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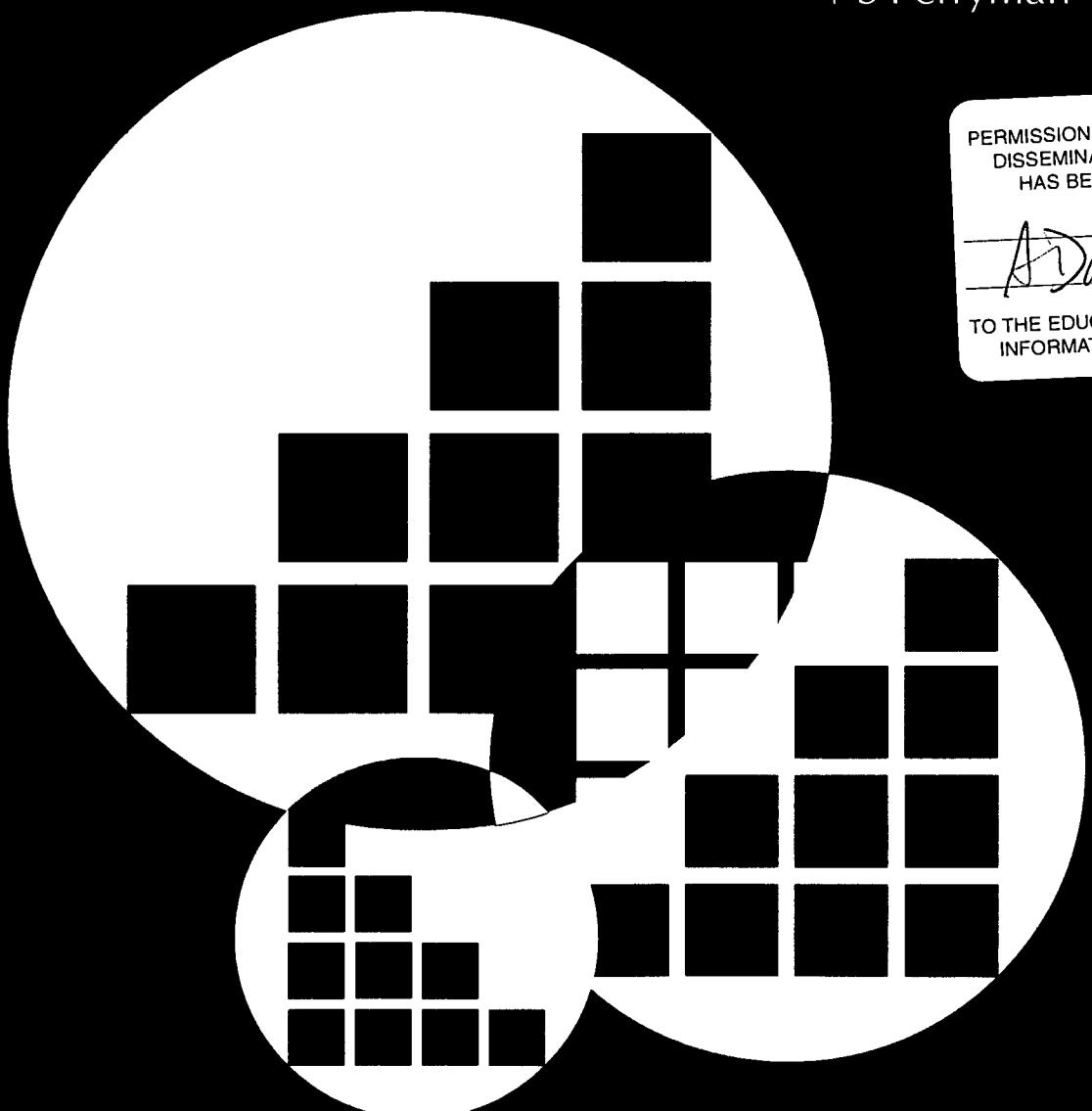
ABSTRACT

A study examined the feasibility of measuring employment in high-technology sectors at the regional level. First, the effect of definition of the term "high-technology" on survey results was considered along with potential effects of using 2- and 3-digit classifications of technology occupations from the Nomenclature of Economic Activities in the European Union (NACE). Methodological issues involved in using the United Kingdom (UK) Labour Force Survey (LFS) to measure high-technology employment at the regional level were studied by using microdata from the LFS and data from the UK Census of Employment. The use of establishment surveys and censuses as an alternative method of deriving high-technology employment figures and the degree of clustering exhibited by high-technology employment were analyzed. Results of an analysis of the LFS, including results from France, Italy, and Spain, were detailed. (Contains 41 tables/figures and 55 references. Appendixes contain information about employment censuses in 15 countries and tables detailing the following: definition of high-technology at the 3-digit NACE level; high-technology employment in regions covered by the 1994 LFS in Europe; current and past year employment in the sector; total and industrial employment in regions covered by the 1994 LFS in Europe; region of residence and region of employment design factors; and region of residence by region of employment.) (MN)

the Institute for Employment Studies

Measurement of Employment in High Technology Sectors at the Regional Level

N Jagger
S Perryman



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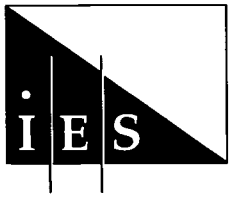

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Contents

1. Introduction

This report gives details of a study commissioned by Eurostat, designed to examine the feasibility of measuring employment in high technology sectors at the regional level. The research aims to assist Eurostat in improving their regional scientific and technological data collection procedures. The study consists of theoretical exercise, examining the methodological issues involved in using the Labour Force Survey (LFS) to measure high technology employment at the regional level. It was done by using microdata from the Labour Force Survey and data from the UK Census of Employment.

The report:

- examines the preferred OECD definition of high technology sectors based on Research and Development (R&D) intensity (Chapter 2)
- examines the methodological problems involved in using the LFS for the purpose of measuring regional employment, especially the impact of the proposal to combine separate surveys (Chapter 3)
- gives details of the results obtained using the UK LFS microdata, concentrating especially on the reliability of the results (Chapter 4)
- examines data from the UK LFS and other sources which either validates the estimates of high technology employment or provides contextual information (Chapter 5)
- examines the use of establishment surveys and censuses as an alternative method of deriving high technology employment figures and the degree of clustering exhibited by high technology employment (Chapter 6)
- gives details of results obtained from analysis of the Labour Force Survey, including for France, Italy and Spain estimates of the household design effects for high technology employment (Chapter 7)
- discusses the results and draws conclusions about the feasibility of using the LFS to measure high technology employment at the regional level (Chapter 8).

2. OECD Definition of High Technology

2.1 Products or sectors

The definition of what constitutes high technology has a long and rather fraught history. The concept of high technology is usually applied to products. Unfortunately, there is no clear statistical relationship between product data and employment data; employment is usually measured in terms of sectors. Various approaches have been used to define high technology sectors and hence high technology employment.[1] The approach which has probably had the greatest staying power and coherence is based on Research and Development (R&D) intensity. R&D intensity is defined in terms of the ratio of R&D expenditure to GDP for each of the sectors. Sectors with a high R&D ratio are considered to be high technology sectors.

The US International Trade Administration (ITA) developed a definition of high technology sectors along these lines in 1985 (ITA, 1985). Since then there have been a series of revisions and modifications to this approach (OECD, 1993, 1994a and 1995b).

It is this work by the OECD involving R&D intensity that is used as a basis of a definition of high technology sectors for this exercise. The approach used the direct R&D intensities of earlier work, with the addition of indirect R&D intensities. The direct R&D intensities were calculated, as previously, from the R&D expenditure by companies in sectors, as a proportion of GDP generated by that sector. The indirect R&D intensities were calculated using input-output data, and reflects the R&D embedded in products utilised by the various sectors. Since the direct R&D intensities were based on R&D or Frascati sectors (OECD, 1994b) the data are presented in these terms. Fortunately these sectors are defined in terms of ISIC Revision 3 (International Standard Industrial Classification) and NACE Revision 1 (Nomenclature of Economic Activities in the European Union) (OECD, 1994a, Table 3.1). The next section examines this definition and its applicability to measuring high technology employment at the regional level.

[1] For example Butchart, 1987; Abbott, 1991; Hadlock *et al.*, 1991; Papagni, 1992; and Grupp 1995.

Table 2.1: OECD high technology sectors

Technology level	Frascati sectors	ISIC Rev. 3	NACE 1	Global R&D Intensities 1985-86 (10 countries) **
High	Aerospace	353	35.3	24.29
	Computers, office machinery	30	30	14.39
	Electronics-Communications	32	32	10.25
	Pharmaceuticals	2,423	24.4	8.75
Medium high	Scientific Instruments	33	33	na
	Electrical machinery	31	31	4.06
	Motor vehicles	34	34	3.90
	Chemicals	24 less 2,423	24 less 24.4	3.12
	Non-electrical machinery	29	29	2.66
Medium low	Shipbuilding	351	35.1	2.56
	Rubber and plastic products	25	25	2.45
	Other transport equipment	35 less 351 and 353	35 less 35.1 and 35.3	2.11
	Stone, clay and glass	26	26	1.70
	Non-ferrous metals	272 + 2,732	27.4 + 27.53/54	1.63
	Other manufacturing	36	36	1.61
	Fabricated metal products	28	28	1.39
Low	Petroleum refining	23	23	1.05
	Ferrous metals	271 + 2,731	27.1–27.3 + 27.51/52	1.02
	Paper and printing	21, 22	21, 22	0.81
	Textiles and clothing	17, 18, 19	17, 18, 19	0.77
	Wood and furniture	20, 361	20, 36.1	0.72
	Food, beverages	15+16	15+16	0.68

** Global R&D intensity incorporates the Direct R&D intensity based on R&D expenditures by that sectors and Indirect R&D intensities based on inputs into that sector from other R&D intensive sectors. The 10 countries were the United States, Japan, Germany, France, the United Kingdom, Canada, Italy, the Netherlands, Australia and Denmark.

Source: OECD, 1995b and 1994a

2.2 OECD definition of high technology

This list of high technology sectors was originally based on the average R&D intensities of eight OECD countries (OECD, 1993) updated in 1994 (OECD, 1994a) and 1995 (OECD, 1995b). The analysis is based on Frascati sectors which are defined in terms of ISIC Revision 3 (OECD, 1994b). Most of the ISIC Revision 3 sectors map directly onto NACE Revision 1 sectors, which are also given.

There is no R&D intensity information on NACE division 37

(Recycling) however, intuitively this sector would appear to be low technology.

There are also problems of compatibility between ISIC and NACE when dealing with ferrous and non-ferrous metals. ISIC makes this distinction, but with NACE it is only possible at the lowest levels. This is important as the OECD list considers non-ferrous metals to be medium low technology while ferrous metals are considered low technology. Since the focus of this study is high technology employment it was felt that this problem could be ignored and medium low and low technology industries aggregated into one category.

2.3 NACE two-digit definition of high technology

In terms of NACE Revision 1, a simple breakdown of manufacturing sectors into high and low technology can be derived from Table 2.1 at the level of two-digit NACE divisions.

This simple high/low breakdown is constructed as follows:

- *high and medium high technology* NACE 2-digit divisions: 24, 29, 30, 31, 32, 33 and 34
- *low and medium low technology* NACE 2-digit divisions: 15, 16, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 35, 36 and 37.

Table 2.2 expands on the NACE divisions involved.

This allows us to produce a high level aggregation of sectors of economic activity, incorporating this breakdown. This breakdown is similar to NACE CLIO used to integrate LFS employment data with National Accounts data. All NACE divisions from 1 to 14 are included in a *primary production* category, while all NACE divisions above 37 are put into another category entitled *general services*. This produces the following breakdown of economic activity sectors:

- primary production: NACE 1 to 14
- high technology manufacturing
- low technology manufacturing
- general services: NACE 40 to 99.

It is this breakdown of sectors of economic activity that is largely used in the rest of this report.

Table 2.2: High or low technology status of NACE two-digit manufacturing divisions

Division	Group	
15	Manufacture of Food Products and Beverages	Low
16	Manufacture of Tobacco Products	Low
17	Manufacture of Textiles	Low
18	Manufacture of Wearing Apparel; Dressing and Dyeing of Fur	Low
19	Tanning and Dressing of Leather; Manufacture of Luggage, Handbags, Saddlery, Harness and Footwear	Low
20	Manufacture of Wood and Products of Wood and Cork, Except Furniture; Manufacture of Articles of Straw and Plaiting Materials	Low
21	Manufacture of Pulp, Paper and Products	Low
22	Publishing, Printing and Reproduction of Recorded Media	Low
23	Manufacture of Coke, Refined Petroleum Products and Nuclear Fuel	Low
24	Manufacturing of Chemicals and Chemical Products	High
25	Manufacture of Rubber and Plastic Products	Low
26	Manufacture of Other Non-Metallic Mineral Products	Low
27	Manufacture of Basic Metals	Low
28	Manufacture of Fabricated Metal Products	Low
29	Manufacture of Machinery and Equipment n.e.c.	High
30	Manufacture of Office Machinery and Computers	High
31	Manufacture of Electrical Machinery and Apparatus n.e.c.	High
32	Manufacture of Radio, Television and Communications Equipment and Apparatus	High
33	Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks	High
34	Manufacture of Motor Vehicles, Trailers and Semi-trailers	High
35	Manufacture of Other Transport Equipment	Low
36	Manufacturing of Furniture; Manufacturing n.e.c.	Low
37	Recycling	Low

Source: Based on OECD 1994a and OECD 1995b

2.4 NACE three-digit definition

The OECD analysis of high technology sectors allows a more detailed breakdown of the high technology category into a higher technology and medium high technology. This is defined at the three-digit NACE group level. The other breakdown in the OECD analysis into low technology and medium low technology requires five-digit NACE data, mainly because of the distinction between ferrous metal and non-ferrous metals. Since the focus of this study is high technology employment, it was felt inappropriate to make this distinction. Therefore at this more disaggregated level we are not proposing to use this breakdown into low technology and medium low technology.

The disaggregated higher technology, medium high technology and low technology breakdown is derived from Table 2.1 and defined as follows:

- higher technology: NACE 2-& 3-digit divisions/groups: 24.4, 30, 32, 35.3
- medium high technology: NACE 2-& 3-digit divisions/ groups: 24 less 24.4, 29, 31, 33, 34
- low technology: NACE 2-digit divisions: 15, 16, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 35 less 35.3, 36 and 37.

The Table in Appendix A give the definitions of each of the NACE groups involved in the above definition. Importantly, the higher and medium high three-digit definition of high technology does not map directly onto the two-digit definition. This is because Aerospace (NACE 35.3), which has the highest R&D intensity, is subsumed into the other transport equipment category in the two-digit definition. Since the bulk of employment in the two-digit other transport category (NACE 35) is in low technology areas at that level it has to considered low technology. Apart from the ability to distinguish between higher and medium high technology allowed by the three-digit definition, the treatment of Aerospace in the three-digit definition makes it preferable.

3. Methodological Issues Regarding the Use of the LFS

The Labour Force Survey (LFS) has common definitions and a largely common methodology across the European Union (Eurostat, 1992). This was the basis for selecting the LFS as the primary data source for estimating high technology employment at the regional level.

The LFS is composed of a common series of national Labour Force Surveys, each of which are sample surveys with defined sample sizes. Each country adopts subtly different sampling procedures for their component national surveys, which creates problems with developing a common approach. One of the important design specifications of the LFS is that it should be able to produce reliable unemployment data at the regional level.[1] However, the different sampling procedures, especially the use of stratified clustered sampling, generate differences in the design factors at the regional level between national surveys. This is particularly important for high technology employment; high technology establishments tend to be larger than low technology establishments and are therefore more likely to be clustered (Angel, 1991). The degree of clustering of high technology establishments is further examined in Chapter 6, based on UK Census of Employment establishment based data.

