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**Industry-level estimates of ICT and non-ICT employment,  
qualifications and wages in the UK and USA, 1979-2000<sup>1</sup>**

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## **1. Introduction**

In order to identify the impact of ICT skills formation and utilisation on output, employment and productivity in the UK, the US, France and Germany over the last 20 years, we needed to develop a consistent time series of skill levels for all four countries which would enable us to distinguish clearly between ICT and non-ICT skills. Following the preparation of estimates of output, employment, hours and capital service levels over this period for 47 different industries in the four countries, our aim was to provide estimates of ICT and non-ICT skills to the same level of industrial disaggregation for each country, or to the nearest level of disaggregation permitted by the data.

To do this information was required on ICT and non-ICT employment, qualifications and wages, disaggregated by industry, in order to estimate separate labour quality indices for each country, weighting each qualification group by its average wage. This was a departure from previous analysis (e.g. in O'Mahony, 1999) which attempted to match qualifications across countries and then weight by average cross-country labour shares for each type. The latter procedure is only valid in a growth accounting framework if the qualification groups are capturing similar skill levels. Given the wide variation in qualification categories across countries, we elected instead to standardise each country's labour quality indices on the qualification group that is most comparable across countries, namely, university graduates. A companion technical note will soon be available, setting out the theoretical framework, the assumptions underlying the growth accounting methods and their relationship with alternative approaches. This note describes the data and methods to ensure consistent series over time.

The initial requirements for each country were:

1. To define ICT and non-ICT labour inputs.
2. To aggregate formal qualifications listed in the relevant surveys in each country into a small number of meaningful groups, one of which would equate to university graduates.
3. To identify the best measure of relative wages for our purposes.

4. To identify the levels of disaggregation by industry at which the grossed-up numbers of respondents in each cell of a three-way matrix [industry by labour-type (ICT/non-ICT) by qualification group] would be sufficient to generate well-founded estimates of mean wages in each cell.

The aim of the present paper is to document how these requirements have been met for the UK and USA.

## **2. Data sources**

The primary UK data source for our purposes was the Labour Force Survey (LFS) for the UK (biennial from 1979 to 1983, then annual between 1984-91, and quarterly since Spring 1992). For Great Britain (but not Northern Ireland) the sample size of 60,000 households for each quarterly survey since 1992 is roughly the same as for the annual surveys between 1984-91. Our annual estimates for the years 1992-2000 are averages across the four quarters for each calendar year. Since wage data were not collected by the LFS prior to 1992, wage estimates by qualification group for earlier years have been prepared using data from the General Household Survey and New Earnings Survey (see Section 6 below).

For the US our primary data source was the Current Population Survey (CPS) which covers about 50,000 households every month. Each household entering the CPS is interviewed monthly for four months, after which there is an eight month gap until the respondents for each household are again interviewed monthly for another four months. During this process earnings and working hours data are only collected in Months 4 and 8 from the 'outgoing rotation groups'. Our estimates of annual data are based on the time series prepared by the National Bureau of Economic Research (NBER) for 'merged outgoing rotation groups' in each year between 1979-2000.

### **3. Defining ICT and non-ICT occupations**

Our estimates of employment cover both employees and the self-employed in each country. In the LFS there was a temporary change in the data relating to economic status in 1984 when the number of categories for the relevant variable expanded from around 28 to 52, many of them relating to participation in government training schemes of different kinds. Following ONS guidance,<sup>2</sup> if individuals were classed as employed full-time and then sub-categorised into government scheme or student categories, we have classified them as employed to ensure consistency with earlier and later years. For the US our definition of employment covers those employed by the government, those privately employed and the self-employed in all years.

Predictably, there has been a great deal of variety in the occupations classified as ICT occupations by researchers in different countries, partly because of the different official Standard Occupational Classifications (SOCs) in each country and partly because of changes over time in occupational structures.

Starting with the SOCs in use in 2000, we defined 'ICT occupations' to comprise the following three categories:

1. IT/computing occupations
2. Electronic/electrical occupations
3. Telecommunications and broadcasting occupations not elsewhere specified

A decision was made to include electrical occupations with electronic occupations throughout because of the many occupational categories where the two types of occupation cannot be distinguished. This electrical/electronic category also includes many higher-level telecommunications occupations which cannot be separately identified.

Tables 1-4 show a breakdown of UK and US occupations on this basis, derived from the 1990 and 1980 SOCs for the UK and the 1980 and 1970 SOCs for the US. (Note that the 1980 SOC in the US was still in use in the year 2000).

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<sup>2</sup> Lester Browne, ONS, private communication.

There are several issues to discuss relating, firstly, to the consistency of our classification of occupations between the two countries and, secondly, to problems of discontinuity between different SOC's over time in each country.

Several apparent differences between the UK and US in the most recent classifications (shown in Tables 1-2) are of less concern than might first be thought, for example:

1. Data processing equipment repairers (US 525) are not shown separately in the UK but 'computer repairers' in the UK Standard Occupational Classification 1990 turn out to be classified to 526 Computer engineers.
2. Data entry keyers (US 385) are not shown separately for the UK but database assistants/ clerks (including data entry clerks) were included under 490 Computer etc operators in the 1990 SOC.
3. Peripheral equipment operators (US 309) are defined as follows:

D309 PERIPHERAL EQUIPMENT OPERATORS

Exclude Data Entry Keyers (D385).

Operate on-line or off-line peripheral machines, according to instructions, to transfer data from one form to another, print outputs, and read data into and out of electronic computer.

