dummy	-0.049	0.045	
Finland country dummy	-0.091	0.039	**
Sweden country dummy	-0.013	0.046	
United States country dummy	0.023	0.042	

Source: IES/SPRU Model

levels than the UK. Finland was the only country with a significant and negative coefficient, although many other countries also had negative coefficients. Interestingly, these results might suggest that labour market flexibility may not be as important as believed in terms of TFP levels. However, labour market flexibility may allow some countries to move workers from unproductive sectors into more productive sectors which is not being measured here.

6.25 Year dummies

Another concern was that there might be significant variation over time. To check for this year dummies were included in the analysis.

Table 6.48 shows there might be pattern in terms of 1992, 1993 and 1994 having significant positive coefficients. The extent of missing data in the early years, most notably from Germany, may in part explain this pattern.

Table 6.48: TFP levels and year dummies

	Coefficient	Standard errors	Significance
1992	0.123	0.028	***
1993	0.071	0.024	***
1994	0.060	0.024	**
1995	0.023	0.021	
1996	0.028	0.021	
1997	0.021	0.019	
1998	0.016	0.020	
1999	0.016	0.019	
2000	0.003	0.020	

Source: IES/SPRU Model

6.26 Missing values dummies

The last area of concern with this sector level regression is the impact of missing values. Cases with missing data for TFP levels, high-level education and/or intermediate-level education were excluded. This left missing data for the training, ICT occupations, managers and professionals variables as potential sources of concern. As Table 4.49 shows apart from professionals the coefficients were relatively low and the standard errors for training and ICT occupations were not significant. However, coefficient for the missing professionals data was larger and the standard error highly significant. This indicates that some caution should be applied to any interpretation of the results covering professionals. Otherwise, these results suggest that missing values were not influential in the regression.

Table 6.49: TFP levels and missing data dummies

	Coefficient	Standard errors	Significance
Missing training data dummy	0.009	0.035	
Missing ICT data dummy	0.051	0.035	
Missing managers data dummy	0.086	0.043	**
Missing professionals data dummy	-0.128	0.041	***

Source IES/SPRU Model

6.27 Chapter summary

This chapter examined the interaction of a range of skills indicators with TFP levels for 23 sectors on an international basis. This showed a wide variation in impact of indicators with some having a positive impact in some sectors and a negative impact in others. The highlights include:

- High-level skills – have a significant positive impact in wood, pulp and paper products; machinery, electrical and optical; electricity, gas and water; education, as well as health and social work, but a significant negative impact in hotels and restaurants.
- Intermediate-level skills – have a significant positive impact in many sectors including: textiles and clothing wood, pulp; and paper products; printing and publishing; energy and chemicals; metals and fabricated parts; machinery, electrical and optical; transport equipment; other products and recycling; construction; public administration and defence; education; health and social work, as well as other public and personal services.
- Education of training in the last four weeks – had a significant positive impact in food, drink and tobacco, as well as printing and publishing, but a significant negative impact in machinery, electrical and optical as well as transport equipment.
- ICT occupations – had a significant positive impact in post and telecommunications, as well as private sector professional services but a negative impact in energy and chemicals.
- Managers – had a significant positive impact in food, drink and tobacco; energy and chemicals; metals and fabricated parts; other products and recycling; post and telecommunications, as well as; private sector professional services but a significant negative impact in financial services; other public and personal services
- Professionals – had a significant positive impact in construction; post and telecommunications; public administration and defence but a significant negative impact in private sector professional services; health and social work.

7. Conclusions

This chapter has three main components:

- Some summary results highlighting the UK's relative position
- A section examining the policy conclusions and implications of the results
- A section that outlines potential further analyses using this approach.

7.1 Summary results

The previous chapters have shown that there are both important differences in Total Factor Productivity at the sectoral level as well as internationally important differences in the contributions of a range of skills inputs. The following three tables (7.1, 7.2 and 7.3) put these results into context by examining for each of the sectors:

- UK's relative TFP levels.
- Growth or contraction in terms of hours worked.
- Percentage of overall hours worked accounted for by the sector.
- Relative endowment of the sector in the UK compared with other sectors internationally of high-level educated employers.
- Relative endowment of intermediate-level education employees.
- Relative endowment of education and training in the last four weeks.
- Relative endowment of employees in ICT occupations.
- Relative endowment of employees in managerial occupations.
- Relative endowment of employees in professional occupations.

The sectoral relative TFP levels are the same as those used elsewhere in this report, and are sectoral averages for the period 1992 to 2001. A TFP level figure higher than one means that the sector in the UK had a higher TFP level, between 1992 and 2001, than the average for all other countries.

In Table 7.1 below, hours worked is used rather than total employment as this is the basis for the productivity figures, and because this more accurately reflects the relative pattern of employment. The rates have also been expressed as percentage Compound Annual Growth Rates (CAGR), this in part evens out any business cycle effects. Overall, there has been a two per cent CAGR, which means that every year between 1993 and 2001 two per cent more hours were worked, either as a result of more people working, or as a result of those in work working longer hours. Finally, the table also shows the percentage of all hours worked that each sector accounts for. This gives the relative size of each of the sectors in terms of one of the main determinants of output levels. This shows that some of the sectors which have TFP levels below the international norm are also some of the largest in terms of hours worked.

Table 7.1: UK sectoral TFP levels, growth and distribution of hours worked and

Sector	Mean UK TFP levels (international average = 1)	UK hours worked per cent- compound annual growth rate 1992 - 2001	Percentage of total hours worked in 2001
Agriculture, hunting forestry and fishing	1.31	-4.06	1.62
Mining and quarrying	0.92	-7.92	0.26
Manufacture of food, drink & tobacco	1.21	-0.66	1.57
Manufacture of textiles and clothing	1.03	-6.32	0.76
Manufacture of wood, pulp and paper products	0.97	-1.73	0.56
Publishing, printing and reproduction of media	1.16	0.00	1.11
Energy and chemicals	0.92	-0.99	2.05
Manufacture of basic metals and metal products	1.10	-1.98	1.62
Manufacture of machinery, electrical and optical	1.09	-0.73	2.64
Manufacture of transport equipment	0.92	-0.46	1.29
Manufacture of other products and recycling	1.24	1.84	0.63
Electricity, gas and water supply	1.07	-7.83	0.36
Construction	1.04	0.12	6.01
Wholesale, retail and car repairs	0.81	1.07	13.22
Hotels and restaurants	0.79	1.30	5.00
Transport	1.11	0.56	3.86
Post and telecommunications	0.89	1.66	1.99
Financial services	0.69	1.14	3.64
Private sector professional services	2.24	4.60	12.47
Public administration and defense	1.15	0.07	3.64
Education	0.81	14.39	15.21
Health and social work	0.84	0.91	15.21
Other public and personal services	1.26	1.13	5.29

Source IES/SPRU Model

The UK sectoral TFP levels as mentioned before show wide variation. This indicates that the UK's productivity problem is more of a sectoral problem than a generic national problem. Many sectors show significant rates of contraction in terms of hours worked. These include, most notably:

- mining and quarrying — reflecting the contraction of coal mining
- manufacture of textiles and clothing — reflecting increasing overseas competition
- electricity, gas and water supply — reflecting restructuring following technical change and privatisation.

Growth in hours worked was much more concentrated with the bulk occurring in education and the private sector professional services.