This chapter examines the definitions of high technology given in Chapter 2, in terms of the LFS. It examines the methodological problems imposed by the sample designs in making reliable estimates of high technology employment at the regional level. In particular, this chapter examines the various design effects involved and the feasibility of combining two years' surveys to generate a larger pooled sample.

[1] The specification for the LFS indicates that: 'to ensure a reliable foundation for comparative analysis at Community level, as well as at the level of Member States and of specific regions, the sampling plan shall guarantee that for characteristics relating to 5% of the population of working age the relative standard error at NUTS II level (or equivalent) does not exceed 8%, assuming the design effect for the variable "unemployment"' (*Council Regulation (EEC) No. 3771/91*).

3.1 High technology in terms of the LFS

Since 1993 it has been obligatory to report sectors of economic activity data in the LFS in terms of two-digit NACE Revision 1 divisions. This means that the simpler high/low technology approach is all that is currently possible using the LFS.

After the period of transition ending in December 1994[1] all member states should be capable of producing data compatible with NACE Revision 1. This may mean that three-digit NACE information at least will become available in the LFS. If this becomes the case the more sophisticated approach of higher, medium high, and low technology can be used.

As two-digit NACE division data is all that is currently available, the bulk of the analysis presented in this report will be carried out on that basis. However, as the UK LFS and the UK Census of Employment are currently capable of generating data at the three-digit NACE group level, a few tables have been generated on that basis for illustrative purposes.

3.2 Sources of error in the estimates

The introduction to this chapter outlined the possible sources of error in the estimates based on the LFS. This section examines each of these in more detail.

3.2.1 Survey design

The LFS is designed as a household based survey with the information about the employment characteristics of individuals in the household collected either directly or by proxy via another household member. This means that the Primary Sampling Unit (PSU) for these surveys is the household. Since we are interested in the sectors of employment of individuals, this generates an additional design effect variance into any estimates of individual characteristics, such as employment. By calculating the additional variance due to this household based sample design, the standard error of the estimates can be modified to take account of these design factors.

The UK households are selected on the basis of Simple Random Sampling (SRS). Details of the sample designs of the other national surveys that represent the European LFS have been sought. However, the timescale and scope of this study has not allowed an exhaustive analysis of the various sample designs.[2]

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[1] Council Regulation (EEC) No. 3037/90, Article 11.

[2] The sampling methodologies of the component surveys have yet to be documented centrally and the only available documentation refers to earlier surveys or are produced nationally.

However, it is known that the sample design of the Italian LFS is based in part on stratified clustered samples (di Pietro, 1993). This introduces possible further variance into any estimates, especially at the regional level. This issue is examined in more detail in Chapter 7.

3.2.2 Aggregation of NACE categories

It is possible that by using an aggregation of NACE categories further biases may be introduced into the estimates. The problem here is that the distribution of the component NACE categories is not homogeneous and therefore the presence or absence of single sectors could influence the overall aggregated figures. This is particularly the case with Aerospace (NACE 35.3), for instance, which tends to be located in a few large establishments. Similarly, the Motor Vehicles sector (NACE 34) is the largest single sector in terms of employment in the high technology aggregation and differences in the distribution of employment in this sector have a strong influence on the aggregate.

The high technology employment in some regions also may be composed of an aggregation of small sectors rather than one large sector. This would mean that the larger sampling errors associated with small samples would be aggregated as well. This is a problem with all aggregations, including any other definition, so little can be done about this problem.

3.2.3 Using region of work rather than region of residence

The samples for the UK LFS and all other European LFSs are based on the region of residence, while employment need not be in the region of residence. This means that when analysing regional employment patterns, the region of work rather than region of residence has to be used.

Appendix F contains a cross-tabulation of UK region of residence by region of employment for the March to May quarters in 1994 and 1995. This shows that within the UK the bulk of people are employed in their region of residence, with the percentages ranging from 95 per cent to 99 per cent. Importantly, the regions with the smallest working populations (Scotland and Northern Ireland) are also the most self contained.

To examine the extent of this problem, the design factors using region of residence and region of main employment in the UK were examined. These differences are reported in Appendix E. In summary, using region of work rather than region of residence increases the design factor. There is a possibility that a clustered sample design may further increase the design factors, in that people from households in clusters nearer a regional border are more likely to work across the border. Without the full details of

the sampling method and the locations of the clusters this problem cannot be addressed.

3.3 Calculating the additional variance

The impact of the sample design and the use of household as the primary sampling unit rather than the individual can be calculated. This means that the additional variance due to these factors and hence the additional margins of error in the estimates based on the sample can be derived. There is a range of methods for calculating the additional variance, each of which has its advantages and disadvantages. However, in the context of the LFS, all the methods available require details of the sample design and access to the microdata.

The UK Employment Department and OPCS recommends the use of the mean square successive differences method to calculate the additional variance in the UK LFS. This method of calculating variance was first developed by Von Neumann in 1941, and has computational advantages compared with more modern techniques such as the Jack-knife method. The method of successive differences aggregates the squared variation between each sampling unit and the preceding sampling unit. The variation in the number of people employed in high technology sectors is calculated separately from the variation in the numbers of those employed in all sectors in each household, as well as the covariance of high technology and total employment. Once these have been calculated, it is then possible to combine these variances to calculate the standard error of the proportion of high technology employment due to using households as the primary sampling unit rather than individuals.

This method can be expressed algebraically in the following way:

$$\text{Variance (Y)} = \frac{N}{2(N-1)} \sum_{p=2}^{N} (Y_p - Y_{p-1})^2$$

$$\text{Variance (X)} = \frac{N}{2(N-1)} \sum_{p=2}^{N} (X_p - X_{p-1})^2$$

$$\text{Covariance (X,Y)} = \frac{N}{2(N-1)} \sum_{p=2}^{N} (X_p - X_{p-1})(Y_p - Y_{p-1})$$

$$\text{Standard Error (R)} = \frac{1}{X} \sqrt{(VAR(Y) - 2R\,x\,COV(X,Y) + R^2\,x\,VAR(X))}$$

Where X represents in this instance the employed population of a region,

Y represents, again in this instance, the number of people working in high technology industries in a region,

p the household (PSU),

i the individual case,

X_p and Y_p the household totals, of the employed and those in high technology respectively,

N the number of households in the region,

R is the ratio of high technology employment to total employment in the region.

To expand the formula, the method used to calculate the Variance of Y starts by calculating for each region the sum across all households in the region:

$$\sum_{p=2}^{N} (Y_p - Y_{p-1})^2$$

that is, the number of people employed in high technology sectors in each household in that region minus the number of employed in high technology sectors in the previous household.

This sum is then multiplied by the number of households in that region divided by two times the number of households minus one.

The standard error assuming Simple Random Sampling (SRS) is then calculated using the following formula:

$$SE = \sqrt{\frac{R\,(1-R)}{N}}$$

The design factor is then calculated by dividing the standard error taking into account the design, by the standard error calculated on the basis of SRS.

3.4 Methodological issues with combining LFS surveys

As manufacturing employment in some European regions is relatively small, this will in turn generate small samples in the LFS. Further, as there is a wide range in R&D expenditures between the regions, it can also be assumed that in some regions the proportion of manufacturing employment in high technology sectors will be low. Both of these factors suggest that when the methodology developed here is used across Europe, the degree of variance encountered as a result of small samples may invalidate any results.

Appendix D contains data from *Employment in Europe — 1994* (EC, 1994). This shows that the smallest employed population for a NUTS level region is comparable with Northern Ireland. Similarly, the lowest percentage of those employed in manufacturing is again comparable with Northern Ireland, except for some capital city regions which have relatively large employed populations. This suggests that if the methodology can be successfully applied in Northern Ireland, the methodology

should be equally reliable in other NUTS level 1 regions. However, as a result of differing sampling procedures, the standard errors used in other EU countries could be larger than those in the UK. This means that the estimates will be less reliable. As a precaution, the authors have suggested that two LFS surveys one year apart are combined to increase the sample sizes and hence the reliability of the results. This section examines the benefits of such an approach and the known problems.

The practice of using more than one sample survey to generate reliable estimates of small populations has a long history. However, it has usually been used for studying invariant groups such as religious groups (Allinsmith and Allinsmith, 1948 and Reed, 1975) or ethnic groups (Casey and Creigh, 1989). While the population of interest has been relatively invariant, the characteristics of these studied populations do change between surveys. A similar approach, examining the size of a variant population, has equal validity.

3.4.1 Dynamics between years

The two-wave approach of the LFS means that 50 per cent of the sample has also been surveyed six months previously. Surveys six months apart cannot be considered to be independent as they have duplicates.[1] Therefore, it is necessary to use surveys conducted one year apart, as they have no duplicated observations.

The LFS survey asks for the economic activity of the local unit of the establishment in which the person was working one year before the survey. By examining those in high technology employment, and the high/low technology status of their employment one year ago, the relative stability of jobs in the various sectors can be examined.

Appendix C gives a cross-tabulation of high/low technology employment status with that of a year previously, from the UK LFS March to May quarter of 1994. This shows that about 85 per cent of those working in the high technology sector in 1994 were also working in it in 1993. The bulk of the movement into the high technology sector came from the unemployed, students, or other labour market new entrants. There was some small entry from the general services sector and the low technology sector, but this could simply represent movement of support staff, such as secretaries and accountants.

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[1] It is possible, as suggested by a Monte Carlo simulation of animal behaviour data with repeated individual observations, that pooled samples containing duplicated observations may in fact be considered for practical statistical purposes to be independent (Leger and Didrichsons, 1994).

3.4.2 Additional variance due to combining surveys

The general rule given in Kiecolt and Nathan (1985) when pooling sample surveys, is to double the standard error. This only need apply when there is no clustering of the sample frame (Reed, 1975-1976). As there is no other way of estimating the increase in the variance due to possible clustering of the component surveys' sample frames, this approach seems to be the best one when pooling results from the LFS.

This may be an over-cautious approach, as the doubling of the standard error is primarily intended for use when a relatively large number of surveys have been combined. Specifically, this approach was used when pooling quota sample telephone surveys, where the surveying organisations are known to often return to the same respondents. Equally the 'general' rule appears to be a 'rule of thumb' and not based on simulation. There is a case for further examination of this question using simulation methods. This is particularly the case as the use of pooled LFS samples could allow the examination of other small populations, such as university graduates across Europe.

4. Using the UK LFS

4.1 The UK LFS

4.1.1 Outline of the UK LFS

The Great Britain[1] LFS uses a five-wave panel design with quarterly interviews. The first interview is face to face (except in Scotland north of the Caledonian canal), with the subsequent interviews carried out by telephone if possible (Chamberlain and Purdie, 1992). Northern Ireland is surveyed every six months using a two-wave panel design as required by Eurostat. These two surveys are combined to produce the UK LFS.

4.1.2 NACE and UK data

In response to the Council Regulation (EEC No. 3037/90) implementing NACE Revision 1, the UK has adopted a new industrial classification system, SIC 92 (Standard Industrial Classification 1992). SIC 92, apart from some additional sub-categories, is directly compatible with NACE Revision 1.

4.1.3 UK LFS sampling methodology

The UK OPCS (Office of Population Censuses and Surveys), which carries out the design and fieldwork for the LFS, uses an unclustered simple random sampling method at the level of households. This is achieved by using the Postal Address File (PAF) which lists all establishments receiving on average less than 15 items of post per day. The sample is constructed by selecting households from the file at intervals of 251. These households are used as the sample frame, without replacement. Since the PAF is in postcode sorted order, this generates a regionally balanced simple random sample.[2]

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[1] Great Britain is the United Kingdom minus Northern Ireland, the Isle of Man and the Channel Islands.

[2] As the PAF does not cover Northern Ireland, and in Scotland north of the Caledonian Canal telephone interviewing is used, the samples are constructed differently. However, these samples are also considered to be simple random samples.

Table 4.1: High technology and low technology by UK NUTS I region (1,000s)

	Base (inc. DNA)	Primary production	High technology	Low technology	General services
Northern	1,225	29	63	184	948
Yorks and Humberside	2,225	50	84	391	1,613
East Midlands	1,769	67	77	375	1,248
East Anglia	989	45	47	160	736
South East	8,108	92	393	769	6,847
South West	2,132	82	76	288	1,685
West Midlands	2,303	48	165	474	1,613
North West	2,658	22	150	444	2,040
Wales	1,133	56	60	164	853
Scotland	2,205	99	93	278	1,735
Northern Ireland	580	33	13	76	457

Note: filtered on the ILO definition of in employment

Sources: IES and March to May 1994 UK LFS

4.1.4 Released Quanvertised data sets

The Department for Education and Employment[1] releases the LFS datasets approximately six months after the surveys are conducted, via Quantime. This allows independent researchers and companies to access the data via the software package Quanvert. It is recommended that all data generated by Quanvert is rounded to the nearest 1,000 and that all cells below 10,000 are ignored as likely to be unreliable. The tables follow these conventions, with the symbol ** representing a cell containing less than 10,000 and — representing a cell with a value of zero.

4.2 The high and low technology results at UK NUTS level I regions

4.2.1 Basic results

This shows that the numbers employed in high technology sectors ranged from approximately 393,000 in the South East to approximately 13,000 in Northern Ireland. The concentration in the South East reflects mainly the numbers employed in this region.[2]

[1] Following recent ministerial reorganisation the CSO (the Central Statistical Office) has taken responsibility for employment surveys from the DfEE.

[2] It is understood the Central Statistical Office is considering changing the UK standard economic regions (and hence NUTS level I regions) because the South East is so large by comparison with the other regions.

Of those employed in the South East, 4.9 per cent worked in high technology sectors, while in the West Midlands (a traditional manufacturing region) this figure was 7.1 per cent.

4.2.2 Design factors and 95 per cent confidence limits

The 95 per cent confidence limits were calculated using SPSS and Excel[1] on the basis of the design factors obtained from the microdata. These design factors are lower than those obtained by OPCS for unemployment at the regional level. This is to be expected: a household containing one unemployed person is more likely to contain a second also unemployed, than a household containing a high technology employee is to contain another.

Table 4.2 gives the design factors and 95 per cent confidence limits for the population estimates of high technology employment at the regional level in March to May 1994.

The Northern Ireland design factor is possibly anomalous; the released data suggests that the sample in Northern Ireland came from very large households. Since this was probably not the case, there appears to have been some error in transposing the household numbers when the separate Northern Ireland survey was aggregated with the GB survey to produce the UK survey. We have found other anomalies with the Northern Ireland data, for instance the released data set for March to May 1995 shows approximately 670,000 residents as employed in Northern Ireland, while only 70,000 are shown as working in the province.

Overall, Table 4.2 shows that the sample sizes and the numbers employed in high technology sectors, combined with relatively low design factors, means that the estimates are relatively robust.

4.3 The higher and medium high technology results at UK NUTS level I regions

4.3.1 Basic results

As we have mentioned, a further disaggregation of the high technology sector into higher technology and medium high technology is possible where three digit NACE data are available (Table 4.3).

This shows that the higher technology group of sectors employs fewer people than the medium high technology group. Significantly, the estimate for Northern Ireland is too small to be reliably shown.

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[1] Printouts of the workings are available if required.