Peripheral machines include printers, card readers, and tape and disk drives. Include High Speed Printer Operators, Data Processing, Printing, Sorting, or Tabulating Operators.

In the UK SOC 90, data processors and VDU operators are included alongside data entry clerks in the category 490 Computer etc operators, so on that basis we have chosen to include peripheral equipment operators among IT occupations for the US.

4. Tool programmers, numerical control (US 233) are not shown separately in the UK. However, 'robot programmers' are included under 320 Computer programmers in the UK and this may be assumed to include full-time programmers of CNC machine tools as well.

The main outstanding difficulty is that computer systems managers (UK 126) are not shown separately for the US. In our later analysis we will run sensitivity tests for the effects of including or excluding this managerial category from the designated ICT occupations in the UK.

**Table 1: ICT occupations in the United Kingdom, based on Standard Occupational Classification 1990**

<b>IT/computing</b>		<i>Notes:</i>
126	Computer systems managers	
214	Software engineers	
320	Computer analysts, programmers	<i>Includes robot programmers</i>
490	Computer operators	<i>Includes data processors, VDU operators, data entry clerks and database assistants</i>
526	Computer engineers, installation and maintenance	<i>Includes computer repairers</i>
<b>Electronic/electrical</b>		
212	Electrical engineers	
213	Electronic engineers	
302	Electrical, electronic technicians	
520	Electrical production fitters	
521	Electricians, electrical maintenance fitters	
522	Electrical engineers (non-professional)	
529	Other electrical/electronic trades nec	
850	Assemblers etc (electronic goods)	
<b>Telecommunications and broadcasting equipment-related occupations (nes)</b>		
386	Camera, sound equipment operators	
462	Telegraph operators	
463	Radio and telegraph operators	
523	Telephone fitters	
524	Cable jointers, lines repairers	
525	Radio, TV and video engineers	

**Table 2: ICT occupations in the United States, based on the Occupational Classification from the 1980 Census**

<b>IT/computing</b>	
64	Computer systems analysts and scientists
65	Operations and systems researchers and analysts
229	Computer programmers
233	Tool programmers, numerical control
304	Supervisors, computer equipment operators
308	Computer operators
309	Peripheral equipment operators
385	Data entry keyers
525	Data processing equipment repairers
<b>Electronic/electrical</b>	
55	Engineers, electrical and electronic
213	Electrical and electronic technicians
523	Electronic repairers, communications and industrial equipment
533	Miscellaneous electrical and electronic equipment repairers
575	Electricians
576	Electrician apprentices
577	Electrical power installers and repairers
683	Electrical/electronic equipment assemblers
<b>Telecommunications and broadcasting equipment-related occupations (nes)</b>	
228	Broadcast equipment operators
348	Telephone operators
353	Communications equipment operators nec
527	Telephone line installers and repairers
529	Telephone installers and repairers

However, there were more serious issues of discontinuity to consider when changes in SOCs were implemented in each country. For the years 1979-90 in the UK the classification of ICT and non-ICT occupations is based on a cross-tabulation between the Classification of Occupations 1980 (CO80) and SOC 1990 for the 1991 LFS which showed that there were four CO80 occupations which straddled both ICT and non-ICT categories as we have defined them above:

- 27.1 Electrical engineers (87% in ICT, 13% in non-ICT)
- 27.2 Electronic engineers (90% in ICT, 10% in non-ICT)
- 30.2 Engineering technicians (32% in ICT, 68% in non-ICT)
- 37.2 Office managers nec (18% in ICT, 82% in non-ICT)

For the two categories of engineering technicians and office managers, we employed the cross tabulations for 1991 to allocate employees proportionately to ICT and non-ICT occupations in each industry. But in view of the small numbers represented by electrical and electronic engineers in non-ICT occupations in the majority of industries, all electrical and electronic engineers were allocated to the ICT occupations category (Table 3).

Another problem of potential concern was the category of 'office machinery operators' in CO80 which was the nearest equivalent to 'computer operators' in SOC 1990. In principle, 'office machinery operators' could include many people operating mechanical rather than electronics-based equipment. However, according to a cross-classification of job titles between the two SOCs supplied by ONS, only about 3% of the individuals classified to 'computer operators, data processing operators and other office machinery' in 1990 had job titles which were clearly not related to electronics-based equipment (for example, print room operators and supervisors, reprographic operators and revenue assistants). This suggests that the transition from mechanical to largely electronics-based equipment was complete in most offices by the end of the 1980s and for that reason we have classified the earlier CO80 category of 'office machinery operators' as an ICT occupation.

For the US the only major change in occupational classification relevant to this dataset concerns the transition from the 1970 to 1980 SOC which took effect in 1983. For the 1980 SOC the Bureau of the Census overhauled the system, altering the

structure, order and content of the classification in quite radical ways (Bureau of the Census, 1989) and for this reason matching between the two classifications is generally regarded as difficult. The Bureau of Labour Statistics conducted a double coding approach for 20 per cent of the sample of CPS occupational records over a 6 month period between 1982 and 1983. However, the extent of the overhaul was such that attempts to match between the two classifications have been made only at the aggregate level since 'the procedure was not considered adequate to provide estimates for the occupational categories below the major group level' (Pisetzner Klein, 1984).