Sectors that have low TFP levels and are large in terms of hours worked make a disproportionate contribution to the UK's overall poor productivity ranking. These sectors include:

- wholesale, retail and car repairs — with a TFP level of 0.81 and representing 13.2 per cent of overall hours worked
- financial services — with a TFP level of 0.69 and representing 3.6 per cent of overall hours worked
- education — with a TFP level of 0.82 and representing 15.2 per cent of overall hours worked
- health and social work — with a TFP level of 0.84 and representing 15.21 per cent of overall hours worked.

This is only partly counterbalanced by some other sectors with high TFP levels that also represent a relatively large proportion of total hours worked. These include:

- private sector professional services — with a TFP level of 2.24 and representing 12.3 per cent of overall hours worked
- other public and personal services — with a TFP level of 1.26 and representing 5.29 of overall hours worked.

Table 7.2 provides data on the relative endowment of high-level and intermediate-level skills, as well as the extent of training compared with the international norm. The relative sectoral skills endowments have been calculated by comparing the UK sector's average endowment between 1993 and 2001 with the average endowment of the sector for all the countries. A figure higher than one indicates that the sector in the UK is more endowed with that input than the international norm. The converse is true when the figure is less than one.

Table 7.2: UK's sectoral relative endowment of skills inputs

Sector	UK's relative endowment of high-level education	UK's relative endowment of intermediate-level education	UK's relative endowment of training in the last 4 weeks
Agriculture, hunting forestry and fishing	1.57	1.02	1.81
Mining and quarrying	1.47	0.95	2.04
Manufacture of food, drink & tobacco	1.17	0.96	1.69
Manufacture of textiles and clothing	1.01	0.92	2.21
Manufacture of wood, pulp and paper products	0.99	1.15	2.17
Publishing, printing and reproduction of media	1.14	1.01	1.59
Energy and chemicals	1.18	0.96	2.13
Manufacture of basic metals and metal products	1.22	1.11	1.97
Manufacture of machinery, electrical and optical	1.13	1.00	1.96
Manufacture of transport equipment	1.23	1.05	2.21
Manufacture of other products and recycling	1.13	1.10	1.83
Electricity, gas and water supply	1.41	0.92	2.22
Construction	1.40	1.32	2.05
Wholesale, retail and car repairs	0.86	0.95	2.02
Hotels and restaurants	1.12	1.01	2.09
Transport	0.95	0.90	1.96
Post and telecommunications	0.94	0.86	1.43
Financial services	0.80	0.91	1.81
Private sector professional services	1.03	0.93	1.93
Public administration and defense	1.05	0.91	2.06
Education	0.94	0.81	1.95
Health and social work	1.10	0.71	2.05
Other public and personal services	1.05	0.89	1.69

Source IES/SPRU Model

Overall, in the UK there were generally higher levels of high-level education than internationally, reflecting the national comparison. Interestingly, the large UK sectors with a poor TFP performance often had lower levels of high-level education than the international norm. These included:

- wholesale, retail and car repairs — with a TFP level of 0.81 and only 0.86 graduates compared with an international norm of one
- financial services — with a TFP level of 0.80 and only 80 graduates for every 100 internationally
- education — with a TFP level of 0.81 and only 94 graduates for very 100 internationally.

However, reassuringly, in many of the sectors where intermediate level skills were shown to be important for TFP levels, the UK has above the international norm of this level of education. Also reassuring was the high relative levels of training. All UK sectors showed higher levels of training than the international norm. For many sectors there was twice the reporting of training than for our comparators.

Table 7.3 shows the UK's relative endowments in terms of ICT occupations, managers and professions. ICT occupations were taken as a proxy for ICT investment levels and generally, this showed that the UK had below the international norm. The exceptions to this were:

- agriculture, hunting forestry and fishing — with 1.37 people in ICT occupations for every one internationally

Table 7.3: UK's sectoral relative endowment of skills inputs (continued)

Sector	UK's relative endowment of ICT occupations	Managers	Professionals
Agriculture, hunting forestry and fishing	1.37	2.18	0.23
Mining and quarrying	0.93	1.71	1.84
Manufacture of food, drink & tobacco	1.01	2.03	0.55
Manufacture of textiles and clothing	0.49	1.84	0.26
Manufacture of wood, pulp and paper products	0.84	1.93	0.37
Publishing, printing and reproduction of media	1.04	2.27	1.51
Energy and chemicals	0.85	2.14	1.25
Manufacture of basic metals and metal products	0.88	2.20	0.87
Manufacture of machinery, electrical and optical	0.92	2.13	1.56
Manufacture of transport equipment	0.96	2.24	2.34
Manufacture of other products and recycling	1.26	1.69	0.28
Electricity, gas and water supply	0.72	2.01	2.13
Construction	1.06	1.64	0.93
Wholesale, retail and car repairs	0.81	1.27	0.11
Hotels and restaurants	0.53	1.06	0.03
Transport	1.11	1.81	0.43
Post and telecommunications	1.04	2.41	0.89
Financial services	1.17	1.79	0.81
Private sector professional services	0.94	2.04	3.07
Public administration and defense	0.94	1.71	2.84
Education	1.22	1.04	15.21
Health and social work	1.09	2.26	8.81
Other public and personal services	0.83	1.86	2.15

Source IES/SPRU Model

- manufacture of other products and recycling — with 1.26 people in ICT occupations for every one internationally
- financial services — with 1.17 people in ICT occupations for every one internationally.

The UK has generally higher levels of managers than our international comparators. Only the education sector had levels of managers similar to the international norm. All the other sectors had more, and often twice as many, managers as the norm. The pattern in terms of professionals is much more varied with some sectors with more and some with less than the international norm. Sectors with less than half the international norm of professionals were:

- agriculture, hunting forestry and fishing — with 0.23 professionals for each one internationally
- manufacture of textiles and clothing — with 0.26 professionals for each one internationally
- manufacture of wood, pulp and paper products — with 0.37 professionals for each one internationally
- manufacture of other products and recycling — with 0.28 professionals for each one internationally
- wholesale, retail and car repairs — with 0.11 professionals for each one internationally
- hotels and restaurants — with 0.03 professionals for each one internationally
- transport — with 0.43 professionals for each one internationally.

Conversely, there are a range of UK sectors which appear to have more professionals than the international norm. These include:

- manufacture of transport equipment — with 2.34 professionals for each one internationally
- electricity, gas and water — with 2.13 professionals for each one internationally
- private sector professional services — with 3.07 professionals for each one internationally
- public administration and defense — with 2.84 professionals for each one internationally
- education — with a staggering 15.21 professionals for each one internationally
- health and social work — with 8.81 professionals for each one internationally
- other public and private services — with 2.15 for each professional internationally.

One explanation of the pattern in terms of levels of managers and professionals is that in the UK, and in some sectors, many professionals have to become managers to progress. Another explanation is that when professionals report an occupation in these sectors this is coded as a managerial rather than professional. Both of these explanations are worthy of further examination.

In summary, the relationship between UK relative TFP levels, UK relative endowments, and the relative importance for each of the sectors of these skills indicators is complex.

7.2 Policy conclusions and implications

Much research and UK policy development remains to be undertaken, especially if some of the underlying data is subject to measurement errors. Therefore, the policy conclusions of this report are necessarily sketchy as the real implications for this analysis will derive from the collective interpretations of the results by policy actors. These include, for example, the relevant sector skills councils, professional bodies, higher education departments and others responsible for training and economic development.