Table 4.2: High technology by UK NUTS I regions, 95 per cent confidence limits

	Economically active (1,000s)	High technology employment (1,000s)	% high technology	Design factor	95% confidence limits + or – (1,000s)
Northern	1,225	63	5.2	1.08	0.5
Yorks and Humberside	2,137	84	3.9	1.11	0.6
East Midlands	1,769	77	4.4	1.15	0.6
East Anglia	989	47	4.8	1.06	0.4
South East	8,108	393	4.8	1.08	1.3
South West	2,132	76	3.6	1.08	0.6
West Midlands	2,303	165	7.2	1.11	0.8
North West	2,658	150	5.7	1.12	0.8
Wales	1,133	60	5.3	1.09	0.5
Scotland	2,205	93	4.2	1.13	0.7
Northern Ireland	580	13	2.2	0.93	0.2

Note: Filtered on the ILO definition in employment

Source: IES and March to May 1994 UK LFS

Table 4.3: Higher, medium-high and low technology by UK NUTS I region (1,000s)

	Base	Primary production	Higher technology	Medium high technology	Low technology	Services general
Northern	1,225	29	16	72	159	948
Yorks and Humberside	2,137	50	23	127	325	1,613
East Midlands	1,769	67	34	107	312	1,248
East Anglia	989	45	14	63	131	736
South East	8,108	92	184	355	623	6,847
South West	2,132	82	56	95	214	1,685
West Midlands	2,303	48	28	224	387	1,613
North West	2,658	22	62	169	363	2,040
Wales	1,133	56	22	57	145	853
Scotland	2,205	99	55	74	242	1,735
Northern Ireland	580	33	**	14	66	457

Note: Filtered on the ILO definition in employment

Sources: IES and March to May 1994 UK LFS

Table 4.4: Higher technology design factors and 95 per cent limits by UK NUTS I regions

	Higher technology employment (1,000s)	% of employment	Design factor	95% confidence limits (+ or –) (1,000s)
Northern	16.4	1.3	1.15	0.3
Yorks and Humberside	22.8	1.1	1.09	0.3
East Midlands	33.6	1.9	1.13	0.4
East Anglia	13.7	1.4	1.11	0.3
South East	184.4	2.3	1.07	0.9
South West	55.6	2.6	1.14	0.5
West Midlands	28.2	1.2	1.01	0.3
North West	62.2	2.3	1.03	0.5
Wales	22.4	2.0	1.04	0.3
Scotland	54.8	2.5	1.15	0.5
Northern Ireland	**	**	**	0.2

Source: IES and March to May 1994 UK LFS

However, it also shows that higher technology employment is relatively evenly spread around the country, with the highest levels (2.6 per cent of employees) found in the South West and Scotland. The lowest level was found in the Yorkshire and Humberside and in the West Midlands. The figures for the West Midlands suggest that the manufacturing base there is generally medium high technology or low technology.

4.3.2 Design factors and 95 per cent confidence limits

As with the high technology breakdown, the design factors were generally quite low for the higher technology category. However, there was some variation between the regions, and the design factors at this level of technology appeared to be unrelated to those for the more general technology category (Table 4.4). Despite this, the sample sizes apart from Northern Ireland still produced relatively reliable estimates with low margins of error.

Similarly (apart from Northern Ireland) relatively robust estimates are obtained for medium high technology at the regional level (Table 4.5). However, if this categorisation was used throughout Europe, it would probably be necessary to combine two years' LFS surveys.

4.4 The impact of combining surveys

As previously discussed a critical problem was discovered with the UK LFS March to May 1995 data released on 10th September 1995, in that the region of work variable for Northern Ireland

Table 4.5: Medium high technology design factors and 95 per cent limits by UK NUTS I regions

	Medium high technology employment (1,000s)	% of employment	Design factor	95% confidence limit (+ or –) (1,000s)
Northern	71.6	5.9	1.15	0.6
Yorks and Humberside	126.7	5.9	1.09	0.7
East Midlands	107.2	6.1	1.13	0.7
East Anglia	62.6	6.3	1.11	0.5
South East	354.6	4.4	1.07	1.2
South West	94.8	4.5	1.14	0.7
West Midlands	224.1	9.7	1.01	0.9
North West	169.0	6.4	1.03	0.8
Wales	56.6	5.0	1.04	0.5
Scotland	73.6	3.3	1.15	0.6
Northern Ireland	14.2	2.6	0.93	0.2

Note: Filtered on ILO definition of in employment

Source: IES and March to May 1994 UK LFS

was not correct.[1] Since this exercise is mainly designed to confirm the feasibility of the proposed methodology, it has been decided to use the Northern Ireland usual region of residence data in place of the corrupted Northern Ireland region of work data. This does not radically change the results, as very few Northern Ireland residents work outside the region and very few people resident outside work in the region.

4.4.1 Basic results

The basic results have been obtained by averaging the values obtained from each year. This has been the approach used in the past when pooling LFS data (Jones, 1993). However, the design factors and standard errors have been calculated on the basis of the pooled values.

Overall, the results from combining two years' data are very much the same as those obtained from 1994 (Tables 4:6 and 4:7). The main difference is that the figures for high technology employment are higher, reflecting a general improvement in UK employment between 1994 and 1995.

[1] The data indicated approximately only 70,000 people worked in Northern Ireland, while the economically active population of Northern Ireland was reported in the region of 670,000. This is obviously erroneous and the Employment Department and OPCS have been informed and the data has subsequently been amended.

Table 4.6: High technology and low technology by UK NUTS I region, 1994 & 1995 (1,000s)

	Base	Primary production	High technology	Low technology	Services general
Northern	1,219	29	77	172	940
Yorks and Humberside	2,160	54	110	361	1,635
East Midlands	1,781	62	106	363	1,249
East Anglia	994	43	59	141	751
South East	8,164	91	461	715	6,889
South West	2,142	83	97	269	1,693
West Midlands	2,306	53	198	425	1,627
North West	2,642	28	174	410	2,029
Wales	1,139	53	75	162	848
Scotland	2,204	92	107	255	1,750
Northern Ireland	602	36	14	79	471

Sources: IES and March to May 1994 UK LFS and March to May 1995 UK LFS

4.4.2 Reliability of the results

As can been seen, especially when compared with Table 4.2, the results are more reliable when based on a two year pooled sample. However, the improvements are not that dramatic. This is partly because high technology employment increased between the two years and partly because the standard error was doubled to take account of the extra variance generated by pooling.

Table 4.7: High technology employment in UK NUTS level I regions 1994 and 1995

	High technology employment (1,000s)	% of employment	Design factor	95% confidence limit (+ or –) (1,000s)
Northern	77	6.3	1.04	0.4
Yorkshire & Humberside	110	5.1	1.07	0.5
East Midlands	106	5.9	1.11	0.5
East Anglia	59	5.9	1.05	0.3
South East	461	5.7	1.07	1.0
South West	97	4.5	1.06	0.5
West Midlands	198	8.6	1.09	0.6
North West	174	6.6	1.09	0.6
Wales	75	6.6	1.08	0.4
Scotland	107	4.8	1.08	0.5
Northern Ireland	14	2.3	0.97	0.2

Source: IES and March to May UK LFS 1994 and 1995

5. Supporting Information from the UK LFS and Other Sources

5.1 Other information

There is a range of other data sources that can be used to further examine or validate the regional breakdown of high technology employment. The three main complementary data sources are:

- UK data on the regional pattern of R&D expenditures and employment
- further LFS breakdowns
- the 1993 Census of Employment.

Similar data sources are available in every EU country. The latter source is covered in Chapter 6.

The UK data on R&D expenditures and employment provides various regional breakdowns, which can be examined in terms of high technology employment.

The LFS can generate a range of further breakdowns of high technology employment. However, for some of these breakdowns the statistical reliability of the estimates at the regional level is in doubt unless surveys are combined. To illustrate this for each section we report the data for the March-May 1994 quarter for the UK followed by the combined March-May quarters for 1994 and 1995. Where the data appears to be reliable we report the standard errors.

The information that can be derived from the UK Census of Employment, especially that relating to the clustering of high technology employment, is covered in Chapter 6.

5.2 UK LFS high technology employment and regional business enterprise R&D employment

Since the definition of high technology sectors is based on R&D intensity this would suggest some correlation between Full-time Equivalent (FTE) R&D employment and high technology employment. Table 5.1 examines the relationship between these indicators.

Table 5.1: High technology and R&D employment at the regional level

UK NUTS Region	% of total high technology employment March 1994	% of total business enterprise R&D FTE employment, 1993	% of total manufacturing R&D FTE employment, 1993*
Northern	5.0	1.8	2.5
Yorkshire & Humberside	8.1	3.7	4.2
East Midlands	7.4	8.5	9.2
East Anglia	4.3	3.0	2.5
South East	29.2	50.6	45.4
South West	6.7	6.7	6.7
West Midlands	14.0	9.8	10.9
North West	12.0	10.4	12.6
Wales	4.3	1.8	2.5
Scotland	7.0	3.0	4.2
Northern Ireland	1.0	0.6	0.8
Total	100.0	100.0	–
Base	*1,212,000*	*164,000*	*119,000*

* Does not sum to 100 as source data rounded to the nearest 1,000.

Sources: IES, UK LFS March to May 1994 Quarter and CSO, 1995

Analysis indicates that the percentages of total FTE R&D employment and of total high technology employment are highly correlated. They have a Pearson correlation coefficient of 0.9108, which is significant at the one per cent level. This correlation is partially influenced by the concentration of both FTE R&D employment and high technology employment in the South East region. The South East accounts for 29.2 per cent of high technology employment and 50.6 per cent of FTE R&D employment. If the South East is excluded, the correlation coefficient drops to 0.8807, which is still significant at the one per cent level.

When high technology employment is regressed using R&D FTE employment as the dependent variable, an adjusted R^2 of 0.90 is obtained. Using manufacturing R&D FTE employment as the dependent, an adjusted R^2 of 0.93 is obtained. The residuals show that the North, Yorkshire and Humberside, the West Midlands, the North West, Wales, and Scotland have higher high technology employment than predicted by manufacturing FTE R&D employment. As these are also regions with the highest inward investment by high technology sectors, a possible explanation is suggested. However, at this stage there are not enough data points or data on parent company nationality to test this hypothesis.

Table 5.2: UK male and female high technology employment (1,000s)

	Male employment	Female employment	% Female
Primary production	502	146	22.5
High technology	905	329	26.6
Low technology	2,600	1,041	28.6
General services	10,067	9,962	49.7
Workplace outside UK	**	**	31.5
NA and DNA	90	46	—
Base	*14,176*	*11,526*	*44.9*

Note: Filtered on ILO definition of in employment

Source: UK LFS March to May 1994

5.3 UK LFS high technology employment and gender

Another possible explanation for the divergence between manufacturing R&D employment and high technology employment, may be that some regions are more likely to attract establishments which are essentially 'screwdriver' plants putting together high technology sub-assemblies produced elsewhere.

At a national level, employment can safely be broken down using high/low technology and gender (Table 5.2). This shows that female employment is concentrated in the general services sector, with an effective 50/50 split in the gender composition. The primary production sector contains the fewest females, followed by the high technology sector. A partial explanation of

Table 5:3 Male and female high technology employment by region (1,000s)

UK NUTS Region	Male employment	Female employment	% Female
Northern	45	18	28.9
Yorkshire & Humberside	66	18	22.1
East Midlands	59	19	23.3
East Anglia	33	14	29.7
South East	275	118	29.9
South West	57	19	24.7
West Midlands	129	35	21.2
North West	118	32	22.1
Wales	41	19	31.2
Scotland	64	28	30.4
Northern Ireland	**	**	27.0
Base (inc. NA & DNA)	*905*	*329*	*26.6*

Source: IES and March to May 1994 UK LFS

these differences may be found in the different levels of qualifications, especially scientific and technical qualifications, amongst UK females.

If the gender split within the high technology sector is examined by region the estimates become less reliable (Table 5.3). Indeed for Northern Ireland, using the Employment Department 'rule of thumb' of not reporting cells containing less than 10,000 at the grossed up level, the gender split cannot be reliably estimated. Northern Ireland has a similar employed population and a similar sized manufacturing employment to other NUTS level I regions. This means that it is probable that a gender split of high technology employment is unreliable using only one year's LFS.

5.4 UK LFS high technology employment and full-time/part-time status

At a national level it is possible to examine the numbers of people working full time or part time by technology level (Table 5.4). Part-time employment, as with women's employment, is much more prevalent in the general services sector. Despite the primary production sector having low female participation, it has the next highest level of part-time employment, while the high technology sector has the lowest levels of part-time employment at about six per cent of those whose status is known.

However, at the regional level the numbers of people working part time mean that no reliable estimates can be made (Table 5.5). If this was a priority, it would be necessary to combine more than one LFS survey to improve the reliability of the estimates.

Table 5.4: UK high technology employment and full-time and part-time status 1994 (1,000s)

	Full-time employment	Part-time employment	% of known PT	NA & DNA
Primary production	530	108	16.9	11
High technology	1,158	68	5.5	**
Low technology	3,283	333	9.2	25
Services	14,250	5,591	28.2	185
Workplace outside UK	**	**		—
NA and DNA	58	12		54
Base	*19,297*	*6,112*	*24.1*	*283*

Source: IES and UK LFS March to May 1994

Table 5.5: Full-time and part-time high technology employment by region, 1994 (1,000s)

UK NUTS Region	FT employment	PT employment	PT as % of known
Northern	60	**	**
Yorkshire & Humberside	80	**	**
East Midlands	70	**	**
East Anglia	45	**	**
South East	368	25	6.3
South West	72	**	**
West Midlands	159	**	**
North West	143	**	**
Wales	57	**	**
Scotland	87	**	**
Northern Ireland	13	—	**
Base (inc. NA & DNA)	*1,158*	*68*	*5.5*

Note: Filtered on ILO definition of in employment

Source: IES and March to May 1994 UK LFS

5.5 UK LFS high technology and graduate employment

The LFS records the highest level of educational attainment. ISCED (International Standard Classification of Educational Diplomas) 6 and 7 graduates, in the UK First Degree and above, are usually considered to be associated with high technology employment. At the national level it is possible to confirm this (Table 5.6). The general services and the high technology sectors have comparable levels of graduates at above 14 per cent of those employed. These levels are over twice those found in the low technology and the primary production sectors.

Table 5.6: UK high technology employment and graduate employment, 1994 (1,000s)

	UK employment March to May 1994 quarter	Employees that are ISCED 6 or 7 graduates	ISCED 6 or 7 graduates as a percentage of total
Primary production	648	35	5.4
High technology	1,234	177	14.3
Low technology	3,641	254	7.0
General services	20,028	2,917	14.6
Workplace outside UK	10	**	**
NA and DNA	132	**	**
Base	*25,546*	*3,396*	*13.2*

Note: Filtered on ILO definition of in employment

Source: IES and UK LFS March to May 1994

However, given the relatively small numbers of graduates, it is unlikely that reliable figures for high technology graduate employment can be generated at a regional level. Again, it might be worthwhile examining the extent to which this would be possible by combining LFS surveys. A note of caution needs to be sounded, as graduates are more likely to live with other graduates, which means that the design factors for graduates may be relatively high.

5.6 UK LFS high technology and employment of professionals and scientists and engineers

The OECD Canberra Manual (OECD, 1995) recommends analysis of the HRST population in terms of occupations using ISCO-88 (International Standard Classification of Occupations — 1988). If the LFS data sustain such analysis, further information about the nature of regional high technology employment could be obtained.

The released version of the UK LFS codes occupations in terms of SOC (Standard Occupational Classification) which is not directly compatible with ISCO-88. This means that the analysis that follows is in terms of SOC Groups. SOC Groups 1 and 2 contain Managers and Administrators, and Professional Occupations, and for the purposes of a feasibility study these can be considered equivalent to ISCO-88 Major Groups 1 and 2. SOC Group 3 covers the Associate Professional & Technical Occupations and SOC Group 5 covers Craft and Related Occupations, and for the purposes of a feasibility study these are broadly the same as ISCO-88 Major Group 3.

Table 5.7 gives the national level breakdown by these SOC groups, while Table 5.8 breaks this down by percentages of the workforce. This shows the feasibility of using ISCO-88 as an extra dimension at the national level.

