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**Working Party on the Information Economy**

**NEW PERSPECTIVES ON ICT SKILLS AND EMPLOYMENT**

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## **FOREWORD**

In December 2004 this report was presented to the Working Party on the Information Economy (WPIE), as part of its work on global value chains and ICT skills and employment and as a contribution to the Organisation's work on growth and services issues. It was recommended to be made public by the Committee for Information, Computer and Communications Policy in March 2005.

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## NEW PERSPECTIVES ON ICT SKILLS AND EMPLOYMENT

### Introduction

This paper provides an overview of ICT skills and employment across OECD economies and analyses some of the impacts on economic performance. ICTs are increasingly important in the economy and have a growing impact on the organisation of economic activity. However, capturing the importance and impacts of ICTs is always not straightforward. Measurement problems are complicated further by an often unclear terminology, combined with the existence of a multiplicity of definitions (new economy, e-economy, ICT sector, ...), but analytical results vary according to the precise definition adopted. For example, the term “ICT employment” can be taken to mean all employment in the ICT sector (*i.e.* including people whose jobs are unrelated to ICTs), or all employment that is ICT-related (across all sectors, also non-ICT related sectors). Analysis of employment characteristics (such as age, wage, and gender) will then depend on which definition is adopted.

This paper explains and updates a new approach to capturing the diffusion of ICTs in the economy. In particular, two measures of ICT-skilled employment are developed. Using occupational data, a narrow measure captures ICT specialists (*e.g.* programmers, software developers but also cable layers), and a broad measure includes those people who use ICTs intensively in order to do their work (both basic and advanced intensive users), as well as the specialists. These measures are calculated for the economy as a whole, and also by sector.

The paper is organised as follows. The first section briefly reviews previous efforts made to capture the presence of ICTs in the economy. These previous efforts focused on defining the ICT producing sector, or considered the use of ICTs throughout the economy through ICT investment measures. The second section describes a new measurement approach developed for the *2004 OECD Information Technology Outlook*, which attempts to capture the diffusion of ICTs throughout the economy based on the degree of their actual use. The industry rankings based on the share of ICT-skilled employment in total employment are compared to the results of other studies that classify industrial sectors on the basis of ICT usage. The subsequent section presents some preliminary results from the analysis relating the ICT skills measures to productivity measures. The final section draws conclusions.

### The ICT sector

There are different definitions of the ‘the ICT sector’ which tend to be guided by the needs of the users of the various definitions. The OECD has a standard definition of the ICT-producing sector, but other definitions exist (an example is shown in Appendix Table 14). Various studies have also attempted to identify ICT-using sectors. These are generally based on measures of investment in ICTs. The present paper takes another approach, using occupational employment data to look at the actual use of ICTs in sectors.

#### *The ICT-producing sector*

The OECD definition approved at the OECD Working Party on Indicators for the Information Society (WPIIS) meeting in 1998 was based on the consensus that the ICT producing sector, at least initially,

should be defined as an industrial sector obtained by regrouping business units (establishments, enterprises or enterprise groups) that share common ICT activities. It was felt that the ISIC Rev. 3 industrial activity classification was most suited to this exercise aimed at collecting indicators that were comparable internationally, in spite of not actually allowing all activities that could be considered as ICT to be identified. This activity-based definition was a compromise and limited itself to industries that facilitate, by electronic means, the processing, transmission and display of information, thus excluding those industries that create and provide the information ('content' industries). Moreover, it was recognised that a different procedure, whereby ICT goods and services would have been defined at individual product level in the first instance, and subsequently defining ISIC classes containing activities involved in these goods and services (manufacturing, wholesaling etc.), would have been preferable. However, one important feature of this standard OECD definition of the ICT producing sector is that it ascribes both manufacturing and services industries to the ICT sector. The Appendix recalls the principles underlying the choice of activities to be included as ICT (Appendix Box 1), as well as the definition itself (Appendix Box 2).

### ***ICT-using sectors***

Other work undertaken at the OECD, mainly within the analysis of sectoral contributions to productivity, made a distinction between ICT producing and ICT using sectors. Thus, in Pilat and Lee (2001), the aim was to examine the contributions made by the ICT producing sector and certain key ICT using industries to overall productivity growth in OECD countries.

The standard OECD definition of the ICT producing sector was used to describe the behaviour of the ICT producing industries. However, in order to identify key ICT using industries, Pilat and Lee (2001) examined empirical evidence on ICT use by industry based on capital flow matrices and capital stock estimates. They found that, even though industrial classifications are not entirely compatible, some patterns emerge. In particular, certain manufacturing industries (printing and publishing, electronic equipment, machinery and equipment), as well as communications, wholesale and retail trade, finance, insurance and business services turned out to be the largest relative investors in ICT equipment (Appendix Box 3). Thus, they found that the use of ICT was mainly concentrated in the services sector and in some manufacturing industries.

### **The ICT-skilled employment approach**

ICT using sectors are identified by their employment of ICT-skilled personnel, in other words through the degree of actual ICT usage, rather than through the investment in ICT capital as in the previous approach. Industries are then ranked according to the degree of the ICT-skills specialisation of their workforce, or the share of the industry's 'ICT-skilled employment'. This approach effectively corresponds to a different way of looking at the ICT specialisation of industries.

The term 'ICT employment' can be interpreted in two ways: (i) employment in industries traditionally identified as belonging to the ICT sector, thus including all types of occupations, also those which bear no relation to the use of ICTs, and (ii) employment in occupations that use ICTs to variable degrees, but across all industries. The focus here in this paper is on the latter.

### *The definition of ICT skills*

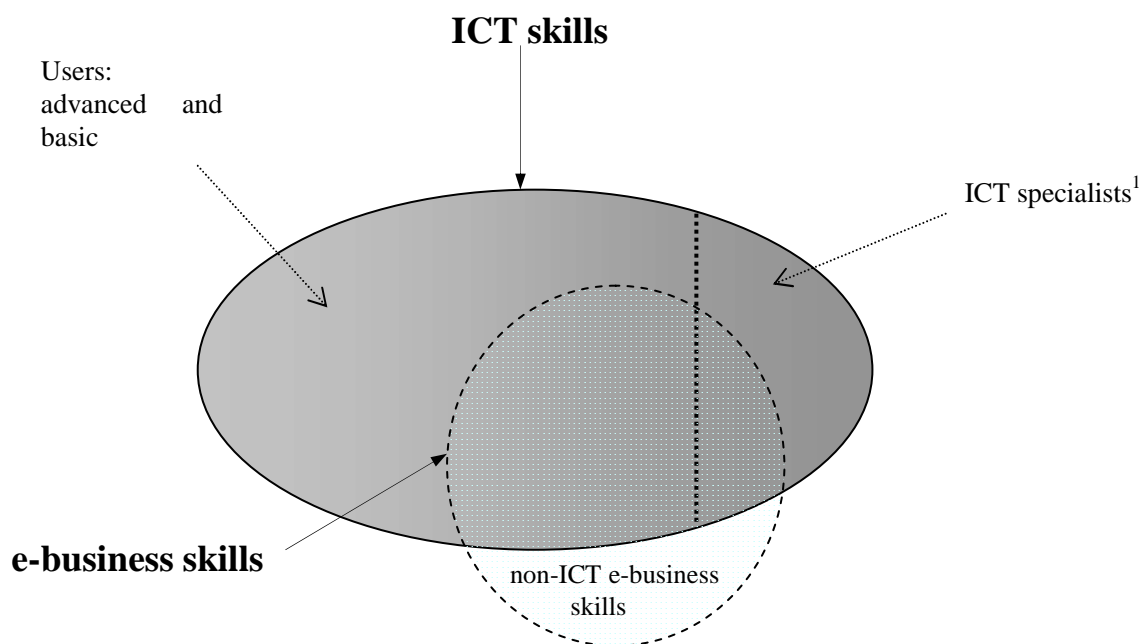
First, ICT skills need to be defined. There is currently no commonly adopted definition of ICT skills, but efforts are ongoing to characterise the various types of ICT skills, for example through the European e-Skills Forum (2004). It is important to bear in mind that while the term “skills” refers to a set of capabilities, it may have different meanings for an employer or a jobseeker. Three categories of ICT competencies are distinguished:

1. *ICT specialists*, who have the ability to develop, operate and maintain ICT systems. ICTs constitute the main part of their job – they develop and put in place the ICT tools for others.
2. *Advanced users*: competent users of advanced, and often sector-specific, software tools. ICTs are not the main job but a tool.
3. *Basic users*: competent users of generic tools (e.g. Word, Excel, Outlook, PowerPoint) needed for the information society, e-government and working life. Here too, ICTs are a tool, not the main job.

