Employers Skill Survey
New Analyses and Lessons Learned

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EMPLOYERS SKILL SURVEY: NEW ANALYSES AND LESSONS LEARNED -- AN OVERVIEW

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1.1 Background

In late 2001 the Department for Education and Skills (DfES) commissioned new secondary analysis of the 1999 and 2001 Employers Skills Surveys (ESS) in order to provide further information on skill deficiencies in the labour market. The first of these two large scale surveys (ESS1999) was intended to inform the National Skills Task Force (NSTF) in 1999. The Task Force recommended that a new national system for collecting and disseminating information on labour market and skill needs should be established. As part of its contribution to meeting these information requirements, the DfES conducted a second survey in 2001 (ESS2001). Subsequently, a smaller survey was commissioned for 2002 (ESS2002).

The research carried out for this project had several objectives. These fall under three main headings:

- an over-arching objective, to identify the most informative and useful measures of skill deficiencies to be drawn from ESS, as well as to assess the general strengths and weakness of the ESS data sets;
- sectoral objectives, including the development of useful and reliable data to inform the new Sector Skills Councils (SSCs); and
- finally, a set of more general objectives relating to the nature, extent and consequences of different types of skill deficiencies and employer responses to them.

The research delivered a number of specific outputs which form the following chapters of this volume:

- an assessment of the reliability and robustness of ESS data (Chapter 2);
- an overall assessment of the advantages and disadvantages of different measures of skill deficiencies in ESS (Chapter 3);
- a series of statistical reports aimed at providing the new 'Trailblazer' SSCs with key components of the labour market information that they need to meet their objectives;
- an analysis of the persistence of skill deficiencies between 1999 and 2001 (Chapter 4);
- the development of a new typology of sectors on the basis of their skill requirements and reported skill deficiencies (Chapter 5);
- an exploration of the links between qualifications and skill deficiencies (Chapter 6);
- an analysis of the main determinants of skill deficiencies in key occupations (Chapter 7); and
- an examination of the apparent paradox of low training in high qualification regions (Chapter 8).

The aim of this introductory chapter is to synthesise the main findings of these chapters with particular emphasis on:

1) the extent to which the surveys can be used to provide reliable information on skill deficiencies at a detailed level of sectoral disaggregation;
2) the distinction between 'skill-shortage vacancies' and 'internal skill gaps';
3) the extent and nature of cross-sectoral variation in the incidence of different kinds of skill deficiency;
4) the main determinants of skill deficiencies;
5) the main determinants of training which might help alleviate skill deficiencies;
6) a critical assessment of the strengths and weaknesses of the ESS methodology and some suggestions as to how future labour market information-gathering might be improved as a result of the lessons learned from ESS.

1.2 Sampling issues and the reliability and robustness of ESS data

ESS2001 was an establishment-level survey consisting of a total of 27, 031 telephone interviews across all sectors and all size bands. In contrast to ESS1999, the 2001 survey included workplaces with fewer than five employees. The principal respondent in each case was the senior person responsible for human resource or personnel issues. In workplaces with 25 or more employees this was the human resources or personnel director/manager. In workplaces with fewer than 25 employees it was the owner, managing director or general manager. The respondent was asked to report upon the supply of, and demand for, skills at their establishment. Interviewing was restricted to England.

The main stage of interviewing was carried out between November 2000 and April 2001. The overall response rate from employers was 53 per cent. The sample was drawn from BT's Business Database, a regularly up-dated list of establishments with a business telephone line. Further information about the sample and design of the study can be found in Hogarth *et al* (2001).

As in 1999, the 2001 survey was intended to provide data at both a sectoral and spatial level. In 2001 the sampling procedures involved the setting of quota targets on the basis of a three-dimensional matrix comprising 720 cells (5 size bands, 16 industry sectors and 9 regions). Most analysis of ESS to date has therefore focussed on relatively broad sectors of the economy corresponding to the Sections of the *Standard Industrial Classification 1992* (SIC1992). However, there has been considerable interest in learning more about the extent to which the ESS may be used to provide reliable information on skill deficiencies at a lower level of industrial aggregation.

This issue is addressed by John Forth in Chapter 2 of this volume. He considers three types of estimates:

1. *Workplace percentages*, e.g., the percentage of establishments in a particular sector that report a particular kind of skill deficiency;
2. *Employee totals*: e.g., the total number of employees in a particular sector that are deemed to lack the required proficiency for their current jobs;
3. *Employee ratios*: e.g., the ratio of the number of employees lacking full proficiency to the total number of employees in the sector concerned.

An assessment of the reliability and robustness of survey estimates such as these depends upon estimates of the sampling error (precision) and non-sampling error (bias) of the disaggregated estimates. Together, sampling error and non-sampling error indicate the likely deviation of a survey estimate from the true population value. Forth conducts a detailed assessment of the methodology used to conduct the surveys and of the estimated sampling and non-sampling errors associated with sectoral estimates from ESS. He suggests that, if all establishments are included, then a minimum sub-sample size of roughly 900 observations will usually be necessary (and sufficient) for estimates of proportions of establishments, employee totals and employee ratios to have a reasonable level of precision (for example, a coefficient of variation of 20% or less). In the case of sub-samples which exclude establishments with fewer than 5 employees, this minimum cell size will typically fall to about 400 observations (see Chapter 2 for examples).

These recommended thresholds are not set in concrete: in practice, the precision of different types of estimate in particular sectors can only be guaranteed through investigation of the data on a sector by sector basis. Nevertheless, they provide useful broad guidelines to the limits to sectoral disaggregation in ESS, for example, in generating headline statistics such as the proportion of establishments in a sector with skill-related external recruitment difficulties. Even larger sectoral sub-samples are needed for analysis involving disaggregation by other dimensions such as occupation or geography.

1.3 Different measures of skill deficiencies

Primary analysis of ESS1999 and ESS2001 data has been reported by NSTF (1999), Bosworth *et al*. (2000) and Hogarth *et al*. (2001). These reports developed establishment-based and employee-based measures of two main kinds of skill deficiency:

(1) '*skill-shortage vacancies*' – hard-to fill vacancies at the time of interview which were described by survey respondents as difficult to fill for at least one of the following reasons:

- 'Low number of applicants with the required skills'
- 'Lack of work experience the company demands'
- 'Lack of qualifications the company demands'

Establishment-based measures of skill-shortage vacancies provide an estimate of the total number of establishments reporting a given skill deficiency. Employee-based measures provide an indication of the total number (or proportion) of employees which are affected by a given skill deficiency. For example, one employee-based measure, the "density" of skill-shortage vacancies in a particular sector, relates the proportion of skill shortage vacancies to the level of total employment in that sector.

(2) 'internal skill gaps' – reported deficiencies in the skills and knowledge of existing employees.

Employee-based estimates of the total number of internal skill gaps refer to all employees who were described by survey respondents as lacking 'full proficiency' in their current jobs. Establishments themselves are defined as having an internal skill gap if it was reported that, in at least one occupational area, 'over half' or fewer employees were fully proficient. [1]

In a detailed assessment of these different measures, John Forth, Geoff Mason and Philip Stevens (Chapter 3) suggest that establishment-based measures of skill deficiencies are useful as preliminary indicators of the incidence of skill problems but have the disadvantage of tending to be dominated by small establishments. Conversely, an alternative approach of weighting establishment-based measures by the levels of employment in each establishment serves only to indicate the proportion of employees working in establishments with skill deficiencies, rather than the extent of the deficiencies themselves. They suggest that information about the extent and seriousness of skill shortcomings is better conveyed by employee-based density measures which can show where different kinds of skill problem are concentrated and how acute they are, if related to total employment in the sector, occupation or region concerned.

These evaluations were taken into account by Terence Hogarth and Rob Wilson in the preparation of customised reports on skill deficiencies for each of the Trailblazer SSCs (Hogarth and Wilson, 2002). As well as focusing on skill shortage vacancies and internal skill gaps, they also report estimates based on ESS data of labour turnover, sales growth, product market strategy and training. For Trailblazer sectors where the numbers of establishments surveyed in ESS fell below the thresholds discussed above, a comparison was made with the Annual Business Inquiry and other data sources to assess how representative the ESS data were for each sector under consideration.

1.4 Cross-sectoral variation in skill deficiencies

Table 1.1 illustrates how sectoral rankings in terms of skill-shortage vacancies differ depending on what type of measure is used. In terms of the establishment-based measure (Columns 1-2), the two worst affected sectors are business services and education. However, the employee-based density

[1] This is the so-called 'narrow' definition of internal skill gaps at establishment level; see Forth, Mason and Stevens (2003; Chapter 3 in this volume) for further discussion about skill gap definitions.

measure shows that the acuteness of the problem – relative to total employment -- is greatest in construction (Columns 3-4). Business services also ranks highly on this measure but education declines to 10th out of 11 in the rankings.

Table 1.1: Incidence of skill-shortage vacancies, 2001, analysed by sector

	Percent of establishments reporting at least one skill-shortage vacancy (a)	Ranking: estab-lishment-based measure (b)	Skill-shortage vacancies as percent of total employment	Ranking: employee-based measure (b)
Business services	5.0	1	1.7	2
Education	4.8	2	0.4	10
Manufacturing	4.3	3	0.6	5
Public administration	4.3	4	0.2	11
Health & social work	4.2	5	0.8	4
Transport and communication	4.1	6	0.6	6
Finance	3.6	7	0.5	9
Construction	3.4	8	1.7	1
Hotels & restaurants	3.0	9	0.5	7
Other community services	2.9	10	0.8	3
Wholesale, retail	2.5	11	0.5	8
TOTAL (c)	**3.6**		**0.8**	

Notes:
(a) Sample-based estimates grossed-up to ensure that they are representative of the entire population of establishments in England.
(b) Rankings apply to non-rounded figures.
(c) Total figures include three sectors for which separate results are not shown here due to small cell sizes: agriculture, mining and quarrying and electricity and water supply.

In the case of internal skill gaps, there is less divergence between the two types of measure which both show the same four sectors – public administration, manufacturing, finance and hotels and restaurants – as worst affected by skill deficiencies among existing staff (Table 1.2). On the density measure (Columns 3-4), the highest proportions of employees regarded as lacking full proficiency are in public administration and hotels/restaurants, two sectors which rank fairly low in terms of skill-shortage vacancies. Conversely, construction, which ranked highest in terms of the density of skill-shortage vacancies, ranks second lowest on both measures of internal skill gaps. Business services is ranked well down the list on both measures.

Table 1.2: Incidence of internal skill gaps (a), 2001, analysed by sector

	Percent of establishments reporting an internal skill gap in at least one occupational area (b)	Ranking: estab-lishment-based measure (c)	Internal skill gaps as percent of total employment	Ranking: employee-based measure (c)
Public administration	12	1	12.0	1
Manufacturing	10	2	11.2	3
Finance	10	3	10.1	4
Hotels and restaurants	9	4	11.2	2
Health and social work	9	5	8.2	8
Education	8	6	6.4	11
Wholesale, retail	7	7	9.6	5
Business services	6	8	8.3	7
Transport and communication	6	9	9.4	6
Construction	5	10	7.6	10
Other community services	5	11	7.6	9
TOTAL (d)	**7**		**9.3**	

Notes:
(a) Establishments are defined as having an internal skill gap if they reported that, in at least one occupational area, 'over half' or fewer employees were fully proficient
(b) Sample-based estimates grossed-up to ensure that they are representative of the entire population of establishments in England.
(c) Rankings apply to non-rounded figures.
(d) Total figures include three sectors for which separate results are not shown here due to small cell sizes: agriculture, mining and quarrying and electricity and water supply.

These inter-sectoral contrasts in the incidence of skill deficiencies are associated to a considerable extent with the occupational profiles of skill-shortage vacancies and internal skill gaps. As outlined in Chapter 3, skill-shortage vacancies are most heavily concentrated in craft-skilled occupations (an important group in the construction sector) and in professional and associate professional occupations (which account for relatively high proportions of employment in business services). By contrast, these occupations rank fairly low in terms of internal skill gaps. Here the occupations most affected tend to be the lower-skill categories (that is, personal service and sales occupations, process and machine operators and elementary occupations), which account for sizeable proportions of employment in sectors such as hotels and manufacturing.

In a detailed assessment of the persistence of reported skill deficiencies between the ESS1999 and ESS2001 surveys, John Forth and Geoff Mason find a high degree of stability in sectoral rankings between the two years (Chapter 4). Since ESS1999 excluded establishments with fewer than five employees, the comparison necessarily has to exclude these micro-

establishments as well. This enables the analysis to be carried out at a much more detailed level of sectoral disaggregation than if the establishments with one to four employees were included. Some 32 sectors can be identified, with sufficient observations for estimates to have a reasonable level of precision when analysis is confined to establishments with five or more employees (see Section 1.2 above).

As Table 1.3 shows, four of the six sectors most affected by skill-shortage vacancies in 1999 were also among the six sectors worst affected in 2001: building installation and completion; computer services; building of complete constructions, including civil engineering; and transport services (Columns 2-3). At the other end of the scale four of the six sectors least affected by skill-shortage vacancies in 1999 were among the six sectors least affected in 2001: chemicals, rubber and plastics; primary education; non-specialised retailing; and public administration.

These rankings contrast markedly with those for internal skill gap densities in the two years which show the highest incidence in sectors such as food drink and tobacco; restaurants, canteens and catering; hotels, motels and other accommodation; and chemicals, rubber and plastics (Table 1.3, Columns 5-6). The bottom six sectors in terms of internal skill gap densities in both years include sectors such as building installation and completion and human health activities, which are much more likely to experience problems with skill-related external recruitment difficulties. In both years the top three positions and the bottom three positions for internal skill gaps are taken by the same sectors in each case.

There are some notable changes in sectoral rankings between ESS1999 and ESS2001. For example, the density of skill-shortage vacancies in architectural, engineering and related technical consultancy rises from 12th in the 1999 sectoral ranking to 1st in 2001 while restaurants, canteens and catering declines from 6th to 24th. In the case of internal skill gaps, the reported density of such shortcomings in postal and telecoms services rises from 23rd to 6th in the rankings. However, the dominant impression conveyed by the analysis for the great majority of sectors is one of stability in the sectoral incidence of skill deficiencies over the period covered by the two surveys.

Table 1.3: Ranking of sectors by densities of skill-shortage vacancies and internal skill gaps, 1999 and 2001

	Density of skill-shortage vacancies			Density of internal skill gaps	
Industry sector	ESS99 Rank	ESS01 Rank	Industry sector	ESS99 Rank	ESS01 Rank
Building installation, building completion and other construction activities	1	3	Food, drink and tobacco	1	1
Computer services	2	2	Restaurants, canteens, catering	2	2
Building of complete constructions; civil engineering	3	4	Hotels, motels and other accommodation	3	3
Transport services	4	6	Retailing - specialised stores	4	11
Sales of motor vehicles, parts, fuel	5	8	Chemicals, rubber and plastics	5	4
Restaurants, canteens, catering	6	24	Retailing - non-specialised stores; other retail and repair	6	7
Other service industries	7	16	Financial services, including insurance	7	12
Other business services	8	10	Electrical, electronic and instrument engineering	8	8
Bars	9	14	Mechanical engineering, vehicles and other engineering	9	10
Printing, publishing, recorded media	10	28	Bars	10	20
Legal, accounting, auditing, business and management consultancy, etc.	11	5	Public administration	11	5
Architectural and engineering activities and related technical consultancy; technical testing, analysis	12	1	Other manufacturing industries	12	9
Retailing - specialised stores	13	19	Other business services	13	15
Electrical, electronic and instrument engineering	14	7	Wholesaling	14	16
Wholesaling	15	12	Transport services	15	26
Social work	16	13	Fabricated metal products	16	13
Other manufacturing industries	17	18	Sporting activities, arenas, stadia	17	18
Sporting activities, arenas, stadia	18	20	Printing, publishing, recorded media	18	21
Postal and telecommunications services	19	26	Computer services	19	14
Human health activities	20	9	Other service industries	20	24
Hotels, motels and other accommodation	21	17	Auxiliary transport activities, travel agents	21	17
Financial services, including insurance	22	23	Higher education, adult education and other education	22	25
Auxiliary transport activities, travel agents	23	21	Postal and telecommunications services	23	6
Fabricated metal products	24	11	Sales of motor vehicles, parts, fuel	24	29
Mechanical engineering, vehicles and other engineering	25	27	Building of complete constructions; civil engineering	25	22
Higher education, adult education and other education	26	15	Legal, accounting, auditing, business and management consultancy, etc.	26	28
Chemicals, rubber and plastics	27	31	Social work	27	19
Primary education	28	30	Building installation, building completion and other construction activities	28	27
Retailing - non-specialised stores; other retail and repair	29	32	Architectural and engineering activities and related technical consultancy; technical testing and analysis	29	23
Food, drink and tobacco	30	22	Human health activities	30	30
Public administration	31	29	General secondary education	31	31
General secondary education	32	25	Primary education	32	32

1.5 The determinants of skill deficiencies

1.5.1 A typology of sectors based on skill needs

In Chapter 5 Andy Dickerson, Geoff Mason and John Forth assess the main factors underlying the patterns of similarity and difference in reported skill deficiencies among sectors. This is accomplished by developing a new typology of sectors according to their skill *requirements* (associated with the predominant product/service strategies in each sector) as well as their reported skill deficiencies. Skill requirements are measured by a wage-weighted index of the qualifications of each establishment's labour force, together with a measure of the product or service strategy of the establishment. The latter includes, for example, indicators of where establishments position themselves on a spectrum ranging from low to high product complexity or the extent to which establishments compete in a 'premium quality' product market as compared to a 'standard or basic quality' product market. Skill deficiencies are measured by the extent of skill-shortage vacancies and internal skill gaps in establishments in 2001.

Cluster analysis of these measures of skill requirements and deficiencies identifies a robust agglomeration of sectors into nine distinctive groups which differ sharply, not just in terms of predominant product strategies and associated skills, but in terms of the incidence of skill-shortage vacancies and internal skill gaps. When the nine groups are ranked from highest to lowest in terms of skill requirements – as in Table 1.4 – what stands out are the different levels of skill deficiencies experienced by groups which ostensibly have similar skill requirements. Thus, for example, the three most skill-intensive groups all suffer from relatively high levels of external skill shortages but Group 6 (computer services) is notable for also reporting a relatively high proportion of internal skill gaps. Computer services is more concentrated regionally in London and the South East than any other group, and this may have implications in terms of competition for scarce skills in this region.

At the other end of the scale the three lowest groups in terms of skill requirements all experience above average problems with internal skill gaps but Group 5 (hotels and other accommodation) stands out for having moderate levels of external skill shortages as well. Firms in the hotels sector have extremely high hiring and quit rates (as shown in ESS2001). Coupled with the fact they have the lowest level of training of any of the sectoral groups, it is perhaps unsurprising that they have high levels of skill deficiencies, despite having relatively low skill requirements.

In the middle of the skills ranking, Group 3 (including craft-intensive sectors such as construction and metal-working) is conspicuous for its combination of high levels of external skill shortages with apparently low levels of internal skill gaps. This suggests that while the bulk of existing employees in these sectors possess the required skills, there are marked difficulties in recruiting skilled workers on the open market (e.g., workers with craft skills which can only be developed through long-duration training).

Another factor underlying differences in the incidence of skill deficiencies is variation in average growth rates between sectors. Groups 6 (computer services) and 8 (technical business services such as architectural and engineering consultancies) report the highest concentrations of establishments whose sales have increased 'a great deal' in the previous 12 months and this is associated with their relatively high incidence of external skill shortages. It is notable also that Groups 6 and 8 have higher proportions of low-training establishments and lower proportions of high-training establishments than other relatively high-skill groups such as Group 9 (primary education) and Group 7 (legal, accounting services; health; secondary and higher education).

Finally, it turns out that the lower-skill groups such as Groups 5, 4 and 1, which report relatively serious problems with internal skill gaps, also have relatively high proportions of low-training establishments. Group 3 (including construction and metal-working) has a similarly high proportion of low-training establishments even though, as noted above, it suffers from high levels of external skill shortages. One hypothesis here is that a sizeable proportion of establishments in this group continue to rely on recruiting craft-skilled employees on the open market rather than undertake high levels of training.

1.5.2 Skill deficiencies and qualifications of the workforce

In Chapter 6 David Campbell and Terence Hogarth shed further light on the determinants of skill deficiencies by exploiting ESS data on workforce qualifications in detail. They examine two propositions:

- firstly, skill deficiencies are likely to be highest in occupation groups which typically require high levels of qualifications; and
- secondly, for each occupation group, skill deficiencies are more likely to occur in establishments where the typical level of qualifications is above average for the occupation group in question.

The density of skill-shortage vacancies is indeed found to be above average in professional and associate professional occupations where the typical qualifications level is NVQ 4/5 (or equivalent) but the highest density of all is found in the skilled trades group where the most common qualifications level is NVQ3. In the case of internal skill gaps, there is a clear tendency for the reported incidence to be highest in the lower-skilled occupations (clerical, operators, elementary occupations) where the most common level of qualifications is NVQ2 (or equivalent).

In intermediate and lower-skilled occupation groups, there are some signs of skill-shortage densities being comparatively high in establishments where the typical level of qualifications is above average for the occupation group in question. However, the story is different for internal skill gaps where there is little or no evidence of the incidence of such problems within each occupation group being positively correlated with the required level of qualifications.

Table 1.4: Typology of sectors, 2001, analysed by mean skill score and product strategy, internal skill gap and external skill shortage factors

		Mean skill score	Product strategy factor	Internal skill gaps factor	External skill shortages factor
Group 6	Computer services	Highest	Highest	Moderate	Highest
Group 8	Architectural and engineering activities and related technical consultancy	High	High	Moderate/ low	High
Group 7	Legal, accounting, auditing activities; tax consultancy etc General secondary education Higher education, adult education and other education Human health activities	High	Moderate /high	Low	Moderate/ high
Group 9	Primary education	Moderate/ high	High	Lowest	Lowest
Group 2	Printing, publishing, recorded media Electrical, electronic and instrument engineering Auxiliary transport activities, travel agents Financial services, including insurance Other business services Public administration Social work Other service industries	Moderate	Moderate	Moderate/high	Moderate/ low
Group 3	Fabricated metal products Building of complete constructions; civil engineering Building installation, completion and other construction activities Sales of motor vehicles, parts, fuel Transport services	Moderate/ low	Low	Low	High
Group 1	Food, drink and tobacco Chemicals, rubber and plastics Mechanical engineering, vehicles and other engineering Other manufacturing industries Restaurants, canteens, catering Postal and telecommunications services	Low	Moderate/ low	High	Low
Group 4	Wholesaling Retailing – specialised stores Retailing - non-specialised stores; other retail and repair Bars Sporting activities, arenas, stadia	Low	Low	High	Low
Group 5	Hotels, motels and other accommodation	Lowest	Lowest	Highest	Moderate

Further analysis by Campbell and Hogarth suggests that establishments' plans to improve significantly the quality of their products/services are associated with relatively high levels of educational attainment among their employees, and particularly among their managers. Of the establishments that did seek to improve product quality, some 41% reported that their managers were typically educated to NVQ4/5 level, while only 7% typically employed managers with no qualifications. In contrast, amongst those establishments that did not implement similar plans, some 32% had managers educated to NVQ4/5 level and 10% typically employed managers with no formal qualifications.

At sectoral level the proportion of establishments containing managers who were more highly educated than the average for managers across all sectors ranged from 15% in the motor vehicle sales sector to 97% in general secondary education. Across 32 different sectors there is a positive and statistically significant correlation between the average levels of qualifications held by managers and the extent to which establishments in those sectors were operating in 'premium quality' product markets as compared to 'standard or basic quality' product markets.

1.5.3 Detailed analysis of skill deficiencies by occupation

In Chapter 7 Geoff Mason and Philip Stevens undertake multivariate analysis of the determinants of skill deficiencies making use of an occupational data set derived from ESS2001 which contains information on vacancies, hard-to-fill vacancies and skill-shortage vacancies in 25 occupational groups at the 2-digit SOC level. This data set is supplemented with data on average pay levels for selected occupations at sector level (obtained from the New Earnings Survey) and data on local labour market conditions at Local Learning & Skills Council (LLSC) level (obtained from the Local Area Labour Force Survey 2000).

Their findings suggest that there is a marked diversity between different occupations in the extent to which the incidence of hard-to-fill vacancies and skill-shortage vacancies is affected by factors such as labour turnover and off-the-job training rates. For example, in the case of skilled construction trades and business and public service professionals, the probability of an establishment having at least one hard-to-fill vacancy is positively related to the establishment's labour turnover rate (proxied by the ratio of employees who left in the previous 12 months to total employment). In a range of other occupations – such as science and technology professionals, skilled metal and electrical trades, leisure and other personal service occupations and administrative occupations – there is no significant relationship between the probability of reporting hard-to-fill vacancies and labour turnover at establishment level.

In the case of off-the-job training rates, an initial hypothesis was that the probability of reporting skill-shortage vacancies might be greater in establishments where relatively little training is carried out. In occupations such as business and public service professionals, skilled metal and electrical

trades and process plant and machine operators, the incidence of skill-shortage vacancies is found to be positively and significantly associated with the rate of training. This suggests that the causality might run from experiencing recruitment difficulties to making more effort to develop skills internally.

The matching of New Earnings Survey (NES) data to the ESS occupational data set proved to be difficult because the NES is still classified to the 1990 Standard Occupational Classification (SOC) whereas ESS is classified to SOC2000. For two occupational areas where estimates of relative sector wages were prepared – science and technology professionals and administrative occupations – the probabilities of establishments reporting hard-to-fill vacancies or skill-shortage vacancies were found to be negatively related to relative sector wages (as expected) but the relationships were not statistically significant. The lack of precision in these estimates may reflect the heterogeneity within the two-digit occupational groups under consideration (for example, 'science and technology professionals' include occupations as diverse as chemists, mechanical engineers and ICT professionals).

In respect of the matching local labour market data, local unemployment rates were found to be inversely related to the probability of reporting hard-to-fill vacancies in occupations such as administrative occupations and skilled construction trades. This is after controlling for a range of other potential determinants such as sector, region, foreign ownership, labour turnover, establishment growth rates and training rates. However, in several other occupation groups – covering professional, intermediate-skilled and low-skilled occupations – local labour market conditions were not found to be significantly associated with the probabilities of reporting either hard-to-fill vacancies or skill-shortage vacancies.

1.6 Off the job training provision and employee qualifications

In the past evidence from the Labour Force Survey and other sources has suggested that employer-provided training is positively related to the qualifications held by individuals, that is, that better qualified people tend to receive more training. In a recent assessment of skills in England, Campbell *et al* (2001) noted an apparent paradox concerning the levels of training activity across Regional Development Agency (RDA) areas, in that regions employing relatively high proportions of qualified people appeared to have relatively low training activity levels and vice versa.

In Chapter 8 Andy Dickerson and Rob Wilson explore the relationship between Off the Job Training (OJT) on the one hand and workforce qualifications in detail, with a view to assessing this issue using ESS2001 data. In doing so, they throw new light on the factors determining the incidence and intensity of training activity in establishments. They adopt a variety of statistical techniques and data sources although the main emphasis is on the use of ESS2001.

A number of significant influences on OJT activity are identified. These include establishment size, business type (industry), private versus public sector status, and various local labour market characteristics. A key conclusion is that, even after controlling for a large number of potential factors which can plausibly affect OJT activity, training rates still frequently differ between apparently similar establishments. The factors identified as important in the econometric equations only account for a relatively small proportion of the variation between establishments in OJT rates. Further research is therefore required to identify additional characteristics of establishments which might explain such variation.

The multivariate analysis of that data set suggests that the apparent paradox which was the inspiration for this particular piece of analysis does not exist. While the correlations between OJT activity (both incidence and intensity) and the qualification structure are not strong, they are generally positive. The analysis of the ESS2001 data suggests that this applies both at RDA and LLSC level and regardless of whether the focus is upon the qualifications of those employed in the establishment or on the wider labour market within which the establishment is located.

1.7 Assessment of the strengths and weaknesses of the ESS: the key lessons for the future

Now that there have been a number of Employers Skill Surveys (ESS1999, ESS2001 and ESS2002) and a range of researchers have had some experience of analysing the data, it is an appropriate time to review the role and function of the surveys before another is commissioned.

Improvements on past surveys

In general, the *Employers Skill Surveys* represent a huge improvement compared with their predecessors, such as the *Skill Needs in Great Britain* (SNIB) surveys. In particular, they have gathered systematic information on skills deficiencies which clearly distinguishes between skill-shortage vacancies (skill-related external recruitment difficulties) and internal skill gaps. They have also addressed much more directly the causes and consequences of such problems.

As shown in Chapter 3, previous surveys and analyses had tended to conflate various kinds of skill deficiencies, for example, the *CBI Quarterly Industrial Survey* (which also has the drawback of being largely confined to manufacturing). ESS has also improved on the *British Chambers of Commerce Quarterly Survey* which focuses on recruitment difficulties in general rather than skill-related recruitment difficulties.

Another advantage of ESS is that it provides a much more comprehensive picture of vacancies than does the vacancy series produced by the Employment Service (ES), in which notified vacancies tend to be

concentrated in only a few occupational groups. These ES "Job Centre" based estimates, pick up only around a third of all vacancies.[2]

In addition, the forward-looking survey questions in ESS can provide useful information for policy-makers about enterprises' intentions with regard to product/service innovation and upgrading of product/service quality and the new or additional skills which are needed to bring such plans to fruition.

Advantages and disadvantages of continuity in survey questions

Continuity is important in order to enable evaluation of trends over time and the stability or persistence of some of the initial ESS findings. However, there are drawbacks to simply repeating the same questions in each new version of the survey.

Successive versions of the ESS have continued to devote most of the questions to monitoring the extent, nature, causes of and responses to skill-shortage vacancies and internal skill gaps. Unfortunately, although it is a survey of employers, the current questions on key and generic skills are heavily biased towards assessing the *supply* of skills amongst the workforce and applicants for jobs. There are only a few questions regarding employers' *demands* for skills, either implicitly (such as through product strategy questions) or explicitly. If the surveys are to be genuinely useful in documenting external skill shortages and internal skills gaps and feeding into the policy debate and decision process, a clearer picture of what skills employers are looking for is needed.

A particular problem is that the more detailed questions about skill needs are only addressed to the small minority of establishments which report that they have skill-shortage vacancies or internal skill gaps of some kind. The vast majority of establishments are asked nothing about what kind of skills they demand. There is a danger that such an emphasis, focussing on the margins, may provide a biased view of the country's overall skill needs.

Opportunities need to be taken to learn from past experience and to seek to improve some of the questions. For example, the initial version of ESS1999, did not include a quantitative question on respondents' evaluations of the proportions of staff lacking full proficiency in their jobs. While ESS1999 was in progress, supplementary questions were posed to a substantial proportion of sample establishments which showed the practicality of obtaining quantitative estimates of internal skill gaps. However, the main question on staff proficiency has stayed unimproved through ESS2001 and 2002. The case for changing it has now been strengthened by the recent qualitative work carried out by the Institute for Employment Studies for ESS2002 (Hillage et al, 2002) which confirmed that satisfactory quantitative estimates of skill gaps can be obtained from survey respondents. But this research has also cast some doubt on the use of the term 'proficiency' itself, in that respondents may

[2] The ES series have subsequently been suspended but ONS is about to introduce a new series.

understand ‘proficiency’ to mean very different things. This is another reason for reconsidering the precise wording of this set of questions.

Another example relates to questions about what respondents mean by a ‘vacancy’. Does an unfilled job have to be advertised to be formally regarded as a vacancy? Although the qualitative work for ESS2002 showed that most employers meant very similar things by the term ‘vacancy’, this type of issue needs further clarification.

Another reason for questioning the repeated use of the same questions relates to *fitness for purpose*: did ESS ask the right questions? The information requirements of the NSTF (which dictated the design of the first ESS) may well differ from the labour market information needs of the main current users of the ESS (such as the LSC, the RDAs and the new Sector Skills Councils). For example, these organisations may require more detailed information about establishments’ training activities and the extent of their satisfaction with local, regional and national education and training provision than is currently provided by ESS. They may also need more information about the changing skill requirements of the great majority of firms across the economy rather than just focus on the minorities of firms with skill-shortage vacancies and/or internal skill gaps.

In this context we suggest that policy-makers and other ESS data users should carry out a formal review of their information needs and how well they have been met by ESS to date. Given that many things change only slowly over time, there may be grounds for combining a core group of questions which enable continuity of analysis with a second (changing) group of questions designed to elicit information on specific questions regarding skills or other chosen topics. For example, a section of questions on computing use at establishments could be included periodically to monitor trends in such activity and its links with skill requirements. Equally, more detail on gender composition, labour retention and returning workers, age distribution, ethnic composition of the workforce, recruitment practices (New Deal, unemployed etc), training, etc. might all be useful for particular users who have been assigned remits to consider such target groups and issues.

Some questions may need to be dropped or only asked at intervals as a result. For example, the results presented in Chapter 4 below suggest that detailed questions on the extent and nature of skill-shortage vacancies and internal skill gaps may not need to be asked every year.

Sampling issues

The scope for sectoral and regional disaggregation of the data depends heavily on the specifics of the quota sampling methodology which is employed. If data users want reliable information on relatively small sectors and regions, then the sampling quota targets need to be set accordingly. This is especially important if it is hoped to draw out inferences for local LSC areas and sectors. In the past there have been unrealistic expectations about the level of detail that such surveys can provide. The present project has proved

especially fruitful in exploring the limits to sectoral disaggregation, as set out in Chapter 2. The results there on quota sampling have already proved useful in advising the LSC about the follow up to ESS to be undertaken in 2003.

The problems in achieving adequate sub-sample sizes for analysis by detailed sector and region are increased by including establishments in the 1-4 size-group. As discussed in Chapter 2, there is no satisfactory sampling frame for this size of establishment and their sheer quantity in the economy means that they are invariably under-sampled, with the consequence that large grossing-up factors have to be attached to them.

Given the advantages of achieving complete coverage of all sizes of establishment, it may seem reasonable to accept the loss of precision arising from the inclusion of the 1-4s. However, because of filtering in the questionnaire, many estimates may not be calculated on the full sample base (for example, breakdowns of the types of skills sought by the already small proportions of establishments reporting skill-shortage vacancies). This needs to be kept in mind when considering the trade-off between including establishments with 1-4 employees and the minimum level of precision which is required for estimates.

Under these circumstances, we suggest there are strong arguments for the successor surveys to ESS to focus on establishments with 5 or more employees – which do in fact account for 90% of all employees in the economy. For those sectors where data users badly need to have information about micro-establishments, it might be better to address the problem by separate surveys targeted at that size of establishment or at the self-employed. In addition. the sectoral detail sought by many data users, such as the newly-formed Sector Skills Development Agency, may still be rather difficult to achieve for some of the smaller sectors unless the sub-samples for these sectors are boosted substantially in size.

Redesigning the survey instruments

ESS1999 and 2001 were both designed and implemented to very tight timetables. The first survey was needed to meet the needs of the National Skills Task Force. The second was aimed at providing timely labour market information for the newly formed LSC. Both of the present authors participated in the Steering Committee which was responsible for designing the ESS1999 survey instrument. They experienced first hand the pressure to deliver the survey results within a relatively short space of time. Many of those involved thought that the end product could have been improved with more time for reflection in between revisions of the survey instrument and for assimilation of pilot study findings. The preparation for ESS2001 was equally time-constrained. For ESS2002 a much reduced survey was undertaken but, importantly, this did include a parallel qualitative study to evaluate the respondents' perceptions of some of the questions. Their findings have provided much food for thought (Hillage et al, 2002). Given the very large sums of money that are now being committed to carrying out these surveys, we strongly urge that more time and resources be devoted to analysis of past

survey data -- as in the present project – and to the design of future surveys.

In our view, the planning for new surveys should begin at least 6 months before the main fieldwork is scheduled to begin, taking full account of previous surveys. It should be anticipated that the survey instrument will go through several redrafts both before and after the pilot stage. While the main input about the content of questions should come from policy-makers and other data users, we suggest that there is a necessary division of labour in survey design between the end user policy-makers, experienced analysts of large datasets such as ESS (who will have ideas about what types of data have proved useful in skills research in the past) and survey organisations (which have a lot to offer on what the precise wording and format of questions should be). We suggest that at least as much time and effort needs to be to given to the design of new survey instruments as to the mechanics of organising and executing the survey.

Specific suggestions for improvements to the survey instrument used in ESS include the following:

- The questions on ***training activity*** might benefit from further thought, in particular whether information about *on*-the-job training needs to be included as well as off-the-job training.

- Questions about the ***history of skill deficiencies*** are a useful measure of persistence and should be retained in future surveys. Similarly, respondents should be encouraged to provide information about ***future skill needs*** and likely skill problems. There are arguments for both forward-looking and backward-looking types of question. Forward-looking questions can be criticised as hypothetical and speculative but they are often in harmony with the way employers think about problems. Backward-looking questions are based on experience but may or may not be relevant to future skill requirements. The analysis of ESS1999 data in particular suggested that forward looking questions provide some useful insight into issues relating to latent or unperceived skill gaps (Bosworth, Davies and Wilson, 2001).

- If ESS is to be repeated on the scale of the 1999 and 2001 surveys, there is an opportunity to ***develop a panel of employers*** so that information can be gathered about change over time in a particular establishment.

- Since the purpose of the survey is to clarify the extent and nature of recruitment problems and their causes, it may be worthwhile asking more explicit questions about **the recruitment process** and the extent to which employers are adopting innovative approaches to recruitment which might reduce recruitment and retention problems (see Hasluck and Hogarth, 2002, for examples).

- ESS1999 demonstrated the value and feasibility of having some ***performance questions*** built in to the survey. These kinds of questions are essential to get to grips with issues concerning 'latent' skill gaps and

related matters. Although these issues are difficult to get a handle on, the availability of some indicators of performance within the survey should permit econometric and related analysis that would otherwise be impossible.

- The introduction of performance questions raises the thorny issue of whether the survey should be targeted at establishments or enterprises. Good performance data may often only be available for the latter. Such information is of course available from other sources, which can (in principle) be matched in to an ESS data set. However, the practical difficulties of doing this are enormous and so the incorporation of some performance measures within the survey would be useful.

- It is difficult to separate the incidence and intensity of skill shortages from questions about ***wage levels***. The ESS1999 face-to-face survey asked for information about wage levels for specific occupations. Consideration should be given once again to including questions of this type. Questions which can establish how well the establishment pays compared to the norm may have an important role to explaining many recruitment problems and other skill deficiencies.

2. ASSESSMENT OF THE RELIABILITY AND ROBUSTNESS OF SECTORAL DATA FROM THE EMPLOYERS SKILLS SURVEYS

John Forth (NIESR)

2.1 Introduction

Much of the primary analysis of the data from the Employers Skills Surveys of 1999 and 2001 has focused on the exploration of patterns across broad industry sectors, largely equating to the Sections of the *Standard Industrial Classification 1992* (SIC(92)). However, the Department is interested to establish whether, and to what degree, the Surveys may be used to provide reliable information on skill deficiencies at a lower level of industrial aggregation.

The provision of such information was not the primary purpose of ESS 1999 or ESS 2001 and so challenges the capabilities of both surveys. The purpose of this chapter is to outline the relevant issues that need to be considered in this regard and to provide guidelines on the appropriate limits to sectoral disaggregation of the ESS data. The chapter does so in part by focusing on the practicalities of disaggregating to SIC(92) Group level (3-digit level), since this is the lowest level of sectoral detail that is recorded in ESS. In practice, one is perhaps more likely to study agglomerations of SIC(92) Groups or Divisions (such as the Audio-Visual industry: Groups 921 and 922). The issues are therefore also illustrated by referring to a number of sectors which are naturally defined in this way. These comprise the industry sectors covered by the five Trailblazer Sector Skills Councils plus six additional sectors that have been specified by the Department.

Three types of estimates are considered. These represent the three principal means through which one may produce sectoral estimates from the ESS data.

1. *Workplace percentages*: The first type of estimate involves the calculation of the percentage of workplaces in a sector that report a particular skill deficiency. For example, using ESS 2001, we estimate that 2.4 per cent of establishments in the Retail sector had at least one skill-shortage vacancy at the time of the survey. We will consider how reliable this estimate of 2.4 per cent is, given the properties of the overall sample and the Retail sub-sample. This method represents the most common means of producing sectoral estimates from the ESS survey.

2. *Employee totals*: The second type of estimate involves the calculation of the total number of vacancies or the total number of employees that

are not fully proficient within a sector. For example, from ESS 2001, we estimate that there were 10,594 skill shortage vacancies in the Retail sector at the time of the survey. We will consider how reliable this estimate of 10,594 is, given the properties of the overall sample and the Retail sub-sample.[3]

3. *Employee ratios*: The third and final type of estimate involves the calculation of the total number of vacancies or non-proficient employees present within a sector, expressed as a percentage of the total number of employees in that sector. Such estimates are calculated as the ratio of two *employee totals* and are often referred to as 'density measures'. For example, from ESS 2001, we estimate the density of skill-shortage vacancies in the Retail sector at the time of the survey to have been 0.45 per cent ((10,594/2,334,867)X100 = 0.45 per cent). We will consider how reliable this estimated density of 0.45 per cent is, given the properties of the overall sample and the Retail sub-sample.

An assessment of the reliability and robustness of any estimate necessarily relies upon the evaluation of the sampling error (precision) and non-sampling error (bias) of disaggregated estimates. Together, sampling error and non-sampling error indicate the likely deviation of a survey estimate from the true value pertaining in the wider population. By considering the degree of sampling error and non-sampling error present in disaggregated estimates from the ESS surveys, we are able to assess the reliability and robustness of such estimates.

In order to be able to evaluate the sampling errors and non-sampling errors present in disaggregated estimates from ESS, we first need to examine the methodology used to conduct the surveys. The first half of the chapter therefore explores the methodology used in ESS 1999 and ESS 2001. Section 2.2 contains a brief description of the survey methodology. This is followed in Sections 3.1 to 3.3 by a discussion of some of the main principles of survey sampling and survey methodology, so that the methods used in the ESS surveys can be located within a broader context. Some particular elements of the ESS methodology are then re-examined in more detail in Section 2.3.4 to highlight the implications of methodological choices, which are drawn out in Section 2.3.5.

The second half of the chapter uses this knowledge to evaluate the reliability of estimates from the ESS surveys. Section 2.4 begins by developing some principles or rules to guide the evaluation. This leads onto a more focused discussion of the issues surrounding sectoral disaggregation of ESS data in Sections 5 to 9. Section 2.10 concludes.

[3] By extension, this type of estimate also includes sectoral estimates of the numbers of vacancies in particular occupational groups and of the numbers of employees in particular occupational groups that are not fully proficient.

2.2 The ESS methodology

ESS 1999 and ESS 2001 are establishment-level surveys in which the senior person with responsibility for human resource or personnel issues is asked to report upon the supply of, and demand for, skills at their establishment. The first of the two surveys, undertaken in 1999, covered establishments in England with 5 or more employees in all industries except: Agriculture, Hunting and Forestry (Section A of the *Standard Industrial Classification 1992*); Fishing (Section B); and Private Households with Employed Persons (Section P). The second survey in 2001 broadened its scope to also include establishments with 1-4 employees and to include workplaces in all primary industries. Establishments under private and public ownership were covered in both surveys. The desire to permit analysis at both sectoral and regional levels of disaggregation necessitated a large sample. Accordingly, the surveys have provided achieved samples of around 27,000 interviews in both years.[4]

The requirement for timely information, combined with the need to deliver that information within budgetary limits, led to the preference in both ESS 1999 and ESS 2001 for a quota sample methodology. Under this methodology, the overriding aim was to obtain an achieved sample of workplaces that was representative of the wider population in terms of workplace size (number of employees), industry sector and region. The inherent assumption in quota sampling is that, if a sample can be collected which closely approximates the profile of the population across observable characteristics, the sample can then also reasonably be expected to closely approximate the population across hitherto unobserved characteristics (in this case, skills deficiencies).

The first stage of the quota sample methodology is to set quota targets – targets for the number of interviews one aims to achieve with workplaces of a particular type. The quota matrix for ESS 1999 comprised 540 cells in total (4 size bands x 15 industry sectors x 9 regions).[5] The broader coverage of ESS 2001 necessitated a slightly more complex matrix comprising 720 cells (5 size bands x 16 industry sectors x 9 regions).[6] The population data used to construct the targets was taken from the Annual Employment Survey.

The target number of interviews for each cell of the matrix was set in a number of stages. First, around 13,500 interviews (half of the overall target) were distributed equally across the nine Regional Development Agency areas. This ensured that a minimum number of interviews would be achieved within each region. The remaining half were then allocated across regions in proportion to number of establishments estimated to be located within each

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4 These interviews were conducted by telephone, except for approximately 4,000 interviews that were conducted face-to-face in 1999.

5 The 4 size bands were: 5-24 employees; 25-99; 100-499; and 500 or more. The 15 industry sectors corresponded to Sections F to O of SIC(92) plus 5 categories to cover Sections C to E. The 9 regions corresponded to the areas covered by the nine Regional Development Agencies of England.

6 The additional size band covered workplaces with 1-4 employees, whilst the additional industry sector covered SIC(92) Sections A and B.

region in the overall population. This aspect of the regional allocation ensured that more interviews would be undertaken in more populous regions, thereby helping the sample to effectively capture the variability of behaviour in the population. The final regional element, which took place in ESS 2001 only, was to adjust the targets so as to obtain at least 400 interviews within each Learning and Skills Council area, so as to permit separate analysis of these areas.

Within each region, interviews were distributed in proportion to workplace size (i.e. number of employees). This meant that a disproportionate amount of the sample was allocated to interviews with larger workplaces. Such a strategy is often pursued in establishment samples since large workplaces are comparatively rare but employ a large proportion of all employees. Large workplaces are therefore over-sampled in comparison with small ones so as to provide sufficient cases for separate analysis and to promote greater precision in employee-based estimates. One necessary side-effect, however, is the loss of some precision in workplace-based estimates.

Finally, within each region-size group combination, interviews were distributed in proportion to the number of establishments estimated to be located within each industry. As with the latter part of the initial regional allocation, this ensured that more interviews would be undertaken in larger industry sectors and can be expected to have improved the efficiency of the sample in comparison with an equal allocation across industries.

This process led to a detailed set of quota targets: 540 in total within ESS 1999; 720 within ESS 2001. The task for the fieldwork agency and their interviewers was to meet each of the individual quota targets within the specified fieldwork period, thereby achieving the desired total number of interviews (27,000) in a way which ensured that the variety in the population was adequately represented within the achieved sample.

The sampling process for each of the ESS surveys began with the selection of a large number of establishments from the BT Business register - a register of around 1.6 million establishments with a business telephone line. Interviewers worked through this sample in ways described below (Section 2.3.4) and, upon successful completion of each interview, allocated the workplace to the appropriate cell of the quota matrix until such time as the target number of interviews for that cell had been met.

Once the overall target number of interviews had been achieved (approximately 27,000 interviews in either survey), and fieldwork was thereby brought to an end, population estimates from the Annual Employment Survey (and MAFF) were then used again to construct post-stratification grossing weights. These grossing weights were compiled by comparing the achieved number of interviews in each cell of the quota matrix with the number of workplaces of that particular type that were estimated to be present in population. These weights correct for the fact that the profile of achieved sample would not naturally match the profile of the population because of the way in which the sample was distributed across the cells of the quota matrix.

The grossing weights in ESS 1999 were derived at the same level of detail as the quota matrix. In ESS 2001, however, the grossing matrix had 1,296 cells rather than 720 cells, since separate grossing factors were devised for workplaces with 1, 2, 3, 4, 5-10 and 11-24 employees; these workplaces had been grouped into only two categories in the quota matrix.

In summary then, each of the ESS surveys is based upon a quota sampling methodology which has the basic objective of ensuring that the sample includes workplaces from across the range of workplace sizes, industry sectors and regions. To the extent that this procedure necessarily produces an achieved sample whose profile is out of kilter with that of population, because of the over-sampling of large workplaces for example, grossing factors are used to enable the profile of the grossed up sample to more closely resemble the population.

The central question addressed by this chapter is whether, and to what extent, these procedures provide data which, after grossing, produce reliable estimates at sub-sectoral level, in other words, at a level beyond that used for setting quota targets and deriving grossing weights. In order to answer this question, we must consider two more. First, to what extent is any sub-sample of ESS 1999 or ESS 2001 likely to be fully representative of the population it intends to represent after applying the grossing factors (i.e. to what extent is the sub-sample likely to provide an unbiased estimate)? And secondly, how precise is that estimate likely to be given that all samples necessarily incorporate some degree of uncertainty?

It would be relatively straightforward to answer these questions if ESS 1999 and ESS 2001 were based upon high-quality probability samples. To show why this is so, the next section explains some of the essential features of probability samples. The chapter then goes on to investigate the extent to which the quota sampling procedures used in ESS 1999 and 2001 follow or deviate from these principles.

2.3 Some principles of sampling

The purpose of any survey sample is to be able to draw reliable inferences about the underlying population. To meet this end, one wishes to minimize the degree of non-sampling error (bias) in estimates based on the sample and to be able to specify the likely sampling error (precision) of these estimates. These criteria, which are alluded to at the end of the previous section, are fully met by the principle of probability sampling. Firstly, probability samples incorporate the random selection of units from the population into the sample. This necessarily guards against selection bias since every unit has an equal (or known) probability of appearing in the sample. Secondly, because the estimates from repeated probability samples tend to be approximately normally distributed, one can also judge the extent to which the estimate would vary under repeated sampling. One is therefore able to gauge its precision as an estimate of the true population value.

Before proceeding to further describe some common methods of probability

sampling against which the ESS methods can be compared, it should be briefly noted that there are some additional requirements of any survey sample if it is to provide unbiased estimates, namely:

- A good quality sampling frame: a sampling frame which has less than complete coverage of the population that is being investigated will inevitably impair the sample's ability to fully and reliably represent that population
- Absence of non-response bias: non-response, whether to the survey as a whole or to individual questions, can lead to biased estimates if the propensity to respond is in some way correlated with the characteristic or behaviour being studied
- Absence of measurement error: errors in the measurement of characteristics or behaviour may clearly affect the accuracy of any estimates.

These three requirements are taken as given in the remainder of this section, but are considered within the context of ESS in Section 2.4.

2.3.1 Simple random sampling

The most straightforward application of probability sampling is simple random sampling. In a simple random sample, *n* units are selected from the population of *N* units such that each of the *N* units has an equal chance of being selected into the sample. Sampling is usually carried out without replacement, meaning that, once selected, a unit is then removed from the population for subsequent draws and so cannot appear in the sample more than once.

The properties of simple random samples are well known. First, it can be shown that simple random samples produce unbiased estimates (Cochran, 1997: 22). Second, the precision of an estimate, measured by its standard error, may itself be estimated as follows (Cochran, 1977: 25-27):

$$SE_{SRS}(\bar{x}) = \sqrt{\frac{v(x)}{n} \cdot \left(1 - \frac{n}{N}\right)} \qquad (1)$$

where *v(x)* is the variance of *x* within the sample.[7]

If ESS 1999 and ESS 2001 had been conducted under simple random sampling, estimates for, or based on, 3-digit SIC sectors would necessarily be unbiased and so the robustness of such estimates would be determined solely by their precision. Following the formula set out above, the precision of an estimate (whether a percentage, mean or total) with a given sample variance, would be determined by n (the sample size) and N (the size of the population).

[7] This is distinct from the variance of the population estimate $\bar{x}$, which is the square of the standard error.

The inherent danger that lies within the method of simple random sampling is that one may obtain a 'bad' sample. Such a sample may, by chance, fail to include any very large establishments or may contain an uncharacteristically low proportion of establishments from a particular industry sector. One means of guarding against this is to stratify the sample.

2.3.2 Stratified random sampling

In stratified random sampling, the population of *N* units is first divided into *H* non-overlapping sub-populations or strata: $N_1, N_2, \ldots, N_H$. Simple random samples are then taken within each of these strata.

The stratification of the population prior to sampling ensures that units from each category of the stratifying variables appear within the sample. This helps to ensure that the heterogeneity of the population is captured in the sample and so helps to reduce sampling error. But stratification is often accompanied by the use of sampling fractions which are set to vary in prescribed ways between strata. This may be done either to ensure a minimum yield from each stratum, or to promote efficiency by devoting more of the sample to parts of the population that show greater variability in their behaviour.

If the sampling fractions are not equal across strata, the sample will inevitably contain selection bias. However, since the sampling fractions are set by the sampler, the probability of selection within each stratum is known. Weighting the sample by the inverse of the probability of selection will eliminate this selection bias. It can therefore be shown that stratified random sampling with unequal sampling fractions gives unbiased estimates once the sample has been weighted in this way (Cochran, 1977: 91). The robustness of the estimates is therefore again determined solely by their precision.

If ESS 1999 and ESS 2001 had been conducted under stratified random sampling, the precision of an estimate (whether a percentage, mean or total) would be determined by n_h (the sample size) and N_h (the size of the population) within each applicable industry by size by region stratum, *N* (the size of the overall population) and the extent to which strata grouped together homogeneous units.[8] Formally, the standard error of an estimate $\bar{x}$ under stratified random sampling – often termed the complex standard error of $\bar{x}$ – may be estimated as:

$$SE_{STR}(\bar{x}) = \sum_{h=1}^{H} \sqrt{\frac{v_h(x)}{n_h} \cdot \left(\frac{N_h}{N}\right)^2 \left(1 - \frac{n_h}{N_h}\right)} \qquad (2)$$

Clearly, in a sample with a substantial number of strata, the calculation of this statistic could be very time-consuming. Fortunately, the facility is available

[8] This is because the process of stratification ensures that variance between strata is captured within the sample. If it were possible to devise the strata in such a way that all units belonging to the same stratum had the same value, we could estimate the population value without sampling error.

within a small number of statistical software packages, including Stata.[9]

On its own, stratification usually helps to reduce sampling error. But when it is accompanied by unequal sampling fractions, the implications for sampling error are determined by the way in which the sampling fractions are allocated (Cochran, p.92). It is common in establishment surveys to over-sample large establishments and under-sample small ones, for the reasons set out in Section 2.2. However, as stated there, this often means a gain in the precision of employee-based estimates over simple random sampling but a loss in the precision of workplace-based estimates.

Given the properties of $SE_{STR}(\bar{x})$, the extent to which the precision of an estimate under stratified random sampling will deviate from that under simple random sampling will clearly vary across both across estimates and sub-samples. It is therefore common to calculate complex standard errors for a number of 'headline' variables across a range of sub-samples and to calculate the average deviation from the equivalent $SE_{SRS}(\bar{x})$ in each case. This average deviation, termed the Design Factor (DEFT), indicates the gain (or loss) in precision which results from the use of a particular complex sample design compared to a simple random sample of the same size.

Since complex standard errors cannot be calculated readily by hand, and are not calculated by many statistical software packages, this DEFT may then be used in conjunction with the usual formulae for calculating standard errors from simple random samples to provide estimates of $SE_{STR}(\bar{x})$, as follows:

$$SE_{STR}(\bar{x}) \approx DEFT \cdot SE_{SRS}(\bar{x}) \qquad (3)$$

Design Factors of 1.3 or higher are not uncommon in establishment surveys that under-sample small establishments and over-sample large ones. Using the formula above, we can see that estimated standard errors from a survey with a DEFT of 1.3 would be 30 per cent larger than those arising from a simple random sample of the same size.

It follows that, if a complex sample were to offer the same level of precision as a simple random sample of the same population, the size of the complex sample would need to be larger than that of the simple random sample by a factor of DEFT squared. A complex sample with a DEFT of 1.3 would therefore need to be 69 per cent larger than a simple random sample of the same population in order to provide the same degree of precision.

[9] Unfortunately, it is not available within SPSS.

2.3.3 Quota sampling

The essential feature of a quota sample is that the sample is constructed in such a way that its profile matches that of the population across one or more specified dimensions. In this respect, quota sampling clearly has parallels with stratified random sampling. However, a quota sample does not necessarily possess the properties of random selection and known selection probabilities that are an essential feature of stratified random sampling, and so the robustness of sub-sample estimates from a quota sample is not straightforward to establish. Specifically, since the definition of a quota sample is rather broad, there is a great deal of scope for variation in the method of quota sampling. This means that there are no general rules that enable one to specify the statistical properties of a quota sample.

The most common criticism levelled at quota samples is that of non-random selection, since it is common to allow interviewers some discretion in filling quota targets. This may lead to an unknown degree of selection bias if it means that the probabilities of selection are no longer equal within cells of the quota matrix.

The essential test of comparability between a particular application of quota sampling and stratified random sampling therefore lies in the extent to which the quota sampling methodology follows the principles of random selection. If the element of discretion in the selection of units for interview is eliminated, the two can be seen as equivalent (Cochran, 1977: 135). The implication of this result is that the rules governing bias and precision in stratified random sampling can be used to indicate the properties of the quota sample.

For our purposes, we must therefore evaluate the extent to which the principles of random selection were adhered to in the quota sampling procedures that were applied in ESS 1999 and ESS 2001.

2.3.4 The form of quota sampling used in ESS 1999 and ESS 2001

Discussions with the principal fieldwork contractor on both ESS 1999 and ESS 2001 suggest that the critical elements of the methodology of the ESS surveys did serve to promote the principal of random selection within cells of the quota matrix.

First, it is apparent that the selection of units from the sampling frame (the BT Business Register) was random within each cell of the matrix. This eliminates the risk of selection bias in the first stage of the quota sampling procedure.

Second, the technology used to allocate the selected units to interviewers also mitigated against the most common criticism of quota samples – interviewer discretion. CATI (Computer Assisted Telephone Interviewing) technology was used to conduct both ESS 1999 and ESS 2001. Under this CATI system, units selected from the sampling frame were loaded into the system in randomly-selected batches of around 2,000. Individual units were then randomly allocated to interviewers who had no personal discretion in

deciding which establishments they approached for interview. This means that interviewers were unable to target units that they may have considered more likely to participate or avoid ones considered more likely to refuse. An example of the latter might be workplaces belonging to large, bureaucratic organisations, where approval to participate is often required from higher levels.

2.3.5 Implications

Since the methodology used for the ESS surveys closely resembles stratified random sampling, it is reasonable to use the methods that are available for estimating sampling errors from stratified random samples (as described in Section 2.3.2) to provide an indication of the precision of estimates from the ESS surveys, $\hat{SE}_{ESS}(\bar{x})$. Here, the symbol ^ is used to indicate that we can only approximate $SE_{ESS}(\bar{x})$, the true value of which, as stated in Section 2.3.3, is unknown. The approximated values $\hat{SE}_{ESS}(\bar{x})$ indicate the precision (in terms of sampling error) of estimates for, or based on, 3-digit industry sectors.

The methods described in Section 2.3.2 involve the calculation of $\hat{SE}_{ESS}(\bar{x})$, for a number of 'headline' variables across a range of sub-samples in both ESS surveys. These complex standard errors can then be compared with $SE_{SRS}(\bar{x})$ to obtain the average DEFTs pertaining to different types of estimate. The average DEFTs indicate the extent to which the precision of different types of estimate from ESS has, in general, been affected by the sample design. And these values can, in turn, be used in conjunction with guidelines on acceptable degrees of precision to develop rules of thumb governing the limits of sectoral disaggregation.

However, we should not rely solely on estimated sampling errors. This is because there is a risk that the achieved samples in either ESS survey may suffer from uncorrected non-sampling errors, most obviously non-response bias.

During the course of fieldwork for ESS 1999 and ESS 2001, repeated attempts were made to contact each selected establishment (up to a maximum of seven attempts for establishments with less than 500 employees, and a maximum of ten attempts for larger establishments). However, it is still the case that, in ESS 2001, 18,677 refusals or incomplete interviews were registered in the process of obtaining 27,031 complete interviews (a ratio of more than two refusals/incomplete interviews for every three complete interviews).

If those establishments which refused to participate or did not complete interviews differed from those who fully participated, but differed solely on the basis of those characteristics used to compile the grossing factors (workplace size, industry and region), and there was no variation in refusal rates across sub-categories of these characteristics (e.g. SIC(92) Groups within a broader Section), there is no risk of non-response bias in weighted estimates. The

grossing factors will have corrected for any such bias in the unweighted data and the weighted data from ESS will provide unbiased estimates at any level of disaggregation, mimicking the results of stratified random sampling described earlier. Put simply, this means that, the grossed estimates of the numbers of workplaces in each 3-digit industry, or of the proportion of workplaces in each industry that possess a particular characteristic, will not suffer from non-response bias.