7.2.1 International comparisons for sectors

Generating TFP levels and TFP growth for the detailed sectors across the range of advanced OECD countries provides useful comparative information before the econometric analysis. For instance, the UK's finance sector has a poor relative TFP level, while many other sectors show a much better position than the whole economy comparisons would suggest. This allows sectors with poor TFP records to be targeted for performance and productivity enhancing measures.

There is some evidence that this targeting of underperforming sectors is starting with reports on:

- the finance sector (HM Treasury, 2005)
- the retail sector (Griffith, Harmgart, 2005) which suggests that the comparative position maybe due to measurement errors
- the way public sector output is measured in the UK has also been looked at (Atkinson, 2005) , with a special focus on the health sector (Dawson *et al.*, 2004).

Since the levels reported here are relative to the international average the suggestion that the UK's relative poor showing in some of the public sectors might be due to measurement errors would mean that the majority of the other countries would have to have no measurement errors. This suggests that the differences are unlikely to be totally a result of measurement error and still worthy of investigation. If they are a result of measurement error this would imply a major reworking of the UK's statistics and the UK's overall relative productivity levels.

7.2.2 Differences suggest sector specific solutions

There is a wide variation in UK sectoral TFP levels, and TFP growth, as well as widely varying impacts of the skills indicators on sectoral performance. This suggests that policy prescriptions need to be made at the sectoral level. Importantly, the strategies not only have to take into account the impact of the various skills indicators groups on the sector. The strategies also need to be aware of the UK's relative TFP levels.

7.2.3 Some world beating sectors

In terms of TFP levels, the UK's agriculture, hunting, forestry and fishing sector is second only to Japan. Similarly, the UK's food drink and tobacco sector is second only to Canada, while the publishing, printing and media sector is second only to the USA. Finally, for the manufacture of other products and recycling sector the UK has the highest TFP levels. These, sometimes unsung, UK sectors, clearly are world beating in terms of their productivity.

7.2.4 Some laggard sectors

At the same time as having some world beating sectors, the UK also has some seriously lagging sectors. These include the wholesale, retail and car repairs sector, where the UK has the worst TFP level record for those countries we have data for. Apart from Canada, the UK's finance sector also has the worst record in terms of TFP levels. These sectors attract a lot of UK media attention, but not necessarily for their low levels of TFP productivity.

In policy terms the root causes of the lower TFP productivity in these sectors needs to be established. It could be that these sectors in the UK are extremely competitive meaning that they cannot achieve the levels of profits achieved elsewhere in the world. If that is the case the UK may be attaining other benefits from this low productivity and overall this might not be a problem. A highly competitive sector might have lower TFP than internationally but supply other benefits to the UK economy. An example of this might be the wholesale, retail and car repair sector, which might be supplying cheaper groceries to consumers while generating less added-value. Given that competition can sometimes be reflected in the size composition of the sector this could be examined. The relative structure, in terms of how many large enterprises and how many smaller enterprises, might explain some of the TFP variation. However, the internationally comparative data that exists on the size structure of sectors in terms of enterprises tend to be limited (Eurostat, 2004).

7.2.5 The role of ICT occupations

The picture for ICT occupations is very mixed, but those sectors that appear to have successfully integrated ICT have had some very large benefits from it. The largest benefits appear to come in sectors which on inspection have little history of ICT usage. The explanation that is suggested, is that countries can gain greater benefit from ICT in areas where few if any of their competitor countries are using ICT. In sectors where every country is using ICT, less competitive advantage can be derived.

7.2.6 Roles of high and intermediate-level education

High-level education appears to be more important in high technology and knowledge intensive services, while intermediate-level education is almost exclusively important for lower technology, or mature, manufacturing sectors. The complex and somewhat contradictory results for high and intermediate-level education may go some way to explaining the contradictory results from earlier econometric exercises and case studies. For instance many of the factory level comparisons emphasise intermediate-level skills (Steedman *et al.*, 1998), while international comparisons emphasise high-level skills (Sianesi, Van Reenen, 2000). These differences have led to debate over the optimal levels of graduate skills and intermediate-level skills (Mason, 2001a).

In policy terms this means that the target for more people to experience university education is justified, as those with the higher level qualifications are needed to sustain the TFP levels where the UK is already highly competitive internationally. However, there is also a requirement for intermediate-level skills, especially if we are going to improve productivity in lower technology sectors. This suggests that a simplistic policy that supports one form of education over another will not serve the needs of the country. Similarly, given the extent of sectoral variation a 'one model fits all sectors' approach is equally simplistic.

7.2.7 No one indicator works for all

Importantly there is not a single skills indicator that has positive association with TFP levels for all the sectors. As such this means that there is no simple panacea to productivity problems across the board. The safest generalisations that are possible, are to say that high-level education is fairly generally important for TFP levels while intermediate-level skills and training are also important, but often in combination. Similarly, ICT occupations have generally positive associations for TFP levels and appear to have a bigger impact in sectors where they are not usually found in large concentrations. This reinforces the idea that policy analysis and development needs to take into account of the very real differences in skill demands that occur at these detailed sectoral levels.

7.3 Potential further analysis

There are several possible avenues for further analyses. These include:

- data and methodological improvements
- looking at UK's endowment of managers and professionals
- a breakdown by country
- further descriptive analysis
- a potential breakdown by gender
- a potential breakdown by region
- work by individual SSCs.

These ideas are expanded upon below.

7.3.1 Data and methodological improvements

The simplest method of improving the analysis would be to wait for more data to be available. The longer the wait the potentially more reliable and sophisticated the analysis. However, there are already advanced plans to change the international and UK sectoral classifications in 2007. This means that ultimately there will be a limit to any advantage gained by waiting for longer time series. More sophisticated approaches could involve greater use of interpolation and other techniques to improve the run of data. Some of the panel data techniques, which depend on more complete data series, can address the thorny issue of multi collinearity, providing further incentive for interpolation. There are particular problems with some variables (most notably educational level) in some countries with noticeable data discontinuities (especially around the transition from ISCED66 to ISCED77). Careful adjustment of this underlying data could produce a more robust dataset and therefore a more robust analysis. Other variables may also benefit from closer examination, the incorporation of national data or further imputation of missing values.

There were also suggestions that the UK's poor showing in some sectors, such as the wholesale, retail and car repair sector, is due to measurement errors. This needs to be established and if it is the case substantial revisions to the UK economic data will have to be made. This in turn would influence many of the results reported here.

7.3.2 Endowment of managers and professionals

The UK has generally higher levels of managers, and some very divergent distributions of professionals compared with our international comparators. Explanations of these patterns and a better understanding of the relationship between the patterns and relative TFP levels could be potentially important. This suggests that this could be an area for future research.

7.3.3 Breakdown by country

Given the importance of the country fixed effects, there would appear to be a case for a more detailed analysis at the national level. Holding the sectoral mix constant would allow a better understanding of the national peculiarities. Some of the national productivity differences may be explained by the relative importance in terms of employment in different sectors in the UK. For instance, a greater proportion of the UK's employment could be in inherently low productivity sectors. Equally, as also appears to be the case, a greater proportion of UK employment could be in sectors with internationally relatively low productivity such as retail and finance. In particular, taking account of sectoral mix would allow any UK specific national messages from the analysis to be more easily extracted from the data.

7.3.4 Further descriptive analysis

A large data set has been assembled for this analysis and Chapter 3 has necessarily only skimmed the surface of this data. There is great potential for further analysis of this data. This is especially the case as all the data sources used are updated annually, or more regularly. This means that the descriptive analysis is relatively easy to repeat.