This paper uses the first category for the narrow measure of ICT-skilled employment, and the sum of all three categories for the broad measure of ICT-skilled employment.

Finally, the term “*e-business skills*” is increasingly used. It refers to skills that are needed to exploit the business opportunities provided by ICTs, and in particular the Internet, to explore possibilities for new ways of conducting business, to enhance the efficiency of various types of organisations, and perhaps even to establish businesses (European e-Skills Forum, 2004). These skills play an increasingly important role in a company’s competitiveness and include both ICT specialist and ICT user skills, as well as non-ICT e-business skills (e.g. managerial and organisational skills).

**Box 1. Illustration of the definition of ICT skills**



1. Includes programmers, but also equipment and cable fitters, for example.

Based on the findings of Lemaître (2002) occupational data are used to proxy for skills. Lemaître (2002) examined two measures of skills that can be obtained from using Labour Force Survey data: educational attainment and job requirements, as built into the ISCO<sup>1</sup> classification of occupations. He found that the educational measure that has traditionally been used as a skills proxy is a very partial measure, and that the skills measure embedded in data on occupations (i) identifies another dimension of skills which is correlated with the educational measure, and (ii) that it holds up independently too.

The standard OECD list of 'ICT occupations' used so far in publications such as the *Information Technology Outlook* editions prior to 2004, the *STI Scoreboard* and *Measuring the Information Economy*, can be interpreted as roughly referring to the first category of skills<sup>2</sup> (ICT specialists). The approach taken in the broad measure is a first attempt to identify the sum of the three levels of ICT skills, *i.e.* undertaking analysis based on both ICT specialists as well as ICT users, both advanced and generic. However, in the absence of any formal guidance as to the 'ICT content' of ISCO occupations (for European data, and other occupational classifications according to the country in question), the choice of occupations to be included was based on an assessment of the degree to which workers are expected to use ICTs for their own output/production.

The selection of occupations included in the analysis under the narrow and broad measure of ICT-skilled employment for Europe, the United States, Canada and Australia are given in Appendix Tables 1 to 4. The appendix also shows examples of selections of ICT-related occupations and/or ICT-using occupations in other studies (Appendix Tables 5 to 10). Most studies focus on ICT-related occupations and are therefore, often, relatively similar to the selections for the narrow measure of ICT-skilled employment. Only the selection in Arnal *et al* (2001) bears some resemblance to the broad measure of ICT-skilled employment, mainly in the first three categories: knowledge workers, managerial workers, and data workers (Appendix Table 5).

### ***ICT-skilled employment at the aggregate level***

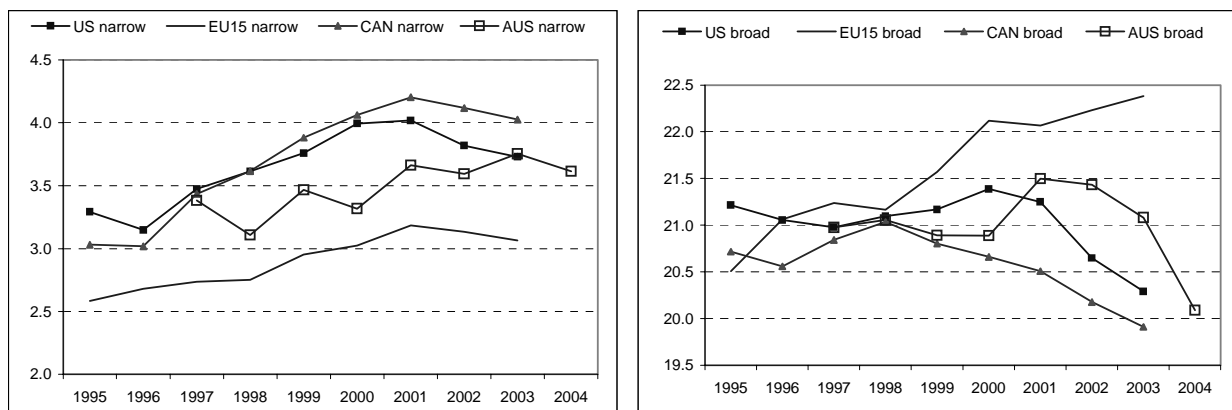
The analysis in this paper was carried out for the EU15 countries, the United States, Canada and Australia. The first set of results from this analysis was published in the *2004 OECD Information Technology Outlook* (OECD, 2004). This paper updates that analysis and extends it to also cover Canada which was not included in the initial analysis.

It was not attempted to harmonise classifications across countries, but the same logic and rationale were applied to the individual country data, and efforts were made to keep the choice of occupations as much as possible comparable, in spite of national differences and different levels of detail in the various classification systems, for example. Results indicate that, overall, less than 5% of total employment can be classified under the narrow measure of ICT-skilled employment, and around 20% of total employment under the broad measure. Even though the levels cannot be compared directly as the classifications and the selections of occupations were not harmonised, there are some interesting differences in the trends. Comparing the results for the average of the EU15, the United States, Canada and Australia, the trend of the narrow measure follows a similar path (although the Australian share fluctuates). The broad measure, however, shows a clear divergence in trends, with the share of ICT-skilled employment on the increase for the EU15, but decreasing for the United States, Canada and Australia, especially towards the end of the period (Figure 1).

These trends would be consistent with the recent increase in the offshoring of IT-related and backoffice activities, for example, from the United States and more recently also from Canada and Australia as these countries may have lost out to emerging locations such as India. Another explanation could be a relatively faster rate of adoption and integration of new technologies. As a consequence, relatively more jobs could have been lost through automation and/or digitisation. The increasing trend in

Europe would be consistent with rising employment in the services sector, as well as findings from surveys that European firms tend to offshore within Europe. Moreover, Ireland is also a large recipient of offshoring from the United States (in particular of IT-related activities). Further research on the potential offshoring of ICT-intensive using occupations looks at these issues in more detail (van Welsum and Vickery, 2005).

**Figure 1. The share of ICT-skilled employment in total employment for ICT specialists and ICT intensive users; U.S., EU15, Canada and Australia, 1995-2002/3/4<sup>1</sup>**  
percentages



Notes: 1. Data for the Netherlands and Luxembourg refer to 2002. Includes estimates where a full data set was not available. Due to classification changes, the numbers for the United States for 2003 are estimates. Data for Australia are from May 2004.

Source: Authors' calculations based on EULFS, US Current Population Survey, Statistics Canada, and Australian Bureau of Statistics (2004).

Some differences can also be observed within the EU15 aggregate. For nearly all 15 countries, the share of both narrow and broad ICT-skilled employment was higher at the end of the period (2003, except for the Netherlands and Luxembourg: 2002) than at the beginning (except for Belgium, Spain, and Portugal for the narrow measure, and France for the broad measure). The average increase for the narrow series was of 0.5 percentage points, whereas for the broad series, most countries experienced an increase comprised between 1.5 to 8 percentage points. By 2003, Sweden had the highest share of narrow ICT-skilled employment (4.7%) and Belgium the lowest (2.1%). The United Kingdom had the highest share of broad ICT-skilled employment (27.7%), as over the whole of the period, and Greece the lowest (13.6%). Between 2002 and 2003, eight countries experienced a decrease in the narrow share, four in the broad share.