However, if response bias means that some SIC(92) Groups within a broader Section were more likely to respond than others, the Section-level grossing factor will not accurately correct for non-response bias at this more detailed level. The grossing factor applied to SIC(92) Groups with lower than average response rates will therefore be too small, whilst the grossing factor applied to Groups with higher than average response rates will be too large.

Similarly, if small establishments in a particular SIC(92) Group, for example, were more (or less) likely to refuse to participate in ESS than the average establishment within the broader SIC(92) Section, the element of the Section-level grossing factor that addresses the size distribution of the Section will fail to make an accurate correction within each Group. Since establishment size is related to many indicators of skills deficiencies, any uncorrected response bias that is related to establishment size will necessarily bias the estimates arising from such indicators.

Unfortunately, the variation in response rates at such a detailed level is unknown. The likelihood that the grossing factors satisfactorily correct for any non-response bias is clearly greater if the SIC(92) Group accounts for a large proportion of establishments within the broader Section. But the presence/absence of such bias in the profile of ESS establishments at SIC(92) Group level (or any other level of detail below that used to compile the weighting matrix) can only be assessed in practice by comparison with the profile of the population.[10]

A further source of non-sampling error may be the sampling frame. If the sampling frame offered only partial coverage of particular sub-sectors, perhaps because employers in those sectors were more likely to operate from a residential rather than a business telephone line, such sectors may be under-represented in the sample. If the under-representation was not corrected by the grossing factors, there may remain a degree of bias in grossed estimates.

This means that our evaluation of the robustness of ESS estimates based on 3-digit industry sectors should not only take account of the sampling error of

[10] It should also be noted that, if respondents differed from non-respondents in some other tangible way (e.g. in the prevalence of skills deficiencies) for reasons that were not fully explained by the characteristics used in the weighting matrix, this will also result in the presence of uncorrected non-response bias within the weighted ESS samples. However, in the absence of population data on characteristics other than industry, workplace size or region, the presence of response bias on other such dimensions cannot be assessed.

those estimates, but should also examine the sub-sector sample for evidence of (observable and uncorrected) non-sampling errors. Here, we must first assess whether the grossed number of establishments in the sub-sector closely resembles the size of the sub-sector population. We must then also assess whether the profile of the sub-sector sample by workplace size and region also closely resembles that of the sub-sector population. If the sub-sector meets both of these criteria, we can be more confident that any estimates based on that sub-sample are of good quality.

We therefore pursue two strands of investigation:

1. We estimate the precision of estimates from the ESS samples, $\hat{SE}_{ESS}(\bar{x})$, across a range of 'headline variables' and a range of sub-samples, on the basis that the ESS samples are likely to exhibit very similar levels of precision to equivalent stratified random samples. This permits the calculation of average DEFTs for different types of estimate and enables us to develop guidelines governing the limits of sectoral disaggregation.
2. We look for evidence of non-sampling errors, which may have arisen from deficiencies in the sampling frame or non-response bias but which have not already been corrected by the grossing factors.

In selecting SIC(92) Groups to use as examples in our investigation, we first choose three of the 215 *bona fide* SIC(92) Groups that are represented in ESS 2001. Our criterion for selecting these three Groups is based upon the number of observations for each industry in the ESS 2001 sample. The three Groups are chosen as follows:

- a Group represented by 36 unweighted cases (36 cases representing the median unweighted sample size within the 215 Groups). We selected SIC(92) Group 24.6: "Manufacture of other chemical products" (36 unweighted cases).

- a Group represented by 131 unweighted cases (131 cases representing the 75th percentile in the distribution of unweighted sample sizes within the 215 Groups). We selected SIC(92) Group 55.5: "Canteens and catering" (131 cases).

- and a Group represented by around 637 unweighted cases (637 cases representing the 95th percentile in the distribution of unweighted sample sizes within the 215 Groups). We selected SIC(92) Group 45.3: Building installation (632 cases).

In addition, we also consider ten example sectors suggested by the Department. These include one further SIC(92) Group, 803: Higher Education, and nine sectors formed from combinations of multiple Groups. These include the Audio-Visual sector which comprises only two SIC(92) Groups: 921 and 922.

In the case of the nine agglomerated sectors, our assessment of non-sampling errors also includes an assessment of the composition of the sector

at SIC(92) Group level.

Further detail on each of the example sectors is included in Appendix 2A at the end of this chapter.

2.4 Developing guidelines for the evaluation

There are few 'official' criteria for acceptable levels of sampling error which we might apply to ESS, and even fewer in respect of bias. However, in this section we outline a small range of criteria which may guide our evaluation.

We first consider criteria that might be used to indicate acceptable degrees of sampling error.

2.4.1 Guidelines on acceptable degrees of sampling error

As indicated in Section 2.1, we are considering three types of estimate:

1. *Workplace percentages*: for example, estimates of the percentage of workplaces in a sector that report a particular skill deficiency.

2. *Employee totals*: for example, estimates of the total number of skill-shortage vacancies within a sector.

3. *Employee ratios*: for example, estimates of the density of skill-shortage vacancies within a sector.

Two types of criteria might be applied to assess whether estimates of these types have acceptable degrees of sampling error. The first are **relative** criteria, based on the magnitude of the sampling error in comparison to the estimate. An appropriate measure in this respect is the Coefficient of Variation (CV) or 'relative standard error', which is the ratio of an estimate's standard error to the estimate itself:

$$CV(\bar{x}) = \frac{SE(\bar{x})}{\bar{x}} \qquad (4)$$

The second are **absolute** criteria, based on the absolute magnitude of the sampling error $\left|SE(\bar{x})\right|$.

To the extent that we are able to identify the minimum numbers of cases broadly required to meet these criteria for different types of estimate from the ESS survey, these minima will form a key part of any subsequent recommendations on the limits to sectoral disaggregation of the survey data.

The identification of such minima is a relatively straightforward task for *workplace percentages*, since estimates of this type are derived from binary variables (i.e. variables which take only the values 0 or 1). The sample variance of a binary variable in a given survey depends only on the estimated

mean value *p* of the variable in question:

$$v(p) = p \cdot (1 - p) \tag{5}$$

As a result, one can determine the sampling error of the estimate *p* in any given sub-sample simply through knowledge of *p* and knowledge of the sizes of the sub-sample and the wider population.

However, the identification of minimum required sample sizes is more difficult for *employee totals* and *employee ratios* since estimates of these types are derived from continuous variables, rather than binary ones. Estimates of *employee totals* are derived from a single continuous variable, the value of which is averaged across relevant cases to provide a sample mean. This mean is then multiplied by the total number of units in the population to provide an estimated population total. Estimates of *employee ratios* are derived from the ratio of two such totals.

The sample variance of a continuous variable in a given survey depends not only on the estimated mean value of the variable in question, $\bar{y}$, but also upon the dispersion of values around $\bar{y}$:

$$v(\bar{y}) = \frac{\sum (y_i - \bar{y})}{n - 1} \tag{6}$$

The degree of dispersion around $\bar{y}$ varies between samples and sub-samples. For instance, in one industry sector the number of vacancies in each establishment may be tightly gathered around the industry mean, whereas in another industry sector there may be great variability. As a result, the sampling error of the estimated total for any given sub-sample can only be reliably estimated with knowledge of the dispersion of the item within the relevant sample or sub-sample.

Nevertheless, if one finds through investigation that the degree of dispersion is similar across sub-samples, it may still be possible to reach broad and generalisable conclusions.

Guidelines based on relative criteria

In developing our own guidelines for the maximum permissible Coefficient of Variation of any estimate, we are fortunate in being able to refer to official guidelines developed by the Office for National Statistics (ONS) for use with the Quarterly Labour Force Survey (QLFS). Under these guidelines, the ONS suppress any estimates with a CV of 20 per cent or more (Office for National Statistics, 2001a).

The ONS' choice of 20 per cent as their threshold value for the Coefficient of Variation does not appear to be rooted in any strong theoretical or practical foundations. In fact, the Australian Bureau of Statistics allow the value to rise to 25 per cent when presenting estimates from their own Labour Force Survey

(Australian Bureau of Statistics, 2002). However, there seems no compelling reason to depart from the guidelines set by our domestic statistical agency and so we shall seek to apply the 'CV less than 20 per cent' rule to estimates from the ESS surveys as a key part of our evaluation.

This rule can be applied to all three types of estimates listed above. An illustration of the way in which it yields guidelines on the acceptable limits of disaggregation in respect of estimated *workplace percentages* is provided in Table 2.1. The first three columns of the table illustrate how the CV for an estimate of 25 per cent (obtained under simple random sampling) rises as the sample size decreases.

Table 2.1: Impact of sample size on standard errors and confidence intervals of percentages under simple random sampling

Illustration based on an estimate of 25 per cent:

Sample size	Standard error	Coefficient of Variation	1.96 X standard error	95% confidence interval
1600	1.1%	5.5%	2.1%	22.9% - 27.1%
800	1.5%	6.1%	3.0%	22.0% - 28.0%
400	2.2%	8.7%	4.2%	20.8% - 29.2%
200	3.1%	12.2%	6.0%	19.0% - 31.0%
100	4.3%	17.3%	8.5%	16.5% - 33.5%
75	5.0%	20.0%	9.8%	15.2% - 34.8%
50	6.1%	24.5%	12.0%	13.0% - 37.0%
25	8.7%	34.6%	17.0%	8.0% - 42.0%

In this illustrative example, a sample of more than 75 cases would be required to obtain a CV of less than 20 per cent.

In fact, in the case of *workplace percentages*, this minimum sample size can be directly calculated as follows:

Since $CV(p) = \frac{SE(p)}{p} = \frac{DEFT \cdot \sqrt{\frac{p \cdot (1-p)}{n}}}{p}$, it follows that $n = \frac{DEFT^2 \cdot p \cdot (1-p)}{CV(p)^2 \cdot p^2}$.

Under simple random sampling, where DEFT=1.0, if p=0.25 then for CV(p) to be less than 0.2 we require:

$$n > \frac{1.0^2 \cdot 0.25 \cdot (1-0.25)}{0.2^2 \cdot 0.25^2} = 75$$

If we had used an estimate of 10 per cent for the illustration, rather than 25 per cent, the required minimum sample size would be 225 cases.

Such calculations cannot be made so easily for estimates of *employee totals* and *employee ratios* for the reasons outlined in the previous section. However, this example does show the limitations of relative approach, since it

becomes clear that the CV rule requires extreme estimates to be measured with a greater degree of absolute precision than less extreme ones. Specifically, an estimate of 25 per cent must have a standard error of less than 5 percentage points, whereas an estimate of 10 per cent must have a standard error of less than 2 percentage points. This suggests that it is also appropriate for us to utilise criteria that require the same absolute degree of precision from all estimates.

Guidelines based on absolute criteria

Absolute criteria place limits on the simple magnitude of the sampling error, and thus on the maximum width of the estimate's confidence interval. Whilst the use of confidence intervals is widespread, we are unable to refer to official guidance on a reasonable maximum: ONS guidelines developed for the QLFS provide no guidance in this area, for example. We must therefore devise our own common-sense limits to guide our evaluation. Separate rules must be devised for each of the three types of estimate.

It is proposed that a reasonable requirement for estimates of *workplace percentages* would be that the 95 per cent confidence interval of any estimate does not exceed 10 percentage points (i.e. does not extend more than 5 percentage points either side of the estimate). This requires that the standard error of the estimate be no greater than 2.5 percentage points. Such a requirement seems reasonable for estimates which, as we shall see, rarely venture outside the range from 0 to 25 per cent.

Estimates of *employee ratios* are also expressed in percentage terms. However, their range is typically much smaller. Investigation suggests that the density of skill-shortage vacancies within a sector rarely extends beyond 3 per cent, whilst the density of employees that are not fully proficient rarely extends beyond 10 per cent. Permitting 95 per cent confidence intervals of plus or minus 5 percentage points therefore seems too generous. Instead, we propose that the absolute threshold for *employee ratios* be set at a 95 per cent confidence interval of no more than 2 percentage points (i.e. a standard error no greater than 1 percentage point).

It is actually much less likely to be practical to derive absolute thresholds for estimates of *employee totals*. At first glance, it might appear reasonable to require our estimates of the number of skill-shortage vacancies in a sector to be accurate to within 1,000 vacancies, for example. However, such a rule would, paradoxically lead to the identification of maximum sample sizes, rather than minimum sample sizes. This is because sectors that comprise large numbers of establishments have large numbers of vacancies, and such large totals have substantial sampling errors in absolute terms. Absolute rules are therefore not appropriate and it will be most profitable to rely on relative rules for such estimates.

To provide an illustration of the way in which an absolute rule yields guidelines on the acceptable limits of disaggregation, we again refer specifically to estimates of *workplace percentages* and to the figures

presented for the case of simple random sampling in Table 2.1. The fourth and fifth columns of the table show that a sample of between 200 and 400 cases would be required to achieve a 95 per cent confidence interval of less than 10 percentage points for an estimate of 25 per cent from a simple random sample.

Again, the minimum sample size that is required for a specified percentage to meet the criterion can be directly calculated:

Since $95\%CI(p) = 1.96 \cdot SE(p) = 1.96 \cdot DEFT \cdot \sqrt{\frac{p(1-p)}{n}}$, it follows that

$$n = \frac{1.96^2 \cdot DEFT^2 \cdot p \cdot (1-p)}{95\%CI(p)^2} \ .$$

Under simple random sampling, where DEFT=1.0, if p=0.25 then for 95%CI(p) to be no greater than 0.05 we require:

$$n \geq \frac{1.96^2 \cdot 1.0^2 \cdot 0.25 \cdot (1-0.25)}{0.05^2} = 288$$

Only 138 cases would be required to obtain the same absolute degree of precision for an estimate of 10 per cent.

These examples show that the relative and the absolute rules we have proposed counterbalance each other since one requires larger samples for extreme estimates, the other smaller samples. It therefore makes sense to apply the rules in tandem to develop usable guidelines on the appropriate limits to sectoral disaggregation.

See Sections 2.6-8 for the application of these tests to the three types of ESS estimates under consideration.

2.4.2 Guidelines on acceptable degrees of bias

Unlike our guidelines for the acceptable degrees of sampling error, it has not been possible to develop numerical guidelines on the acceptable degrees of bias. We have experimented with the use of chi-square tests to identify significant differences between the profiles of the example sectors shown respectively by ESS and by population data. However, this avenue has proved unproductive since the grossed numbers of establishments involved are so large as to register significant differences in each and every comparison. This aspect of our evaluation is therefore primarily qualitative in nature.

In practice, our evaluation of bias focuses on those example sectors that meet the desired limits for sampling error discussed in the previous section. To make an assessment of whether a particular sector may suffer from a biased sample, we compare the grossed profile of establishments in that sector as

suggested by ESS 2001 with the population profile suggested by the Annual Employment Survey (AES) of 1998 and the Annual Business Inquiry (ABI) of 2000. We compare against the 1998 AES since it was used to calculate the grossing factors for ESS2001. And we compare against the 2000 ABI because it is considered to provide more accurate information on the profile of specific industry sectors at the time that ESS2001 took place. Comparisons are made of the size and region profile of establishments in the sector and of the total number of establishments estimated in the sector.

If the ESS estimate of the total number of establishments in a specific industry is substantially at odds with the totals suggested by the 1998 AES or 2000 ABI, this implies that ESS 2001 may be providing biased estimates of *employee totals* as well. If the industry profile is at odds then, to the extent that establishment size and region are related to the incidence of skills deficiencies, this suggests that ESS 2001 may be giving biased estimates of *workplace percentages*, *employee totals* and *employee ratios*.

Our assessment of the degree of bias in ESS estimates is presented in Section 2.9.

2.5 Complex standard errors for ESS estimates in our example sectors

Our aim is to develop broad guidelines on the limits to sectoral disaggregation of the ESS data. However, such guidelines must be based upon empirical calculations made across a range of variables and sub-samples, through which we assess properties of the ESS sample design.

Consequently, we calculate complex standard errors for a range of 'headline variables' of the three types specified in Section 2.1, doing so within each of the example sectors specified in Section 2.3.5. [11]

In respect of *workplace percentages*, we consider estimates of the percentage of establishments in a sector that have:

- a vacancy
- a hard-to-fill vacancy
- a skill-shortage vacancy
- a skill-shortage vacancy lasting 3 months or more
- any employees that are not fully proficient
- an occupational group where less than 'Nearly All' employees are fully proficient

In respect of *employee totals*, we consider sectoral estimates of the number of:

- vacancies
- hard-to-fill vacancies

[11] The estimated complex standard errors for ESS01 are conservative estimates, since our statistical software package (Stata) is unable to take account of the fact that the weighting matrix was more detailed than the quota matrix. Such 'post-stratification' can bring about some reduction in the variance of survey estimates (see, for example, Rust and Johnson, 1992).

- skill-shortage vacancies
- skill-shortage vacancies lasting 3 months or more
- employees that are not fully proficient.

And in respect of *employee ratios*, we consider sectoral estimates of the density of:

- skill-shortage vacancies
- employees that are not fully proficient.

We focus our discussion on the results from ESS 2001, although calculations have been carried out for both surveys. Table 2.2 shows the results of our calculations on the full sample for ESS 2001. The table shows the unweighted sample size (27,031) and then, for each item: the weighted estimate; its complex standard error; and the standard error under the assumption of simple random sampling (i.e. ignoring the complex sample design). From these, we calculate the DEFT and two measures of the precision of the estimate: the Coefficient of Variation and the 95 per cent confidence interval. Both measures of precision utilise the complex standard error.

These calculations are interesting in themselves. In particular, they indicate the precision of many of the main estimates which appear in the reports that are being prepared for the Department under Task 3.

But the calculations also show the extent to which the thresholds proposed in Section 2.4.1 are in fact met within our example sectors. The results of these evaluations are used to develop broad indicators of the **minimum sample sizes** that are necessary to levels of precision specified in Section 2.4 with the ESS data. The results for our example sectors are discussed in more detail in Sections 2.6 to 8 below.

Table 2.2: Calculating DEFTs, CVs and 95% confidence intervals for a range of estimates from ESS 2001 (full sample)

FULL SAMPLE	N	Estimate	Complex SE	SRS SE	DEFT	CV	95% CI
Percentage of establishments with:							
A vacancy	27031	14.53%	0.66%	0.21%	3.09	4.56%	1.30%
A hard-to-fill vacancy	27031	7.50%	0.52%	0.16%	3.23	6.90%	1.01%
A skill-shortage vacancy	27031	3.71%	0.43%	0.12%	3.70	11.45%	0.83%
A skill-shortage vacancy lasting 3+ months	27031	1.40%	0.16%	0.07%	2.28	11.65%	0.32%
Any employees not fully proficient	27031	11.31%	0.34%	0.19%	1.74	2.96%	0.66%
An occupational group where less than 'Nearly All' employees are fully proficient	27031	6.90%	0.40%	0.15%	2.59	5.77%	0.78%
Total number of:							
Vacancies	27031	768941	32169	31484	1.02	4.18%	63051
Hard-to-fill vacancies	27031	355943	23591	18724	1.26	6.63%	46239
Skill-shortage vacancies	27031	158056	14457	12329	1.17	9.15%	28335
Skill-shortage vacancies lasting 3+ months	27031	74382	8179	8790	0.93	11.00%	16030
Employees not fully proficient	27031	1911856	24050	111849	0.22	1.26%	47137
Density (as percentage of total employment) of:							
Skill-shortage vacancies	27031	0.77%	0.07%	0.05%	1.49	9.13%	0.14%
Employees not fully proficient	27031	9.29%	0.10%	0.07%	1.44	1.13%	0.20%

2.6 The precision of estimated workplace percentages in sectoral sub-samples of ESS 2001

We can expect the precision of estimated *workplace percentages* to be most impaired by the complex sample design of the ESS surveys because of the disproportionate allocation of sample units towards the minority of large establishments.

Looking across the six estimated *workplace percentages* for the full sample (Table 2.2), we see that, in each case, the complex standard error is substantially larger than the standard error calculated under the assumption of simple random sampling. In the full sample, the DEFTs range from 1.7 for the percentage of establishments with at least some employees that are not fully proficient, to 3.7 for the percentage of establishments with a skill-shortage vacancy. However, because the full sample is so large, even the complex standard errors of these estimates are very small. In Table 2.2, the CV is therefore well inside tolerance levels for each of the six estimates, and their 95 per cent confidence intervals are also very small. At this level, the complex design has not noticeably impaired the precision of workplace-level estimates and neither our relative nor absolute thresholds for sampling error have been breached. But we can expect a more noticeable lack of precision in smaller sub-samples.

An examination of the calculations made within the example sectors shows some variation in the DEFTs across sectors. In E-skills, the DEFTs of *workplace percentages* are somewhat larger than those calculated for the full sample. In other sectors, notably SIC(92) Groups 246 and 555 and the Audio-Visual sector, they are somewhat smaller. Across many of our example sectors, the DEFTs are slightly smaller that those calculated on the full sample. Despite this, the effect of smaller sample sizes is generally to produce an increase in CVs and confidence intervals. At the level of sectoral detail shown by our example sectors, the effect of small sample sizes is commonly to produce wide confidence intervals and CVs that exceed the 20 per cent threshold.

In order to synthesise the results into a usable tool, we calculate the average DEFT across each of the six *workplace percentages* and each of the example sectors. This produces an overall mean DEFT of 1.9 for such estimates from ESS 2001. This figure is used in conjunction with the familiar formula for the standard error of a proportion from a simple random sample in order to assess the implications of different sample sizes on the precision of estimated *workplace percentages* from ESS 2001. The results are shown in Tables 4 and 5.

Table 2.3 shows the minimum sample sizes that are required for a range of estimates if those estimates are to have CVs of 20 per cent or less. It is clear that much larger samples are required for extreme estimates (5 per cent, 10 per cent) than for estimates in the middle of the distribution (45 per cent, 50 per cent). This is because the CV rule requires extreme estimates to have much smaller standard errors in absolute terms.

Table 2.3: Minimum sample sizes required to produce estimates with CV less than or equal to 20 per cent (assuming DEFT = 1.9)

		CV (%, taken as 20 per cent of estimate)									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Estimate	**5**	1715									
(%)	**10**		812								
	15			511							
	20				361						
	25					271					
	30						211				
	35							168			
	40								135		
	45									110	
	50										90

However, our absolute criterion leads us to an alternative set of calculations, presented in Table 2.4. As anticipated, we see that larger samples are required for less extreme estimates in order to achieve a given absolute precision.

Table 2.4: Minimum sample sizes required to achieve specified 95 per cent confidence intervals (assuming DEFT = 1.9)

		95% Confidence Interval (%, +/-)									
		10	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
Estimate	**5**	66	81	103	134	183	263	412	732	1647	6587
(%)	**10**	125	154	195	255	347	499	780	1387	3120	12481
	15	177	218	276	361	491	707	1105	1965	4420	17682
	20	222	274	347	453	616	888	1387	2465	5547	22189
	25	260	321	406	531	722	1040	1625	2889	6501	26003
	30	291	360	455	594	809	1165	1820	3236	7281	29123
	35	316	390	493	644	876	1262	1972	3506	7888	31550
	40	333	411	520	679	925	1331	2080	3698	8321	33284
	45	343	424	536	700	953	1373	2145	3814	8581	34324
	50	347	428	542	708	963	1387	2167	3852	8668	34670

On the basis of these calculations, it would seem reasonable to suggest that sectoral sub-samples within ESS 2001 contain at least 900 observations if *workplace percentages* based on those sub-samples are to have a reasonable level of precision. With 900 observations, estimates as low as 10 per cent have CVs within the suggested level of tolerance. Furthermore, estimates at all levels have 95 per cent confidence intervals of less than 14 percentage points (plus or minus 7 percentage points) and all estimates below 20 per cent have confidence intervals of less than 10 percentage points (plus or minus 5 percentage points). It should be noted that most workplace-level estimates of the prevalence of skill deficiencies, such as the percentage of workplaces with skill-shortage vacancies, will be below 20 per cent, since

relatively few workplaces are affected in aggregate.[12]

One should also note, at this point, that the recommended minimum of 900 observations relates to the calculation of headline estimates based on the full sub-sample. If one wishes to look at the causes of skill-shortage vacancies or other 'filtered' variables within a particular sub-sector, much greater numbers of cases will be required in the initial sectoral sub-sample.

Returning to the achieved sample for ESS 2001, we find that only six of the 215 SIC(92) Groups represented in the sample have 900 or more observations (Groups 45.2, 55.3, 55.4, 74.1, 85.1 and 85.3). Moreover, only seven of the 57 SIC(92) Divisions represented in the sample meet this threshold (Divisions 45, 52, 55, 74, 80, 85 and 92). And only four of our example sectors have 900 or more observations (Retail, EMTA, CITB and Logistics).

The sample size required for sectoral sub-samples in ESS 2001 is so large because the complex sample design of ESS 2001 means that it generates much less precise *workplace percentages* than a simple random sample. This is illustrated by the DEFT of 1.9. As we inferred at the beginning of this section, the DEFT is large because such a low proportion of the ESS 2001 sample is allocated to small workplaces (Table 2.5).

Table 2.5: Allocation of ESS 2001 sample by establishment size

Estab. size	Population of establishments		ESS 2001		ESS 2001 as % of popn.	Population of employees	
500+	3054	0.2%	703	2.6%	23%	3419719	17.0%
100-499	26142	1.3%	4384	16.4%	17%	5075512	25.3%
25-99	116176	5.8%	9405	35.2%	8%	5193624	25.9%
5-24	420563	21.1%	8625	32.3%	2%	4335543	21.6%
1-4	1431585	71.7%	3585	13.4%	0.3%	2039698	10.2%
Total	1997520	100%	26702	100%		20064096	100%

Source of population data: Annual Employment Survey 1998
Note: All columns exclude establishments/employees in SIC(92) Sections A and B due to absence of population data.

At this point it is worth noting that, if we ignore units in the least-efficiently-sampled size band (1-4 employees), the average DEFT for estimated *workplace percentages* in ESS 2001 is only 1.25. The implication of this smaller DEFT is that smaller sample sizes are required to meet the same levels of precision. In fact, if we were to restrict our analysis to those units in ESS 2001 with 5 or more employees, we would require a minimum of only

[12] It is, perhaps, helpful to point out that a relaxation of the CV rule from 20 per cent to 25 per cent would not materially alter these conclusions. The main effect would be to bring the estimate of 0.05 (5 per cent) in Table 2.3 much closer to satisfying the rule, whereas it currently fails the 20 per cent rule by some margin.

400 observations in order to satisfy the same criteria as are met by the minimum of 900 observations in the full sample.

Once we remove establishments with 1-4 employees from the ESS 2001 sample, the minimum sample size of 400 observations is met within 16 of the 215 SIC(92) Groups, 15 of the 57 SIC(92) Divisions and six of our example sectors (SIC(92) Group 453; Retail; EMTA; CITB; E-Skills; and Logistics). But it must be borne in mind that, by restricting the sample in this way, we are also restricting the scope of our estimates. Estimates made on the basis of this restricted sample would apply to a much smaller population of workplaces - only 28.3% of full population, according to Table 2.5. Nevertheless, our estimates would still cover those workplaces that employ the vast majority (around 90 per cent) of all employees.

- 2.7 The precision of estimated employee totals in sectoral sub-samples of ESS 2001

We can expect the precision of estimated *employee totals* to be less impaired by the complex sample design of the ESS surveys than that of estimated *workplace percentages*, because the sample is disproportionately allocated towards establishments with large numbers of employees, where most employment is located.

Looking across the five estimated *employee totals* for the full sample (Table 2.2), we see that, in four of the five estimates, the complex standard error is of a similar magnitude to that which would have arisen from a simple random sample of the same size. The exception is the estimated number of employees that are not fully proficient, where it is actually smaller. This means that the complex sample design of ESS 2001 has enabled us to estimate the number of employees that are not fully proficient with greater precision than if we had used a simple random sample.

Looking across our example sectors we see, again, some variation in the DEFT values for the five estimates. As was the case for *workplace percentages*, the DEFTs tend to be particularly high in the E-skills sub-sample and low in the Audio-Visual sector, the Petro-Chemicals sector and in SIC(92) Groups 246 and 555. The average DEFT for the first four of the five estimates is calculated at 1.2 across our example sectors, whereas that for the final estimate (the number of employees that are not fully proficient) averages just 0.3.

Turning to the evaluation of our relative rule which is based on the Coefficient of Variation, we find that, despite the low DEFTs of our estimated *employee totals*, the 20 per cent threshold is breached in many of our example sectors. This is particularly true for estimates of the numbers of hard-to-fill vacancies, skill-shortage vacancies and long-duration skill-shortage vacancies. The threshold is more readily met by our estimates of the number of vacancies, whereas our estimates of the number of employees that are not fully proficient comes within the threshold in all sub-sectors except Group 246, which is the smallest.

This variation means that it is difficult to develop general guidelines for *employee totals* per se, since the CV is highly dependent upon the item that is being summed. For example, the CV for the total number of long-duration skill-shortage vacancies tends to be much larger than that for the total number of employees not fully proficient. Below, we attempt to develop some guidelines which are specific to each estimate, but we can also expect these to have only partial success.

We know from equations (1), (3) and (4) in previous sections that:

$$CV(\bar{x})^2 = \left(\frac{SE(\bar{x})}{\bar{x}} \right)^2 = DEFT^2 \cdot \frac{v(x)}{n} \cdot \frac{1}{\bar{x}^2}$$

Therefore, if we calculate a mean value for $v(x)/\bar{x}^2$ for each of our five estimates, after averaging across our example sectors, we can use this in conjunction with the average DEFT for each estimate to identify the value of *n* which satisfies the requirement that the CV be less than 0.2. Doing so, we obtain the following minimum sample sizes:

Vacancies	647
Hard-to-fill vacancies	1680
Skill-shortage vacancies	3122
Skill-shortage vacancies lasting 3+ months	5224
Employees not fully proficient	163

However, we can see by looking across the example sectors that these proposed minimum sample sizes are rather imperfect. This is because, for any one of the five estimates, the values of DEFT and $v(x)/\bar{x}^2$ vary considerably across sectors. So, for example, we see that the estimated numbers of vacancies in the Textiles and Petro-Chemicals sectors both have CVs of less than 20 per cent, despite these sectors having sample sizes of only 130 and 234 observations respectively. The conclusion to be drawn from this exercise would be that there is no reliable substitute for calculation the precision of a specific *employee total* within a particular sector of interest.

Having said that, the 900-observation minimum which we proposed in Section 2.6 does seem to have some merit for *employee totals*. The merit of this minimum is that the four example sectors which have 900 or more observations (Retail, EMTA, CITB and Logistics) are also those which appear to clearly perform best against our CV rule. These four sectors all come within the 20 per cent threshold for estimates of the numbers of hard-to-fill vacancies and the numbers of employees that are not fully proficient. And if they are not within the threshold, they are close to it for estimates of the numbers of vacancies, skill-shortage vacancies and long-duration skill-shortage vacancies. A single limit is clearly less helpful for estimates of *employee totals* than it is for estimates of *workplace percentages*, for the reasons stated in the previous paragraph. But if we were to opt for a single figure, there would appear to be a reasonable case for adopting the 900-

observation minimum that we arrived at in Section 2.6.

- 2.8 The precision of estimated employee ratios in sectoral sub-samples of ESS 2001

We can expect the precision of estimated *employee ratios* to be affected by the complex sample design of the ESS surveys to a similar degree as estimated *employee totals*, since the ratio is formed from two such totals.

Looking at the two estimated ratios in the full sample (Table 2.2), we see that the DEFT is around 1.2 for the density of skill-shortage vacancies but only 0.3 for the density of employees that are not fully proficient. As with the other estimates we have discussed in the previous two sections, there is considerable variation across our example sectors, but the average values are similar to those in the full sample, standing at 1.0 and 0.4 respectively. The precision of estimates of the density of skill-shortage vacancies has therefore, on average, been little affected by the complex sample design, whereas the precision of the density of employees that are not fully proficient has been substantially enhanced.

When we examine the precision of our sectoral estimates against the relative and absolute criteria proposed in Section 2.4.1, we find mixed results. Looking first at the Coefficients of Variation, we see that the CV for the density of skill-shortage vacancies exceeds the 20 per cent threshold in all of our example sectors, falling within this tolerance level only in the full sample. However, it is noticeable that the CV comes closest to 20 per cent in three of the four largest sectors (CITB, EMTA and Logistics). The CV for the density of employees that are not fully proficient, on the other hand, comes within the 20 per cent tolerance level in all of our example sectors. To a large extent, this must reflect the much smaller DEFTs of these estimates.

Turning to the 95 per cent confidence intervals of our sectoral estimates, and comparing against our proposed limit of ± 1 percentage point, we find that the density of skill-shortage vacancies comes within this tolerance level in all of our example sectors except SIC(92) Group 453 and the E-skills sector. This reflects a combination of relatively high DEFTs and smaller sample sizes in these sectors. On the other hand, the density of employees that are not fully proficient passes only in three of our largest sectors (Retail, EMTA and CITB). However, it is also very close to the threshold in Logistics, and the confidence interval only exceeds 2 percentage points in the three smallest sectors (SIC(92) Groups 246 and 555 and the Audio-Visual sector).

The formula required to obtain the standard error of a ratio estimate is too complex to allow us to go any further in trying to develop any more-generalisable rules about the minimum sample sizes required to meet our specified levels of precision. But from our example sectors, we can conclude that large sample sizes are required if the density measures we have studied are to meet both the relative and absolute criteria that have been proposed. Indeed, we find again that the minimum of 900 observations serves to best identify those sectors which come closest to meeting our criteria.

To summarise our assessment of the precision of estimates from ESS 2001, three main points can be made. First, our assessment has shown that the complex sample design of ESS 2001 has affected the precision of estimates from the survey when compared with simple random sampling. The precision of *workplace percentages* has clearly been impaired by the complex sample design, whereas the precision of most *employee totals* and *employee ratios* has been little affected, aside from a small number of such estimates whose precision has actually been enhanced.

Second, our sectoral estimates have shown varying degree of success in meeting the relative and absolute criteria for precision that were proposed earlier in the chapter. In large part this is due to the small sample sizes in some of our example sectors and we have been able to develop some guidelines for minimum recommended sample sizes on this basis. However, we have also identified estimates which routinely pass or fail our criteria across sectors of almost all sizes.

Finally, we have shown that the determination of minimum sample sizes must ultimately be guided by an investigation of the properties of the sector that is being considered and the item that one wishes to estimate. In particular, the recommended limits to disaggregation can vary widely across different types of estimate, and even within types. If one wished to settle upon a single, recommended limit to sectoral disaggregation which maximised the chances of meeting the criteria proposed in Section 2.4.1, it would be to focus on sectors having a minimum of 900 observations in ESS 2001. But, at the same time, one must also recognise the limitations of such a single threshold given the variation that we have observed.

2.9 Observable bias in sectoral sub-samples from ESS 2001

Our examination of the precision of estimates from the ESS surveys has suggested reasonable limits to the disaggregation of the survey samples along sectoral lines. However, for the reasons outlined in Section 2.3.5, it is also appropriate to compare the profile of sectoral sub-samples with the profile of the broader population in order to identify any observable bias that may have resulted from patterns of non-response.

To do so, we compare the profiles of our example sectors (after grossing) with the population profiles suggested by data from the 1998 Annual Employment Survey (AES 1998) and Annual Business Inquiry 2000 (ABI 2000). AES 1998 was used to compile the grossing factors for ESS 1999 and precedes by one year the AES 1999 data that was used to compile the grossing factors for ESS 2001. A comparison is also made with ABI 2000, however, because its timing is closer to ESS 2001 and because doubts have arisen over the reliability of the Annual Employment Survey (see Partington, 2000, for example).[13] We focus our discussion on ESS 2001 and only on those four

[13] The Inter Departmental Business Register (IDBR) was rejected as a source of population data since much of the workplace size data recorded on the IDBR against small establishments is very old. The recent IDBR quality review suggests that 40%

example sectors which meet the 900 observation threshold suggested at the end of the previous section (i.e. Retail, EMTA, CITB and Logistics).

When comparing the profiles of our example sectors against the corresponding population profiles, it should be noted that some discrepancies are inevitable as a result of sampling error in both ESS 2001 and AES 1998/ABI 2000. We are therefore seeking to identify substantial discrepancies only.

Retail:

The profile of the Retail sub-sample in ESS 2001 by workplace size and region compares well with the population profiles suggested by both AES 1998 and ABI 2000, which are themselves very similar. The composition of Retail by SIC(92) Group is also broadly in line with population data, although the ESS 2001 sample has an under-representation of establishments from SIC(92) Group 521 and 522 and an over-representation of establishments from Group 523. This will affect sector-level estimates if these Groups have different levels of skill deficiencies. But one would not expect any inter-Group differences in behaviour to be so large as to cause a noticeable bias in estimates for Retail as a whole.

The most notable element of the Retail comparison is perhaps the high number of establishments estimated by ESS 2001 to reside within the sector. This number is at least 20 per cent larger than that suggested by either AES 1998 or ABI 2000. This will not affect the accuracy of workplace-level estimates or densities, but does raise the possibility that estimates of the total numbers of vacancies or skills gaps within Retail may be upward-biased.

EMTA:

The profile of the EMTA sub-sample in ESS 2001 by workplace size and region also compares well with the population profiles suggested by both AES 1998 and ABI 2000. EMTA comprises a large number of SIC(92) Groups, but the broad profile suggested by ESS 2001 is also comparable with the broader population. ESS 2001 may have an over-representation of establishments from SIC(92) Groups 281 and 295 and an under-representation of those from Group 285 but, as in the case of Retail, the differences are unlikely to affect sector-level estimates to more than a very minor degree.

The ESS 2001 estimate of the grossed number of establishments in EMTA also matches well with that suggested by AES 1998, but is around 10 per cent larger than that suggested by ABI 2001. This is of less concern than the case of Retail, where the ESS estimate was substantially larger than both external estimates.

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of the employment in workplaces with 10-19 employees is located within establishments which have not had that employment data updated since 1993 (Office for National Statistics, 2001b: Table 10). A principal reason is that there is no systematic proving of records from enterprises with less than 20 employees (Jones, 2000).

CITB:
The profile of the CITB sub-sample in ESS 2001 compares well with the population profile suggested by AES 1998 and ABI 2000 in terms of establishment size and region. The only concern would be an over-representation of SIC(92) Group 454 and an under-representation of SIC(92) Group 452 in the grossed ESS sub-sample. However, the differences are likely to have only a marginal effect on sector-level estimates.

The ESS 2001 estimate of the grossed number of establishments in CITB also matches well with that suggested by AES 1998 but, as in the case of EMTA, is around 10 per cent larger than that suggested by ABI 2001. Again, we would be more concerned if the ESS estimate was substantially larger than both external estimates.

Logistics:

The industry, size and region profiles of the Logistics sub-sample in ESS 2001 compare well with the population profiles suggested by AES 1998 and ABI 2000, raising no concerns in this respect. The ESS 2001 estimate of the grossed number of establishments in Logistics is around 10 per cent lower than the number suggested by AES 1998, but is in line with the estimate from ABI 2001.

The results of these comparisons suggest no real cause for concern over the size and region profiles of the four example sectors. But this is perhaps not surprising since each accounts for a substantial share of their broader SIC(92) Section (100 per cent in the case of CITB). The Section-level grossing factors can therefore be expected to correct much of the sample-selection or non-response bias that may have been present in the unweighted samples for the three sectors. There are some small discrepancies in the industry composition of the Retail, EMTA and CITB sectors but, as stated above, these will only have substantive implications if behaviour varies markedly within the example sector. There is perhaps most concern over the scale of the grossing factors for the Retail sector, which appear to be too large by a factor of at least 20 per cent.

2.10 Conclusions and recommendations

The foregoing discussion has considered both the sampling and non-sampling errors associated with sectoral estimates from ESS in order to make an assessment of the limits to sectoral disaggregation of the data. Our investigation of sampling errors has shown that it is difficult to identify a single, recommended limit that is broadly applicable across different types of estimate and different sectoral sub-samples. The most appropriate single threshold that emerges from our investigation is of a minimum sample size of 900 observations, but we have shown that this has its own limitations. So it is possible to identify sectors with less than the recommended number of observations in which the precision of certain estimates comes within our specified targets. And it is possible to identify sectors with more than 900 observations in which these targets are not met for all estimates. In practice,

the precision of different types of estimate in particular sectors can only be guaranteed through investigation of the data on a sector by sector basis.

Focusing on those four of our example sectors which pass the recommended threshold of 900 observations (Retail, EMTA, CITB and Logistics), we find no substantial evidence of non-sampling biases in the achieved samples for these sectors. This is arguably because these sectors themselves comprise substantial proportions of the wider industry sectors used in the compilation of grossing factors. Nonetheless, there are a small number of 'deviations' which ought to be considered when presenting estimates on these sectors. Again, this suggests that a thorough consideration of the reliability of the ESS data in sectors that have hitherto not been examined would involve some case-by-case evaluation of the extent to which the sector profile suggested by ESS corresponds with that of the relevant population.

Appendix 2A: Specific sectors considered in the evaluation

Table 2.A.1 Specific sectors considered in the evaluation

Sector	Definition (as employed in this chapter)	SIC(92) code(s)
Individual SIC(92) Groups:		
246	At 50th percentile of number of unweighted observations (ESS01)	24.6
555	At 75th percentile	55.5
453	At 95th percentile	45.3
Trailblazers:		
Apparel, Footwear & Textiles	Manufacture of textiles, clothing and allied products, associated design, manufacture of leather goods, footwear and leather products. Linked retailing (52.43) and shoe repairs (52.71) are excluded.	17.1-17.7, 18.1-18.3, 19.1-19.3, 24.7
Audio-visual	Animation; Business communication; Commercials; Facilities; Film; Interactive Media; Radio; TV	92.1, 92.2
Petro-chemicals	Chemicals manufacturing and the petroleum industry, oil and gas extraction	11.1, 11.2, 23.2, 24.1-24.7
Retail	Retail trade, except motor vehicles	52.1-52.7
LANTRA	Land-based and rural industries. Agriculture and Fishing (01.1-02.0) not covered in ESS 1999. Fish hatcheries and fish farms (0502) excluded from definition.	01.1-01.5, 02.0, 29.3, 85.2
Other sectors:		
HE	Higher Education	80.3
EMTA	Basic metal manufacturing, metal products, mechanical equipment, electronics and electrical equipment, manufacture of motor vehicles and other transport equipment.	27.4, 27.5, 28.1-28.3, 28.5-35.5
CITB	Construction	45.1-45.5
E-skills	IT industry. IT professionals in other industries are excluded.	64.2, 72.1-72.6
Logistics	Freight transport, storage and warehousing. Passenger transport is also included in our definition. Courier activities (64.12) are excluded.	60.1, 60.2, 61.1, 61.2, 62.1, 63.1, 63.4
Motor industry	Sale, maintenance and repair of motor vehicles; retail sale of automotive fuel	50.1-50.4

3. ASSESSMENT OF MEASURES OF SKILLS DEFICIENCIES IN THE EMPLOYERS SKILL SURVEYS

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3.1 Introduction

There is room for wide differences of opinion as to how best to define and present the various measures of skill deficiencies which can be generated from the ESS datasets. In this chapter we assess the main strengths and weaknesses of several different indicators with the aim of providing guidance as to which measures are most informative and appropriate to use in different circumstances.

We consider the use of different measures of skill deficiency under the following headings:

- Establishment-based measures of incidence
- Employee-based measures of incidence and density
- Comparison of ESS vacancies with Employment Service vacancies
- ESS compared with the CBI and British Chambers of Commerce (BCC) surveys of skill shortages
- Combining different measures of skill deficiency
- Forward-looking indicators of skill deficiency

On the basis of the various issues raised in this assessment, we then compile summary tables outlining the advantages and disadvantages of using different measures for different purposes.

3.2 Definitions of skill deficiencies

The design of the ESS questionnaires enables a clear distinction to be made between two main types of skill deficiencies:

- Skill-related external recruitment difficulties
- Internal skill shortcomings amongst existing staff

This clarity contrasts with, for example, the CBI's quarterly Industrial Trends Survey which asks manufacturing employers to indicate whether skilled labour is likely to limit their output in the following four-month period. A follow-up study of CBI survey participants suggested that about 60% of respondents interpreted this question as referring to external recruitment difficulties while 45% thought it referred to the skills possessed by their existing workforce (Mann and Junankar, 1998).

In the case of skill deficiencies deriving from external recruitment difficulties, there is now widespread agreement that '*skill-shortage vacancies*' refer to unfilled jobs at the time of interview which are described by survey respondents as 'hard-to-fill' for at

least one of the following reasons:

- 'Low number of applicants with the required skills'
- 'Lack of work experience the company demands'
- 'Lack of qualifications the company demands'

In the case of '*internal skill gaps*' – that is, skill deficiencies among existing members of staff – definitions are less straightforward. In both 1999 and 2001 the survey question on this topic asked respondents: 'What proportion of your existing staff at this establishment in [each occupation] would you regard as being fully proficient at their current job: all, nearly all, over half, some but under half, very few?' Follow-up questions in 1999 about the percentage signified by an evaluation of 'nearly all' elicited a median score of 85% fully proficient (inter-quartile range 80%-90%); for an evaluation of 'over half' the equivalent percentage ratings had a median of 65% (inter-quartile range 60-70%).

At an establishment level the ESS reports to date have distinguished between two definitions of internal skill gaps:

1. a 'broad' definition including all establishments which reported that at least *some* of their staff lacked full proficiency (that is, in at least one occupational area, 'nearly all' employees or fewer employees were regarded as fully proficient)
2. a 'narrow' definition including only those establishments which reported that, in at least one occupational area, 'over half' or fewer employees were fully proficient -- on the basis of the median percentage score discussed above, this can be taken to imply that roughly a third or more of employees in the occupations concerned lacked full proficiency

Both these measures have their uses. However, as we will discuss below, great care needs to be taken in distinguishing between broad and narrow measures of internal skill gaps when referring to *employee-based* measures of this type of skill deficiency.

3.3 Establishment-based measures of incidence

3.3.1 Sectors, regions and size-groups

One simple way to compare the incidence of skill-shortage vacancies and internal skill gaps across sectors, regions and size-groups is to show the percentage of all establishments which report a particular kind of problem. [14] Among other things this gives some idea of the extent to which the problems are concentrated in a small number of establishments in one sector, region or size-group compared to another. However, such measures are less useful as indicators of the scale and intensity of skill deficiencies, in large part because they implicitly attach the same importance to small establishments as to large and medium-sized establishments.

It is worth recalling the size-group distribution of the ESS samples. If we take ESS1999 as an example, then Table 3.1A shows that establishments with 5-24

[14] Comparisons across occupational categories are necessarily different (see Section 3.3.2 below).

employees accounted for 39% of all establishments in the raw sample while establishments with 100 or more employees represented 23% of sample respondents (Column 1). When the responses are grossed up ('population-weighted') to ensure that sample-based estimates are representative of the entire population of establishments in England with 5 or more employees, then establishments with 5-24 employees represent 75% of workplaces while establishments with 100 or more employees represent only 5.6% of workplaces (Column 3). However, establishments in the 5-24 size-group account for only 27% of all *employees* across the sample compared to the 45% of employees who work in establishments with 100-plus employees (Column 5). In ESS2001 the sample was widened to include establishments with 1-5 employees. Hence, in this broader sample, establishments with 100 or more employees represent only 1.65% of workplaces while employing 42% of all employees (Table 3.1B, Columns 3 and 5).

The upshot of this distribution of establishments and employees is that simple population-weighted estimates of the proportions of establishments reporting problems such as skill-shortage vacancies (Table 3.2, Column 1; Table 3.3, Column 1) are necessarily dominated by small establishments.

An alternative employment-weighted measure can be defined in which each establishment reporting skill-shortage vacancies is weighted by its share of total employment in the sample even if those vacancies represent only a small proportion of its total labour force (Table 3.2, Column 3; Table 3.3, Column 3). However, this merely provides a broad indicator of how employment is distributed across establishments with and without skill-shortage vacancies.

In the case of regions, the employment-weighted rankings are virtually the same as the population-weighted rankings and it is clear that the absolute differences between regions in the proportions of establishments affected by skill-shortage vacancies are not large on either measure (Table 3.3). But, in terms of sectoral rankings, the health and social work sector shoots to the top on the employment-weighted measure compared with 4th place on the population-weighted measure (Table 3.2). It seems likely that the employment-weighted measure tells us as much about inter-sectoral differences in the size-distribution of workplaces as it does about the relative incidence of skill-shortage vacancies. In general, the use of an employment-weighted measure at establishment level tends to be dominated by large establishments including some who may have only a very few skill-shortage vacancies (or perhaps even only one).

Table 3.1: Size-distribution of establishments and employees in ESS

A: 1999

Establishment size-group	Unweighted establishments		Population-weighted establishments		Population-weighted employees	
	Per cent	Unweighted base	Per cent	Weighted base	Per cent	Weighted base
5 to 24	39	10417	75	399724	27	4660793
25 to 49	24	6425	12	65620	13	2235063
50 to 99	14	3771	7	39983	15	2665465
100 to 199	12	3361	3	15059	11	2009572
200 to 499	8	2236	2	10370	17	3018639
500 to 999	2	515	0.4	2061	8	1318380
1000 or over	1	227	0.2	906	9	1645231
TOTAL	100	26952	100	533723	100	17553142

B: 2001

	Unweighted establishments		Population-weighted establishments		Population-weighted employees	
	Per cent	Unweighted base	Per cent	Weighted base	Per cent	Weighted base
Establishment size-group						
1 to 5	14	3701	72	1481190	10	2147726
5 to 24	32	8766	21	430708	22	4578680
25 to 49	23	6151	4	75978	13	2577550
50 to 99	12	3306	2	41507	13	2714846
100 to 199	10	2605	1	15493	10	2064570
200 to 499	7	1799	0.5	10928	16	3223543
500 to 999	2	456	0.1	1895	6	1236325
1000 or over	1	247	0.05	1014	10	1954732
TOTAL	100	27031	100	2058713	100	20497972

One way round this kind of problem is to look at the proportion of establishments affected by size group as well as by sector or region. This is illustrated by Table 3.4 which shows that, in most (though not all) sectors, the proportion of establishments reporting at least one skill-shortage vacancy rises steadily with establishment size-group.

However, even this kind of table is still potentially misleading in that some figures may refer to certain sector by size-group cells where in fact very few establishments exist. One alternative would be to expand such tables by adding more information about the distribution of establishments and employees across the various cells. However, that would make for very large and hard-to read tables. In general, it is easier for readers to gauge the relative importance of skill problems in any particular

sector by size-group cell if information is provided about the ratio of skill-shortage vacancies to employees in those cells. For this reason in the various ESS reports a range of employee-based measures of the incidence of different kinds of skill problem have been developed. These are discussed in Section 3.3.4.

Table 3.2: Proportions of establishments reporting at least one skill-shortage vacancy, 2001, analysed by sector (a)

	Population-weighted (b) estimates (%)	Ranking of population-weighted measures	Employment-weighted (c) Estimates (%)	Ranking of employment-weighted measures	Population-weighted base	Unweighted base
Business services	5.0	1	15	3	514314	4140
Education	4.8	2	10	6	46032	1437
Manufacturing	4.3	3	11	4	170423	4215
Public administration	4.3	4	18	1	19563	545
Health & social work	4.2	5	17	2	96370	2461
Transport and communication	4.1	6	10	5	84560	1872
Finance	3.6	7	8	8	37940	820
Construction	3.4	8	10	7	212480	2364
Hotels & restaurants	3.0	9	6	10	128156	2991
Other community services	2.9	10	7	9	183022	2374
Wholesale, retail	2.5	11	6	11	495565	3361
TOTAL (a)	3.6		11		2058713	27031

Notes:

(a) Total figures include three sectors for which separate results are not shown here due to small cell sizes: agriculture, mining and quarrying and electricity and water supply. *This note also applies to all subsequent tables showing sectoral comparisons*.

(b) 'Population-weighting' here refers to the grossing-up of sample-based estimates to ensure that they are representative of the entire population of establishments in England.

(c) In 'employment-weighted' estimates each establishment is allocated a weight proportional to its share of employment in the grossed-up sample of establishments.

Table 3.3: Proportions of establishments reporting at least one skill-shortage vacancy, 2001, analysed by region

	Population-weighted (a) estimates (%)	Ranking of population-weighted measures	Employment-weighted (b) estimates (%)	Ranking of employment-weighted measures	Population-weighted base	Unweighted base
Eastern	5	1	11	4	232823	3035
South West	4	2	10	7	226182	2916
London	4	3	12	1	380237	4011
South East	4	4	12	2	373911	3908
North West	4	5	10	5	246821	3109
West Midlands	3	6	12	3	194483	2816
North East	3	7	9	8	66197	1999
Yorkshire & Humberside	2	8	8	9	179126	2677
East Midlands	2	9	10	6	158934	2560
TOTAL	4		11		2058713	27031

Notes:
(a) See Table 3.2, Note b.
(b) See Table 3.2, Note c.

Table 3.4: Proportions of establishments reporting at least one skill-shortage vacancy, 2001, analysed by sector and size group

Percent of establishments reporting at least one skill-shortage vacancy

		Establishment size-group:							
	TOTAL	1 to 4	5 to 24	25 to 49	50 to 99	100 to 199	200 to 499	500 to 999	1000 or over
Manufacturing	4	3	4	7	10	12	13	20	14
Construction	3	3	7	10	14	15	20	21	36
Wholesale, retail	2	2	4	6	10	7	7	4	0
Hotels and restaurants	3	2	4	6	5	9	13	17	0
Transport and communication	4	3	7	9	7	11	9	0	8
Finance	4	3	3	8	8	14	12	12	3
Business services	5	4	7	11	16	16	22	24	51
Public administration	4	0	4	4	9	1	14	12	32
Education	5	2	3	6	13	13	10	8	21
Health and social work	4	2	4	9	11	16	15	27	30
Other community services	3	3	4	4	9	10	9	7	42
TOTAL	4	3	5	7	11	12	13	15	22

The points made about establishment-based measures of the incidence of skill-shortage vacancies are equally applicable when such measures are applied to internal skill gaps.

Using the broad definition of such gaps, as described in Section 3.2, their incidence is highest in public administration (Table 3.5). When the narrow definition is used,

public administration remains at the top but the ranking of some of the other sectors changes (for example, education drops from second to sixth). Table 3.6 shows considerable differences in regional rankings depending on which definition is used. However, the size-group rankings are unaffect ed (Table 3.7): in general, small establishments (with less than 25 employees) are much less likely to report internal skill gaps than are large or medium-sized establishments.

With all three Tables 3.5-3.7, it is important to recognise that the establishment-based measures of the incidence of internal skill gaps are dominated by small establishments. Furthermore, the occupations affected by lack of proficiency may account for only a small proportion of employment in each sector, region or size-group. Hence, as discussed below in Section 3.4, there are strong arguments for complementing establishment-based measures of skill deficiencies with employee-based measures.

Table 3.5: Proportions of establishments reporting an internal skill gap in at least one occupational area, 2001, analysed by sector

	Broad definition est. 15% lack proficiency in at least one occupation	Broad definition – Ranking	Narrow definition – est. one third or more lack proficiency in at least one occupation	Narrow definition - Ranking
	% of establishments		*% of establishments*	
Public administration	40	1	12	1
Education	32	2	8	6
Finance	32	3	10	3
Manufacturing	31	4	10	2
Health and social work	30	5	9	5
Hotels and restaurants	27	6	9	4
Wholesale, retail	24	7	7	7
Transport and communication	22	8	6	9
Construction	20	9	5	10
Business services	19	10	6	8
Other community services	17	11	5	11
TOTAL	23		7	

Note: In this and subsequent tables rankings apply to non-rounded figures.

Table 3.6: Proportions of establishments reporting an internal skill gap in at least one occupational area, 2001, analysed by region

	Broad definition est. 15% lack proficiency in at least one occupation	Broad definition – Ranking	Narrow definition – est. one third or more lack proficiency in at least one occupation	Narrow definition - Ranking
	% of establishments		*% of establishments*	
West Midlands	27	1	8	4
North East	27	2	9	1
North West	25	3	6	7
Yorkshire & Humberside	25	4	6	8
Eastern	24	5	6	5
South East	22	6	6	6
East Midlands	22	7	8	3
South West	21	8	9	2
London	19	9	6	9
TOTAL	23		7	

Table 3.7: Proportions of establishments reporting an internal skill gap in at least one occupational area, 2001, analysed by size group

	Broad definition est. 15% lack proficiency in at least one occupation	Broad definition – Ranking	Narrow definition – est. one third or more lack proficiency in at least one occupation	Narrow definition - Ranking
	% of establishments		*% of establishments*	
500 to 999	79	1	26	1
200 to 499	76	2	24	2
1000 or more	76	3	23	3
100 to 199	69	4	22	4
50 to 99	66	5	22	5
25 to 49	58	6	20	6
5 to 24	45	7	14	7
1 to 4	12	8	3	8
TOTAL	23		7	

3.3.2 Occupations

The use of establishment-based measures of skill deficiencies is more complicated when assessing the incidence of such deficiencies across occupations. It seems best to first show the proportions of establishments that actually employ at least one person in each occupation. This ranges from 60% of establishments (in the case of managers) to 7% for production operators and assembly workers (Table 3.8). [15] Once this is done, establishment-based measures can be calculated along the same lines as for sectors, regions or size-groups. These have the same disadvantages of being heavily influenced by small establishments but can still be informative. For example, Table 3.8 shows very clearly that the highest-ranked occupations in terms of skill-shortage vacancies (associate professionals and operators) differ from those occupations most affected by internal skill gaps (personal service and sales occupations).

In summary, establishment-based measures of the incidence of particular kinds of skill problem have some uses as preliminary measures to be presented at the outset of any analysis. However, to gain a better understanding of the relative *importance* of skill-shortage vacancies and internal skill gaps in different sectors, regions, size-groups or occupations, it is necessary to consider measures based on the absolute numbers of skill deficiencies of different kinds and their density in relation to total employment.

[15] Note that the large proportion of establishments apparently not employing managers reflects the inclusion of establishments employing less than 5 employees in ESS 2001. In ESS 1999, covering establishments with 5-plus employees, some 98% of establishments reported employing at least one manager.

Table 3.8: Proportions of establishments reporting skill-shortage vacancies or internal skill gaps, 2001, analysed by occupation

	% of establishments reporting employment within occupation	Of which: % reporting skill-shortage vacancy within occupation		% reporting internal skill gap within occupation	
	% of all establishments	*% of establishments reporting employment in each occupation*	*Skill-shortage vacancies ranking*	*% of establishments reporting employment in each occupation*	*Internal skill gaps -- ranking*
Occupation					
Managers and senior administrators	60	0.4	9	4	9
Professionals	15	4	4	4	8
Associate professionals	10	6	1	7	4
Clerical and secretarial	31	1	8	5	6
Craft and skilled	17	4	3	5	7
Personal service	10	3	5	9	1
Sales	18	2	6	8	2
Operative and assembly	7	5	2	7	3
Other manuals	12	2	7	7	5

3.4 Employee-based measures of incidence and density

One straightforward way to see at a glance where (in terms of sectors, regions, size-groups or occupations) the largest numbers of, say, skill-shortage vacancies are located and also to appreciate their relative importance in each category is to present estimates of the total number of such vacancies in each category alongside density measures (such as ratios of skill-shortage vacancies to total employment). Thus in Table 3.9, it is not surprising that some of the largest sectors – such as business services, manufacturing and retailing -- show the largest number of skill-shortage vacancies. But the acuteness of the problem – relative to total employment -- is greatest in the much smaller construction sector. Of the three sectors with the highest absolute numbers of skill-shortage vacancies, it is only in business services that the density of such vacancies is comparable to that in construction. Similarly, in Table 3.10, the East Midlands and South East are only third and fourth among regions in terms of absolute numbers of skill-shortage vacancies but, interestingly, are slightly ahead of London and the South East in terms of the density measure.

In respect of establishment size-groups, the patterns revealed by employee-based measures contrast sharply with those shown by establishment-based measures. As shown in Table 3.4 above, large establishments are more likely to report having at least one skill-shortage vacancy. However, Table 3.11 shows that the largest absolute numbers of skill-shortage vacancies are found in the smallest size-groups which also experience the greatest proportionate impact of such vacancies.

Depending on the issues which policy-makers and other users wish to explore in

detail, various other employee-based measures of this kind can be developed. For example, it may be considered useful to focus on a defined category of 'more serious' skill-shortage vacancies. One example would be skill-shortage vacancies lasting 3 months or more, the numbers and densities of which can be compared across sectors, regions, size-groups and occupations in the same way as total skill-shortage vacancies.