7.3.5 Breakdown by gender

All the skills indicators are capable of being broken down by gender. Therefore, any differential impact of female versus male employees, managers, etc. could be examined. There may be an issue with small numbers of females in some categories in some countries, which might mean that a lot of data might need to be suppressed. However, this is an analysis that might generate interesting results either at the national or sectoral level.

7.3.6 Breakdown by region

The same approach could be used to examine the pattern of skills demand and utilisation at the regional level. However, given that the skills indicators data comes from sample surveys it would undoubtedly be impossible to produce a detailed sectoral breakdown at the same time as producing a regional breakdown. There may also be problems in getting reliable enough regional economic data, although recently there have been published estimates of regional added value, and such statistics are one of the objectives of the Allsopp Review (Allsopp, 2004).

7.3.7 Further work by SSCs

The sectors underlying this report are based on the SSDA's Sector Matrix. As such, they do not directly map onto the Sector Skills Council's (SSCs) footprints. Direct mapping would require data at the four digit level of SIC, which is simply not available internationally. Despite this, there is a case for each SSC to estimate their sector's relative productivity position compared with the UK's competitors. This will be a tricky exercise to establish empirically, as the level of data disaggregation needed to map the SSC's footprints does not exist internationally. However, based on the available evidence and informed opinion an estimate could be made. Once this position is established, the SSCs could then examine their strategies towards various skills groups in the light of their estimated productivity position and the results presented in this report.

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Technical Annex

This technical annex is designed to provide more detail, especially technical and methodological detail, on the Sectors Matter report. As such, this technical annex should be read in conjunction with the main body of the report.

This annex provides more information on the following topics:

- how the TFP levels were calculated
- how the TFP growth figures were calculated
- details of the data used for both the TFP levels and TFP growth figures
- how the TFP levels and growth figures were adjusted to take account of R&D efforts
- details of the two step process adopted to take account of country specific effects leaving just the sectoral effects
- how the R&D spillover pools were calculated
- the alternative TFP levels and growth residuals
- the method by which the TFP levels were presented
- then some detailed TFP levels data by country and sector, and
- finally some detailed TFP growth data by country and sector.

Details of the TFP levels calculations

TFP levels and TFP growth are conceptually, and as we shall see, practically very different. We follow Harrigan (1999) in the presentation and measure of Total Factor Productivity (TFP) levels. We start by using a rewriting of the Solow equation that assumes that sectoral value added can be modelled as a function of its traditional factor endowment of capital *C* and labour *L*:

(1) $$Q_{sit} = A_{sit} \cdot F_s(C_{sit}, L_{sit})$$

where:

- subscripts *s*, *i* and *t* refer to the sector *s*, country *i* and the current year *t*
- *Q* is output measured by value added

- A is the residual, or that part of the output that is not explained by capital and labour, usually referred to as total factor productivity
- F is a country and sector specific function
- *C* is the gross value of plant and equipment,
- *L* is the number of employees (in practice we use the preferred hours worked).

The most general formulation of TFP can be expressed as the ratio of output over input:

$$TFP_{sit} = \frac{Q_{sit}}{F_s(C_{sit}, L_{sit})} = A_{sit}$$

Cross country comparisons of TFP levels imply that both inputs and outputs are measured perfectly, and in the same units, for each observations. TFP comparison between any two countries is tantamount to raising the questions of how much a given country could produce using another's country's inputs. This can be expressed as the distance function $D_a(Q_b,(C_b,L_b))$ as follows (leaving subscripts *s* and *t* aside for the sake of simplicity):

(2) $$D_a(Q_b,(C_b,L_b)) = \text{Min}_\delta\{\delta \in \Re_+ : f_a(\delta(C_b,L_b) \geq Q_b)\}:$$

This definition implies that: $D_a(C_b,L_b)$ is the smallest input bundle of country *b* (C_b,L_b) capable of producing output Q_b in country *a*.

If $\delta \leq 1$, then $\delta_a(C_b,L_b) \leq (C_b,L_b)$, then $Q_b/\delta_a(C_b,L_b) \geq Q_b/(C_b,L_b)$: if $\delta_a \leq 1$, country *a* has a higher TFP than country *b*. If $\delta_a \geq 1$, country *a* has a lower TFP than country *b*.

In practical terms, however, the measure $D_a(Q_b,(C_b,L_b))$ raises a number of problems. For example in the case of multilateral comparisons, the choice of a base country is likely to affect the outcomes.

As a solution to this index problem, Caves (1982) shows that the geometric mean of the two distance functions $D_a(Q_b,(C_b,L_b))$ and $D_a(Q_b,(C_b,L_b))$ between countries *a* and *b* is :

(3) $$\begin{aligned} TFP_{ab} &= \left(\frac{Q_a}{Q_b}\right)\cdot\left(\frac{\overline{L}}{L_a}\right)^{\sigma_a}\cdot\left(\frac{\overline{C}}{C_a}\right)^{1-\sigma_a}\left[\left(\frac{\overline{L}}{L_b}\right)^{\sigma_b}\cdot\left(\frac{\overline{C}}{C_b}\right)^{1-\sigma_b}\right]^{-1} \\ &= \left(\frac{Q_a}{Q_b}\right)\cdot\left(\frac{\overline{L}}{L_a}\right)^{\sigma_a}\cdot\left(\frac{\overline{C}}{C_a}\right)^{1-\sigma_a}\cdot\left(\frac{L_b}{\overline{L}}\right)^{\sigma_b}\cdot\left(\frac{C_b}{\overline{C}}\right)^{1-\sigma_b} \end{aligned}$$

Where a bar denotes a geometric mean over all observations and $\sigma_a = (\alpha_a + \overline{\alpha})/2$, where α_a is the share of labour compensation over value added in country *a* and $\overline{\alpha}$ is the geometric mean of all labour share across countries, given sector *s* and year *t*.

An attractive feature of Equation (3) is that it is superlative, meaning that it is equivalent to assuming a flexible translog function form; we do not need to assume specific rates of substitution of capital for labour. Furthermore, TFP is transitive, meaning that $TFP_{ac} = TFP_{ab} \times TFP_{bc}$, which makes the choice of base country inconsequential.

Therefore, we measure TFP level of each country relative to a *common* reference point: the geometric mean of all countries, so that Equation (3) generalises to:

$$
\begin{aligned}
TFP_{sit} &= \left(\frac{Q_{sit}}{\overline{Q}}\right) \cdot \left(\frac{\overline{L}}{L_{sit}}\right)^{\sigma_{sit}} \cdot \left(\frac{\overline{C}}{C_{sit}}\right)^{1-\sigma_{sit}} \left(\frac{\overline{L}}{\overline{L}}\right)^{\overline{\sigma}} \cdot \left(\frac{\overline{C}}{\overline{C}}\right)^{1-\overline{\sigma}} \\
&= \left(\frac{Q_{sit}}{\overline{Q}}\right) \cdot \left(\frac{\overline{L}}{L_{sit}}\right)^{\sigma_{sit}} \cdot \left(\frac{\overline{C}}{C_{sit}}\right)^{1-\sigma_{sit}} \\
&= \left(\frac{Q_{sit}}{\overline{Q}}\right) \div \left(\left(\frac{L_{sit}}{\overline{L}}\right)^{\sigma_{sit}} \cdot \left(\frac{C_{sit}}{\overline{C}}\right)^{1-\sigma_{sit}}\right)
\end{aligned} \quad (4)
$$

or in the log form:

$$
\ln TFP_{sit} = \ln\left(\frac{Q_{sit}}{\overline{Q}}\right) - \sigma_{sit} \cdot \ln\left(\frac{L_{sit}}{\overline{L}}\right) - (1-\sigma_{sit}) \cdot \ln\left(\frac{C_{sit}}{\overline{C}}\right) \quad (5)
$$

where $\sigma_{sit} = (\alpha_{sit} + \overline{\alpha})/2$. Note that when the productivity of a given country is strictly equal to that of the *average* country, then $\ln TFP_{sit} = 0$ and thus $TFP_{sit} = 1$. When a country productivity level is *above* that of the *average* country, $\ln TFP_{sit}$ is higher than unity. Conversely, when a country productivity level is below the *average* country, $\ln TFP_{sit}$ is lower than unity.