In our case the ICT and non-ICT categories we have defined are sufficiently broad that we were only confronted by one significant problem which related to the assemblers category.<sup>3</sup> In the post-1982 data, the electronic/electrical category includes 'electrical assemblers'. However, under the 1970 classification these were incorporated into an undifferentiated 'assemblers' occupation. Information received from the Bureau of Labour Statistics and the Bureau of the Census indicated that the 1970 occupation classification for assemblers included the following: aircraft engine mechanics, millwrights, supervisors production occupations, precision assemblers, metal, electrical and electronic equipment assemblers, adjusters and calibrators, assemblers and production helpers. Tables supplied using 1970 census data show that 16.7 per cent of the total assemblers category (in excess of 188,000 employees) were electrical and electronic equipment assemblers.<sup>4</sup> Accordingly, this proportion of assemblers have been allocated to the electrical/electronic occupations category for the US between 1979-82 (Table 4).

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<sup>3</sup> In the light of the information cited above that the transition from mechanical to electronics-based office equipment was largely completed by the end of the 1980s in the UK, we classified office machinery operators in the US to ICT/computing occupations in the same way as was done for that occupation in the UK (Tables 3 and 4).

<sup>4</sup> Thomas Scopp , US Bureau of the Census, private communication.

**Table 3: ICT occupations in the United Kingdom,  
based on Classification of Occupations 1980 (CO80)**

	<b>IT/computing</b>
4.2	Systems analysts, computer programmers
37.2	18% of Office managers nec
48.2	Supervisors of office machine operators
50.0	Office machine operators
	<b>Electronic/electrical</b>
27.1	Electrical engineers
27.2	Electronic engineers
30.2	32% of Engineering technicians, technician engineers
120.1	Foremen of production fitters (electrical / electronic)
120.2	Foremen of electricians, electrical maintenance fitters
120.7	Foremen of other electronic maintenance engineers
121.1	Production fitters (electrical / electronic)
121.2	Electricians, electrical maintenance fitters
121.3	Electrical engineers (so described)
123.2	Other electronic maintenance engineers
129.5	Foremen of electronics wiremen
129.6	Foremen of coil winders
131.6	Electronics wiremen
131.7	Coil winders
134.1	Foremen of electrical, electronic assemblers
135.1	Assemblers (electrical, electronic)
	<b>Telecommunications and broadcasting equipment-related occupations (not elsewhere specified)</b>
22.1	Photographers, cameramen
22.2	Sound & vision equipment operators
48.3	Supervisors of telephone operators
48.4	Supervisors of radio and telegraph operators
51.2	Telephone operators
51.3	Radio and telegraph operators
120.4	Foremen of telephone fitters
120.5	Foremen of cable jointers, linesmen
120.6	Foremen of radio, TV mechanics
122.1	Telephone fitters
122.2	Cable jointers, linesmen
123.1	Radio, TV mechanics

**Table 4: ICT occupations in the United States, based on the Occupational Classification from the 1970 Census**

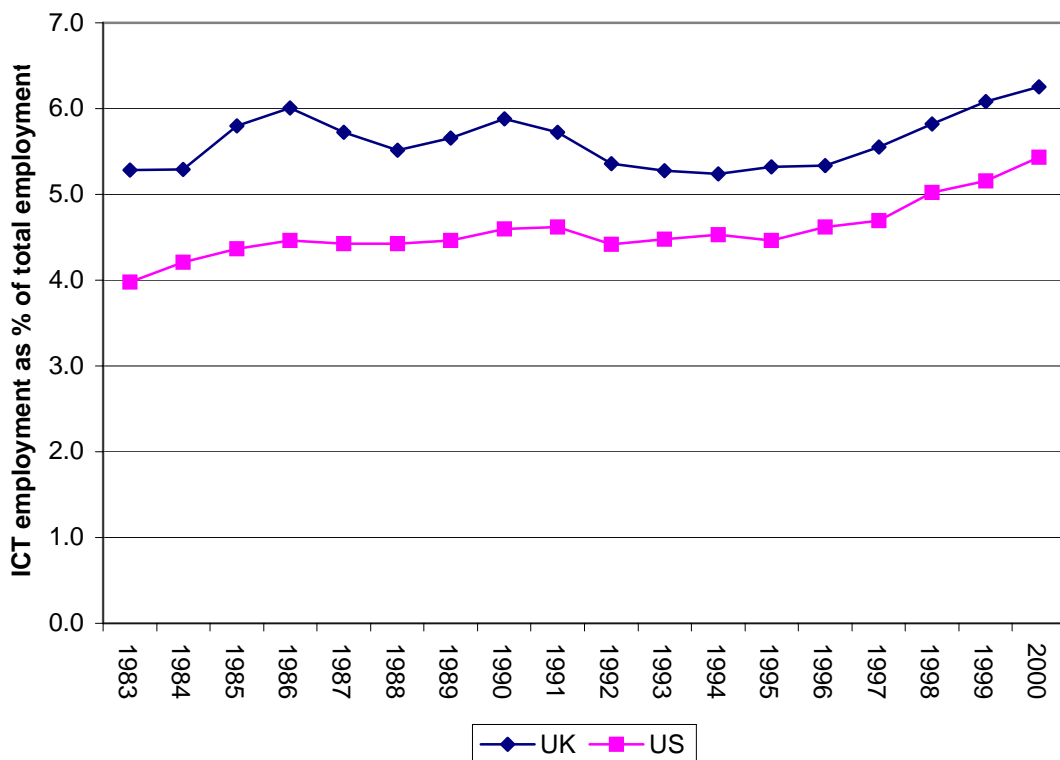
	<b>IT/computing</b>
3	Computer programmers
4	Computer systems analysts
5	Computer specialists
172	Tool programmers, numerical control
341	Bookkeeping and billing machine operators
342	Calculating machine operators
343	Computer and peripheral equipment operators
344	Duplicating machine operators
345	Key punch operators
350	Tabulating machine operators
355	Office machine operators nec.
475	Data processing machine repairmen
484	Office machine repairmen
	<b>Electronic/electrical</b>
12	Electrical and electronic engineers
153	Electrical and electronic engineering technicians
430	Electricians
431	Electrician apprentices
433	Electric power linemen and cablemen
602	16.7% of Assemblers <i>[remainder classified to non-ICT occupations; see text]</i>
	<b>Telecommunications and broadcasting equipment-related occupations (not elsewhere specified)</b>
171	Radio operators
385	Telephone operators
552	Telephone installers and repairmen
554	Telephone linemen and splicers
384	Telegraph operators
485	Radio and TV mechanics and repairmen