Table 3.9: Sectoral distribution of skill-shortage vacancies and ratios of skill-shortage vacancies to total employment, 2001

ranked by total number of skill-shortage vacancies

	Est. number of skill-shortage vacancies	Ranking	Total skill-shortage vacancies as percent of total employment	Ranking
Business services	51749	1	1.7	2
Manufacturing	21443	2	0.6	5
Wholesale, retail	18516	3	0.5	8
Health and social work	16945	4	0.8	4
Construction	15438	5	1.7	1
Other community services	8013	6	0.8	3
Transport and communication	7215	7	0.6	6
Hotels and restaurants	5881	8	0.5	7
Education	5314	9	0.4	10
Finance	4253	10	0.5	9
Public administration	2729	11	0.2	11
TOTAL	159081		0.8	

Table 3.10: Regional distribution of skill-shortage vacancies and ratios of skill-shortage vacancies to total employment, 2001

ranked by total number of skill-shortage vacancies

	Est. number of skill-shortage vacancies	Ranking	Total skill-shortage vacancies as percent of total employment	Ranking
London	33649	1	0.9	4
South East	31862	2	1.0	3
East Midlands	22950	3	1.1	2
South West	22115	4	1.1	1
North West	16582	5	0.6	6
West Midlands	13974	6	0.6	5
Yorkshire & Humberside	7288	7	0.4	9
Eastern	6892	8	0.4	7
North East	3770	9	0.4	8
TOTAL	159081		0.8	

Table 3.11: Distribution of skill-shortage vacancies and ratios of skill-shortage vacancies to total employment, 1999

ranked by total number of skill-shortage vacancies

	Est. number of skill-shortage vacancies	Ranking	Total skill-shortage vacancies as percent of total employment	Ranking
1 to 4	63781	1	3.0	1
5 to 24	35653	2	0.8	2
50 to 99	15710	3	0.6	3
25 to 49	13054	4	0.5	5
100 to 199	11420	5	0.6	4
200 to 499	8293	6	0.3	8
1000 or over	6900	7	0.4	6
500 to 999	4271	8	0.3	7
TOTAL	159081		0.8	

Employee-based measures also help to bring out the very different profiles of skill-shortage vacancies and internal skill gaps across different categories such as occupations and sectors. For example, Table 3.12 shows very clearly that skill-shortage vacancies are most heavily concentrated in craft-skilled, professional and associate professional occupations, and are most serious (as shown by the density figures) in craft and associate professional areas. By contrast, these occupations rank fairly low in terms of internal skill gaps which are most heavily concentrated in sales and clerical occupations and proportionately most serious in operative and other manual occupations (Table 3.13).

Similarly, while large sectors such as manufacturing, retailing and business services feature prominently in terms of the numbers of employees believed to lack full proficiency in their jobs (Table 3.14), the highest proportions of employees in this category are in public administration and hotels/restaurants. These two sectors rank fairly low in terms of skill-shortage vacancies (Table 3.9). Conversely, construction, which arguably has the most severe problems in terms of skill-shortage vacancies, ranks low on measures of internal skill gap density.

The estimated 1.91 million total of internal skill gaps shown in Table 3.14, Column 1 equates to a broad definition. This includes all employees said to lack full proficiency in all establishments which did not answer 'All proficient' for all occupations, in response to the relevant survey question (see Section 3.2 above). This is the most useful measure to use when seeking to assess the incidence and density of skill gaps across the whole economy.

By contrast, a narrow measure of internal skill gaps is confined to the number of employees said to lack full proficiency in the minority of establishments which answered 'more than half' or fewer in at least one occupational area, in response to the survey question on proficiency. This provides a useful indicator of the types of establishment where skill gaps are most intense. Another reason for sometimes focussing on narrowly-defined skill gaps at employee level derives from the design of the ESS questionnaires to date. Follow-up questions on the type of skills missing when staff lacked full proficiency – and on the impacts of and responses to internal

skill gaps – were only asked of those establishments which reported that, in the occupational area(s) concerned, 'over half' or fewer employees were fully proficient.

Table 3.12: Occupational distribution of skill-shortage vacancies and ratios of skill-shortage vacancies to total employment, 2001

ranked by total number of skill-shortage vacancies

	Est. number of skill-shortage vacancies	Ranking	Total skill-shortage vacancies as percent of total employment	Ranking
Craft and Skilled	31592	1	1.7	1
Professionals	28886	2	1.1	3
Associate professionals	28287	3	1.7	2
Personal Service	14889	4	1.0	4
Sales	14500	5	0.6	6
Operative and Assembly	14440	6	0.7	5
Clerical and Secretarial	10831	7	0.3	8
Other Manuals	8100	8	0.5	7
Managers and senior administrators	7436	9	0.2	9
TOTAL	159081		0.8	

Table 3.13: Occupational distribution of internal skill gaps and ratios of internal skill gaps to total employment, 2001

ranked by total number of internal skill gaps

	Est. number of internal skill gaps (individuals lacking full proficiency)	Ranking	Total internal skill gaps as percent of total employment	Ranking
Sales	288769	1	11.2	3
Clerical and Secretarial	284886	2	9.1	5
Operative and Assembly	256701	3	11.8	1
Managers and Snr. Administrators	230457	4	7.3	9
Professionals	197390	5	7.4	8
Other Manuals	194987	6	11.4	2
Personal Service	163457	7	11.0	4
Craft and Skilled	154285	8	8.2	6
Associate professionals	138328	9	8.2	7
TOTAL	1909261		9.3	

Table 3.14: Sectoral distribution of internal skill gaps and ratios of internal skill gaps to total employment, 2001

	Est. number of internal skill gaps (individuals lacking full proficiency)	Ranking	Internal skill gaps as a percentage of total employment	Ranking
Manufacturing	392933	1	11.2	3
Wholesale, retail	349936	2	9.6	5
Business services	255049	3	8.3	7
Health and social work	175364	4	8.2	8
Public administration	140801	5	12.0	1
Hotels and restaurants	126179	6	11.2	2
Transport and communication	113104	7	9.4	6
Education	96794	8	6.4	11
Finance	91543	9	10.1	4
Other community	73502	10	7.6	9
Construction	69040	11	7.6	10
TOTAL	1909261		9.3	

3.5 Comparison of ESS vacancies with Employment Service vacancies

The ESS dataset also provides a means of checking the extent to which vacancies reported to the Employment Service are representative of the economy as a whole. The most readily available data for present purposes are for 1999; there is no reason to believe that more recent data would tell a different story. Table 3.15 shows that the total number of unfilled vacancies reported to the Employment Service (ES) in July 1999 was less than half that estimated to be in existence in establishments with five or more employees at the time of the ESS1999 survey. Furthermore, the occupational distribution of vacancies reported to the Employment Service differed sharply from that in the surveyed establishments with larger proportions of unfilled positions in personal service and other manual occupations and smaller proportions of associate professional, professional, managerial and sales positions. The only occupation for which the total number of ES vacancies roughly corresponded to the ESS total was other manual occupations (Table 3.15, Column 3). Even in personal service occupations the total number of ES vacancies was only 71% of the estimated ESS total.

Table 3.15: Occupational distribution of unfilled vacancies reported to the Employment Service and those reported by ESS establishments, 1999

	Employment Service (ES), England, July 1999 Unfilled vacancies	ESS 1999 estimates Total unfilled vacancies (a)	Ratio of ES:ESS vacancies
Est. total no. of vacancies	248828	557658	0.45
	Percent of vacancies		
Managers/senior administrators	4	7	0.25
Professional	1	6	0.07
Associate professional/technical	3	11	0.12
Clerical/secretarial	14	16	0.39
Craft and skilled	10	8	0.56
Personal service	24	15	0.71
Sales	14	19	0.33
Operative and assembly	10	11	0.41
TOTAL	100	100	

Note: (a) ESS-based estimates for 1999 refer to establishments with 5 or more employees.

One inference from this is that it is only useful to compare trends in Employment Service vacancies against those found in successive ESS surveys in occupational areas in which vacancies are commonly reported to the Employment Service (which means, in particular, that managerial, professional and associate professional occupations should be excluded). Even if this is done, the differences in the two datasets warrant a full investigation at regional level before any firm conclusions of a comparative nature are drawn.

3.6 Comparisons with CBI and BCC surveys

Clearly, the two Employers Skills Surveys to date shed only limited light on trends over time in the incidence of skill deficiencies. For evidence on this score, the two main data series available are published by the Confederation of British Industry (CBI) and the British Chambers of Commerce (BCC). As described above (Section 3.2), the CBI's quarterly Industrial Trends Survey asks employers to indicate whether skilled labour is likely to limit their output in the following four-month period. The two main disadvantages of the CBI survey are, firstly, the ambiguity in its skill question about whether it refers to skill-related recruitment difficulties or internal skill gaps (see Section 3.2 above); and secondly, the fact that it is largely confined to manufacturing (with the exception of small numbers of respondents in mining and printing & publishing). However, it does offer a useful 30 year perspective on trends in skill deficiencies.

As Figures 1 and 4 in Frogner (2002) show, the reported incidence of skilled labour

constraints in the CBI survey has risen rapidly during periods of rapid economic growth and falling unemployment while reaching its lowest levels during peak periods of unemployment such as in the early 1980's and early 1990's. In the current business cycle, the proportion of manufacturing respondents citing such constraints has been on a rising trend from late 1999 to late 2001 but is still some way below earlier peaks in 1988-89 and 1978-79.

Detailed analysis of CBI survey data by BSL (1999) suggests that this trend decline in reported skill problems may owe more to the decline in manufacturing output and employment over the period than to any improvement in the workings of the labour market. Indeed, their statistical evidence suggests that periodic increases in the proportion of employers reporting skill problems since the 1960's may have actually contributed to subsequent falls in output and employment.

Frogner (2002) also provides a detailed description of BCC survey data on skill shortages and compares them with CBI data. Although the BCC survey has the merit of covering service industries as well as manufacturing, its questions about difficulties in recruiting different types of labour (skilled manual, professional/managerial, clerical and un/semi-skilled) do not enable researchers to distinguish between recruitment problems which reflect a shortage of suitably skilled or qualified applicants and those which are due to other reasons such as low pay. [16]

3.7 Combining different measures of skill deficiency

Given the different nature of the problems associated with skill-shortage vacancies as compared to internal skill gaps – in particular, the differences between them in the occupational areas which are most affected – we advise against the development of 'combined' measures of skill deficiencies which tend to conceal those differences. We also caution against combining different measures in a way that leads to 'double-counting', for example, combining a sectoral ranking of hard-to-fill vacancy densities with a ranking of skill-shortage vacancy densities (since clearly skill-shortage vacancies are a subset of all hard-to-fill vacancies).

At most we suggest that it might be useful to show the proportions of establishments in each sector, region or size-group which report *both* skill-shortage vacancies and internal skill gaps (narrow definition) alongside figures for those which report only one of these types of problem. Table 3.16 shows that, in relation to sectors, the degree of overlap between the two types of problem is very small. The proportion of establishments reporting neither of these problems ranges from 86% in public administration and manufacturing to 93% in construction and in other community services (Column 4). Similar tables could be prepared for comparisons of regions and size-groups. In the case of occupations, any comparisons would of course have to be confined to establishments reporting employment in each occupational area.

[16] In Frogner (2002, Table 2) it is stated that the BCC data are the percentage balances of respondents claiming higher levels of recruitment difficulties less respondents claiming lower levels. However, the BCC point out that their recruitment difficulties data actually refer to the percentage of those firms attempting to recruit last quarter who reported difficulties in doing so (BCC, private communication).

The measure shown in Table 3.16 has the same shortcomings as all establishment-based measures in that equal weighting is given to each establishment regardless of its size. Hence, it may be useful to analyse the incidence of both types of skill deficiency by size group as well as sector or region – but this level of detail is probably best reserved for individual sector or regional studies rather than for sectoral or regional comparisons.

In respect of employee-based measures of the incidence of skill problems, it might be useful to combine skill-shortage vacancy and internal skill gap density and ranking measures on the same table for sectoral or regional comparisons but, again, we warn against combining them into a single measure of any kind.

Table 3.16: Proportions of establishments reporting either skill-shortage vacancies or internal skill gaps (a) or both types of skill deficiency, 2001, analysed by sector

Ranked by proportion of establishments reporting at least one kind of skill deficiency

	Establishments reporting skill-shortage vacancies AND internal skills gap in at least one occupational area	**Establishments reporting skill-shortage vacancies but NO internal skills gap**	**Establishments reporting internal skills gap but NO skill-shortage vacancies**	**Establishments reporting NEITHER skill-shortage vacancies nor internal skills gap**	**TOTAL**
	Percent of establishments				
Manufacturing	1.1	3.3	9.2	86.4	100
Construction	1.0	2.4	3.8	92.8	100
Wholesale, retail	0.3	2.2	6.5	91.0	100
Hotels and restaurants	0.5	2.5	8.6	88.4	100
Transport and communication	0.6	3.5	5.0	90.9	100
Finance	1.9	1.8	8.0	88.4	100
Business services	0.4	4.6	6.0	89.0	100
Public administration	1.8	2.5	10.0	85.6	100
Education	0.9	4.0	7.1	88.0	100
Health and social work	0.7	3.6	7.9	87.9	100
Other community	0.4	2.6	4.4	92.6	100
TOTAL	0.6	3.1	6.3	90.1	100

Note: (a) Refers to establishments reporting that, in at least one occupational area, 'over half' or fewer employees were fully proficient.

3.8 Forward-looking indicators of skill deficiency

A notable feature of the main measures of skill deficiency identified through the ESS is that only relatively small proportions of establishments are affected. In the 1999 ESS (but not in 2001) some forward-looking questions were asked about product

strategy and associated skill requirements, and these questions succeeded in capturing the types of skill issues confronting many establishments which did not report either skill-shortage vacancies or internal skill gaps.

For example, Table 3.17, Column 1 shows the proportion of private sector establishments which said that the following statement was either 'very' or 'fairly applicable' to them:
'We are implementing, or are about to implement, plans to move into new, higher quality product or service areas with higher profit margins'

The proportion of establishments so responding ranged from 45% in financial services down to 24% in private health and social work establishments. Column 2 of this table then shows the large proportions of establishments moving up-market in each sector which required at least one new or additional skill in order to do so.

Table 3.17: Proportion of establishments requiring new or additional skills in order to move into new higher quality product/service areas, 1999, analysed by sector [private sector establishments only]

Ranked by proportion of establishments planning to move into higher quality product/ service areas

	Percent of all establishments intending to move into higher quality product/ service areas	**Percent of all establishments moving into higher quality product/ service areas who will require new or additional skills for this purpose**
Finance	45	95
Business services	44	95
Wholesale, retail	41	94
Manufacturing	41	93
Hotels and restaurants	38	93
Other community	36	95
Education	35	97
Construction	33	93
Health and social work	24	96
TOTAL	39	94

Analysis of forward-looking questions of this kind – including the responses about what *types* of new or additional skill were required – can potentially add greatly to knowledge and understanding of the skill issues confronting different sectors and regions. We recommend that questions of this kind be restored to future Employer Skills Surveys for several reasons:

- They complement backward-looking questions and questions focussed on short-term indicators of skill deficiencies (e.g., skill-shortage vacancies at the time of the survey)
- Policy-makers need information about enterprises' future plans to help guide decisions regarding future skills and training initiatives

- Careful design of forward-looking questions can reduce the element of speculation involved, for example, asking about future plans to introduce new products/services or upgrade the quality of existing products *before* asking about new or additional skill requirements associated with implementing those plans
- The forward-looking skill needs questions can be based on a much larger proportion of survey respondents than are picked up by the skill-shortage vacancy and internal skill gap questions

3.9 Conclusions

The advantages and disadvantages of using establishment-based and employee-based measures of skill deficiencies are best summarised in Table 3.18.

Caution should be exercised in combining different measures of skill deficiency obtained from the ESS, partly because of the very different nature and impact of skill-shortage vacancy problems and internal skill gaps, and partly because of the risk of double-counting of different kinds.

It is hard to compare ESS findings against CBI quarterly survey data because the CBI survey question conflates skill-shortage vacancies and internal skill gaps. The CBI survey is also largely confined to manufacturing. However, it does provide a valuable 30 year perspective on trends in skill problems which can not be obtained from any other source.

Finally, we suggest that forward-looking survey questions can provide useful information for policy-makers about enterprises' intentions with regard to product/service innovation and upgrading of product/service quality and the new or additional skills which will be required to bring such plans to fruition.

Table 3.18: Comparison of establishment-based and employee-based measures of skill deficiencies

	SECTORS, REGIONS AND SIZE-GROUPS	OCCUPATIONS
ESTABLISHMENT-BASED MEASURES		
When/how to use	Simple ways of showing % of establishments affected by particular problem.	Can only be used after first identifying proportion of establishments which report employment in each occupational area.
Main advantages/ disadvantages	Easily understood by general audience. Useful as preliminary indicators of incidence of skill problems but tend to be dominated by small establishments. Don't convey much information about extent and seriousness of problems	(Same as for sectors, regions and size-groups)
Other considerations	Alternative employment-weighted measures may be dominated by large establishments. Much harder for general audience to understand what employment-weighted measure means.	(Same as for sectors, regions and size-groups)
EMPLOYEE-BASED MEASURES		
When/how to use	Whenever wish to clearly show where different kinds of skill problem are concentrated and how acute they are.	(Same as for sectors, regions and size-groups)
Main advantages/ disadvantages	Straightforward way of showing the scale of particular skill problems (numbers of employees affected in each category) and just how serious such problems are (relative to total employment in each category)	(Same as for sectors, regions and size-groups)
Other considerations	Particularly valuable for contrasting differences in extent, nature and proportionate impact of skill-shortage vacancies and internal skill gaps. Also valuable for assessing differences in extent and relative importance of vacancies, hard-to-fill vacancies and skill-shortage vacancies.	(Same as for sectors, regions and size-groups)

4. PERSISTENCE OF SKILL DEFICIENCIES ACROSS SECTORS, 1999-2001

John Forth and Geoff Mason (NIESR)

4.1 Introduction

Both the Employers Skills Surveys in 1999 and 2001 have shown marked disparities between sectors in the reported incidence of skill-shortage vacancies and internal skill gaps. The aim of this chapter is to assess whether, and to what extent, different kinds of skill deficiency were persistent at sectoral level between 1999-2001. Since ESS 1999 was confined to establishments with 5 or more employees and excluded the agricultural sector, the comparisons between the two surveys presented here necessarily exclude establishments with 1-4 employees as well as all agricultural establishments.

In what follows '*skill-shortage vacancies*' refer to unfilled jobs at the time of interview which were described by survey respondents as 'hard-to-fill' for at least one of the following reasons: 'Low number of applicants with the required skills'; 'Lack of work experience the company demands'; 'Lack of qualifications the company demands'. Employee-based estimates of the total number of '*internal skill gaps*' refer to all employees who were described by survey respondents as lacking 'full proficiency' in their current jobs. Establishments themselves are defined as having an internal skill gap if it was reported that, in at least one occupational area, 'over half' or fewer employees were fully proficient. [17]

Hogarth et al (2001) briefly summarise the main points of contrast between the two surveys in terms of the reported incidence of skill-shortage vacancies and internal skill gaps. As Table 4.1 shows, the proportion of establishments reporting at least one skill-shortage vacancy declined from 8% in 1999 to 6% in 2001. The proportion of establishments reporting an internal skills gap in at least one occupational area declined from 20% to 16%.

In 2001 there was an increase in the density of skill-shortage vacancies in professional occupations compared to 1999. However, the highest-ranked occupations in terms of skill-shortage vacancies in 2001 were the same as in 1999: associate professionals and skilled trades people. The types of skills most commonly sought in connection with skill-shortage vacancies – technical and practical, communication and customer-handling skills – were also fairly similar in both years (Hogarth et al, 2001, Figure 6.8).

[17] This is the so-called 'narrow' definition of internal skill gaps at establishment level; see Forth, Mason and Stevens (2003; Chapter 3 in this volume) for further discussion about skill gap definitions.

Table 4.1: Incidence of vacancies, hard-to-fill vacancies, skill-shortage vacancies and internal skill gaps in ESS99 and ESS01

	% of all establishments reporting	No. of vacancies (a) (000s)	% change in no. of vacancies 1999-2001
1999			
All vacancies	32	558	
Hard-to-fill vacancies	16	247	
Skill-shortage vacancies	8	102	
Internal skill gaps	20		
2001			
All vacancies	27	532	-4.7
Hard-to-fill vacancies	14	232	-6.1
Skill-shortage vacancies	6	94	-7.8
Internal skill gaps	16		

Source: Hogarth et al (2001) Tables 2.1 and 6.9
Base: All establishments with 5 or more employees, excluding agricultural sector

In the case of internal skill gaps, the occupations most affected tended to be the lower-skill categories in both surveys (that is, personal service and sales occupations, process and machine operators and elementary occupations) but with some changes in ordering. Whereas sales occupations registered the highest proportion of internal skill gaps in 1999, the later survey found elementary occupations (typically involving routine tasks) to have the highest proportion of internal skill gaps (ibid).

At a broad sectoral level the great majority of sectors experienced a decline in the ratio of skill-shortage vacancies to total employment between 1999-2001. The only exceptions identified by Hogarth et al (2001, Table 6.5) are Business services where this ratio rose from 0.8% to 1.0% over the period and Public administration (up from 0.1% to 0.2%). In the case of internal skill gaps, the equivalent ratio declined or remained constant in all but two sectors: Hotels and restaurants (up from 4.5% to 6.6%) and Construction (up from 3.6% to 3.9%).

The aim of this chapter is to examine the trends in persistence of skill deficiencies across sectors at a more disaggregated level. In doing so we are limited by the need for each sectoral sub-sample to have sufficient observations for estimates of proportions of establishments and employee ratios to have a reasonable level of precision (for example, a coefficient of variation of 20% or less). In the case of sub-samples which exclude establishments with less than 5 employees, Forth (2003; Chapter 2 in this volume) suggests that a minimum cell size of 400 observations is likely to be necessary (and usually sufficient) to meet this criterion. Accordingly, we have defined 32 sectors which, with a small number of exceptions, are all represented by 400 or more establishments in both surveys or come very close to it

(Table 4.2). The noteworthy exceptions are Postal and telecommunications services and Auxiliary transport services which had sufficient observations in ESS 2001 but fell short of the threshold in 1999; greater caution is therefore attached to the estimates relating to these two sectors.

The chapter is ordered as follows: Section 4.2 assesses the degree of persistence between sectors in respect of skill-shortage vacancies. Section 4.3 does the same for internal skill gaps. Section 4.4 reports on the proportions of establishments in each sector which reported at least one of these two kinds of skill deficiency in the two survey years. Section 4.5 investigates changes in the occupational distribution of reported skill deficiencies in three broadly-defined sectors – manufacturing, private services and public services – for which there are sufficient observations of establishments reporting skill deficiencies to permit further analysis. Section 4.6 concludes.

4.2. Persistence of skill-shortage vacancies across sectors

4.2.1 Establishment-based measure of the incidence of skill-shortage vacancies

Table 4.3 shows that the great majority of the 32 sectors recorded declines in the proportion of establishments reporting at least one skill-shortage vacancy in 2001 compared to 1999. However, these reductions were only statistically significant at the 5% level or better in ten of the 32 sectors.[18] At the same time three sectors recorded statistically significant increases:

- 'Technical business services' (that is, architectural and engineering activities and related technical consultancy; technical testing and analysis), up from 6.5% of establishments to 15.1%
- General secondary education (up from 6.6% to 12.9%)
- Public administration (up from 3.0% to 5.7%)

As a result the first two of these sectors – which were only 23rd and 24th respectively in the rankings in 1999 -- shot up to second and third most affected sectors in 2001 (Table 4.3, Columns 5 and 6).

In other respects the ranking is moderately stable between the two years (Spearman r=0.56). The decline in the proportion of Computer services establishments reporting skill-shortage vacancies is not statistically significant and it remains the most affected sector in 2001 as in 1999. Other sectors staying in the top six most affected on this measure in both years are Electrical, electronic and instrument engineering and Legal, accounting, auditing, business and management consultancy services.

[18] Unless otherwise stated, all references to statistical significance in the text refer to the 5% level or better.

Table 4.2: Profile of ESS samples and estimated populations of establishments

Industry sector	ESS99 No. of establish-ments (un-weighted)	ESS01 No. of establish-ments (un-weighted)	ESS99 No. of Weighted establish-ments	ESS01 No. of Weighted establish-ments	ESS99 % of weighted establish-ment count	ESS01 % of weighted establish-ment count
Food, drink and tobacco	436	369	4966	5119	0.9	0.9
Printing, publishing, recorded media	563	483	9313	11514	1.7	2.0
Chemicals, rubber and plastics	646	490	8039	7373	1.5	1.3
Fabricated metal products	961	629	10301	12014	1.9	2.1
Electrical, electronic and instrument engineering	940	379	7420	8846	1.4	1.5
Mechanical engineering, vehicles and other engineering	1429	750	13246	12967	2.5	2.2
Other manufacturing industries	1199	802	18831	18182	3.5	3.1
Building of complete constructions; civil engineering	760	984	12730	15579	2.4	2.7
Building installation, building completion and other construction activities	665	852	13033	15132	2.4	2.6
Sales of motor vehicles, parts, fuel	722	378	22446	20266	4.2	3.5
Wholesaling	1096	729	32459	36344	6.1	6.3
Retailing – specialised stores	1800	1043	58601	64880	11.0	11.2
Retailing - non-specialised stores; other retail and repair	1011	733	16587	14696	3.1	2.5
Hotels, motels and other accommodation	687	685	10107	9683	1.9	1.7
Restaurants, canteens, catering	877	1052	17532	18740	3.3	3.2
Bars	769	879	18815	21317	3.5	3.7
Transport services	644	751	14487	12845	2.7	2.2
Postal and telecommunications services	253	396	4233	5082	0.8	0.9
Auxiliary transport activities, travel agents	316	510	6742	9330	1.3	1.6
Financial services, including insurance	1134	690	20620	20402	3.9	3.5
Computer services	405	439	10527	9577	2.0	1.7
Legal, accounting, auditing, business and management consultancy, etc.	685	799	15387	17791	2.9	3.1
Architectural and engineering activities and related technical consultancy; technical testing, analysis	445	508	11592	12017	2.2	2.1
Other business services	1277	1584	37178	46074	7.0	8.0
Public administration	805	516	15203	14807	2.8	2.6
Primary education	479	528	13164	18518	2.5	3.2
General secondary education	622	454	5401	5394	1.0	0.9
Higher education, adult education and other education	440	392	9854	9890	1.8	1.7
Human health activities	1155	873	18120	17489	3.4	3.0
Social work	1627	1382	32632	34493	6.1	6.0
Sporting activities, arenas, stadia	527	562	10457	8583	2.0	1.5
Other service industries	1084	1334	25026	28525	4.7	4.9
Not classified	493	375	8671	14051	1.6	2.4
All establishments (inc industries not available for sector analysis)	**26952**	**23330**	**533723**	**577523**	**100.0**	**100.0**

Table 4.2a: Notes on industrial classification

Industry sector	SIC (1992) codes
Food, drink and tobacco	151-160
Printing, publishing, recorded media	221-223
Chemicals, rubber and plastics	241-252
Fabricated metal products	281-287
Electrical, electronic and instrument engineering	300-335
Mechanical engineering, vehicles and other engineering	271-277, 291-297, 341-355
Other manufacturing industries	171-212, 231-232, 261-268, 361-366, 371-372
Building of complete constructions; civil engineering	452
Building installation, building completion and other construction activities	451, 453-455
Sales of motor vehicles, parts, fuel	501-505
Wholesaling	511-517
Retailing – specialised stores	522-524
Retailing - non-specialised stores; other retail and repair	521, 525-527
Hotels, motels and other accommodation	551-552
Restaurants, canteens, catering	553, 555
Bars	554
Transport services	601-603,611-623
Postal and telecommunications services	641-642
Auxiliary transport activities, travel agents	631-634
Financial services, including insurance	651-652, 660, 671-672
Computer services	721-726
Legal, accounting, auditing activities; tax consultancy; market research and public opinion polling; business and management consultancy; holdings	741
Architectural and engineering activities and related technical consultancy; technical testing, analysis	742-743
Other business services	701-703, 712-721, 730-732, 744-748
Public administration	751-753
Primary education	801
General secondary education	802
Higher education, adult education and other education	803-804
Human health activities	851
Social work	853
Sporting activities, arenas, stadia	926
Other service industries	852, 900,911-913, 921-925, 927, 930

In all, some 18 sectors did not experience any statistically significant change in the proportion of establishments reporting at least one skill-shortage vacancy. The sectors which did record statistically significant declines in the proportions of establishments reporting skill-shortage vacancies comprise a mix of manufacturing, construction and service sectors:

- Mechanical engineering, vehicles and other engineering
- Food, drink and tobacco
- Printing, publishing and recorded media
- Chemicals, rubber and plastics
- Miscellaneous manufacturing activities
- Building installation and completion
- Financial services, including insurance

- Restaurants, canteens, catering
- Retailing – specialised stores
- Public administration
- Miscellaneous service industries

The drops in rankings are particularly sharp for Printing, publishing and recorded media (down from 7th to 29th) and Chemicals, rubber and plastics (down from 13th to 24th). Restaurants, canteens, catering and Food, drink and tobacco also show large drops of, respectively, 13 and 11 places. By contrast, Building installation and completion remains 7th in the ranking in spite of a declining proportion of establishments reporting skill-related recruitment problems.

4.2.2 Employee-based measure of the incidence of skill-shortage vacancies

When we turn to an employee-based measure such as the ratio of skill-shortage vacancies to total employment (also termed the density of skill-shortage vacancies), then technical business services are again prominent, up from 0.6% to 1.9% between the two years and rising from 12th to 1st in the sectoral ranking (Table 4.4). The only other sector to record a statistically significant increase is General secondary education but in absolute terms the density of skill-shortage vacancies in this sector remains comparatively low (ranked 25th in 2001).

In spite of a significant decline of 1 percentage point in its skill-shortage density ratio, building installation and completion falls only two places to third-highest in the rankings. Computer services remains in second place with no significant change in skill-shortage density. Other sectors in the top six in both years are Building of complete constructions (including civil engineering) and Transport services. Overall, the stability of the rankings is slightly greater (Spearman r=0.69) than for the establishment-based measure of the incidence of skill-shortage vacancies.

In total 24 of the 32 sectors did not record any significant change in skill-shortage density ratios between the two surveys. The most prominent decreases apart from that of Building installation and completion are in Restaurants, canteens and catering (down from 0.8% to 0.3% and from 6th to 24th in the rankings) and Printing, publishing and recorded media (down from 0.7% to 0.3% and from 10th to 28th in the rankings).

Table 4.3: Percentage of establishments with skill-shortage vacancies[(a)]

Ranked by incidence of skill-shortage vacancies in ESS 1999

Industry sector	ESS99 Per cent	ESS01 Per cent	ESS01-ESS99 Change (pp)[(a)]		ESS99 Rank	ESS01 Rank
Computer services	17.8	14.9	-3.0		1	1
Building installation, building completion and other construction activities	14.4	9.0	-5.4	***	2	7
Building of complete constructions; civil engineering	11.4	8.3	-3.1	*	3	10
Electrical, electronic and instrument engineering	11.0	10.5	-0.5		4	4
Mechanical engineering, vehicles and other engineering	10.8	6.3	-4.6	***	5	14
Legal, accounting, auditing, business and management consultancy, etc.	10.2	9.2	-1.0		6	6
Printing, publishing, recorded media	10.0	3.3	-6.7	***	7	29
Hotels, motels and other accommodation	9.9	7.4	-2.5		8	11
Other manufacturing industries	9.9	5.8	-4.2	***	9	15
Transport services	9.7	10.0	0.3		10	5
Sales of motor vehicles, parts, fuel	9.4	6.5	-2.9		11	13
Higher education, adult education and other education	9.0	8.9	-0.1		12	8
Chemicals, rubber and plastics	8.6	4.5	-4.1	**	13	24
Human health activities	8.2	7.3	-0.9		14	12
Fabricated metal products	7.8	8.4	0.6		15	9
Other service industries	7.7	4.6	-3.0	***	16	22
Financial services, including insurance	7.6	4.6	-3.0	**	17	23
Restaurants, canteens, catering	7.3	3.1	-4.2	***	18	31
Food, drink and tobacco	7.2	3.2	-4.0	**	19	30
Wholesaling	7.1	5.3	-1.8		20	17
Postal and telecommunications services	7.1	5.2	-1.9		21	18
Auxiliary transport activities, travel agents	6.7	5.1	-1.6		22	20
General secondary education	6.6	12.9	6.3	***	23	3
Architectural and engineering activities and related technical consultancy; technical testing, analysis	6.5	15.1	8.6	***	24	2
Other business services	6.3	4.9	-1.5		25	21
Social work	6.2	5.2	-1.1		26	19
Sporting activities, arenas, stadia	5.9	3.8	-2.2		27	26
Bars	5.8	4.5	-1.3		28	25
Retailing – specialised stores	5.5	3.6	-2.0	**	29	28
Retailing - non-specialised stores; other retail and repair	5.4	3.6	-1.8		30	27
Primary education	3.5	2.6	-1.0		31	32
Public administration	3.0	5.7	2.7	**	32	16
All establishments (inc industries not available for sectoral analysis)	7.7	5.9	-1.8	***	-	-

Notes: (a) *** indicates 1999-2001 difference is statistically significant at 1% level, ** 5% level and* 10% level
(b) Sectoral rankings, 1999-2001: Spearman rank correlation = 0.56 ***

Table 4.4: Skill-shortage vacancies as percent of total employment[(a)]

Ranked by density of skill-shortage vacancies in ESS 1999

Industry sector	ESS99 Per cent	ESS01 Per cent	ESS01-ESS99 Change (pp)[(a)]		ESS99 Rank	ESS01 Rank
Building installation, building completion and other construction activities	2.2	1.2	-1.0	***	1	3
Computer services	1.7	1.4	-0.2		2	2
Building of complete constructions; civil engineering	1.5	0.9	-0.6	*	3	4
Transport services	1.0	0.8	-0.2		4	6
Sales of motor vehicles, parts, fuel	0.9	0.7	-0.2		5	8
Restaurants, canteens, catering	0.8	0.3	-0.5	***	6	24
Other service industries	0.7	0.5	-0.3	*	7	16
Other business services	0.7	0.6	-0.1		8	10
Bars	0.7	0.5	-0.2		9	14
Printing, publishing, recorded media	0.7	0.3	-0.4	**	10	28
Legal, accounting, auditing, business and management consultancy, etc.	0.6	0.8	0.2		11	5
Architectural and engineering activities and related technical consultancy; technical testing, analysis	0.6	1.9	1.2	***	12	1
Retailing - specialised stores	0.6	0.4	-0.2	*	13	19
Electrical, electronic and instrument engineering	0.6	0.8	0.2		14	7
Wholesaling	0.6	0.5	-0.1		15	12
Social work	0.6	0.5	-0.1		16	13
Other manufacturing industries	0.6	0.4	-0.2		17	18
Sporting activities, arenas, stadia	0.6	0.4	-0.2		18	20
Postal and telecommunications services	0.6	0.3	-0.3		19	26
Human health activities	0.5	0.7	0.2		20	9
Hotels, motels and other accommodation	0.5	0.5	-0.1		21	17
Financial services, including insurance	0.5	0.3	-0.2		22	23
Auxiliary transport activities, travel agents	0.4	0.4	-0.1		23	21
Fabricated metal products	0.4	0.6	0.2		24	11
Mechanical engineering, vehicles and other engineering	0.4	0.3	-0.1	**	25	27
Higher education, adult education and other education	0.4	0.5	0.1		26	15
Chemicals, rubber and plastics	0.3	0.2	-0.2	**	27	31
Primary education	0.3	0.2	-0.1		28	30
Retailing - non-specialised stores; other retail and repair	0.3	0.1	-0.1	**	29	32
Food, drink and tobacco	0.2	0.4	0.2		30	22
Public administration	0.1	0.2	0.1		31	29
General secondary education	0.1	0.3	0.2	***	32	25
All establishments (inc industries not available for sectoral analysis)	0.6	0.5	-0.1	**	-	-

Notes: (a) *** indicates 1999-2001 difference is statistically significant at 1% level, ** 5% level and * 10% level
(b) Sectoral rankings, 1999-2001: Spearman rank correlation = 0.69 ***

4.3. Persistence of internal skill gaps across sectors

4.3.1 Establishment-based measure of the incidence of internal skill gaps

In general the persistence of internal skill gaps across sectors was greater than for skill-shortage vacancies. As Table 4.5 shows, only 11 out of the 32 recorded statistically significant changes in the proportion of establishments reporting an internal skill gap and these changes were only significant at the 5% level or better in six sectors. The top four sectors on this measure of skill shortcomings in 1999 remained in the top four in 2001:

- Restaurants, canteens, catering
- Hotels, motels and other accommodation
- Food, drink and tobacco
- Chemicals, rubber and plastics

In addition, the stability of the sectoral rankings for this establishment-based measure of internal skill gaps was slightly greater than for the equivalent skill-shortage vacancy measure (Spearman r=0.64). No sector recorded a statistically significant increase. However, as noted, six sectors show decreases which are statistically significant at the 5% level. Four of these sectors shot down the rankings as a result:

- Auxiliary transport activities, travel agents (down from 8th to 29th)
- Retailing – specialised stores (down from 10th to 21st)
- Wholesaling (down from 11th to 18th)
- Other service industries (down from 12th to 28th)

The remaining two sectors – Other business services and Legal, accounting, auditing, business and management consultancy etc – were already positioned relatively low in the rankings.

4.3.2 Employee-based measure of the incidence of internal skill gaps

The impression of stability in the sectoral incidence of internal skill gaps is even greater when considering the employee-based measure. Of the 32 sectors, 22 recorded no statistically significant change in the density of internal skill gaps (Table 4.6). The top three sectors – Food, drink and tobacco; Restaurants, canteens and catering; and Hotels, motels and other accommodation – stay in their respective positions. The two retailing sectors and the Chemicals, rubber and plastics sector also stay well towards the upper end of the ranking in both surveys. Overall, the correlation between the sectoral rankings in the two surveys is higher than for any of the other skill deficiency measures considered in this chapter (Spearman r=0.84).

No sectors recorded statistically significant increases in the density of internal skill gaps but Postal and telecoms services rose from 20th to 6th in rankings between 1999-2001 even though the rise in its density ratio was not statistically significant. Of the ten sectors which experienced significant declines in the proportion of employees lacking full proficiency, the biggest changes – showing drops of 2-3 percentage points in the density ratios -- were in:

- Retailing – specialised stores (down from 4th to 11th in the rankings)
- Financial services, including insurance (down from 7th to 12th)
- Bars (down from 10th to 19th)
- Transport services (down from 15th to 26th)

4.4. Persistence of skill deficiencies: measures combining skill-shortage vacancies and internal skill gaps

One way to gauge the incidence of skill deficiencies is to consider the proportion of establishments which have at least one skill-shortage vacancy *or* an internal skill gap in at least one occupation *or* fit into both categories. On this measure the sectoral rankings in both survey years were largely dominated by sectors which had an above average incidence of one or other type of skill deficiency, for example, Computer services which is strongly affected by skill-shortage vacancies and Restaurants, canteens, catering and Chemicals, rubber and plastics which rank highly in terms of internal skill gaps (Table 4.7). The one sector that stands out as experiencing above-average problems with both skill-shortage vacancies and internal skill gaps is Electrical, electronic and instrument engineering: its combined ratio of 30% of establishments reporting one or other kind of skill problem in 1999 was third-highest in that year; in 2001 it was 7th in the rankings.

Of the 32 sectors, some 21 show no statistically significant change between the two survey years. But a few sectors did experience very large changes in this measure of skill problems which contributed to very sharp movements up and down the sectoral rankings. In technical business services (architectural and engineering activities and related technical consultancy; technical testing and analysis) the combined incidence of skill-shortage vacancies and internal skill gaps rose by almost ten percentage points and the sector's place in the rankings rose from 31st to 2nd. At the same time three sectors experienced *de*creases of 11-12 percentage points in this ratio:

- Printing, publishing and recorded media (down from 7th to 29th)
- Auxiliary transport activities, travel agents (down from 9th to 31st)
- Miscellaneous service industries (down from 14th to 30th)

As a result of these and other changes, the sectoral rankings on this combined measure of skill problems are considerably less stable between the two survey years than for more specific measures of skill deficiencies (Spearman r=0.46).

Table 4.5: Percentage of establishments with internal skill gaps [(a)]

Ranked by incidence of internal skill gaps in ESS 1999[(a)]

Industry sector	ESS99 Per cent	ESS01 Per cent	ESS01-ESS99 Change (pp) [(b)]		ESS99 Rank[(c)]	ESS01 Rank[(c)]
Restaurants, canteens, catering	25.0	21.9	-3.1		1	4
Hotels, motels and other accommodation	24.0	22.4	-1.6		2	3
Food, drink and tobacco	24.0	24.2	0.2		3	2
Chemicals, rubber and plastics	23.5	26.8	3.3		4	1
Postal and telecommunications services	23.5	18.3	-5.2		5	8
Electrical, electronic and instrument engineering	23.2	18.3	-4.9		6	7
Retailing - non-specialised stores; other retail and repair	22.8	17.8	-5.0	*	7	11
Auxiliary transport activities, travel agents	21.6	11.7	-9.9	***	8	29
Retailing - specialised stores	21.2	14.6	-6.6	***	10	21
Wholesaling	21.0	15.6	-5.4	**	11	18
Other service industries	21.0	11.8	-9.2	***	12	28
Computer services	21.6	16.2	-5.4		9	16
Fabricated metal products	20.7	17.0	-3.8		13	13
Other manufacturing industries	20.7	19.1	-1.6		14	6
Sporting activities, arenas, stadia	20.6	17.8	-2.8		15	12
Bars	20.5	16.3	-4.2		16	15
Printing, publishing, recorded media	20.5	14.4	-6.0	*	17	23
Mechanical engineering, vehicles and other engineering	20.4	19.7	-0.7		18	5
Sales of motor vehicles, parts, fuel	19.9	18.2	-1.7		19	9
Financial services, including insurance	19.8	15.2	-4.6	*	20	19
Public administration	19.3	15.1	-4.3		21	20
Transport services	18.9	13.8	-5.0	*	22	26
Other business services	18.6	14.4	-4.2	**	23	24
General secondary education	18.4	14.2	-4.2		24	25
Social work	17.3	16.4	-0.8		25	14
Higher education, adult education and other education	17.1	11.1	-6.0	*	26	30
Architectural and engineering activities and related technical consultancy; technical testing, analysis	16.3	17.9	1.6		27	10
Building installation, building completion and other construction activities	16.1	14.6	-1.5		28	22
Building of complete constructions; civil engineering	15.7	15.7	0.0		29	17
Legal, accounting, auditing, business and management consultancy, etc.	15.3	9.6	-5.8	**	30	31
Human health activities	14.9	12.4	-2.4		31	27
Primary education	11.9	8.3	-3.5		32	32
All establishments (inc industries not available for sectoral analysis)	19.7	15.6	-4.1	***	-	-

Notes: (a) Establishments are defined as having an internal skill gap if it was reported that, in at least one occupational area, 'over half' or fewer employees were fully proficient.

(b) *** indicates 1999-2001 difference is statistically significant at 1% level, ** 5% level and * 10% level

(c) Sectoral rankings, 1999-2001: Spearman rank correlation = 0.64 ***

Table 4.6: Internal skill gaps as percent of total employment [a]

Ranked by density of internal skill gaps in ESS 1999

Industry sector	ESS99 Per cent	ESS01 Per cent	ESS01-ESS99 Change (pp)[a]		ESS99 Rank[b]	ESS01 Rank[b]
Food, drink and tobacco	14.9	14.4	-0.4		1	1
Restaurants, canteens, catering	14.4	13.6	-0.8		2	2
Hotels, motels and other accommodation	13.9	12.9	-0.9		3	3
Retailing - specialised stores	13.5	10.7	-2.8	***	4	11
Chemicals, rubber and plastics	13.5	12.9	-0.6		5	4
Retailing - non-specialised stores; other retail and repair	13.2	12.1	-1.2	*	6	7
Financial services, including insurance	13.1	10.4	-2.7	***	7	12
Electrical, electronic and instrument engineering	12.3	11.8	-0.5		8	8
Mechanical engineering, vehicles and other engineering	11.7	10.9	-0.8		9	10
Bars	11.5	9.5	-2.0	***	10	19
Public administration	11.4	12.1	0.7		11	5
Other manufacturing industries	11.4	11.0	-0.4		12	9
Other business services	11.4	9.9	-1.5	**	13	14
Wholesaling	11.2	9.8	-1.4	**	14	15
Transport services	11.2	8.5	-2.6	***	15	26
Fabricated metal products	11.0	10.2	-0.8		16	13
Sporting activities, arenas, stadia	10.7	9.6	-1.1		17	17
Printing, publishing, recorded media	10.5	9.4	-1.1	*	18	20
Computer services	10.3	9.4	-0.9		21	21
Other service industries	10.4	8.6	-1.9	***	19	24
Auxiliary transport activities, travel agents	10.4	9.6	-0.8		20	16
Higher education, adult education and other education	10.2	8.6	-1.6	*	22	25
Postal and telecommunications services	10.1	12.1	2.0		23	6
Sales of motor vehicles, parts, fuel	9.9	8.1	-1.7	**	24	29
Building of complete constructions; civil engineering	9.9	9.1	-0.7		25	22
Legal, accounting, auditing, business and management consultancy, etc.	9.7	8.3	-1.4	*	26	28
Social work	9.3	9.6	0.3		27	18
Building installation, building completion and other construction activities	9.2	8.4	-0.7		28	27
Architectural and engineering activities and related technical consultancy; technical testing and analysis	8.8	8.8	0.1		29	23
Human health activities	8.5	7.6	-0.9		30	30
General secondary education	8.3	6.5	-1.9	***	31	31
Primary education	6.1	4.6	-1.5	***	32	32
All establishments (inc industries not available for sectoral analysis)	11.1	10.0	-1.1	***	-	-

Notes: (a) *** indicates 1999-2001 difference is statistically significant at 1% level, ** 5% level and * 10% level
(b) Sectoral rankings, 1999-2001: Spearman rank correlation = 0.84 ***

Table 4.7: Percentage of establishments with at least one skill-shortage vacancy or an internal skill gap in at least one occupation or both [(a)]

Ranked by incidence of skill shortage vacancies / internal skill gaps in ESS 1999

Industry sector	ESS99 Per cent	ESS01 Per cent	ESS01-ESS99 Diff[(a)]		ESS99 Rank[(b)]	ESS01 Rank[(b)]
Computer services	32.8	27.6	-5.2		1	3
Restaurants, canteens, catering	30.2	24.0	-6.2	**	2	8
Electrical, electronic and instrument engineering	29.9	25.1	-4.8		3	7
Chemicals, rubber and plastics	29.7	30.2	0.5		4	1
Hotels, motels and other accommodation	29.5	27.0	-2.5		5	4
Postal and telecommunications services	28.9	22.2	-6.7		6	14
Printing, publishing, recorded media	28.0	17.0	-11.1	***	7	29
Mechanical engineering, vehicles and other engineering	27.9	23.6	-4.3		8	9
Auxiliary transport activities, travel agents	27.7	15.5	-12.2	***	9	31
Food, drink and tobacco	27.5	25.9	-1.6		10	5
Other manufacturing industries	27.3	22.5	-4.8	*	11	11
Building installation, building completion and other construction activities	26.9	21.5	-5.3	*	12	16
Retailing - non-specialised stores; other retail and repair	26.8	20.8	-5.9	**	13	17
Other service industries	26.7	15.7	-11.0	***	14	30
Wholesaling	26.7	19.6	-7.0	**	15	21
Sales of motor vehicles, parts, fuel	26.6	22.5	-4.1		16	10
Transport services	26.3	21.7	-4.7		17	15
Fabricated metal products	25.8	22.5	-3.3		18	12
Higher education, adult education and other education	25.3	19.0	-6.3		19	22
Retailing – specialised stores	24.6	17.5	-7.1	***	20	28
Building of complete constructions; civil engineering	24.4	22.5	-1.9		21	13
Financial services, including insurance	24.4	18.4	-5.9	**	22	23
General secondary education	24.2	25.4	1.2		23	6
Sporting activities, arenas, stadia	24.0	20.0	-4.1		24	20
Bars	23.9	20.1	-3.8		25	19
Legal, accounting, auditing, business and management consultancy, etc.	23.3	17.6	-5.8	**	26	27
Other business services	23.1	18.3	-4.8	**	27	26
Social work	21.8	20.4	-1.4		28	18
Public administration	21.4	18.4	-3.0		29	24
Human health activities	20.8	18.3	-2.5		30	25
Architectural and engineering activities and related technical consultancy; technical testing and analysis	20.4	29.9	9.6	**	31	2
Primary education	14.5	9.8	-4.7		32	32
All establishments (inc industries not available for sectoral analysis)	25.1	20.0	-5.0	***		

Notes: (a) *** indicates 1999-2001 difference is statistically significant at 1% level, ** 5% level and * 10% level
(b) Sectoral rankings, 1999-2001: Spearman rank correlation = 0.46 ***

4.5 Changes in occupational distribution of skill-shortage vacancies and internal skill gaps at broad sectoral level

As the sub-samples of establishments reporting skill deficiencies in these 32 sectors are too small to be subjected to further analysis, we conclude by examining the degree of persistence in the occupational distribution of skill deficiencies in three broadly-defined sectors: private sector manufacturing and construction, private services and public sector establishments.

In private manufacturing and construction the proportion of skill-shortage vacancies in craft-skilled occupations dropped from 53% in 1999 to 42% in 2001 but this occupational group remains far and away the worst affected (Figure 4.1). The occupations whose shares of skill-shortage vacancies increased the most between the two survey years were professional occupations and – at the other end of the skill spectrum – operatives.

In private services the proportion of skill-shortage vacancies in professional occupations rises even faster than manufacturing over this time period, up from 8% to 22% (Figure 4.2). In part this must reflect the sharp growth in the incidence of skill-shortage vacancies in technical business services noted in Section 4.3. Two of the three worst affected occupations in 1999 remain in the top three in 2001: associate professionals and sales occupations. The exception is personal and protective occupations whose share of skill-shortage vacancies drops from 16% to 8%.

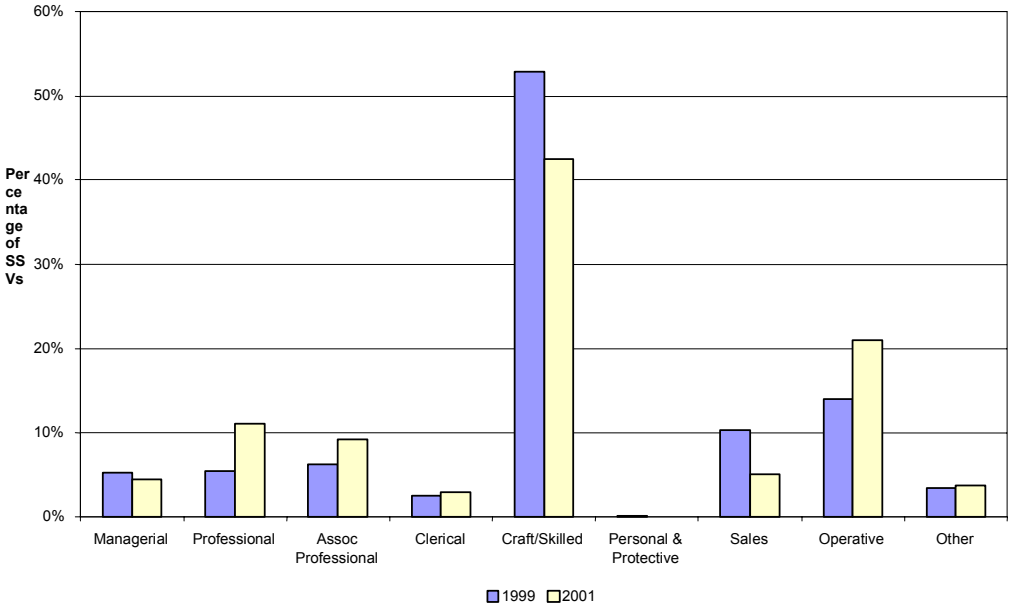
In public sector establishments the occupation most affected by skill-shortage vacancies is associate professionals in both years (38% of the total in 1999, 36% in 2001). Over the two years the professional share of skill-shortage vacancies rises from 14% to 21%, probably due in part to the significant increase in the proportion of establishments in general secondary education reporting skill-shortage vacancies (Table 4.3).

Turning to internal skill gaps, in manufacturing and construction these are heavily concentrated in operative and craft-skilled occupations in both years, in combination representing 54% of all internal skill gaps in 1999 and 57% in 2001 (Figure 4.4). However, the balance shifts towards operators and away from craft workers over this period.

In private services, the occupational group with the largest share of internal skill gaps (sales) remains the same in both survey years and, if we discount the ‘other occupations’ category, so does the ranking of the next three occupations: clerical, personal and managerial and protective occupations (Figure 4.5).

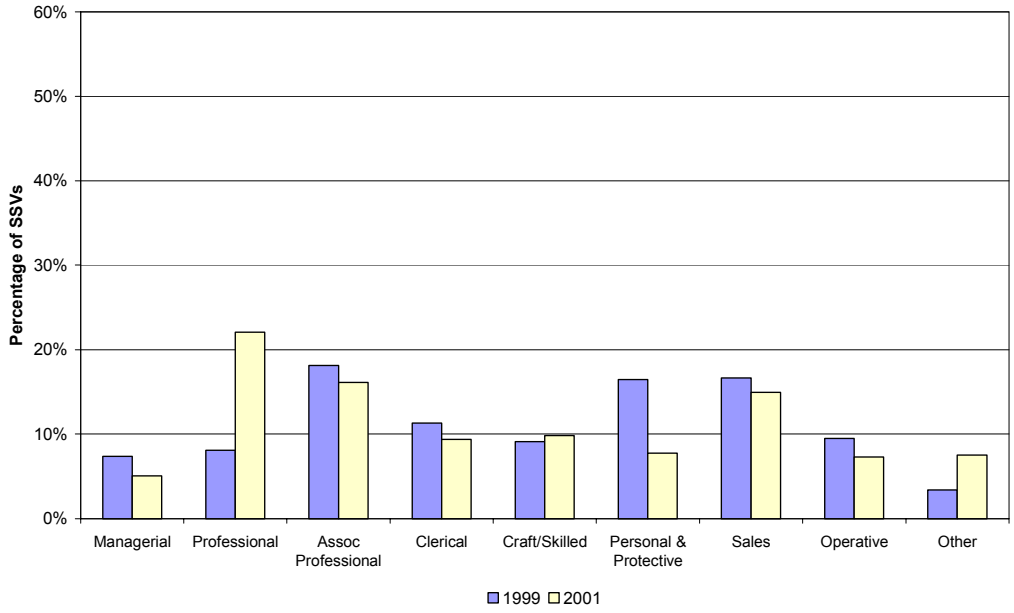
Finally, in public sector establishments we note that the occupation with the largest share of internal skill gaps (clerical) remains the same in both years (Figure 4.6). The next most affected occupational group – professionals—is also the same in both years. In other occupational areas there is a slight shift in the distribution of internal skill gaps from managerial to associate professional occupations.

Figure 4.1: Change in the occupational distribution of skill-shortage vacancies in private sector manufacturing and construction, 1999 and 2001



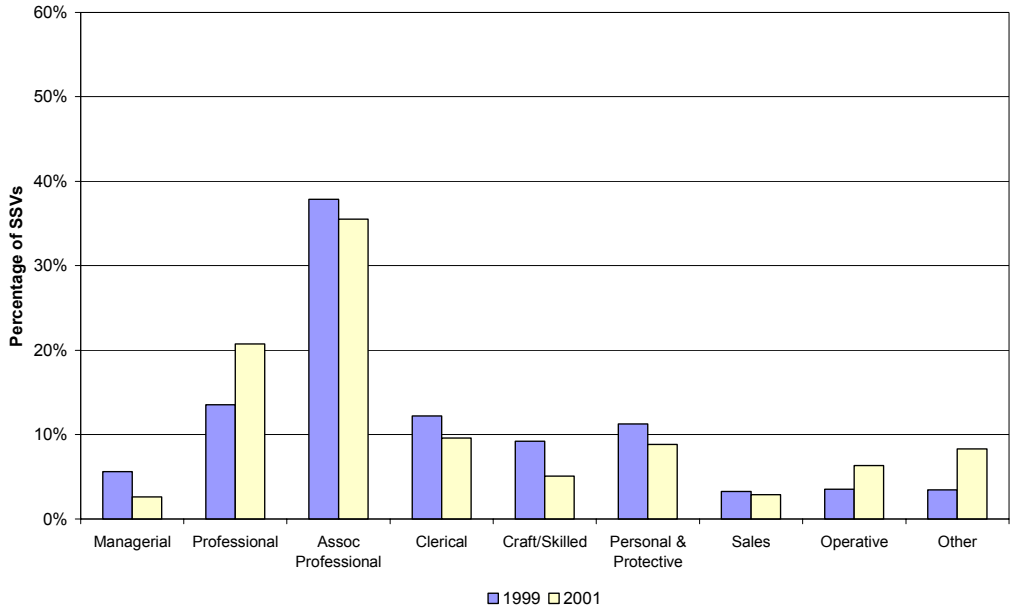
Source: ESS 1999 and ESS 2001

Figure 4.2: Change in the occupational distribution of skill-shortage vacancies in private sector services, 1999 and 2001



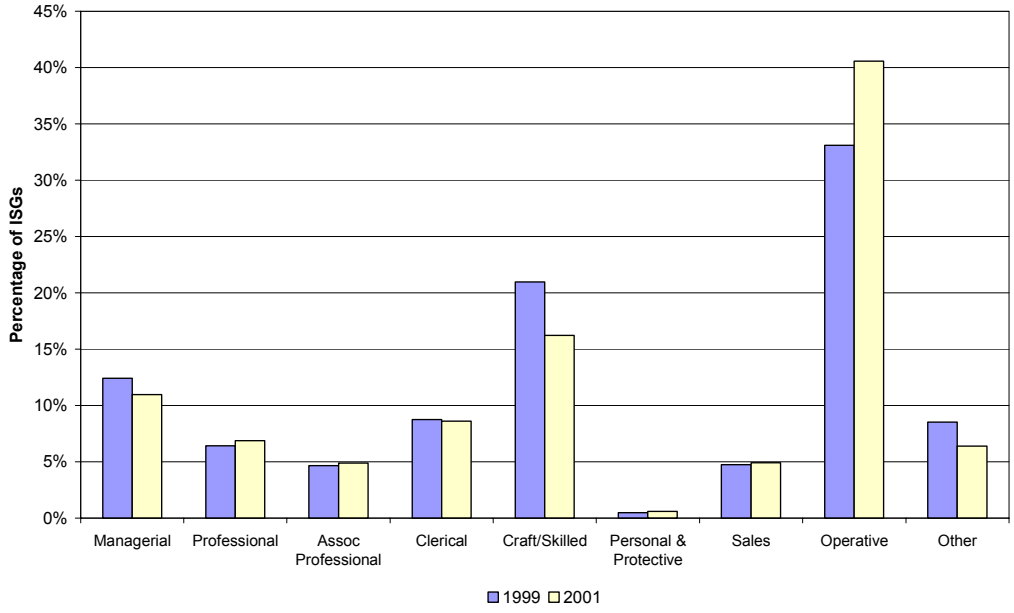
Source: ESS 1999 and ESS 2001

Figure 4.3: Change in the occupational distribution of skill-shortage vacancies in the public sector, 1999 and 2001



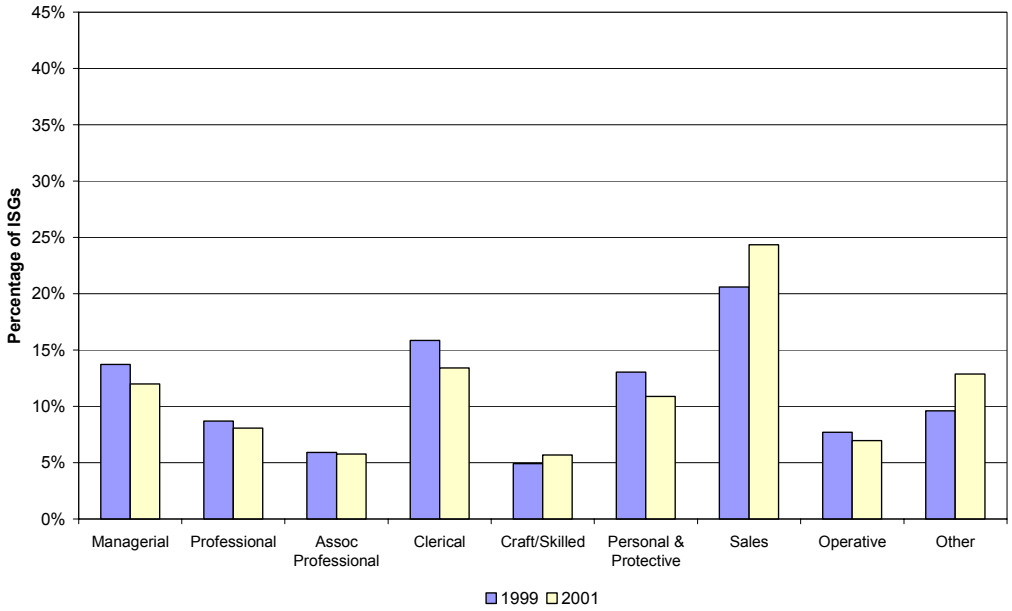
Source: ESS 1999 and ESS 2001

Figure 4.4: Change in the occupational distribution of internal skill gaps in private sector manufacturing and construction, 1999 and 2001



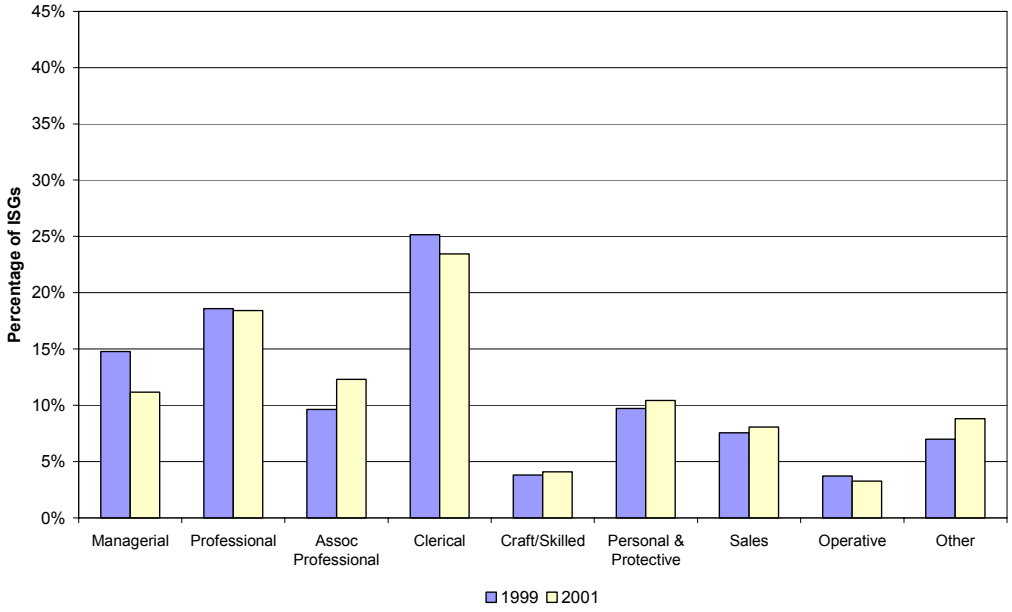
Source: ESS 1999 and ESS 2001

Figure 4.5: Change in the occupational distribution of internal skill gaps in private sector services, 1999 and 2001



Source: ESS 1999 and ESS 2001

Figure 4.6: Change in the occupational distribution of internal skill gaps in the public sector, 1999 and 2001



Source: ESS 1999 and ESS 2001

4.6. Conclusions

This chapter has identified some individual sectors which recorded sharp changes in the incidence of different kinds of skill deficiencies between the two survey years. Prominent examples include the apparent growth in skill-shortage vacancies in Technical business services even while other industries such as Printing, publishing and recorded media and Chemicals, rubber and plastics were experiencing significant declines in the extent of such vacancies. Some sectors also recorded significant falls in the proportion of establishments suffering from internal skill gaps.