### *ICT-skilled employment at the sectoral level*

The initial analysis (OECD, 2004) covered Europe, the United States, Australia, Japan and Korea. The analysis here is updated for Europe and Australia and extended to also cover Canada.

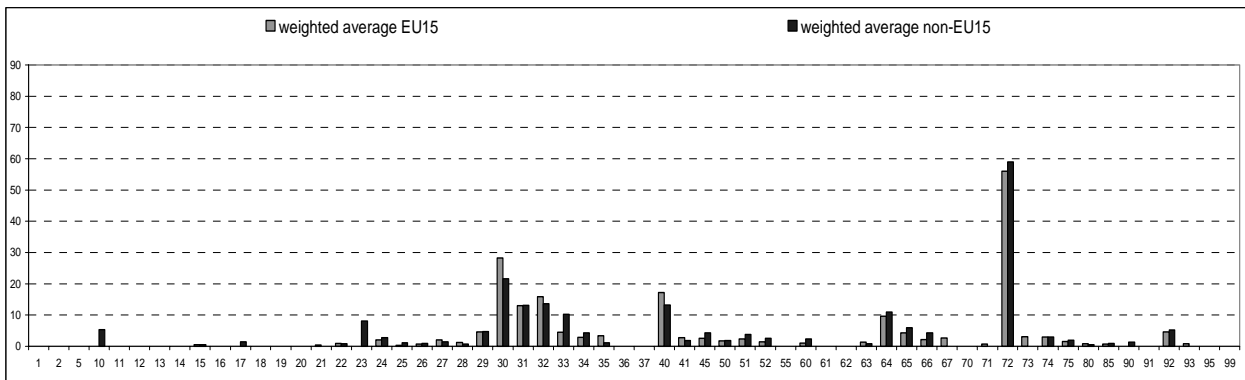
#### *Europe*

This section shows results from the sectoral analysis, starting with Europe. The choice of occupations included in the narrow and broad measure of ICT-skilled employment in the European data is summarised in Appendix Table 1. Data from the European Labour Force Surveys for 2003 (except for the Netherlands and Luxembourg: 2002) are used in order to calculate the share of ICT-skilled employment in total employment for each sector. In particular, data on employment by occupation (three digit ISCO88) by

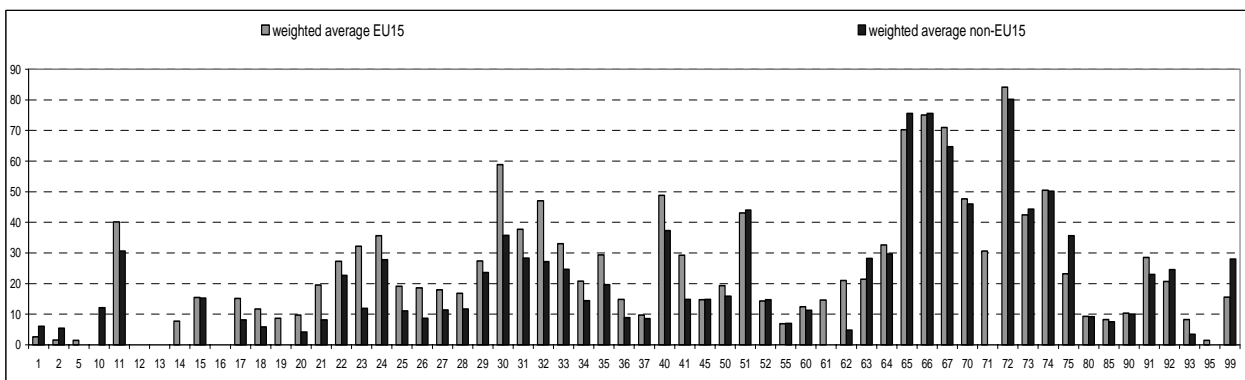


industry (two digit NACE<sup>3</sup>) are used to calculate the ratio of those employed under the narrow, and respectively, broad definition of ICT-skilled employment in an industry divided by total employment in the industry. Calculating a weighted average across countries (where the weights are calculated as the ratio of employment in industry  $i$  in country  $j$  divided by total employment in industry  $i$  across all countries), the following distribution across sectors is obtained.

**Figure 2. Europe: share of ICT-skilled employment in total employment, narrow definition, by sector, 2003**  
Percentages



**Figure 3. Europe: share of ICT-skilled employment in total employment, broad definition, by sector, 2003**  
Percentages



*Note:* Data refer to 2003, except the Netherlands and Luxembourg: 2002. Non-EU15 data refer to the following non-EU15 European countries: Norway, Switzerland, Czech Republic, Hungary, Slovak Republic. As fewer data were available to calculate the ratios for non-EU15 Europe, outliers may have a relatively larger effect than in the EU15 distribution.

*Source:* Authors' calculations, based on EULFS (2004).

The two obvious outliers in both distributions are 30 – Manufacture of Office Machinery and Computers, which is also where the difference between EU and non-EU Europe is greatest. The other outlier is sector 72 – Computer and related activities. Finally, non-EU Europe has a relatively larger share of broad ICT employment than EU countries in sector 99 – Extra-territorial organisations and bodies. Nevertheless, it should be kept in mind that less data were available to calculate data for non-EU Europe, and as a result, outliers could have a relatively larger effect on its distribution.

The next step is to rank the industries according to their share of ICT-skilled employment under the broad measure. The following ranking was obtained on the basis of data for EU15, in descending order of

the share of broad ICT-skilled employment in total sector employment. The ranking was split up into three groups<sup>4</sup>, the first consisting of industries with a share of ICT-skilled employment of 30% and above, the second with industries with a share between 10% and 30%, and finally the industries with a share below 10%:

**Table 1. Ranking of industries<sup>1</sup> according to their share of broadly defined ICT-skilled employment, EU15, 2002 and 2003**