Table 5.7: UK employment by SOC social groups and by technology level, 1994 (1,000s)

	Employees in SOC Groups 1 or 2	Employees in SOC Group 3	Employees in SOC Group 5
Primary production	267	16	89
High technology	328	94	224
Low technology	668	217	1,069
Services	5,396	2,103	1,994
Workplace outside UK	**	**	**
NA and DNA	**	**	**
Base	*6,668*	*2,433*	*3,377*

Note: Filtered on ILO definition of in employment

Source: UK LFS March 1994 and March 1995

Table 5.8: UK employment by SOC social groups and by technology level, 1994 (per cent)

	Employees in SOC Groups 1 or 2	Employees in SOC Group 3	Employees in SOC Group 5
Primary production	41.2	2.4	13.7
High technology	26.6	7.6	18.1
Low technology	18.3	6.0	29.4
Services	26.9	10.5	10.0
Workplace outside UK	**	**	**
NA and DNA	**	**	**
Base	*25.9*	*9.5*	*13.1*

Note: Filtered on ILO definition of in employment

Source: IES and UK LFS March to May 1994

Table 5.9 continues this analysis at the regional level and shows that using the OPCS 'rule of thumb' on validity, a breakdown by the key major occupational groups is possible (except in Northern Ireland). If such a breakdown is considered important, it probably should be conducted using samples from more than one LFS survey to improve the accuracy.

Using a more detailed SOC classification (Table 5.10) it is possible to examine the numbers of managers, and scientists and technologists, working in each of the sectors at a national level. The grouping managers is similar to a grouping of ISCO-88 Major Groups 12 and 13, while the grouping scientists and technologists compares with ISCO-88 Major Group 21 (physical, mathematical and engineering science professionals).

Table 5.9: High technology employment by SOC groups and regions, 1994 (1,000s)

UK NUTS region	SOC Groups 1 and 2	SOC Groups 3 and 5	SOC Groups 4, 6, 7, 8, and 9
Northern	15	13	35
Yorkshire & Humberside	14	30	40
East Midlands	18	20	39
East Anglia	15	12	20
South East	137	92	164
South West	21	17	38
West Midlands	36	43	85
North West	37	42	72
Wales	10	16	35
Scotland	21	25	47
Northern Ireland	**	**	**
Base (inc. NA & DNA)	*328*	*318*	*586*

Note: filtered on ILO definition of in employment

Source: IES and UK LFS March to May 1994

Table 5.10: UK technology level, managerial and scientific and technical† employment, 1994 (1,000s)

	Managers*	Scientists and technologists	Others
Primary production	246	24	378
High technology	196	179	857
Low technology	514	199	2,923
Services	3,040	709	16,245
Workplace outside UK	**	**	**
NA and DNA	**	**	**
Base	*4,002*	*1,112*	*20,418*

Note: Filtered on ILO definition of in employment

† In this context the term scientific and technical employment means someone employed in any of the following SOC Minor Groups: 20 Natural Scientists, 21 Engineers and Technologists, 30 Scientific Technicians and 32 Computer Analysts/Programmers.

* In this context managerial occupations are defined as SOC Minor Groups 10, 11, 12, 13, 14, 16, 17, 18 and 19.

Source: IES and UK LFS March to May 1994

Apart from the primary production sector there are similar proportions of managers in each of the sectors (Table 5.11). The large number of managers (38 per cent) in the primary production sector partially reflects the categorisation of sole farmers as farming managers. Scientists and technologists represent almost 15 per cent of employees in the high technology sector, nearly three times the proportion in the low technology sector.

However, if scientists and technologists in the high technology sector are examined at the regional level (Table 5.12), the numbers start to become too small to be reliable.

Table 5.11: UK technology level, managerial and scientific and technical employment 1994 (per cent of Base)

	Managers	Scientists and technologists	Others
Primary production	38.0	3.8	58.3
High technology	15.9	14.5	69.5
Low technology	14.1	5.5	80.3
Services	15.2	3.5	81.1
Workplace outside UK	**	**	**
NA and DNA	**	**	**
Base	*15.6*	*4.3*	*79.5*

Source: IES and UK LFS March to May 1994

Table 5:12 High technology employment of scientists technologists by regions 1994 (1,000s)

UK NUTS region	Managers	Scientists and technologists	Others
Northern	**	**	46
Yorkshire & Humberside	10	**	64
East Midlands	12	**	57
East Anglia	10	**	28
South East	82	67	243
South West	13	11	52
West Midlands	21	18	125
North West	22	22	107
Wales	**	**	48
Scotland	11	15	67
Northern Ireland	**	**	10
Base (inc. NA & DNA)	*196*	*179*	*857*

Note: Filtered on ILO definition of in employment

Source: IES and UK LFS March to May 1994

5.7 Number of employees per establishment in high technology sectors

The UK LFS and the European LFS only has limited information about the number of persons working at the local unit of the establishment. Part of this is due to the problems of self reporting this sort of information: many employees do not know accurately the number of employees at their establishment. More reliable establishment based data from the UK Census of Employment is reported in Chapter 6.

6. Establishment Surveys and Clustering of High Technology Employment

6.1 Establishment based surveys

An alternative approach to using the Labour Force Survey as the basis for measuring high technology employment is to use establishment based surveys. This chapter examines this alternative and examines the impact of clustering of high technology establishments on this approach.

There is a range of EU-wide establishment surveys which generate data on employment by sector at the regional level. These are primarily designed to generate earnings statistics (OECD, 1994c). The main survey is the Survey of Labour Costs which is designed to generate data on total numbers of staff, working hours and wage costs, plus all incidental expenditures for establishments in industrial and service sectors.[1] As with the Labour Force Survey, the Survey of Labour Costs has a broadly similar methodology in each country and is performed by the national statistical agencies to a common Eurostat specification.

The labour cost survey is a sample survey and excludes establishments with less than ten employees. It is only conducted every four years which means that the actual results are not particularly useful for measuring high technology employment at the regional level. As covered later in this chapter, the problem of clustering of high technology establishments means that results gained from sample surveys have larger margins of error than would otherwise be expected. However, the sample frames required to carry out the surveys provide an alternative basis for measuring high technology employment. Details of these censuses, often derived from administrative sources, are given in Appendix G. These censuses of employment are categorised by number of employees, size of employer, sector using NACE and region, which means that they provide an alternative source of information for measuring employment in high technology sectors at the regional level. Some of these sources may be considered confidential, which

[1] Council Regulation (EEC) No. 3949/92 of 21 December 1992, relating to the organisation of a survey of labour costs in industry and the services sector.

means that data might not be readily available. This issue is beyond the scope of the current study.

The impact and extent of clustering of high technology employment is analysed using UK data from the Census of Employment which is generated partially to act as a sample frame for the Survey of Labour Costs.

6.2 The problem of clustering

The descriptions 'Silicon Valley' in California or 'Silicon Glen' in Scotland are used to describe the observed clusters of high technology industries. Despite a large literature on these clusters of high technology industries (*eg* Porter, 1990) the actual extent to which these industries do cluster does not appear to have been examined statistically.[1] The problem is that a random distribution will include clusters, in fact an even distribution of these industries would be considered exceptionally non-random. The issue is whether the observed clusters are those that would be expected from a random distribution or whether they are more highly concentrated than would be expected.

The reason for wishing to examine this problem is that random sampling, and the reliability of the estimates based on the sample, rely on the assumption that the phenomenon being measured is normally distributed. If high technology employment is significantly more geographically clustered than a normal distribution suggests, then estimates based on sample surveying will become less reliable than suggested by normal sampling theory.

This problem especially applies to stratified sampling techniques such as that used in the Italian LFS survey. With an non-random or clustered distribution of high technology employment, a stratified clustered sampling approach could select a sample which either over or under represents high technology employment.

6.3 Analysis of clustering

The main literature devoted to the analysis of clustering is an epidemiological literature examining the nature of disease clusters, mainly cancers, and attempting to discover point sources for these diseases. The literature describes two main methods for identifying clusters. The more usual method examines the distribution of expected incidence and observed incidence within geographic areas, while the more complex

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[1] The main literature relates to how the existing distribution of high technology employment influences inward investment or start ups *eg* Fingleton, 1992; Woodward, 1992; Bessley and Hamilton, 1994; Head *et al.*, 1995; Braunerhjelm and Svensson; 1996.

method uses the geographical grid-reference of the disease incidence (Marshal, 1991). However, these techniques generally apply to events with low probabilities of occurring and are not really applicable to an analysis of the distribution of high technology employment.

Since we are interested in whether the distribution will affect the reliability of estimates based on sample surveying, the method that will be used is to examine the extent of the deviation from a normal distribution. Then we will examine the possible impact of these distributions under varying sampling strategies.

The distribution that is important is that of the percentage of employment in high technology sectors with geographic small areas. If this is distributed normally it can be assumed that high technology employment is distributed normally and that there is no impact due to clustering.

6.4 Description of the census of employment

The UK Census of Employment is a postal, establishment based census survey using the income tax PAYE (Pay As You Earn) register. This allows analysis of numbers of employees, both full- and part-time, in very small geographic areas by industry sector. The 1993 Census of Employment survey used SIC 92 (or NACE) as the basis for the sectoral analysis. This survey acts as the basis for developing the sampling fractions and weights for the Labour Costs Survey.

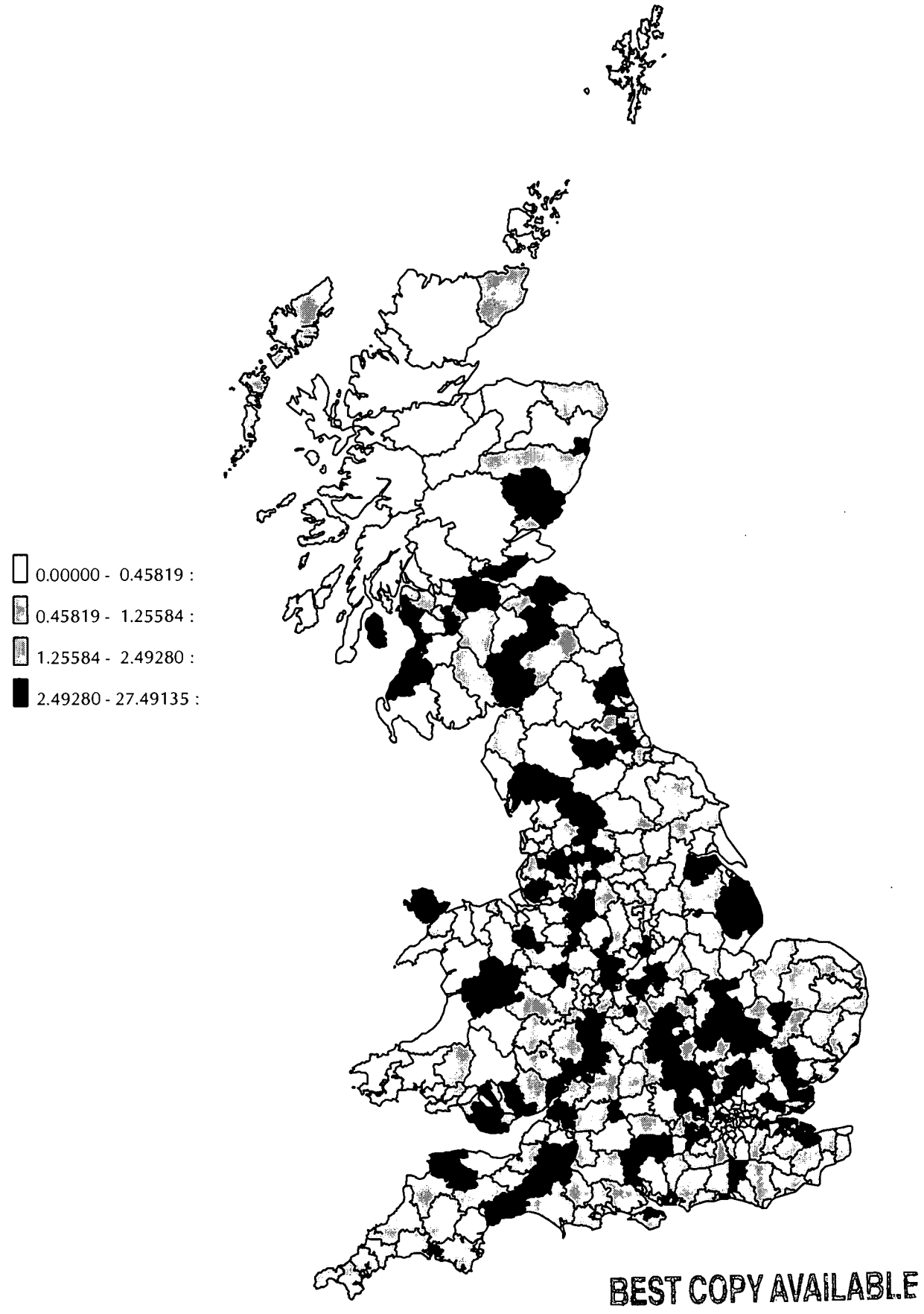
The ability to examine employment reliably by sector for small geographic areas means that the UK Census of Employment can be used to validate the methodology developed using the LFS. Importantly, the UK Census of Employment can also be used to examine the potential problem posed by clustering of high technology industries.

6.5 Analysis of high technology clusters

The following analysis of the degree of clustering of high technology employment is based on a special analysis of the data from the 1993 UK Census of Employment. We obtained data on full-time and part-time employment by three-digit NACE at the level of Local Authority District (LAD). The data was only available for non-agricultural employment and for Great Britain rather than the UK.

Given the richness of this data source, we present details of employment in all non-agricultural sectors, the NACE two-digit definition of high technology, the three-digit definition of higher and medium high technology and the individual Frascati sectors for which we have R&D intensity data. Figure 6.1 shows LADS with specified percentages of employment in high technology.

Figure 6.1: Percentage of high technology employment by LAD



Source: IES/1993 UK Census of Employment

Table 6.1: Summary statistics of all employment by LAD and sector

	Mean	Standard deviation	Median	Variance	Kurtosis	Skewness
High technology	1.87	2.39	1.26	5.73	32.41	4.30
Low technology	13.81	7.81	11.88	60.99	0.47	0.91
Manufacturing	15.68	8.30	13.96	68.83	0.55	0.86
General Services	83.18	8.78	84.77	73.61	0.29	-0.76

Source: IES/1993 UK Census of Employment

6.6 Clustering and the two-digit definition

One method of examining the distribution of high technology employment is to examine the summary statistics for the percentage of all non-agricultural employment in each LAD that is in high technology sectors. Table 6.1 presents these summary statistics, as can be seen high technology has a relatively high kurtosis statistic. This high kurtosis statistic indicates that the distribution is significantly more clustered around a central point than expected in a normal distribution. Since the median is smaller than the mean and the skewness is positive, this indicates a positive skew to the distribution. Combined, these measures indicate that there are more LADs with higher percentages of employment in high technology sectors than would be expected from a normal distribution. Importantly, the variance for high technology employment is much less than for the other sectors, indicating that the bulk of LADs have levels close to the mean.