However, on balance the analysis points to a great deal of stability in the sectoral incidence of skill deficiencies over the period covered by the two surveys. In the case of skill-shortage vacancies, changes in the establishment-based measure were not statistically significant at the 5% level in 19 of the 32 sectors and this rises to three quarters of all sectors in the case of the employee-based measure (Table 4.8). There is also a notable absence of significant change in internal skill gap measures in the great majority of sectors and the degree of stability in sectoral rankings of the two skill gap measures is greater than was found for skill-shortage vacancy measures.

On another measure of persistence we note that, for both establishment-based and employee-based measures of skill-shortage vacancies and internal skill gaps, 3 or 4 of the top six sectors in 1999 remained in the top six for 2001 and a similar degree of stability is found in the bottom six sectors in each case (Table 4.8, Columns 5 and 6).

In the case of our combined measure of skill-shortage vacancies and internal skill gaps, the sectoral ranking correlation between the two years is much lower than for single measures of skill deficiencies (Table 4.8, Row 5). However, even on this measure, roughly two thirds of sectors did not record any significant change in the proportion of establishments affected over this period.

Finally, the occupational distributions of skill-shortage vacancies and internal skill gaps also suggest that the main problem areas identified in 1999 persisted into 2001. In manufacturing and construction skill-shortage vacancies were most heavily concentrated in craft-skilled occupations in both years. In public sector establishments the occupational group worst affected by skill-shortage vacancies in both years was associate professionals. Similarly, internal skill gaps were concentrated in the same occupational groups in both years: craft-skilled and operative occupations in manufacturing and construction; sales, clerical and managerial occupations in private services; and clerical and professional occupations in public sector establishments.

Table 4.8: Changes in measures of skill deficiencies in 32 sectors, 1999-2001

	No significant change	Statistically significant increase (at the 5% level or better)	Statistically significant decrease (at the 5% level or better)	Sectoral rankings 1999-2001: Spearman rank correlation	No.of sectors in top 6 in both years	No.of sectors in bottom 6 in both years
	No. of sectors				*No. of sectors*	
Skill-shortage vacancies (establishment-based measure)	19	3	10	0.56***	3	3
Skill-shortage vacancies (employee-based measure)	24	2	6	0.69***	4	4
Internal skill gaps (establishment-based measure)	26	0	6	0.64***	4	3
Internal skill gaps (employee-based measure)	22	0	10	0.84***	4	4
Combined measure of skill-shortage vacancies and internal skill gaps (establishment-based)	21	1	10	0.46***	3	1

*** statistically significant at the 1% level

5. SKILL REQUIREMENTS AND SKILL DEFICIENCIES: DEVELOPING A NEW TYPOLOGY OF SECTORS

Andy Dickerson, Geoff Mason and John Forth

5.1 Introduction

The two principal aims of this chapter are:

- firstly, to group sectors in terms of their reported skill 'requirements' and skill 'deficiencies', and
- secondly, to identify how these groups vary in terms of a number of factors which may contribute to our understanding of any mismatches between skill supply and skill demand.

The starting point for the analysis in this chapter is thus the identification of a sectoral categorisation of ESS2001. Clearly we do not want to be constrained in the first instance by the standard industrial classification. However, in seeking to define a large number of sectors below one- and two-digit level, we are limited by the need for each sectoral sub-sample to have sufficient observations for estimates of proportions of establishments and employee ratios to have a reasonable level of precision (for example, a coefficient of variation of 20% or less). In the case of sub-samples which include establishments with less than 5 employees, Forth (2003, Chapter 2 in this volume) suggests that a minimum cell size of 900 observations is likely to be necessary to meet this criterion from the 27,031 establishments which were surveyed in ESS2001. If we adhere to this requirement, it is not possible to define more than 19 different sectors, many of which are quite heterogeneous in nature. Unsurprisingly, our attempts to develop a skill requirements and deficiencies typology on the basis of these 19 sectors have proved disappointing.

However, if we exclude establishments with less than 5 employees, then the recommended minimum cell size for sectoral analysis drops to 400 observations from the 23,330 establishments which meet this criterion. For establishments with 5 or more employees we are able to define 32 different sectors and this has proved to be a much more fruitful starting point for the development of a new typology of sectors according to skill requirements and deficiencies. Accordingly, the analysis in this chapter proceeds on this basis (i.e. excluding establishments with 1-4 employees). Table 4.2a in Chapter 4 outlines the 32 sectors in terms of their industrial composition, while Table 4.1 shows that, with a small number of exceptions, they are all represented by 400 or more establishments in the raw data, and that only a small fraction of SIC codes are not covered by this sectoral decomposition[19]. The grossed up (population) estimates in Table 4.1 reveal that, despite excluding the large

[19] The 'not covered' category also includes a small number of establishments for which it has not been possible to identify SIC codes from the verbatim responses in ESS2001.

number of establishments with less than 5 employees, around 90% of employment in England is included in this 32 sector classification.

Skill requirements and skill deficiencies in ESS2001 can be defined in a number of ways. Two measures of skill requirements are utilised. First, we construct a measure based around the qualifications of the workforce at each establishment. This information is combined with the valuation of those qualifications in the labour market as indicated by the average hourly earnings which individuals with those qualifications receive. Second, numerous cross-country comparisons have suggested that the pursuit of 'high-end' product strategies – for example, producing complex goods or services which command a price premium over more basic goods and services – are associated with relatively high skill requirements (Prais, 1995). Accordingly, we utilise the questions in ESS2001 on product strategy to define an indirect measure of each sector's skill requirements. The definition and construction of these two measures is described in detail in Section 5.2.

Skill deficiencies can also be defined in a number of ways. Here, we again use two different measures. First, as our measure of *external skill shortages*, we utilise information on the incidence and rate of 'skill-shortage' vacancies at the establishment. These are unfilled jobs at the time of interview which were described by survey respondents as 'hard-to-fill' for at least one of the following reasons: low number of applicants with the required skills; lack of work experience the company demands; or lack of qualifications the company demands.

Second, as a measure of *internal skill gaps*, we use the measures of workforce proficiency and, in particular, the broad skill gap and narrow skill gap measures as defined in Hogarth *et al* (2001), together with the average proficiency score of the establishment's workforce. Definitions and details of the construction of these two measures are provided in Section 5.3.

Section 5.4 uses the measures of skill requirements and deficiencies to define a typology of the 32 sectors according to their similarities and differences across these measures. We use cluster analysis to identify the sectoral groupings. Having settled on a 9 group structure, in Section 5.5 we then turn to examine a number of characteristics of the establishments which comprise these groups, such as their size, location, ownership, labour turnover and training, in order to identify the factors which might contribute to the commonalities in skill requirements and deficiencies that the sectoral groupings signal. Our conclusions are presented in Section 5.6.

5.2 Defining and Identifying Skill Requirements

In order to assess the skill requirements at the establishment level, we construct a wage-weighed qualifications index to serve as a proxy skills measure for the existing workforce. We use the ESS2001 data on the 'most common level of (formal) qualifications' among each of nine occupational groups, combined with Labour Force Survey data on the mean hourly earnings of each of five qualification groups in the UK economy[20]. The skills score is then defined as:

$$\text{skills score index} = \sum_{i=1}^{5} w_i q_i / N$$

where w_i is the mean hourly earnings of qualifications group i (indexed to unity in the case of the 'no formal qualifications' group), q_i is the number employed in qualifications group i and N is total establishment employment. There are missing values on the qualifications variables in 13.5% of cases. These are roughly evenly distributed across the 32 sectors and we therefore choose to omit these observations rather than attempting to impute values from the other characteristics of the establishment[21]. The variation in the skills score index by the 32 sector classification is shown in Table 5.1. The highest-ranked sectors are secondary education (sector 27) and computer services (21) while the two lowest are non-specialised retailing (13) and transport services (17).

The term 'product strategy' attempts to capture the choices made by enterprises about product or service differentiation within particular markets. As noted above, cross-country comparisons have suggested that 'high-end' product strategies are typically associated with relatively high skill requirements. However, as yet it remains an open empirical question to what extent this kind of correspondence between product strategies and skill requirements can be identified at sectoral or establishment level within individual countries. ESS 2001 contains several questions which help to explore these issues. Survey respondents were invited to say where their establishments (as compared to other establishments in the same industries) were positioned on a four- or five-point scale in respect of the following characteristics:

- production volumes;
- product or service complexity;
- the extent to which competitive success depended on price (for private sector establishments) or the extent to which cost control was a critical measure of performance (for public sector establishments);

[20] The five qualification groups are: NVQ4 and above (including, for example, Higher degrees, First degrees and BTEC Higher National awards), NVQ3 (e.g., A levels and trade apprenticeships), NVQ2 (e.g., GCSE grades A*-C and City & Guilds craft qualifications), NVQ1 (e.g., GCSE below grade C and GNVQ foundation awards) and No Formal Qualifications.

[21] In fact, an alternative version of the skills score index using imputed values for missing observations produced a sectoral ranking which was very similar to that derived from the skills score index used in this chapter (Spearman r = 0.993). The main results of our sector-level cluster analysis shown below are not sensitive to the inclusion or exclusion of imputed missing values for establishments which did not provide information on workforce qualifications.

Table 5.1: Skill score index (wage-weighted qualification score) by sector

No.	Industry Sector	Mean	Std Dev	Rank
1	food, drink & tobacco	1.31	0.20	30
2	printing, publishing etc.	1.51	0.33	11
3	chemicals, rubber & plastics	1.34	0.21	27
4	fabricated metal products	1.37	0.24	21
5	electrical & electronic	1.51	0.30	13
6	mech. eng & vehicles	1.43	0.26	16
7	other manufacturing nes.	1.32	0.22	29
8	building constructions	1.43	0.29	15
9	building installation	1.40	0.25	18
10	sales of motor vehicles etc.	1.37	0.23	22
11	wholesaling	1.40	0.30	19
12	retailing - specialised stores	1.35	0.26	25
13	retailing - non-specialised	1.28	0.18	31
14	hotels, motels etc.	1.34	0.25	28
15	restaurants	1.36	0.26	23
16	bars	1.36	0.27	24
17	transport services	1.28	0.22	32
18	postal & telecommunications	1.35	0.30	26
19	auxiliary transport activities	1.42	0.29	17
20	financial serv. incl. insurance	1.57	0.34	8
21	computer services	1.90	0.34	2
22	legal, accnting, auditing etc.	1.84	0.32	3
23	architect, tech etc.	1.80	0.34	4
24	other business services	1.51	0.36	12
25	public administration	1.56	0.30	9
26	primary education	1.70	0.26	6
27	general secondary education	1.96	0.22	1
28	higher & adult education	1.78	0.33	5
29	human health activities	1.67	0.30	7
30	social work	1.53	0.34	10
31	sporting activities & arenas	1.38	0.25	20
32	other service industries	1.48	0.34	14
	Mean	**1.48**	**0.33**	

Note to table: 1. Ranking is from high to low.

- the extent to which the establishment competed in a ‘premium quality’ product market as compared to a ‘standard or basic quality’ product market (for private sector establishments) or provided a highly specialist service as compared to a basic or standard quality service (for public sector establishments);
- the extent to which the establishment provided ‘a demonstrably better quality product or service than similar or competitor establishments’; and
- the extent to which establishments regarded themselves as leaders in terms of developing new products, materials or techniques.

Table 5.2: Correlation analysis of establishment ratings of product/service strategy and market characteristics

		P1	P2	P3	P4	P5	P6
P1:	Production volumes	1					
P2:	Product complexity	-0.11***	1				
P3:	Price-dependence/ cost control	-0.03***	0.14***	1			
P4:	Product quality/ specialist service	-0.09***	0.39***	0.18***	1		
P5:	Product quality	-0.11***	0.17***	0.13***	0.29***	1	
P6:	Innovation leadership	-0.14***	0.20***	0.06***	0.21***	0.21***	1

Notes to table:

1. P1: production volumes;
   P2: product or service complexity;
   P3: the extent to which competitive success depended on price (for private sector establishments) or the extent to which cost control was a critical measure of performance (for public sector establishments);
   P4: the extent to which the establishment competed in a 'premium quality' product market as compared to a 'standard or basic quality' product market (for private sector establishments) or provided a highly specialist service as compared to a basic or standard quality service;
   P5: the extent to which the establishment provided 'a demonstrably better quality product or service than similar or competitor establishments'; and
   P6: the extent to which establishments regarded themselves as leaders in terms of developing new products, materials or techniques.
   All variables are on a (1,…,5) point scale except for P6 which is on a (1,…,4) point scale.
2. Base: n = 20,912 (all establishments with 5 or more employees, excluding establishments which responded 'don't know' to any one of the five questions).
3. *** denotes statistically significantly different from zero at the 1% level.

Table 5.2 shows a significant degree of positive correlation between the establishment ratings on five of these six factors[22]. However, the correlations between these five factors and production volumes are consistently negative and relatively small. Accordingly, we have chosen to retain production volumes as a separate variable. In search of a summary variable relating to product strategy, a factor analysis was carried out across the five product/service strategy or market characteristic variables which are positively related to each other (P2 to P6 in Table 5.2). This analysis extracted one factor with an eigenvalue in excess of unity which explained 37% of the total variation of the five variables. As Table 5.3 shows, all five variables loaded positively on this factor which is readily interpretable as an indicator of where establishments are positioned on a product or service strategy spectrum[23].

[22] Where appropriate the four- or five-point scales used in the original questionnaire have been inverted so that high values always represent a high-end positioning in relation to product strategy.

[23] There is room for debate about whether all five of the product strategy variables should be included in the factor analysis (in part because of the different wording of some of the questions) and also whether private sector and public sector responses should be combined together as we have done here (since the questions asked of public establishments were similar to but hardly identical to those asked of private sector establishments). Alternative specifications have been tried and all have led to the identification of a single factor which is readily interpretable as a measure of product strategy.

Table 5.3: Variable loadings for 'product strategy' factor

		factor loading
P2:	Product complexity	0.67
P3:	Price-dependence/ cost control	0.41
P4:	Product quality/ specialist service	0.75
P5:	Product quality	0.60
P6:	Innovation leadership	0.53

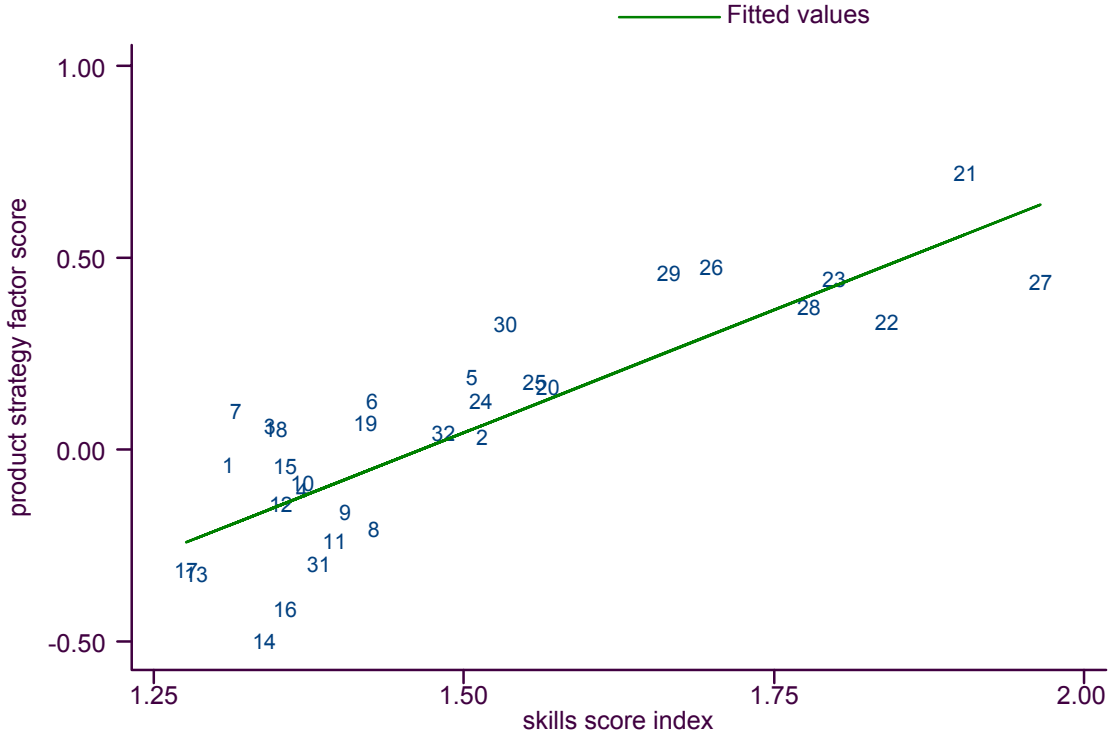
Notes:
1. Kaiser-Meyer-Olkin measure of sampling adequacy: 0.669.
2. Bartlett's test of sphericity: p=0.000***.

Table 5.4: Product strategy factor by sector

No.	Industry Sector	Mean	Std Dev	Rank
1	food, drink & tobacco	-0.06	1.00	20
2	printing, publishing etc.	0.01	0.93	19
3	chemicals, rubber & plastics	0.04	0.98	16
4	fabricated metal products	-0.13	0.93	23
5	electrical & electronic	0.17	0.92	9
6	mech. eng & vehicles	0.11	1.02	12
7	other manufacturing nes.	0.08	0.97	14
8	building constructions	-0.23	0.97	26
9	building installation	-0.18	0.91	25
10	sales of motor vehicles etc.	-0.11	0.97	22
11	wholesaling	-0.26	1.01	27
12	retailing - specialised stores	-0.16	1.06	24
13	retailing - non-specialised	-0.34	0.99	30
14	hotels, motels etc.	-0.52	1.02	32
15	restaurants	-0.06	0.98	21
16	bars	-0.44	0.98	31
17	transport services	-0.33	1.02	29
18	postal & telecommunications	0.03	1.00	17
19	auxiliary transport activities	0.05	0.91	15
20	financial serv. incl. insurance	0.14	0.96	11
21	computer services	0.70	0.75	1
22	legal, accnting, auditing etc.	0.31	0.89	7
23	architect, tech etc.	0.42	0.78	4
24	other business services	0.10	0.95	13
25	public administration	0.15	0.80	10
26	primary education	0.46	0.83	2
27	general secondary education	0.42	0.79	5
28	higher & adult education	0.35	0.91	6
29	human health activities	0.44	0.84	3
30	social work	0.31	0.93	8
31	sporting activities & arenas	-0.32	0.98	28
32	other service industries	0.02	1.04	18
	Mean	**0.00**	**1.00**	

Note:
1. Ranking is from high to low

Figure 5.1: Mean product strategy factor score and mean skill scores by sector



Note:
1. The numbers refer to the 32 sector classification defined in Table 5.1.

Table 5.4 shows the variation in the 'product strategy' factor score across the 32 sectors. Computer services (21) ranks highest of all the sectors while the two lowest-ranked sectors in terms of mean product strategy score are bars (16) and hotels (14).

There is a strong relationship between our two measures of skills requirements as shown in Figure 5.1. The correlation coefficient between the two measures is 0.83 (and the Spearman rank order correlation coefficient is 0.81). Clearly the skills of an establishment's incumbent workforce are closely related to their product/service strategy. However, especially towards the bottom end of the skills spectrum, there is still considerable variation between the sectors such that combining the two indices would appear to be inappropriate. Thus, we retain these two separate measures in developing the typology of sectors in Section 5.4.

5.3. Defining and Identifying Skill Deficiencies

Skill deficiencies at the establishment are indicated by their external skill shortages and internal skills gaps. External skills shortages are revealed by (a) whether the establishment has any skill-shortage vacancies and (b) the skill-shortage vacancy rate, defined as the proportion of jobs (employment plus vacancies) at the establishment which are unfilled due to skill-shortages (either qualifications or experience) amongst the applicants[24].

[24] This skill-shortage vacancy *rate* differs from the skill-shortage vacancy *density* in Chapter 3 which is defined as skill-shortage vacancies as a proportion of current employment. In large establishments there is little difference between the vacancy rate and the vacancy density. However, in small establishments the

Estimates of the total number of 'internal skill gaps' refer to employees who were described by the survey respondents as lacking 'full proficiency' in their current jobs. Establishments are defined as having an internal skill gap if it was reported that, in at least one occupational area, 'over half' or fewer employees were fully proficient. This is the so-called 'narrow' definition of internal skill gaps at establishment level[25]. We also utilise the 'broad' definition of internal skill gaps defined as where less than all staff at the establishment are fully proficient, together with a weighted proficiency score aggregated across all occupational groups at the establishment.

The correlation between these five variables is presented in Table 5.5. While the correlation coefficients are all statistically significantly different from zero, clearly the two external skill-shortage indicators are highly correlated in terms of the magnitude of the correlation coefficient, as are the three internal skill gap variables. However, there would appear to be only a weak relationship between external and internal skill shortages. As confirmation of this, we performed a factor analysis across the five skill-shortage and skill gaps variables. This produced two distinctive factors with eigenvalues greater than unity which together account for 80% of the variation in the five variables. As shown in Table 5.6, the first factor loads heavily on the internal skill gaps variables whereas the second picks up the variation in the external skill shortages as revealed by the incidence and rate of skill-shortage vacancies.

Summaries of these two factors, labelled internal skill gaps and external skill shortages respectively, across the 32 sector classification, are shown in Table 5.7 and Table 5.8. Their relationship at the 32 sector level is shown in Figure 5.2. Unlike the skill requirement measures, the two skill shortage factors are not strongly related – the correlation coefficient is -0.25 and the Spearman rank order correlation coefficient is -0.38, neither of which is significantly different from zero. Hence internal and external skill deficiencies appear to be signalling rather different sectoral difficulties.

vacancy rate may exceed the vacancy density by a considerable amount and may in principle even exceed 100%.

[25] See Forth *et al* (2003, Chapter 3 in this volume) for further discussion about skill gap definitions.

Table 5.5: Correlation analysis of establishment skill gaps and skill shortages

		S1	S2	S3	S4	S5
S1:	Any skill-shortage vacancies	1				
S2:	Skill-shortage vacancy rate	0.76***	1			
S3:	Narrow skill gap	0.06***	0.04***	1		
S4:	Broad skill gap	0.09***	0.05***	0.43***	1	
S5:	Weighted proficiency score	0.07***	0.05***	0.70***	0.73***	1

Notes:
1. S1: (1,0) indicator for any skill shortage vacancies;
   S2: number of skill shortage vacancies as a proportion of establishment size (employment plus total vacancies);
   S3: (1,0) indicator for less than nearly all staff at the establishment fully proficient;
   S4: (1,0) indicator for less than all staff at the establishment fully proficient; and
   S5: occupation-weighted average establishment level proficiency score.
2. Base: n = 23,330 (all establishments with 5 or more employees).
3. *** denotes statistically significant at the 1% level.

Table 5.6: Variable loadings for 'skill-gap' and 'skill-shortage' factors

		factor loading	factor loading
S1:	Any skill-shortage vacancies	-0.01	0.53
S2:	Skill-shortage vacancy rate	-0.02	0.53
S3:	Narrow skill gap	0.36	-0.02
S4:	Broad skill gap	0.37	-0.00
S5:	Weighted proficiency score	0.42	-0.02

Notes:
1. Kaiser-Meyer-Olkin measure of sampling adequacy: 0.560.
2. Bartlett's test of sphericity: p=0.000***.

Table 5.7: Internal skill gap factor by sector

No.	Industry Sector	Mean	Std Dev	Rank
1	food, drink & tobacco	0.20	1.10	4
2	printing, publishing etc.	-0.08	0.91	25
3	chemicals, rubber & plastics	0.32	1.13	1
4	fabricated metal products	0.01	0.98	17
5	electrical & electronic	0.17	1.01	5
6	mech. eng & vehicles	0.05	1.03	11
7	other manufacturing nes.	0.09	1.02	8
8	building constructions	-0.05	0.98	22
9	building installation	-0.11	0.98	27
10	sales of motor vehicles etc.	-0.03	1.02	19
11	Wholesaling	0.02	1.05	15
12	retailing - specialised stores	0.05	1.00	10
13	retailing - non-specialised	0.14	1.04	6
14	hotels, motels etc.	0.22	1.09	3
15	restaurants	0.23	1.11	2
16	bars	0.02	1.05	16
17	transport services	-0.09	1.00	26
18	postal & telecommunications	0.11	0.98	7
19	auxiliary transport activities	-0.07	0.94	24
20	financial serv. incl. insurance	0.04	0.99	12
21	computer services	-0.01	1.04	18
22	legal, accnting, auditing etc.	-0.19	0.84	31
23	architect, tech etc.	-0.03	1.00	21
24	other business services	-0.03	0.99	20
25	public administration	0.04	0.98	13
26	primary education	-0.29	0.81	32
27	general secondary education	-0.06	0.86	23
28	higher & adult education	-0.13	0.86	28
29	human health activities	-0.13	0.92	29
30	social work	0.07	1.01	9
31	sporting activities & arenas	0.02	0.97	14
32	other service industries	-0.17	0.91	30
	Mean	**0.00**	**1.00**	

Note:

1. Ranking is from high to low

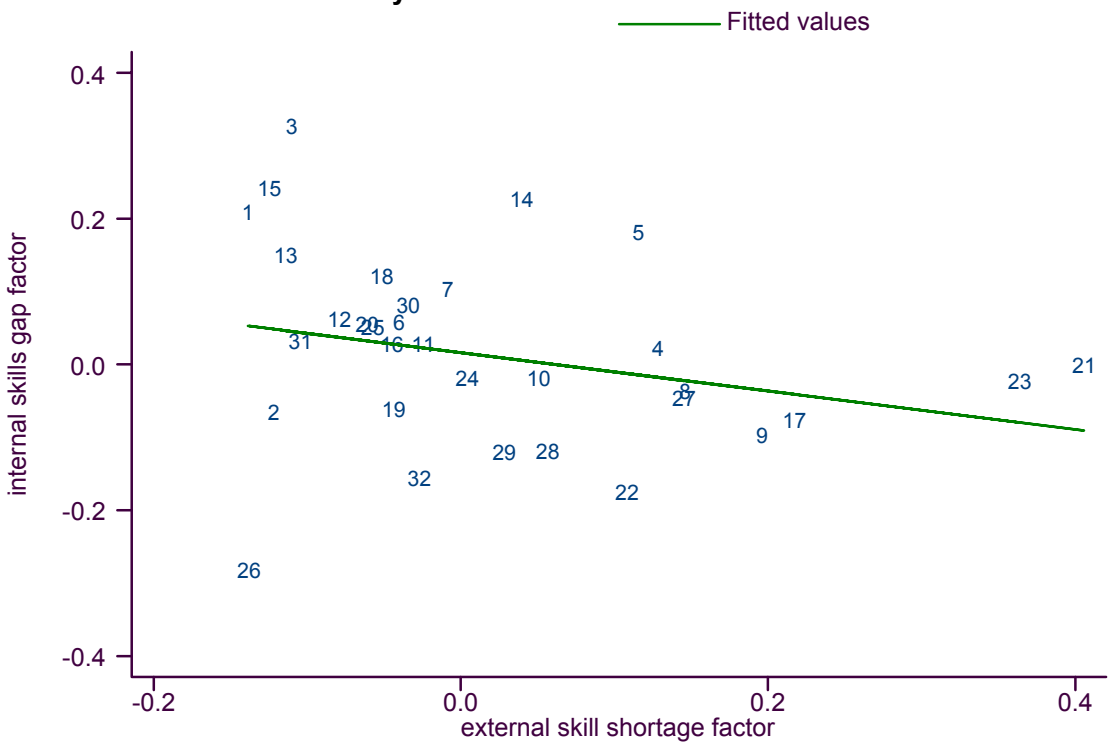
Table 5.8: External skill-shortage factor by sector

No.	Industry Sector	Mean	Std Dev	Rank
1	food, drink & tobacco	-0.14	0.61	32
2	printing, publishing etc.	-0.12	0.60	29
3	chemicals, rubber & plastics	-0.11	0.64	27
4	fabricated metal products	0.13	1.28	7
5	electrical & electronic	0.12	1.09	8
6	mech. eng & vehicles	-0.04	0.78	19
7	other manufacturing nes.	-0.01	0.99	15
8	building constructions	0.15	1.35	5
9	building installation	0.20	1.43	4
10	sales of motor vehicles etc.	0.05	1.12	11
11	wholesaling	-0.02	0.92	16
12	retailing - specialised stores	-0.08	0.84	25
13	retailing - non-specialised	-0.11	0.66	28
14	hotels, motels etc.	0.04	1.04	12
15	Restaurants	-0.12	0.69	30
16	Bars	-0.05	0.91	21
17	transport services	0.22	1.44	3
18	postal & telecommunications	-0.05	0.82	22
19	auxiliary transport activities	-0.04	0.83	20
20	financial serv. incl. Insurance	-0.06	0.82	24
21	computer services	0.41	1.67	1
22	legal, accnting, auditing etc.	0.11	1.10	9
23	architect, tech etc.	0.36	1.47	2
24	other business services	0.00	1.19	14
25	public administration	-0.06	0.75	23
26	primary education	-0.14	0.54	31
27	general secondary education	0.15	1.00	6
28	higher & adult education	0.06	0.93	10
29	human health activities	0.03	0.96	13
30	social work	-0.03	0.91	18
31	sporting activities & arenas	-0.10	0.67	26
32	other service industries	-0.03	0.96	17
	Mean	**0.00**	**1.00**	

Note:

1. Ranking is from high to low.

Figure 5.2: Mean internal skill gap factor score and mean external skill shortage factor score by sector



Note:

1. The numbers refer to the 32 sector classification defined in Table 5.1.

5.4. Developing a New Typology of Sectors by Skill Requirements and Deficiencies

Our main purpose is to produce a typology of sectors grouped in terms of their skills requirement and deficiencies. That is, we want a classification of sectors which produces groupings that are as similar as possible within the groups, and as different as possible between the groups, in terms of their skill requirements and deficiencies – so that we group together sectors which have commonalities in terms of their skills needs and skill gaps. We can then investigate the other characteristics that these sectors share and/or differ by in order to identify the correlates and perhaps causes of any mismatch between their skills demand and supply. That is, we can determine what other features they share apart from their skill deficiencies which perhaps 'lead' (and the causality here is difficult to determine) to their having common problems in terms of their skills requirements and deficiencies.

A methodology that we can use to differentiate the sectors by their skill deficiencies is cluster analysis. This is a technique designed to group together similar objects and distinguish them from dissimilar objects[26]. 'Similarity' and 'dissimilarity' can be defined in many ways, as can the measure of difference or 'distance' between two objects or groups of objects. However, some agglomeration techniques and distance metrics are employed more regularly than others. For agglomeration methods, single

[26] See, for example, Everitt (1993) and Gordon (1999).

linkage (or nearest neighbour method), average linkage and complete linkage (or furthest neighbour method) are commonplace, while for the measure of distance, the squared Euclidian distance is frequently used. However, we can investigate the sensitivity of our final sectoral grouping to the precise method of agglomeration and distance measure used.

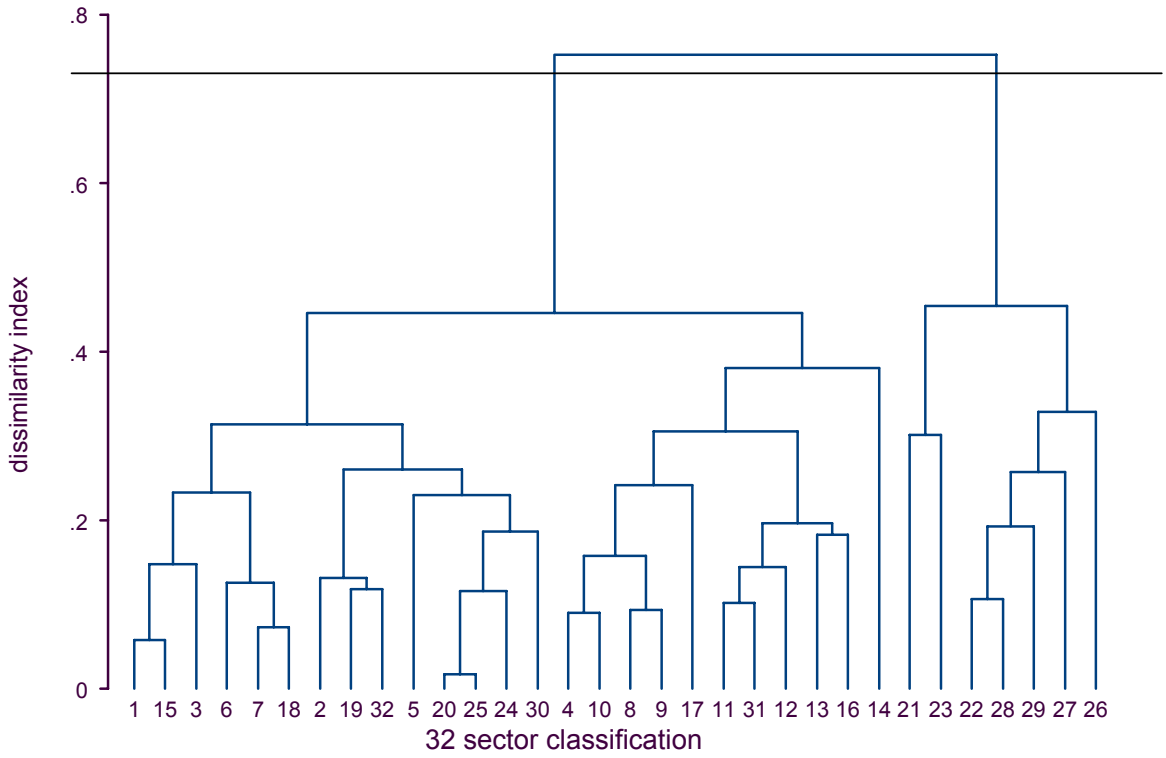
The use of cluster analysis for developing the typology of sectors has a number of advantages. First, cluster analysis is an exploratory data analysis tool. While there are some criticisms of the methodology (mainly centred on accusations of data mining), it imposes few priors in terms of the nature of the relationship between the skill deficiencies and the grouping of sectors. Second, the distance metric can be used to assess the degree of similarity/dissimilarity between the groupings, and the process of agglomeration can be stopped at an appropriate point. That is, we do not need to choose the number of groups that we will end up with at the start of the process – we can make this judgement on the basis of how similar/dissimilar the sectoral groupings are. Third, we can let the data decide the relative weight to place on the different measures of skill deficiencies – and subsequently investigate which particular measures are important in distinguishing the sectors. This is important because some measures of skill deficiencies differ more than others, but their larger variance may simply be random variation (noise) in the data or an artefact of their construction (factors have a standard deviation of unity) rather than capturing any key identifying differences between sectors. Finally, we can produce a graphical illustration demonstrating the process of agglomeration and the degree of similarity between the sectors and resulting groups of sectors – a so-called dendrogram or tree diagram.

One potential difficulty with any attempt to produce a typology of sectors in terms of their skill requirements and deficiencies is revealed by the analysis that has already taken place with ESS2001, both here and elsewhere. For example, we know that there is considerable variation in the skill-shortage vacancy incidence and vacancy rates between otherwise identical establishments (in terms of size, ownership, industry, etc.) – that is, skill deficiencies, at least as recorded by these measures, are very 'noisy'. This suggests that it will be difficult to find a typology that can easily distinguish sectors in terms of their skill deficiencies – there is likely to be more variance in the skill deficiencies within than between any sectoral groupings that are produced whatever methodology is used to produce the grouping. However, starting the process from the initial 32 sector classification will average out some of this establishment level noise.

The result of the cluster analysis employing the average linkage method using the two skill requirement measures (skill score index and product strategy factor) and the two skill deficiency measures (internal skill gaps factor and external skill shortage factor) is depicted in the dendrogram illustrated in Figure 5.3. While the choice of the number of groups is essentially arbitrary, and is defined by the degree of similarity (or dissimilarity) between groups that is tolerable, we have decided to select a 9 group classification for our further analysis. This accords to a degree of dissimilarity of around one third of the total (as measured by the vertical axis in the dendrogram), and is a compromise (as always with cluster analysis) between parsimony and heterogeneity. The groups are presented in Table 5.9. As can be seen, there are

four ‘singletons’:
hotels, motels and other accommodation (14);
computing services (21);
architectural and engineering activities and related technical consultancy (23);
primary education (26).
These are distinctive enough from the other sectors across the four clustering variables to be still individually distinguishable at this level of agglomeration[27].

Figure 5.3: Dendrogram for clustering of sectors by skill requirements and skill deficiencies



Note:
1. The industry numbers refer to the 32 sector classification defined in Table 5.1.

Summary statistics of the population of establishments and employment for this 9 group classification are presented in Table 5.10. There is considerable variation in the size of the groupings by both the number of establishments and coverage of employment. This is the inevitable result of the rather different groupings of the sectors illustrated in the dendrogram and presented in Table 5.9. Four sectors remain differentiated sufficiently that they are singletons, whereas the other 5 groupings combine a range of between 4 and 8 sectors. This is therefore reflected in the rather different sizes of the groupings resulting from the cluster analysis.

[27] We have investigated the sensitivity of our clustering agglomeration to the choice of clustering algorithm used. Encouragingly, other methods repeatedly gave a very similar set of groups to that presented in Table 5.9. In particular, the four singletons consistently emerge as differentiated groups when using single (nearest neighbour) or complete (further neighbour) linkage methods. Membership of the other groups is also very stable whatever methods of clustering are utilised.

Table 5.9: 9-group classification of sectors

	Industry sector:
Group 1	Food, drink and tobacco
	Chemicals, rubber and plastics
	Mechanical engineering, vehicles and other engineering
	Other manufacturing industries
	Restaurants, canteens, catering
	Postal and telecommunications services
Group 2	Printing, publishing, recorded media
	Electrical, electronic and instrument en
	Auxiliary transport activities, travel a
	Financial services, including insurance
	Other business services
	Public administration
	Social work
	Other service industries
Group 3	Fabricated metal products
	Building of complete constructions; civil engineering
	Building installation, completion and other construction activities
	Sales of motor vehicles, parts, fuel
	Transport services
Group 4	Wholesaling
	Retailing - specialised stores
	Retailing - non-specialised stores; other retail and repair
	Bars
	Sporting activities, arenas, stadia
Group 5	Hotels, motels and other accommodation
Group 6	Computer services
Group 7	Architectural and engineering activities and related technical consultancy
Group 8	Legal, accounting, auditing activities; tax consultancy etc.
	General secondary education
	Higher education, adult education and other education
	Human health activities
Group 9	Primary education

Table 5.10: Summary statistics for establishments and employment for 9-group classification

Sectoral group	Sample size	Grossed establishments	Grossed employment
Group 1	3,859	67,464	3,011,402
Group 2	6,879	173,999	5,563,684
Group 3	3,594	75,837	1,737,148
Group 4	3,946	145,819	3,270,763
Group 5	685	9,683	324,796
Group 6	438	9,570	381,555
Group 7	508	12,017	384,393
Group 8	2,518	50,564	2,841,034
Group 9	528	18,518	525,838
Total	22,955	563,472	18,040,614

Table 5.11A summarises the four clustering variables by the 9 group classification, Table 5.11B ranks the groups by each measure and finally Table 5.11C categorises the groups by these measures[28]. Group 6, which is the computing services singleton, stands out as having both high skill requirements as well as a high level of skill deficiencies. This can be contrasted with Group 5 which has low skill requirements, but relatively high skill deficiencies, a reflection of the high turnover rate (and low levels of pay?) in the hotel sector. Group 9, primary education, has high skill requirements, but only low levels of skill deficiencies. A low incidence of internal skill gaps in this sector may reflect the fact that most employees have the requisite qualifications. The other groupings which combine a number of sectors are less easily distinguished. The dendrogram in Figure 5.3 indicates that further agglomeration to, say, around one half of the total dissimilarity would combine together Groups 1 and 2, Groups 3 and 4, Groups 6 and 7, and Groups 8 and 9, leaving Group 5 (hotels, motels and other accommodation) still separated from any other sector. There would therefore appear to be rather distinctive set of skill requirements and skill deficiencies in this sector.

When the 9 groups are ranked from highest to lowest in terms of skill requirements – as in Table 5.11C – what stands out are the different levels of skill deficiencies experienced by groups which ostensibly have similar skill requirements. Thus, for example, the three most skill-intensive groups all suffer from relatively high levels of external skill shortages but Group 6 (computer services) is notable for also reporting a relatively high proportion of internal skill gaps. At the other end of the scale the three lowest groups in terms of skill requirements all experience above average problems with internal skill gaps but Group 5 (hotels and other accommodation) stands out for having moderate levels of external skill shortages as well.

In the middle of the skills ranking, Group 3 (including craft-intensive sectors such as construction and metal-working) is conspicuous for its combination of high levels of external skill shortages with apparently low levels of internal skill gaps. Similarly, Group 9 (primary education) stands out for reporting relatively low levels of both external skill shortages and internal skill gaps.

[28] The typology is based on the ranking from 1 to 9, with: 1=highest; 2,3=high; 4=moderate/high; 5=moderate; 6=moderate/low; 7,8=low; 9=lowest.

Table 5.11A: Summary of skill requirements and deficiency variables by groupings

	Skill requirements		Skill deficiencies	
	skill score	product strategy factor	internal skill gaps factor	external skill shortages factor
Group 1	1.35	0.02	0.17	-0.08
Group 2	1.51	0.12	-0.00	-0.03
Group 3	1.37	-0.20	-0.05	0.15
Group 4	1.35	-0.30	0.05	-0.07
Group 5	1.34	-0.52	0.22	0.04
Group 6	1.90	0.70	-0.01	0.41
Group 7	1.80	0.42	-0.03	0.36
Group 8	1.81	0.38	-0.13	0.08
Group 9	1.70	0.46	-0.29	-0.14

Table 5.11B: Ranking of skill requirements and deficiency variables by groupings

	Skill requirements		Skill deficiencies	
	skill score	product strategy factor	internal skill gaps factor	external skill shortages factor
Group 1	8	6	2	8
Group 2	5	5	4	6
Group 3	6	7	7	3
Group 4	7	8	3	7
Group 5	9	9	1	5
Group 6	1	1	5	1
Group 7	3	3	6	2
Group 8	2	4	8	4
Group 9	4	2	9	9

Table 5.11C: Categorisation of skill requirements and deficiency variables by groupings

	Skill requirements		Skill deficiencies	
	skill score	product strategy factor	internal skill gaps factor	external skill shortages factor
Group 6	highest	highest	moderate	highest
Group 7	high	high	moderate/low	high
Group 8	high	moderate/high	low	moderate/high
Group 9	moderate/high	high	lowest	lowest
Group 2	moderate	moderate	moderate/high	moderate/low
Group 3	moderate/low	low	low	high
Group 1	low	moderate/low	high	low
Group 4	low	low	high	low
Group 5	lowest	lowest	highest	moderate

5.5. Characteristics of Identified Groupings

We now turn to investigate the 9 group classification according to a number of other characteristics of the sectors that comprise the groupings. Table 5.12 presents summary statistics across a range of variables which might, *a priori*, be thought to have an influence on skill requirements and deficiencies. Again, ranking the groups in terms of skill requirements helps to focus on differences between groups which are ostensibly similar in terms of their skill requirements.

The first two columns suggest that there are few if any systematic relationships between the size distribution of establishments and skill requirements or skill deficiencies. However, across the other characteristics, clearer patterns emerge. For example, Group 6 (Computing services) which was identified as having high skill requirements and high skill deficiencies stands out as being more concentrated regionally in London and the South East than any other group, and this may have implications in terms of the competition they face in seeking to recruit skilled employees.

Group 5 (hotels and other accommodation) can also be clearly distinguished when compared to the other groups. Firms in this sector have extremely high hiring and quit rates, and coupled with the fact they have the lowest level of training of any of the sectoral groups, it is perhaps unsurprising that they have high levels of skill deficiencies despite having low skill requirements. (Of course, firms' incentive to train inexperienced workers for this sector would be diminished to the extent that they are faced with high turnover rates, although cause and effect in these circumstances are never easy to disentangle).

Groups 6 (computer services) and 7 (technical business services such as architectural and engineering consultancies) report the highest concentrations of establishments whose sales have increased 'a great deal' in the previous 12 months and this is associated with their relatively high incidence of external skill shortages. However, it is notable also that Groups 6 and 7 have higher proportions of low-training establishments and lower proportions of high-training establishments than other relatively high-skill groups such as Group 9 (primary education) and Group 8 (legal, accounting services; health; secondary and higher education).

Finally, Table 5.12 reveals the relatively high proportions of low-training establishments in the lower-skill groups such as Groups 5, 4 and 1 which report relatively serious problems with internal skill gaps. Perhaps surprisingly, Group 3 (including construction and metal-working) has a similarly high proportion of low-training establishments even though, as noted above, it suffers from high levels of external skill shortages. One hypothesis here is that a sizeable proportion of establishments in this group continue to rely on recruiting craft-skilled employees on the open market rather than undertake high levels of training.

Table 5.12: Characteristics of sectoral groupings

	1 median size	2 mean size	3 private	4 single	5 headoff	6 foreign	7 increase	8 decrease	9 hirerate	10 quitrate	11 low training	12 high training	13 London/ SE
Group 6	15	40	0.95	0.62	0.18	0.11	0.34	0.04	0.34	0.18	0.27	0.15	0.51
Group 8	16	56	0.58	0.54	0.15	0.02	0.12	0.01	0.21	0.15	0.18	0.26	0.34
Group 7	10	32	0.92	0.57	0.19	0.04	0.20	0.04	0.24	0.19	0.23	0.18	0.34
Group 9	24	28	0.20	0.52	0.07	0.00	0.09	0.03	0.16	0.09	0.08	0.37	0.25
Group 2	11	32	0.68	0.46	0.13	0.04	0.14	0.02	0.30	0.24	0.31	0.24	0.38
Group 3	11	23	0.94	0.68	0.11	0.03	0.14	0.04	0.26	0.22	0.41	0.11	0.26
Group 1	16	45	0.91	0.55	0.11	0.07	0.14	0.04	0.34	0.28	0.41	0.11	0.28
Group 4	10	22	0.84	0.35	0.10	0.06	0.13	0.03	0.37	0.32	0.43	0.13	0.32
Group 5	13	34	0.89	0.50	0.09	0.04	0.11	0.03	0.56	0.50	0.43	0.15	0.28
Average	**12**	**32**	**0.77**	**0.49**	**0.12**	**0.04**	**0.14**	**0.03**	**0.31**	**0.25**	**0.35**	**0.18**	**0.33**

Notes:
1. Median size: median number of employees at the establishment.
2. Mean size: average number of employees at the establishment.
3. Private: proportion of establishments in private sector.
4. Single: proportion of establishments which are the only establishment in the organisation.
5. Headoff.: proportion of establishments which are the overall head office of the organisation.
6. Foreign: proportion of establishments foreign owned or controlled.
7. Increase: proportion of establishments for which sales/budget has increased a great deal in the past 12 months.
8. Decrease: proportion of establishments for which sales/budget has decreased a great deal in the past 12 months.
9. Hirerate: hiring as a proportion of employment in the past 12 months.
10. Quitrate: leaving as a proportion of employment in the past 12 months.
11. Low training: proportion of establishments funding or arranging off-the-job-training for 0% of employees in past 12 months.
12. High training: proportion of establishments funding or arranging off-the-job-training for 80-100% of employees past 12 months.
13. London/SE: proportion of establishments in London or the South East.

Base: All establishments with 5 or more employees. NB: These are establishment (weighted) averages in each case.

5.6. Summary and Conclusions

This chapter has developed a new typology of industrial sectors according to their skill requirements and skill deficiencies. Skill requirements are measured by a wage-weighted index of the qualifications of the establishments' labour force together with a measure of the product or service strategy of the establishment. Skill deficiencies are measured by the extent of skill-shortage vacancies and internal skill gaps among the establishments' existing workforce. Using these measures of skill requirements and deficiencies, we are able to identify a robust agglomeration of sectors into clearly distinctive groups. Some of these groups comprise a single industrial sector, while others comprise a number of sectors. We then examine the characteristics of the resulting groups in an attempt to identify the commonalities and differences across other dimensions of their constituent establishments.

A number of interesting findings emerge from our analysis. For example, sectors with high skill requirements do not necessarily suffer the greatest skill deficiencies. Nor do those sectors with low skill requirements necessarily have a fully proficient workforce. Significant differences exist between the groups in terms of other characteristics, particularly perhaps in the amount of off-the-job training that workplaces offer. In part, these differences may contribute to the skill deficiencies that exist. Finally, the typology that we have developed highlights one or two sectors - such as primary education and the computing services sector - as being strongly differentiated from others in terms of their skill requirements and skill deficiencies. The continued growth of the latter in particular - and the associated increasing demand for the skills that it requires - has important implications for education and training providers.

6. QUALIFICATIONS AND SKILL DEFICIENCIES

David Campbell and Terence Hogarth (IER)

6.1 Introduction

Qualification level might be seen as a proxy measure of skill. But this begs the question as what is meant by skill. In the context of the Employers Skill Survey, skill is implicitly defined as the ability to undertake the current job. In this sense, qualification is measuring something quite distinct, in that it reveals a level of educational attainment which may or may not be directly related to the skills demanded in the current job. Qualification provides a measure, albeit imperfectly, of intellectual achievement and the ability to grasp ideas at different levels of conceptual difficulty. By coupling qualification level to occupation a more detailed measure of 'skill' is obtained than by viewing either in isolation. National policy, with its attendant targets for qualification attainment, has striven recently to achieve higher rates of participation in post-compulsory education, as a means of improving overall economic performance. It is apposite, therefore, to consider employers' skill needs in relation to their qualification profile of their workforces. There are three questions to be addressed:

i. are employers with more qualified workforces, and by implication with more demanding recruitment needs, more or less likely to experience recruitment problems?

ii. are employers with relatively highly skilled workforces more or less likely to be critical of the proficiency of their existing workforce; and

iii. is there a link between the qualification profile of establishments' workforces and their product market position?

The remainder of this chapter is divided into three main sections:

i. the distribution of qualifications by occupational group;

ii. the relationship between qualifications and skill deficiencies; and

iii. an analysis of the relationship between workforce educational attainment and establishments' product market position.

In Section 6.2, a general overview is presented of the educational attainment of different occupational groups and how this varies across establishments of different sizes, establishments located across different geographic regions, and industrial sectors. This part of the analysis centres around a question contained within ESS2001 that requests establishments to report the most commonly held qualification for each occupational group in their workforce. For each occupational group (of which there are nine), therefore, it is possible to determine the proportion of workers within the group who are educated to the equivalent of NVQ4/5, down to the proportion holding no formal qualifications. After exploring the extent to which the distribution of qualifications varies across the nine occupational groups, it is also possible to compare these distributions according to establishment size, industrial sector, and region.

Section 6.3 addresses the relationship between qualifications and the extent of recruitment problems and skill gaps. For each of the occupational and educational groups identified in the first section, it is possible to determine the incidence of recruitment problems by referring to the number of vacancies and hard-to-fill vacancies (HtFVs) reported by establishments. Skill deficiencies are defined as the number of HtFVs that are skill related (skill shortage vacancies, SSVs) plus the number of skill gaps (*i.e.* the number of employees considered not to be fully proficient at their current job). The main purpose of this analysis is to determine whether recruitment problems and skill gaps are more likely to exist in occupations that consist of more highly educated workers. In addition, within each occupational group, it is possible to analyse whether such recruitment problems and skill gaps are more prevalent amongst those who are more highly educated than the typical level of attainment within the occupational group.

In Section 6.4, a brief investigation is undertaken of the link between educational attainment and product market competitiveness. Establishments with more than five employees are divided into 32 industrial sectors to determine whether industries with a more highly educated workforce relative to the mean across all industries are associated with more competitive product market strategies. A composite index has been constructed from a series of indicators contained within ESS2001 to capture the extent to which each establishment competes on factors such as price and/or quality. This can be averaged across all establishments within each of the 32 industrial groups. This index for each industry may then be plotted against an industry's relative educational attainment to identify the relationship between educational attainment and product market position. In addition to examining this relationship across all occupational groups, the analysis is repeated and restricted to only include managers. Previous evidence indicates that it is the competence of managers that is central to establishments achieving a relatively high value-added position in their respective product markets (Hogarth and Wilson, 2001). Qualifications do not necessarily measure the competence of managers or reflect their strategic vision, but it provides one measure, albeit imperfect, of the intellectual stock of the workforce. Section 6.5 concludes.

6.2 Occupation and Qualification Level

In section D of the 2001 Employer Skill Survey questionnaire, each establishment is asked to record the most common level of qualification held by each of the occupational groups that it employs. Using the information obtained from this question, it is possible within each establishment to derive a variable for managers that ranges from zero to five covering the cases where the establishment's managers were typically educated with:

- no formal qualifications
- other qualifications
- lower level: *e.g.* NVQ1/RSA/Foundation GNVQ
- basic level: *e.g.* NVQ2/GCSE/O-Levels/Intermediate GNVQ
- intermediate level: *e.g.* NVQ3/A-Levels/BTEC National/OND
- higher level: *e.g.* NVQ4/Nursing/HND/HNC/Higher Diploma[29]

[29] The wording of this categorisation and the examples referred to is obtained directly from the survey. An additional category was also defined to cover the cases where the respondent did not know the most common level of qualification held by managers.

After deriving this variable for the group of managers employed by each establishment, similar variables were constructed for the educational attainment of the remaining eight occupational groups that could potentially be employed by each establishment.

Table 6.1 presents the distribution of educational attainment across the nine different occupational groups, alongside the distribution relating to all ('total') employees. The first column of the table suggests that the establishments contained within ESS2001 employ a total of 236,022 managers, which when grossed up using the weights contained within ESS2001, amounts to an overall population of 3,204,396 managers. The employee weighted statistics in Table 6.1 then reveal that, amongst this population of managers, almost 49 per cent are educated to the highest level, while only 5 per cent are associated with 'no qualifications'.[30] Managers are not the most highly educated group within the labour market. Approximately 82 per cent of professionals and 55 per cent of associate professionals are educated to the equivalent of NVQ4/5.[3132] By reading across the first row of Table 6.1, it may be seen that it is only the first three occupational groups that have a tendency to contain highly educated individuals. For each of the remaining six occupational groups, the proportion of employees holding the highest qualification level does not exceed 10 per cent and even falls below 1 per cent for the case of operatives. Across the whole workforce, 26 per cent are educated to the highest level.

The fall in the proportions of employees holding the highest level qualification across the occupational groups is mirrored by a rise in the proportions holding lower level qualifications. 41 per cent of elementary workers hold the equivalent of NVQ2, compared to only 3 per cent of professionals. Almost one-quarter of elementary workers have no formal qualifications, while for professionals this figure is less than 1 per cent. Approximately 5 per cent of managers appear to have no formal qualifications. When looking at the entire workforce, 6 per cent of employees have no formal qualifications.

The typical level of qualification held by each occupational group is as follows:

- managers (higher level qualifications, NVQ levels 4/5);
- professionals (higher level qualifications, NVQ levels 4/5);
- associate professionals (higher level qualifications, NVQ levels 4/5);
- administrative and secretarial (lower level qualifications, NVQ level 2);
- skilled trades (intermediate level NVQ level 3 and lower level NVQ level 2);
- sales and customer service (lower level qualifications, NVQ level 2);

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30 These figures are comparable with previously published employer weighted statistics relating to the typical educational attainment of managers, and the remaining occupational groups. Hogarth *et al* (2001, p79, Table 3.17) report that 24,136 establishments in ESS2001 employ managers, which when grossed up, gives a population of 1,227,660 establishments. 39 per cent and 25 per cent of these establishments have managers typically educated to NVQ4/5 and NVQ3 respectively. The difference between these figures and those in Table 1 arises in the use of employer and employee weights.

31 The interpretation of these statistics is complex. By weighting, all workers within an occupational group are assigned the most commonly held qualification, even though some will have above the typical qualification and others below. It is, therefore, not completely accurate to say, for example, that 82% of professionals hold the highest qualification. The exact figure is unknown, but the interpretation given in the text is used throughout to simplify the analysis.

32 The comparison with LFS in Table 6.2 suggests that the ESS figures are similar to those from the LFS.

- personal service (lower level qualifications, NVQ level 2);
- operatives(lower level qualifications, NVQ level 2);
- elementary (lower level qualifications, NVQ level 2).