NACE 2-digit	Industry	Share (%) 2003	Share (%) 2002	Difference 03-02	Difference %-points
<b>&gt;30%</b>					
72	Computer and related activities	84.1	84.2	-	-0.08
66	Insurance and pension funding, except compulsory social security	75.1	74.8	+	0.32
67	Activities auxiliary to financial intermediation	71.6	67.9	+	3.74
65	Financial intermediation, except insurance and pension funding	70.2	69.2	+	0.99
30	Manufacture of office machinery and computers	61.7	57.1	+	4.54
74	Other business activities	50.5	50.4	+	0.04
40	Electricity, gas, steam and hot water supply	48.9	45.1	+	3.74
32	Manufacture of radio, television and communication equipment and apparatus	47.8	44.8	+	3.10
70	Real estate activities	47.7	46.1	+	1.66
73	Research and development	43.4	41.3	+	2.09
51	Wholesale trade and commission trade, except of motor vehicles and motorcycles	43.0	42.7	+	0.27
23	Manufacture of coke, refined petroleum products and nuclear fuel	41.3	35.2	+	6.16
31	Manufacture of electrical machinery and apparatus, n.e.c.	38.0	35.3	+	2.71
24	Manufacture of chemicals and chemical products	35.7	35.9	-	-0.19
71	Renting of machinery and equipment without operator and of personal and household goods	34.0	31.4	+	2.64
41	Collection, purification and distribution of water	33.3	26.2	+	7.12
33	Manufacture of medical, precision and optical instruments, watches and clocks	33.2	31.0	+	2.15
64	Post and telecommunications	32.6	32.6	-	-0.07
35	Manufacture of other transport equipment	30.2	27.2	+	3.00
<b>10-30%</b>					
91	Activities of membership organisation, n.e.c.	28.6	28.6	+	0.02
29	Manufacture of machinery and equipment, n.e.c.	27.4	26.9	+	0.41
22	Publishing, printing and reproduction of recorded media	27.3	26.4	+	0.91
62	Air transport	23.8	18.5	+	5.33
75	Public administration and defence; compulsory social security	23.2	23.6	-	-0.41
63	Supporting and auxiliary transport activities; activities of travel agencies	21.4	22.1	-	-0.66
34	Manufacture of motor vehicles, trailers and semi-trailers	21.2	19.7	+	1.51
21	Manufacture of pulp, paper and paper products	20.7	21.9	-	-1.21
92	Recreational, cultural and sporting activities	20.7	22.3	-	-1.58
25	Manufacture of rubber and plastic products	19.6	18.4	+	1.10
50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel	19.3	18.1	+	1.19
27	Manufacture of basic metals	18.8	17.1	+	1.72
26	Manufacture of other non-metallic mineral products	18.6	19.0	-	-0.45
28	Manufacture of fabricated metal products, except machinery and equipment	17.0	16.7	+	0.33
17	Manufacture of textiles	16.2	12.9	+	3.27
15	Manufacture of food products and beverages	15.5	14.7	+	0.75
36	Manufacture of furniture; manufacturing n.e.c.	15.3	14.9	+	0.40
45	Construction	14.7	14.5	+	0.16
52	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	14.3	14.0	+	0.35
18	Manufacture of wearing apparel; dressing and dyeing of fur	13.1	10.4	+	2.70
60	Land transport; transport via pipelines	12.4	11.2	+	1.16
90	Sewage and refuse disposal, sanitation and similar activities	12.0	14.0	-	-2.00
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	10.9	9.5	+	1.37
<b>&lt;10%</b>					
80	Education	9.3	8.8	+	0.48
93	Other service activities	8.7	8.6	+	0.02
85	Health and social work	8.2	8.3	-	-0.08
55	Hotels and restaurants	6.9	7.2	-	-0.35
1	Agriculture, hunting and related service activities	2.8	2.9	-	-0.13

Note: 1. Industries for which the share was significant only.

Source: Authors' calculations, based on EULFS (2004).

There are a striking number of services sectors included in the group of industries with a share >30%, and they are also situated mainly at or near the top of the ranking, as well as some manufacturing sectors and wholesale trade. Retail trade, on the other hand, can be found quite far down in the group of industries with a share comprised between 10 and 30%. Printing and publishing is also found in this group. This group of industries with a share between 10 and 30% is dominated by manufacturing industries, and the group of industries with a share <10% by primary industries as well as 'personal services' industries (as opposed to 'business services' industries which tend to be in the group with the highest shares). Comparing the results for 2002 with those for 2003, most industries have experienced some increase in the share of broad ICT-skilled employment in total employment and, overall, the changes were relatively small. Only two industries changed groups (in shaded grey in Table 1): manufacture of other transportation equipment moved from 10-30% to >30%, and manufacture of wood products moved from <10% to 10-30%.

#### Comparisons with other work

Comparing the classification of industries based on their share of broad ICT-skilled employment with the OECD standard definition of the ICT-producing sector (see appendix for details), it appears that most of both the manufacturing and services industries included there are identified as having a share of ICT-skilled employment over 30%, *i.e.* these industries are both producers of ICT and have a high-intensity of ICT use as measured by the share of their ICT-skilled employment.

Comparing the classification based on the share of ICT-skilled employment to the ICT using industries identified by Pilat and Lee (2001) based on capital flow matrices and capital stock estimates (Appendix Box 3), it appears that most of the industries identified as ICT-using in the latter study are classified as also having a high share of ICT-skilled employment (>30%), with a few exceptions. In particular, among the manufacturing industries, 'printing and publishing' is included in the group of industries with a share between 10 and 30%, and for the services industries, retail trade is also included in this group (10-30%).

The distribution of industries obtained by Peneder (2003)<sup>5</sup> is similar to the results from the ICT-skilled employment approach. Pender divides industries up into four categories: (i) IT producer – services, (ii) IT producer – manufacturing, (iii) dynamic IT users with a high and growing IT labour intensity, and (iv) other IT user industries (Appendix Table 15). Most of the industries that figure in Peneder's first three categories are classified as having a high-intensity share of ICT-skilled employment.<sup>6</sup> Peneder's result that the distribution of IT, as proxied in his study by the share of IT personnel in the total workforce, is not evenly distributed among IT user industries is also confirmed by the results from the ICT-skilled employment approach.

Peneder (2003) also finds that those industries that started off with a relatively higher share of IT employment have also increased their share faster than other industries. There is some indication of this taking place in the classification based on the share of ICT-skilled employment too, with the largest changes (in percentage points) mainly taking place in the industries that already had a relatively large share (*i.e.* over 30%).

Arnal *et al* (2001) report a classification of 10 U.S. manufacturing industries according to their ICT-intensity (Appendix Table 13), based on the proportion of non-supervisory workers using computers, where high-ICT intensity is defined as the proportion being greater than the average ratio (> 52.07%). Most of these U.S. industries classified there as having a high-ICT intensity are also ranked among industries with a relatively high share of ICT-skilled employment (>30%) for the average of the EU, with the exception notably of 'printing and publishing' which can be found among industries with a share of ICT-skilled employment comprised between 10 and 30%.

### *United States*

Results for 2002 were published in the *2004 OECD Information Technology Outlook*. The Appendix recalls the selection of occupations used in the analysis (Appendix Table 2) as well as the list of industries that were found to have a share of ICT-skilled employment in total employment in excess of 30% (Appendix Table 11). Like for the classification obtained for the average of the EU15, many similar (business) services sectors appear at the top of the list (*e.g.* accounting, auditing, and bookkeeping services, computer and data processing services, and legal services), as well as certain similar manufacturing sectors (*e.g.* computers and related equipment and TV and communication equipment). An interesting point to note is that for the U.S., quite a few retail sectors have a share >30% whereas retail has a relatively low share in the European classification (14.3%). Even though other factors, such as firm size for example, are not controlled for, and while this result could be due just to the difference in aggregation, it does confirm the idea that retail trade is more ICT intensive in the U.S. than in Europe, a finding also confirmed in studies examining productivity differentials between the U.S. and Europe, for example. Printing and publishing is (like in the European classification), ranked in the group with a share between 10 and 30% of broadly defined ICT-skilled employment, whereas in the classification of Arnal *et al* (2001) it was classified as having a high-intensity (Appendix Table 13).

This analysis for the U.S. has not been updated yet as both the occupational and industrial classification systems have changed. The Current Population Survey collects information on both the industry and the occupation of the employed and unemployed. However, beginning with data from January 2003, the 1990 Census Industrial Classification System was replaced by one based on the North American Industry Classification (NAICS), and the 1990 Census Occupational Classification was replaced by one derived from the U.S. Standard Occupational Classification (SOC).<sup>7</sup>

### *Canada*

The selection of occupations for Canada was guided by the same criteria as for the other countries included in the analysis, namely whether the individuals are expected to use ICTs intensively in order to do their job, while a maximum of comparability with the selection for other countries was also sought (even though classifications were not harmonised). The selection of occupations to be included for Canada in the narrow and broad measure of ICT-skilled employment is given in Appendix Table 3.

Many business services, and some manufacturing sectors, are found at the top of the ranking, as for the other countries. However, the distribution of industries is more uneven in Canada than in the other countries. In particular, relatively more industries have a share of less than 10% of ICT-skilled employment (Table 2), even more so when also taking into account the industries with a zero-share (Appendix Table 12). This may be the result of differences in the occupational selections (as these are not harmonised across countries) so there may be categories that are captured less well in the Canadian selection than in the selections for other countries. Differences in the level of detail of the industries could also play a role.