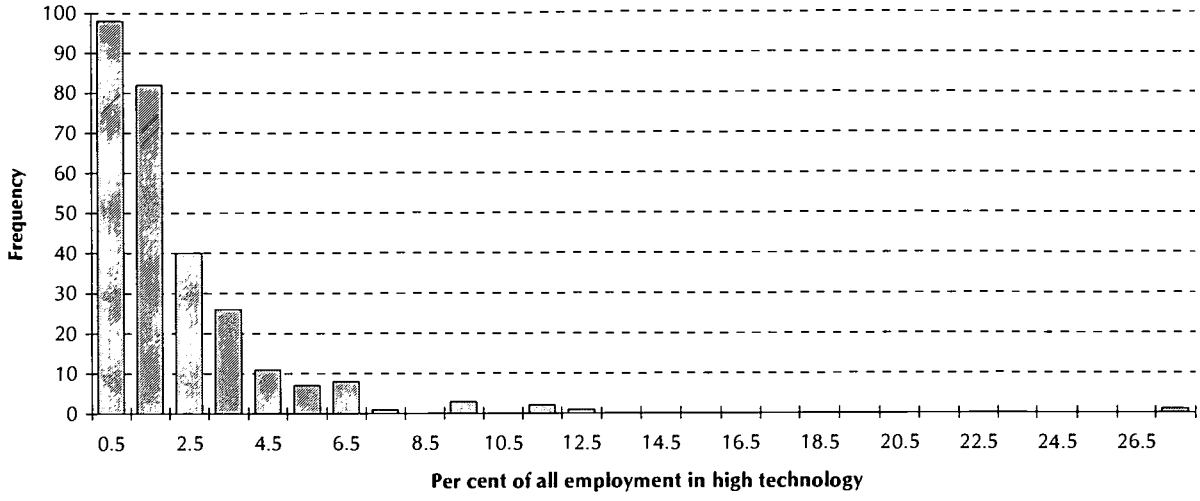
Compared to high technology, the low technology, manufacturing and general services sectors have a much more normal distribution.

Another approach is to examine the distribution visually. Figure 6.2 plots the frequency of increasing levels of high technology employment as a percentage of all employment for the 459 LADs in Great Britain. This visually illustrates the points about the distribution revealed by the summary statistics. The bulk of LADs have a low percentage of non-agricultural employment in the high technology sectors, while a few LADs have significantly more than would be expected if this employment was distributed normally.

By comparison, Figure 6.3 illustrates the distribution of manufacturing as a percentage of all non-agricultural employment. Although the distribution is slightly positively skewed the distribution approximates more closely to a normal distribution.

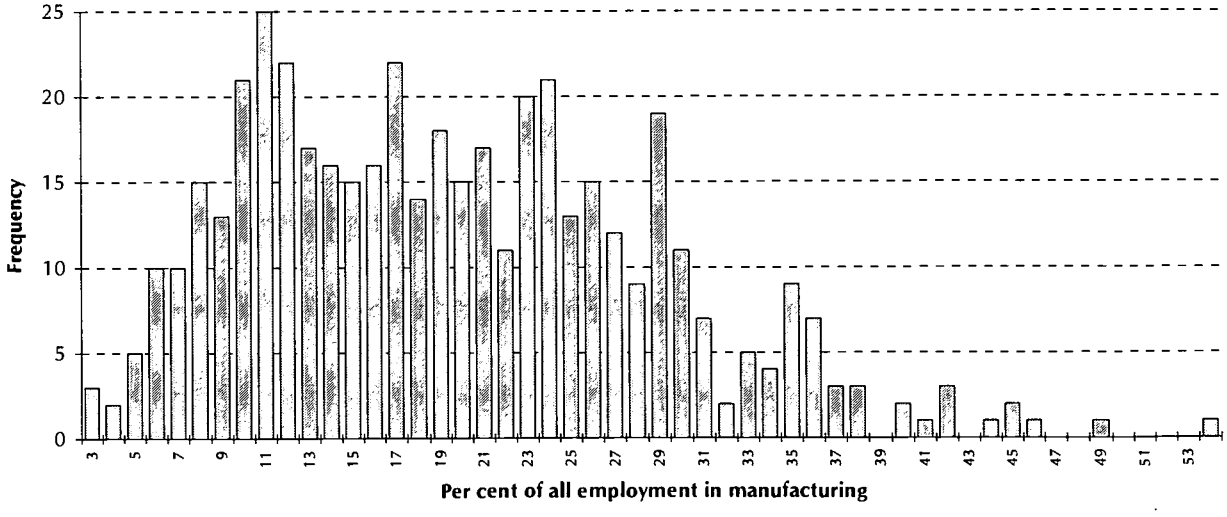
Figure 6.4 gives the distribution of high technology employment as a percentage of manufacturing employment. This shows that even within manufacturing, high technology is positively skewed and exhibits features of clustering.

Figure 6.2: Distribution of the percentage of all non-agricultural employment in high technology



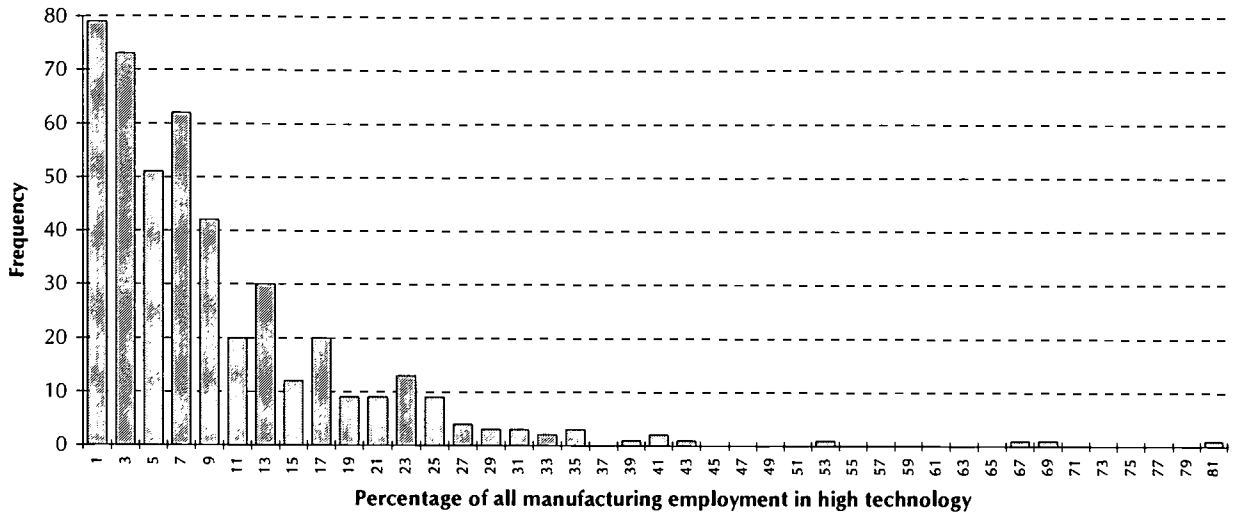
Source: IES/1993 UK Census of Employment

Figure 6.3: Distribution of the percentage of all non-agricultural employment in manufacturing



Source: IES/UK 1993 Census of Employment

Figure 6.4: Distribution of the percentage of all manufacturing employment in high technology



Source: IES/UK 1993 Census of Employment

The Census of Employment also provides data on the number of employees and the number of establishments in various size bands by sector. Table 6.2 gives the percentage of all establishments with above and below 100 employees and the percentage of all employment in these establishments. Additionally, Table 6.2 gives the average number of employees per establishment by technology level. This shows that in the high technology sectors eight per cent of establishments have more than 100 employees, compared with 2.4 per cent of all non-agricultural establishments. Similarly, 67.7 per cent employees in the high technology sectors are in establishments with more than 100 employees, compared with only 42.5 per cent overall.

Since the size data is presented in terms of size bands, multiple analysis of variance cannot be utilised to discover the extent to which the clustering is due to difference in the average size of establishments. However, the larger average establishment size

Table 6.2: Size of establishment and average number of employees by sector

	% of units with 1 to 99 employees	% of employees in units with 1 to 99 employees	% of Units with more than 100 employees	% of employees in units with more than 100 employees	Average no. of employees per establishment
High technology	92.0	32.3	8.0	67.7	39.9
Low technology	95.1	46.9	4.9	53.1	24.9
Manufacturing	94.5	42.4	5.5	42.5	16.2
General Services	97.9	60.8	2.1	39.2	14.8
All non-agricultural employment	97.6	57.5	2.4	42.5	16.2

Source: IES/1993 UK Census of Employment

Table 6.3: Size of establishment by sector and UK NUTS 1 region

	Average no. employees per establishment: High technology	Average no. employees per establishment: Low technology	Average no. employees per establishment: All non-agricultural employment
Northern	65.5	36.1	17.1
Yorkshire & Humberside	31.4	32.1	16.8
East-Midlands	39.7	29.4	16.6
East Anglia	29.0	26.1	16.0
South East	39.2	18.0	15.4
South West	39.2	23.3	14.8
West Midlands	28.3	26.1	16.8
North West	46.8	26.0	16.9
Wales	66.5	31.6	16.1
Scotland	72.6	29.2	15.8
Great Britain	39.9	24.9	16.2

Source: IES/1993 UK Census of Employment

would generate more clustered distribution. Continuous variables have been imputed from banded income data (Bhat, 1994) and this method might be applied here.

When the average number of employees per establishment is examined by region (Table 6:3), the variability of employment patterns in high technology sectors is further underlined. The average number of employees per establishment in high technology sectors ranges from 72.6 in Scotland to 28.3 in the West Midlands. This range is much less than found for all non-agricultural employment which ranges from 17.1 in the Northern region to 15.4 in the South East.

6.7 Clustering and three-digit definition

The data from the Census of Employment is available at five digit SIC 92, this means that the distribution of employment can also be analysed in terms of the three-digit level of NACE. Table 6.4 presents the summary statistics for this level of analysis. This shows that clustering is especially apparent in the higher technology sectors.

Table 6.5 gives the breakdown by size and the average number of employees per establishment, of the higher and medium high technology sectors. Again this indicates that the degree of clustering in the higher technology sectors can at least partially be explained by the larger than average size of higher technology establishments.

Table 6.4: Summary statistics of all employment by LAD and three-digit sector

	Mean	Standard deviation	Median	Variance	Kurtosis	Skewness
Higher technology	1.81	3.19	0.72	10.14	21.34	3.97
Medium high technology	3.94	3.32	3.19	10.99	6.63	2.00
Manufacturing	15.68	8.30	13.96	68.83	0.55	0.86
General Services	83.18	8.58	84.77	73.60	0.29	-0.76

Source: IES/1993 UK Census of Employment

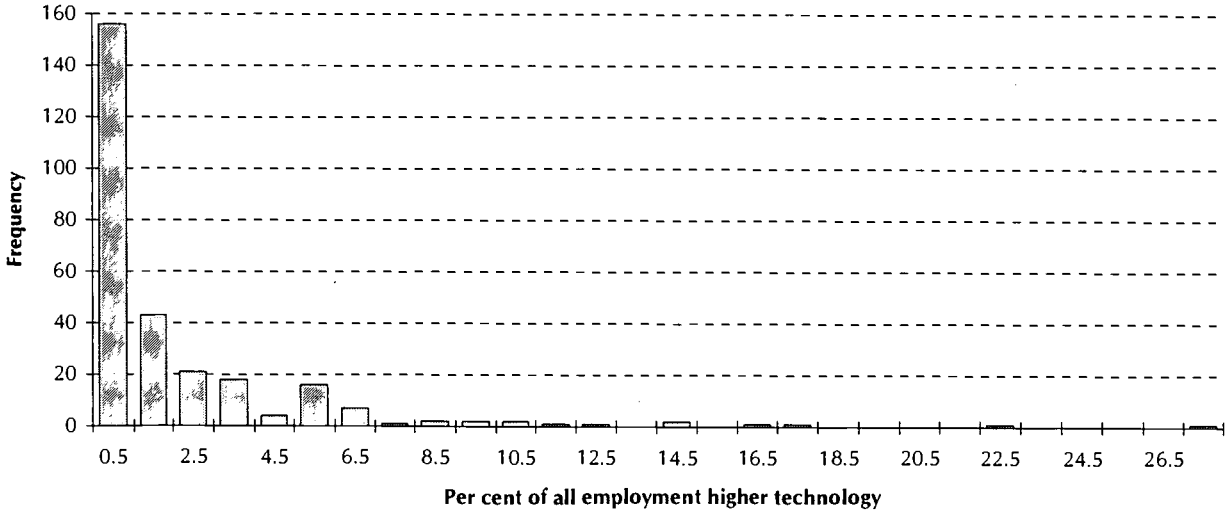
Table 6.5: Size of establishment by three-digit definition

	% of units with 1 to 99 employees	% of employees in units with 1 to 99 employees	% of units with more than 100 employees	% of employees in units with more than 100 employees	Average no. employees per establishment
Higher Technology	89.4	19.3	10.6	80.7	63.5
Medium High	92.9	35.1	7.1	64.9	36.2
Low	95.1	46.9	4.9	53.1	24.9
Manufacturing	94.5	42.4	5.5	57.6	28.1
All non-agricultural	97.6	57.5	2.4	42.5	16.2

Source: IES/1993 UK Census of Employment

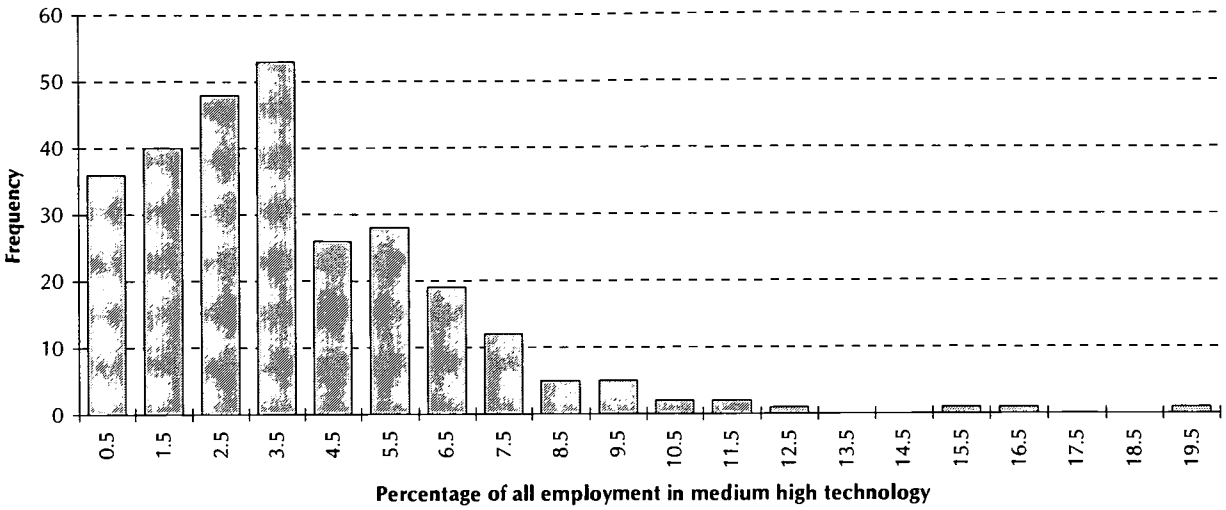
Figure 6.5 visually illustrates this clustered distribution of higher technology employment with a small number of LADs, with a large percentage of employment in the higher technology sectors. Figure 6.6 also indicates that the medium high technology sectors are much less clustered and their distribution more closely approximates to that of a normal distribution.

Figure 6.5: Distribution of the percentage of employment in higher technology by LAD



Source: IES/UK 1993 Census of Employment

Figure 6.6: Percentage distribution of medium high technology employment by LAD



Source: IES/UK 1993 Census of Employment

As with the high/low definition there is further variation when the average size of establishment is examined regionally (Table 6.6). The average size of higher technology establishments in Scotland and Wales are over three times the size of those in East Anglia and the South East. The medium high technology establishments have a more evenly distributed average size. The largest average medium high technology establishments are found in the Northern region (55.4) and the smallest in the South West (30.6).

Table 6.6: Size of establishment by three-digit definition and region

	Average no. employees per establishment: Higher technology	Average no. employees per establishment: Medium high technology	Average no. employees per establishment: All non-agricultural employment
Northern	82.2	55.4	17.1
Yorkshire & Humberside	54.5	34.2	16.8
East-Midlands	92.7	34.1	16.6
East Anglia	29.2	33.5	16.0
South East	52.7	33.2	15.4
South West	92.2	30.6	14.8
West Midlands	47.3	41.1	16.8
North West	84.8	40.8	16.9
Wales	100.0	52.6	16.1
Scotland	107.8	35.9	15.8
Great Britain	*63.5*	*36.2*	*16.2*

Source: IES/1993 UK Census of Employment

6.8 Clustering and Frascati sectors

Since the UK Census of Employment is a census survey rather than a sample survey, exceptionally disaggregated data is available on the basis that confidentiality is maintained. This means that the distribution of the individual Frascati sectors for which we have R&D intensity data can be examined. Part of the reason for wanting to examine the data at this level is to discover the extent to which the aggregation of sectors to generate the high and higher technology categories effect the reliability of the estimates.