In order to verify that the distributions of qualifications from the ESS2001 presented in Table 6.1 are comparable with other datasets, the equivalent table was reproduced using data from the Labour Force Survey 2001. These figures are presented in Table 6.2 where it may be seen that the distribution of qualification across the workforce obtained from LFS2001 is similar to that of ESS2001. Around 28 per cent of workers are recorded in the LFS as holding the highest qualification compared to 26 per cent in ESS2001. At the lowest level of attainment, 9 per cent have no formal qualifications in the LFS, while in ESS2001, this figure is lower at 6 per cent. It may also be seen that the typical qualification held amongst workers in a particular occupational group is similar in the LFS to that of ESS2001. It is found that 42 per cent of managers and 81 per cent of professionals are educated to the equivalent of NVQ4/5. As was found using the ESS2001, operatives and elementary workers tend to possess lower level qualifications, or no qualifications.

Table 6.3 shows the distribution of educational attainment across the nine occupational groups within establishments of varying sizes.[33] For the three most educated occupational groups (managers, professionals, and associate professionals), the proportion of these employees who are educated to the highest level rises as the overall size of the establishment increases. Approximately 92 per cent of professionals working in establishments that employ 500 or more workers are educated to the highest level, compared to 59 per cent working in establishments with 1-4 employees. It would appear, therefore, that larger establishments demand a higher proportion of managers, professionals, and associate professionals to be educated to the highest level than smaller establishments. The increased propensity for these occupational groups to be more highly educated in larger establishments appears to drive the overall result, presented in the final 'total' rows of Table 6.3, that larger establishments employ more educated workers. This is because for the remaining six groups, there is little change in the proportions of employees possessing each type of qualification as the size of the establishment increases. While larger establishments therefore appear to require higher educational attainment for those employed in managerial and professional occupations, there is no evidence to suggest that such higher educational attainment is required of the remaining less skilled occupations.

In addition to examining the educational attainment of the nine occupational groups across varying establishment sizes, corresponding statistics are produced according to industry and region. When looking across regions, there is little difference in the educational attainment of the nine occupational groups. As a result, there is also no notable difference in the distribution of qualifications across the regional labour markets.[34] The figures across industrial sectors are presented in Table 6.4. By inspecting the final 'total' rows, it may be seen that the industries classified as primary, finance/business, and public administration are associated with workforces that are more typically educated to the highest level, NVQ4/5. Construction and distribution tend to employ less educated employees. The proportion of workers in each industry who have no formal qualifications

[33] Here the weighted base implies that there are 2,240,986 workers employed in establishments with 1-4 employees. In total, almost 24 per cent of these are educated to qualification level 4/5.

[34] Since there was very little variation across regions, these statistics are not presented.

is broadly similar across the eight industrial groups, although around 10 per cent of workers in manufacturing, distribution, and transport have no qualifications. The greater tendency to employ more highly educated employees in the primary, finance/business, and public administration sectors is generally reflected across all of the occupational groups. Although there are naturally some exceptions, each occupational group tends to be more highly educated in these three industrial sectors.

Given the massive increase in staying-on rates at school and the attendant rise in educational attainment, those without any qualifications remain an interesting group. To a large extent this is a cohort effect in that older workers are less likely to hold formal qualifications, but there remains a small but significant minority of individuals who still manage to leave compulsory education without any qualifications. The statistics presented in Tables 6.1-4 offer some insight into the extent to which some workers possess no formal qualifications and the types of establishments in which they work. Overall, 6 per cent of employees are estimated to have no qualifications. It appears from the figures given in Table 6.3 that smaller establishments (1-4 employees) employ a greater proportion of employees with no formal qualifications than larger establishments (over 500 employees). The analysis presented in Table 6.4 also suggests that such employees are more likely to be located in manufacturing, construction, distribution and communication than in sectors, such as finance/business services.

6.3 Qualifications, Recruitment Problems and Skill Deficiencies

The figures presented in Section 6.2 reveal that the occupational groups relating to managers, professionals, and associate professionals could be considered as high skilled since they contain a high proportion of workers qualified to the highest level relative to the other occupational groups. The main aim of this section is to determine whether skill deficiencies are more highly concentrated in highly qualified occupations than occupations containing a less qualified workforce. General recruitment problems are captured by the number of HtFVs and SSVs. SSVs are said to occur when HtFVs are attributed to job applicants not possessing the skills, qualifications or experience required for the job. In addition, internal skill problems, or skill gaps, may be considered in terms of the proportion of existing staff within each occupational group who are not considered as being fully proficient in their jobs.

ESS2001 provides information on the number of vacancies that each establishment currently has for each of the relevant occupational groups that it employs. By grossing up these data using the relevant weights and utilising the information relating to the most commonly held qualification, it is possible to compute the number of vacancies according to educational attainment for each of the nine occupational groups. This information is presented in the first column of Table 6.5, where it may be seen that there is a total of 32,706 vacancies amongst managers. Just over half of these managerial vacancies are located in the highest educational attainment category. Although there are proportionately more vacancies amongst the most highly educated managers, the total number of managerial vacancies is only around 7 per cent of the total number of vacancies across all occupational groups (461,169).[35] A similar pattern emerges for professionals and associate professionals. A high proportion of the vacancies occur for the highest level of education, but each of these occupational groups only accounts for

[35] The total number of vacancies given here is lower from that reported in previous work since vacancies for an occupational group are only referred to in establishments that already employ a positive number of workers in that group.

around 11 per cent of the total number of vacancies. It would appear, therefore, that the three most highly skilled occupational groups do not account for the largest proportions of the total number of vacancies. In fact, each of the nine occupational groups contributes a similar proportion to total vacancies, ranging from 7 per cent (managers) to 16 per cent (personal services).

In Table 6.5, the most common or typical level of qualification held by each occupational group (identified in Table 6.1) is depicted in bold italics.

The second column of Table 6.5 reports the number of HtFVs. Overall, 46 per cent of the vacancies identified in column 1 are considered hard-to-fill. Once again, there is little evidence to suggest that these HtFVs are concentrated in the most highly skilled occupational groups. Only 4 per cent of HtFVs occur amongst managers, while the corresponding proportions for professionals and associate professionals are 14 per cent and 11 per cent respectively. Lower skilled occupations such as skilled trades and personal services account for 14 per cent and 13 per cent of HtFVs, meaning that such vacancies are not disproportionately represented by the high skilled occupations.

In the third column of Table 6.5, the number of SSVs is given. Around 20 per cent of SSVs are found amongst professionals, but this is matched by a similar proportion in skilled trades, suggesting that recruitment problems are not confined to the most highly educated occupations.

The final column of Table 6.5 considers skill gaps. This is derived from variables in ESS2001 that ask establishments to report the proportion of their existing staff in each occupational group who are fully proficient in their job. For the cases where the establishment reports that "nearly all" of their staff are proficient, it is taken to imply that 85 per cent of workers are proficient. "Over half" being fully proficient is seen as being a proficiency rate of 65 per cent.[36] Using this information, it is possible to calculate within each occupational group the number of workers who are not fully proficient in their job, which can then be grossed up to provide an aggregate measure for the workforce. Overall, around 1,900,000 skill gaps are estimated to exist across the workforce. This appears high since it relates to the number of workers who are not *fully* proficient in their job. As in the third column of Table 6.5, there is no evidence to suggest skill gaps are overly concentrated in particular occupational groups. Managers and professionals account for 12 per cent and 10 per cent of all skill gaps, while occupations containing less educated workers, such as administrative/secretarial and personal services account for 15 per cent.

Table 6.5 looks at recruitment problems and skill gaps in terms of absolute numbers. It is also necessary to analyse these measures in terms of densities, *i.e.* as a percentage of employment. For example, in Table 6.6, it may be seen that the total number of vacancies amongst managers educated to the highest level expressed as a percentage of the total number of managers employed with the highest educational attainment is 1.1 per cent. By looking down the first two columns of Table 6.6, it can be verified that recruitment problems appear to be no more severe in the occupational groups identified in Table 6.1 as containing more highly educated workers. In fact, vacancies and HtFVs as a percentage of employment have a slight tendency to increase when moving down to occupational groups containing less educated workers, such as personal services and elementary occupations. The number of skill gaps as a percentage of employment tends to be higher in occupational groups like personal services, operatives, and elementary

[36] A full discussion of skill gaps is presented in Hogarth *et al* (2001).

than in the more highly educated groups of managers and professionals. When comparing across occupational groups, therefore, it does not appear to be the case that recruitment problems and skill gaps are more pronounced in more highly skilled occupational groups.

Within each of the less skilled occupational groups, where the typical qualification reported in Table 6.1 is NVQ2 (qualification level 2), there are instances where recruitment problems are more likely to occur amongst the more highly educated. For example amongst operatives, the HtFV rate for those educated to level 3 is 1.9 per cent, which is greater than the rate of 0.9 per cent associated with the typical attainment of level 2. In addition, the third and fourth columns of Table 6.6 suggest that within the less skilled occupational groups, ranging from sales to elementary, there is no tendency for skill shortages to be greater for those possessing a higher level of qualifications relative to the typical level 2 attainment.

For the medium skilled occupational groups (secretarial and skilled trades), where the typical attainment is level 2 or 3, there is evidence that the hard-to-fill vacancy rate is higher amongst those who are educated to higher levels. A similar pattern emerges with respect to skill-shortages vacancies.

Both the incidence of recruitment problems and of skills gaps with respect to the typical qualification of the workforce varies by occupation such that the presentation of the data for the workforce as a whole (across all occupations) is a relatively crude indicator. Nevertheless a number of useful comments can be made:

- with respect to vacancies there appears to be a 'U' shaped relationship, where vacancies as a percentage of employment are higher where the workforce is typically qualified to a higher level or has no qualifications, and lower where they the workforce is typically qualified to NVQ level 1 or 2;
- with respect to HtFVs a similar pattern is evident although the shape of the 'U' is much shallower;
- it is with respect to SSVs that a relationship between unsatisfied skill demand and the qualifications profile of the workforce is most apparent. The density of SSVs increases the higher the typical qualification of the workforce. While the differences between respective qualification groups are not large, a pattern is evident.

An intriguing picture emerges with respect to skill gaps. The picture is mixed in that there is no obvious evidence that skill gaps increase or decrease uni-directionally with respect to typical qualification level of the workforce. But they are intriguing insofar as the density of skill gaps is highest where employees are typically either qualified to the lowest educational level (NVQ 1) or possess no qualifications. In this respect skills gaps may be interpreted as arising where the qualification level of the workforce is not sufficient to meet the business of the establishment. Of course, this begs the question as to whether one should interpret qualifications as a proxy measure of skill. Clearly there is some overlap insofar as skill gaps are more in evidence in relation to lower level occupations, where the qualification profile of the workforce is lowest (Hogarth *et al*, 2001).

6.4 Qualifications and product market strategies

This section investigates any possible relationship between the qualifications held by an establishment's workforce and its strategies for competing in its relevant product market. One possibility is that establishments that employ a more highly educated workforce are

more likely to compete in a variety of ways and adopt measures to enhance their overall productivity or market share. ESS2001 contains a number of variables that may potentially be used as indicators of product market strategies.

In section C of the ESS2001 questionnaire each establishment is asked whether over the last year it has implemented any plans to significantly improve the quality of its product/service, and the efficiency with which it produces its existing product/service. By looking at the responses to these questions according to the educational attainment of the workers that the establishment employs, it is possible to gain some insight into whether establishments that adopt such plans are associated with more qualified workers. Table 6.7 examines the decision to implement product improving or efficiency enhancing plans for establishments that employ workers who are categorised as managers. When using the establishment weights contained with ESS2001 to gross up the number of establishments to be representative of the population, 72 per cent of establishments that employed managers, and answered the relevant question, implemented plans to improve the quality of its product/service. Of the establishments that sought to improve the quality of its product, 41 per cent employed managers who were commonly educated to the highest level, NVQ4/5, while only 7 per cent employed managers with no qualifications. In contrast, amongst those establishments that did not implement similar plans, 32 per cent had managers educated to the highest level and 10 per cent employed managers with no formal qualifications. This suggests that establishments striving to improve its product or service contain more highly educated managers and less managers with no qualifications than those not attempting to increase product quality. By looking across the remaining columns of Table 6.7, it may be seen that a similar pattern emerges relating to the implementation of plans to improve efficiency in that of the establishments that do implement such plans, a greater proportion employ more highly educated managers.

Although the decision to implement plans relating to product quality and efficiency are perhaps most likely to be influenced by the managers employed by the establishment, Table 6.8 repeats the analysis for all of the nine occupational groups. In order to do this, the mean educational attainment is calculated amongst the occupational groups that are employed by each firm to give an overall measure of the level of education held within each establishment.[37] The figures are similar to those obtained when looking only at managers in establishments implementing improvements in product quality and production efficiency, except that it is more common to find a slightly more educated workforce, although the differences are relatively small. Overall, therefore, Tables 6.7 *and 6.8* provide some evidence to support the view that a more qualified workforce is associated with superior plans to improve the quality of the product and efficiency.

An alternative method of analysing any relationship between the qualifications of the workforce and product market strategy is to construct an index to measure the extent to which an establishment competes on a range of factors. Section C of the ESS2001 questionnaire contains questions that may be referred to when constructing an overall measure of competitiveness. The first of these questions asks establishments to record on a five-point scale whether they are a high volume producer (which is assigned the value 5 for the analysis presented here) or a low volume producer (which takes the value 1). The second question then provides information on whether the establishment produces a complex product (5) or a simple product (1). Private sector firms are then

[37] The mean educational attainment is weighted according to the proportion of employees in each occupational group within the establishment.

asked if they compete on price (5), while non-private sector establishments record the extent to which cost control is a critical measure of performance (5). For the fourth question, those in the private sector state whether they compete in a market for high quality products (5), while non-private sector establishments are asked if they provide a highly specialised service (5). Finally, in the fifth question, establishments report the extent to which they produce a higher quality product or service than a competitor, with 5 being the maximum value.

These five questions may therefore be used to construct a composite index capturing each establishment's level of competitiveness, ranging from a minimum of 5 to a maximum of 25. This is not a perfect measure of competitiveness, but nevertheless gives an indication of the extent to which establishments are competing in a mass production, price sensitive segment of the market, or a low volume, high profit margin segment. After excluding any establishments with less than five employees, each establishment may be categorised into one of 32 different sectors, which are based on the three digit codes from the Standard Industrial Classification.[38] The full listing of these sectors and their SIC codes is presented in Table 6.9. By taking the mean of the composite index term over all of the establishments located in each of the 32 sectors, it is possible to determine the competitiveness of each of these 32 different sectors.[39] The competitive index for each of the 32 sectors, along with each sector's ranking, is given in the first column of Table 6.10. The mean score across the 32 sectors was found to be 17.42 and ranged from 16.13 in sector 14 (hotels, motels and other accommodation) to 18.52 in sector 27 (general secondary education).

Having derived a measure of the competitiveness in each of the 32 sectors, it was necessary to derive a measure of the relative educational attainment of the workers employed in each sector. This was calculated by initially determining the mean level of qualification held across the occupational groups employed within each establishment (as in Table 6.8, except excluding establishments with fewer than five employees). Given the sector that each establishment was a member of, it was possible to calculate the weighted mean educational attainment of workers in each sector, and then the mean attainment across all sectors. For each establishment, it was then possible to determine whether its workers were more highly qualified than the 32-sector mean, enabling the proportion of establishments within a sector with a workforce more highly educated than the 32-sector mean to be identified. It was found that in transport services (sector number 17 in Figure 6.1), 26 per cent of establishments had a workforce more highly educated than the mean across all 32 sectors, while in general secondary education (sector 27), this figure was 95 per cent. The second column of Table 6.10 provides the relative educational attainment and ranking for each of the 32 sectors. This measure of the educational attainment in each sector relative to the mean could then be plotted against the sector's index of competitiveness to establish if there is any link between a more qualified workforce and competitiveness.

Figure 6.1 plots relative educational attainment against the competitiveness index for each of the 32 sectors. It may be seen that there is a positive relationship between the two with sectors containing a workforce that is highly educated relative to the mean scoring more highly on the index relating to competitiveness. The coefficient of

[38] Full details of this classification are given in Chapter 5 *Skill Requirements and Skill Deficiencies: Developing a New Typology of Sectors*.

[39] The establishment weights for each establishment are used when constructing the mean level of competitiveness in each sector.

correlation is calculated to be 0.70 and is significant at the 1 per cent level. The diagram suggests that sectors such as non-specialised retailing (13), hotels (14), bars (16), and sporting activities (31) are associated with workforces that are not highly educated relative to the mean and a low level of competitiveness. In contrast, industries such as primary education (26), secondary education (27), both higher education (28) and human health activities (29) appear to have highly educated workforces and a high degree of competitiveness. Financial services (20) and accounting (22) are two sectors that appear to be outliers in that they contain highly educated workforces, but are positioned only midway along the competitive index. Similarly, other manufacturing (7) has a ranking of nineteen on the competitive index, but has a workforce educated well below the mean.

It could be argued that the real driving force behind the extent to which an establishment is competitive rests not in the workforce as a whole, but amongst the group of managers. The relationship between education and competitiveness was therefore investigated restricting the analysis to only include managers. Following the same steps as for the entire workforce described above, it was possible to derive a measure of the relative educational attainment of managers within each of the 32 different sectors. The proportion of establishments containing managers who were more highly educated than the mean ranged from 15 per cent in sector 10 (sales of motor vehicles) to 97 per cent in sector 27 (general secondary education). Full details of the relative educational attainment of managers in each sector are provided in the final column of Table 6.10. Figure 6.2 plots education against competitiveness for the group of managers and it can again be seen that there is a positive relationship with a correlation coefficient of 0.69 that is significant at 1 per cent. The pattern displayed in Figure 6.2 is similar to that of Figure 6.1 in that retailing and leisure services have low educational attainment and competitiveness, while the educational sectors have high educational attainment and competitiveness.

6.5 Conclusions

The evidence provided is revealing about the operation of the labour market. Those employers with relatively highly skilled workforces - at any given occupational level - are more likely to reveal recruitment problems, especially those related to SSVs. The most plausible explanation is that their recruitment demands are high, related not just to qualification level but to the range of technical and generic skills they require of would be recruits. Other data collected in relation to ESS provides proof of this (see Hogarth and Wilson, 2001). There is also a link between more highly qualified workforces being in establishments positioned in market segments characterised by the production of high quality, specialised products and services, which are relatively less sensitive to price considerations. There is, at the very least, *prima facie* evidence that this product market position is fed and driven by the quality of their workforces. Qualification would appear to be an important indicator of workforce quality in this respect.

HtFVs, rather than SSVs, are also more likely to occur where establishments have relatively low qualified workforces. Available evidence indicates that non-skill related HtFVs occur because of the poor quality of employment on offer, measured by wage levels, how staff are treated by management, and so on. HtFVs arise because of high labour turnover. These are exactly the establishments where the highly skilled and qualified staff, recognised by many employers are a scarce resource, are unlikely to be employed, or at least not for long. Skill gaps are more likely to arise in workforces where the typical qualification level is low. Qualification, therefore, is related to our

understanding of proficiency: more proficient workforces are more highly qualified ones. It is difficult to say with certainty what role qualification plays in fostering proficiency but there is clearly a relationship.

What does qualification level tell us about the incidence of skill deficiencies and achievement of a relatively favourable product market position? Qualification would appear to be an important component of skill, separate from measures such as occupation. But unravelling the picture is difficult. Employers with particularly demanding skill needs may simply use qualification as a screening device rather than valuing qualifications in their own right for what they confer on the individual. It is, however, well worth noting that there are few other measures of intellectual achievement readily available to employers, and should they use qualification simply as a screen it seems incredible that these employers should think qualification does not improve individuals' potential. On balance, the level of qualification attainment as presented here provides a more refined measure of skill composition in the workplace than relying solely on qualification. Moreover, the results suggest that the more qualified the workforce the more likely that a less price sensitive, high quality product market position has been achieved.

Table 6.1 Occupation and qualification level (ESS2001)

	Managers	Professionals	Associate Professionals	Admin and secretarial	Skilled trades	Sales and customer service	Personal service	Operatives	Elementary	Total
Higher level qualifications (NVQ4/5)	49.0	81.7	55.3	7.2	9.6	3.4	7.1	0.7	1.6	26.1
Intermediate level qualifications (NVQ level 3)	24.7	11.6	27.8	34.3	36.5	19.5	21.9	7.1	8.3	17.1
Lower level qualifications (NVQ level 2)	13.7	3.2	10.6	47.2	33.7	50.7	51.0	45.0	40.8	39.8
Elementary level qualifications (NVQ level 1)	1.78	0.3	1.3	2.4	5.9	9.9	6.0	18.7	16.9	5.5
No qualifications	5.12	0.9	1.3	3.7	6.2	9.7	7.7	18.2	22.4	5.8
Other	1.7	0.3	0.4	0.4	1.8	0.9	0.7	3.9	1.6	1.3
Unknown	4.1	2.0	3.3	4.9	6.3	6.0	5.6	6.5	8.4	4.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Unweighted base	236,022	338,687	224,097	323,257	177,869	154,477	263,230	286,930	190,165	2,194,733
Weighted base	3,204,396	265,100	1,692,398	3,157,178	1,876,068	1,499,103	2,571,572	2,184,788	1,717,402	20,587,007

Source: Employers Skill Survey 2001 (IER/IFF)
Base: employee weighted measure

Table 6.2 Occupation and qualification level (LFS2001)

	Managers	Professionals	Associate Professionals	Admin and secretarial	Skilled trades	Sales and customer service	Personal service	Operatives	Elementary	Total
Higher level qualifications (NVQ4/5)	42.1	80.7	48.2	16.1	7.6	8.8	14.4	4.3	4.3	27.9
Intermediate level qualifications (NVQ level 3)	15.9	6.9	15.9	17.0	23.6	15.4	13.8	8.4	9.4	14.1
Lower level qualifications (NVQ level 2)	19.8	6.1	18.7	28.0	35.7	27.5	28.5	23.0	21.8	22.5
Elementary level qualifications (NVQ level 1)	10.9	2.1	9.8	25.4	13.3	24.2	20.0	21.5	21.3	15.9
No qualifications	6.4	3.7	4.9	6.7	8.6	8.6	11.9	19.9	13.4	8.7
Other	5.0	0.6	2.6	7.0	15.4	15.4	11.5	22.9	29.9	10.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Unweighted base	5,443	4,568	5,179	5,841	3,719	3,000	2,874	3,426	4,607	38,657
Weighted base	2,536,347	2,135,298	2,411,310	2,623,938	1,774,573	1,373,318	1,272,665	1,579.094	2,097,138	17,803,681

Source: LFS 2001; figures refer to employees only and those living in England

Table 6.3 Occupation, qualification level, and establishment size

column percentages for each occupational group

	Number of employees				
	1-4	5-49	50-249	250-499	500 or more
Managers					
Qualification level 4/5	37.2	40.7	60.0	65.4	77.3
Qualification level 3	23.8	28.9	23.8	23.0	14.9
Qualification level 2	19.1	17.1	7.7	5.7	4.0
Qualification level 1	3.4	1.8	0.8	0.1	0.2
No qualifications	9.8	5.7	1.8	1.2	0.3
Other	3.0	1.5	1.3	0.4	0.2
Unknown	3.8	4.4	4.7	4.2	3.1
Professionals					
Qualification level 4/5	58.8	69.5	86.3	89.0	92.0
Qualification level 3	23.4	18.3	9.1	8.2	5.8
Qualification level 2	11.2	6.4	2.0	1.3	0.2
Qualification level 1	0.8	0.6	0.1	0.3	0.0
No qualifications	4.2	1.4	0.7	0.0	0.0
Other	0.4	0.5	0.2	0.6	0.1
Unknown	1.2	3.3	1.7	0.5	1.9
Associate professionals					
Qualification level 4/5	43.3	36.6	48.7	52.8	81.9
Qualification level 3	37.2	35.0	31.7	31.2	15.0
Qualification level 2	12.4	19.3	12.3	8.9	0.9
Qualification level 1	0.7	2.1	0.8	4.4	0.0
No qualifications	3.0	2.3	1.2	0.3	0.4
Other	0.2	0.6	0.6	0.2	0.2
Unknown	3.2	4.1	4.7	2.3	1.6
Administrative/secretarial					
Qualification level 4/5	11.3	6.7	6.3	5.9	7.9
Qualification level 3	29.8	32.1	33.8	35.0	40.9
Qualification level 2	37.8	48.4	50.2	50.2	44.0
Qualification level 1	4.6	2.9	1.8	1.9	1.4
No qualifications	11.4	4.1	2.4	2.0	1.6
Other	1.3	0.5	0.3	0.1	0.0
Unknown	3.8	5.4	5.3	5.0	4.2
Skilled trades					
Qualification level 4/5	7.0	7.6	11.4	13.8	12.9
Qualification level 3	31.3	34.7	37.1	42.7	42.6
Qualification level 2	30.5	35.4	32.8	32.5	34.2
Qualification level 1	7.5	6.3	5.4	3.2	6.0
No qualifications	14.8	7.1	4.2	2.7	0.4
Other	1.5	2.2	2.0	1.6	0.3
Unknown	7.5	6.7	7.0	3.6	3.7

continued

Table 6.3 Occupation, qualification level, and establishment size (continued)

column percentages for each occupational group

	Number of employees				
	1-4	5-49	50-249	250-499	500 or more
Sales/customer service					
Qualification level 4/5	2.2	4.5	2.4	4.2	1.3
Qualification level 3	25.0	21.8	20.0	16.0	7.6
Qualification level 2	39.6	48.3	51.0	50.7	66.2
Qualification level 1	10.9	8.8	9.9	9.8	13.3
No qualifications	13.5	10.0	8.5	9.0	9.3
Other	0.8	1.1	1.1	0.5	0.0
Unknown	7.9	5.4	7.1	9.9	2.4
Personal service					
Qualification level 4/5	7.9	6.5	8.3	6.0	7.0
Qualification level 3	22.1	22.0	21.6	21.6	22.5
Qualification level 2	42.6	50.4	50.7	54.9	55.0
Qualification level 1	8.3	5.7	5.3	6.6	6.5
No qualifications	14.0	9.5	7.0	4.5	2.4
Other	0.6	0.9	0.7	0.7	0.0
Unknown	4.6	4.9	6.5	6.0	6.7
Operatives					
Qualification level 4/5	1.1	1.0	0.8	0.6	0.0
Qualification level 3	10.7	8.8	6.5	4.4	8.0
Qualification level 2	40.2	40.2	45.3	50.1	47.4
Qualification level 1	18.9	15.6	21.0	17.0	20.3
No qualifications	20.5	21.5	15.6	17.3	19.0
Other	1.4	4.6	3.2	3.9	4.6
Unknown	7.2	8.3	7.6	6.7	0.6
Elementary					
Qualification level 4/5	1.2	2.2	2.1	0.1	0.3
Qualification level 3	13.0	11.3	6.9	4.2	2.2
Qualification level 2	34.9	39.9	40.8	49.3	38.3
Qualification level 1	12.8	14.6	16.8	16.9	28.5
No qualifications	30.1	21.3	21.8	20.1	25.5
Other	6.3	9.2	9.2	8.01	5.2
Total					
Qualification level 4/5	23.8	19.5	26.1	26.1	42.0
Qualification level 3	24.9	24.4	20.3	19.8	18.2
Qualification level 2	27.3	34.4	32.8	35.3	26.0
Qualification level 1	5.7	6.0	6.9	6.5	5.7
No qualifications	12.0	8.7	6.9	6.2	4.6
Other	1.8	1.4	1.2	1.1	0.6
Unknown	4.5	5.6	5.8	4.9	2.9
Total	100.0	100.0	100.0	100.0	100.0
Unweighted base	9,744	310,920	680,195	415,285	778,589
Weighted base	2,240,986	7,153,600	5,497,264	2,504,118	3,191,039

Source: Employers Skill Survey 2001 (IER/IFF); Base: employee weighted measure

Table 6.4 Occupation, qualification level and industry

column percentages

	Primary/ Utilities	Manufacturing	Construction	Distribution	Transport and Communication	Finance and Business Services	Public Administration, Health and Education	Other Services
Managers								
Qualification level 4/5	75.3	45.8	32.2	26.2	32.7	65.3	72.7	35.3
Qualification level 3	15.8	27.2	33.7	33.0	29.5	17.8	16.8	29.4
Qualification level 2	2.4	13.5	18.9	21.8	21.8	7.3	5.5	18.9
Qualification level 1	0.0	1.9	1.5	3.2	2.1	0.9	0.8	2.3
No qualifications	3.2	5.3	5.3	8.0	6.4	4.1	1.3	7.4
Other	1.3	1.9	3.2	1.6	2.8	0.8	0.5	3.5
Unknown	2.1	3.9	5.2	6.5	4.8	3.9	2.4	3.2
Total	100	100	100	100	100	100	100	100
Professionals								
Qualification level 4/5	94.3	75.2	56.6	52.7	62.9	83.6	88.7	64.0
Qualification level 3	3.1	15.2	31.2	25.4	20.4	10.0	8.4	18.9
Qualification level 2	0.3	4.4	7.2	10.6	6.0	3.0	1.5	9.4
Qualification level 1	0.4	0.9	0.6	0.6	0.6	0.3	0.1	0.6
No qualifications	0.0	1.1	0.7	4.6	3.6	0.5	0.3	3.1
Other	0.0	0.9	0.3	0.6	0.9	0.2	0.2	0.9
Unknown	2.0	2.3	3.5	5.5	5.6	2.4	0.9	3.2
Associate professionals								
Qualification level 4/5	37.1	44.5	34.8	25.9	45.5	57.9	62.2	41.8
Qualification level 3	54.2	38.9	42.6	37.1	35.7	28.8	22.6	29.8
Qualification level 2	5.9	11.2	14.4	24.0	12.4	6.7	10.1	16.4
Qualification level 1	0.0	0.8	1.8	1.4	0.2	0.4	1.7	1.6
No qualifications	0.3	2.2	1.2	2.9	4.1	1.21	0.8	2.4
Other	0.0	0.1	0.6	0.7	0.3	0.8	0.1	3.0
Unknown	2.4	2.3	4.6	8.0	2.0	4.2	2.5	5.0

Source: Employers Skill Survey 2001 (IER/IFF); Base: employee weighted measure

Table 6.4 Occupation, qualification level and industry (continued)

column percentages

	Primary/ Utilities	Manufacturing	Construction	Distribution	Transport and Communication	Finance and Business Services	Public Administration, Health and Education	Other Services
Administrative/secretarial								
Qualification level 4/5	2.7	4.4	5.5	5.4	5.2	10.8	5.1	10.9
Qualification level 3	35.3	34.7	28.4	30.6	33.9	37.2	33.3	33.1
Qualification level 2	50.2	49.9	50.1	49.3	46.5	41.3	52.4	41.2
Qualification level 1	1.3	3.3	3.3	3.3	2.4	2.0	2.0	2.8
No qualifications	1.7	3.4	7.2	5.4	8.2	3.5	2.0	4.8
Other	1.2	0.5	0.9	0.6	0.5	0.3	0.1	2.0
Unknown	7.6	3.8	4.6	5.5	3.4	5.0	5.2	5.3
Skilled trades								
Qualification level 4/5	21.1	8.5	4.2	8.3	6.3	23.9	7.1	10.0
Qualification level 3	45.8	38.0	39.1	37.5	32.7	32.5	36.6	34.3
Qualification level 2	22.3	35.3	34.2	26.9	36.3	28.0	40.9	37.8
Qualification level 1	3.1	5.4	6.4	8.5	11.5	2.8	4.3	4.6
No qualifications	1.8	6.1	6.5	10.6	5.5	2.1	4.0	5.7
Other	1.7	1.8	2.6	1.5	3.8	1.4	1.1	1.5
Unknown	4.3	4.8	7.0	6.6	4.0	9.4	6.1	6.2
Sales/customer service								
Qualification level 4/5	7.2	0.9	2.3	3.2	0.3	6.2	3.1	3.8
Qualification level 3	0.0	15.5	9.5	11.0	5.5	10.2	18.3	25.4
Qualification level 2	52.8	49.5	32.6	53.8	87.7	41.0	52.6	45.6
Qualification level 1	10.2	11.0	11.5	12.2	2.6	8.4	11.5	8.3
No qualifications	10.0	12.0	11.2	11.6	3.3	22.3	8.7	9.5
Other	0.0	1.2	0.0	1.8	0.2	1.3	0.7	1.0
Unknown	19.8	10.0	33.0	6.6	0.5	10.6	5.2	6.4

Table 6.4 Occupation, qualification level and industry (continued)

column percentages

	Primary/ Utilities	Manufacturing	Construction	Distribution	Transport and Communication	Finance and Business Services	Public Administration, Health and Education	Other Services
Personal service								
Qualification level 4/5	18.4	16.6	5.8	3.2	7.5	16.1	8.1	5.9
Qualification level 3	28.6	31.8	28.3	17.5	29.2	28.3	29.0	23.2
Qualification level 2	38.8	36.2	49.5	56.4	48.5	41.5	44.4	49.7
Qualification level 1	3.0	3.8	1.8	7.8	4.5	1.4	5.1	7.0
No qualifications	2.3	5.0	3.9	9.1	5.4	4.6	6.9	9.6
Other	0.0	0.3	0.5	0.7	0.8	0.4	1.7	0.7
Unknown	9.0	6.2	10.2	5.2	4.2	7.7	4.9	3.9
Operatives								
Qualification level 4/5	0.6	0.4	2.6	1.4	0.6	0.9	2.5	0.7
Qualification level 3	4.5	6.1	11.0	8.1	8.4	9.7	7.6	10.7
Qualification level 2	32.8	47.7	45.2	38.5	41.7	42.5	37.8	50.8
Qualification level 1	46.7	19.3	14.5	18.0	16.7	17.0	17.5	9.9
No qualifications	9.8	18.7	16.9	20.9	13.7	19.2	27.7	17.4
Other	0.0	2.7	5.3	4.7	8.9	2.6	1.8	2.4
Unknown	5.6	5.2	4.6	8.4	10.1	8.1	5.1	8.1
Elementary								
Qualification level 4/5	0.0	1.6	0.4	0.4	0.7	1.0	2.3	3.1
Qualification level 3	4.9	3.0	5.0	5.6	6.7	5.2	5.8	16.2
Qualification level 2	69.3	33.4	36.2	55.5	38.4	35.5	34.3	41.4
Qualification level 1	12.6	20.6	22.5	13.7	23.8	17.0	19.7	11.8
No qualifications	3.5	30.8	28.1	14.9	21.0	26.3	30.6	16.8
Other	0.0	1.0	1.5	1.6	1.7	3.3	0.9	1.6
Unknown	9.6	9.6	6.3	8.3	7.7	11.7	6.2	9.1
Total								
Qualification level 4/5	34.2	17.2	15.0	9.5	11.4	41.1	44.1	14.7
Qualification level 3	23.5	20.8	31.3	21.7	19.7	23.1	19.5	24.6
Qualification level 2	23.3	34.7	31.5	43.9	39.0	22.7	25.0	36.7
Qualification level 1	10.5	9.9	6.0	7.6	10.0	2.5	3.8	6.7
No qualifications	3.2	10.9	8.0	9.8	10.2	4.7	4.0	9.7
Other	0.6	1.7	2.3	1.3	3.6	0.7	0.4	1.8
Unknown	4.7	4.8	5.9	6.2	6.1	5.2	3.4	5.9
Unweighted base	15,872	488,083	71,403	314,145	130,599	356,297	590,626	216,626
Weighted base	116,103	3,561,432	876,526	3,598,460	1,211,254	4,015,096	4,808,383	2,127,610

Table 6.5 Occupation, qualification and volume of skill deficiencies

Absolute numbers

	Vacancies	Hard-to-fill vacancies	Skill shortage vacancies	Skill gaps (Broad measure)
Managers				
Qualification level 4/5	16,906	4,647	2,892	123,054
Qualification level 3	5,514	1,859	1,068	59,812
Qualification level 2	5,901	2,084	279	30,955
Qualification level 1	206	78	0	1,983
No qualifications	3,374	230	210	7,834
Other	599	416	112	2,091
Unknown	206	57	0	6,098
Total	32,706	9,371	4,561	231,827
Professionals				
Qualification level 4/5	48,288	26,280	16,793	161,881
Qualification level 3	4,008	2,461	1,876	23,117
Qualification level 2	214	205	35	5,840
Qualification level 1	0	0	0	644
No qualifications	44	8	0	1,735
Other	8	0	0	604
Unknown	76	65	11	2,641
Total	52,638	29,019	18,715	196,462
Associate professionals				
Qualification level 4/5	33,802	15,642	7,115	70,962
Qualification level 3	15,043	6,122	3,486	41,505
Qualification level 2	2,850	1,506	479	17,393
Qualification level 1	138	64	9	2,293
No qualifications	512	304	262	1,339
Other	542	151	144	448
Unknown	537	174	127	4,413
Total	53,424	23,963	11,622	138,353
Administrative/secretarial				
Qualification level 4/5	5,907	1,263	917	16,445
Qualification level 3	24,189	6,189	2,525	93,175
Qualification level 2	35,820	10,468	3,942	148,234
Qualification level 1	791	189	90	8,225
No qualifications	1868	418	121	5,599
Other	424	238	0	561
Unknown	1363	389	119	13,540
Total	70,362	19,154	7,714	285,779
Skilled trades				
Qualification level 4/5	4,426	3,015	2,713	11,794
Qualification level 3	15,847	9,758	5,541	56,869
Qualification level 2	1,504	10,766	7,658	55,555
Qualification level 1	2,436	870	639	9,383
No qualifications	2,833	1,480	1,150	8,707
Other	689	443	207	2,050
Unknown	4,413	3,246	2,831	9,882
Total	32,148	29,578	20,739	154,240

continued

Table 6.5 Occupation, qualification and volume of skill deficiencies (continued)

	Vacancies	Hard-to-fill vacancies	Skill shortage vacancies	Skill gaps (Broad measure)
Sales/customer service				
Qualification level 4/5	1,024	340	19	3,507
Qualification level 3	12,511	5,469	1,398	27,350
Qualification level 2	22,627	14,026	5,240	86,711
Qualification level 1	3,487	1,697	537	19,441
No qualifications	2,033	1,388	140	18,185
Other	233	125	11	957
Unknown	1,548	857	67	8,137
Total	43,463	23,902	7,412	164,288
Personal service				
Qualification level 4/5	4,614	1,942	541	16,455
Qualification level 3	15,732	5,324	2,106	58,594
Qualification level 2	37,065	12,532	2,935	153,830
Qualification level 1	3,646	1,198	115	26,449
No qualifications	5,111	1,755	309	20,658
Other	445	309	94	1,169
Unknown	6,329	4,275	2,576	11,353
Total	72,942	27,335	8,676	288,508
Operatives,				
Qualification level 4/5	161	27	27	979
Qualification level 3	8,277	2,967	959	13,047
Qualification level 2	15,873	8,878	2,702	119,523
Qualification level 1	6,642	2,792	924	51,818
No qualifications	7,732	4,276	1,722	51,473
Other	2,172	1,477	327	9,148
Unknown	2,802	1,725	687	11,086
Total	43,659	22,142	7,348	257,074
Elementary				
Qualification level 4/5	1,761	1,074	64	2,724
Qualification level 3	5,167	1,628	305	13,884
Qualification level 2	25,274	11,744	2,081	85,871
Qualification level 1	7,648	3,859	750	35,563
No qualifications	14,240	5,657	647	40,065
Other	1,222	305	138	2,398
Unknown	4,515	2,328	555	14,819
Total	59,827	26,595	4,540	195,324
Total				
Qualification level 4/5	116,889	54,230	31,081	407,801
Qualification level 3	106,288	41,777	19,264	387,353
Qualification level 2	147,128	72,209	25,351	703,912
Qualification level 1	24,994	10,747	3,064	155,799
No qualifications	37,747	15,516	4,561	155,595
Other	6,334	3,464	1,033	19,426
Unknown	21,789	13,116	6,973	81,969
OVERALL TOTAL	461,169	211,059	91,327	1911,855

Source: Employers Skill Survey 2001 (IER/IFF); Base: employee weighted measure
Typical levels of educational attainment for each occupational group (from Table 6.1) are given in bold italics.

Table 6.6 Occupation, qualification and extent of skill deficiencies

densities

	Vacancies as a percentage of employment	Hard-to-fill vacancies as a percentage of employment	Skill shortage vacancies as a percentage of employment	Skill gaps as a percentage of employment
Managers				
Qualification level 4/5	1.1	0.3	0.2	8.0
Qualification level 3	0.7	0.2	0.1	7.6
Qualification level 2	1.4	0.5	0.1	7.1
Qualification level 1	0.4	0.1	0.0	3.5
No qualifications	2.0	0.1	0.1	4.8
Other	1.1	0.8	0.2	4.0
Unknown	0.2	0.0	0.0	4.9
Professionals				
Qualification level 4/5	2.2	1.2	0.8	7.5
Qualification level 3	1.3	0.8	0.6	7.5
Qualification level 2	0.3	0.2	0.0	6.8
Qualification level 1	0.0	0.0	0.0	8.4
No qualifications	0.2	0.0	0.0	7.6
Other	0.1	0.0	0.0	6.8
Unknown	0.1	0.1	0.0	6.3
Associate professionals				
Qualification level 4/5	3.6	1.7	0.8	7.7
Qualification level 3	3.2	1.3	0.7	8.9
Qualification level 2	1.6	0.8	0.3	9.8
Qualification level 1	0.6	0.3	0.0	10.5
No qualifications	2.4	1.4	1.2	6.6
Other	7.2	2.0	1.9	6.0
Unknown	1.0	0.3	0.2	9.0
Administrative/secretarial				
Qualification level 4/5	2.6	0.6	0.4	7.4
Qualification level 3	2.2	0.6	0.2	8.8
Qualification level 2	2.4	0.7	0.3	10.1
Qualification level 1	1.1	0.3	0.1	11.1
No qualifications	1.6	0.4	0.1	4.9
Other	3.3	1.9	0.0	4.4
Unknown	0.9	0.3	0.1	9.4
Skilled trades				
Qualification level 4/5	2.5	1.7	1.5	6.7
Qualification level 3	2.3	1.4	0.8	8.4
Qualification level 2	2.4	1.7	1.2	8.8
Qualification level 1	2.2	0.8	0.6	8.5
No qualifications	2.4	1.3	1.0	7.7
Other	2.0	1.3	0.6	6.0
Unknown	3.8	2.8	2.4	8.7

continued

Table 6.6 Occupation, qualification and extent of skill deficiencies (continued)

densities

	Vacancies as a percentage of employment	Hard-to-fill vacancies as a percentage of employment	Skill shortage vacancies as a percentage of employment	Skill gaps as a percentage of employment
Sales/customer service				
Qualification level 4/5	2.0	0.7	0.0	7.0
Qualification level 3	4.3	1.9	0.5	9.4
Qualification level 2	3.0	1.9	0.7	11.6
Qualification level 1	2.4	1.2	0.4	13.2
No qualifications	1.4	1.0	0.1	12.6
Other	1.8	0.9	0.1	7.4
Unknown	1.7	1.0	0.1	9.4
Personal service				
Qualification level 4/5	2.5	1.1	0.3	9.1
Qualification level 3	2.8	1.0	0.4	10.5
Qualification level 2	2.8	1.0	0.2	11.8
Qualification level 1	2.4	0.8	0.1	17.2
No qualifications	2.6	0.9	0.2	10.4
Other	2.5	1.7	0.5	6.7
Unknown	4.4	2.9	1.8	8.9
Operatives				
Qualification level 4/5	1.1	0.2	0.2	6.5
Qualification level 3	5.3	1.9	0.6	8.4
Qualification level 2	1.6	0.9	0.3	12.2
Qualification level 1	1.6	0.7	0.2	12.8
No qualifications	1.9	1.1	0.4	13.0
Other	2.6	1.8	0.4	11.1
Unknown	2.0	1.2	0.5	8.3
Elementary				
Qualification level 4/5	6.3	3.8	0.2	10.0
Qualification level 3	3.7	1.2	0.2	9.9
Qualification level 2	3.6	1.7	0.3	12.2
Qualification level 1	2.6	1.3	0.3	12.3
No qualifications	3.7	1.5	0.2	10.5
Other	4.5	1.1	0.5	9.0
Unknown	3.1	1.6	0.4	10.6
Total				
Qualification level 4/5	2.2	1.0	0.6	7.6
Qualification level 3	3.0	1.2	0.6	11.0
Qualification level 2	1.8	0.9	0.3	8.6
Qualification level 1	2.2	0.9	0.3	13.7
No qualifications	3.3	1.3	0.4	13.0
Other	2.4	1.3	0.4	7.5
Unknown	2.4	1.5	0.8	9.1

Source: Employers Skill Survey 2001 (IER/IFF); Base: employee weighted measure
Typical levels of educational attainment for each occupational group (from Table 6.1) are given in bold italics.

Table 6.7 Plans to improve quality and efficiency (Managers)

	Implemented plans to improve quality of products or services		Implemented plans to improve efficiency with which products or services are produced	
	Yes	No	Yes	No
Managers				
Qualification level 4/5	41.3	32.1	40.2	33.6
Qualification level 3	25.0	25.9	26.2	21.9
Qualification level 2	18.6	20.3	18.2	22.3
Qualification level 1	2.8	2.9	3.0	2.7
No qualifications	7.3	10.0	7.1	10.9
Other	1.7	4.0	1.6	4.9
Unknown	3.3	4.8	3.7	3.7
Total	100.0	100.0	100.0	100.0
Unweighted base	16,890	6,699	17,823	5,763
Weighted base	867,574	344,150	914,709	295,785

Base: establishment weighted measure

Table 6.8 Plans to improve quality and efficiency (All workers)

	Implemented plans to improve quality of products or services		Implemented plans to improve efficiency with which products or services are produced	
	Yes	No	Yes	No
All occupations				
Qualification level 4/5	22.3	15.7	20.9	18.4
Qualification level 3	28.0	25.8	29.5	22.3
Qualification level 2	28.9	27.4	28.6	27.9
Qualification level 1	7.1	7.8	7.2	7.9
No qualifications	10.6	19.0	10.7	19.2
Other	3.1	4.3	3.2	4.3
Unknown	-	-	-	-
Total	100.0	100.0	100.0	100.0
Unweighted base	17,673	8,761	18,543	7,857
Weighted base	1,346,128	668,430	1,409,794	597,323

Base: establishment weighted measure

Table 6.9 Sectoral classification: 32 Groups

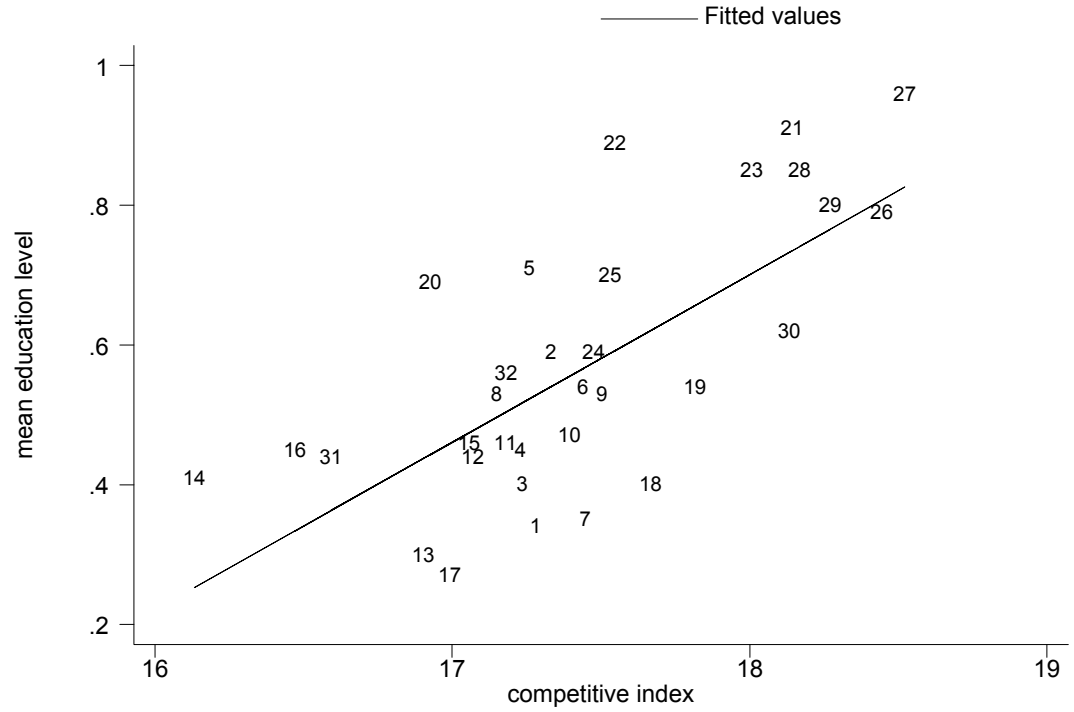
No.	Industry sector	SIC (1992) codes
1	Food, drink and tobacco	151-160
2	Printing, publishing, recorded media	221-223
3	Chemicals, rubber and plastics	241-252
4	Fabricated metal products	281-287
5	Electrical, electronic and instrument engineering	300-335
6	Mechanical engineering, vehicles and other engineering	271-277, 291-297, 341-355
7	Other manufacturing industries	171-212, 231-232, 261-268, 361-366, 371-372
8	Building of complete constructions; civil engineering	452
9	Building installation, building completion and other construction activities	451, 453-455
10	Sales of motor vehicles, parts, fuel	501-505
11	Wholesaling	511-517
12	Retailing – specialised stores	522-524
13	Retailing - non-specialised stores; other retail and repair	521, 525-527
14	Hotels, motels and other accommodation	551-552
15	Restaurants, canteens, catering	553, 555
16	Bars	554
17	Transport services	601-603,611-623
18	Postal and telecommunications services	641-642
19	Auxiliary transport activities, travel agents	631-634
20	Financial services, including insurance	651-652, 660, 671-672
21	Computer services	721-726
22	Legal, accounting, auditing activities; tax consultancy etc.	741
23	Architectural and engineering activities and related technical consultancy	742-743
24	Other business services	701-703, 712-714, 730-732, 744-748
25	Public administration	751-753
26	Primary education	801
27	General secondary education	802
28	Higher education, adult education and other education	803-804
29	Human health activities	851
30	Social work	853
31	Sporting activities, arenas, stadia	926
32	Other service industries	852, 900,911-913, 921-925, 927, 930

Table 6.10 Sectoral classification: competitiveness and educational attainment

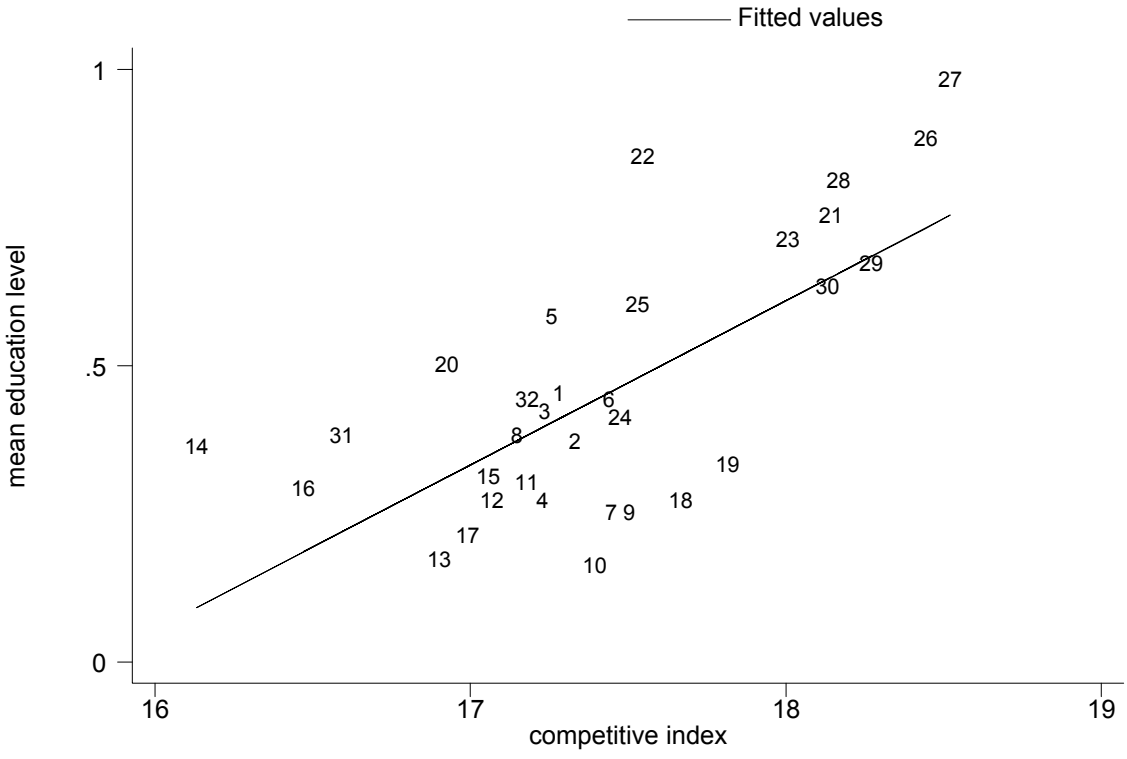
No.	Industry sector	Competitive Index		Education All		Education Managers	
1	Food, drink and tobacco	17.28	(15)	0.33	(3)	0.44	(21)
2	Printing, publishing, recorded media	17.33	(16)	0.58	(20)	0.36	(14)
3	Chemicals, rubber and plastics	17.24	(13)	0.39	(6)	0.41	(18)
4	Fabricated metal products	17.23	(12)	0.44	(11)	0.26	(7)
5	Electrical, electronic and instrument engineering	17.26	(14)	0.70	(25)	0.57	(23)
6	Mechanical engineering, vehicles and other engineering	17.44	(18)	0.53	(18)	0.43	(19)
7	Other manufacturing industries	17.45	(19)	0.34	(4)	0.24	(4)
8	Building of complete constructions; civil engineering	17.15	(9)	0.52	(16)	0.37	(16)
9	Building installation, building completion and other construction activities	17.50	(21)	0.52	(15)	0.24	(5)
10	Sales of motor vehicles, parts, fuel	17.39	(17)	0.46	(14)	0.15	(1)
11	Wholesaling	17.18	(10)	0.45	(12)	0.29	(10)
12	Retailing – specialised stores	17.07	(8)	0.43	(8)	0.26	(8)
13	Retailing - non-specialised stores; other retail and repair	16.90	(4)	0.29	(2)	0.16	(2)
14	Hotels, motels and other accommodation	16.13	(1)	0.40	(7)	0.35	(13)
15	Restaurants, canteens, catering	17.06	(7)	0.45	(13)	0.30	(11)
16	Bars	16.47	(2)	0.44	(10)	0.28	(9)
17	Transport services	16.99	(6)	0.26	(1)	0.20	(3)
18	Postal and telecommunications services	17.67	(24)	0.39	(5)	0.26	(6)
19	Auxiliary transport activities, travel agents	17.82	(25)	0.53	(17)	0.32	(12)
20	Financial services, including insurance	16.93	(5)	0.68	(23)	0.49	(22)
21	Computer services	18.14	(28)	0.90	(31)	0.74	(28)
22	Legal, accounting, auditing activities; tax consultancy etc.	17.55	(23)	0.88	(30)	0.84	(30)
23	Architectural and engineering activities and related technical consultancy	18.01	(26)	0.84	(28)	0.70	(27)
24	Other business services	17.48	(20)	0.58	(21)	0.40	(17)
25	Public administration	17.53	(22)	0.69	(24)	0.59	(24)
26	Primary education	18.44	(31)	0.78	(26)	0.87	(31)
27	General secondary education	18.52	(32)	0.95	(32)	0.97	(32)
28	Higher education, adult education and other education	18.17	(29)	0.84	(29)	0.80	(29)
29	Human health activities	18.27	(30)	0.79	(27)	0.66	(26)
30	Social work	18.13	(27)	0.61	(22)	0.62	(25)
31	Sporting activities, arenas, stadia	16.59	(3)	0.43	(9)	0.37	(15)
32	Other service industries	17.18	(11)	0.55	(19)	0.43	(20)

Note: The rankings in brackets go from the lowest (1) to the highest (32)

Figure 6.1 Relative educational attainment and competitiveness (All workers)



(Managers)



7. THE DETERMINANTS OF HARD-TO-FILL VACANCIES AND SKILL-SHORTAGE VACANCIES IN KEY OCCUPATIONAL GROUPS

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7.1 Background

The occupational dataset derived from ESS2001 contains information on vacancies, hard-to-fill vacancies and skill-shortage vacancies in 25 occupational groups at the 2-digit SOC level. It is based on Question D3 and succeeding questions in the main survey which asked establishments to identify specific occupations in which they currently had vacancies. In some cases the level of detail on job titles recorded at the time of the interview was inadequate for coding to 2-digit level and the numbers of vacancies recorded in the occupational dataset are therefore slightly lower than in the main ESS2001 dataset (Tables 7.1 and 7.2).

The main aims of this chapter are to examine the determinants of vacancies being (a) hard-to-fill and (b) skill-shortage in nature for key selected occupations. In particular, we wish to explore the hypotheses that, all else being equal, vacancies are more likely to be skill shortage in nature:

1. in relatively low-paying sectors, and
2. in relatively low-training sectors.

However, the analysis also provides opportunities to assess the relative importance of other key factors likely to impinge on the incidence of vacancies, hard-to-fill vacancies and skill-shortage vacancies such as establishment growth rates, labour turnover rates and local labour market conditions.

Data on training, growth (e.g. recent changes in sales and employment) and labour turnover are available at establishment level from ESS2001. Data on pay for selected occupations were obtained at sectoral level from the New Earnings Survey (NES). Data on regional labour market conditions at LLSC level were obtained from the Local Area Labour Force Survey 2000.

The chapter is ordered as follows: Section 7.2 describes the format of the dataset, sets out criteria for the selection of particular occupations for detailed analysis and provides descriptive statistics for the chosen occupations. Section 7.3 outlines the empirical model used to estimate the determinants of hard-to-fill vacancies and skill-shortage vacancies in key occupational groups. Section 7.4 reports detailed findings for two occupations: science and technology professionals and administrative occupations. Section 7.5 widens the analysis to several other occupations: business and public service professionals, health and social welfare associate professionals, skilled metal and electrical trades, skilled construction and building trades, leisure and other personal service occupations and process, plant and machine operatives. Section 7.6 summarises the main findings of interest.

Table 7.1: Vacancies, hard-to-fill vacancies and skill-shortage vacancies in the Main ESS 2001 Dataset

	Number vacancies		Number of hard-to-fill vacancies		Number of skill-shortage vacancies	
Occupation	*weighted*	*unweighted*	*weighted*	*unweighted*	*weighted*	*unweighted*
Managerial & senior officials	37,889	2,334	13,264	587	8,209	327
Professional occupations	69,167	6,564	41,971	3,344	29,959	1,993
Associate professional & technical	125,164	9,556	61,948	4,117	29,151	2,036
Admin. & secretarial	94,380	6,908	24,324	1,714	10,708	896
Skilled trades	77,976	4,143	51,375	2,345	27,396	1,188
Personal services	70,251	4,417	38,450	2,578	14,834	760
Sales & customer services	109,378	6,847	44,605	1,932	14,572	533
Process, plant & machine operatives	69,368	5,297	33,756	2,667	14,645	1,077
Elementary occupations	109,254	8,783	46,072	3,128	8,460	537
Total classified	***762,826***	***54,849***	***355,766***	***22,412***	***157,936***	***9,347***
Unclassified	6,115	405	177	21	120	10
Total	**768,941**	**55,254**	**355,943**	**22,433**	**158,056**	**9,357**

Table 7.2: Vacancies, hard-to-fill vacancies and skill-shortage vacancies in the Occupational Dataset, 2001

	Number of vacancies		Number of hard-to-fill vacancies		Number of skill-shortage vacs	
Occupation	*weighted*	*unweighted*	*weighted*	*unweighted*	*weighted*	*unweighted*
Managerial & senior officials	33,990	1,922	12,590	555	7,759	312
Professional occupations	69,121	6,552	41,971	3,344	29,959	1,993
Associate professional & technical	125,061	9,533	61,948	4,117	29,151	2,036
Admin. & secretarial	94,380	6,908	24,324	1,714	10,708	896
Skilled trades	77,939	4,138	51,375	2,345	27,396	1,188
Personal services	70,029	4,377	38,450	2,578	14,834	760
Sales & customer services	109,313	6,846	44,539	1,931	14,572	533
Process, plant & machine operatives	69,360	5,296	33,756	2,667	14,645	1,077
Elementary occupations	109,219	8,781	46,037	3,126	8,460	537
Total classified	***758,411***	***54,353***	***354,991***	***22,377***	***157,486***	***9,332***
Unclassified	460	61	118	19	70	9
Total	**758,871**	**54,414**	**355,109**	**22,396**	**157,556**	**9,341**

Note: These groupings are created by aggregating the entries from the 2-digit SOC level

7.2 Descriptive statistics and selection of key occupations

7.2.1 Dataset format

In the main ESS2001 dataset the grossed-up proportion of establishments reporting at least one vacancy at the time of the survey was 14.5% (corresponding to an unweighted 35% or 9,426 of the 27,031 establishments in the survey).