Comparisons of TFP levels potentially embody two types of measurement errors. First, TFP level comparisons across countries are affected by moves in currency exchange rates, which in turn affects the measures of both inputs and outputs. This means that relative TFP is likely to reflect currency moves irrespective of its *true* value $\hat{TFP}_{sit}$. Second, isolated measurement errors in either input or output affects the computations of the reference points $\overline{Q}$, $\overline{L}$, $\overline{C}$ and $\overline{\alpha}$. In other words, isolated measurement errors deviate all TFP measures from their *true* values $\hat{TFP}_{sit}$.

Thus, the use of mean information from all the countries involved implies that any error or noise from one country is transmitted to all the other countries. Another inevitable major source of noise with the levels approach is the exchange rates adopted. Even using the OECD's Purchasing Power Parity (PPP) exchange rates rather than market exchange rates does not totally address this problem. For these reasons emphasis is often put on TFP growth rates rather than TFP levels. However, TFP levels are often more useful for comparative purposes. A country's growth rate can be high, but if the country is starting from a low level this is less impressive, than a high growth rate from a country with already high-levels of TFP.

Details of TFP growth calculations

Given the potential impact of exchange rates on comparative TFP levels, it is often preferred to compute TFP growth as follows:

6)

$$\Delta TFP_{sit} = \ln\left(\frac{Q_{sit}}{Q_{sit-1}}\right) - \frac{1}{2}\cdot\left(\alpha_{sit}+\alpha_{sit-1}\right)\cdot\ln\left(\frac{L_{sit}}{L_{sit-1}}\right) - \left(1-\frac{1}{2}\cdot\left(\alpha_{sit}+\alpha_{sit-1}\right)\right)\cdot\ln\left(\frac{C_{sit}}{C_{sit-1}}\right)$$

A major difference between Equations (5) and (6) is that Equation (6) does not necessitate the conversion of currencies into a common unit nor the computation of a common reference point. This also means that any measurement error in one country does not influence the results for the other countries. This approach also implies that:

(7) $\Delta TFP_{sit}^{Eq.6} \neq TFP_{sit}^{Eq.5} - TFP_{sit-1}^{Eq.5}$

Data used for the TFP calculations

Two main sources of financial data were used. These were the OECD's STAN database and the Groningen database. These sources and the indicators that were derived from them are detailed below.

Value added (Q)

The GGDC 2003 Database was used to compute sectoral level value added. The GGDC 2003 Database provide sectoral value added for 54 sectors, whereas we need to further aggregate these sectors into 24 categories in order to conform to the SSDA sector classes. To recover sector specific deflators, we firstly aggregated the value added and deflated value added data. We then computed the aggregated sector specific deflator, in order to use for other series (e.g. R&D data derived from ANBERD). The base year for deflated computation used was 1995 across all currencies.

The computation of Equation (5) requires calculation of value added in a common currency. We used the OECD Purchasing Power Parity (PPP) currency exchange rates provided by STAN and expressed the derived value added in 1995 PPP dollars. PPP exchange rates are preferable to market exchange rates as they reflect actual cost differences rather than differences imposed by market valuations.

Capital (C)

Unlike the previous version of STAN, the International Sectoral Database (ISDB), the new version of STAN provides details on sectoral capital stocks. However, STAN reports industry investments in current own-currency values. Because investment flows are found in STAN and not GGDC, there are gaps in the series. We dealt with missing values by interpolating between non-missing values only. We did not extrapolate backward or forward in time.

Industry investments were then converted into US dollars using the Purchasing Power Parties (PPP) provided by STAN. These investment flows were then deflated into constant 1995 US dollars, using the implicit deflator for US fixed, non-residential investment from the National Income and Product Accounts.

Given the series on real investments flows, we then computed sectoral capital stocks as a function of past investment flows. Following previous studies (Harrigan, 1999), we computed capital stocks as a distributed lag of past investment flows using the so-called Permanent Inventory Method (PIM) :

$$(7) \qquad C_{sit} = \sum_{\tau=1}^{\tau=T} (1 - \delta)^{\tau} \cdot I_{sit-\tau}$$

Where C_{sit} is the capital stock of sector *s* in country *i* at time *t*, δ is the discount factor accounting for capital depreciation and *I* is real investment. We assumed δ to be 0.15 and T to be equal to 15.

Furthermore, we adjusted for the fact that countries may have different economic cycles, and that during economic down turns capital may not be fully used while in economic booms, capital is used closer to its total capacity. We follow Griffith, et al. (2001) and constructed a measure of capacity utilisation by first estimating a smoothed series of output $\hat{Q}_{sit}$ from the regression:

$$(8) \qquad Q_{sit} = \varpi_{si} + t_t$$

where *t* is time trend. Capital input adjusted for capacity utilisation is then defined as:

$$(9) \qquad C_{sit}^{cu} = C_{sit} \times \left(1 + \frac{Q_{sit} - \hat{Q}_{sit}}{\hat{Q}_{sit}}\right)$$

Labour (L)

Labour was derived from industry employment in the STAN database. Labour can be measured in several ways. Perhaps the simplest measure of labour is the total number of employees in a given industry, but this requires controls for both country and industry differences in the use of labour. Using hours worked allows more accurate international comparability than using simple head counts. This is the preferred basis for calculating international productivity comparisons (HM Treasury, 2004).

Normally, when examining TFP further adjustments of the hours worked by some indices of labour quality are undertaken at this stage. Typically, these adjustments aim to control for systematic differences across industries and countries in skills, education, occupations, gender, and more generally, quality of human capital. In this study these sorts of adjustment were not introduced at this stage as the purpose of the exercise was to determine the relative impact of a wide range of skills indicators described in Chapter 3.