Table 6.7 presents the summary statistics for the percentage of all non-agricultural employment in each of the Frascati sectors in the high and higher categories. This shows that pharmaceuticals shows extreme kurtosis and a high level of skewness. However, pharmaceuticals is also one of the smaller sectors in the high and higher technology aggregations, and this skew therefore has less impact on the aggregated figures.

This pattern of the greater kurtosis and greater skewness associated with smaller populations appears to hold true for all the Frascati sectors. Interestingly, the highest kurtosis and skewness is not associated with the sector with the largest average establishment size. Aerospace has the largest average establishment size, at 119 employees per establishment, but has a smaller skewness than pharmaceuticals. It appears that more of the skewness in aerospace is due to the large average size, but there is more clustering of establishments in pharmaceuticals and office machinery.

Since the distribution of the pharmaceuticals sector shows the greatest kurtosis and skewness it is useful to examine this visually as well (Figure 6.7). Here the impact of a small number of LADs with a high percentage of employment in pharmaceuticals becomes apparent.

Table 6.7: Summary statistics percentage of all employment by LAD and Frascati sector

Frascati sector and NACE code	Mean	Standard deviation	Median	Variance	Kurtosis	Skewness
Pharmaceuticals – 24.4	0.37	1.55	0.01	2.41	210.46	12.89
Office Machinery & Computers – 30	0.23	0.73	0.02	0.53	73.86	7.41
Radio, TV and Comms – 32	0.61	1.30	0.16	1.70	32.40	5.08
Aerospace – 35.3	0.61	2.19	0.01	4.80	43.71	6.02
Chemicals – 24 less 24.4	1.07	1.86	0.49	3.44	31.68	4.89
Non-electrical machinery – 29	1.34	1.62	0.85	2.63	16.67	3.23
Electrical machinery – 31	0.77	1.40	0.37	1.96	82.33	7.20
Instruments – 32	0.76	1.18	0.38	1.39	40.70	5.04
Motor vehicles – 34	0.80	1.97	0.16	3.89	29.93	5.01

Source: IES/1993 UK Census of Employment

Table 6.8: Size distribution of Frascati sectors

Frascati sector and NACE code	% of units with 1 to 99 employees	% of employees in units with 1 to 99 employees	% of units with more than 100 employees	% of employees in units with more than 100 employees	Average no. employees per establishment
Pharmaceuticals – 24.4	82.2	15.0	17.8	85.0	92.1
Office Machinery & Computers – 30	91.7	29.8	8.3	70.2	41.3
Radio, TV and Comms – 32	91.3	28.4	8.7	71.6	43.9
Aerospace – 35.3	87.1	9.0	12.9	91.0	118.8
Chemicals – 24 less 24.4	90.0	31.2	10.0	68.8	45.8
Non-electrical machinery – 29	94.0	40.2	6.0	59.8	32.6
Electrical machinery – 31	91.0	33.2	9.0	66.8	40.3
Instruments – 32	95.2	43.6	4.8	56.4	24.5
Motor vehicles – 34	90.7	19.2	9.3	80.8	62.1

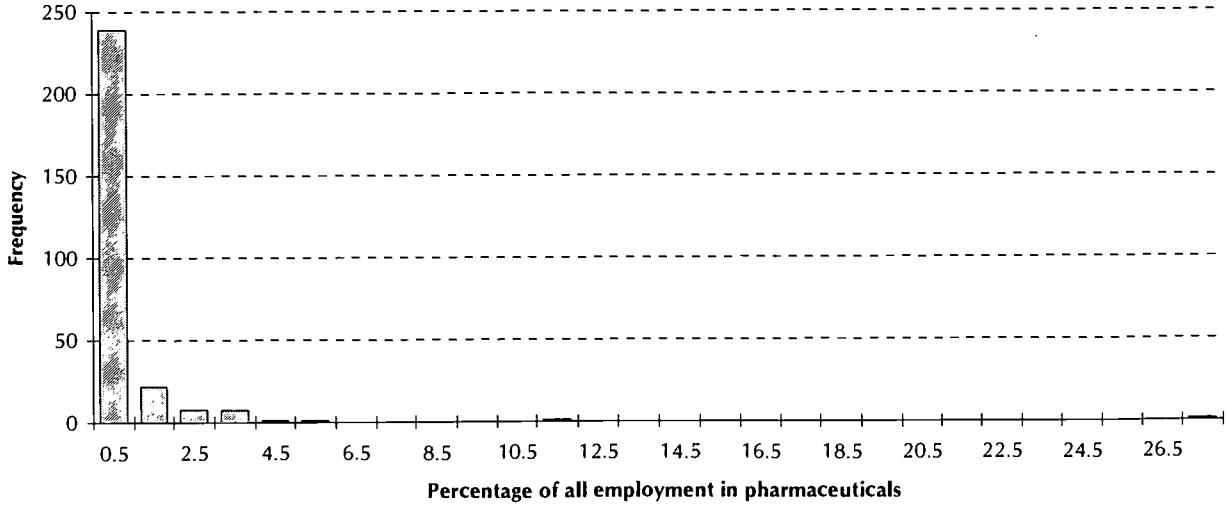
Source: IES/1993 UK Census of Employment

6.9 The impact of clustering on the LFS estimates

When examining the impact of the clustered distribution of high technology employment, it is necessary to distinguish between the distribution of employment, and the primary sampling unit of the LFS which is the household. Even if the location of employment is clustered, but the individuals employed by these establishments come from normally distributed households, then the sample estimates of high technology employment would not be effected by the clustering.

It is clear that high technology establishments are clustered, at least partially because of the larger average unit size. However,

Figure 6.7: Percentage distribution of pharmaceuticals employment



Source: IES/UK 1993 Census of Employment

these larger units possibly have a larger employee catchment area, meaning that the contributing households are not as clustered as the distribution of employment suggests. Unfortunately, there is no published data on the catchment areas of establishments by sector. However, the Sample of Anonymised Records (SARs), based on the UK 1991 Census, could provide such a breakdown (although sectors are coded using SIC 80 and therefore are not directly compatible with NACE). Such an analysis is beyond the scope of this study.

If the sample survey was of establishments, the skewed nature of the distribution would mean that a larger sample size was necessary to obtain a reliable estimate. One approach used to estimate the necessary sample size is based on the skewness measure (Cochram, 1977, Chapter 2):

$$n \rangle 25G_1^2$$

Where G_1 is the Fisher measure of skewness.

With the size of the skewness discovered, for instance, in the pharmaceuticals sector, this would imply a substantial increase in the sample size to obtain a reliable result.

Despite the evidence for clustering of high technology employment, especially at the level of the constituent sectors, the variance between LADs in the percentage of employment in these sectors is low. This is mainly because we are dealing with a small sub-population. The problem for sample based estimates is the few LADs with relatively high levels of employment in the high technology sectors. However, Simple Random Sampling (SRS) of households has the same likelihood of correctly identifying the proportion of employees in high technology employment, regardless of the clustering of the establishment. The problem only exists where the PSUs are selected from stratified geographic clusters. If the stratification process selects an area for sampling which contains a cluster of high technology employment, then the estimates would be biased upwards, while the converse is also true.

The known example of LFS stratified clustered sampling is used in the Italian survey, which uses a complex stratification process. The primary stratification is to select a random sample of the larger *Communi* (municipal areas) and then from the smaller *Communi* a further random sample stratified partly on the basis of altitude and partly on the basis of whether they are predominately agricultural, manufacturing or service sector (di Pietro, 1993).

As we have seen, at least for the UK, areas of greater high technology employment are usually also areas of greater manufacturing employment. This means that stratification on the basis of manufacturing would reduce the problem. The

rationale for stratification in the first place is also to reduce the sampling error. These factors in common could mean that clustering of high technology employment may not be a problem. This is examined in more detail in Chapter 8, where the Italian microdata are analysed.

7. Using the Labour Force Survey

On the basis of successfully deriving information about high technology employment at the regional level from the UK LFS, this chapter provides details of the data derived from the EU-wide LFS held by Eurostat. The first section outlines the data obtained using the two-digit NACE definition for the EU, while the later sections examine the household design effects for Spain, France and Italy.

7.1 High technology employment by NUTS region

Data were extracted from the Labour Force Survey on the basis of the two-digit definition of high and low technology. The data includes all those in employment (using the ILO definition) over the age of 16 and not resident in collective institutions. The data also exclude those for whom the region of employment was not reported; sometimes this is because the employment is mobile and covers more than one region, sometimes the question was not answered, and more rarely the respondent is employed in an extra-territorial organisation. Although cross-national border flows of employment are relatively small, these were partially taken into account. When cross-national border employment occurs and the region of employment does not border the country of residence, the region of employment is not recorded.

Table 7.1 shows the top ten regions in terms of the percentage of employment in high technology sectors. Appendix B contains the data for all the 71 NUTS level I regions covered by the 1994 Labour Force Survey. As suspected on the basis of the levels of manufacturing employment for nine of the NUTS level I regions, the figures for high technology employment are too low to report. These regions are mainly offshore island regions, however, the figures for Luxembourg and Mecklenburg-Vorpommern are also too low to report.

The highest percentage of employment in high technology sectors occurs in Baden-Württenburg at 14.4 per cent of all employment.

Table 7.1: Top ten regions in terms of high technology employment — 1994

NUTS level 1 Region	Total (1,000s)	High technology (1,000s)	% High technology
Baden-Württenburg — DE	2,362	340	14.4
Saarland — DE	224	28	12.7
Niedersachsen — DE	1,111	137	12.3
Hessen — DE	1,387	169	12.2
Nord Ovest — IT	2,076	245	11.8
Rheinland-Pfalz — DE	920	108	11.8
Lombardia — IT	3,190	359	11.3
West Midlands — UK	2,297	243	10.6
Bremen — DE	182	19	10.5
Est — FR	1,754	173	9.9

Source: IES/Labour Force Survey

7.2 Design effects

Using the techniques developed to examine the UK LFS microdata, the household design effects were also examined for Spain, France and Italy. This was to extend the tests for the reliability of the data generated and to examine where possible the impact of stratified sampling techniques.

7.3 Household design effects

Since the Primary Sampling Unit of all the constituent national surveys is the household, while employment is an individual characteristic, the main design factor influencing the sample estimates of high technology employment will be the household effects. Simply put, the household design factors account for households where more than one person is employed in high technology sectors. Since the LFS data held by Eurostat does not contain any strata information, it is impossible to examine the impact of stratification. The method adopted, successive differences, is the same as that outlined in Chapter 3.

7.3.1 Household design effects in Spain

Due to the nature of the microdata extraction, the analysis excludes people resident in other countries but employed in Spain. Similarly, the analysis also excludes those for whom a region of employment was not recorded, for whatever reason. This means that the figures reported may be slightly different than those reported in the preceding analysis.

Table 7.2: High technology employment in Spain, 95 per cent confidence limits

NUTS Level 1 region	Employed (1,000s)	High technology employment (1,000s)	% high technology	Household design factor	95% confidence limits + or – (1,000s)
Noroeste	1,367	30	2.2	0.99	0.3
Noreste	1,304	110	8.4	0.96	0.6
Madrid	1,574	108	6.9	0.99	0.6
Centro	1,497	38	2.6	0.97	0.4
Este	3,502	256	7.3	0.98	0.9
Sur	2,061	66	3.2	0.96	0.5
Canarias	440	**	**	–	–

Source: IES/Labour Force Survey

Table 7.2 gives the results of the analysis of the household design effects in Spain, and derive the 95 per cent confidence limits for the estimates of high technology employment. This shows that reliable data can be generated for all the Spanish regions apart from the Canary Islands. It also illustrates that the sample sizes and the low household effects mean that the 95 per cent confidence limits are relatively low. Importantly, even taking the most pessimistic assumptions about the confidence limits the ranking of percentage of high technology employment remains the same. Further the design factors are remarkably similar for each of the Spanish regions, despite the range of values for high technology employment.

7.3.2 Household design effects in France

Similar considerations about the data apply to the analysis of the household design effect in France as in Spain. Table 7.3 gives the results of this analysis for France. Again this indicates that the

Table 7.3: High technology employment France, 95 per cent confidence limits

NUTS Level 1 region	Employed (1,000s)	High technology employment (1,000s)	% high technology	Household design factor	95% confidence limits + or – (1,000s)
Ile-de-France	4,784	291	6.1	1.02	1.0
Bassin parisien	3,262	274	8.4	1.02	1.0
Nord-Pas-de-Calais	1,176	63	5.3	1.02	0.5
Est	1,754	173	9.9	1.00	0.8
Ouest	1,514	87	5.7	1.04	0.6
Sud-Ouest	1,984	93	4.7	1.02	0.6
Centre-Est	2,492	199	8.0	1.04	0.9
Mediterrance	2,140	55	2.6	1.03	0.5

Source: IES/Labour Force Survey

estimates are robust for all the metropolitan French regions. Importantly, the household design effects again are remarkably similar for each of the regions despite the range in values.

7.3.3 Household design effects in Italy

The analysis of the household design effects are perhaps more important for Italy, since it is known that a stratified clustered sampling methodology is adopted. Since the strata information is not held by Eurostat, the full impact of this sampling methodology cannot be assessed. The stratification is based on the degree of industrialisation of a *communi.* The linkage between manufacturing and high technology employment means that the reduction in the variance of industrial employment due to stratification should also reduce the variance due to high technology employment.

Table 7.4 gives details of the analysis of the household effects for Italy. This analysis does not take into account the stratification, only the household design factors. As with all the other countries where such an analysis has been carried out, the design effects are relatively low and the estimates appear robust.

In an attempt to further examine the effect of stratification, Table 7.5 examines the components of the household design factor, specifically the amount of variance that is due to multiple people employed in the household, and multiple people employed in high technology sectors. Examination of these data suggests that there is no significant impact on the estimates due to stratification. However, to be sure of this it would be necessary to examine the strata information as well.

Table 7.4: High technology employment Italy, 95 per cent confidence limits

NUTS Level 1 region	Employed (1,000s)	High technology employment (1,000s)	% high technology	Household design factor	95% confidence limits + or – (1,000s)
Nord Ovest	2,076	245	11.8	1.02	0.9
Lombardia	3,190	359	11.3	1.06	1.2
Nord Est	2,289	164	7.2	1.04	0.8
Emilia-Romagna	1,436	142	9.9	1.04	0.7
Centro	1,937	81	4.2	1.04	0.6
Lazio	1,632	71	4.4	0.99	0.5
Campania	1,355	52	3.8	0.97	0.4
Abruzzi-Molise	479	26	5.5	1.05	0.3
Sud	1,554	30	1.9	1.02	0.3
Sicilia	1,100	23	2.1	0.98	0.3
Sardega	419	**	–	–	–

Source: IES/Labour Force Survey

Table 7.5: High technology employment Italy, variance and covariance

NUTS Level 1 region	Variance in high technology employment	Variance in total employment	Covariance	Household design factor	95% confidence limits + or – (1,000s)
Nord Ovest	735.1	1960.9	153.5	1.02	0.9
Lombardia	812.2	2007.4	156.0	1.06	1.2
Nord Est	641.1	3286.5	178.0	1.04	0.8
Emilia-Romagna	372.1	1169.0	54.5	1.04	0.7
Centro	294.1	1970.4	61.5	1.04	0.6
Lazio	202.1	1164.3	24.0	0.99	0.5
Campania	142.5	902.3	21.5	0.97	0.4
Abruzzi-Molise	159.1	808.4	27.5	1.05	0.3
Sud	128.0	1407.3	22.5	1.02	0.3
Sicilia	76.0	729.7	-0.5	0.98	0.3
Sardega	33.0	404.3	2.0	–	–

Source: IES/Labour Force Survey

8. Conclusions and Discussion

This chapter reviews the feasibility of measuring high technology employment at the regional level, based on the Labour Force Survey. Any measurement of high technology employment critically depends on the definition used, fortunately the OECD exercise gives a solid foundation for a definition. This chapter initially examines the NACE two-digit information and then the NACE three-digit definition, and finally concludes with the potential for further exercises using the definition and the LFS.