**Table 2. Ranking of industries according to their share of broad ICT-skilled employment<sup>1</sup>, Canada, 2003**

Industry	code	%
Credit Intermediation and Related Activities	522	89.0
Finance and Insurance	52	84.3
Securities, Commodity Contracts, and Other Financial Investment and Related Activities	523	82.2
Professional, Scientific and Technical Services	54	68.7
Insurance Carriers and Related Activities	524	67.4
Broadcasting and Telecommunications	513	43.9
Real Estate	531	43.0
Computer and Electronic Product Manufacturing	334	38.4
Information and Cultural Industries	51	34.9
Real Estate and Rental and Leasing	53	34.2
Federal Government Public Administration	911	32.3
Information Services and Data Processing Services	514	31.9
Provincial and Territorial Public Administration	912	30.6
Public Administration	91	29.7
Utilities	22	27.8
Machinery, Equipment and Supplies Wholesaler-Distributors	417	25.2
Wholesale Trade	41	23.3
Oil and Gas Extraction	211	18.8
Machinery Manufacturing	333	16.9
Religious, Grant-Making, Civic, and Professional and Similar Organizations	813	16.6
Construction	31	16.3
Building Material and Supplies Wholesaler-Distributors	416	16.3
Chemical Manufacturing	325	16.2
Miscellaneous Wholesaler-Distributors	418	15.8
Ambulatory Health Care Services	621	14.9
Mining and Oil and Gas Extraction	21	13.0
Publishing Industries	511	12.9
Textile Product Mills	314	12.1
Local, Municipal and Regional Public Administration	913	12.0
Administrative and Support, Waste Management and Remediation Services	56	11.8
Repair and Maintenance	811	10.5
Food, Beverage and Tobacco Wholesaler-Distributors	413	9.9
Transportation Equipment Manufacturing	336	9.8
Electronics and Appliance Stores	443	9.2
Other Services (except Public Administration)	81	9.1
Electrical Equipment, Appliance and Component Manufacturing	335	8.8
Health Care and Social Assistance	62	8.6
Printing and Related Support Activities	323	8.4
Wholesale Trade	48	8.2
Educational Services	61	8.0
Hospitals	622	8.0
Fabricated Metal Product Manufacturing	332	7.4
Motor Vehicle and Parts Wholesaler-Distributors	415	7.4
Personal and Household Goods Wholesaler-Distributors	414	7.3
Amusement, Gambling and Recreation Industries	713	7.1
Warehousing and Storage	493	6.9
Food Manufacturing	311	6.8
Arts, Entertainment and Recreation	71	6.7
Construction	23	6.5
Motor Vehicle and Parts Dealers	441	6.5
Trade Contracting	232	6.4
Miscellaneous Manufacturing	339	5.9
Truck Transportation	484	5.8
Prime Contracting	231	5.1
Plastics and Rubber Products Manufacturing	326	5.1
Support Activities for Transportation	488	4.8
Wholesale Trade	44	4.6
Air Transportation	481	4.5
Beverage and Tobacco Product Manufacturing	312	4.4
Couriers and Messengers	492	4.2
Wood Product Manufacturing	321	4.1
Non-Metallic Mineral Product Manufacturing	327	3.8
Miscellaneous Store Retailers	453	3.6
Primary Metal Manufacturing	331	3.2
Building Material and Garden Equipment and Supplies Dealers	444	3.1
Clothing Manufacturing	315	3.1
Support Activities for Mining and Oil and Gas Extraction	213	2.6
Furniture and Related Product Manufacturing	337	2.4
Social Assistance	624	2.3
Sporting Goods, Hobby, Book and Music Stores	451	2.2
Postal Service	491	2.1
Farming (N.E.C.)	11	2.1
Paper Manufacturing	322	2.1
Accommodation Services	721	1.6
Accommodation and Food Services	72	1.3
Food and Beverage Stores	445	0.9
General Merchandise Stores	452	0.6
Food Services and Drinking Places	722	0.2

Note: 1. Except industries with a zero share which are given in Appendix Table 12.  
Source: Authors' calculations based on Statistics Canada (2004).

*Australia*

The selection of occupations for Australia for the narrow and broad measures of ICT-skilled employment is given in Appendix Table 4. The choice of occupations to be included was again guided by the same criteria as for the other countries in the analysis, namely whether the individuals are expected to use ICTs intensively in order to do their job, while also trying to achieve a maximum of comparability with the selection for other countries (even though classifications were not harmonised). Like for the other countries included in the analysis, many business services are found at the top of the ranking, but unlike for the other countries, there are no manufacturing sectors in the group of industries with a share >30%. This could be because the classifications, and therefore the selections of occupations, are not harmonised and as a result, certain types of jobs may not be captured. Differences in the industrial classification systems could also play a role again.

**Table 3. Ranking of industries according to their share of broad ICT-skilled employment<sup>1</sup>, Australia, May 2004**

Industry	%
73 Finance	87.7
75 Services to Finance and Insurance	83.5
74 Insurance	72.9
12 Oil and Gas Extraction	52.4
78 Business Services	52.3
82 Defence	45.8
36 Electricity and Gas Supply	39.2
15 Services to Mining	37.6
71 Communication Services	37.2
81 Government Administration	34.4
46 Machinery and Motor Vehicle Wholesaling	29.1
91 Motion Picture, Radio and Television Services	28.5
25 Petroleum, Coal, Chemical and Associated Product Manufacturing	28.0
37 Water Supply, Sewerage and Drainage Services	27.3
45 Basic Material Wholesaling	25.7
65 Other Transport	25.0
24 Printing, Publishing and Recorded Media	24.8
13 Metal Ore Mining	24.2
47 Personal and Household Good Wholesaling	22.7
26 Non-metallic Mineral Product Manufacturing	21.8
03 Forestry and Logging	21.7
28 Machinery and Equipment Manufacturing	20.4
62 Rail Transport	19.6
63 Water Transport	18.9
92 Libraries, Museums and the Arts	18.8
77 Property Services	18.7
21 Food, Beverage and Tobacco Manufacturing	17.8
14 Other Mining	17.6
64 Air and Space Transport	16.6
66 Services to Transport	16.5
96 Other Services	15.3
22 Textile, Clothing, Footwear and Leather Manufacturing	14.4
27 Metal Product Manufacturing	14.1
41 General Construction	14.1
11 Coal Mining	14.0
02 Services to Agriculture; Hunting and Trapping	13.4
61 Road Transport	12.0
93 Sport and Recreation	11.8
23 Wood and Paper Product Manufacturing	11.5
67 Storage	11.2
29 Other Manufacturing	10.9
04 Commercial Fishing	10.8
84 Education	10.6
53 Motor Vehicle Retailing and Services	9.8
42 Construction Trade Services	9.7
95 Personal Services	9.4
52 Personal and Household Good Retailing	8.3
86 Health Services	7.8
87 Community Services	7.0
01 Agriculture	5.5
57 Accommodations, Cafes and Restaurants	3.4
51 Food Retailing	2.2
97 Private Households Employing Staff	0.0

Note: 1. Numbers in shaded grey are based on estimates subject to sampling variability too high for most practical purposes.

Source: Authors' calculations based on data provided by the Australian Bureau of Statistics.