The occupational dataset consists of 'records' for each establishment/occupation pairing where at least one vacancy is recorded. Each record holds information on the number of vacancies, hard-to-fill vacancies and skill-shortage vacancies in that occupational group. In total there are 14,238 different records, that is, separate establishment/occupation pairings, representing an average of 1.5 different occupational groups with vacancies for each establishment reporting vacancies.

The distribution of establishment-occupational records across 2-digit occupational groups is shown in Table 7.3. These 14,238 records contain information about a total of 54,414 vacancies (unweighted) which grosses up to an estimated 758,871 vacancies across the whole economy (see Table 7.2, Columns 1 and 2). In order to derive descriptive information on the proportion of vacancies that are hard-to-fill or skill-shortage in nature for a given occupational group (as shown in Table 7.4 below), it is necessary to weight each record by the number of reported vacancies or skill-shortage vacancies reported for the occupation in question, in addition to the standard establishment weighting.

7.2.2 Selection of key occupations

Table 7.4 shows that the largest numbers of vacancies are in occupations such as sales occupations (71), elementary administration and service occupations (92) and administrative occupations (41). However, the occupation with the largest numbers of skill-shortage vacancies is science and technology professionals (21) which also has the highest intensity of skill-shortage vacancies (expressed as a proportion of total vacancies). Other occupations with above-average intensity of skill-shortage vacancies include skilled construction and building trades (53), science and technology associate professionals (31), business and public service professionals (24) and skilled metal and electrical trades (52).

In this chapter we wish to focus on a mix of occupations in which vacancies are most numerous and those in which the intensity of skill-shortage vacancies is greatest. Occupation 21 (science and technology professionals) falls into both these categories and Occupation 41 (administrative occupations) exemplifies an occupation in which vacancies are numerous but are not necessarily skill-related. Hence, these two occupations were chosen for an initial detailed investigation of the determinants of hard-to-fill vacancies

and skill-shortage vacancies. Subsequently in Section 7.5 below we apply a similar analysis to several other occupations (24, 32, 52, 53, 62 and 81).

Table 7.3: Numbers of establishment/occupation vacancy records, analysed by 2-digit SOC group

Ranked by size of unweighted group

SOC	Occupation	%	*n*	Rank
92	Elementary Administration and Service Occupations	14.2	2,017	1
41	Administrative Occupations	11.9	1,700	2
71	Sales Occupations	8.5	1,214	3
35	Business and Public Service Associate Professionals	6.0	852	4
61	Caring Personal Service Occupations	5.0	715	5
11	Corporate Managers	4.9	694	6
81	Process, Plant and Machine Operatives	4.7	666	7
23	Teaching and Research Professionals	3.9	557	8
21	Science and Technology Professionals	3.9	556	9
54	Textiles, Printing and other skilled Trades	3.9	551	10
52	Skilled Metal and Electrical Trades	3.7	525	11
32	Health and Social Welfare Associate Professionals	3.6	508	12
42	Secretarial Related Occupations	3.4	488	13
82	Transport and Mobile Machine Drivers and Operatives	3.4	478	14
31	Science and Technology Associate Professionals	2.9	414	15
91	Elementary Trades, Plant and Storage Related Occupations	2.9	413	16
62	Leisure and Other Personal Service Occupations	2.8	392	17
24	Business and Public Service Professionals	2.6	373	18
53	Skilled Construction and Building Trades	2.2	311	19
72	Customer Service Occupations	1.7	246	20
34	Culture, Media and Sports Occupations	1.6	233	21
12	Managers and Proprietors in Agriculture and Services	1.5	218	22
22	Health Professionals	0.4	51	23
51	Skilled Agriculture Trades	0.3	38	24
0	Unclassified	0.1	16	25
33	Protective Service Occupations	0.1	12	26
	All establishments	**100**	**14,238**	

Table 7.4: Grossed-up numbers of vacancies and skill-shortage vacancies

Ranked by intensity of skill-shortage vacancies (proportion of total vacancies)

SOC	Occupation	Vacancies		Skill-shortage Vacancies		Intensity	
		V	Rank	SSV	Rank	$\frac{SSV}{V}$	Rank
21	Science and Technology Professionals	30,084	9	16,587	1	0.55	1
31	Science and Technology Associate Professionals	24,502	14	12,352	3	0.50	2
53	Skilled Construction and Building Trades	24,013	15	11,636	4	0.48	3
24	Business and Public Service Professionals	20,957	16	9,708	6	0.46	4
52	Skilled Metal and Electrical Trades	32,345	7	11,517	5	0.36	5
62	Leisure and Other Personal Service Occupations	24,615	13	6,134	15	0.25	6
81	Process, Plant and Machine Operatives	29,597	10	7,046	11	0.24	7
11	Corporate Managers	28,394	11	6,570	12	0.23	8
22	Health Professionals	1,551	24	338	24	0.22	9
12	Managers and Proprietors in Agriculture and Services	5,595	22	1,188	21	0.21	10
54	Textiles, Printing and other skilled Trades	18,609	17	3,753	16	0.20	11
23	Teaching and Research Professionals	16,530	18	3,327	17	0.20	12
32	Health and Social Welfare Associate Professionals	31,986	8	6,268	14	0.20	13
61	Caring Personal Service Occupations	45,415	5	8,700	9	0.19	14
82	Transport and Mobile Machine Drivers and Operatives	39,764	6	7,600	10	0.19	15
51	Skilled Agriculture Trades	2,972	23	489	23	0.16	16
35	Business and Public Service Associate Professionals	57,094	4	9,078	7	0.16	17
0	Unclassified	460	26	70	25	0.15	18
71	Sales Occupations	95,801	1	13,820	2	0.14	19
34	Culture, Media and Sports Occupations	10,313	21	1,443	20	0.14	20
42	Secretarial Related Occupations	15,756	19	1,958	19	0.12	21
41	Administrative Occupations	78,624	3	8,750	8	0.11	22
91	Elementary Trades, Plant and Storage Related Occupations	24,705	12	2,151	18	0.09	23
92	Elementary Administration and Service Occupations	84,514	2	6,309	13	0.07	24
72	Customer Service Occupations	13,512	20	753	22	0.06	25
33	Protective Service Occupations	1,165	25	11	26	0.01	26
	All establishments	**758,871**		**157,556**		**0.21**	

7.2.3 Background on occupation groups 21 and 41

The majority of two-digit occupational groups are fairly heterogeneous in nature. Occupational group 21, science and technology professionals, includes scientists (e.g., chemists, biologists and physicists), engineers (e.g., civil, mechanical, chemical, electrical and electronic engineers) and information and communication technology (ICT) professionals (e.g., IT strategy and planning professionals and software engineers and computer analysts and programmers). Occupational group 41, administrative occupations, covers a range of administrative and clerical occupations such as credit controllers, accounts and wages clerks, filing clerks, telephonists and civil service and local government administrative and clerical officers.

The vacancies for occupation group 21 are heavily concentrated in the business services sector (details provided in Appendix Table C7.1). This is because many people in this group are working in computer-related activities (in particular, computer software consultancy) or in architectural, engineering or technical consultancy. Occupation 41 is more evenly spread throughout the whole economy. The vacancies for occupation 21 are also heavily concentrated in the eastern RDA region with one third of vacancies for science and technology professionals being in establishments there (Appendix Table C7.2).[40] This may reflect the rapid growth in demand for engineers, scientists and ICT professionals in 'Silicon Fen'. The vacancies for occupation 41 are more regionally dispersed, although a quarter of them are in London and a further fifth in the south-east.

While establishments in the 1-4 employee size group account for 25% of grossed-up vacancies in the case of science and technology professionals, they report as many as 40% of skill-shortage vacancies (Appendix Table C7.3). For administrative occupations, these micro-establishments account for a similarly large proportion (29%) of grossed-up vacancies but the distribution of skill-shortage vacancies across size-groups is more in line with the distribution of vacancies than is the case for science and technology professionals.

[40] Note that the share of vacancies in the Eastern region remains disproportionately large even if an important outlier establishment in that region (with 180 vacancies) is excluded.

7.3 Empirical model

Our aim is to model the probability that an establishment has a hard-to-fill or skill-shortage vacancy in a particular occupational area. Given the format of the occupational dataset described above, we estimate the following equations for each occupation group:

$$\text{(i)}\ \Pr\left(HTF_i = 1 \middle| X_i\right) = f\left(X_i \beta_h\right)$$

$$\text{(ii)}\ \Pr\left(SSV_i = 1 \middle| X_i\right) = f\left(X_i \beta_s\right)$$

where:

$$HTF_i \begin{cases} = 1 \text{ if the establishment/occupation group record includes at least one hard - to - fill vacancy} \\ = 0 \text{ Otherwise} \end{cases}$$

and

$$SSV_i \begin{cases} = 1 \text{ if the establishment/occupation group record includes at least one skill - shortage vacancy} \\ = 0 \text{ Otherwise} \end{cases}$$

and X_i is a vector of establishment and occupation characteristics including information on relative sector wages for each occupation and local unemployment rates and establishment-level characteristics such as nationality of ownership, recent growth in sales/budgets, labour turnover and the incidence of off-the-job training. This approach can be seen as a natural extension of Bosworth *et al* (2001), who investigated the determinants of the probability of reporting hard-to-fill and skill-shortage vacancies at establishment level using data from the previous Employers Skills Survey.

In what follows we use a logit regression model which is highly tractable: a simple transformation of its β parameters indicates the factor change in the odds of a vacancy being hard-to-fill or skills-related, which greatly facilitates the interpretation of the results.

The relative sector wage variable is constructed using data from the New Earnings Survey (NES), 2000-1.[41] The relative sector wage for occupation *j* in industry *k* is calculated as:

$$R_{jk} = \frac{\overline{W}_{jk}}{\overline{W}_j}$$

where $\overline{W}_{jk}$ is the mean wage for occupation *j* in industry *k* and $\overline{W}_j$ is the mean wage for occupation *j* in the economy as a whole. This was calculated at the two-digit SOC occupation-level and 3-digit SIC industry-level where the number of observations permitted. Because the NES in 2000-1 was still coded to the 1990 Standard Occupational Classification (SOC), the relative wage data shown in Table 7.5 are estimates based on available information about

[41] For an example of a similar approach to deriving a relative wage variable, see Haskel and Martin (2001) who use data on weekly earnings from the Workplace Industrial Relations Survey (WIRS) in the course of analysing data from the 1991 Employee Manpower and Skills Practices Survey (EMSPS).

correspondences between SOC 1990 and SOC 2000 occupational groups (see Appendix A for details). Using these estimates, we proceeded on the following basis: if there were less than 30 observations for the selected occupation at the 3-digit industry level, the sector mean $\overline{W}_{jk}$ was calculated at the 2-digit level. If there were less than 30 observations at the 2-digit industry level, the sector mean was calculated at the 1-digit level. In order to pick up other sectoral variation, we include dummy variables for industries in which we had at least 30 establishments (Table 7.6).

Since migration within the UK may be inhibited by house-price differentials and other factors, it is important to account for the fact that there may be regional disparities in the alternative wage on offer. We do this by including a set of regional variables which take account of local labour market conditions at the Local Learning and Skills Council (LLSC) area level. These include regional dummies at the RDA level, a measure of local area unemployment and the percentages of the workforce employed in each area in relevant sectors and Major SOC group (see Tables 7.7-7.8).

In order to account for differences in establishment growth rates we utilise the answers to survey questions B4a and B4b, which ask how much the establishment's sales or budget increased in the past twelve months, for private and public sector establishments, respectively. From these we create dummy variables for those whose sales/budget increased or decreased 'a great deal' in past twelve months.

Table 7.5: Estimated mean weekly wages by occupation group and sector

	21 Science & Technology Professionals		41 Administrative Occupations	
	Mean (£)	*Index (average=100)*	*Mean (£)*	*Index (average=100)*
Agriculture & Fishing	499	90	209	81
Mining & quarrying	588	106	270	104
Manufacturing	546	98	258	99
Electricity, gas & water supply	645	116	318	123
Construction	545	98	250	97
Wholesale & retail	574	103	242	93
Hotels & restaurants	573	103	239	92
Transport & comm.	630	113	297	115
Finance	635	114	307	119
Business services	558	100	268	103
Public admin	506	91	264	102
Education	444	80	257	99
Health & social care	464	83	231	89
Other services	535	96	239	92
Total	**557**	**100**	**259**	**100**

Source: Derived from New Earnings Survey, 2000-1 (See Appendix to Chapter 7 for details)

Table 7.6: Number of Establishments in Occupational Dataset

	21 Engineers & Technologists	41 Numerical Clerks & Cashiers
Agriculture & Fishing	0	4
Mining & quarrying	3	3
Manufacturing	182	221
Electricity, gas & water supply	5	9
Construction	25	90
Wholesale & retail	14	164
Hotels & restaurants	1	49
Transport & communications	16	152
Finance	6	130
Business services	259	365
Public admin	2	154
Education	21	111
Health & social care	11	146
Other services	11	100
Total	**556**	**1698**

The survey data also permit estimates of labour turnover across each establishment (although not for separate occupations). This indicator of labour mobility is proxied here by the *separation rate* defined as the number of separations in the past 12 months (quits plus dismissals) divided by the total number of employees in the establishment.

Descriptive statistics for the variables are presented in Table 7.7 below. We also present more detailed descriptive statistics for the continuous variables in Table 7.8.

Table 7.7: Variable definitions and descriptive statistics for Occupations 21 and 41 (at the level of establishment/occupation group records) [(a)]

*Weighted by population weights*number of vacancies*

		SOC21		SOC41	
Variable Name	**Definition**	**Mean**	**s.d.**	**Mean**	**s.d.**
Hard-to-fill	1=Vacancy is hard-to-fill	0.735	0.442	0.349	0.477
Skill-shortage	1=Vacancy is skill-shortage vacancy	0.581	0.494	0.160	0.367
Single	1=single-site enterprise	0.460	0.499	0.393	0.489
Head office	1=Head office	0.217	0.413	0.290	0.454
Foreign	1=Foreign owned or joint UK/foreign-owned	0.200	0.400	0.101	0.302
Foreign – nk	1= Ownership nationality not known	0.005	0.067	0.006	0.078
Public	1=Public sector	0.062	0.241	0.287	0.452
Sector – nk	1=Public/private status not known			0.001	0.030
Declining sales/budgets	1=Sales/budget decreased a great deal in past 12 months	0.032	0.177	0.070	0.255
Increasing sales/budgets	1=Sales/budget increased a great deal in past 12 months	0.472	0.500	0.192	0.394
Growth – nk	1= Change in sales/budgets not known	0.028	0.166	0.006	0.075
Labour turnover	Quits and dismissals in last 12 months as % of on-site employment	0.116	0.162	0.582	1.241
Turnover – nk	1= Quits/dismissals not known	0.026	0.159	0.064	0.245
Rel. sector wage	Relative sector wage	1.013	0.068	0.995	0.097
Training dummies:					
No training	*No off-the-job training given*	*0.271*	*0.445*	*0.318*	*0.466*
Low training	Low off-the-job training (1-29%)	0.245	0.430	0.231	0.422
Medium training	Medium off-the-job training (30-79%)	0.239	0.427	0.202	0.401
High training	High off-the-job training (80-100%)	0.214	0.411	0.208	0.406
Training – nk	1= Off-the-job training incidence not known	0.032	0.175	0.041	0.199
Size-group dummies:					
Size1_4	*1-4 employees at establishment*	*0.254*	*0.436*	*0.296*	*0.457*
Size5_9	5-9 employees at establishment	0.041	0.198	0.076	0.265
Size10_24	10-24 employees at establishment	0.080	0.271	0.112	0.315
Size25_49	25-49 employees at establishment	0.103	0.305	0.083	0.276
Size50_99	50-99 employees at establishment	0.113	0.317	0.094	0.293
Size100_199	100-199 employees at establishment	0.176	0.381	0.067	0.250
Size200_499	200-499 employees at establishment	0.113	0.317	0.140	0.348
Size500plus	500-plus employees at establishment	0.120	0.325	0.131	0.337
Sector dummies:					
Manufacturing	*Manufacturing*	*0.157*	*0.364*	*0.102*	*0.302*
Construction	Construction			0.051	0.220
Retail	Wholesale & retail			0.108	0.310
Hotels	Hotels & restaurants			0.010	0.097
Transport	Transport & communications			0.075	0.263
Finance	Finance			0.091	0.287
Business services	Business services	0.714	0.452	0.275	0.447
Public admin	Public administration			0.131	0.337
Education	Education			0.031	0.173
Health	Health & social care			0.074	0.262
Other sectors - 21	Sectors other than manufacturing or business services	0.129	0.336		
Other sectors - 41	Other services; agriculture; mining & quarrying; electricity, gas and water supply			0.053	0.223

Note: Italics indicate baseline categories for sets of dummy variables. (continued)

Table 7.7: Variable definitions and descriptive statistics (continued)

Variable name	Definition	SOC21 Mean	SOC21 s.d.	SOC41 Mean	SOC41 s.d.
Regional dummies:					
Eastern	*Eastern RDA*	*0.366*	*0.482*	*0.105*	*0.306*
East Midlands	East Midlands RDA	0.069	0.254	0.054	0.227
London	London RDA	0.152	0.359	0.265	0.442
North East	North East RDA	0.025	0.157	0.027	0.162
North West	North West RDA	0.055	0.228	0.080	0.272
South East	South East RDA	0.139	0.346	0.182	0.386
South West	South West RDA	0.086	0.281	0.120	0.325
West Midlands	West Midlands RDA	0.054	0.227	0.096	0.295
Yorks	Yorkshire & Humberside RDA	0.053	0.224	0.070	0.255
Local labour market variables:					
Log unemployment	log % of working age unemployed	1.2	0.4	1.3	0.4
Professional emp.	% emp. in professional occupations	11.7	2.1		
Secretarial emp.	% emp. in secretarial & clerical occupations			14.8	1.7
Manufacturing emp.	% employed in manufacturing	2.6	6.4	1.4	4.4
Construction emp.	% employed in construction			0.4	1.5
Distn, clerical emp.	% emp. in distribution, hotels & restaurants			0.2	1.8
Transport emp	% emp. in transport and communications			0.5	1.8
Public services emp.	% emp. in public admin., education, health & social care			3.1	8.2

Note: Italics indicate baseline categories for sets of dummy variables

Table 7.8: Additional descriptive statistics for continuous variables

Variable name	Definition	SOC21 min	SOC21 median	SOC21 max	SOC41 min	SOC41 median	SOC41 max
Labour turnover	Quits/dismissals in last 12 months as % of on-site employment	0	0.1	1.0	0	0.2	6.0
Rel. sector wage	Relative sector wage	0.8	1.0	1.2	0.8	1.0	1.3
Log unemployment	log % of working age unemployed	0.7	1.2	1.9	0.7	1.3	1.9
Professional emp.	% emp. In professional occupations	7.7	11.2	16.9			
Admin. emp.	% emp. in administrative and secretarial occupations				11.0	15.1	17.9
Manufacturing emp.	% employed in manufacturing	0	0	29.3	0	0	29.3
Construction emp.	% employed in construction				0	0	9.0
Distn, hotels emp.	% emp. in distribution, hotels & restaurants				0	0	23.1
Transport emp	% emp. in transport and communications				0	0	12.0
Public services emp.	% emp. in public admin., education, health & social care				0	0	30.9

Note: Weighted by population weights*number of vacancies

7.4 Regression results for science and technology professionals and administrative occupations

The following tables present results from logit models estimating the probabilities that, for the two selected occupations, establishment/occupation group records contain at least one hard to fill vacancy or skill-shortage vacancy. For each model two different specifications are shown, one without the local labour market variables and one with those variables. Each record is weighted by the number of vacancies reported for the occupation in question in addition to the population weighting factor. Since the standard goodness-of-fit measure is not valid in the case of categorical dependent variables, we include the pseudo-R^2 measures due to McKelvey & Zaviona (1975) and Cragg and Uhler (1970).[42] In view of concerns that standard errors may be reduced by the use of aggregated variables as regressors in all the equations shown, we also caution against placing any weight on results which are not statistically significant at the 5% level or better, and indeed the 1% level would be a safer criterion.

Occupation 21, Science and Technology Professionals

The results of the estimates applying to vacancies for science and technology professionals are presented in Table 7.9. Our expectations for this and most other occupations are that, all else being equal, employers in low-paying sectors will find it more difficult to recruit. Similarly, it is also likely that recruitment will be harder in areas with relatively low unemployment. Therefore, we would expect the probabilities of an establishment/occupation group record including (i) at least one hard to fill vacancy, or (ii) at least one skill-shortage vacancy, to be inversely related to the relative sector wage and to the local unemployment rate. However, we expect that the effect of the local unemployment rate will be less important for higher-skilled occupations where the relevant labour markets are more often regional or national in character.

In the case of science and technology professionals, recall that Table 7.5 above shows that, even at the 1-digit level, some sectors can afford to pay up to 16% over the national mean wage while other sectors pay as much as 20% below the average. However, our expectations that recruitment difficulties in this occupational group would be negatively related to the relative sector wage are only partially supported by the present analysis. In respect of hard-to-fill vacancies, the coefficients on the relative sector wage variable are negatively-signed as expected (Table 7.9, Equations 1-2) but they are only weakly significant (at the 10% level). In the case of skill-shortage vacancies (Equations 3-4), neither of the coefficients on the relative sector wage variable are statistically significant.

By contrast, some local labour market indicators are significantly related to the probability of scientist and technologist vacancies being hard-to-fill or skill-

[42] For more details on these measures see Appendix B. See also Long (1997), p. 102, for a cautionary note on the use of goodness-of-fit measures in the analysis of models with categorical dependent variables.

shortage in nature. In particular, establishments in areas with large numbers of people employed in professional occupations are less likely to report hard-to-fill or skill-shortage vacancies (coefficients significant at 5% level in Equations 2 and 4), perhaps reflecting an effect of having a large body of potential job-applicants in a local area. The local unemployment rate is also found to have a statistically significant negative effect on the probability of a vacancy being hard-to-fill or skill-shortage which is harder to account for given that many employers of science and technology professionals advertise in and recruit from wider regional and national labour markets (Mason, 1999). One possible conjecture is that a high (low) incidence of difficulties in filling vacancies for science and technology may be correlated with unobserved variables contributing to high (low) demand in local labour markets for employees across a wide range of occupations. [43]

With regard to the effects of labour turnover, the relevant coefficients on the separation rate variable all lack statistical significance in relation to both hard-to-fill and skill-shortage vacancies. Since this variable refers to quits and dismissals among all employees, it is perhaps not surprising that it is not significantly related to difficulties in recruiting scientists and technologists which represent only a small proportion of the workforce in many establishments.

In the case of training effects, prior expectations are mixed. On the one hand, high levels of training could help to meet establishments' skill needs without recourse to the external labour market and thus, all else being equal, reduce the probability of establishments reporting skill-shortage vacancies. On the other hand, it is not hard to imagine circumstances where establishments with relatively high demand for skills simultaneously engage in training a large proportion of their workforce and seek to recruit more skilled people. In fact, the results in Table 7.9 (Equations 3-4) suggest that firms who offer off-the-job training to 30% or more of their employees are significantly less likely to have skill-shortage vacancies for science and technology professionals than are firms who do no training.

In respect of the relationship between establishment growth and recruitment difficulties, causality is unlikely to be straightforward. It is possible that, on the one hand, rapid growth may cause the incidence of hard-to-fill vacancies and skill shortages to increase in some establishments while, on the other hand, recruitment difficulties may themselves contribute to declining sales in other establishments. At the same time establishments with shrinking sales or budgets may experience recruitment difficulties if potential job applicants view them as belonging to a declining part of the economy.

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[43] In order to check whether the negative correlation between local area unemployment and difficulties in recruiting science and technology professionals was being driven by very small establishments (which may well confine advertising and recruitment to local areas), alternative regressions (not shown) were carried out excluding establishments with less than 5 employees. The results showed that the negative correlation between local area unemployment and the probability of a vacancy being hard-to-fill remained statistically significant; however, the equivalent relationship was no longer significant in the case of skill-shortage vacancies.

In the case of science and technology professionals, there are signs that the growth of the establishment in terms of sales (or budget for the public sector) over the past twelve months is positively related to the probability of reporting both hard-to-fill vacancies and skill-shortage vacancies. However, the coefficients are not significant for establishments where sales (or budgets) have declined 'a great deal'.

Table 7.9: Logits for SOC 21 Science & Technology Professionals

Logits of the probabilities that:
(1)-(2) establishment/occupation group record includes at least one hard-to-fill vacancy (H2F)
(3)-(4) establishment/occupation group record includes at least one skill-shortage vacancy (SSV)

Weighted by population weights x number of vacancies

	(1) H2F	(2) H2F - with local labour market variables	(3) SSV	(4) SSV - with local labour market variables
Size5_9	-2.500**	-2.149**	-2.533***	-2.096**
	(1.030)	(1.023)	(0.956)	(0.938)
Size10_24	-1.140	-0.923	-0.387	-0.196
	(1.017)	(0.970)	(0.959)	(0.949)
Size25_49	-0.128	0.032	0.289	0.429
	(0.988)	(0.994)	(0.934)	(0.930)
Size50_99	0.650	0.878	0.564	0.741
	(1.089)	(1.062)	(1.025)	(0.992)
Size100_199	0.522	0.736	0.804	0.930
	(1.097)	(1.103)	(1.090)	(1.078)
Size200_499	0.722	1.106	-0.307	-0.065
	(1.104)	(1.104)	(1.053)	(1.062)
Size500plus	1.778	1.842	0.149	0.063
	(1.138)	(1.138)	(1.102)	(1.085)
Single	0.185	0.098	0.582	0.485
	(0.484)	(0.506)	(0.495)	(0.509)
Head office	-0.133	-0.122	-0.117	-0.125
	(0.361)	(0.349)	(0.347)	(0.345)
Foreign	-0.409	-0.370	0.332	0.398
	(0.362)	(0.355)	(0.364)	(0.361)
Foreign - nk	-1.280	-1.025		
	(1.306)	(1.307)		
Public	-1.774***	-1.544***	-2.159***	-2.023**
	(0.582)	(0.590)	(0.751)	(0.794)
Declining sales/budgets	-0.150	0.003	0.833	1.026*
	(0.541)	(0.556)	(0.540)	(0.561)
Increasing sales/budgets	0.781**	0.807**	0.749**	0.775**
	(0.398)	(0.384)	(0.371)	(0.367)
Growth – nk	2.411**	3.247**	2.773**	3.601***
	(1.210)	(1.511)	(1.112)	(1.324)
Labour turnover	1.147	1.154	0.424	0.374
	(1.106)	(1.068)	(0.934)	(0.922)
Turnover – nk	-2.004***	-1.973***	-0.676	-0.592
	(0.707)	(0.693)	(0.739)	(0.750)

(Continued)

Table 7.9: Logits for SOC 21 Science & Technology Professionals (continued)

	(1) H2F	(2) H2F - with local labour market variables	(3) SSV	(4) SSV - with local labour market variables
Low training	-1.171	-1.135	-1.668*	-1.598*
	(0.804)	(0.818)	(0.891)	(0.888)
Medium training	-1.124	-1.053	-1.781**	-1.687**
	(0.818)	(0.830)	(0.870)	(0.853)
High training	-1.517*	-1.495*	-1.840**	-1.778**
	(0.795)	(0.804)	(0.864)	(0.855)
Training – nk	-0.295	-0.453	-1.032	-0.993
	(1.053)	(1.024)	(1.033)	(1.054)
Rel. sector wage	-3.932*	-3.561*	-3.117	-3.049
	(2.075)	(2.036)	(2.403)	(2.414)
Business services	0.399	0.411	1.104***	1.210
	(0.451)	(1.200)	(0.406)	(1.285)
Other sectors -21	-0.014	-0.090	0.563	0.561
	(0.509)	(1.204)	(0.494)	(1.336)
East Midlands	-1.654**	-0.995	-0.920	-0.312
	(0.786)	(0.819)	(0.909)	(0.944)
London	-1.293**	1.003	-0.974*	1.251
	(0.506)	(0.864)	(0.524)	(0.847)
North East	-0.970	0.333	-0.266	0.931
	(0.828)	(1.125)	(0.803)	(1.044)
North West	-0.789	0.009	0.009	0.795
	(0.635)	(0.698)	(0.572)	(0.675)
South East	-0.507	-0.461	-0.257	-0.178
	(0.512)	(0.530)	(0.506)	(0.525)
South West	-1.021	-0.627	-1.179*	-0.825
	(0.670)	(0.631)	(0.673)	(0.645)
West Midlands	-1.355*	0.164	0.146	1.611*
	(0.695)	(0.863)	(0.704)	(0.851)
Yorks	-1.081	-0.157	-0.184	0.581
	(0.801)	(0.877)	(0.682)	(0.784)
Log unemployment		-2.412***		-2.316***
		(0.880)		(0.871)
Professional emp.		-0.233**		-0.242**
		(0.098)		(0.098)
Manufacturing emp.		-0.010		-0.003
		(0.070)		(0.074)
Constant	6.027***	10.439***	3.670	8.316***
	(2.251)	(2.784)	(2.614)	(3.185)
Observations	548	548	545	545
Log-likelihood	-242.29	-234.26	-263.43	-255.58
C2	148.72	164.77	213.64	229.35
Prob. c2	0.00	0.00	0.00	0.00
McKelvey & Zaviona R2	0.97	0.97	0.98	0.98
Cragg & Uhler R2	0.35	0.38	0.44	0.46

Notes: Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1% .
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Occupation 41, Administrative occupations

Table 7.10 shows the results of similar estimates for administrative occupations of the determinants of the probabilities of an establishment/occupation group record including at least one hard-to-fill vacancy or at least one skill-shortage vacancy.

As shown in Table 7.5 above, there is much the same degree of variation in relative sector wages for administrative occupations as there is for science and technology professionals, but if anything the relationship between the relative sector wage variable and the incidence of hard-to-fill and skill-shortage vacancies is even weaker than for science and technology professionals. None of the relevant coefficients in Table 7.10 are statistically significant. Nonetheless, the fact that they are all (contrary to expectations) positively signed deserves some comment.

We need first to recall that the great majority (89%) of hard to fill vacancies in administrative occupations are *not* skills-related (Table 7.4). In the small minority of cases where the vacancies are attributed to skill shortfalls, we may conjecture that establishments in higher-paying sectors perhaps have more demanding selection criteria. But we also need to recall the structure of the survey questionnaire. Establishments reporting hard to fill vacancies were asked open questions about the possible causes of the recruitment problem: in the case of these occupations, it may well be that the respondents for many lower-paying establishments were conscious of their inability to compete well on salaries and were therefore less likely to cite skill-shortages as a cause of their problem.

More in line with prior expectations for a relatively low-skilled occupation group, the probability of a vacancy being hard-to-fill is found to be inversely related (at a 1% significance level) to local unemployment rates (Table 7.10, Equation 2). Other local labour market characteristics appearing to have some effects on recruitment difficulties are:

(i) the proportion of the workforce employed in manufacturing (positively associated with both hard-to-fill vacancies and skill-shortage vacancies)
(ii) the proportion of the workforce employed in public administration, education and health (negatively associated with both hard-to-fill and skill-shortage vacancies) and
(iii) the proportion of the workforce employed in distribution, hotels and restaurants (negatively associated with skill-shortage vacancies at establishment level).

In this context it seems likely that positive associations reflect the effects of competition from other local employers while negative associations suggest that the predominant effect on recruitment prospects comes from the size of the local pool of available labour.

The labour turnover rate has no significant effect on the ability of the firm to fill a vacancy. Similarly, there is no evidence of off-the-job training rates having systematic effects on the probability of vacancies being hard-to-fill or skill-

shortage in nature. This may reflect the fact that the labour turnover and training data available in this dataset apply to establishments as a whole and are not occupation-specific.

Establishment growth rates appear to have some effects on both hard-to-fill vacancies and skill-shortage vacancies in administrative occupations. The probability of a vacancy being hard-to-fill is positively and significantly related (at the 5% level) to the variable indicating a marked decrease in sales or budgets. By contrast, the probability of a vacancy being skill-shortage in nature is significantly positively related to the variable showing rapid recent growth in sales or budgets.

Table 7.10: Logits for SOC 41 Administrative Occupations

Logits of the probabilities that:
(1)-(2) establishment/occupation group record includes at least one hard-to-fill vacancy (H2F)
(3)-(4) establishment/occupation group record includes at least one skill-shortage vacancy (SSV)

Weighted by population weights x number of vacancies

	(1) H2F	(2) H2F - with local labour market variables	(3) SSV	(4) SSV - with local labour market variables
Size5_9	0.496	0.352	-1.123	-1.247
	(0.593)	(0.578)	(0.763)	(0.760)
Size10_24	1.173**	1.042*	0.308	0.257
	(0.565)	(0.536)	(0.628)	(0.606)
Size25_49	0.979*	0.859	-0.161	-0.323
	(0.574)	(0.548)	(0.656)	(0.637)
Size50_99	1.332**	1.229**	0.214	0.187
	(0.604)	(0.565)	(0.698)	(0.670)
Size100_199	0.999*	0.951*	0.210	0.123
	(0.586)	(0.571)	(0.627)	(0.618)
Size200_499	1.400**	1.365**	0.241	0.318
	(0.609)	(0.574)	(0.686)	(0.656)
Size500plus	2.397***	2.379***	1.523**	1.539**
	(0.645)	(0.630)	(0.677)	(0.664)
Single	0.589**	0.536**	0.430	0.444
	(0.258)	(0.246)	(0.306)	(0.292)
Head office	-0.076	-0.038	-0.403	-0.232
	(0.253)	(0.239)	(0.332)	(0.315)
Foreign	-0.424	-0.372	-0.024	0.049
	(0.327)	(0.325)	(0.376)	(0.360)
Foreign - nk	0.994	0.939		
	(1.092)	(1.090)		
Public	-0.054	0.001	-0.493	-0.526
	(0.282)	(0.291)	(0.383)	(0.401)
Sector - nk	-1.282	-1.155		
	(1.228)	(1.198)		
Declining sales/budgets	0.959**	0.820**	0.684	0.522
	(0.385)	(0.400)	(0.417)	(0.450)
Increasing sales/budgets	0.432	0.503	0.947***	1.024***
	(0.318)	(0.306)	(0.363)	(0.358)
Growth – nk	0.727	0.082	1.180	0.951
	(1.128)	(0.912)	(1.517)	(1.185)

(Continued)

Table 7.10: Logits for SOC 41 Administrative Occupations (continued)

	(1) H2F	(2) H2F - with local labour market variables	(3) SSV	(4) SSV - with local labour market variables
Labour turnover	0.134	0.148	-0.151	-0.139
	(0.205)	(0.201)	(0.257)	(0.268)
Turnover – nk	0.594	0.325	-0.785	-0.947
	(0.478)	(0.421)	(0.644)	(0.656)
Low training	-0.530	-0.556	-0.082	-0.102
	(0.356)	(0.340)	(0.409)	(0.417)
Medium training	-0.410	-0.431	0.350	0.387
	(0.384)	(0.363)	(0.419)	(0.408)
High training	0.210	0.305	0.431	0.493
	(0.452)	(0.420)	(0.500)	(0.486)
Training – nk	-0.374	-0.301	1.091*	0.928*
	(0.553)	(0.503)	(0.595)	(0.551)
Rel. sector wage	1.837	1.449	3.734	3.441
	(2.140)	(1.983)	(2.712)	(2.509)
Construction	-0.880	0.682	-1.915**	-2.887
	(0.702)	(5.171)	(0.879)	(8.714)
Retail	0.627	3.555***	0.719	2.872**
	(0.569)	(1.147)	(0.594)	(1.277)
Hotels	0.224	0.720	0.419	9.659**
	(0.583)	(4.924)	(0.685)	(4.854)
Transport	0.703	5.245***	-0.533	2.348
	(0.560)	(1.620)	(0.746)	(2.628)
Finance	-0.032	2.972***	-0.386	1.766
	(0.624)	(1.133)	(0.693)	(1.212)
Business services	0.172	3.076***	0.075	2.163*
	(0.423)	(1.070)	(0.416)	(1.124)
Public admin	0.712	9.369***	0.361	11.945***
	(0.534)	(2.664)	(0.603)	(3.533)
Education	-0.058	2.727**	-0.232	1.851
	(0.511)	(1.101)	(0.613)	(1.222)
Health	0.994*	3.870***	1.018	3.103**
	(0.539)	(1.137)	(0.662)	(1.285)
Other sectors - 41	0.246	3.114***	-0.014	2.085*
	(0.529)	(1.125)	(0.620)	(1.212)
East Midlands	0.530	0.572	0.942	0.852
	(0.526)	(0.507)	(0.650)	(0.640)
London	-0.039	1.001**	0.369	0.640
	(0.363)	(0.477)	(0.502)	(0.592)
North East	0.336	1.672**	0.068	0.690
	(0.616)	(0.716)	(0.761)	(0.817)
North West	0.103	0.894	1.141*	1.517**
	(0.567)	(0.653)	(0.670)	(0.704)
South East	0.513	0.498	0.868*	0.919*
	(0.369)	(0.360)	(0.516)	(0.510)
South West	0.011	0.278	0.898	1.104*
	(0.512)	(0.519)	(0.624)	(0.634)
West Midlands	-0.762*	-0.136	-0.069	0.123
	(0.403)	(0.465)	(0.568)	(0.629)
Yorks	0.110	0.947*	0.731	1.158*
	(0.478)	(0.547)	(0.674)	(0.680)
Log unemployment		-1.568***		-0.506
		(0.499)		(0.565)
Secretarial emp.		-0.073		-0.078
		(0.057)		(0.076)
Manufacturing emp.		0.187***		0.126**
		(0.056)		(0.058)

(Continued)

Table 7.10: Logits for SOC 41 Administrative Occupations (continued)

	(1) H2F	(2) H2F - with local labour market variables	(3) SSV	(4) SSV - with local labour market variables
Construction emp.		0.168		0.438
		(0.696)		(1.256)
Distn, hotels emp.		0.128		-0.387
		(0.254)		(0.250)
Transport emp.		-0.229		-0.104
		(0.155)		(0.316)
Public services emp.		-0.245**		-0.398***
		(0.101)		(0.140)
Constant	-4.145*	-3.934	-6.725**	-6.949**
	(2.201)	(2.519)	(2.807)	(3.143)
Observations	1685	1685	1671	1671
Log-likelihood	-924.05	-887.68	-626.97	-608.99
c2	331.75	404.50	226.63	262.58
prob. c2	0.00	0.00	0.00	0.00
McKelvey & Zaviona R2	0.94	0.95	0.95	0.96
Cragg & Uhler R2	0.18	0.21	0.13	0.15

Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1% .

7.5 Results for other key occupations

We now go on to present similar results for a wider range of occupations which have been chosen to encompass diverse manual and non-manual work activities and different levels of qualifications and skills:

- 24 - business and public service professionals
- 32 - health and social welfare associate professionals
- 52 - skilled metal and electrical trades
- 53 - skilled construction and building trades
- 62 - leisure and other personal service occupations
- 81 - process, plant and machine operatives

As Table 7.11 shows, the majority of establishments reporting vacancies in these occupation groups are concentrated in one or two main sectors (in the same way as science and technology professionals, 21) rather than scattered among different sectors (as is the case for administrative occupations, 41).

Tables 7.12 and 7.13 summarize the statistically significant relationships between key variables of interest and the estimated probabilities of vacancies in these six new occupations being hard-to-fill or skill-shortage in nature. (Detailed results are shown in Appendix Tables D7.1-7.7). For these occupations the relative sector wage variable has been omitted from the specifications on the grounds that it did not prove to be significant for either Occupations 21 or 41 and that, due to the difference in occupational classifications between ESS and the NES, relative sector wages can only be approximated for each occupation in any case.

For three occupations (32, 62 and 81) the probability of a vacancy being hard-to-fill is significantly negatively related to the establishment reporting rapid growth in sales or budgets in the previous 12 months (Table 7.12). The same type of relationship is found for Occupation 81 (process, plant and machine operatives) in respect of skill-shortage vacancies (Table 7.13). For these occupations, therefore, we surmise that establishments which are seen as prospering find it easier to attract prospective recruits. The variable indicating recent rapid decline in sales or budgets only has statistically significant effects for one occupation (81) where it is inversely related to the probability of a vacancy being hard-to-fill.

Table 7.11: Numbers of establishment/occupation group vacancy records, analysed by industry

	Occupation							
	21	**24**	**32**	**41**	**52**	**53**	**62**	**81**
Industry				*Percentages*				
Agriculture & fishing	0	0	0	0	0	1	0	1
Mining & quarrying	1	0	0	0	0	0	0	0
Manufacturing	33	5	1	13	44	7	1	75
Electricity, gas & water supply	1	1	0	1	0	0	0	0
Construction	4	9	0	5	15	79	0	7
Wholesale & retail	3	2	1	10	18	3	1	6
Hotels & restaurants	0	1	1	3	1	0	12	0
Transport & communications	3	2	0	9	5	0	8	1
Finance	1	6	0	8	0	0	0	0
Business services	47	49	1	21	13	8	4	7
Public administration	0	8	4	9	0	1	2	0
Education	4	3	3	7	1	0	6	0
Health & social care	2	5	87	9	1	1	6	0
Other services	2	9	3	6	2	1	59	2
TOTAL	100	100	100	100	100	100	100	100
n =	*556*	*373*	*507*	*1698*	*525*	*311*	*391*	*666*

Foreign ownership has no significant effects on the probability of vacancies being hard-to-fill in any of these six occupations but is positively related to the probability of vacancies being skill-shortage in nature for two non-manual occupations (24 and 32). Public sector ownership is inversely related to the probability of vacancies being hard-to-fill for health and social welfare associate professionals (32) and skilled metal and electrical trades (52).

The establishment-level labour turnover rate is positively associated with the probability of vacancies being hard-to-fill for skilled construction trades (53) which account for a sizeable proportion of total employment in construction establishments. This finding accords with expectations that higher rates of turnover will in general add to recruitment difficulties. However, in two non-manual occupations -- health and social welfare associate professionals (32) and leisure and other personal service occupations (62) -- the probability of

vacancies being skill-shortage in nature turns out to be inversely related to labour turnover. One possible explanation might be that, in the labour markets for these occupations, high levels of labour turnover are associated with regular interchanges of employees between establishments so that departing employees are fairly easily replaced by most firms. But we lack the information needed to explore this kind of proposition.

Off-the-job training rates are found to be significantly and positively associated with the probability of vacancies being hard-to-fill for two occupations (skilled construction trades and process and machine operatives) and with the probability of vacancies being of a skill-shortage type for three occupations: business and public service professionals, skilled metal and electrical trades and process and machine operatives. One potential inference is that many establishments experiencing difficulties in filling jobs for these occupation groups react to these problems by spending more on training existing staff. But the causality could just as easily run the other way: high-training companies may find that their skilled employees in these occupation groups tend to be lured away by low-training or no-training companies and then prove hard to replace.

The results of including local labour market variables are statistically significant for three of these six occupations. In skilled construction trades (53) the probability of vacancies being hard-to-fill is inversely related to local area unemployment rates and the probability of vacancies being skill-shortage vacancies is positively related to the proportion of local employees working in construction, implying that competition between local employers contributes to skill shortages in these trades. By contrast, in the case of business and public service professionals (24), the probabilities of vacancies being either hard-to-fill or skill-shortage are inversely related to the proportion of local employees in professional occupations, suggesting that many employers recruiting to these occupation groups may benefit from large pools of suitably qualified labour in local labour markets.

In addition, RDA regional dummies pick up statistically significant differences between regions in the ease of recruiting to vacancies for health and social welfare associate professionals (32), skilled metal and electrical trades (52) and leisure and other personal service occupations (62). These findings suggest that labour markets for occupations such as nurses and housing and community workers (32) and electricians (52) may spread much further than LSC local areas but tend to be differentiated across more broadly defined geographical areas.

By contrast, after controlling for region and the wide range of establishment-level characteristics described above, there are few signs of significant differences between sectors in the probabilities of vacancies being hard-to-fill or skill-shortage in nature. The only exceptions are reduced likelihood of (1) hard-to-fill vacancies for process operators in non-manufacturing sectors and for health and social welfare associate professionals outside the health and social care sectors; (2) skill-shortage vacancies for business and public services professionals occurring outside the business services sector.

Table 7.12: Probability that establishment/occupation group record includes at least one hard-to-fill vacancy: estimated relationship to selected variables (Statistically significant relationships at 5% level or better)

	24 - Business and public service professionals	32 – Health and social welfare associate professionals	52 - Skilled metal and electrical trades	53 – Skilled construction and building trades	62 - Leisure and other personal service occupations	81 - Process, plant and machine operatives
Hard-to-fill vacancies / Vacancies (%)	60	47	67	73	49	49
Establishment growth in last 12 months:						
Rapid growth		Negative			Negative	Negative
Slow growth			Negative			
Establishment foreign-owned						
Establishment in public sector		Negative	Negative			
Labour turnover rate				Positive		
Off-the-job training rate				Positive		Positive
Log % local unemployment rate				Negative		
% local employment in same occupation group	Negative					
% local employment in key sectors						
Sector dummies (Base categories = manufacturing)[a]		Non-health and social care –ve				Non-manufg +ve
RDA regional dummies (Base category = Eastern region)	South West -ve	South East –ve London -ve Yorks -ve South West -ve	London +ve Yorks –ve North East -ve		E Midlands -ve North West -ve	E Midlands -ve

Note: a) 52,81; business services 24; construction, 53; health and social care, 32; other services, 62.

Table 7.13: Probability that establishment/occupation group record includes at least one skill-shortage vacancy: estimated relationship to selected variables (Statistically significant relationships at 5% level or better)

	24 - Business and public service professionals	32 - Health and social welfare associate professionals	52 - Skilled metal and electrical trades	53 - Skilled construction and building trades	62 - Leisure and other personal service occupations	81 - Process, plant and machine operatives
Skill-shortage vacancies/Vacancies (%)	46	20	36	48	25	24
Establishment growth in last 12 months:						
Rapid growth						
Slow growth						Negative
Establishment foreign-owned	Positive	Positive				
Establishment in public sector						
Labour turnover rate		Negative			Negative	
Off-the-job training rate	Positive		Positive			Positive
Log % local unemployment rate						
% local employment in same occupation group	Negative					
% local employment in key sectors				Positive		
Sector dummies (Base categories = manufacturing)	Non-business services -ve					
RDA regional dummies (Base category = Eastern region)	E Midlands +ve	E Midlands +ve North West +ve W Midlands +ve North West +ve	North West +ve		North East -ve North West -ve	E Midlands -ve

Note: a) 52,81; business services 24; construction, 53; health and social care, 32; other services, 62.

7.5 Conclusions

The occupational dataset derived from ESS sheds a great deal of light on differences between two-digit occupation groups in the incidence of vacancies, hard-to-fill vacancies and skill-shortage vacancies. For example, some occupational vacancies and recruitment difficulties are heavily concentrated in one or two industries while others are spread across many industries. The intensity of recruitment difficulties also varies sharply between occupations, for example, while over half of the vacancies reported for science and technology professionals were proving hard-to-fill for skill-related reasons, the equivalent proportion for administrative occupations was only 11%.

7.5.1 Main findings

In this chapter we have investigated the main determinants of hard-to-fill vacancies and skill-shortages in eight different occupation groups, with particular emphasis on the role played by relative sector wages, off-the-job training, establishment growth rates, labour turnover and local labour market conditions. After controlling for a number of establishment-level characteristics (such as employment-size, foreign ownership, and public sector ownership) and industry-specific and region-specific factors, the following main conclusions emerge:

Relative wage levels:

Estimates of relative sector wages were entered as independent variables in the equations applying to science and technology professionals and administrative occupations. The relevant coefficients were not statistically significant at the 5% level for either occupation. In the case of science and technology professionals, the coefficients were negatively-signed (as expected) but the reverse was true for administrative occupations: for the latter group of occupations we conjecture that respondents for many lower-paying establishments may have been conscious of their inability to compete well on salaries and were therefore less likely to cite skill shortages as a cause of their recruitment difficulties.

Training provision:

For two out of the eight occupations under consideration (skilled construction trades and process and machinery operatives), the probability of an establishment/vacancy record including at least one hard-to-fill vacancy was positively and significantly related to the incidence of off-the-job training. The causation in this relationship is hard to pinpoint. It may be that in these occupational areas training is a form of response to recruitment difficulties. Alternatively, or in addition, higher-training companies may find it hard to prevent trained staff in these occupations being hired away by other employers. A similar inference can be drawn for three occupations – business and public service professionals, skilled metal and electrical trades and process and machinery operatives – where the probability of vacancies being skill-shortage in nature was positively and significantly related to off-the-job training provision. However, for science and technology professionals, the

relationship was significantly negative, implying that willingness to train may (all else being equal) improve establishments' abilities to recruit successfully to that occupation group

Establishment growth rates:

In the case of administrative occupations, the probability of an establishment/ vacancy record including at least one hard-to-fill vacancy was found to be significantly positively related to the variable identifying establishments which had experienced a rapid decline in sales or budgets while the probability of vacancies being skill-shortage in nature was positively related to rapid growth in sales or budgets. However, this was the only occupation group where there were signs of a 'U-shaped' relationship between the incidence of recruitment difficulties and establishment growth rates.

For establishments reporting vacancies for science and technology professionals, rapid growth was significantly and positively associated with rapid growth in sales but not with rapid decline. And for other occupation groups where significant effects of growth rates were identified, the evidence suggests that rapid growth in sales or budgets largely eased the process of new recruitment. The probability of vacancies being hard-to-fill was lower for rapidly-growing establishments seeking to recruit new staff to jobs in four areas: health and social welfare associate professionals, skilled metal and electrical trades, leisure and other personal service occupations and process and machinery operatives. Recent rapid growth in sales or budgets was also found to be inversely related to the probability of vacancies being skill-shortage in nature for process and machinery operatives.

Labour turnover:

Contrary to expectations that labour turnover rates would be positively associated with recruitment difficulties for several occupations, this kind of relationship was found to apply for only one occupation -- skilled construction trades – in respect of the probability of hard-to-fill vacancies being hard-to-fill. In the cases of health and social welfare associate professionals and leisure and other personal service occupations, the probability of vacancies being skill-shortage in nature was found to be significantly inversely related to our establishment-level measure of labour turnover. These relationships are hard to assess without more detailed and occupation-specific data on labour turnover.

Local labour market conditions:

For five of the eight occupations under consideration, the probabilities of an establishment/occupation vacancy record including at least one hard-to-fill vacancy or one skill-shortage vacancy were not significantly affected by including local unemployment rates as regressors in the relevant equations. The exceptions were science and technology professionals, administrative occupations and skilled construction trades.

In the cases of science and technology professionals and business/public

service professionals, the probability of vacancies being skill-shortage in nature was found to be inversely related to the proportion of local area employees in professional occupations, suggesting that the availability of large pools of professional labour may predominate over the disadvantages arising from intense local competition for these types of employee.

For all other occupation groups which were investigated, no link could be identified between the proportions of local employment in the same occupation groups and the probabilities of vacancies being hard-to-fill or skill-shortage in nature. However, in the case of administrative occupations, both hard-to-fill vacancies and skill-shortage were found to be less (more) likely to occur in local areas with relatively high (low) proportions of employees working in manufacturing or public administration, education, health and social care. By contrast, in skilled construction trades the probability of vacancies being skill-shortage vacancies was positively related to the proportion of local area employees working in the construction sector, implying strong effects of competition between employers for skilled workers.

7.5.2 Limitations and potential of the occupational dataset

In general, the impacts of potential influences on the probabilities of vacancies being hard-to-fill or skill-shortage were found to vary widely between occupations even when those occupations ostensibly had key features in common, e.g. being classed as skilled manual trades. In part, this diversity in findings may reflect the fact that many of the variables which one can derive from the dataset are not occupation-specific. For example, the available measures of labour turnover and off-the-job training rates apply to all employees at each establishment, not to any of the occupation groups under consideration.

More generally, the explanatory power of the multivariate analysis we have carried out has probably been reduced by the degree of heterogeneity within the two-digit occupations identified in the dataset. For example, there is unlikely to be much overlap in labour markets for mechanical engineers and ICT professionals in SOC 21 or for credit controllers and telephonists in SOC 41.

Nonetheless, the dataset should repay further detailed analysis. For example, our findings suggest that, for several occupation groups, the probabilities of vacancies being hard-to-fill or skill-shortage in nature are more likely to be associated with differences between broadly-defined regions than they are with differences between local area labour markets. In future research making use of this occupational dataset, it could prove useful to incorporate other geographical measures of employment and unemployment such as those based on travel-to-work areas in order to gain a better understanding of the regional dimension of different types of occupational skill shortage.

Appendix to Chapter 7: Estimates of relative sectoral wages

As noted in Section 7.5, the relative sector wage data used in our analysis were derived from the New Earnings Survey (NES) for the period 2000-1 in which the Employers Skills Survey was carried out. Because the NES in 2000-1 was still coded to the 1990 Standard Occupational Classification (SOC), we needed to use information about correspondences between SOC 1990 and SOC 2000 occupational groups in order to derive estimates of relative sectoral wages for Occupations 21 and 41 on the SOC 2000 classification.

Unpublished data based on the Labour Force Survey (LFS) for Summer 2000 (kindly provided by the Office of National Statistics) showed that LFS respondents classified to SOC 2000 Group 21 (Science & Technology Professionals) were distributed across SOC 90 2-digit groups as follows:

21 Engineers and technologists - 43%
32 Computer analyst/programmers - 22%
20 Natural scientists - 10%
30 Scientific technicians - 3%
52 Electrical / electronic trades - 3%
11 Production managers in manufacturing, construction, mining and energy industries - 2%
51 Metal machining, fitting and instrument making trades - 2%
Other occupations - 15%

In order to derive estimates of mean wages by sector for SOC 2000 Group 21, we took the three SOC 90 occupational groups accounting for more than 5% of SOC 2000 Group 21 employment and defined a Restricted Science & Technology Professionals (RSTP) category to consist solely of those SOC 90 Groups: 20, 21 and 32 (in fact representing 75% of all LFS respondents classified to SOC 2000 Group 21).

Table 7.A.1: Mean wage per week by sector for main SOC 90 occupation groups classified to SOC 2000 Group 21 Science & Technology Professionals

Industry sector	*SOC 1990 Group*					
	20		***21***		***32***	
	Mean (£)	*n*	*Mean (£)*	*n*	*Mean (£)*	*n*
Agriculture & Fishing	481	7	583	4	479	1
Mining & quarrying	868	16	754	38	578	12
Manufacturing	581	322	553	2459	514	432
Elec, gas & water supply	596	28	657	217	637	73
Construction	426	4	520	225	396	21
Wholesale & retail	552	63	603	360	538	366
Hotels & restaurants	.		395	10	431	7
Transport & comms	598	5	638	312	597	188
Finance	529	5	660	166	630	465
Business services	556	451	594	2053	524	1247
Public admin	470	190	512	265	499	91
Education	437	178	474	141	408	184
Health & social care	488	247	456	28	440	52
Other services	422	36	577	113	466	56

Source: New Earnings Survey 2000-1

For each sector the NES wage data for each of these three SOC 90 groups were then weighted by the proportions of RSTPs employed in each of the three groups. This procedure was carried out to the highest level of sectoral disaggregation consistent with minimum cell size requirements (25 respondents) in the NES. Mean wages by sector for the three SOC 90 groups concerned are shown in Table 7.A.1.

In the case of Occupation 41 Administrative Occupations, LFS respondents classified to this group in Summer 2000 were distributed across SOC 90 2-digit groups as follows:

41 Numerical clerks and cashiers - 31%
43 Clerks nes - 19%
40 Administrative/clerical officers and assistants in civil service and local government - 12%
42 Filing and records clerks - 7%

13 Financial institution and office managers, civil service executive officers - 6%

44 Stores and despatch clerks, storekeepers - 3%
46 Receptionists, telephonists and related occupations - 3%
49 Clerical and secretarial occupations - 3%
Others - 16%

In order to obtain estimates of mean wages by sector for SOC 2000 Group 41, we then carried out a similar procedure as for SOC 2000 Group 21. In this case a new Restricted Administrative Occupations group was defined to consist of the five SOC 90 two digit groups accounting for more than 5% of SOC 2000 Group 41 employment. By coincidence these selected groups also happened to represent 75% of estimated employment in the relevant SOC 2000 Group (41). Mean wages by sector for these five SOC 90 occupational groups are shown in Table 7.A.2.

Table 7.A.2: Mean wage per week by sector for main SOC 90 occupation groups classified to SOC 2000 Group 41 Administrative Occupations

	SOC 1990 Group									
	13		***40***		***41***		***42***		***43***	
Industry sector	*Mean (£)*	*n*	*Mean (£)*	*n*	*Mean (£)*	*n*	*Mean (£)*	*n*	*Mean (£)*	*n*
Agriculture & Fishing	308	13	177	2	206	34	226	3	211	39
Mining & quarrying	607	21	.		251	17	362	15	269	26
Manufacturing	487	701	190	4	266	1132	279	581	235	1503
Elec, gas & water supply	597	79	282	4	320	121	337	40	280	441
Construction	451	142	262	33	231	258	230	55	213	373
Wholesale & retail	463	686	232	8	223	1463	221	418	210	2472
Hotels & restaurants	538	43	226	4	224	153	215	40	188	228
Transport & comms	535	652	341	6	266	610	267	782	281	1406
Finance	612	2211	260	6	271	5113	271	132	250	1834
Business services	522	1138	250	113	259	1866	242	465	203	3200
Public admin	357	1863	234	4814	280	214	244	117	237	807
Education	470	224	229	1981	269	374	183	720	204	1994
Health & social care	382	339	210	608	237	320	192	227	195	1890
Other services	457	158	272	108	198	543	210	192	216	617

Source: New Earnings Survey 2000-1

Appendix 7B: Goodness of fit measures

Since the standard goodness-of-fit measure is not valid in the case of categorical dependent variables, we include the pseudo-R^2 measure due to McKelvey & Zaviona (1975)[44]. This is calculated as

$$R^2_{M\&Z} = \frac{\hat{Var}\left(\hat{Y}*\right)}{\hat{Var}\left(\hat{Y}*\right)+\hat{Var}\left(\hat{\varepsilon}\right)}.$$

where

$$\hat{Var}\left(\hat{Y}*\right)= \hat{\beta}'\hat{Var}\left(X\right)\hat{\beta}$$

Care must be taken when using such a measure with weighted data since this measure is not scale-invariant, as $\hat{Var}\left(\hat{\varepsilon}\right)$ is fixed to identify the model[45]. Therefore, we normalise the weights so that they sum to one.

In addition to the McKelvey and Zaviona (1975) pseudo-R^2 $\left(R^2_{M\&Z}\right)$, we also present one based on a transformation of the likelihood ratio due to Cragg and Uhler (1970), $R^2_{C\&U}$. The Cragg and Uhler (1970) pseudo-R^2 measure is a normed improvement on that suggested by Maddala (1983) so that, like R^2 in the standard linear regression model, it has one as its upper limit[46]:

$$R^2_{C\&U} = \frac{R^2_{ML}}{\max R^2_{ML}} = \frac{1-\left[L\left(M_{Int}\right)/L\left(M_{Full}\right)\right]^{2/N}}{1-L\left(M_{Full}\right)^{2/N}}.$$

where $L(M_{Int})$ is the likelihood for the model with just the intercept and $L(M_{Full})$ is that for the model including the regressors.

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44 In simulation studies of a number of alternative pseudo R^2 measures, Windmeijer (1995) and Hagle and Mitchell (1992) found that the measure due to McKelvey & Zaviona (1975) most closely approximates the R^2 obtained by estimating a linear regression model on the underlying latent variable.