Wages and compensation (α)

We used data on wages and compensation to compute the share of wages of compensation in value added: $\alpha_{sit} = W_{sit} / Q_{sit}$. Because this share is a ratio, we did not need to deflate nor to convert the data into a common currency. A recurrent problem with TFP measures is that the share of labour on value added α_{sit} is quite volatile. This is suggestive of measurement error. Therefore, we used the assumption of the translog function and of standard market cleaning conditions to smooth the observed α_{sit} , and expressed it as a function of the capital to labour ratio and as a vector of sector-country constants:

$$(10) \qquad \alpha_{sit} = \xi_{si} + \beta_s \cdot \ln\left(\frac{C_{sit}}{L_{sit}}\right)$$

The fitted values of labour cost shares $\hat{\alpha}_{sit}$ were then used for our estimations of TFP. In cases where the fitted values exceeded one, we follow O'Mahony *et. al.* (2003) and artificially set the values to 0.95. Equations (5) and (6) now become:

$$(11) \quad \ln TFP_{sit} = \ln\left(\frac{Q_{sit}}{\overline{Q}}\right) - \hat{\sigma}_{sit} \cdot \ln\left(\frac{L_{sit}}{\overline{L}}\right) - \left(1 - \hat{\sigma}_{sit}\right) \cdot \ln\left(\frac{C_{sit}}{\overline{C}}\right)$$

and:

(12)

$$\Delta TFP_{sit} = \ln\left(\frac{Q_{sit}}{Q_{sit-1}}\right) - \frac{1}{2}\cdot\left(\hat{\alpha}_{sit} + \hat{\alpha}_{sit-1}\right)\cdot\ln\left(\frac{L_{sit}}{L_{sit-1}}\right) - \left(1 - \frac{1}{2}\cdot\left(\hat{\alpha}_{sit} + \hat{\alpha}_{sit-1}\right)\right)\cdot\ln\left(\frac{C_{sit}}{C_{sit-1}}\right)$$

Empirical models of TFP levels and TFP growth

We use a similar approach to Crépon, Duguet and Mairesse (1998) and model TFP as a function of R&D and human capital:

(13) $$TFP_{sit} = A + \delta_Z \cdot Z_{sit} + \vartheta_H + u_{sit}$$

Equation (13) specifies that Total factor Productivity is a function of:

- a constant A
- Z as defined as a series of stocks of knowledge from which sectoral TFP can benefit
- Parameters δ_Z and ϑ_H represents the extent to which knowledge sources and human resources are associated with high productivity sectors
- H as a vector of sector-specific variables related to human capital.

It is assumed that R&D can influence a sector's TFP in three ways: directly though R&D funded by the sector; via inter-sectoral spillovers from other R&D conducted in the country; via international spillovers from R&D conducted in more technically advanced countries. In other words, we assume that:

(14) $$Z_{sit} \equiv R_{sit} \cdot N_{sit} \cdot I_{sit}$$

Where subscripts s, i and t are defined as previously. R_{sit} is sectoral R&D, N_{sit} is national R&D and N_{sit} is total sectoral imports. Therefore, Equation (13) can be seen as a test for structural association between TFP levels, and a vector of knowledge-related variables.

We follow Griffith et al. (2001) and model TFP growth as a function of several spillover pools as follows:

(15)

$$\Delta TFP_{sit} = A \cdot \beta_1 \cdot \Delta TFP_{sFt} + \beta_2 \cdot \left(\frac{TFP_{sit-1}}{TFP_{sFt-1}} \right) + \delta_Z \cdot Z_{sit} + \vartheta_H \cdot H_{sit} + u_{sit}$$

where:

- subscripts *s*, *i* and *t* are defined as previously
- Z_{sit} is defined as $Z_{sit} \equiv R_{sit} \cdot N_{sit} \cdot I_{sit}$
- ΔTFP_{sFt} is TFP growth of the frontier, the latter being defined as the highest value of TFP level at time *t*-1
- Parameters β_1 and β_2 represent technology transfer from the frontier.

Parameter β_1 catches the effect of TFP growth of the cross-country, sectoral frontier on non-frontier sectoral TFP of a given country, whereas parameter

β_2 represents a test for cross-country convergence in TFP levels. Those countries with the lowest TFP initial levels relative to the frontier should experience the highest growth rates (β-convergence).

The error term u_{sit} is decomposed into γ_s, η_i, λ_t and ε_{it} ($u_{sit} = \gamma_s + \eta_i + \lambda_t + \varepsilon_{sit}$), where $\gamma_s \sim IID(0,\sigma^2_\gamma)$ is a 1×1 scalar constant capturing persistent, but unobserved heterogeneity across sectors such as materials, energy consumption, distribution channels, type of demand, *etc*. Then $\eta_i \sim IID(0,\sigma^2_\eta)$ is a 1×1 scalar constant capturing persistent, but again unobserved heterogeneity across countries such as the type of economic environment, national systems of innovation, *etc*. Equally, $\lambda_t \sim IID(0,\sigma^2_\lambda)$ is a 1×1 scalar constant representing the time fixed effect which would capture positive or negative macroeconomic shocks common to all sectors and countries. Finally $\varepsilon_{sit} \sim IID(0,\sigma^2_\varepsilon)$ is the individual disturbance.

Our sample shows that the bulk of the variance of the dependent variable is found at the sector – country interaction. Therefore, we define $\varphi_{si} = \gamma_s \times \eta_i$ and rewrite u_{sit} as $u_{sit} = \varphi_{si} + \lambda_t + \varepsilon_{sit}$. Equations (13) and (15) can be estimated by ordinary least squares.

Addition of Canada, Norway and Japan

The addition of extra countries to the calculation of TFP levels effectively smoothes out the impact of poor data from any individual country. Therefore, solely for the purposes of the TFP levels calculations data from Canada Norway and Japan was included.

Specifying the final regressions

An intriguing feature of the human resources variables is their extreme stability over time. From the econometric viewpoint this represents a major issue, because it implies that we cannot use the standard panel techniques to estimate the relationships between TFP and human capital.

The extent of this problem was illustrated by examining the results of an ANOVA analysis of the data presented in Table A.1. This shows that a sector's TFP of the previous year, explained 73 per cent of the variance in the current year's TFP for the sector. Similarly, the growth rate in the previous year explains 15 per cent of the current year's variance. Importantly, the R-squared values for the skills indicators variables are all in the nineties indicating that there is very little variance left for the regressions to get a purchase on. Essentially, our dependent variables and explanatory variables were highly correlated.

Table A.1: ANOVA on explanatory variables as a functions of sectoral - country interaction

	F	R^2
$(TFP)_{i,t-1}$	44.36	0.730
$\Delta(TFP)_{I,t-1}$	2.74	0.151
Core human resources	266.51	0.973
SET occupations	90.16	0.930
Professional training	78.92	0.920
Highly qualified managers	93.88	0.929
Highly qualified professionals	335.61	0.979
ISCO 1	89.16	0.929
ISCO 2	508.94	0.987
ISCO 3	164.33	0.960
ICT occupation	50.88	0.880
High-level education	141.29	0.949
Intermediate-level education	76.04	0.908
Low-level education	89.82	0.921
Sectoral research & development intensity	247.69	0.959
Rest of economy research & development intensity	128.54	0.923
$(TFP)_{i,t-1}$ - $(TFP)_{F,t-1}$	25.27	0.607
$\Delta(TFP)_{F,t/t-1}$	1.19	0.072

Source: IES/SPRU model

TFP levels and growth rates can be explained by both medium-run permanent factors and medium-run transitory factors. By the latter, we mean that there are short run relationships between TFP levels and growth and some of the above explanatory variables. This is the case, for example, for imports and technology transfer.

However, some other factors are stable overtime, which implies that they lose all their explanatory power.

To address these fixed effect all transitory variables and included a set of dummy variables, which aimed to capture the sector-country fixed effects. These fixed effects have a direct economic interpretation, since they represent the residual TFP (level or growth) which is not explained by the transitory variables. A high fixed effect means that country *i* in sector *s* has on average a high TFP. Conversely, a low fixed effect means that country *i* in sector *s* has on average a poor TFP.