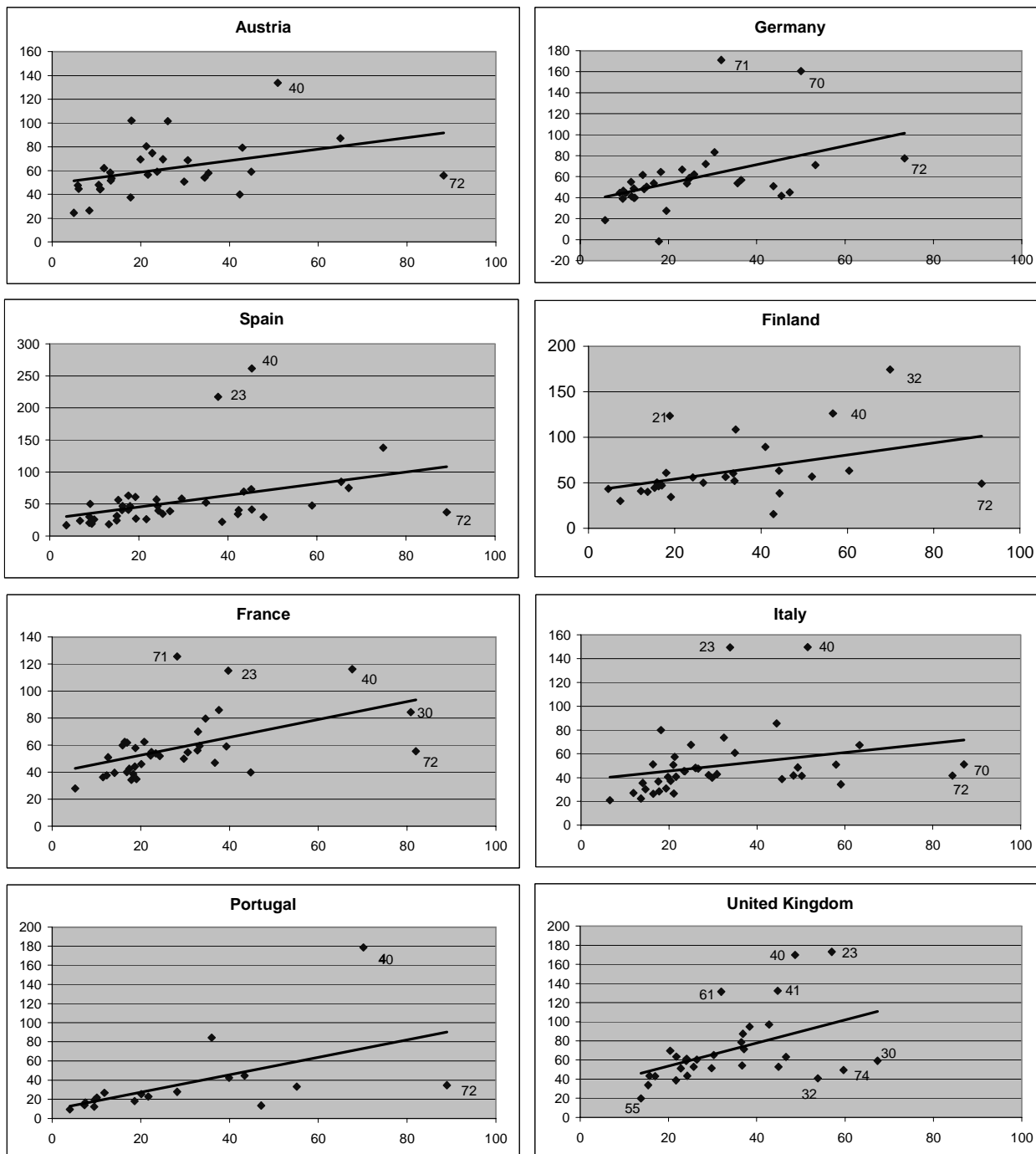
### **ICT-skilled employment and productivity**

In view of the debate and measurement problems concerning the productivity gains realised in ICT-sectors as well as ICT-induced productivity gains in other sectors, the broad measure of ICT-skilled employment is related to productivity measures, for as many sectors as possible. However, data on gross value added per employee are not available for all sectors, and many services sectors in particular are missing. Initial results relating the ICT-skilled employment measure to productivity for selected EU15 countries were published in OECD (2004). Using data for 2002 for the skills measure and 2001 for the productivity measure it was shown that there was an overall positive and significant correlation between a sector's share of ICT-skilled employment and gross value added per employee. NACE sector 72 (computer and related activities) was found to be an outlier in most cases with a high share of ICT-skilled employment but relatively low value added per employee.

This exercise was repeated using data for 2003 for the skills measure, although data on gross value added per employee are still only available for 2001 (Eurostat, NewCronos). The results obtained in OECD (2004) appear to be fairly robust though as, again, higher levels of value added per employee tend to be associated with a higher share of ICT-skilled employment at the sectoral level (Figure 4 and Appendix Table 16).

These results suggest that the ICT-skilled employment measure could be an important variable in understanding labour productivity. This will be examined further in more in-depth analysis which will consider more complex productivity equations. Additional data will be collected in order to examine whether the ICT-skilled employment measure could be of use in analyses of productivity growth. This will be done for as many countries as possible, but data limitations will affect the scope of the analysis. In particular, for some countries the classification system of industries used in the productivity data is not the same as the one used in the employment data.

**Figure 4. Gross value added per employee (thousands Euro per head; y-axis) and broad ICT employment (percentages; x-axis), selected EU countries**



Note: Data for the ICT-skilled employment measure refer to 2003; data on value added per employee are for 2001. Some outliers have been removed for clarity (NACE 11 in Italy and the United Kingdom).

Source: Authors' calculations, based on EULFS and NewCronos (2004).

## Conclusions

This paper expands the analysis of ICT-skilled employment from the *2004 OECD Information Technology Outlook*, and has extended it to cover Canada. A narrow and a broad measure of ICT-skilled employment were calculated at the aggregate level. It was found that the narrow measure of ICT specialists followed a similar pattern across countries (EU15, United States, Canada and Australia), but that the trends for broad measure of ICT-intensive users and specialists diverged. In particular, the share of broad ICT-skilled employment is increasing in the EU15, but decreasing in the United States, Canada and Australia. The relatively recent phenomenon of the offshoring of IT-related and backoffice activities could be an explanatory factor, as could diverging trends in technology adoption and integration reducing employment of some ICT-intensive using occupations.

The broad ICT-skilled employment measure was also analysed at the sectoral level. Many business services sectors were found to have a very large share of ICT-skilled employment (*e.g.* computer and related services, financial intermediation services, and research and development), as well as certain manufacturing sectors (such as manufacturing of office machinery and computers). Personal services tended to have a relatively low share. For the EU15 a comparison was made between 2003 and 2002. Most sectors were found to have increased their share of ICT-skilled employment somewhat, and in particular those that already had a relatively large share. A comparison with classification of ICT-intensity at the sectoral level in other studies revealed many similarities, confirming the usefulness of this approach that exploits existing data sources.

The broad ICT-skilled employment measure was also related to a measure of labour productivity at the sectoral level. As in OECD (2004), it was found that a higher level of value added per employee tended to be associated with a share of ICT-skilled employment at the sectoral level. As these results appear to be robust, the usefulness of the ICT-skilled employment measure in productivity analyses will be analysed further.

Future work will include updates and extensions of the analysis for as many countries and years as possible, as well more sophisticated analysis of the role the ICT-skilled employment measure can play in understanding labour productivity. Furthermore, the analysis could be expanded distinguishing between different types of users, for example high and low skilled ICT-intensive users.