45 In the logit model $\hat{Var}\left(\hat{\varepsilon}\right)$ is assumed to equal $\pi^2/3$, in the probit model it is assumed to equal 1.

46 rather than $1-L(M_{Int})^{2/N}$

Appendix 7C: Descriptive statistics relating to SOC groups 21 and 41

Table 7.C.1: Sectoral Breakdown of Vacancies for SOC groups 21 and 41

	21 Science & Technology Professionals						*41 Administrative Occupations*					
	Vacancies		**Hard-to-fill vacancies**		**Skill-shortage vacancies**		**Vacancies**		**Hard-to-fill vacancies**		**Skill-shortage vacancies**	
Industry sector	*V*	%	*H*	%	*S*	%	*V*	%	*H*	%	*S*	%
Agriculture & Fishing	.	.	.	.	.	.	166	0.2	90	0.5	90	1.0
Mining & quarrying	98	0.3	18	0.1	8	0.0	259	0.3	23	0.1	0	0.0
Manufacturing	4,711	15.7	3,023	14.8	1,453	8.8	8,002	10.2	1,219	6.1	483	5.5
Elec, gas & water supply	67	0.2	6	0.0	6	0.0	308	0.4	57	0.3	6	0.1
Construction	599	2.0	478	2.3	423	2.6	4,012	5.1	326	1.6	117	1.3
Wholesale & retail	561	1.9	186	0.9	177	1.1	8,459	10.8	1,973	9.9	1,094	12.5
Hotels & restaurants	3	0.0	0	0.0	0	0.0	751	1.0	191	1.0	82	0.9
Transport & comms	754	2.5	534	2.6	189	1.1	5,864	7.5	2,920	14.7	684	7.8
Finance	598	2.0	125	0.6	25	0.1	7,128	9.1	2,332	11.7	1,433	16.4
Business services	21,490	71.4	15,554	75.9	14,103	85.0	21,638	27.5	5,000	25.2	2,775	31.7
Public admin	11	0.0	0	0.0	0	0.0	10,276	13.1	3,835	19.3	1,059	12.1
Education	500	1.7	302	1.5	175	1.1	2,413	3.1	201	1.0	116	1.3
Health & social care	365	1.2	216	1.1	28	0.2	5,805	7.4	1236	6.2	649	7.4
Other services	327	1.1	38	0.2	0	0.0	3,409	4.3	435	2.2	161	1.8
Total classified	***30,084***	***100***	***20,480***	***100***	***16,587***	***100***	***78,489***	***99.8***	***19,838***	***99.8***	***8,750***	***100***
Not coded	-	-	-	-	-	-	135	0.2	40	0.2	-	-
Total	**30,084**	**100**	**20,480**	**100**	**16,587**	**100**	**78624**	**100**	**19878**	**100**	**8750**	**100**

Table 7.C.2: Regional Breakdown of Vacancies for SOC groups 21 and 41, population-weighted

	21 Science & Technology Professionals						*41 Administrative Occupations*					
	Vacancies		**Hard-to-fill vacancies**		**Skill-shortage vacancies**		**Vacancies**		**Hard-to-fill vacancies**		**Skill-shortage vacancies**	
RDA Region	*V*	%	*H*	%	*S*	%	*V*	%	*H*	%	*S*	%
Eastern	11014	36.6	9498	46.4	8145	49.1	8233	10.5	1906	9.6	731	8.4
East Midlands	2086	6.9	1187	5.8	977	5.9	4265	5.4	1718	8.6	328	3.7
London	4568	15.2	2714	13.3	2025	12.2	20851	26.5	5209	26.2	1754	20.0
North East	760	2.5	389	1.9	305	1.8	2130	2.7	499	2.5	88	1.0
North West	1657	5.5	1016	5.0	924	5.6	6313	8.0	1789	9.0	1223	14.0
South East	4168	13.9	2625	12.8	1915	11.5	14337	18.2	3990	20.1	1498	17.1
South West	2602	8.6	1380	6.7	811	4.9	9434	12.0	2723	13.7	2049	23.4
West Midlands	1635	5.4	866	4.2	837	5.0	7568	9.6	984	5.0	440	5.0
Yorkshire & Humberside	1594	5.3	806	3.9	648	3.9	5493	7.0	1060	5.3	639	7.3
Total	**30084**	**100**	**20480**	**100**	**16587**	**100**	**78624**	**100**	**19878**	**100**	**8750**	**100**

Table 7.C.3: Vacancies for SOC groups 21 and 41 by Establishment size, population-weighted

	21 Science & Technology Professionals						*41 Administrative Occupations*					
	Vacancies		**Hard-to-fill vacancies**		**Skill-shortage vacancies**		**Vacancies**		**Hard-to-fill vacancies**		**Skill-shortage vacancies**	
Number of employees	*V*	%	*H*	%	*S*	%	*V*	%	*H*	%	*S*	%
1-4	7636	25.4	6977	34.1	6662	40.2	23281	29.6	4701	23.6	2505	28.6
5-9	1227	4.1	282	1.4	174	1.1	5992	7.6	1495	7.5	384	4.4
10-24	2400	8.0	1187	5.8	1108	6.7	8798	11.2	3092	15.6	1554	17.8
25-49	3105	10.3	1832	8.9	1554	9.4	6541	8.3	1700	8.6	568	6.5
50-99	3402	11.3	1964	9.6	1749	10.5	7425	9.4	2203	11.1	935	10.7
100-199	5307	17.6	3875	18.9	3506	21.1	5248	6.7	849	4.3	332	3.8
200-499	3405	11.3	2044	10.0	1031	6.2	11040	14.0	2875	14.5	795	9.1
500-999	1881	6.3	1223	6.0	675	4.1	4766	6.1	1134	5.7	912	10.4
1000+	1721	5.7	1096	5.3	127	.8	5533	7.0	1828	9.2	766	8.8
Total	30084	100	20480	100	16587	100	78624	100	19878	100	8750	100

Appendix 7D: Detailed results of multivariate analyses for selected occupations

Table 7.D.1: Variable definitions and descriptive statistics for Occupations 24, 32, 52, 53, 62 and 81 (at the level of establishment/ occupation group records)

Weighted by population weights x number of vacancies

		24		32		52		53		62		81	
Variable	**Definition**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Hard-to-fill	1=Vacancy is hard-to-fill	0.676	0.469	0.605	0.489	0.711	0.454	0.752	0.432	0.525	0.500	0.558	0.497
Skill-shortage	1=Vacancy is skill-shortage vacancy	0.530	0.500	0.270	0.444	0.378	0.485	0.506	0.501	0.259	0.439	0.270	0.444
Single	1=single-site enterprise	0.532	0.500	0.461	0.499	0.657	0.475	0.881	0.324	0.678	0.468	0.474	0.500
Head office	1=Head office	0.277	0.448	0.225	0.418	0.098	0.297	0.060	0.237	0.106	0.309	0.194	0.396
Foreign	1=Foreign owned or joint UK/foreign-owned	0.097	0.296	0.010	0.100	0.097	0.296	0.005	0.073	0.028	0.166	0.144	0.352
Foreign – nk	1= Ownership nationality not known	0.004	0.067	0.002	0.049	0.014	0.119	0.003	0.053	0.000	0.016	0.001	0.036
Public	1=Public sector	0.443	0.497	0.786	0.410	0.068	0.252	0.017	0.130	0.124	0.330	0.066	0.248
Sector – nk	1=Public/private status not known	0.001	0.026	0.001	0.024	0.008	0.090	0.002	0.047	0.001	0.027	0.013	0.113
Declining sales/budgets	1=Sales/budget decreased a great deal in past 12 months	0.023	0.149	0.032	0.176	0.079	0.271	0.045	0.207	0.093	0.291	0.083	0.276
Increasing sales/budgets	1=Sales/budget increased a great deal in past 12 months	0.177	0.382	0.056	0.230	0.362	0.481	0.362	0.481	0.081	0.273	0.264	0.441
Growth – nk	1= Change in sales/budgets not known	0.000	0.000	0.002	0.041	0.000	0.000	0.058	0.234	0.250	0.434	0.004	0.066
Labour turnover	Quits and dismissals in last 12 months as % of on-site employment	0.134	0.367	0.194	0.262	0.182	0.320	0.362	0.688	0.485	0.870	0.305	0.423
Turnover – nk	1= Quits and dismissals not known	0.040	0.195	0.067	0.250	0.018	0.134	0.004	0.067	0.024	0.152	0.049	0.217
Training dummies:													
No training	*No off-the-job training given*	0.053	0.223	0.073	0.260	0.322	0.468	0.504	0.501	0.259	0.439	0.314	0.465
Low training	Low off-the-job training (1-29%)	0.169	0.375	0.168	0.374	0.214	0.411	0.235	0.425	0.142	0.349	0.353	0.478
Medium training	Medium off-the-job training (30-79%)	0.267	0.443	0.214	0.411	0.208	0.406	0.076	0.266	0.171	0.377	0.168	0.374
High training	High off-the-job training (80-100%)	0.486	0.500	0.474	0.500	0.223	0.417	0.178	0.383	0.418	0.494	0.141	0.348
Training – nk	1= Off-the-job training incidence not known	0.026	0.159	0.071	0.257	0.033	0.179	0.007	0.083	0.010	0.099	0.023	0.152

continued

Table 7.D.1: (continued) *Weighted by population weights x number of vacancies*

		24		32		52		53		62		81	
Variable	**Definition**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Size-group dummies:													
Size1_4	*1-4 employees at establishment*	0.320	0.467	0.148	0.356	0.357	0.480	0.596	0.491	0.587	0.493	0.137	0.344
Size5_9	5-9 employees at establishment	0.040	0.196	0.055	0.229	0.093	0.291	0.093	0.290	0.087	0.282	0.061	0.239
Size10_24	10-24 employees at establishment	0.115	0.320	0.132	0.339	0.184	0.388	0.147	0.355	0.106	0.309	0.154	0.361
Size25_49	25-49 employees at establishment	0.060	0.237	0.069	0.254	0.109	0.313	0.066	0.248	0.078	0.269	0.131	0.338
Size50_99	50-99 employees at establishment	0.088	0.284	0.081	0.274	0.085	0.279	0.061	0.239	0.076	0.266	0.141	0.348
Size100_199	100-199 employees at establishment	0.107	0.309	0.048	0.215	0.055	0.228	0.020	0.139	0.037	0.190	0.115	0.320
Size200_499	200-499 employees at establishment	0.154	0.362	0.070	0.255	0.050	0.218	0.014	0.119	0.024	0.152	0.132	0.339
Size500plus	500-plus employees at establishment	0.115	0.320	0.396	0.489	0.066	0.249	0.003	0.057	0.004	0.062	0.129	0.335
Sector dummies:													
Manufacturing	*Manufacturing*					0.324	0.469					0.677	0.468
Construction	Construction					0.091	0.288	0.763	0.426				
Retail	Wholesale & retail					0.379	0.486						
Hotels	Hotels & restaurants												
Transport	Transport & communications												
Finance	Finance												
Business services	Business services	0.705	0.457			0.093	0.290						
Public admin	Public administration												
Education	Education												
Health	Health & social care			0.796	0.404								
Other services	Other services									0.801	0.400		
Other sectors - 24	1=Sectors other than business services	0.295	0.457										
Other sectors - 32	1=Sectors other than health and social care			0.204	0.404								
Other sectors - 52	1=Sectors other than manuf-acturing, construction, wholesale / retail or business services					0.113	0.317						
Other sectors - 53	1=Sectors other than construction							0.237	0.426				
Other sectors - 62	1=Sectors other than other services									0.199	0.400		
Other sectors - 81	1=Sectors other than manufacturing											0.323	0.468

continued

Table 7.D.1: (continued)

Variable	Definition	24		32		52		53		62		81	
		Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Regional dummies:													
Eastern	*Eastern RDA*	0.069	0.253	0.106	0.308	0.125	0.331	0.083	0.276	0.123	0.329	0.203	0.402
East Midlands	East Midlands RDA	0.048	0.215	0.067	0.250	0.065	0.247	0.062	0.241	0.137	0.345	0.118	0.322
London	London RDA	0.521	0.500	0.252	0.434	0.233	0.423	0.193	0.395	0.123	0.329	0.068	0.252
North East	North East RDA	0.008	0.089	0.060	0.237	0.026	0.159	0.016	0.125	0.028	0.164	0.036	0.186
North West	North West RDA	0.063	0.244	0.116	0.321	0.097	0.296	0.078	0.269	0.227	0.420	0.093	0.291
South East	South East RDA	0.148	0.356	0.168	0.375	0.161	0.368	0.116	0.321	0.189	0.392	0.168	0.374
South West	South West RDA	0.049	0.216	0.086	0.281	0.158	0.365	0.172	0.378	0.069	0.254	0.140	0.347
West Midlands	West Midlands RDA	0.050	0.219	0.105	0.307	0.053	0.224	0.205	0.404	0.071	0.257	0.098	0.298
Yorks	Yorkshire & Humberside RDA	0.043	0.203	0.040	0.197	0.082	0.274	0.076	0.265	0.032	0.177	0.076	0.266
Local labour market variables:													
Log unemployment	log % of working age unemployed	4.792	1.488	4.364	1.531	4.228	1.451	3.867	1.293	4.145	1.457	3.734	1.225
Professional emp.	% employed in professional occupations	12.156	2.463			11.874	2.889						
Assoc.prof.emp.	% employed in associate professional occupations			11.164	2.188								
Manufacturing emp.	% employed in manufacturing					5.727	8.568					12.239	9.314
Construction emp.	% employed in construction					0.644	2.067	5.674	3.379				
Distn, hotels emp.	% employed in distribution, hotels & restaurants					0.009	0.411						
Public services emp.	% employed in public admin., education, health & social care			0.428	3.192					20.693	10.743		

Note: Italics indicate baseline categories for sets of dummy variables

Table 7.D.2: Logits for SOC 24 Business and public service professionals

Logits of the probabilities that:
(1)-(2) establishment/occupation group record includes at least one hard-to-fill vacancy (H2F)
(3)-(4) establishment/occupation group record includes at least one skill-shortage vacancy (SSV)

Weighted by population weights x number of vacancies

	(1) H2F	(2) H2F - with LLSC	(3) SSV	(4) SSV - with LLSC
Size5_9	-1.905	-1.650	0.072	0.352
	(1.246)	(1.148)	(1.104)	(1.136)
Size10_24	-1.383	-0.561	-0.560	0.275
	(1.172)	(1.173)	(0.931)	(1.089)
Size25_49	-0.380	0.308	-0.099	0.532
	(1.189)	(1.167)	(0.908)	(0.983)
Size50_99	-1.455	-1.003	-0.605	-0.366
	(1.210)	(1.206)	(1.126)	(1.193)
Size100_199	-1.680	-0.842	-1.064	-0.413
	(1.175)	(1.202)	(0.942)	(1.012)
Size200_499	-2.021*	-1.247	-0.761	0.100
	(1.131)	(1.131)	(1.001)	(1.049)
Size500plus	-1.695	-1.067	-1.209	-0.551
	(1.204)	(1.192)	(1.171)	(1.116)
Single	0.799	0.724	1.364**	1.280*
	(0.578)	(0.562)	(0.618)	(0.668)
Head office	1.095**	1.081**	2.086***	2.123***
	(0.525)	(0.523)	(0.643)	(0.698)
Foreign	1.277*	1.494*	2.031***	2.305***
	(0.716)	(0.797)	(0.734)	(0.771)
Foreign - nk	1.989	1.808	3.890**	3.950**
	(1.710)	(1.941)	(1.539)	(1.618)
Public	-0.694	-0.537	-0.044	0.136
	(0.500)	(0.456)	(0.611)	(0.565)
Declining sales/budgets	-1.269	-1.706	0.359	0.107
	(1.259)	(1.045)	(1.523)	(1.085)
Increasing sales/budgets	-0.853*	-0.748	-0.702	-0.450
	(0.461)	(0.470)	(0.550)	(0.538)
Labour turnover	2.539*	2.158*	-0.013	-0.016
	(1.354)	(1.269)	(0.503)	(0.415)
Turnover – nk	-0.164	0.139	-2.037**	-1.765*
	(0.936)	(0.903)	(1.019)	(0.988)
Low training	0.561	0.792	0.292	0.762
	(0.614)	(0.676)	(0.810)	(0.941)
Medium training	-0.439	0.045	-0.428	0.362
	(0.731)	(0.638)	(0.911)	(0.887)
High training	1.157	1.228*	1.879**	2.214**
	(0.751)	(0.724)	(0.833)	(0.909)
Training – nk	1.233	0.996	-0.339	-0.966
	(1.035)	(1.152)	(1.374)	(1.551)
Other sectors - 24	-0.248	-0.267	-1.692***	-1.829***
	(0.415)	(0.430)	(0.501)	(0.522)
East Midlands	1.061	0.403	3.419***	2.989***

(*Continued*)

Table 7.D.2: Logits for SOC 24 Business and public service professionals (continued)

Logits of the probabilities that:
(1)-(2) establishment/occupation group record includes at least one hard-to-fill vacancy (H2F)
(3)-(4) establishment/occupation group record includes at least one skill-shortage vacancy (SSV)

Weighted by population weights x number of vacancies

	(1) H2F	(2) H2F - with LLSC	(3) SSV	(4) SSV - with LLSC
	(1.121)	(1.152)	(1.145)	(1.131)
London	-0.983	-0.537	0.741	2.036*
	(0.711)	(0.994)	(0.695)	(1.227)
North East	-1.300	-2.505*	1.567	1.117
	(1.057)	(1.280)	(0.978)	(1.332)
North West	-0.886	-1.391	0.720	0.409
	(0.815)	(0.857)	(0.907)	(0.947)
South East	-0.257	0.182	1.189	1.441*
	(0.783)	(0.832)	(0.738)	(0.776)
South West	-1.198	-1.749**	-0.084	-0.478
	(0.799)	(0.839)	(0.871)	(0.874)
West Midlands	-1.557	-1.812*	0.415	0.924
	(0.987)	(1.068)	(1.179)	(1.274)
Yorks	-0.144	-1.174	-0.195	-0.614
	(1.129)	(1.147)	(1.283)	(1.451)
Log unemployment		0.501		-0.746
		(0.900)		(1.304)
Professional emp.		-0.286**		-0.327**
		(0.141)		(0.145)
Constant	1.586	3.540	-1.882	1.635
	(1.372)	(2.229)	(1.349)	(2.376)
Observations	371	371	371	371
Log-likelihood	-188.86	-181.63	-164.76	-157.57
c2	89.33	103.78	183.39	197.77
prob. c2	0.00	0.00	0.00	0.00
McKelvey & Zaviona R2	0.97	0.97	0.99	0.99
Cragg & Uhler R2	0.30	0.34	0.52	0.55

Notes: Robust standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1% .

Table 7.D.3: Logits for SOC 32 Health and social welfare associate professionals

Logits of the probabilities that:
(1)-(2) establishment/occupation group record includes at least one hard-to-fill vacancy (H2F)
(3)-(4) establishment/occupation group record includes at least one skill-shortage vacancy (SSV)

Weighted by population weights x number of vacancies

	(1) H2F	(2) H2F - with local labour market variables	(3) SSV	(4) SSV - with local labour market variables
Size5_9	3.191*	3.269*		
	(1.826)	(1.909)		
Size10_24	3.165*	3.134*	0.367	0.165
	(1.703)	(1.851)	(1.350)	(1.545)
Size25_49	4.374***	4.476**	1.740	1.332
	(1.681)	(1.823)	(1.360)	(1.468)
Size50_99	4.281**	4.254**	1.807	1.449
	(1.708)	(1.850)	(1.416)	(1.524)
Size100_199	3.067*	3.127*	1.969	1.623
	(1.665)	(1.796)	(1.362)	(1.451)
Size200_499	4.633***	4.675***	1.198	0.410
	(1.695)	(1.813)	(1.350)	(1.477)
Size500plus	4.140***	4.154**	2.668**	2.493*
	(1.605)	(1.732)	(1.269)	(1.370)
Single	-0.105	-0.119	0.020	-0.043
	(0.439)	(0.442)	(0.452)	(0.473)
Head office	0.722	0.693	-0.150	-0.172
	(0.487)	(0.481)	(0.486)	(0.497)
Foreign	-1.159	-1.138	1.141	1.614**
	(1.010)	(0.942)	(0.794)	(0.785)
Public	-0.847**	-0.810*	-0.217	-0.346
	(0.429)	(0.447)	(0.428)	(0.463)
Sector - nk	-2.204**	-2.227**		
	(1.093)	(1.102)		
Declining sales/budgets	0.553	0.477	-0.530	-0.444
	(0.846)	(0.895)	(0.757)	(0.703)
Increasing sales/budgets	-1.153**	-1.178**	0.220	0.373
	(0.570)	(0.542)	(0.770)	(0.741)
Labour turnover	-0.165	-0.173	-1.842*	-2.024**
	(0.782)	(0.790)	(0.978)	(1.003)
Turnover – nk	0.540	0.548	-0.830	-0.934
	(0.795)	(0.774)	(0.730)	(0.698)
Low training	1.398**	1.359**	0.980	0.956
	(0.682)	(0.687)	(0.611)	(0.621)
Medium training	0.807	0.748	0.534	0.533
	(0.654)	(0.659)	(0.612)	(0.616)
High training	0.559	0.453	0.552	0.619
	(0.609)	(0.607)	(0.587)	(0.565)
Training – nk	-0.139	-0.197	-0.695	-0.679
	(0.851)	(0.830)	(0.900)	(0.864)
Other sectors - 32	-1.539**	-1.384**	-0.643	-1.354

(Continued)

Table 7.D.3: Logits for SOC 32 Health and social welfare associate professionals (continued)

Logits of the probabilities that:
(1)-(2) establishment/occupation group record includes at least one hard-to-fill vacancy (H2F)
(3)-(4) establishment/occupation group record includes at least one skill-shortage vacancy (SSV)

Weighted by population weights x number of vacancies

	(1) H2F	(2) H2F - with local labour market variables	(3) SSV	(4) SSV - with local labour market variables
	(0.603)	(0.693)	(0.735)	(1.245)
East Midlands	0.095	-0.006	2.993***	2.594***
	(0.836)	(0.884)	(0.841)	(0.851)
London	-1.738**	-2.540**	1.522*	1.441
	(0.697)	(1.032)	(0.861)	(1.164)
North East	-1.092	-1.615	2.137**	1.258
	(0.902)	(1.045)	(0.883)	(1.088)
North West	-0.636	-0.839	1.810**	1.442
	(0.639)	(0.730)	(0.791)	(0.892)
South East	-1.387**	-1.265*	0.098	0.382
	(0.689)	(0.663)	(0.842)	(0.872)
South West	-2.124***	-2.152***	1.618*	1.448
	(0.714)	(0.734)	(0.895)	(0.931)
West Midlands	-1.180*	-1.429*	3.209***	2.561***
	(0.604)	(0.808)	(0.766)	(0.938)
Yorks	-2.419***	-2.703***	1.334	0.835
	(0.729)	(0.846)	(0.867)	(0.952)
Log unemployment		0.885		0.886
		(0.769)		(0.915)
Assoc. prof. emp.		0.066		-0.108
		(0.113)		(0.128)
Public services emp.		-0.011		0.105*
		(0.059)		(0.060)
Constant	-1.678	-3.348	-4.317***	-3.739*
	(2.088)	(2.320)	(1.630)	(2.030)
Observations	505	505	502	502
Log-likelihood	-209.53	-208.17	-203.22	-199.29
c2	257.28	260.01	180.40	188.28
prob. C2	0.00	0.00	0.00	0.00
McKelvey & Zaviona R2	0.99	0.99	0.98	0.98
Cragg & Uhler R2	0.54	0.55	0.44	0.45

Notes: Robust standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7.D.4: Logits for SOC 52 Skilled metal and electrical trades

Logits of the probabilities that:
(1)-(2) establishment/occupation group record includes at least one hard-to-fill vacancy (H2F)
(3)-(4) establishment/occupation group record includes at least one skill-shortage vacancy (SSV)

Weighted by population weights x number of vacancies

	(1) H2F	(2) H2F - with local labour market variables	(3) SSV	(4) SSV - with local labour market variables
Size5_9	-0.588	-0.422	0.239	-0.066
	(0.804)	(0.790)	(0.735)	(0.729)
Size10_24	-1.070	-1.020	-0.347	-0.440
	(0.731)	(0.674)	(0.630)	(0.638)
Size25_49	-0.560	-0.524	-0.101	-0.286
	(0.737)	(0.712)	(0.660)	(0.680)
Size50_99	-0.260	-0.236	-0.708	-0.924
	(0.763)	(0.724)	(0.686)	(0.698)
Size100_199	-0.926	-0.891	-0.836	-0.930
	(0.811)	(0.787)	(0.689)	(0.694)
Size200_499	-0.989	-0.906	-0.758	-0.935
	(0.915)	(0.870)	(0.838)	(0.848)
Size500plus	0.557	0.540	-0.583	-0.570
	(1.128)	(1.121)	(0.918)	(0.931)
Single	0.291	0.345	0.292	0.331
	(0.513)	(0.520)	(0.534)	(0.553)
Head office	0.288	0.375	0.114	0.070
	(0.536)	(0.528)	(0.514)	(0.530)
Foreign	-0.986*	-1.014*	-0.471	-0.365
	(0.562)	(0.572)	(0.571)	(0.586)
Foreign - nk	0.043	0.029	-2.333	-2.613
	(1.079)	(1.154)	(1.648)	(1.800)
Public	-0.592	-0.633	-0.932	-1.133
	(0.757)	(0.713)	(0.825)	(0.857)
Declining sales/budgets	-1.464**	-1.444**	-1.093	-1.237*
	(0.614)	(0.590)	(0.726)	(0.671)
Increasing sales/budgets	0.255	0.260	-0.112	-0.039
	(0.384)	(0.376)	(0.438)	(0.450)
Labour turnover	-1.083*	-0.915	0.000	-0.189
	(0.642)	(0.644)	(0.616)	(0.627)
Turnover – nk	1.068	1.145	2.209***	2.227***
	(0.763)	(0.764)	(0.748)	(0.751)
Low training	0.344	0.462	0.808	0.846
	(0.522)	(0.519)	(0.573)	(0.566)
Medium training	0.210	0.295	0.450	0.446
	(0.568)	(0.535)	(0.559)	(0.547)
High training	0.935*	1.065*	1.881***	1.959***
	(0.556)	(0.549)	(0.609)	(0.611)
Training – nk	0.418	0.549	-1.168	-0.989

(Continued)

Table 7.D.4: Logits for SOC 52 Skilled metal and electrical trades (continued)

Logits of the probabilities that:
(1)-(2) establishment/occupation group record includes at least one hard-to-fill vacancy (H2F)
(3)-(4) establishment/occupation group record includes at least one skill-shortage vacancy (SSV)

Weighted by population weights x number of vacancies

	(1) H2F	(2) H2F - with local labour market variables	(3) SSV	(4) SSV - with local labour market variables
	(0.957)	(1.023)	(1.045)	(1.075)
Construction	-0.112	3.163	-0.490	1.057
	(0.627)	(4.676)	(0.535)	(2.954)
Retail	0.162	-0.011	-0.870*	-1.903
	(0.438)	(1.049)	(0.467)	(1.217)
Business Services	-0.638	-0.846	-0.764	-1.837
	(0.512)	(1.068)	(0.576)	(1.290)
Other sectors - 52	-0.490	-0.630	-0.854	-2.008
	(0.581)	(1.085)	(0.556)	(1.278)
East Midlands	0.991	0.724	0.534	0.724
	(0.625)	(0.620)	(0.609)	(0.685)
London	1.872***	0.566	-0.985	-0.104
	(0.691)	(1.010)	(0.837)	(1.226)
North East	-1.651	-2.870**	-2.077	-1.615
	(1.116)	(1.453)	(1.558)	(1.679)
North West	1.117	0.484	1.695**	2.058**
	(0.750)	(0.734)	(0.732)	(0.851)
South East	0.449	0.572	0.083	0.196
	(0.560)	(0.539)	(0.541)	(0.563)
South West	1.157*	0.934	0.546	0.592
	(0.627)	(0.596)	(0.631)	(0.665)
West Midlands	0.553	-0.207	-0.136	0.367
	(0.619)	(0.744)	(0.708)	(0.912)
Yorks	-1.099*	-1.912**	-0.877	-0.560
	(0.630)	(0.754)	(0.637)	(0.850)
Log unemployment		1.614*		-0.736
		(0.966)		(1.006)
Professional emp.		0.065		-0.124
		(0.119)		(0.125)
Manufacturing emp.		-0.010		-0.069
		(0.056)		(0.068)
Construction emp.		-0.484		-0.386
		(0.634)		(0.412)
Distn, hotels emp.		-0.154*		0.068
		(0.085)		(0.086)
Constant	0.755	-1.678	-0.447	2.885
	(1.022)	(2.459)	(0.925)	(2.541)
Observations	520	520	520	520
Log-likelihood	-231.46	-228.32	-257.87	-255.07
c2	164.77	171.03	175.20	180.81
prob. c2	0.00	0.00	0.00	0.00
McKelvey & Zaviona R2	0.98	0.98	0.98	0.98
Cragg & Uhler R2	0.39	0.40	0.39	0.40

Notes: Robust standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

Table D7.5: SOC 53 Skilled construction trades

Logits of the probabilities that:
(1)-(2) establishment/occupation group record includes at least one hard-to-fill vacancy (H2F)
(3)-(4) establishment/occupation group record includes at least one skill-shortage vacancy (SSV)

Weighted by population weights x number of vacancies

	(1) H2F	(2) H2F - with local labour market variables	(3) SSV	(4) SSV - with local labour market variables
Size5_9	-0.384	-0.383	0.813	0.957
	(0.742)	(0.797)	(0.749)	(0.767)
Size10_24	-1.358**	-1.334**	0.061	0.182
	(0.646)	(0.640)	(0.639)	(0.669)
Size25_49	-1.315*	-0.986	0.191	0.265
	(0.770)	(0.808)	(0.819)	(0.794)
Size50_99	-0.579	-0.226	0.608	0.621
	(0.836)	(0.896)	(0.806)	(0.839)
Size100_199	0.372	0.505	-0.146	0.181
	(1.106)	(1.094)	(1.011)	(0.995)
Size200_499	1.579	2.214	2.695*	2.401
	(2.005)	(2.106)	(1.550)	(1.550)
Size500plus	0.256	1.081	2.632*	2.798*
	(1.692)	(1.814)	(1.563)	(1.571)
Single	0.193	0.560	0.599	0.554
	(0.740)	(0.698)	(1.037)	(1.000)
Head office	0.204	0.209	1.207	1.515
	(1.176)	(1.061)	(1.083)	(1.145)
Foreign	-0.107	-0.334	-1.200	-0.530
	(1.693)	(1.648)	(1.559)	(1.462)
Public	-1.795*	-1.887*	-1.463	-1.474
	(1.063)	(1.082)	(1.060)	(1.011)
Declining sales/budgets	0.724	0.342	-0.084	-0.054
	(1.352)	(1.301)	(1.159)	(1.011)
Increasing sales/budgets	-0.316	-0.537	0.835	0.347
	(0.625)	(0.628)	(0.556)	(0.539)
Growth - nk	3.461*	4.030**	3.519**	3.664**
	(1.878)	(1.958)	(1.668)	(1.724)
Labour turnover	1.862**	1.905**	0.229	0.180
	(0.857)	(0.944)	(0.569)	(0.436)
Turnover – nk	-1.236	-0.884	1.096	0.612
	(1.872)	(1.996)	(1.570)	(1.530)
Low training	1.413**	1.587**	0.454	0.521
	(0.701)	(0.715)	(0.664)	(0.689)
Medium training	0.266	0.279	-0.980	-0.985
	(0.596)	(0.607)	(0.957)	(0.923)
High training	1.841**	1.753**	1.532*	1.192
	(0.741)	(0.770)	(0.797)	(0.737)
Other sectors - 53	-1.052*	-2.543	-0.585	3.078*
	(0.589)	(2.097)	(0.631)	(1.655)
East Midlands	-1.086	-0.475	-1.131	-0.652
	(0.900)	(0.991)	(1.021)	(1.082)

(Continued)

Table 7.D.5: Logits for SOC 53 Skilled construction trades (continued)

Logits of the probabilities that:
(1)-(2) establishment/occupation group record includes at least one hard-to-fill vacancy (H2F)
(3)-(4) establishment/occupation group record includes at least one skill-shortage vacancy (SSV)

Weighted by population weights x number of vacancies

	(1) H2F	(2) H2F - with local labour market variables	(3) SSV	(4) SSV - with local labour market variables
London	-1.324	0.357	-0.939	-0.272
	(1.058)	(1.230)	(1.007)	(1.429)
North East	-1.375	0.757	-1.039	-0.633
	(1.023)	(1.315)	(1.365)	(1.681)
North West	0.554	1.142	-2.102*	-1.465
	(1.007)	(1.160)	(1.256)	(1.269)
South East	-0.269	-0.694	-1.354	-1.183
	(0.801)	(0.893)	(0.908)	(0.851)
South West	-1.246	-0.966	0.477	0.351
	(0.892)	(1.022)	(1.053)	(1.079)
West Midlands	0.404	1.553*	0.490	1.207
	(0.768)	(0.929)	(0.943)	(1.137)
Yorks	-1.703*	-0.320	-1.430	-0.935
	(0.919)	(1.175)	(1.077)	(1.341)
Log unemployment		-2.697**		-0.617
		(1.165)		(1.347)
Construction emp.		-0.172		0.546**
		(0.285)		(0.228)
Constant	1.188	4.944**	-0.915	-4.210*
	(1.029)	(2.421)	(1.374)	(2.399)
Observations	307	307	307	307
Log-likelihood	-125.44	-120.81	-150.00	-144.16
c2	94.79	104.06	125.49	137.16
prob. c2	0.00	0.00	0.00	0.00
McKelvey & Zaviona R2	0.99	0.99	0.98	0.99
Cragg & Uhler R2	0.39	0.43	0.45	0.48

Notes: Robust standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7.D.6: Logits for SOC 62 Leisure and other personal service occupations

Logits of the probabilities that:
(1)-(2) establishment/occupation group record includes at least one hard-to-fill vacancy (H2F)
(3)-(4) establishment/occupation group record includes at least one skill-shortage vacancy (SSV)

Weighted by population weights x number of vacancies

	(1) H2F	(2) H2F - with local labour market variables	(3) SSV	(4) SSV - with local labour market variables
Size5_9	-0.680	-0.681	-0.708	-0.830
	(0.889)	(0.880)	(0.843)	(0.875)
Size10_24	-0.898	-0.959	-0.204	-0.229
	(0.646)	(0.641)	(0.698)	(0.755)
Size25_49	-2.194***	-2.170***	-1.613*	-1.594*
	(0.709)	(0.703)	(0.860)	(0.846)
Size50_99	-1.434*	-1.337*	-0.916	-0.806
	(0.766)	(0.770)	(1.124)	(1.183)
Size100_199	-1.750**	-1.575*	-0.506	-0.388
	(0.824)	(0.866)	(1.052)	(1.109)
Size200_499	-1.837**	-1.759**	-1.130	-1.088
	(0.881)	(0.894)	(1.274)	(1.337)
Size500plus	-0.953	-0.881		
	(1.007)	(1.004)		
Single	-0.234	-0.240	0.598	0.614
	(0.451)	(0.453)	(0.667)	(0.710)
Head office	0.457	0.532	0.707	0.772
	(0.653)	(0.646)	(0.790)	(0.782)
Foreign	-0.665	-0.720	1.178	1.126
	(1.224)	(1.217)	(0.901)	(0.917)
Public	-0.414	-0.341	-0.819	-0.775
	(0.439)	(0.438)	(0.625)	(0.635)
Declining sales/budgets	0.080	0.128	1.183	1.261
	(0.610)	(0.590)	(0.791)	(0.803)
Increasing sales/budgets	-1.483***	-1.509***	-0.106	-0.214
	(0.575)	(0.572)	(0.697)	(0.762)
Growth - nk	-2.338***	-2.313**	-0.092	-0.294
	(0.832)	(0.963)	(1.115)	(1.181)
Labour turnover	-0.301	-0.220	-0.824**	-0.792*
	(0.320)	(0.311)	(0.407)	(0.447)
Turnover – nk	-1.830**	-2.105***		
	(0.735)	(0.748)		
Low training	-0.317	-0.278	-0.681	-0.648
	(0.823)	(0.772)	(0.674)	(0.682)
Medium training	-1.052	-1.057	-0.724	-0.692
	(0.693)	(0.682)	(0.731)	(0.721)
High training	-1.085*	-1.185**	-0.346	-0.536
	(0.582)	(0.586)	(0.812)	(0.790)
Training – nk	3.374*	3.248*	-0.551	-1.177
	(1.764)	(1.920)	(1.142)	(1.311)

(Continued)

Table 7.D.6: Logits for SOC 62 Leisure and other personal service occupations (continued)

Logits of the probabilities that:
(1)-(2) establishment/occupation group record includes at least one hard-to-fill vacancy (H2F)
(3)-(4) establishment/occupation group record includes at least one skill-shortage vacancy (SSV)

Weighted by population weights x number of vacancies

	(1) H2F	(2) H2F - with local labour market variables	(3) SSV	(4) SSV - with local labour market variables
Other sectors - 62	-0.410	1.117	-0.373	2.340
	(0.437)	(2.927)	(0.616)	(4.319)
East Midlands	-2.552***	-1.990**	-1.498	-1.157
	(0.965)	(0.997)	(1.044)	(1.102)
London	-0.289	1.195	-1.187	0.117
	(0.693)	(0.991)	(0.996)	(1.304)
North East	0.105	1.129	-2.442**	-1.841
	(0.769)	(1.147)	(1.215)	(1.575)
North West	-2.843***	-1.786*	-3.594**	-2.695
	(0.820)	(1.064)	(1.592)	(2.128)
South East	0.725	0.825	-0.179	-0.107
	(0.629)	(0.631)	(0.915)	(0.848)
South West	-0.785	-0.433	-2.181	-2.126
	(0.681)	(0.688)	(1.334)	(1.414)
West Midlands	-0.531	0.486	-0.468	0.395
	(0.924)	(1.143)	(0.925)	(1.002)
Yorks	0.329	1.275	0.646	1.410
	(0.851)	(1.004)	(0.926)	(1.154)
Log unemployment		-1.808*		-1.708
		(0.930)		(1.452)
Public services emp.		0.070		0.121
		(0.123)		(0.176)
Constant	3.362***	3.339	0.532	-0.671
	(0.965)	(2.663)	(1.077)	(4.020)
Observations	388	388	365	365
Log-likelihood	-169.62	-167.04	-151.80	-149.52
c2	197.62	202.79	119.42	123.99
prob. C2	0.00	0.00	0.00	0.00
McKelvey & Zaviona R2	0.99	0.99	0.98	0.98
Cragg & Uhler R2	0.53	0.54	0.41	0.42

Notes: Robust standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7.D.7: Logits for SOC 81 Process, plant and machine operatives

Logits of the probabilities that:
(1)-(2) establishment/occupation group record includes at least one hard-to-fill vacancy (H2F)
(3)-(4) establishment/occupation group record includes at least one skill-shortage vacancy (SSV)

Weighted by population weights x number of vacancies

	(1) H2F	(2) H2F - with local labour market variables	(3) SSV	(4) SSV - with local labour market variables
Size5_9	1.237	1.243	-1.575*	-1.520*
	(0.874)	(0.852)	(0.910)	(0.875)
Size10_24	-0.663	-0.749	-2.010**	-2.077***
	(0.664)	(0.644)	(0.793)	(0.776)
Size25_49	-0.210	-0.262	-1.932**	-1.969**
	(0.657)	(0.637)	(0.800)	(0.775)
Size50_99	0.055	-0.005	-1.744**	-1.779**
	(0.701)	(0.674)	(0.771)	(0.751)
Size100_199	-0.681	-0.718	-2.265***	-2.293***
	(0.715)	(0.707)	(0.852)	(0.836)
Size200_499	-1.558**	-1.606**	-2.666***	-2.725***
	(0.735)	(0.725)	(0.886)	(0.865)
Size500plus	-0.305	-0.365	-2.030**	-2.070**
	(0.803)	(0.789)	(0.935)	(0.910)
Single	0.014	0.054	0.887***	0.915***
	(0.339)	(0.340)	(0.325)	(0.331)
Head office	0.189	0.222	0.840**	0.877**
	(0.380)	(0.388)	(0.418)	(0.419)
Foreign	-0.063	-0.062	0.199	0.196
	(0.396)	(0.396)	(0.513)	(0.520)
Foreign - nk	-3.050**	-3.034**	-1.180	-1.159
	(1.490)	(1.462)	(1.626)	(1.618)
Public	-0.622	-0.625	-0.222	-0.205
	(0.607)	(0.621)	(0.643)	(0.645)
Sector - nk	-2.918***	-3.049***		
	(1.039)	(1.085)		
Declining sales/budgets	0.013	0.053	-0.362	-0.330
	(0.385)	(0.376)	(0.463)	(0.451)
Increasing sales/budgets	-0.890**	-0.871**	-1.151**	-1.088**
	(0.373)	(0.361)	(0.492)	(0.464)
Labour turnover	-0.154	-0.141	-1.076*	-1.002*
	(0.326)	(0.304)	(0.600)	(0.571)
Turnover – nk	-0.354	-0.333	-1.210*	-1.235**
	(0.692)	(0.716)	(0.621)	(0.611)
Low training	0.667*	0.665*	0.419	0.417
	(0.367)	(0.365)	(0.416)	(0.406)
Medium training	1.333***	1.299***	1.760***	1.715***
	(0.496)	(0.483)	(0.553)	(0.540)
High training	0.294	0.268	1.424***	1.395***
	(0.476)	(0.470)	(0.536)	(0.530)
Training – nk	2.020**	2.017**	0.186	0.154

(Continued)

Table 7.D.7: Logits for SOC 81 Process, plant and machine operatives (continued)

Logits of the probabilities that:
(1)-(2) establishment/occupation group record includes at least one hard-to-fill vacancy (H2F)
(3)-(4) establishment/occupation group record includes at least one skill-shortage vacancy (SSV)

Weighted by population weights*number of vacancies

	(1) H2F	(2) H2F - with local labour market variables	(3) SSV	(4) SSV - with local labour market variables
	(0.906)	(0.905)	(1.304)	(1.378)
Other sectors - 81	0.865***	1.520*	0.265	1.568*
	(0.310)	(0.829)	(0.317)	(0.869)
East Midlands	-1.458***	-1.713***	-1.202**	-1.615**
	(0.534)	(0.538)	(0.575)	(0.641)
London	-0.250	-0.239	0.648	0.928
	(0.539)	(0.611)	(0.580)	(0.698)
North East	-0.566	-0.819	0.422	0.241
	(0.774)	(0.797)	(0.653)	(0.781)
North West	-0.811	-0.981*	-1.006	-1.193
	(0.542)	(0.540)	(0.692)	(0.729)
South East	0.082	0.136	0.124	0.217
	(0.481)	(0.511)	(0.523)	(0.533)
South West	0.797	0.728	0.021	-0.065
	(0.635)	(0.584)	(0.620)	(0.570)
West Midlands	-0.060	-0.400	0.013	-0.488
	(0.537)	(0.563)	(0.567)	(0.689)
Yorks	-0.341	-0.548	0.218	-0.002
	(0.590)	(0.599)	(0.602)	(0.648)
Log unemployment		0.246		0.152
		(0.708)		(0.723)
Manufacturing emp.		0.037		0.077
		(0.043)		(0.047)
Constant	0.372	-0.477	0.104	-1.342
	(0.866)	(1.483)	(0.881)	(1.429)
Observations	665	665	661	661
Log-likelihood	-379.80	-378.95	-327.14	-325.07
c2	152.54	154.24	123.39	127.53
prob. c2	0.00	0.00	0.00	0.00
McKelvey & Zaviona R2	0.95	0.95	0.95	0.95
Cragg & Uhler R2	0.27	0.28	0.25	0.25

Notes: Robust standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%.

8. THE DETERMINANTS OF THE INCIDENCE AND INTENSITY OF OFF-THE-JOB TRAINING

Andy Dickerson and Rob Wilson (IER)

8.1 Introduction and background

In their assessment of *Skills in England 2001*, Campbell *et al* (2001, paragraph 4.109 and Table 4.19) note an apparent paradox concerning the levels of training activity across Regional Development Agency (RDA) areas. The received wisdom is that the amount of training that individuals receive is positively related to their qualifications such that the better qualified receive more training in general (see, for example, Green, 1993; Veum, 1995; National Skills Task Force, 2000). That training provision is skewed towards the most able is confirmed in Campbell *et al* (2001, paragraph 4.88 and Table 4.11) using data on individuals drawn from the Labour Force Survey (LFS). However, when comparing average propensities to train across regions, Campbell *et al* (2001) note that relatively low training activity levels appear to be observed in RDAs employing higher proportions of qualified people, contrary to expectations based on the evidence presented for individuals. This chapter explores this apparent paradox using data drawn from the Employers Skill Survey 2001 (ESS2001) together with other data sources which are detailed in Section 8.2. In addition, the chapter provides a much more general insight into the factors influencing training activity within establishments.

Table 8.1: Training incidence and workforce qualifications by region

	Incidence of training (LTW2000)				Qualifications of workforce (LFS)			
	Off-the-job training[1]		On-the-job training[1]		NVQ level 3+[2]		No qualifications[2]	
RDA Region	%	Rank	%	Rank	%	Rank	%	Rank
Eastern	37	8	66	5	40	5	15	6
East Midlands	46	2	68	4	39	7	19	3
London	38	7	61	7	47	1	14	7
North East	42	4	74	2	37	9	20	1
North West	46	2	73	3	42	4	17	5
South East	39	5	61	7	46	2	12	9
South West	39	5	61	7	44	3	12	8
West Midlands	37	8	66	5	38	8	20	2
Yorks & Humb	48	1	75	1	40	6	19	4
Average	41		66		42		16	

Source: LTW2000: Campbell *et al* (2001) based on Spilsbury (2001, Table 21 and Table 52); and LFS: IER estimates for Winter 2000/1.

Notes:
1. Percentage of employers providing workplace training.
2. Percentage in employment educated to qualification level.

The basis of the observation in Campbell *et al* (2001) is presented in Table 8.1. This table is based on data from the 2000 Learning and Training in Work (LTW2000) survey (Spilsbury, 2001) and estimates from the corresponding Winter 2000/1 LFS. Campbell *et al* (2001) notes that the highest levels of both on- and off-the-job training activity are in northern RDAs, particularly Yorkshire and Humberside. In contrast, southern RDAs, including London, have below average levels of training activity. Yet the latter have the greatest proportions of better qualified people in total employment and lower proportions with no formal qualifications as shown in Table 8.1.

This chapter explores the relationship between training provision and workforce qualifications in further detail. The first key question addressed is whether the findings reported by Campbell *et al* (2001) using the LTW2000 survey are replicated in the ESS2001 dataset. This issue is examined in Section 8.3 which documents the relationship between the measures of training reported in ESS2001 and the qualifications of the workforce using a variety of exploratory statistical techniques and data sources. It should be noted that the observation reported in Campbell *et al* (2001) was based on summary statistics at a high level of aggregation (RDAs). In contrast, using ESS2001 also permits a much more disaggregated analysis. However, an important limitation is that the analysis is restricted to *off*-the-job training only because ESS2001 does not include any information on *on*-the-job training provision.

Of course, there are a number of factors other than the employment of more highly qualified personnel which might be expected to influence the amount of training activity at the establishment. These include workplace size, industrial sector and other establishment characteristics such as sales growth, ownership, product strategy, etc. The results observed may simply reflect a heterogeneous mix of establishments across regions which tends to offset any positive relationship between the level of training activity and the employment of more qualified workers at the establishment. These multiple effects need disentangling, especially with respect to identification of the sectors providing training (e.g. whether they are high or low value added/growing or contracting sectors) and the characteristics of the workplace (e.g. size of establishment).

Thus, in order to fully address the relationship between training provision and workforce qualifications, an establishment-level multivariate analysis is required so that differences in training activity can be compared *ceteris paribus* (i.e. holding all else equal). This chapter therefore extends the aggregate bivariate analysis in Section 8.3 and provides a detailed examination of the underlying determinants of off-the-job training (OJT) at the establishment level. This enables an assessment of whether the many other factors which influence OJT training serve to obscure its underlying relationship with workforce qualifications, or whether there is still an apparent paradox to be explained. Section 8.4 describes the modelling strategy while Section 8.5 reports the empirical results. The analysis also serves to contribute to the general understanding of both the factors and the nature of the processes which give rise to OJT training activity at the establishment. Finally, Section 8.6 concludes.

8.2 Data and definitions

8.2.1 The ESS2001 data set

The Employers Skills Survey 2001 (ESS2001) was a telephone survey of approximately 27,000 establishments in England, conducted mainly during Spring 2001. The overall response rate from employers was 53%. Variable sampling fractions across regions, industrial sector and establishment size were used and, on the basis of the achieved sample, appropriate weights were subsequently constructed so that the achieved sample can be grossed-up to be representative of the population of just over 2 million establishments in England (see Hogarth *et al*, 2001, for further details).

The ESS2001 data were supplemented by a range of external labour market data for individual local Learning and Skills Council (LLSC) areas. These data have been assigned to the individual cases according to the postcode given for the establishment. These additional data include information on employment structure, pay and unemployment in LLSC areas (see Green and Owen, 2002, for further details). Information on the qualifications of the work force used in the present analysis draws from both ESS2001 (focusing on the establishment) and also the LFS (to explore the wider labour market). The analysis covers both RDA areas and more detailed LLSC areas.

Some general information about the ESS2001 sample, including the grossed-up distribution of establishments and employment by establishment size bands is presented in Table 8.2 together with the number of sample observations in each size band. While establishments employing fewer than 5 persons comprise 72% of all establishments, they only account for around 11% of employment. At the other end of the scale, establishments employing 500 or more persons account for only 0.14% of all establishments, but over 15% of employment is located in these establishments. Larger establishments were over-sampled relative to their distribution in the population in order to more accurately capture the characteristics of the relatively large proportion of employment located in these establishments.

Table 8.2: Population distribution of establishments and employment

	Establishments		Employment		Sample	
establishment size	Number	%	Number	%	Observations	%
1-4	1,481,191	71.95	2,233,845	10.85	3,701	13.69
5-9	227,664	11.06	1,473,334	7.16	3,676	13.60
10-24	203,044	9.86	3,105,347	15.09	5,090	18.83
25-49	75,978	3.69	2,577,550	12.52	6,151	22.76
50-99	41,507	2.02	2,714,846	13.19	3,306	12.23
100-199	15,493	0.75	2,064,570	10.03	2,605	9.64
200-499	10,928	0.53	3,223,543	15.66	1,799	6.66
500+	2,909	0.14	3,191,056	15.50	703	2.60
Total	2,058,712	100.00	20,584,090	100.00	27,031	100.00

Source: ESS2001.

In the analysis that follows, a distinction is made between establishment-weighted and employment-weighted statistics. The main focus in Sections 8.4 and 8.5 is on the establishment level provision of training. However, in the next section, which comprises mainly descriptive analysis, both establishment-weighted and employment-weighted statistics are presented for comparative purposes.

8.2.2 Definitions of OJT activity and the qualifications of those employed

Questions regarding training activity in ESS2001 were focussed on off-the-job training activity (OJT).[47] ESS2001 identifies not only the incidence of OJT activity but also its intensity. Respondents were asked if the establishment had funded any OJT for their employees over the last 12 months (or since starting operations). For those who responded positively, questions were subsequently asked about the intensity of training (in terms of the proportion of employees receiving OJT) and the types of training undertaken. They were also asked if any of the training was provided by a third party supplier. The present analysis focuses upon the incidence and intensity of OJT activity. While OJT intensity was recorded in ESS2001 as a series of banded measures, this has been converted to a continuous measure using the mid-points for each band.

ESS2001 respondents were also asked questions about the most common level of qualification amongst each of the 9 SOC2000 major occupational groups. By combining this information with data on the numbers employed in each occupational group, an overall indicator of the qualifications of the workforce can be constructed. The overall qualification 'score' used in this chapter is based on assigning a value of 4 if the most typical qualification was NVQ level 4 (or equivalent), 3 for NVQ level 3 (or equivalent), etc. for each occupational group, and then weighting the scores according to the occupational composition of the establishment. These scores can then be averaged by geographic region by averaging over all establishments, weighted appropriately.

8.3. Descriptive statistics

8.3.1 Preliminary considerations

The first task of this chapter is to document the evidence from ESS2001 on both the incidence and intensity of OJT activity and their relationship with various qualification shares and scores (both within the establishment and in the wider labour market). This is the main topic of this section, which presents an analysis at both RDA and LLSC level. As described in the previous section, the information on OJT activity is drawn primarily from ESS2001 while the information on qualifications of those in employment is based on both ESS2001 (for those employed in the establishment) and on data from the LFS (for the external labour market in the LLSC area in which the establishment is located).

The two key questions addressed in this section are:

[47] ESS2001 does not contain data about ***on*** the job training.

1) Is the apparent paradox identified by Campbell *et al* (2001) confirmed by the ESS2001 data?
2) Does the finding also apply at the more detailed LLSC area?

The choice of the unit of analysis – whether establishment-based or employment-based – is important and is also related to the issue of weighting. The difference is perhaps best understood with an example. Suppose the prime interest is the incidence of OJT. This can be measured in two ways. One could ask workers selected at random from the workforce how many people in their establishment receive training and how many employees there are in total. The ratio of the two would be the employment-weighted OJT incidence rate. However, if the same question were posed only to establishment managers, then the ratio of their responses would yield an estimate of the establishment-weighted OJT incidence rate. The difference is that for the former, the sample will more reflect larger establishments since they have more employees, whereas for the latter, all establishments (irrespective of size) have an equal chance of being sampled.

The choice between the different weighting strategies depends on the questions of interest.[48] If the analysis is primarily concerned with how much training is taking place and how many individuals are engaged in training, then the appropriate weighting is by employment. However, if the concern is primarily with the circumstances under which OJT activity takes place, then an establishment-based approach is arguably of greater interest since this is the relevant unit of analysis at which training provision decisions are taken.

An analysis of variance suggests that most of the variation in OJT activity is *within* rather than *between* RDA or LLSC areas (see Section 8.3.4 below). By retaining the individual establishment-level information on OJT activity rather than averaging it across geographic area, it is therefore possible to investigate the variation and determinants of OJT activity. This is the focus of the establishment-level multivariate analysis of the determinants of training provision and intensity presented in Sections 8.4 and 8.5. However, in this section, the analysis is at the aggregated RDA and LLSC levels in order to investigate the two questions posed above, and is thus based on both establishment- and employment-weighted data.

8.3.2 OJT and qualifications at the regional level

Table 8.3 presents an initial summary of the data on OJT activity based on ESS2001 data. Unlike the information presented by Campbell *et al* (2001), the results suggest that at the RDA level, the apparent paradox described in the introduction is not repeated in ESS2001. In particular Yorkshire and Humberside no longer stands out as the RDA with the highest levels of training activity. London, which in the estimates reported in *Skills in England 2001* was towards the bottom of the training 'league table', now appears in second or third place, depending upon whether one considers

[48] Note that this weighting is in addition to the reweighting which ensures that the ESS2001 sample distribution is the same as the population (England) from which it was drawn despite the quota-based sampling strategy used to compile the ESS2001. That is, in both employment-weighted and establishment-weighted reweighting schemes, the resulting estimates will be representative of the population – of employment and of establishments – in England as a whole.

the incidence or intensity measures of OJT.

Considering the population of establishments with 5 or more employees, a slightly different pattern emerges (see Table 8.3). Both the incidence and intensity of OJT activity are lower amongst the smallest establishments. However, the rank order of the RDA areas does change to be somewhat more in line with that reported by Campbell *et al* (2001).

When these data are plotted against information on the proportions employed in each RDA area holding various high level qualifications, a very mixed pattern emerges. Figures 8.1-8.4 in the separate Appendix to Chapter 8 at the end of this chapter illustrate some typical examples using both measures of incidence and intensity. Comparisons are made with both the average qualifications of all those employed in the geographical area (based on LFS data) and with those actually employed in the establishment itself (based on ESS2001 data). Comparisons have been made for all establishments and also excluding the smallest establishments (those employing fewer than 5 employees).

This detailed graphical and statistical analysis suggests that there is only a weak relationship between OJT (incidence or intensity) and qualification (shares or scores) at the RDA level. If anything, the relationship between OJT activity and qualifications appears to be positive rather than negative as suggested by Campbell *et al* (2001). Similar patterns emerge if external labour market or internal establishment qualification structure (or scores) are used.

Table 8.3: Measures of OJT by RDA from ESS2001

	Incidence of OJT[1]				Intensity of OJT[2]			
	All establishments		Large est. (5+)		All establishments		Large est. (5+)	
RDA Region	Mean %	Rank	Mean %	Rank	Mean %	Rank	Mean %	Rank
Eastern	34.8	8	67.9	2	20.8	6	32.2	3
East Midlands	42.6	1	65.9	3	26.8	1	31.4	4
London	38.7	3	63.6	8	25.2	2	31.2	6
North East	37.4	4	64.8	7	17.9	8	31.2	5
North West	34.8	7	61.0	9	20.5	7	29.1	9
South East	37.0	5	65.3	5	23.0	3	32.4	2
South West	36.2	6	70.0	1	21.6	5	33.1	1
West Midlands	40.5	2	64.9	6	23.0	4	29.6	8
Yorks & Humb	32.3	9	65.6	4	17.6	9	30.9	7
Total	37.1		65.2		22.4		31.2	

Source: ESS2001.

Notes:

1. Proportion of establishments (or larger establishments with 5 or more workers) which funded any OTJ during the previous 12 months.
2. Proportion of employees who received any OJT during the previous 12 months.
3. These are establishment weighted statistics in each case.

This is confirmed if the analysis is repeated at LLSC level (see Figures 8.5-8.8 in the separate Appendix to Chapter 8 at the end of this chapter). The correlation is strongest (and positive) between OJT intensity and ESS2001 (i.e. own establishment) qualification measures. However, the correlations are generally weak, with the highest R-squared values only being around 0.4, although the relationships are stronger if the smaller establishments are excluded.

One possible interpretation of this finding is that, although there may be a link between OJT and the qualifications of the workforce, there is considerable variation in the relationship at the regional and local level. It is therefore helpful to examine other aspects of the pattern of OJT activity.

8.3.3 The pattern of OJT by sector, size, etc.

Incidence
Panel A of Table 8.4 reports the proportion of establishments and employment in workplaces reporting any OJT in the previous 12 months, disaggregated by establishment size. These statistics are weighted to be representative of the population of establishments and employment in England. The first column presents the proportion of establishments that carried out some OJT activity over the previous 12 months. This reveals that just over third of all establishments (37.1%) reported that they undertook some training. The second column gives the proportion of establishments in the population in the various size categories. Columns 3 and 4 present corresponding information weighted by employment. This shows that over three quarters (76.7%) of all workers were working in an establishment with some training activity in the last 12 months. There are marked differences for establishments of different sizes. Incidence of OJT increases with establishment size regardless of whether establishment or employment weights are used.

The remaining three panels of Table 8.4 report the same measures disaggregated by region (Panel B), industry (Panel C) and broad sector (Panel D). As already noted, according to the ESS2001 data, the proportion of establishments carrying out some OJT activity does not show a clear-cut pattern across regions. Compared to other dimensions, the differences by region are not large. Weighted by establishments, the highest recorded value is just under 43% in the East Midlands while Yorkshire & Humberside has the lowest value of just over 32%.

There is considerably more variation in the propensity of establishments to report OJT activity by industry than by region. Around 80% of education and public administration establishments report that they undertook some OJT activity. Apart from these public-sector establishments, those in health and social work, electricity and water supply, mining and quarrying and finance also have a relatively high propensity for some OJT activity. In contrast, relatively few establishments in many of the other industries, including agriculture, manufacturing and construction report that they carry out OJT.

This distribution in responses by industry is reflected in the sectoral propensity to report OJT activity as shown in the final panel of Table 8.4. Establishments in the public and voluntary sectors have much higher incidence than the private sector.