Figure 1 shows the trends in the ratio of ICT employment to total employment that emerge in the two countries after these decisions on how to deal with changes in occupational classifications have been made. Since the 1991 LFS classifies occupations to both CO80 and SOC90, we are able to assess the effects of the change in UK classification between 1990 and 1991: under CO80 the estimated ratio of ICT employment to total employment in 1991 is 6.0%; under SOC 90 this ratio drops to 5.7%. The effect of the change is therefore relatively small at the aggregate level and indeed is equally small in the great majority of industries. Nonetheless, in subsequent analysis we will need to address the problems caused by the change in occupational classification, most likely by smoothing the series over a number of years (eg, using a three year moving average) so that any discontinuities are spread over time.

In summary, after hovering between 5.5-6% in the UK between 1983-90, the ratio of ICT employment to total employment in the UK shows a decline to just over 5% in the early 1990s, only part of which is attributable to the discontinuity in occupational definitions. Another contributing factor may have been a relative decline in firms' demand for ICT workers at this time.

From 1992 onwards the estimated ICT employment ratio in the UK levels off at about 5.2% until 1997 when it starts to rise, reaching 6.2% in 2000. In the US the equivalent ratio also starts to rise in 1997 after a long period of relative stability stretching back to 1985.

**Figure 1: ICT employment as % of total employment, UK and US, 1983-2000**



#### 4. Industrial classifications

Over the time period under consideration the Standard Industrial Classifications (SIC) changed three times in the UK and twice in the US (although there were some minor changes in 1991 inbetween the two major reclassifications in the US in 1991). Our allocations of SIC codes to 47 different industries are shown in Tables 5-6. In general, where discontinuities occurred, we have resolved these problems by combining the industries in question, leading to a smaller, but more reliable, industry set. Table 7 shows the ratios of ICT to total employment in 39 industries in the UK and US in 2000. The pattern of ICT-intensity across industries is broadly similar in both countries, with the highest ICT employment shares in computer services, computer manufacturing, electronics manufacturing (radio, TV and communications equipment), telecommunications services and electrical machinery.

**Table 5: Industry classifications, UK, on basis of 1992 and 1980 Standard Industrial Classifications**

	Industry	SIC92 codes	SIC80 codes
1	Agriculture, forestry & fishing	01-05	010-030
2	Mining & quarrying	10-14	111, 210, 231-239
3	Food, Drink & Tobacco	15-16	411-429
4	Textiles, Leather, Footwear & Clothing	17-19	431-456
5	Wood & Products of Wood and Cork	20	461-466
6	Pulp, Paper & Paper Products; Printing & Publishing	21-22	471-475
7	Mineral Oil Refining, Coke & Nuclear Fuel	23	120-152
8	Chemicals	24	251-260
9	Rubber & Plastics	25	481-483
10	Non-Metallic Mineral Products	26	241-248
11	Basic Metals	27	221-224
12	Fabricated Metal Products	28	311-316
13	Mechanical Engineering	29	320-329
14	Office Machinery, Computers	30	330
15	Electrical Machinery And Apparatus, Nec	31	341-343, 346-348
16	Radio, Television And Communication Equipment	32	344-345
17	Instrument Engineering	33	371-374

18	Motor Vehicles	34	351-353
19	Other Transport Equipment	35	361-365
20	Furniture, Miscellaneous Manufacturing; recycling	36-37	467, 491-495
21	Electricity, Gas And Water Supply	40-41	161-170
22	Construction	45	500-504
23	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel	50	6148, 651-652, 671
24	Wholesale trade and commission trade, except of motor vehicles and motorcycles	51	611-630 except 6148
25	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	52	641-648, 653-656, 672-673
26	Hotels & Catering	55	661-667
27	Railways	601	710
28	Other Inland Transport	602+603	721-726
29	Water Transport	61	740
30	Air Transport	62	750
31	Supporting and auxiliary transport activities; activities of travel agencies	63	761-770
32	Post and courier activities	641	7901
33	Telecommunications	642	7902
34	Financial intermediation, except insurance and pension funding	65	814-815
35	Insurance and pension funding, except compulsory social security	66	820
36	Activities auxiliary to financial intermediation	67	831-832
37	Real Estate Activities	70	834, 850
38	Renting Of Machinery And Equipment	71	841-849
39	Computer And Related Activities	72	8394
40	Research And Development	73	940
41	Other Business Activities	74	835-838, 8395-8396
42	Other Community, Social And Personal Services	90-93	921-923, 963-990
43	Private Households With Employed Persons	95	
44	Extra-Territorial Organizations And Bodies	99	000
45	Public Admin And Defence; Compulsory Social Security	75	911-916
46	Education	80	931-936
47	Health And Social Work	85	951-961