8.1 The two-digit definition

The two-digit definition of high technology sectors based on the OECD R&D intensity data is given Chapter 2. Given the fact that currently the LFS is only capable of generating two-digit NACE sector information, this is the only practical definition that can be used.

8.1.2 Reliability of the two-digit definition

Since the two-digit definition aggregates a number of sectors, there are potential problems with sector aggregation and the clustering of high technology employment. However, the analysis of the UK Census of Employment in Chapter 6 indicates that the most clustered and varied sectors are also the smallest. This reduces the problem and for practical purposes it can be ignored. The main remaining area of doubt is the use of stratified sampling techniques, as in Italy. However, the available evidence also suggests that this is not a particular problem.

For most of the mainland regions of Europe the two-digit definition generates reliably large estimates for high technology employment. Also, where it has been examined, the household design factors are small and do not adversely effect the estimates (Chapter 7).

8.2 The three-digit definition

The three-digit definition, since it distinguishes between higher technology and medium high technology, gives a more useful breakdown. However, the LFS currently is not capable of

analysis at this level. Further, the narrower definition necessarily generates smaller estimates and reduces their reliability, although for all but one of the UK regions where it was possible to use the three-digit definition, reliable estimates could be made.

This suggests that when and if the Labour Force Survey can generate data on the basis of three-digit NACE this definition should be used in preference to the two-digit definition.

8.3 Continued monitoring

Since the Labour Force Survey is performed every six months, there is scope for continued monitoring of high technology employment. This would allow important policy agendas such as the creation of new employment in high technology sectors to be addressed. Equally, it could be used to monitor the effectiveness of various regional initiatives aimed at encouraging high technology industries.

Given the apparent reliability of the estimates generated, it is recommended that the exercise is regularly repeated to allow these policy agendas to be addressed.

8.4 Updating the definition

The OECD work has indicated that the R&D intensity of sectors has changed over the last ten years. This suggests that there will be a continued necessity to monitor the R&D intensities to validate the sectoral definition. Also, since the R&D intensity data are derived partly from countries outside Europe, there might also be a case for checking that the global R&D intensities are also found in Europe.

8.5 Conclusions

Overall, this exercise suggests that reliable estimates of high technology employment at the regional level can be derived from the Labour Force Survey.

Bibliography

Abbott T A (1991), 'Measuring high technology trade: contrasting international trade administration and bureau of census methodology and results', *Journal of Economic and Social Measurement*, Vol. 17, pp. 17-44

Aitkin M, Healy R (1985), 'Statistical Modelling of Unemployment Rates from the European Labour Force Survey', *Journal of the Royal Statistical Society, Series A*, Vol. 148, No. 1, pp. 45-56

Allinsmith W, Allinsmith B (1948), 'Religious Affiliation and Politico-Economic Attitude: A Study of Eight Major U.S. Religious Groups', *Public Opinion Quarterly*, Vol. 12, pp. 377-389

Angel D P (1991), 'High-technology agglomeration and the labour market: the case of silicon valley', *Environment and Planning A*, Vol. 23, pp 1501-1516

Beesley M E, Hamilton R T (1994), 'Entry Propensity, the Supply of Entrants and the Spatial Distribution of Business Units', *Regional Studies*, Vol. 28, No. 3, pp. 233-239

Begg I (1991), 'High Technology Location and the Urban Areas of Great Britain: Developments in the 1980s', *Urban Studies*, Vol. 28, No. 6, pp. 961-981

Begg I G, Cameron G C (1988), 'High Technology Location and the Urban Areas of Great Britain', *Urban Studies*, Vol. 25, pp. 361-379

Besag J, Newell J (1991), 'The Detection of Clusters of Rare Diseases', *Journal of the Royal Statistical Society: Series A*, Vol. 154, No. 1, pp. 143-155

Bhat C R (1994), 'Imputing a continuous income variable from grouped and missing income observations', *Economics Letters*, Vol. 46, pp. 311-319

Braunerhjelm P, Svensson R (1996), 'Host country characteristics and agglomeration in foreign direct investment', *Applied Economics*, Vol. 28, pp. 833-840

Butchart R L (1987), 'A new UK definition of high technology industries', *Economic Trends*, Vol. 400, pp. 82-88

Butcher B, Elliot D (1986), *A Sampling Errors Manual*, OPCS New Methodology Series, No. 13

Casey B, Creigh S (1989), 'Marginal Groups in the Labour Force Survey', *Scottish Journal of Political Economy*, Vol. 36, No. 3, pp. 282-300

Chamberlain E, Purdie E (1992), 'The Quarterly Labour Force Survey — a new dimension to labour market statistics', *Employment Gazette*, October

Chamberlain E (1993), 'Labour Force Trends in the regions 1984-1992', *Employment Gazette*, March

Central Statistical Office (CSO) (1995), *Survey of Business Enterprise R & D 1993*, HMSO, London

Cochran W G (1977), *Sampling Techniques*, John Wiley & Sons

Employment Department (ED) (1994), *LFS User's Guide*, Employment Department, Sheffield

European Commission (1994), *Employment in Europe — 1994*, ISBN 92-826-8965-4

Eurostat (1992), *Labour Force Survey: Methods and definitions*, ISBN 92-826-4354-9

Eurostat (1993), *NACE Rev. 1: Unit B6 Classifications*, Eurostat working document for the SPC (NACE) Committee

Fingleton B (1992), 'The Location of Employment in High-technology Manufacturing in Great Britain', *Urban Studies* Vol. 29, No. 8, pp. 1265-1276

Foley A, Griffith B (1992), 'Indigenous Manufacturing Enterprises in a Peripheral Economy and the Single Market: the Case of the Republic of Ireland', *Regional Studies*, Vol. 26, No. 4, pp. 375-386

Grupp H (1995), 'Science, high technology and competitiveness of EU countries', *Cambridge Journal of Economics*, Vol. 19, pp. 209-223

Guerrieri P, Milana C (1995), 'Changes and trends in the world trade in high-technology products', *Cambridge Journal of Economics*, Vol. 19, pp. 225-242

Hadlock P, Heckler D, Gannon J (1991), 'High technology employment: another view', *Monthly Labor Review*, Vol. 114, No. 7, pp. 26-30

Head K, Ries J, Swenson D (1995), 'Agglomeration benefits and location choice: Evidence from Japanese manufacturing investments in the United States', *Journal of International Economics*, Vol. 38, pp. 223-247

Hyman H H (1972), *Secondary Analysis of Sample Data*, Wesleyan University Press, Middletown, Connecticut

International Trade Administration (1985), *US high technology trade and competitiveness*, ITA

International Labour Organisation (ILO) (1995), *Sources and Methods Labour Statistics, Volume 2: Employment, Wages, Hours of Work and Labour Cost (Establishment Surveys), 2nd Edition*, ILO, Geneva

Jones T (1993), *Britain's Ethnic Minorities: An analysis of the Labour Force Survey*, Policy Studies Institute, London

Kiecolt K J, Nathan L E (1985), *Secondary Analysis of Survey Data*, Sage Publication

Kish L, Hess I (1959), 'On variance of ratios and their differences in multi-stage samples', *Journal of the American Statistical Association*, Vol. 54, pp. 416-446

Kish L (1987), *Statistical Design for Research*, John Wiley & Sons

Leger D W, Didrichsons I A (1994), 'An assessment of data pooling and some alternatives', *Animal Behaviour*, Vol. 48, pp. 823-832

Marshall R J (1991), 'A Review of Methods for the Statistical Analysis of Spatial Patterns of Disease', *Journal of the Royal Statistical Society A*, Vol. 154, No. 3, pp. 421-441.

OECD (1985), *Trade in High Technology Products*, Paris, Directorate for Science, Technology and Industry

OECD (1993), *Seminar on High Technology Industry and Product Indicators: Technology Diffusion: Tracing the flows of embodied R&D in eight OECD countries, 25-26 November 1993*, DSTI/EAS(93)5/ REV 1, OECD, Paris

OECD (1994a), *Classification of High-Technology Products and Industries, Working Party No. 9 of the Industry Committee on Industrial Statistics, DSTI/EAS/IND/WP9(94)11*, OECD, Paris

OECD (1994b), *Proposed Standard Practice for Surveys of Research and Experimental Development: Frascati Manual 1993*, OECD, Paris

OECD (1994c), *The 1993 OECD-Eurostat Compendium of Sources of Earnings Statistics*, OECD, Paris

OECD (1995a), *Manual on the Measurement of Human Resources Devoted to S&T: Canberra Manual*, OECD, Paris

OECD (1995b), *Classification of High-technology products and industries*, DSTI/EAS/IND/STP(95)1, OECD, Paris

OPCS (1990), *Standard Occupational Classification* (3 Volumes), HMSO, London

OPCS (1992), *Standard Industrial Classification 1992*, HMSO, London

Papagni I (1992), 'High-technology exports of ECC countries: persistence and diversity of specialisation patterns', *Applied Economics*, Vol. 24, pp. 925-933

di Pietro E (1993), 'la nuova indagine ISTAT sulle forze de lavoro', *Economia & lavora*, Vol. XXVII, No. 1, pp. 57-64

Porter M (1990), *The Competitive Advantage of Nations*, New York, Free Press, Macmillian

Reed J S (1975-1976), 'Needles in Haystacks: Studying "Rare" Populations by Secondary Analysis of National Sample Surveys', *Public Opinion Quarterly*, Vol. 39, pp. 514-522

Scott A J (1992), 'Low-wage Workers in a High-technology Manufacturing Complex: The Southern Californian Electronics Assembly Industry', *Urban Studies*, Vol. 29, No. 8, pp. 1231-1246

Smith S M, Barkley D L (1991), 'Local Input Linkages of Rural High-technology Manufacturers', *Land Economics*, Vol. 67 No. 4, pp. 472-483

Tonks E (1995), 'Revisions to the Quarterly Labour Force Survey: Re-weighting and seasonal adjustment review', *Employment Gazette*, May

hUallacháin BÓ (1990), The location of US manufacturing: some empirical evidence on recent geographical shifts, *Environment and Planning A*, Vol. 22, pp. 1205-1222

Von Neumanm J, *et al.* (1941), 'The Mean Square Successive Difference', *Annals of Mathematical Statistics*, Vol. 12, pp. 153-162

Woodward D P (1992), 'Locational Determinants of Japanese Manufacturing Start-ups in the United States', *Southern Economic Journal*, Vol. 58, pp. 690-708

Appendix A: Definition of High Technology at the Three Digit NACE Level

Table A.1

Division	Description	
15	Manufacture of Food Products and Beverages	Low
16	Manufacture of Tobacco Products	Low
17	Manufacture of Textiles	Low
18	Manufacture of Wearing Apparel; Dressing and Dyeing of Fur	Low
19	Tanning and Dressing of Leather; Manufacture of Luggage, Handbags, Saddlery, Harness and Footwear	Low
20	Manufacture of Wood and Products of Wood and Cork, Except Furniture; Manufacture of Articles of Straw and Plaiting Materials	Low
21	Manufacture of Pulp, Paper and Products	Low
22	Publishing, Printing and Reproduction of Recorded Media	Low
23	Manufacture of Coke, Refined Petroleum Products and Nuclear Fuel	Low
24	Manufacturing of Chemicals and Chemical Products	Mixed High & Med-high
24.1	Manufacture of Basic Chemicals	Med-high
24.2	Manufacture of Pesticides and Other Agro-Chemical Products	Med-high
24.3	Manufacture of Paints, Varnishes and Similar Coatings, Printing Inks and Mastics	Med-high
24.4	Manufacture of Pharmaceuticals, Medicinal Chemicals and Botanical Products	High
24.5	Manufacture of Soaps and Detergents, Cleaning and Polishing Preparations, Perfumes and Toilet Preparations	Med-high
24.6	Manufacture of Other Chemical Products	Med-high
24.7	Manufacture of Man Made Fibers	Med-high
25	Manufacture of Rubber and Plastic Products	Low
26	Manufacture of Other Non-Metallic Mineral Products	Low
27	Manufacture of Basic Metals	Low
28	Manufacture of Fabricated Metal Products	Low
29	Manufacture of Machinery and Equipment n.e.c.	Med-high
30	Manufacture of Office Machinery and Computers	High
31	Manufacture of Electrical Machinery and Apparatus n.e.c.	Med-high
32	Manufacture of Radio, Television and Communications Equipment and Apparatus	High
33	Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks	Med-high

Table A:1 continued

Division	Description	
34	Manufacture of Motor Vehicles, Trailers and Semi-trailers	Med-hIgh
35	Manufacture of Other Transport Equipment	Mixed High and Low
35.1	Ship, boat building, repairing	Low
35.2	Manufacture of Rail, tram rolling stock *etc.*	Low
35.3	Manufacture of Aircraft and Spacecraft	High
35.4	Manufacture of Motorcycles and Bicycles	Low
35.5	Manufacture of Other transport equipment n.e.c.	Low
36	Manufacturing of Furniture; Manufacturing n.e.c.	Low
37	Recycling	Low

Source: IES from OECD, 1994a

Appendix B: NUTS Level I High Technology Employment

Table B.1: Total and high technology employment at NUTS level 1: 1994

	Total (1,000s)	High technology (1,000s)	% High technology
BELGIQUE-BELGIE			
Vlaams gewest	855	40	4.7
Region Wallone	990	50	5.0
Bruxelles-Brussel	614	29	4.7
DANMARK	2,515	150	6.0
BR DEUTSCHLAND			
Baden-Württenburg	2,362	340	14.4
Bayern	2,821	256	9.1
Berlin	936	38	4.1
Brandenburg	648	25	3.8
Bremen	182	19	10.5
Hamburg	467	24	5.2
Hessen	1,387	169	12.2
Mecklenburg-Vorpommern	466	**	**
Niedersachsen	1,111	137	12.3
Nordrhein-Westfalen	5,012	460	9.2
Rheinland-Pfalz	920	108	11.8
Saarland	224	28	12.7
Sachsen	1,129	33	2.9
Sachsen-Anhalt	711	43	6.0
Schleswig-Holstein	589	30	5.1
Thuringen	647	26	4.1
GREECE			
Voreia Ellada	1,252	14	1.1
Kentriki Ellada	791	**	**
Attiki	1,376	42	3.1
Nisia Aigaiou, Kriti	368	**	**

Table B.1: continued

	Total (1,000s)	High technology (1,000s)	% High technology
ESPANA			
Noroeste	1,367	30	2.2
Noretste	1,304	110	8.4
Madrid	1,574	108	6.9
Centro	1,497	38	2.6
Este	3,502	256	7.3
Sur	2,061	66	3.2
Canaries	440	**	**
FRANCE			
Ile-de-France	4,784	291	6.1
Bassin parisien	3,262	274	8.4
Nord-pas-de-Calais	1,176	63	5.3
Est	1,754	173	9.9
Ouest	1,514	87	5.7
Sud-Ouest	1,984	93	4.7
Centre-Est	2,492	199	8.0
Mediterranée	2,140	55	2.6
Departements d'outre mer	**	**	**
IRELAND	1,202	74	6.2
ITALIA			
Nord Ovest	2,076	245	11.8
Lombardia	3,190	359	11.3
Nord Est	2,289	164	7.2
Emilia-Romagna	1,436	142	9.9
Centro	1,937	81	4.2
Lazio	1,632	71	4.4
Campania	1,355	52	3.8
Abruzzi-Molise	479	26	5.5
Sud	1,554	30	1.9
Sicilia	1,100	23	2.1
Sardegna	419	**	**
LUXEMBOURG	163	**	**
NEDERLAND			
Noord-Nederland	629	26	4.2
Oost-Nederland	1,274	65	5.1
West-Nederland	3,210	111	3.5
Zuid-Nederland	1,438	120	8.3
PORTUGAL			
Continente	4,223	159	3.8
Acores	89	**	**
Maderia	110	**	**

Table B.1: continued

	Total (1,000s)	High technology (1,000s)	% High technology
UNITED KINGDOM			
North	1,224	87	7.1
Yorkshire & Humberside	2,133	141	6.6
East Midlands	1,763	128	7.3
East Anglia	987	75	7.6
South-East	8,087	506	6.3
South-West	2,131	116	5.5
West Midlands	2,297	243	10.6
North-West	2,653	207	7.8
Wales	1,131	74	6.5
Scotland	2,200	121	5.5
Northern Ireland	552	17	3.0

Notes: Data generated at NUTS level II and aggregated to NUT level I, German data generated using previous NACE categories and cross-border flows reassigned.