Table 8.4: Incidence of OJT by establishment and employment

	Establishment[1]		Employment[1]	
Panel A: by Size	**Incidence[2]**	**Pop. %[3]**	**Incidence[2]**	**Pop. %[3]**
1-4	26.2	71.95	28.8	10.85
5-9	52.5	11.06	53.2	7.16
10-24	66.5	9.86	68.2	15.09
25-49	79.0	3.69	79.6	12.52
50-99	85.9	2.02	86.3	13.19
100-199	89.7	0.75	90.0	10.03
200-499	90.7	0.53	90.9	15.66
500+	95.8	0.14	96.2	15.50
Total	37.1	100.00	76.7	100.00
Panel B: by Region	**Incidence**	**Pop. %**	**Incidence**	**Pop. %**
Eastern	34.8	11.35	77.8	10.44
East Midlands	42.6	7.85	75.4	7.99
London	38.7	18.56	75.5	17.86
North-East	37.4	3.50	78.8	4.56
North-West	34.8	11.95	75.5	12.94
South-East	37.0	17.81	76.6	16.32
South-West	36.2	10.50	77.0	9.50
West Midlands	40.5	9.75	77.9	10.79
Yorks & Humberside	32.3	8.72	77.9	9.60
Total	37.1	100.00	76.7	100.00
Panel C: by Industry	**Incidence**	**Pop. %**	**Incidence**	**Pop. %**
Agriculture	28.4	2.97	58.2	1.15
Mining & quarrying	56.1	0.16	88.1	0.23
Manufacturing	32.8	8.85	80.3	17.33
Electricity & water supply	54.2	0.09	92.6	0.34
Construction	30.7	9.16	64.6	4.26
Wholesale, retail	29.6	23.32	65.9	17.54
Hotels and restaurants	29.9	7.00	63.6	5.59
Transport & comm.	27.2	4.45	72.2	5.89
Finance	48.7	2.13	84.7	4.48
Business services	41.0	25.06	74.5	15.04
Public administration	78.7	1.00	90.6	5.73
Education	81.0	2.28	92.6	7.33
Health & social work	69.3	4.37	90.0	10.34
Other community	35.1	9.18	67.2	4.75
Total	37.1	100.00	76.7	100.00
Panel D: by Sector	**Incidence**	**Pop. %**	**Incidence**	**Pop. %**
Private sector	34.0	85.70	72.9	71.82
Public sector	58.4	8.85	87.5	24.51
Voluntary sector	54.9	4.72	82.5	2.99
Not stated/DK	32.4	0.73	67.1	0.67
Total	37.1	100.00	76.7	100.00

Notes:

1. Establishment and employment weighted respectively.
2. Percentage of establishments or employment in establishments, which funded any OTJ during the previous 12 months.
3. Percentage of all establishments, or employment, in the category.

Intensity
Table 8.5 reports OJT intensity as measured by the proportion of employees undertaking some training in the previous 12 months, and also OJT intensity for those establishments where some OJT took place (conditional intensity). Once again, the aggregate statistics by establishment and by employment are supplemented by a decomposition by size, region, industry and broad sector as above. Panel A records that the average establishment has trained 22% of its employees over the past year, while 52% of workers in the average worker's establishment received training. OJT intensity increases with establishment size.

The conditional intensity proportions also vary by size of establishment but in this case the relationship between intensity and size is not monotonic. The conditional intensity of OJT falls and then increase with increasing establishment size. Table 8.6 provides some further information on how the intensity of OJT varies by establishment size. The 'polarisation' of training – either none or all workers at the establishment receiving training – is evident from Table 8.6.

Table 8.5 also reveals that average establishment-level intensities range from just under 18% in Yorkshire and Humberside and the North East to just under 27% in the East Midlands. Public and social services, finance and business service establishments have relatively high OJT rates, while manufacturing industries have relatively low average rates.

There are clear and important differences in the propensity for establishments to report that they have some OJT activity and the intensity of the activity that they report. This is perhaps most clearly evident if Panel A of Table 8.4 is compared to the corresponding panel of Table 8.5. These differences are clearly most obviously related to establishment size, but other factors are likely to be important too as evidenced by the dissimilarities in the rankings between the regional and industry panels in Table 8.4 and Table 8.5. These distinctions in part determine the modelling strategy utilised in Sections 8.4 and 8.5 below.

8.3.4 Decomposition of variance within and between categories

Finally, in order to illustrate the variation that exists in the incidence and intensity of OJT, a decomposition of the total variation in the measures into the between- and within- sub-category proportions by region, industry, sector, establishment size and LLSC area is presented in Table 8.7. The variance in the rates is calculated across all establishments, and then examined to see to what extent this variance is a consequence of variation in establishments' rates within regions, or between regions (or industries, etc). Because the variance can be decomposed exactly into its between and within contributions (see, for example, Cowell, 1995), it is possible to report the proportion of the total variation in the rates which is due to variation in the rate within regions and between regions (or industries etc). This decomposition is carried out for all establishments, and also for just those establishments with some OJT activity.

Table 8.5: Intensity of OJT by establishment and employment

	Establishment[1]			Employment[1]		
Panel A: by Size	**Intensity[2]**	**Conditional intensity[3]**	**Pop. %[4]**	**Intensity[2]**	**Conditional intensity[3]**	**Pop. %[4]**
1-4	18.9	73.2	71.95	19.1	67.3	10.85
5-9	26.7	51.4	11.06	27.0	51.1	7.16
10-24	30.5	46.2	9.86	31.4	46.4	15.09
25-49	36.7	46.6	3.69	36.9	46.5	12.52
50-99	38.9	45.5	2.02	39.2	45.7	13.19
100-199	44.8	50.2	0.75	45.2	50.5	10.03
200-499	48.5	53.8	0.53	48.8	54.1	15.66
500+	57.8	60.7	0.14	57.5	60.2	15.50
Total	22.4	61.0	100.00	39.2	51.8	100.00
Panel B: by Region	**Intensity**	**Conditional intensity**	**Pop. %**	**Intensity**	**Conditional intensity**	**Pop. %**
Eastern	20.8	60.4	11.35	40.6	52.6	10.44
East Midlands	26.8	63.2	7.85	37.3	50.2	7.99
London	25.2	65.7	18.56	39.5	53.4	17.86
North-East	17.9	48.4	3.50	40.6	52.2	4.56
North-West	20.5	60.5	11.95	38.1	51.1	12.94
South-East	23.0	62.4	17.81	41.3	54.5	16.32
South-West	21.6	59.9	10.50	38.9	51.1	9.50
West Midlands	23.0	58.6	9.75	38.0	49.6	10.79
Yorks & Humberside	17.6	55.1	8.72	37.4	48.6	9.60
Total	22.4	61.0	100.00	39.2	51.8	100.00
Panel C: by Industry	**Intensity**	**Conditional intensity**	**Pop. %**	**Intensity**	**Conditional intensity**	**Pop. %**
Agriculture	16.6	59.9	2.97	25.8	44.7	1.15
Mining & quarrying	28.5	50.9	0.16	44.9	51.0	0.23
Manufacturing	12.6	39.2	8.85	32.7	41.1	17.33
Electricity & water supply	33.1	61.7	0.09	69.3	75.4	0.34
Construction	20.5	68.4	9.16	31.4	48.9	4.26
Wholesale, retail	15.3	52.3	23.32	31.4	48.2	17.54
Hotels and restaurants	15.9	53.6	7.00	30.9	49.2	5.59
Transport & comm.	14.4	54.0	4.45	30.9	43.5	5.89
Finance	29.0	59.8	2.13	45.6	54.1	4.48
Business services	28.7	70.5	25.06	40.8	55.5	15.04
Public administration	55.7	71.1	1.00	52.1	58.2	5.73
Education	53.0	65.7	2.28	58.5	63.5	7.33
Health & social work	43.7	63.2	4.37	54.9	61.7	10.34
Other community	22.0	62.9	9.18	32.8	49.4	4.75
Total	22.4	61.0	100.00	39.2	51.8	100.00
Panel D: by Sector	**Intensity**	**Conditional intensity**	**Pop. %**	**Intensity**	**Conditional intensity**	**Pop. %**
Private sector	20.0	59.8	85.70	35.0	48.5	71.82
Public sector	36.7	63.3	8.85	51.4	59.5	24.51
Voluntary sector	39.3	71.7	4.72	47.7	58.0	2.99
Not stated/DK	13.2	41.4	0.73	32.2	48.8	0.67
Total	22.4	61.0	100.00	39.2	51.8	100.00

Notes:

1. Establishment and employment weighted respectively.
2. Average percentage of workers receiving any OJT during the previous 12 months.
3. Average percentage of workers receiving any OJT during the previous 12 months in those establishments with some OJT.
4. Percentage of all establishments, or employment, in the category.

Table 8.6: Intensity of OJT by establishment size

	Establishment Size								
	1-4	5-9	10-24	25-49	50-99	100-199	200-499	500+	All
OJT intensity:	%	%	%	%	%	%	%	%	%
None	74	48	34	21	14	11	10	4	63
<10%	4	10	12	13	16	13	11	6	6
10-<20%	0	4	11	14	16	13	11	10	3
20-<30%	1	7	10	11	10	12	11	10	3
30-<40%	1	4	4	5	5	5	7	6	2
40-<50%	0	3	2	2	3	4	4	3	1
50-<60%	3	5	7	7	8	8	8	10	4
60-<70%	0	2	2	2	3	3	4	5	1
70-<80%	0	2	2	4	4	5	5	7	1
80-<90%	0	2	2	3	3	4	4	6	1
90-<100%	0	1	2	3	3	3	3	6	1
100%	16	14	14	15	15	18	22	25	15
Total	100	100	100	100	100	100	100	100	100
Percentage reporting some OJT activity (%)	26.2	52.5	66.5	79.0	85.9	89.7	90.7	95.8	37.1
Mean intensity of OJT activity (%)	18.9	26.7	30.5	36.7	38.9	44.8	48.5	57.8	22.4
Mean intensity for those with some OJT activity (%)	73.2	51.4	46.2	46.6	45.5	50.2	53.8	60.7	61.0

Note: Establishment weighted.

The results of this decomposition are shown in Table 8.7 for the incidence of OJT activity and the intensity of OJT. A number of features of the variation in OJT are revealed. First, when measured across all establishments, almost all of the variation in both OJT incidence and intensity is within- rather than between- sub-categories. This implies that there is much more variation in training activity rates between establishments within any region (industry, etc), than there is in the rates between regions (industries, etc). This is perhaps unsurprising, but the scale of the magnitude is notable. More than 99% of the differences in overall rates of OJT incidence between establishments are differences within regions, and less than 1% of the variation is between regions. A similar conclusion holds for the other sub-categories. One consequence of this finding is that one would expect to find that differences between regions (or regional effects) would account for very little of the variation in the rate when considering all establishments together. In part, this is a result of a large proportion of establishments having no OJT activity (some 63% of all establishments had undertaken no OJT activity during the previous 12 months).

If attention is restricted to those establishments with some OJT activity, only a very slightly different picture emerges. As previously noted, conditional OJT intensity rates differ between establishment size groups. Around 11% of the variance in the incidence of OJT in those establishments with some training is between establishment size groups. However for all sub-categories, the within-category component still dominates the between-category component. Although there is still little variation in rates between regions, there is slightly more between LLSC areas, suggesting that the regional dimension may disguise some differences in rates that exist at the sub-regional level.

Table 8.7: Decomposition of the variance of OJT incidence and intensity

All Establishments:			**Panel A: Incidence of OJT**			
Sub-category:	total variance	%	within	%	between	%
by region[1]	0.23334	100	0.23261	99.7	0.00073	0.3
by industry[2]	0.23334	100	0.21902	93.9	0.01431	6.1
by sector[3]	0.23334	100	0.22697	97.3	0.00637	2.7
by establishment size[4]	0.23334	100	0.19830	85.0	0.03503	15.0
by LLSC area[5]	0.23334	100	0.22703	97.3	0.00631	2.7
All Establishments:			**Panel B: Intensity of OJT**			
Sub-category:	total variance	%	within	%	between	%
by region	0.14114	100	0.14047	99.5	0.00067	0.5
by industry	0.14114	100	0.13212	93.6	0.00902	6.4
by sector	0.14114	100	0.13745	97.4	0.00369	2.6
by establishment size	0.14114	100	0.13729	97.3	0.00385	2.7
by LLSC area	0.14114	100	0.13790	97.7	0.00324	2.3
All Establishments with some OJT:			**Panel C: Conditional intensity of OJT**			
Sub-category:	total variance	%	within	%	between	%
by region	0.14948	100	0.14805	99.0	0.00142	1.0
by industry	0.14948	100	0.14055	94.0	0.00892	6.0
by sector	0.14948	100	0.14823	99.2	0.00125	0.8
by establishment size	0.14948	100	0.13353	89.3	0.01594	10.7
by LLSC area	0.14948	100	0.14377	96.2	0.00570	3.8

Notes:
1. Region: 9 categories: Eastern, East Midlands, London, North-East, North-West, South-East, South-West, West Midlands, Yorkshire & Humberside
2. Industry: 14 categories: agriculture, mining & quarrying, manufacturing, electricity & water supply, construction, wholesale & retail, hotels & restaurants, transport & communication, finance, business services, public administration, education, health & social work, other community.
3. Sector: 4 categories: private sector, public sector, voluntary sector, not stated/DK.
4. Establishment size: 8 categories: 1-4, 5-9, 10-24, 25-49, 50-99, 100-199, 200-499, 500 or more workers.
5. LLSC area: 47 categories: 47 local Learning and Skills Council areas.
6. Establishment weighted.

8.4 Multivariate modelling strategy

An important limitation of the previous discussion and exploratory analysis is that bivariate correlations between OJT activity and qualification indicators do not account for other potential influences on the level of OJT activity. As already demonstrated, factors such as size of establishment and industrial sector may influence the incidence and intensity of OJT. Establishments in areas dominated by rapidly growing or (declining) industries may face particular problems to keep staff fully trained. Other potential influences include: the level of labour turnover at the establishment; other human resource management policies and practices; other industry features, such as susceptibility to national and international competition; occupational mix; general labour market factors such as unemployment rates, relative wage rates and other local labour market characteristics such as the supply

of skills and occupational composition may have an influence. All of these factors may impact upon the probability of establishments undertaking any training and, if they do so, how extensive this training is. Some, but not all, of these influences can be measured by information available from the supplemented ESS2001 dataset.

The next section presents results of an investigation into the relationship between OJT activity and qualifications, while taking account of the characteristics of the establishment and the local labour market which may impinge upon this relationship.[49] The multivariate analysis incorporates all the potential influences which can be readily measured using the supplemented ESS2001 dataset. This enables the identification of the key correlates/determinants of OJT. The specific links between OJT and qualification indicators both within the establishment and more widely can then be examined.

The prime objective of the multivariate analysis is to examine the relationship between the incidence and intensity of OJT and the qualifications of the workforce and local labour force. In particular:

- is the conventional wisdom that OJT is positively associated with qualifications within the workplace confirmed? That is, at the establishment level, is OJT activity (both incidence and intensity) positively related to qualifications held?
- is there any separate influence of the qualifications structure within the wider labour market?
- is there any evidence of a residual qualifications effect which is 'paradoxical' in that there is high training activity in areas with a relatively poorly qualified workforce (as suggested by Campbell *et al*, 2001)?

It is important to note that the OJT intensity rate can only be non-negative. In addition many establishments indicate that they did not do any OJT. Thus, the estimation procedure cannot be simple linear regression. An appropriate specification which takes account of the clustering of a large proportion of observations at zero, together with only positive values at the non-zero observations is the Tobit model.[50] However, the findings reported above indicate that the influence of establishment size on the probability of an establishment having any OJT (OJT incidence) is positive, while its influence on the conditional intensity of OJT falls and then increases with establishment size. This cannot be accommodated by the simple Tobit specification, which restricts the influence of any variable on both the probability of a non-zero observation, and on its magnitude if non-zero, to be the *same* sign. There may be other variables which also potentially have differential influences on the incidence and conditional intensity of OJT. Two sets of coefficients are therefore needed.

An appropriate specification which does allow for the kinds of differential effects is

[49] The analysis presented here is similar to the analysis of the determinants of vacancies and skill deficiencies that IER has also recently undertaken for DfES (Dickerson, 2003).

[50] The original paper was Tobin (1958), although the Tobit ('Tobin's probit') is now a fairly standard econometric model since it can be seen to apply to a large variety of circumstances. For a discussion and some examples, see, for example, Amemiya (1986) and Greene (2000).

the modification of the Tobit model suggested by Cragg (1971)[51]. This is a two equation model, defined as:

$$P(OJT_i > 0) = \Phi(X_i\beta_1) \quad (1)$$

$$E(OJT_i \mid OJT_i > 0) = X_i\beta_2 \quad (2)$$

The first equation represents the probability of establishment i undertaking any OJT. Given the nature of the dependent variable (either 1 or 0), this is estimated using a probit model which takes into account the dichotomous nature of the dependent variable (Φ is the CDF (cumulative density function, or distribution function, of the standard normal distribution). The second equation specifies a model for the conditional intensity of OJT (conditional on undertaking some OJT). This is estimated using a truncated regression model given that only positive observations on OJT are observed[52]. If $\beta_1 = \beta_2$ then the model becomes the simple Tobit model. As noted above, given the differential impact of establishment size on the probability of carrying out any OJT and on the intensity of OJT, this restriction is not expected to hold.

The prime interest is in the relative importance of the various determinants of the incidence and intensity of OJT. The marginal or partial effects for the regressors for both the probit and truncated regression results are therefore reported. For the probit specification, these are the magnitude of the impact of the regressor on the probability of an establishment reporting any OJT. For dummy variables, since there cannot be marginal change in, say, being in the private sector, the change in the probability for a discrete change in the dummy variable from 0 to 1 is reported. In the truncated regression, the marginal effects record the proportionate impact on the conditional intensity of OJT activity.

Finally, in order to measure the overall impact of any particular variable X on the intensity of OJT, it is necessary to combine its impact on whether there is any OJT activity, together with its impact on the intensity. Simple differentiation yields:

$$\begin{aligned}\frac{\partial OJT}{\partial X} &= \frac{\partial(P(OJT > 0) \times E(OJT \mid OJT > 0))}{\partial X} \\ &= \beta_1\phi(X_1\beta_1) \times E(OJT \mid OJT > 0) + \beta_2 \times P(OJT > 0)\end{aligned} \quad (3)$$

where ϕ is the standard normal density function. These overall effects are also reported in the results in the following section.

8.5 The determinants of OJT

There are a large number of potential factors that may contribute to differences between establishments in the incidence and/or intensity of their OJT. No attempt is made to differentiate between those factors which may determine only the incidence from those that may determine the conditional intensity. Instead a common vector of variables is used for both the probit part and the truncated regression part of the

[51] The classical example in the literature, due to Lin and Schmidt (1984), is the 'loss due to fire' as a function of the 'age of the building'. Newer buildings typically have a lower probability of having fires, but have a greater average loss when a fire does occur.

[52] It is not uncommon to assume that the incidence and intensity elements are unrelated – that is the two equations are independent, although, as noted by Amemiya (1986), this assumption often seems unrealistic despite the computational advantage that this brings.

model. A brief description and summary statistics for the variables used in the empirical estimates is presented in Table 8.A.1 in the separate Appendix to Chapter 8 at the end of this chapter. Tables 8.8 and 8.9 summarise the econometric results.

8.5.1 Establishment and firm characteristics

The first specification in Table 8.8 (specification A) simply includes a number of controls for establishment and firm characteristics. These include a measure of establishment size. Rather than impose linearity or any other functional form on the relationship between OJT and size, 8 grouped measures of establishment size were used (**est. size 5-9; est. size 10-24** etc.), with 1-4 employees as the omitted (base) category. Given the statistics presented in Section 8.3 above, the incidence of OJT activity was expected to increase with increasing establishment size, while the conditional intensity should fall and then relative to the smallest size category.

A number of other characteristics of the establishment, which it is thought might influence the propensity to train are also incorporated. These include a measure of the private/public status of the establishment (**private sector**) which takes a value of 1 if the establishment is in the private sector and 0 otherwise. The descriptive statistics presented earlier suggest that the public (and voluntary) sector may do more training than the private sector. The expected sign on this coefficient is therefore negative.

A dummy variable is also included for whether the firm is wholly or party foreign owned (**foreign owned**). While this is relatively small proportion of establishments in the population, it seems possible that training strategies may well differ for such firms.

A dummy variable is also included to indicate whether or not the establishment is a single or multiple establishment organisation (**single**). In multi-establishment organisations, there may be a greater probability of having formal HR management arrangements which may be associated with OJT activity. A control for whether the establishment is the head office of the organisation is also included (**head office**).

Controls are also added for whether total sales (for private sector enterprises) or budget (for non-private sector establishments) has increased or decreased ‘a great deal’ in the past 12 months, in order to capture any expansionary or contractionary effects on training activity (**increase in sales** and **decrease in sales**). Related to this are controls for the establishments’ underlying hiring and quit rates. The hiring rate and quit rate (**hire rate** and **quit rate**) are measured as a proportion of the current workforce at the establishment who have been taken on or left in the preceding 12 months respectively. Whether or not the establishment has particular recruitment problems is indicated by the use various indicators of vacancy rates. These relate to all vacancies, hard-to-fill vacancies and skill-shortage vacancies (**vacancy rate – any, vacancy rate – h2f** and **vacancy rate – ss**) respectively.

8.5.2 Local area characteristics

The second specification (specification B in Table 8.8) includes a number of local (LLSC) area characteristics that are likely to impinge on the propensity of

establishments to carry out training. These are in addition to the firm and establishment level characteristics included in specification A.

A measure of industrial structure captures the supply of labour to the establishment in the locality (**industry empl.**). This is based on a measure of the proportion of the local labour force (at the LLSC level) which is currently employed in the industry in which the establishment is engaged. The greater is the local supply of labour with the appropriate skills, the less necessary it may be to undertake training. However, such establishments will be competing against a greater number of other establishments for the same workers and hence the demand for these workers is also likely to be greater. The net balance of these two opposing effects is an empirical manner.

The share of employment in the locality is obviously only one of a number of industry characteristics that may be relevant to the incidence and intensity of training. In addition to the industry composition of the current local labour force, the proportionate rate of growth of the locally employed labour force over the last two years is also included (**empl. growth**). High rates of growth in employment may mean a relative shortage of excess labour to fill any vacancies and greater need for training. However, it may also signal to workers currently located outside the locality that the area has good employment prospects, and hence they may be more tempted to migrate to the area. Again, the net balance of these two effects is uncertain.

A further variable introduced to capture the characteristics of the local labour force and their likely impact on training is a measure of local relative wages (**relative wage**). The occupational relative wages in the area (for 1-digit SOC categories, relative to the average for England) are computed, and then averaged, with weights given by the shares of each of the occupations in the local labour force. Rather than simply taking the average wage for all workers in the local area, this captures the extent to which the area has high or low wages relative to the occupational composition of the local labour force. This is important if the occupational distribution of employment is not fairly uniform. The final variable is a measure of unemployment (**log(unempl)**). This is based on ILO unemployment rate for all those aged 16 or over for the LLSC area.

Specification B also includes a series of 14 industry dummy variables (agriculture is the omitted category) to capture any remaining industry-specific effects, including the identification of industries in long term growth or decline. In such cases, there may be particular problems associated with training activity.

8.5.3 Qualifications of the workforce

In order to address the motivating question for this analysis, the effects of two types of indictors of qualifications of the employed workforce are explored in specifications C and D. Both specifications include a measure of the qualifications structure of the people employed within the establishment. As noted in Section 8.2.2 above, ESS2001 respondents were asked about the most common level of qualification for each occupational group employed in the establishment. Assigning numeric values to each qualification level (4 for NVQ level 4 (or equivalent), 3 for NVQ level 3 (or

equivalent), etc.) and weighting by occupational shares enables an establishment-level qualification score to be computed (establishment_qual.). Both specifications C and D include this qualification score for which higher values denote a more qualified workforce. Based on previous research, a positive relationship between this indicator and OJT activity is anticipated.

Specifications C and D differ according to which indicators of the local (LLSC) labour market in which the establishment is located are also included. In specification C, the proportion of the LLSC labour force which has qualifications at NVQ level 3 (or equivalent) or above (**good skills**) is included. This most closely corresponds to the level for which Campbell *et al* (2001) noted the apparently anomalous result of high training in areas with low qualifications. In specification D, the proportion of the local labour force which has no qualifications (**low skills**) and the proportion with qualifications at NVQ level 4 (or equivalent) or above (**high skills**) are used instead.

8.5.4 Results

The main results are presented in Table 8.8. For the four empirical specifications (A, B, C and D as discussed above), first the estimates of the probit equation (1) for the incidence of any OJT are presented, followed by the truncated regression results for OJT intensity, conditional on there being some OJT at the establishment. The net/joint marginal effects as explained in equation (3) for changes in the independent variables on overall OJT intensity are reported in Table 8.9.

Size: The net impact of increasing establishment size on overall OJT activity is positive as can be seen in Table 8.9. The magnitudes of the marginal effects are quite large. For example, for specification D, the impact of an establishment growing from being of average size (10 employees in the sample and thus in **est. size 10-24**) to being one standard deviation above the average size (which would place it in **est. size 50-99**) would be to increase the expected OJT rate by (0.1877-0.1229) =0.065. Given that the average OJT intensity is 0.224, this represents an increase of almost 30% in training intensity.

Sector: If the establishment is in the private sector, this has a significant negative impact on both the incidence and intensity of OJT. The overall marginal effect is therefore strongly negative. In specification D, the net marginal effect is –0.04.

Other establishment characteristics: The net impact of establishments being foreign or joint foreign/UK owned on OJT activity are negligible. However, being a head office has a significantly negative impact on the probability of undertaking any OJT activity and, where it is carried out, being a head office reduces its intensity. The same applies if the establishment is a single site establishment, although both effects are rather larger in this case.

Business activity and related indicators: Establishments which have increased their scale of operation in the last 12 months have higher OJT rates than establishments which have seen little or no change in turnover or budget. Establishments that are contracting have lower OJT rates. In both cases incidence and intensity effects are reinforcing. The net effects on the average OJT rate of 0.224 are +0.05 and -0.07 respectively.

Where quit rates are higher, OJT activity is more prevalent, both in terms of incidence and intensity, although in the case of OJT incidence, the coefficient is very small in magnitude. OJT appears to be largely uncorrelated with the hiring rate at the establishment. In order to gauge the impact of changes in these continuous variables, it is helpful to consider a representative change in the variable. Thus if an establishment has a hiring rate one standard deviation above the mean hiring rate, the impact on the expected OJT rate will be (0.692 $\times$ -0.0066) =–0.005 which is very small compared to the mean OJT rate (0.224). The impact on actual OJT rates would appear to be negligible. In the case of quit rates, the net marginal effects are positive and somewhat larger (0.716 $\times$ 0.0265) =0.019.

Local area characteristics: Location of the establishment in areas of strong employment growth (**empl. growth**) tends to have a negative impact on OJT although the effect on incidence is not statistically significant. The industry composition of the current local labour force (**industry empl.**) has a positive and statistically significant impact on incidence but the effect on intensity is not significant. The net effect of a change of one standard deviation is around 0.02. The coefficient on the (log) LLSC unemployment rate is positive and significant for the incidence of OJT but negative (and statistically insignificant) for the intensity. Its net impact on the overall OJT rate is positive. The relative wage for the locality has a strongly negative impact on incidence and intensity of OJT activity – high wage paying areas appear to engage in less training of their workforce. The net marginal effects associated with these variables are all small.

Qualification effects: In specifications C and D, the effect of qualifications of those employed in the establishment (**establishment_qual**) has a strong and significant impact on both the incidence and intensity of OJT activity. The overall impact of a one standard deviation increase in the qualification score would be to raise the OJT rate by (1.260 $\times$ 0.0431) =0.05. This confirms the conventional wisdom that the better qualified tend to receive more training in general.

When the effect of the qualifications of those employed in the local labour market are considered, the picture is a little less clear. In specification C the effect of the proportion of those qualified at NVQ level 3 or above (**good skills**) on incidence is positive and statistically significant but its impact on intensity is not significant. In specification D, the focus is on those with no (**low skills**) or very high (**high skills**) qualifications. Establishments located in areas of low skills amongst the labour force tend to show no difference in terms of incidence or intensity of OJT activity. However, in areas with a relatively highly qualified workforce there is a statistically significant and positive effect on the incidence of OJT activity but a negative effect on intensity. The net effect on OJT is positive however.

Table 8.8: Determinants of OJT incidence and intensity

	OJT incidence				OJT intensity			
Specification:	A	B	C	D	A	B	C	D
est. size 5-9$	0.255***	0.277***	0.287***	0.286***	-0.184***	-0.168***	-0.161***	-0.161***
est. size 10-24	0.383***	0.394***	0.407***	0.407***	-0.237***	-0.225***	-0.217***	-0.217***
est. size 25-49$	0.487***	0.485***	0.499***	0.499***	-0.241***	-0.235***	-0.226***	-0.225***
est. size 50-99$	0.542***	0.546***	0.560***	0.560***	-0.249***	-0.239***	-0.230***	-0.230***
est. size 100-199$	0.568***	0.574***	0.584***	0.584***	-0.196***	-0.182***	-0.177***	-0.176***
est. size 200-499$	0.577***	0.585***	0.594***	0.594***	-0.154***	-0.132***	-0.125***	-0.125***
est. size 500+$	0.613***	0.616***	0.623***	0.623***	-0.104**	-0.091**	-0.088**	-0.087**
private sector$	-0.141***	-0.088***	-0.079***	-0.079***	-0.077***	-0.038***	-0.032***	-0.032***
foreign owned$	-0.001	0.017	0.015	0.015	-0.001	0.015	0.011	0.011
single$	-0.090***	-0.104***	-0.100***	-0.100***	-0.036***	-0.051***	-0.053***	-0.054***
increase in sales$	0.112***	0.103***	0.089***	0.089***	0.042***	0.035***	0.028***	0.028***
decrease in sales$	-0.108***	-0.102***	-0.113***	-0.113***	-0.080***	-0.075***	-0.072***	-0.072***
hire rate	-0.011*	-0.008	-0.009	-0.010	-0.016***	-0.009**	-0.008*	-0.009*
quit rate	0.051***	0.054***	0.054***	0.054***	0.011**	0.008*	0.009**	0.009**
head office$	-0.018	-0.035**	-0.037***	-0.037***	-0.080***	-0.089***	-0.093***	-0.093***
vacancy rate - any	0.273***	0.294***	0.251***	0.252***	0.041*	0.055**	0.047**	0.046**
vacancy rate - h2f	-0.142**	-0.175***	-0.105*	-0.106*	0.061	-0.010	0.035	0.039
vacancy rate - ss	0.221***	0.169**	0.120*	0.122*	0.184***	0.203***	0.150***	0.147***
LLSC industry empl.		0.763***	0.677***	0.679***		0.021	0.004	0.016
LLSC empl. growth		-0.056	-0.087	-0.046		-0.139**	-0.133**	-0.153**
LLSC relative wage		-0.099***	-0.270***	-0.275***		0.104***	0.093***	0.132***
LLSC log(unempl)		0.042***	0.067***	0.062***		-0.004	-0.010	-0.004
establishment_qual.			0.081***	0.081***			0.027***	0.027***
LLSC good skills			0.394***				-0.045	
LLSC low skills				-0.083				-0.185
LLSC high skills				0.317**				-0.225**
industry dummies	No	Yes	Yes	Yes	No	Yes	Yes	Yes
constant					0.579***	0.467***	0.437***	0.453***
Observations	25652	25652	25652	25652	17374	17374	17374	17374

Notes:

$ denotes dummy variable.

1. * significant at 10%; ** significant at 5%; *** significant at 1%.
2. The coefficients are the marginal effects on training incidence and intensity respectively – see text for details.

Table 8.9: Net marginal effects

Specification:	A	B	C	D
est. size 5-9$	0.0637	0.0776	0.0844	0.0844
est. size 10-24	0.1064	0.1141	0.1229	0.1229
est. size 25-49$	0.1515	0.1521	0.1618	0.1620
est. size 50-99$	0.1737	0.1780	0.1876	0.1877
est. size 100-199$	0.1997	0.2053	0.2123	0.2124
est. size 200-499$	0.2150	0.2236	0.2302	0.2303
est. size 500+$	0.2440	0.2488	0.2533	0.2534
private sector$	-0.0833	-0.0496	-0.0435	-0.0433
foreign owned$	-0.0007	0.0116	0.0096	0.0094
single$	-0.0496	-0.0600	-0.0586	-0.0588
increase in sales$	0.0609	0.0550	0.0469	0.0468
decrease in sales$	-0.0694	-0.0655	-0.0691	-0.0693
hire rate	-0.0092	-0.0060	-0.0064	-0.0066
quit rate	0.0255	0.0261	0.0264	0.0265
head office$	-0.0293	-0.0395	-0.0413	-0.0412
vacancy rate - any	0.1318	0.1452	0.1237	0.1242
vacancy rate - h2f	-0.0467	-0.0801	-0.0370	-0.0368
vacancy rate - ss	0.1472	0.1294	0.0930	0.0929
LLSC industry empl.		0.3440	0.3014	0.3052
LLSC empl. growth		-0.0621	-0.0737	-0.0608
LLSC relative wage		-0.0160	-0.0952	-0.0873
LLSC log(unempl)		0.0175	0.0269	0.0263
establishment_qual.			0.0430	0.0431
LLSC good skills			0.1625	
LLSC low skills				-0.0855
LLSC high skills				0.0810
Industry effects:				
Mining & quarrying		0.0365	0.0070	0.0081
Manufacturing		-0.1322	-0.1323	-0.1324
Electricity & water		0.0370	0.0095	0.0103
Construction		0.0030	-0.0042	-0.0039
Wholesale, retail		-0.1131	-0.1134	-0.1135
Hotels & restaurants		-0.0835	-0.0804	-0.0802
Transport & comm..		-0.0811	-0.0776	-0.0775
Finance		-0.0028	-0.0244	-0.0239
Business services		-0.0070	-0.0356	-0.0355
Public admin.		0.0941	0.0705	0.0713
Education		0.1226	0.0886	0.0890
Health & social work		0.0386	0.0177	0.0182
Other community		-0.0161	-0.0313	-0.0311

Note: Net marginal effects derived from equation (3) – see text for details.

Thus, for the establishment, the better qualified its work force, the greater the incidence and intensity of its training activity. This result confirms individual level analysis and previous research in this area. In the comparison of training activity with the overall qualifications of the workforce in the locality, which was the key feature of the paradox as introduced in Section 8.1, there is no evidence of a significant negative correlation as suggested by Campbell *et al* (2001).

Industry: There are significant differences in OJT intensity by industry. Manufacturing industries and marketed services are significantly less likely to

have engaged in OJT activity over the past 12 months. They also carry out significantly less training where it does occur. In contrast, industries in the non-marketed service sector, such as public administration and education, are significantly more likely to undertake some training and, when they do so, to undertake it more intensively.

It is worth noting that, conditional on establishment size, establishments' OJT activity rates are extremely variable. Thus, while it is possible to identify factors which are correlated with both OJT incidence and intensity, in general there is considerable variation in such activity between establishments which cannot be explained by the various indicators available in the ESS2001 dataset. This is consistent with the variance decomposition in Table 8.7 which suggested that most of the variation in both unconditional and conditional OJT rates was within rather than between the categories examined in the table. The conclusions for the establishment-level analysis conducted in this section are similar. Even controlling for a large number of potential factors which can plausibly affect OJT, the incidence and intensity of such activity are still very different between apparently similar establishments (as measured by the various indicators available). The factors identified as important in the econometric equations can only account for a relatively small proportion of the variation in establishment-level OJT rates.

8.6 Conclusions

The key research issues that this chapter has addressed are:

- what are the patterns of OJT activity across RDAs and LLSCs?
- how do these compare with patterns of qualifications amongst the workforce?
- what are the important determinants of OJT activity?
- how do the estimated relationships help inform our understanding of the 'paradox' of high OJT in 'low qualification' areas?

The analysis suggests that the apparent paradox identified in Campbell *et al* (2001) is not supported by more detailed analysis. In line with conventional wisdom, OJT activity is positively correlated with the overall qualifications of the workforce, once other factors are taken into account.

ESS2001 data suggests that while the correlations between OJT activity (both incidence and intensity) and the qualification structure are not strong, they are generally positive. This applies both at RDA and LLSC level and regardless of whether the focus is upon the qualifications of those employed in the establishment or within the wider labour market within which the establishment is located.

A number of significant influences on OJT activity have been identified. These include establishment size, industry, private versus public sector status, and various local labour market characteristics. However, a key conclusion for the establishment level analysis conducted in this chapter is that, even after controlling for a large number of potential factors which can plausibly affect OJT activity, rates of such activity are still very different between apparently

similar establishments. The factors identified as important in the econometric equations only account for a relatively small proportion of the variation between establishments' OJT rates. Further research is required to identify additional characteristics of the establishment which might explain such variation.

Appendix to Chapter 8

Table 8.A.1: Variable descriptions and summary statistics

Variable	Description	Mean	SD
Dependent variables:			
tr_incidence	any OJT at the establishment in previous 12 months	0.371	0.483
tr_intensity	intensity of OJT at establishment in previous 12 months	0.224	0.376
Establishment and firm characteristics:			
est. size 1-49$	establishment size 1-4 (base)	0.719	0.449
est. size 5-9$	establishment size 5-9	0.111	0.314
est. size 10-24	establishment size 10-24	0.099	0.298
est. size 25-49$	establishment size 25-49	0.037	0.189
est. size 50-99$	establishment size 50-99	0.020	0.141
est. size 100-199$	establishment size 100-199	0.008	0.086
est. size 200-499$	establishment size 200-499	0.005	0.073
est. size 500+$	establishment size 500+	0.001	0.038
private sector$	private sector	0.857	0.350
foreign owned$	foreign or joint UK/foreign owned	0.033	0.178
single$	single establishment organisation	0.725	0.446
increase in sales$	total sales/budget increased a great deal in last year	0.124	0.330
decrease in sales$	total sales/budget decreased a great deal in last year	0.052	0.221
hire rate	number hired in last year as fraction of workforce	0.319	0.692
quit rate	number left in last year as fraction of workforce	0.293	0.716
head office$	establishment is head office of multi-establishment firm	0.070	0.255
vacancy rate - any	vacancy rate, any vacancies	0.042	0.135
vacancy rate - h2f	vacancy rate, any hard-to-fill vacancies	0.021	0.096
vacancy rate - ss	vacancy rate, any skill-shortage vacancies	0.010	0.067
LLSC area characteristics:			
LLSC industry empl.	LSC share of industry employment: source LFS	0.124	0.071
LLSC empl. growth	LSC employment growth in last 2 years: source ABI	0.029	0.048
LLSC relative wage	LSC weighted relative wage: source NES/LFS	1.014	0.149
LLSC log(unempl)	LSC log of the ILO unemployment rate	1.551	0.370
Qualifications and skills variables:			
establishment_qual.	Establishment occupation-weighted qualification score	2.298	1.260
LLSC good skills	LSC proportion of working age with NVQ3+	0.370	0.055
LLSC low skills	LSC proportion of working age with no qualifications	0.154	0.038
LLSC high skills	LSC proportion of working age with NVQ4+	0.238	0.056
14 industry dummies:	*Industrial sector:*		
industry1	agriculture (base)	0.030	0.170
industry2	mining & quarrying	0.002	0.040
industry3	manufacturing	0.088	0.284
industry4	electricity & water supply	0.001	0.030
industry5	construction	0.092	0.288
industry6	wholesale, retail	0.233	0.423
industry7	hotels and restaurants	0.070	0.255
industry8	transport & comm.	0.044	0.206
industry9	finance	0.021	0.144
industry10	business services	0.251	0.433
industry11	public administration	0.010	0.099
industry12	education	0.023	0.149
industry13	health & social work	0.044	0.204
industry14	other community	0.092	0.289

Notes: All statistics are establishment-weighted.

Figure 8.A.1 Incidence of OJT and LFS percentage of employees qualified to NVQ level 3 or higher by RDA

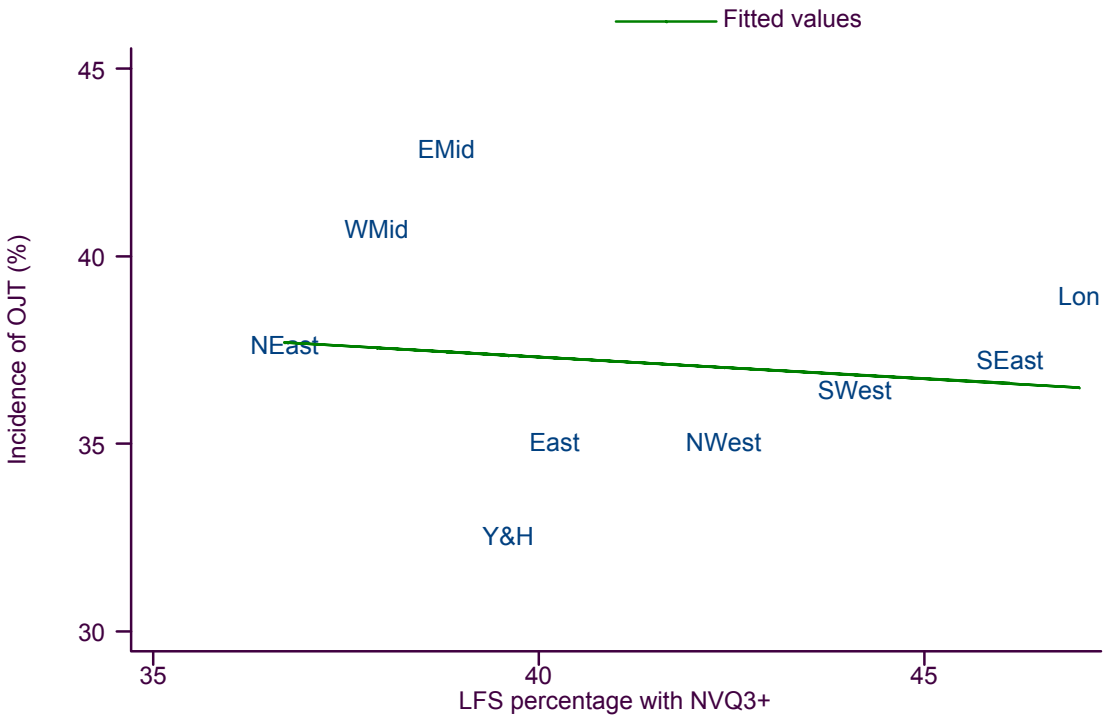


Figure 8.A.2 Incidence of OJT and ESS qualification score by RDA

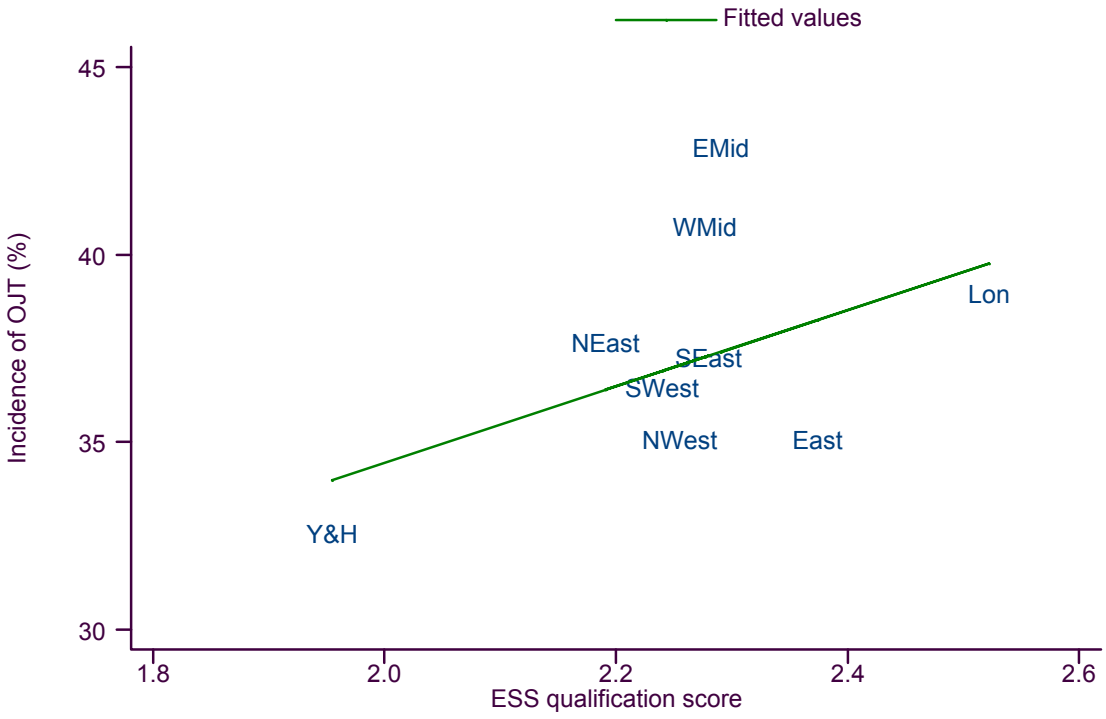


Figure 8.A.3 Intensity of OJT and LFS percentage of employees qualified to NVQ level 3 or higher by RDA

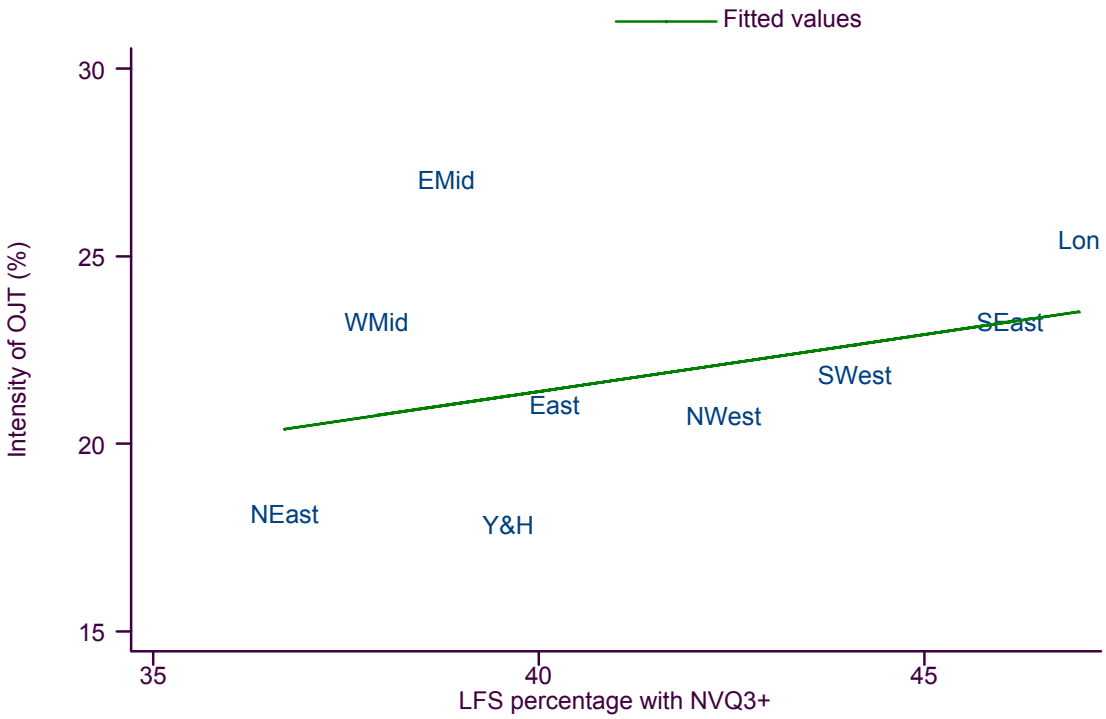


Figure 8.A.4 Intensity of OJT and ESS qualification score by RDA

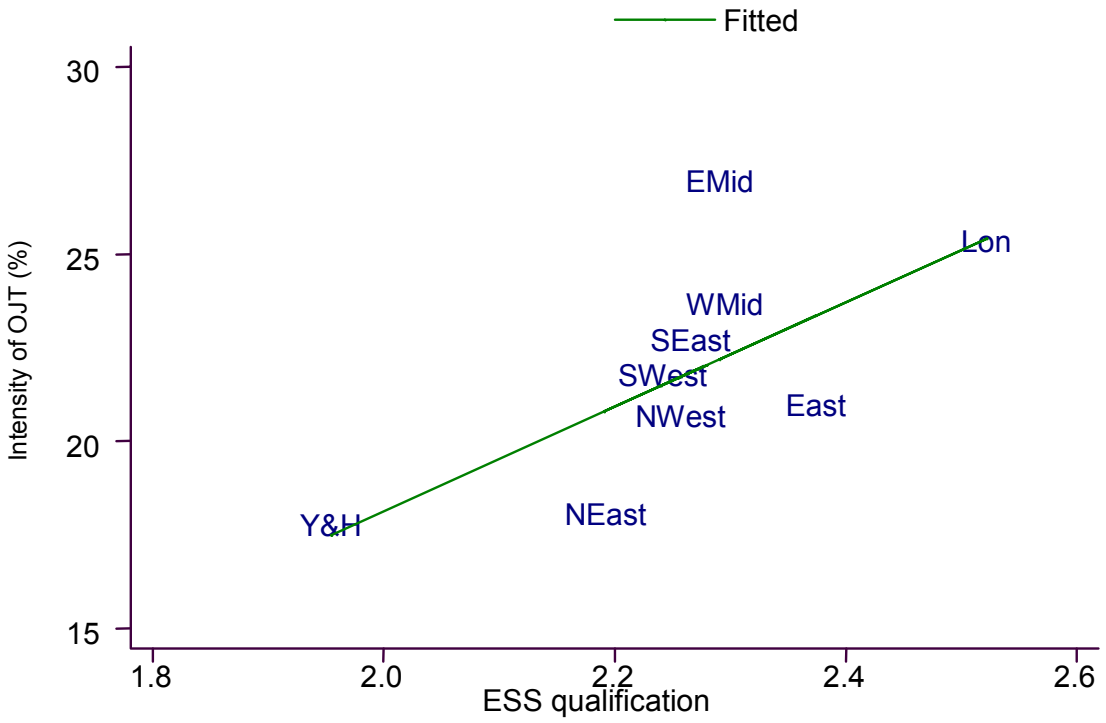


Figure 8.A.5 Incidence of OJT and LFS percentage of employees qualified to NVQ level 3 or higher by LLSC

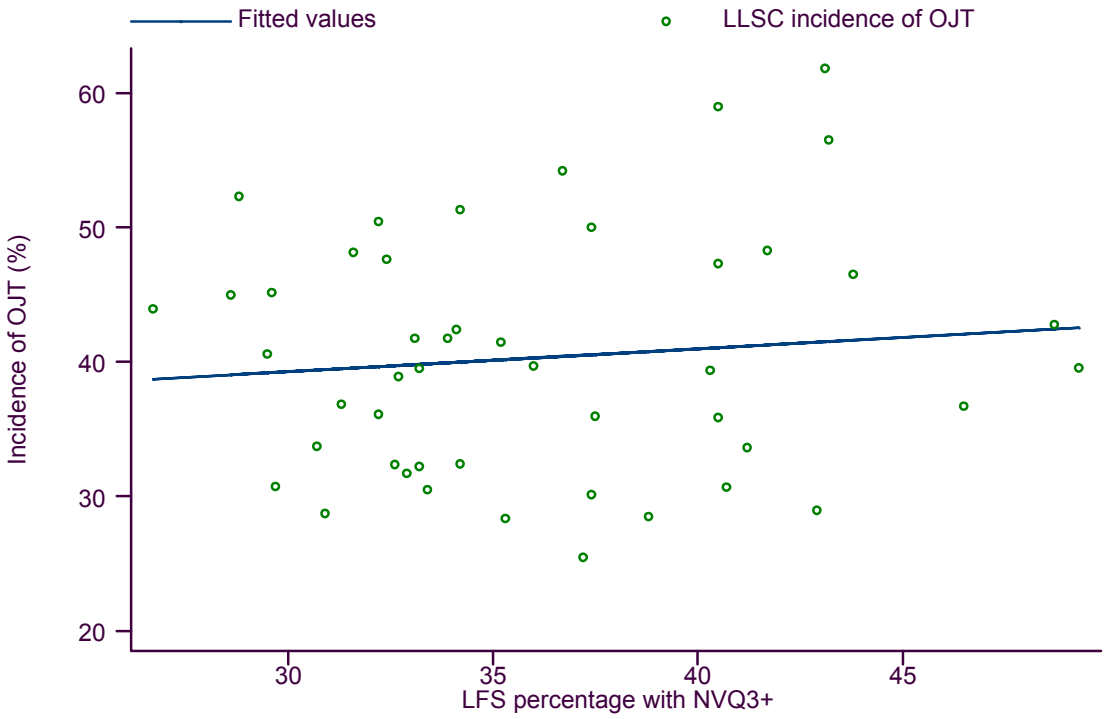


Figure 8.A.6 Incidence of OJT and ESS qualification score by LLSC

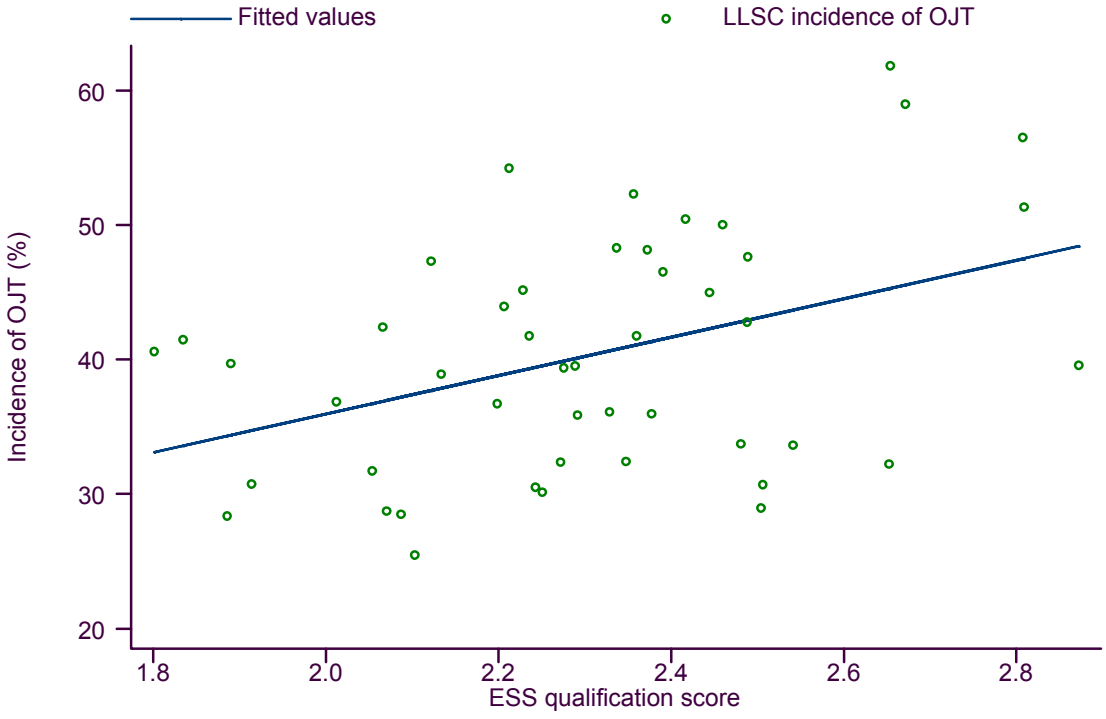


Figure 8.A.7 Intensity of OJT and LFS percentage of employees qualified to NVQ level 3 or higher by LLSC

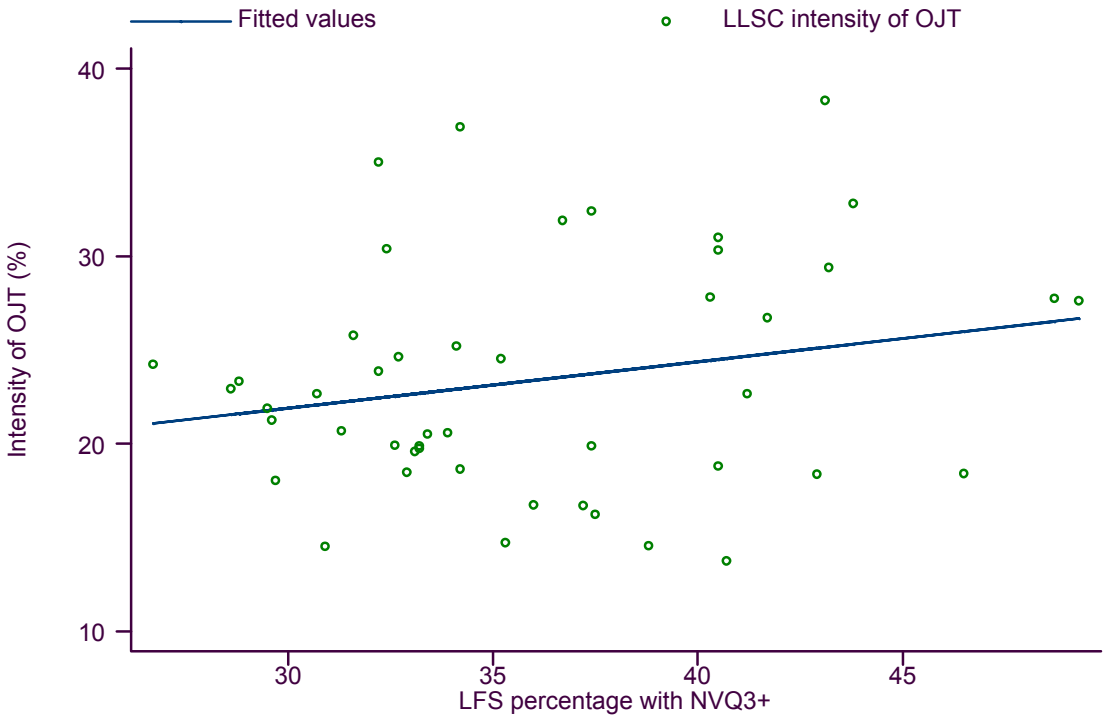
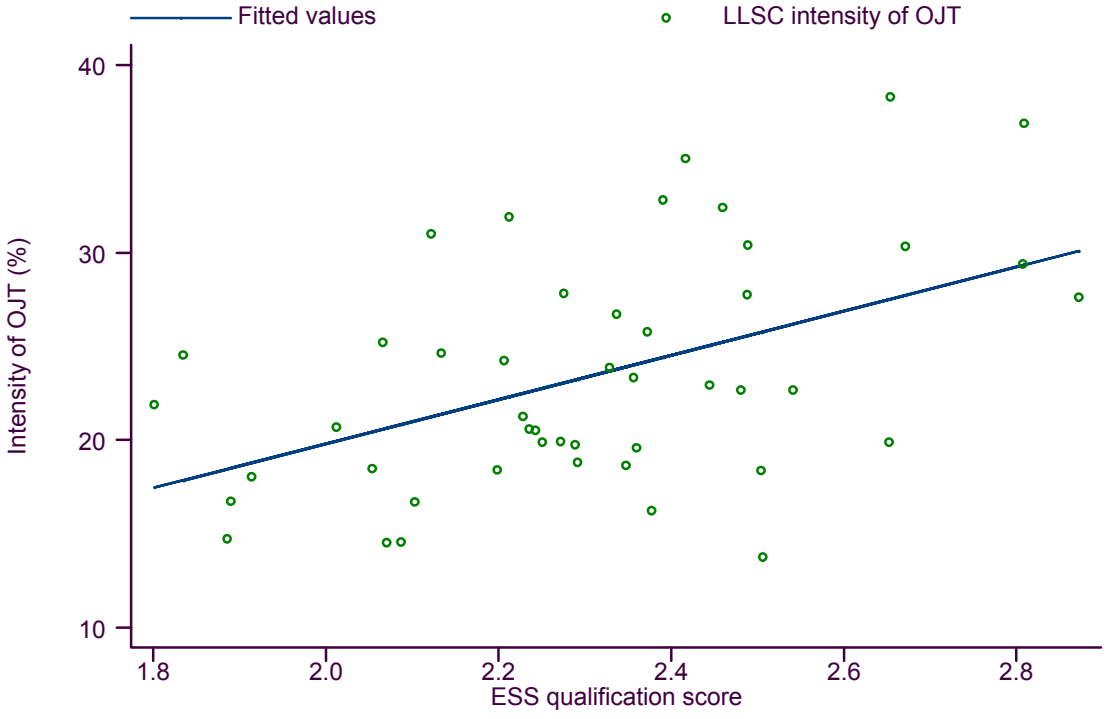


Figure 8.A.8 Intensity of OJT and ESS qualification score by LLSC



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