**Table 6: Industry classifications, US, on basis of 1980 (revised 1991) and 1970 Standard Industrial Classifications**

		<b>1980 SIC</b>	<b>1970 SIC</b>
1.1	Agriculture, forestry & fishing (a)	10, 11,31, 32	17, 27, 28, 29
1.2	Agricultural services (b)	12, 20, 30	18, 19
2	Mining & quarrying	40, 41, 42, 50	47, 48, 49, 57, 58
3	Food, drink & tobacco	100, 101, 102, 110, 111, 112, 120, 121, 122, 130	268, 269, 278, 279, 287, 288, 289, 297, 298, 299
4	Textiles, leather, footwear & clothing	132, 140, 141, 142, 150, 151, 152, 220, 221, 222	307, 308, 309, 317, 318, 319, 327, 388, 389, 397
5	Wood products	230, 231, 232, 241	107, 108, 109
6	Pulp & paper products, printing & publishing	160, 161, 162, 171, 172	328, 329, 337, 338, 339
7	Mineral oil refining, coke & nuclear fuel	200, 201	377, 378
8	Chemicals	180, 181, 182, 190, 191, 192	347, 348, 349, 357, 358, 359, 367, 368, 369
9	Rubber & plastics	210, 211, 212	379, 387
10	Non-metallic mineral products	250, 251, 252, 261, 262	119, 127, 128, 137, 138
11	Basic metals	270, 271, 272, 280	139, 147, 148, 149
12	Fabricated metal products	281, 282, 290, 291, 292, 300, 301	157, 158, 159, 167, 168, 169, 258
13	Mechanical engineering	310, 311, 312, 320, 331, 332	177, 178, 179, 187, 197, 198
14	Computers, office machinery	321, 322	188, 189
15	Electrical machinery	340, 342, 350	199, 208, 209
16	Radio, TV & communications equipment	341	207
17	Instrument engineering	371, 372, 380, 381	239, 247, 248, 249, 257
18	Motor vehicles	351	219
19	Other transport equipment	352, 360, 361, 362, 370	227, 228, 229, 237, 238
20	Miscellaneous manufacturing	242, 390, 391, 392	259, 398, 118, 267, 399
21	Electricity, gas & water supply	450, 451, 452, 460, 461, 462, 470, 471, 472	467, 468, 469, 477, 478, 479, 499
22	Construction	60	67, 68, 69, 77, 78
23.1	Motor vehicle dealers etc	612, 620, 621, 622	639, 647, 648, 649
23.2	Vehicle rental, repair etc (c)	742, 750, 751	749, 757
24	Wholesale trade	500, 501, 502, 510, 511, 512, 521, 522, 530, 531, 540, 541, 542, 550, 551, 552, 560, 561, 571	507, 508, 509, 527, 528, 529, 537, 538, 539, 557, 558, 559, 567, 568, 569, 587, 588, 599
25	Retailing	580, 581, 582, 590, 591, 592, 600, 601, 602, 610, 611, 623, 630, 631, 632, 633, 640, 642, 650, 651, 652, 660, 661, 662, 663, 670, 671, 672, 681, 682, 691, 752, 760	607, 608, 609, 617, 618, 619, 627, 628, 629, 637, 638, 657, 658, 667, 668, 677, 678, 679, 687, 688, 689, 697, 698, 699, 758, 759
26.1	Hotels, motels & lodging places	762, 770	777, 778
26.2	Eating & drinking places	641	669
27	Railways	400	407
28	Other inland transport	401, 402, 410, 411, 422	408, 409, 417, 418, 428
29	Water transport	420	419

30	Air transport	421	427
31	Supporting transport activities, travel agencies	432	429
32	Post & courier services	412	907
33	Telecommunications	441,442	448, 449
34.1	Banking, security, credit agencies nec	700, 701, 702, 710	707, 708, 709
35	Insurance & pension funding	711	717, 719
37	Real estate	712	718
39	Computer services (d)	732,	739
40	Research & development (e)	891	Combined with Other business services (Industry 41)
41	Other business services (f)	721, 722, 730, 731, 740, 741, 841, 882, 892	727, 728, 729, 737, 738, 747, 748, 767, 849, 888, 889, 897, 899
42	Other community, social & personal services	440, 771, 772, 780, 781, 782, 790, 791, 800, 801, 802, 810, 852, 861, 872, 873, 880, 881	447, 779, 787, 788, 789, 797, 798, 799, 807, 808, 809, 817, 819, 859, 869, 877, 887
43	Private households with employed persons	761	769
45	Public admin & defence; compulsory social security	900, 901, 910, 921, 922, 930, 931, 932	917, 927, 937, 947
46	Education	842, 850, 851, 860	857, 858, 867, 868
47	Health & social work	812, 820, 821, 822, 830, 831, 832, 840, 862, 863, 870, 871	828, 829, 837, 838, 839, 847, 848, 878, 879

- (a) Excludes 30 from 1992-2000
- (b) Includes 30 from 1992-2000
- (c) Includes 742 from 1992-2000
- (d) 740 is replaced by 732 from 1992-2000
- (e) Excludes 730 from 1992-2000
- (f) Excludes 732 and 742 from 1992-2000. Includes 730 and 740 from 1992-2000.