## NOTES

- 1 ISCO stands for International Standard Classification of Occupations.
- 2 For example for Europe, ISCO88 categories 213, 312, 313 and 724. A further distinction can be made between high (213, 312, 313) vs. low (724) skilled ICT occupations, and computing occupations (213, 312).
- 3 NACE is the Classification of Economic Activities in the European Community.
- 4 The choice of 30% and 10% as cut-off points was based on distribution analysis for various years of EU15 results. Even though these cut-off points are somewhat arbitrary and the rankings are not necessarily evenly distributed for other countries, this still facilitates comparisons with results from different countries and different years.
- 5 Peneder (2003) adopts a similar approach to the one in the present paper, but with a very different methodology. He uses three-stage statistical cluster analysis, where the dynamic profile of prior cluster identifications is used for the final partition on data for the United Kingdom (UK Labour Force Survey) and the United States (Current Population Survey). He adopts the definition of IT personnel from Mason *et al* (2002) (Appendix Tables 8 and 9), and aggregates the industries into 39 comparable sectors. His sectoral classification is based on IT labour intensity, which is defined on the basis of both occupational information (employment and wage shares of IT personnel in the total workforce), and educational attainment information (the share of persons with a university degree in total IT labour).
- 6 With the exception of (i) 'mining and quarrying' where industry 11 is ranked in the group of industries with a share >30%, but industries 10, 12, 13 and 14 in the group with a share <10%, (ii) 'motor vehicles', 'other transportation equipment', and 'public administration and defence, incl. compulsory social security' which are ranked in the group with a share between 10% and 30%, and (iii) 'education' which is ranked in the group with a share <10%.
- 7 Further information is available on the Web site of the U.S Bureau of Labor Statistics at: <http://www.bls.gov/opub/hom/pdf/homch1.pdf> (accessed November 2004): Chapter 1: Labor Force Data derived from the Current Population Survey.

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## APPENDIX

### The ICT sector

#### ICT producing industries

##### Appendix Box 1: Underlying principles

**For manufacturing industries**, the products of a candidate industry either must be intended to fulfill the function of information processing and communication including transmission and display, or must use electronic processing to detect, measure and/or record physical phenomena or to control a physical process. Components primarily intended for use in such products should also be included.

**For services industries**, the products of a candidate industry must be intended to enable the function of information processing and communication by electronic means. Furthermore, the service provided should go beyond simply the supply of goods. (OECD, 2003, 1998)

##### Appendix Box 2: The ICT-producing sector<sup>1</sup> (ISIC Rev. 3 industries)

###### Manufacturing:

- 3000: Manufacture of office, accounting and computing machinery
- 3130: Manufacture of insulated wire cable
- 3210: Manufacture of electronic valves and tubes and other electronic components
- 3220: Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy
- 3230: Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods
- 3312: Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes except industrial process control equipment
- 3313: Manufacture of industrial process equipment

###### Services:

###### Goods related

- 5150<sup>2</sup>: Wholesale of machinery, equipment and supplies (where available)
- 7123: Renting of office machinery and equipment (including computers)

###### Intangible

- 6420<sup>3</sup>: Telecommunications
- 7200: Computer related activities

Source: OECD (2003, 1998).

Notes: 1. Definition of the ICT producing sector, approved at the 1998 WPIIS meeting, and based on the ISIC Rev. 3 activity classification.

2. Where available, countries should only include those sub-sectors of this industry that directly provide ICT wholesaling services. This will avoid the inclusion of extraneous wholesaling activities. For example, using the NACE nomenclature, only NACE categories 5143, 5164, and 5165 should be included.

3. In those circumstances where countries include telecommunication activities as part of radio and television activities (ISIC 9213), radio and television activities (9213) should be included in this definition. Otherwise, it should not be included.

## ICT-using industries

**Appendix Box 3: ICT using industries<sup>1</sup>**

(Identified on the basis of data on capital flows and estimates of capital stocks)

**Manufacturing:**

- Printing and publishing
- Electronic equipment
- Machinery and equipment

**Services:**

- Communications
- Whole sale and retail trade
- Finance
- Insurance
- Business services

Source: Pilat and Lee (2001).

Note: ICT using industries identified on the basis of capital flow matrices and capital stock estimates in Pilat and Lee (2001).

**ICT-skilled employment: occupational selections****Appendix Table 1. Europe: Occupations included in the narrow and broad measures of ICT-skilled employment**

<b>3 Digit ISCO-88</b>
121: Directors and chief executives
122: Production and operations managers
123: Other specialist managers
211: Physicists, chemists, and related professionals
212: Mathematicians, statisticians and related professionals
213: Computing professionals
214: Architects, engineers, and related professionals
241: Business professionals
242: Legal professionals
243: Archivists, librarians, and related information professionals
312: Computer associate professionals
313: Optical and electronic equipment operators
341: Finance and sales associate professionals
342: Business services agents and trade brokers
343: Administrative associate professionals
411: Secretaries and keyboard-operating clerks
412: Numerical clerks
724: Electrical and electronic equipment mechanics and fitters

Note: All occupations listed are in the broad definition, only occupations shaded in grey are in the narrow measure.

**Appendix Table 2. United States: Occupations included in the narrow and broad measures of ICT-skilled employment**

financial managers	7	Medical scientists	83
personnel and labor relations managers	8	Librarians	164
purchasing managers	9	Archivists and curators	165
managers, marketing, advertising, and public relations	13	Economists	166
accountants and auditors	23	Lawyers and Judges	178
underwriters	24	Electrical and electronic technicians	213
other financial officers	25	Broadcast equipment operators	228
management analysts	26	Computer programmers	229
buyers, wholesale and retail trade except farm products	29	Tool programmers, numerical control	233
architects	43	Supervisors and Proprietors, Sales Occupations	243
aerospace engineer	44	Insurance sales occupations	253
metallurgical and materials engineers	45	Real estate sales occupations	254
mining engineers	46	Securities and financial services sales occupations	255
petroleum engineers	47	Sales occupations, other business services	257
chemical engineers	48	Supervisors, computer equipment operators	304
nuclear engineers	49	Supervisors, financial records processing	305
civil engineers	53	Chief communications operators	306
agricultural engineers	54	Computer operators	308
Engineers, electrical and electronic	55	Peripheral equipment operators	309
Engineers, industrial	56	Secretaries	313
Engineers, mechanical	57	Typists	315
marine and naval architects	58	Bookkeepers, accounting, and auditing clerks	337
engineers, n.e.c.	59	Payroll and timekeeping clerks	338
surveyors and mapping scientists	63	Billing clerks	339
computer systems analysts and scientists	64	Cost and rate clerks	343
operations and systems researchers and analysts	65	Billing, posting, and calculating machine operators	344
Actuaries	66	Data-entry keyers	385
Statisticians	67	Statistical clerks	386
Mathematical scientists, n.e.c.	68	Electronic repairers, communications and industrial equipment	523
Physicists and astronomers	69	Data processing equipment repairers	525
Chemists, except biochemists	73	Telephone line installers and repairers	527
Atmospheric and space scientists	74	Telephone installers and repairers	529
Geologists and geodesists	75	Miscellaneous electrical and electronic equipment repairers	533
Physical scientists, n.e.c.	76	Electrical power installers and repairers	577
Agricultural and food scientists	77	Electrical/electronic equipment assemblers	683
Biological and life scientists	78	Numerical control machine operators	714
Forestry and conservation scientists	79		

Note: All occupations listed are in the broad definition, only occupations shaded in grey are in the narrow measure.