Source: Labour Force Survey 1994

Appendix C: Current Sector and Sector One Year Ago

Table C.1: Sector of employment in March to May 1994 by sector of employment on year previously

(1,000s)	Base	Primary	Low technology	High technology	General services	Inadequate description, no reply	No answer (NA)	Workplace outside UK	DNA
Base	*25,546*	*579*	*2,773*	*1,556*	*17,228*	—	*18*	*13*	*3,378*
primary	644	553	**	**	14	—		—	74
low technology	3,610	**	2,637	452	124	—		—	391
high technology	1,225	**	14	1,045	37	—		—	126
services general	19,925	19	117	56	17,038		**	**	2,682
NA, Inadequate description	19	—	—	—	**		12	—	**
Workplace outside UK	10	—	—	—	**	—	—	**	**
DNA	113		**	**	13	—	—	—	97

Per cent of base	Base	Primary	Low technology	High technology	General services	Inadequate description, no reply	No answer (NA)	Workplace outside UK	DNA
Base	*100.0*	*2.3*	*10.9*	*6.1*	*67.4*	—	*0.1*	*0.1*	*13.2*
primary	100.0	85.8	**	**	2.1	—	0.1	—	11.5
low technology	100.0	**	73.0	12.5	3.4	—	0.0	—	10.8
high technology	100.0	**	1.2	85.3	3.0	—	0.0	—	10.3
services general	100.0	0.1	0.6	0.3	85.5	0.0	**	**	13.5
NA, Inadequate description	100.0	—	—	—	**	1.7	62.9	—	**
Workplace outside UK	100.0	—	—	—	**	—	—	**	**
DNA	100.0	0.3	**	**	11.3	—	—	—	85.3

Source: IES and March to May 1994 UK LFS

Table C.2: Current sector in March to May 1994 by higher, medium high and low-technology sectors a year ago

(1000s) Previous Sector	Base	Primary	Higher technology	Medium high technology	Low technology	Services general	Inadequate description, no reply	Workplace outside UK	DNA
Base	*25,697*	*648*	*505*	*1,370*	*3,235*	*19,792*	*19*	*11*	
primary	583	557	—	**	**	19	—	—	
higher technology	457	—	433	**	**	18	—	—	
medium high technology	1,251	**	**	1,186	18	43	—	—	
low technology	2,659	**	**	12	2,524	112	—	—	
services general	**	14	17	35	289	16,941	**	**	
NA, Inadequate description	18	—	—	—	—	**	12	—	**
Workplace outside UK	14	—	—	—	—	**	—	**	**
DNA	3,403	74	46	131	397	2,654	**	**	

Previous as a % of current	Base	Primary	Higher technology	Medium high technology	Low technology	Services general	Inadequate description, No reply	Workplace outside UK	DNA
Base	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*
primary	2.3	86.0		0.1	0.1	0.1			
higher technology	1.8		85.8	0.3	0.1	0.1			
medium high technology	4.9	0.2	0.4	86.6	0.5	0.2			
low technology	10.3	2.1	1.2	0.9	78.0	0.6			10.4
services general	67.4	2.1	3.4	2.5	8.9	85.6	8.1	10.9	79.4
NA, Inadequate description	0.1						64.6		
Workplace outside UK	0.1								
DNA	13.2	11.4	9.2	9.6	12.3	13.4	27.4	28.1	85.7

Source: IES and UK LFS March to May 1994

Appendix D: NUTS Level I Employment

Table D:1 Total and industrial products employment at NUTS level 1: 1990

(1,000s)	Total	Industrial Products	% Industrial
BELGIQUE-BELGIE	3,584	747	20.8
Vlaams gewest	1,936	498	25.7
Region Wallone	989	188	19.0
Bruxelles-Brussel	659	60	9.1
DANMARK	2,528	472	18.7
BR DEUTSCHLAND	28,487	8,712	30.6
Baden-Württenburg	4,702	1,743	37.1
Bayern	5,497	1,828	33.3
Berlin	975	214	21.9
Brandenburg	:	:	:
Bremen	360	93	25.8
Hamburg	906	169	18.7
Hessen	2,644	778	29.4
Mecklenburg-Vorpommern	:	:	:
Niedersachsen	3,054	806	26.4
Nordrhein-Westfalen	7,327	2,259	30.8
Rheinland-Pfalz	1,510	454	30.1
Saarland	446	128	28.7
Sachsen	:	:	:
Sachsen-Anhalt	:	:	:
Schleswig-Holstein	1,067	240	22.5
Thuringen	:	:	:
GREECE	3,844	:	:
Voreia Ellada	:	:	:
Kentriki Ellada	:	:	:
Attiki	:	:	:
Nisia Aigaiou, Kriti	:	:	:
ESPANA	13,071	2,810	21.5
Noroeste	1,626	255	15.7

Table D:1 continued

(1,000s)	Total	Industrial Products	% Industrial
Noretste	1,478	477	32.3
Madrid	1,740	322	18.5
Centro	1,706	279	16.4
Este	3,812	1,123	29.5
Sur	2,263	323	14.3
Canaries	439	32	7.3
FRANCE	21,941	4,631	21.1
Ile-de-France	4,942	876	17.7
Bassin parisien	3,871	972	25.1
Nord-pas-de-Calais	1,275	317	24.9
Est	1,841	515	28.0
Ouest	2,782	583	21.0
Sud-Ouest	2,210	380	17.2
Centre-Est	2,619	656	25.0
Mediterranee	2,263	271	12.0
Departements d'outre mer	:	:	:
IRELAND	1,113	229	20.6
ITALIA	23,271	5,085	21.9
Nord Ovest	2,725	688	25.2
Lombardia	4,042	1,339	33.1
Nord Est	3,023	822	27.2
Emilia-Romagna	1,844	505	27.4
Centro	2,532	657	25.9
Lazio	2,149	258	12.0
Campania	1,904	232	12.2
Abruzzi-Molise	642	114	17.8
Sud	2,225	277	12.4
Sicilia	1,604	130	8.1
Sardegna	581	62	10.7
LUXEMBOURG	189	37	19.6
NEDERLAND	6,356	:	:
Noord-Nederland	619	:	:
Oost-Nederland	1,287	:	:
West-Nederland	3,032	:	:
Zuid-Nederland	1,418	:	:
PORTUGAL	3,719	826	22.2
Continente	3,719	826	22.2
Acores	:	:	:
Maderia	:	:	:

Table D:1 continued

(1,000s)	Total	Industrial Products	% Industrial
UNITED KINGDOM (1)	24,576	5,271	21.4
North	1,189	266	22.4
Yorkshire & Humberside	2,024	465	23.0
East Midlands	1,703	495	29.1
East Anglia	887	201	22.7
South-East	8,371	1,436	17.2
South-West	1,878	375	20.0
West Midlands	2,220	692	31.2
North-West	2,541	623	24.5
Wales	1,026	206	20.1
Scotland	2,120	410	19.3
Northern Ireland	570	102	17.9

Notes: (1) 1986

Source: (1994) Regions: Statistical Yearbook 1994

Appendix E: Region of Residence and Region of Employment Design Factors

Table E1: High technology employment and design factors by region of residence and region of employment

	High technology employment by region of residence (1,000s)	Design factor	High technology employment by region of employment (1,000s)	Design factor
Northern	62	0.92	63	1.08
Yorkshire & Humberside	83	0.90	83	1.11
East Midlands	80	0.86	76	1.15
East Anglia	51	0.94	48	1.06
South East	386	0.92	392	1.08
South West	78	0.92	76	1.08
West Midlands	169	0.91	162	1.11
North West	148	0.88	150	1.12
Wales	62	0.91	59	1.09
Scotland	93	0.89	91	1.13
Northern Ireland	13	1.07	12	0.93

Source: IES and UK LFS March to May 1994

Appendix F: Region of Residence by Region of Employment

Table F.1: Region of usual residence by region of place of work — March to May 1994 (1,000s)

	Base	Northern	Yorks and Humberside	East Midlands	East Anglia	South East	South West	West Midlands	North West	Wales	Scotland	Northern Ireland
Base	*28,239*	*1,213*	*2,119*	*1,763*	*1,011*	*8,041*	*2,135*	*2,289*	*2,645*	*1,131*	*2,167*	*581*
Northern	1,417	1,176	:	:	:	:	:	:	:	:	:	–
Yorks and Humberside	2,394	:	2,047	20	:	12	:	:	21	–	:	–
East Midlands	2,020	:	42	1,685	13	35	:	39	16	–	:	–
East Anglia	1,098	:	:	:	958	36	:	:	:	–	:	–
South East	8,943	:	:	13	31	7,866	32	14	:	:	:	:
South West	2,360	:	:	:	:	49	2,073	:	:	:	:	:
West Midlands	2,585	:	:	:	:	14	11	2,200	14	:	:	
North West	2,971	14	12	:	:	11	:	13	2,561	:	:	:
Wales	1,297	:	:	:	–	:	:	:	19	1,109	:	–
Scotland	2,471	:	:	:	:	:	:	:	:	:	2,148	–
Northern Ireland	683	–	–	:	–	:	–	–	:	–	:	579
% Region of employment the same as region of residence		96.9	96.6	95.5	94.8	97.8	97.1	96.1	96.8	98.0	99.1	99.7

Source: Labour Force Survey — Spring (March 1994 to May 1994)

Table F:2 Region of usual residence by region of place of work: March to May 1995 (1,000s)

	Northern	Yorks & Humberside	East Midlands	East Anglia	South East	South West	West Midlands	North West	Wales	Scotland	Northern Ireland
Base	*1,226*	*2,202*	*1,798*	*977*	*8,286*	*2,149*	*2,323*	*2,639*	*1,14*	*2,24*	*73*
Northern	1,198	:	:	:	:	:	:	:	:	:	
Yorks & Humberside	:	2,122	26	:	:	:	:	17	:	:	:
East Midlands	:	44	1,714	18	37	:	41	18	:	:	–
East Anglia	:	:	:	932	45	:	:	–	:	:	–
South East	:	:	:	22	8,104	29	13	:	:	:	–
South West	–	:	:	:	49	2,090	13	:	:	:	:
West Midlands	:	:	36	:	20	12	2,222	18	:	:	–
North West	:	17	:	:	:	:	17	2,553	15	:	–
Wales	:	–	:	:	:	:	10	22	1,115	:	–
Scotland	:	:	:	:	:	:	:	:	:	2,219	–
Northern Ireland	–	–	–	–	–	–	–	–	–	–	73
% Employed in region of residence	97.7	96.4	95.3	95.4	97.8	97.2	95.7	96.7	97.2	99.0	98.9

Source: Labour Force Survey — Spring (March 1995 to May 1995)

Appendix G: Employment Censuses

These details of employment censuses and/or the sample frames for the Labour Costs Surveys are taken from the ILO publication which gives details of the sources and methods for their labour statistics (ILO, 1995). More detailed information is available in the OECD/Eurostat database that accompanies their compendium of earnings statistics (OECD, 1994c).

Austria

The Industrial Census which is updated annually is used as sample frame for the Labour Cost Survey in Industry (*Die Arbietskosten in der Industrie Österreichs).* The Industrial Census is coded using the Austrian Standard Industrial Classification, which can be linked to ISIC, Rev. 3 and hence NACE.

Belgium

The Belgian Labour Costs Survey uses the ONSS (*Office National de la Sécurité Sociale*) register of establishments which contains a compulsory registration of all establishments and enterprises.

Denmark

The sample frame for the Danish Labour Costs Survey is their annual census of industry.

Finland

Statistics Finland perform an annual Industrial Statistics survey which is based on a complete enumeration of establishments. This generates data classified by NACE and province and commune.

France

The French *Ministère de l'Emploi et de la Formation* use a database of establishments maintained by INSEE on a daily basis called SIRENE (*Système informatique pour la Réportoire des Enterprise et des Establissment).* This database is classified using NAF, the French equivalent of NACE.

Germany

Germany conducts an establishment census at more or less regular intervals, in general every ten years. The last census was conducted in October 1991 (July 1992 for the five new Länders and Berlin (East)). The census is classified by Länder and the Industrial Classification of Economic Activities (1979) which is not directly compatible with NACE.

Greece

The National Statistical Service of Greece used a register of establishments based on the 1988 census of industry for their labour cost survey.

Ireland

Ireland has a continuously updated Register of Industrial Establishments, which includes information on all industrial firms with three or more people employed. The extent to which this data is available for analysis is not clear, and the sectoral classification allows for more than one classification within a single establishment.

Italy

The details of the Italian sample frame for their Labour Cost Surveys are not documented in the ILO Sources and Methods publication, and other sources were untraceable.

Luxembourg

The *Service central de la Statistique et des études Economiques* (STATEC) maintains a continuously updated directory of enterprises based on VAT and social security administrative records. Rather than using a sample design for their labour cost survey they use a complete enumeration which means that the problems of clustering of high technology establishments do not apply.

Netherlands

The Netherlands CSO maintains a General Business Register (GBR) which aims to incorporate all 'social entities' in the Netherlands. All legal entities are listed with identifying characteristics such as name, address, employment size, economic activity *etc.* The Register also records the relationship between legal entities and statistical units.

Portugal

The Statistics Department of the *Ministère de l'Emploi et de la Sécurité Sociale (MESS)* updates annually on the basis of administrative records a *Quadros de Pessoal* which covers all public and private enterprises with employees. The database is classified by size of establishment, sector and region.

Spain

The *Instituto Nacional de Estadistica* (INE) annually updates a directory of enterprises derived from social security records. This directory is used as a sampling frame for a number of surveys but it is not clear as to the extent to which it is available for analysis.

Sweden

Sweden has a Central Register of Enterprises and Establishments which is continuously updated from administrative records. This register covers all sectors, and enterprise of all sizes.

United Kingdom

The UK carries out an annual Census of Employment, however establishments with 25 and under employees are only fully surveyed once every four years. The results of the census are available classified by size, sector and postcode area, as well as by region.

Measurement of Employment in High Technology Sectors at the Regional Level

N Jagger, S Perryman

Commissioned by Eurostat (the European Commission's statistical body) the study represents a feasibility study into the ways in which high technology employment can be measured at the regional level across the European Union. The study examines a definition of high technology employment and then uses the UK Labour Force Survey to test the reliability of estimates based on this definition. The problems of estimates based on household sample surveys are examined, as well as the problems caused by clustering of high technology establishments with establishment based surveys. Data on high technology employment using the proposed definition at the regional level is also presented.

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