**Table 7: ICT labour as a percent of total employment, UK and US, 2000, analysed by industry**

	<b>UK</b>	<b>US</b>
Agriculture, forestry & fishing	0.5	0.2
Mining & quarrying	8.4	3.8
Food, drink & tobacco	2.9	2.1
Textiles, leather, footwear & clothing	1.7	2.6
Pulp & paper products, printing & publishing	6.4	4.8
Mineral oil refining, coke & nuclear fuel	6.9	7.6
Chemicals	4.9	5.2
Rubber & plastics	2.7	3.6
Basic metals & fabricated metals	4.4	4.0
Mechanical engineering	8.7	4.9
Computers, office machinery	43.7	35.8
Electrical machinery	35.2	32.6
Radio, TV & communications equipment	45.4	39.1
Instrument engineering	15.5	10.3
Motor vehicles	3.8	6.5
Other transport equipment	9.5	13.5
Miscellaneous manufacturing*	2.4	2.9
Electricity, gas & water supply	21.1	17.0
Construction	10.6	7.7
Vehicle maintenance & repair	0.8	1.0
Wholesale trade	3.0	3.7
Retailing	2.3	2.0
Hotels & catering	0.4	0.3
Railways	6.9	7.5
Other inland transport & water transport	2.5	2.0
Air transport	3.3	4.6
Supporting transport activities, travel agencies	3.8	4.7
Post & courier services	2.9	2.5
Telecommunications	40.9	40.0
Financial intermediation (excl, insurance & pension funding)	10.0	6.9
Insurance & pension funding	10.7	7.4
Real estate	1.2	1.9
Computer services	63.7	52.6
Research & development	8.0	10.9
Other business services	5.3	5.0
Other community, social & personal services	2.7	2.6
Public admin & defence; compulsory social security	4.5	6.1
Education	1.8	2.0
Health & social work	1.0	1.4
<b>TOTAL</b>	<b>6.3</b>	<b>5.6</b>

\* Comprises wood and wood products, non-metallic mineral products, furniture and other miscellaneous manufacturing .

Source: Labour Force Survey (2000), Current Population Survey (2000)

## 5. Qualification levels

For the UK, using the LFS ranking of the highest formal qualifications held by respondents (which comprises a mix of general and vocational qualifications), all qualifications were classified into groups based on NVQ levels but separating out the university degree level which we intended, as described in Section 1, to use as a cross-country *numéraire*:

- First degrees and above
- Other NVQ4 (below First degree level)
- NVQ3
- NVQ2
- NVQ1
- No formal qualifications

One issue at the outset was whether to use the ONS mapping or the DfES mapping of qualifications to NVQ levels at NVQ4 and below. The main differences between them concerned the allocation of trade apprenticeships, A and AS levels, Scottish Highers, GCSEs and ‘Other qualifications’. For example, ONS classify all trade apprenticeships to NVQ3 whereas DfES split them 50% to NVQ3 and 50% to NVQ2. Similarly, ONS classify all ‘Other qualifications’ to NVQ1 whereas DfES split them in different proportions between NVQ levels 1, 2 and 3 (Lau, 2002, Annex C; Middlemas and Sly, 1998).

Since it was clear from inspection of LFS data that the small numbers of survey respondents in some industries would make it necessary to consider some further aggregation of qualifications in any event, we decided to proceed using the more straightforward ONS classification. However, we initially retained ‘Other qualifications’ as a separate category because the mean earnings of people in this category are relatively high compared to those in the lower NVQ categories (see Table 9 below) and we therefore needed to develop criteria for allocating these employees across several different qualification groups in an appropriate manner.

**Table 8: Classification of formal qualifications to NVQ framework, UK, 1996-2000**

First degrees and above	Higher degree
	NVQ level 5
	First degree
	Other degree
Other NVQ4 (below First degree level)	NVQ level 4
	Diploma in higher education
	HNC/HND, BTEC higher
	Teaching - further education
	Teaching - secondary education
	Teaching - primary education
	Teaching - level not stated
	Nursing etc
	RSA Higher diploma
	Other higher education below degree level
NVQ3	NVQ level 3
	GNVQ advanced
	A level or equivalent
	RSA advanced diploma or certificate
	OND/ONC, BTEC/SCOTVEC national
	City & Guilds advanced craft
	Scottish 6th year certificate (CSYS)
	SCE higher or equivalent
	AS level or equivalent
	Trade apprenticeship
NVQ2	NVQ level 2 or equivalent
	GNVQ intermediate
	RSA diploma
	City & Guilds craft
	BTEC/SCOTVEC first or general diploma
	O level, GCSE grade A-C or equivalent
NVQ1	NVQ level 1 or equivalent
	GNVQ/GSVQ foundation level
	CSE below grade 1, GCSE below grade C
	BTEC first or general certificate
	SCOTVEC modules or equivalent
	RSA other
	City & Guilds other
	YT/YTP certificate

Source: Derived from ONS classification of qualifications (Lau, 2002, Annex C).

Notes:

- (a) 'Other qualifications' were allocated between the five qualification categories on the basis of mean wage data for the industry in question (see text)
- (b) 'Don't knows' were allocated between the five qualification categories on a pro rata basis.