Detailed results by sector

This table includes all the variables and associated standard errors, significances and Variance Inflation Factors (VIFs) from the sector level regression. These results are also presented in Chapter 6, but there they are reported in a series of sector specific tables. Here all the results are in a single table reflecting the single regression that generated the results.

Table A.2: Sector specific regression results

Variable	Coefficient	Standard error and significance	VIF
High-level education in Agriculture 1	2.365	[1.237]*	5.76
High-level education in Mining & Quarrying	0.150	[0.416]	7.09
High-level education in Food Drink & Tobacco	-0.095	[0.421]	11.35
High-level education in Textiles & Clothing	-0.360	[0.555]	7.91
High-level education in Wood Pulp & Paper	1.900	[0.695]***	9.17
High-level education in Publishing & Printing	-0.434	[0.201]**	17.58
High-level education in Energy & Chemicals	0.090	[0.311]	20.32
High-level education in Metals & Metal Products	0.082	[0.302]	11.99
High-level education in Machinery & Equipment	1.156	[0.294]***	21.08
High-level education in Transport Equipment	0.201	[0.270]	15.67
High-level education in Furniture, Recycling & Other	0.214	[0.344]	6.07
High-level education in Electricity Gas & Water	0.724	[0.218]***	14.99
High-level education in Construction	-0.533	[0.356]	8.11
High-level education in Wholesale & Retail	-0.393	[0.242]	11.12
High-level education in Hotels & Restaurants	-2.197	[0.441]***	10.14
High-level education in Transport	0.057	[0.240]	10.35
High-level education in Post & Telecoms	-0.622	[0.304]**	12.75
High-level education in Financial Services	0.157	[0.283]	22.85
High-level education in Private Services	0.116	[0.874]	95.42
High-level education in Public Administration *etc*	0.133	[0.168]	21.21
High-level education in Education	1.520	[0.280]***	266.42
High-level education in Health and Social Work	0.570	[0.207]***	57.19

Variable	Coefficient	Standard error and significance	VIF
High-level education in Other Public and Personal Services	0.153	[0.356]	27.47
Intermediate education in Agriculture	-0.254	[0.258]	21.55
Intermediate education in Mining & Quarrying	-0.193	[0.139]	7.12
Intermediate education in Food Drink & Tobacco	0.055	[0.134]	9.27
Intermediate education in Textiles & Clothing	0.605	[0.135]***	5.64
Intermediate education in Wood Pulp & Paper	0.567	[0.183]***	6.80
Intermediate education in Publishing & Printing	0.555	[0.140]***	16.17
Intermediate education in Energy & Chemicals	0.375	[0.135]***	13.43
Intermediate education in Metals & Metal Products	0.741	[0.106]***	11.39
Intermediate education in Machinery & Equipment	0.918	[0.214]***	24.23
Intermediate education in Transport Equipment	0.762	[0.109]***	10.54
Intermediate education in Furniture, Recycling & Other	0.466	[0.110]***	6.81
Intermediate education in Electricity Gas & Water	-0.161	[0.216]	24.20
Intermediate education in Construction	0.410	[0.100]***	16.81
Intermediate education in Wholesale & Retail	0.162	[0.101]	25.72
Intermediate education in Hotels & Restaurants	-0.352	[0.158]**	24.68
Intermediate education in Transport	-0.001	[0.108]	28.58
Intermediate education in Post & Telecoms	-0.465	[0.229]**	52.73
Intermediate education in Financial Services	-0.041	[0.284]	40.23
Intermediate education in Private Services	-0.123	[0.795]	84.46
Intermediate education in Public Administration *etc*	0.555	[0.175]***	50.67
Intermediate education in Education	0.783	[0.283]***	53.62
Intermediate education in Health and Social Work	0.732	[0.153]***	48.75
Intermediate education in Other Public and Personal Services	0.618	[0.196]***	33.30
Training in Agriculture	0.602	[0.494]	3.34
Training in Mining & Quarrying	0.646	[0.540]	2.05
Training in Food Drink & Tobacco	0.829	[0.263]***	2.96
Training in Textiles & Clothing	1.303	[0.538]**	2.55
Training in Wood Pulp & Paper	2.351	[1.361]*	2.90
Training in Publishing & Printing	0.634	[0.183]***	2.57
Training in Energy & Chemicals	-0.210	[0.207]	2.79
Training in Metals & Metal Products	-0.243	[0.298]	3.23
Training in Machinery & Equipment	-1.243	[0.344]***	3.44
Training in Transport Equipment	-0.950	[0.272]***	2.85
Training in Furniture, Recycling & Other	-0.095	[0.345]	3.04
Training in Electricity Gas & Water	0.002	[0.209]	2.46
Training in Construction	-0.313	[0.318]	4.49
Training in Wholesale & Retail	0.215	[0.152]	5.06
Training in Hotels & Restaurants	0.378	[0.198]*	2.73

Variable	Coefficient	Standard error and significance	VIF
Training in Transport	-0.064	[0.266]	3.69
Training in Post & Telecoms	-0.230	[0.171]	2.73
Training in Financial Services	0.366	[0.226]	2.97
Training in Private Services	-0.119	[0.542]	6.07
Training in Public Administration *etc*	-0.246	[0.174]	4.52
Training in Education	0.222	[0.205]	4.28
Training in Health and Social Work	-0.085	[0.169]	8.55
Training in Other Public and Personal Services	0.053	[0.233]	4.12
Training missing values	0.009	[0.035]	8.63
ICT Occupations in Agriculture	42.707	[22.471]*	2.96
ICT Occupations in Mining & Quarrying	3.668	[2.361]	2.70
ICT Occupations in Food Drink & Tobacco	0.312	[2.520]	4.66
ICT Occupations in Textiles & Clothing	1.819	[1.573]	2.27
ICT Occupations in Wood Pulp & Paper	-9.965	[8.743]	5.00
ICT Occupations in Publishing & Printing	2.863	[1.300]**	9.42
ICT Occupations in Energy & Chemicals	-4.331	[1.454]***	8.47
ICT Occupations in Metals & Metal Products	-0.173	[0.816]	3.05
ICT Occupations in Machinery & Equipment	0.598	[0.513]	8.68
ICT Occupations in Transport Equipment	-0.874	[0.896]	7.62
ICT Occupations in Furniture, Recycling & Other	4.073	[1.995]**	2.50
ICT Occupations in Electricity Gas & Water	0.193	[0.264]	5.06
ICT Occupations in Construction	-1.714	[0.690]**	3.68
ICT Occupations in Wholesale & Retail	-0.769	[1.776]	9.30
ICT Occupations in Hotels & Restaurants	10.262	[6.758]	4.45
ICT Occupations in Transport	1.653	[2.655]	11.07
ICT Occupations in Post & Telecoms	1.206	[0.392]***	8.18
ICT Occupations in Financial Services	-2.694	[1.754]	13.70
ICT Occupations in Private Services	1.732	[0.654]***	7.71
ICT Occupations in Public Administration *etc*	0.691	[1.430]	9.14
ICT Occupations in Education	-7.445	[4.422]*	5.48
ICT Occupations in Health and Social Work	5.376	[2.839]*	11.06
ICT Occupations in Other Public and Personal Services	-3.964	[2.109]*	9.09
ICT Occupations in _m	0.051	[0.035]	3.41
Managers in Agriculture	0.265	[0.217]	1.62
Managers in Mining & Quarrying	-0.442	[0.864]	17.97
Managers in Food Drink & Tobacco	2.689	[0.527]***	7.42
Managers in Textiles & Clothing	-0.061	[0.570]	5.16
Managers in Wood Pulp & Paper	-0.936	[1.183]	5.03
Managers in Publishing & Printing	0.793	[0.313]**	6.26
Managers in Energy & Chemicals	1.484	[0.463]***	6.53