Table 8 shows the distribution of qualifications across NVQ levels in the last four years of our time series. Over time the list of separate qualifications identified by the LFS has grown considerably, partly due to the development of new certificates and diplomas and partly as a result of a desire for more disaggregated information by LFS users. This presented problems in that, for example, BTEC National and BTEC General qualifications could be classified to NVQ Levels 3 and 2, respectively, from 1992 onwards but prior to that date they were lumped together. The same applies to other qualifications such as City & Guilds (C&G) craft qualifications which are divided between C&G advanced craft and C&G craft from Spring 1993 onwards but prior to then were all described as ‘C&G craft’. Our decision was to use the more recent LFS information to allocate the more broadly-defined qualification headings in the earlier years to the NVQ levels which accounted for the largest shares of employees with that type of qualification in the later years. Thus, for example, BTEC National and General qualifications prior to 1992 were all allocated to NVQ level 3; C&G craft qualifications (including the advanced craft category) prior to 1993 were all allocated to NVQ level 2.

Table 9 shows that, even before the main changes in classification of qualifications in the early 1990s, the estimated proportions of ICT and non-ICT workers holding First or higher degrees were rising and this trend continues throughout the 1990s after the changes in classification. In both the ICT and non-ICT groups this development is mirrored by a decline in the proportions of employees lacking formal qualifications (as more people move up the ladder of qualifications).

**Table 9: Employment in ICT and non-ICT occupations, UK, 1985, 1990, 1995 and 2000, analysed by qualifications group**

	ICT occupations				Non-ICT occupations			
	1985	1990	1995	2000	1985	1990	1995	2000
	<i>% of total employment</i>							
Higher degree	1	2	3	6	2	2	3	5
First degree	9	11	16	20	8	9	11	13
Other NVQ4	8	7	12	12	7	7	9	10
NVQ3	35	43	36	34	18	27	24	25
NVQ2	19	16	17	17	19	19	21	22
NVQ1	6	4	5	3	6	4	7	6
Other qualifications	4	5	4	4	5	7	8	8
No qualifications	19	13	7	4	34	26	17	12
TOTAL	100	100	100	100	100	100	100	100

Source: Labour Force Survey

For the US the qualifications captured by the CPS since 1992 lent themselves to the following groupings:

1. Bachelor degrees and above
2. Associate degrees
3. Some college, no degree
4. High school graduates
5. Did not complete high school

However, prior to 1992 CPS data on education were based on attendance categories (number of years of high school, college etc.) rather than the attainment categories used in subsequent years. Several US researchers have explored how the change of question introduced in 1992 affects the construction of time series of education levels and estimates of the returns to education in the 1990s. For our purposes – needing to identify the education level(s) which corresponded to the ‘Bachelor degrees and above’ category -- the relevant information is provided by Kominsky and Siegel (1993) who report results from the February 1990 CPS which tested the new education questions on respondents who were also asked the old questions. Their cross-tabulation suggests that those who had attended college for four years or more *and* completed a Bachelor or higher degree constituted 98% of all those who had attended college for four years or more and 97% of those who had completed a Bachelor or higher degree.

Accordingly, for the years 1979-91 US qualifications were classified to the following groups:

1. Four years or more of college attendance
2. Three years of college
3. Two years of college
4. One year of college
5. High school graduates
6. Did not complete high school

These six categories were mapped into the previous five using the correspondence matrix reported in Kominsky and Siegel (1993).

Examination of the data for the adjacent years when the change in education question was introduced, 1991 and 1992, shows evidence of a small discontinuity which we will need to take account of in our subsequent analysis: in the case of ICT labour

31.7% had completed four years or more of college compared with 28.8% who had completed Bachelor or higher degrees; for non-ICT labour the respective proportions were 23.7% and 22.1%. Again these differences are small and can be dealt with by smoothing the series.

Over the whole period either side of the change in classification of educational attainments or attendance, Table 10 suggests that -- in both ICT and non-ICT occupations -- there was a growth in the proportions attending college long enough to gain Bachelor or higher degrees while there was a decline in the proportions not at least graduating from high school.

**Table 10: Employment in ICT and non-ICT occupations, United States, analysed by qualifications group**

**A: 1995 and 2000**

	ICT occupations		Non-ICT occupations	
	1995	2000	1995	2000
	<i>% of total employment</i>			
Higher degree	8	9	8	9
Bachelor degree	23	28	16	17
Associate degree	12	12	8	8
Some college, no degree	23	23	21	20
High school graduate	28	24	33	32
Did not complete high school	4	4	15	14
TOTAL	100	100	100	100

**B: 1985 and 1990**

	ICT occupations		Non-ICT occupations	
	1985	1990	1985	1990
	<i>% of total employment</i>			
College – 5-plus years	9	11	9	10
College – 4 years	17	19	12	13
College – 3 years	5	5	4	4
College – 2 years	15	16	10	11
College – 1 year	9	9	8	8
High school graduates	38	34	39	38
Did not complete high school	7	5	18	16
TOTAL	100	100	100	100

Source: Current Population Survey (Merged Outgoing Rotation Groups)

## **6. Relative wages by qualification category**

Wage data in the UK Labour Force Survey are based on information provided by roughly a fifth of the total sample in each quarter between 1992-96 and from two fifths of the sample since 1997. This means that, in several of our designated industries, the numbers of wage observations in individual qualification group cells were too small (<25 observations) to permit well-founded estimates of average earnings and therefore some industries had to be combined together. The same was true of cell sizes for many industries in the US Current Population Survey for which, as noted above, each household entering the sample is interviewed monthly for four months, after which there is an eight month gap until the respondents for each household are again interviewed monthly for another four months. During this process earnings and working hours data are only collected in Months 4 and 8 from the ‘outgoing rotation groups’.