Variable	Coefficient	Standard error and significance	VIF
Managers in Metals & Metal Products	1.530	[0.505]***	4.42
Managers in Machinery & Equipment	1.492	[0.686]**	7.43
Managers in Transport Equipment	-0.353	[0.646]	4.51
Managers in Furniture, Recycling & Other	1.448	[0.448]***	3.87
Managers in Electricity Gas & Water	-0.310	[0.490]	4.38
Managers in Construction	0.215	[0.437]	4.80
Managers in Wholesale & Retail	-0.302	[0.228]	10.51
Managers in Hotels & Restaurants	-0.179	[0.171]	5.78
Managers in Transport	1.536	[0.313]***	5.89
Managers in Post & Telecoms	-2.563	[0.580]***	7.90
Managers in Financial Services	-2.236	[0.342]***	6.52
Managers in Private Services	4.238	[1.189]***	8.11
Managers in Public Administration *etc*	0.433	[0.327]	5.50
Managers in Education	-1.464	[1.052]	8.64
Managers in Health and Social Work	0.550	[0.614]	8.64
Managers in Other Public and Personal Services	-2.025	[0.702]***	7.68
Managers missing values	0.086	[0.043]**	5.90
Professionals in Agriculture	-2.791	[4.733]	3.46
Professionals in Mining & Quarrying	-0.415	[0.949]	17.97
Professionals in Food Drink & Tobacco	-0.091	[1.392]	7.47
Professionals in Textiles & Clothing	1.099	[1.258]	3.17
Professionals in Wood Pulp & Paper	-5.360	[3.199]*	5.20
Professionals in Publishing & Printing	-0.148	[0.302]	12.35
Professionals in Energy & Chemicals	-0.744	[0.816]	16.48
Professionals in Metals & Metal Products	-1.255	[0.985]	4.49
Professionals in Machinery & Equipment	0.112	[0.569]	11.72
Professionals in Transport Equipment	1.392	[0.630]**	11.74
Professionals in Furniture, Recycling & Other	0.870	[1.366]	2.72
Professionals in Electricity Gas & Water	0.279	[0.451]	6.53
Professionals in Construction	2.967	[1.141]***	5.82
Professionals in Wholesale & Retail	1.624	[1.228]	6.67
Professionals in Hotels & Restaurants	1.626	[2.492]	6.73
Professionals in Transport	-1.801	[1.039]*	8.14
Professionals in Post & Telecoms	2.075	[0.793]***	7.65
Professionals in Financial Services	-0.569	[0.543]	7.35
Professionals in Private Services	-1.255	[0.439]***	20.30
Professionals in Public Administration *etc*	1.664	[0.260]***	17.12
Professionals in Education	-0.064	[0.087]	25.71
Professionals in Health and Social Work	-0.400	[0.119]***	8.19
Professionals in Other Public and Personal Services	0.624	[0.561]	25.32

Variable	Coefficient	Standard error and significance	VIF
Professionals missing values	-0.128	[0.041]***	6.68
1992 year dummy	0.123	[0.028]***	1.33
1993 year dummy	0.071	[0.024]***	1.82
1994 year dummy	0.060	[0.024]**	1.82
1995 year dummy	0.023	[0.021]	2.14
1996 year dummy	0.028	[0.021]	1.99
1997 year dummy	0.021	[0.019]	1.90
1998 year dummy	0.016	[0.020]	1.75
1999 year dummy	0.016	[0.019]	1.76
2000 year dummy	0.003	[0.020]	1.78
Belgium country dummy	0.076	[0.042]*	5.97
Denmark country dummy	-0.049	[0.041]	4.61
Germany country dummy	-0.060	[0.041]	4.20
Spain country dummy	0.096	[0.046]**	12.86
France country dummy	0.084	[0.050]*	6.92
Italy country dummy	0.110	[0.044]**	8.30
Luxembourg country dummy	0.214	[0.047]***	5.24
Netherlands country dummy	-0.044	[0.046]	2.74
Austria country dummy	-0.049	[0.045]	4.95
Finland country dummy	-0.091	[0.039]**	3.83
Sweden country dummy	-0.013	[0.046]	3.32
United States country dummy	0.023	[0.042]	7.65
Mining & Quarrying dummy	0.105	[0.141]	13.26
Food Drink & Tobacco dummy	-0.031	[0.124]	36.63
Textiles & Clothing dummy	-0.155	[0.100]	21.23
Wood Pulp & Paper dummy	-0.060	[0.157]	21.26
Publishing & Printing dummy	-0.075	[0.120]	36.93
Energy & Chemicals dummy	0.031	[0.124]	45.94
Metals & Metal Products	-0.226	[0.104]**	37.27
Machinery & Equipment dummy	-0.514	[0.162]***	74.95
Transport Equipment dummy	-0.130	[0.117]	35.10
Furniture, Recycling & Other dummy	-0.150	[0.108]	18.52
Electricity Gas & Water dummy	0.114	[0.150]	52.68
Construction dummy	0.036	[0.104]	46.91
Wholesale & Retail dummy	0.163	[0.109]	91.21
Hotels & Restaurants dummy	0.577	[0.117]***	41.18
Transport dummy	0.168	[0.140]	66.90
Post & Telecoms dummy	0.589	[0.165]***	61.23
Financial Services dummy	0.650	[0.255]**	106.96
Private Services dummy	-0.040	[0.602]	307.62

Variable	Coefficient	Standard error and significance	VIF
Public Administration *etc* dummy	-0.370	[0.140]***	95.84
Education dummy	-0.848	[0.251]***	488.10
Health and Social Work dummy	-0.256	[0.135]*	183.51
Other Public and Personal Services dummy	0.016	[0.161]	67.01
Constant	0.745	[0.109]***	---
Observations	2,148	---	---
R-squared	0.430	---	---
Mean VIF	---	---	21.65

Source: IES/SPRU Model

List of previous SSDA Publications

Please note all publications can be downloaded from out website www.ssda.org.uk

Research Report 1

Skills for Business 1000

Research Report 2

Evaluation of the Trailblazer Phase of the Sector Skills Council Network

Research Report 3

Skills for Business Network – Phase I Evaluation

Research Report 4

Skills for Business 2003 – Survey of Employers

Research Report 5

Skills Pay: The Contribution of Skills to Business Success

Research Report 6

The UK Skills and Productivity Agenda: The Evidence Base for the SSDA's Strategic Plan 2005-2008

Research Report 7

The UK Workforce: Realising our Potential

Research Report 8

Sectoral Management Priorities: Management Skills and Capacities

Research Report 9

Raising Sector Skills Levels – How Responsive is Local Training Supply?

Research Report 10

Skills for Business Network: Phase 2 Evaluation Main Report

Research Report 11

Skills for Business 2004: Survey of Employers

Research Report 12

Skills for Business Network: Phase 2 Evaluation Case Studies

Research Report 13

Sectoral Productivity Differences Across the UK

Working Futures: National Report 2003-04

Working Futures: Regional Report 2003-04

Working Futures: Sectoral Report 2003-04