Our primary estimates of relative wages by qualification category in each country are based on mean weekly earnings data in order to be able to derive each qualification group’s share of the total wage bill. For both countries the self employed are excluded from wage estimates. This is partly because LFS wage data in the UK simply do not cover the self employed. But it also fits with Roth (2002) who suggests that earnings data for the self-employed in the CPS are not reliable. This may in part be a function of poor reporting by the self employed, given the conceptual problems they may have defining their ‘wage’, but is also a function of top-coding. The CPS caps earnings data at \$100,000 per year. Our estimates are therefore based on mean weekly earnings across private and government employees in both countries.

In defining the qualification groups to be used in the development of a wage-weighted labour quality index for each country, we were guided by cell sizes relating to each qualification group and by information on the ‘natural splits’ between qualification groups in respect of gross weekly earnings at an economy-wide level.

In the case of ICT labour, cell sizes for numbers of workers dictated that qualifications should be aggregated to only two categories.

1. First / Bachelor degrees and higher degrees
2. Other qualifications or no qualifications

The ‘graduate and above’ category represented 26% of all employees in ICT occupations in the UK in 2000 (Table 9) compared with 37% of all employees in ICT occupations in the US in the same year (Table 10). In a twofold categorisation there is a case for allocating ‘Other NVQ4 qualifications’ in the UK and Associates degrees in the US to the same category as First / Bachelor degrees and higher degrees. However, estimates of earnings differentials for the UK and the US between 1987 and 2000 (Tables 11-12) suggest that holders of ‘Other NVQ4 qualifications’ in the UK and Associates degrees in the US have more in common with less well-qualified people in terms of average earnings than they do with university graduates. Drawing the dividing line for ICT qualification/wage categories between graduates and others also fitted with our wish to retain university graduates as a separate category in order to use average earnings at that level as a cross-country *numéraire*.<sup>5</sup>

**Table 11: Mean gross weekly earnings in ICT and non-ICT occupations, UK, 1987, 1990, 1995 and 2000, analysed by qualifications group**

	ICT occupations				Non-ICT occupations			
	1987	1990	1995	2000	1987	1990	1995	2000
	<i>Mean gross weekly earnings (Index numbers: First degree =100)</i>							
Higher degree	*	*	115	108	111	122	120	115
First degree	100	100	100	100	100	100	100	100
Other NVQ4	92	88	87	84	70	73	75	75
NVQ3	83	71	77	69	64	67	64	63
NVQ2	59	54	64	58	46	49	49	48
NVQ1	44	(38)	46	48	35	40	44	44
Other qualifications	*	*	85	72	62	53	60	57
No qualifications	57	50	45	43	41	42	38	38
TOTAL	75	69	77	76	54	57	61	63

Sources: Labour Force Survey (1995, 2000); General Household Survey (1987, 1990)

\* Less than 20 observations on which to base an estimate

( ) Estimate based on at least 20, but less than 25 observations

<sup>5</sup> In allocating the ICT labour category ‘other qualifications’ for the UK we were guided by the mean wage data. On average wages of ‘Other NVQ4’ were roughly 85% of the graduate wage. Therefore ‘other qualifications’ were allocated to the higher ICT group if the mean wage was greater than 0.85 x the graduate wage; otherwise these were allocated to the ‘other ICT’ group.

**Table 12: Mean gross weekly earnings in ICT and non-ICT occupations, US, analysed by qualifications group**

**A: 1995 and 2000**

	ICT occupations		Non-ICT occupations	
	1995	2000	1995	2000
	<i>Mean gross weekly earnings (Index numbers: Bachelor degree =100)</i>			
Higher degree	121	122	132	128
Bachelor degree	100	100	100	100
Associate degree	80	76	74	70
Some college, no degree	67	65	63	61
High school graduate	64	61	60	58
Did not complete high school	45	40	39	37
TOTAL	79	79	71	70

**B: 1987 and 1990**

	ICT occupations		Non-ICT occupations	
	1987	1990	1987	1990
	<i>Mean gross weekly earnings (Index numbers: Bachelor degree =100)</i>			
College – 5-plus years	120	120	121	125
College – 4 years	100	100	100	100
College – 3 years	80	79	74	73
College – 2 years	80	80	78	76
College – 1 year	71	70	67	65
High school graduates	70	65	65	62
Did not complete high school	57	54	50	47
TOTAL	82	82	75	74

Source: Current Population Survey (Merged Outgoing Rotation Groups)

In many cases the number of respondents to the wage question were too small to be reliable. For these industries mean wages across the two ICT categories were aggregated to a higher industry division, e.g. mineral oil refining, chemicals and rubber & plastics were aggregated to one wage group. In subsequent analysis this ‘group’ wage has been applied to all sub-group industries. Hence the number of industries has not been constrained by the wage data cell size.

In the case of non-ICT occupations, cell sizes are naturally larger for the majority of industry by qualification group cells in each country and we have therefore been able to proceed with five-six qualification categories for both the UK and the US.

The absence of wage data from the LFS prior to 1992 presented a well-known problem since there was no other survey before then which collected both qualifications and wage data on a sufficiently large scale to permit a detailed disaggregation by industry. Hence, estimates of wage differentials by qualification group, analysed by industry, have been carried out for the UK using General Household Survey data for 1987-92 and New Earnings Survey for the period before 1987.

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