**Appendix Table 3. Canada: Occupations included in the narrow and broad measures of ICT-skilled employment**

SOC91 Canada	
A013 Senior Managers - Financial, Communications Carriers and Other Business Services	B554 Survey Interviewers and Statistical Clerks
A015 Senior Managers - Trade, Broadcasting and Other Services, n.e.c.	C011 Physicists and Astronomers
A016 Senior Managers - Goods Production, Utilities, Transportation and Construction	C012 Chemists
A111 Financial Managers	C013 Geologists, Geochemists and Geophysicists
A112 Human Resources Managers	C014 Meteorologists
A113 Purchasing Managers	C015 Other Professional Occupations in Physical Sciences
A121 Engineering, Science and Architecture Managers	C021 Biologists and Related Scientists
A122 Information Systems and Data Processing Managers	C031 Civil Engineers
A131 Sales, Marketing and Advertising Managers	C032 Mechanical Engineers
A141 Facility Operation and Maintenance Managers	C033 Electrical and Electronics Engineers
A301 Insurance, Real Estate and Financial Brokerage Managers	C034 Chemical Engineers
A302 Banking, Credit and Other Investment Managers	C041 Industrial and Manufacturing Engineers
A303 Other Business Services Managers	C042 Metallurgical and Materials Engineers
A311 Telecommunication Carriers Managers	C043 Mining Engineers
A312 Postal and Courier Services Managers	C044 Geological Engineers
A391 Manufacturing Managers	C045 Petroleum Engineers
A392 Utilities Managers	C046 Aerospace Engineers
B011 Financial Auditors and Accountants	C047 Computer Engineers
B012 Financial and Investment Analysts	C048 Other Professional Engineers, n.e.c.
B013 Securities Agents, Investment Dealers and Traders	C051 Architects
B014 Other Financial Officers	C052 Landscape Architects
B022 Professional Occupations in Business Services to Management	C053 Urban and Land Use Planners
B111 Bookkeepers	C054 Land Surveyors
B112 Loan Officers	C061 Mathematicians, Statisticians and Actuaries
B114 Insurance Underwriters	C062 Computer Systems Analysts
B211 Secretaries (except Legal and Medical)	C063 Computer Programmers
B212 Legal Secretaries	C141 Electrical and Electronics Engineering Technologists and Technicians
B213 Medical Secretaries	C142 Electronic Service Technicians (Household and Business Equipment)
B214 Court Recorders and Medical Transcriptionists	E011 Judges
B311 Administrative Officers	E012 Lawyers and Quebec Notaries
B312 Executive Assistants	E031 Natural and Applied Science Policy Researchers, Consultants and Program Officers
B412 Supervisors, Finance and Insurance Clerks	E032 Economists and Economic Policy Researchers and Analysts
B512 Typists and Word Processing Operators	E033 Economic Development Officers and Marketing Researchers and Consultants
B513 Records and File Clerks	F011 Librarians
B521 Computer Operators	F013 Archivists
B522 Data Entry Clerks	G131 Insurance Agents and Brokers
B523 Typesetters and Related Occupations	G132 Real Estate Agents and Salespersons
B531 Accounting and Related Clerks	H214 Electrical Power Line and Cable Workers
B532 Payroll Clerks	H215 Telecommunications Line and Cable Workers
B533 Tellers, Financial Services	H216 Telecommunications Installation and Repair Workers
B534 Banking, Insurance and Other Financial Clerks	H217 Cable Television Service and Maintenance Technicians

Note: All occupations listed are in the broad definition, only occupations shaded in grey are in the narrow measure.



**Appendix Table 4. Australia: Occupations included in the narrow and broad measures of ICT-skilled employment**

ASCO 4-Digit	
1112 General Managers	2293 Mathematicians, Statisticians and Actuaries
1211 Finance Managers	2294 Business and Organisation Analysts
1212 Company Secretaries	2299 Other Business and Information Professionals
1213 Human Resource Managers	2521 Legal Professionals
1221 Engineering Managers	2522 Economists
1222 Production Managers	2523 Urban and Regional Planners
1223 Supply and Distribution Managers	3123 Electrical Engineering Associate Professionals
1224 Information Technology Managers	3124 Electronic Engineering Associate Professionals
1231 Sales and Marketing Managers	3211 Branch Accountants and Managers (Financial Institution)
1291 Policy and Planning Managers	3212 Financial Dealers and Brokers
2111 Chemists	3213 Financial Investment Advisers
2112 Geologists and Geophysicists	3294 Computing Support Technicians
2113 Life Scientists	3399 Other Managing Supervisors (Sales and Service)
2114 Environmental and Agricultural Science Professionals	4314 Electronic Instrument Tradespersons
2115 Medical Scientists	4315 Electronic and Office Equipment Tradespersons
2119 Other Natural and Physical Science Professionals	4316 Communications Tradespersons
2121 Architects and Landscape Architects	5111 Secretaries and Personal Assistants
2122 Quantity Surveyors	5911 Bookkeepers
2123 Cartographers and Surveyors	5912 Credit and Loans Officers
2124 Civil Engineers	5993 Insurance Agents
2125 Electrical and Electronics Engineers	5995 Desktop Publishing Operators
2126 Mechanical, Production and Plant Engineers	6121 Keyboard Operators
2127 Mining and Materials Engineers	6141 Accounting Clerks
2211 Accountants	6142 Payroll Clerks
2212 Auditors	6143 Bank Workers
2213 Corporate Treasurers	6144 Insurance Clerks
2221 Marketing and Advertising Professionals	6145 Money Market and Statistical Clerks
2231 Computing Professionals	9918 Electrical and Telecommunications Trades Assistants
2292 Librarians	

Note: All occupations listed are in the broad definition, only occupations shaded in grey are in the narrow measure.

**Appendix Table 5: Occupational classification in Arnal, Ok, and Torres (2001), based on Lavoie and Roy (1998)**

	3 Digit ISCO88
Knowledge workers Engineers and applied and social scientists  Computer specialists	<ul style="list-style-type: none"> <li>♦Physical, mathematical and engineering science professionals (<b>211, 212, 214</b>)</li> <li>♦Life science and health professionals (221, 222, 223)</li> <li>♦Teaching professionals (231)</li> <li>♦Other professionals (<b>241, 242, 244, 247</b>)</li> <li>♦Physical and engineering science associate professionals (311, <b>313, 314, 315</b>)</li> <li>♦Life science and health associate professionals (321, 322, 323)</li> <li>♦Other associate professionals (<b>341, 342</b>)</li> <li>♦Computing professionals (<b>213</b>)</li> <li>♦Computer associate professionals (<b>312</b>)</li> </ul>
Managerial workers	<ul style="list-style-type: none"> <li>♦Legislators and senior officials (111, 114)</li> <li>♦Corporate managers (<b>121, 122, 123</b>)</li> <li>♦Manager of small enterprises (131)</li> </ul>
Data workers	<ul style="list-style-type: none"> <li>♦Teaching professionals (232, 233, 234, 235)</li> <li>♦Other professional (<b>243</b>)</li> <li>♦Teaching associate professionals (331, 332, 333, 334)</li> <li>♦Other associate professionals (<b>343, 344</b>)</li> <li>♦Office clerks (<b>411, 412, 413, 414, 419</b>)</li> <li>♦Customer service clerks (421, 422)</li> </ul>
Service workers	<ul style="list-style-type: none"> <li>♦Other professionals (245, 246)</li> <li>♦Other associate professionals (345, 346, 347, 348)</li> <li>♦Personal and protective service workers (511, 512, 513, 514, 515, 516)</li> <li>♦Models, sales persons and demonstrators (521, 522)</li> <li>♦Sales and services elementary occupations (911, 912, 913, 914, 915, 916)</li> </ul>
Goods-producing workers	<ul style="list-style-type: none"> <li>♦Skilled agricultural and fishery workers (611, 612, 613, 614, 615)</li> <li>♦Extraction and building trade workers (711, 712, 713, 714)</li> <li>♦Metal, machinery and related trades workers (721, 722, 723, <b>724</b>)</li> <li>♦Precision, handicraft, printing and related trades workers (731, 732, 733, 734)</li> <li>♦Other craft and related trades workers (741, 742, 743, 744)</li> <li>♦Stationary-plant, and related operators (811, 812, 813, 814, 815, 816, 817)</li> <li>♦Machine operators and assemblers (821, 822, 823, 824, 825, 826, 827, 828, 829)</li> <li>♦Drivers and mobile plant operators (831, 832, 833, 834)</li> <li>♦Agricultural, fishery and related labourers (921)</li> <li>♦Labourers in mining, construction, manufacturing and transport (931, 932, 933)</li> </ul>

Note: Occupations in bold italics are included in the broad definition of 'ICT-skilled employment'; the main overlap occurs within the first three categories of workers (in grey).

**Appendix Table 6: Occupational classification in Habtu (2003)**

IT Occupations	Employment share of total IT occupations, 2001 (based on the experienced labour force), %	Unemployment rate (Total for IT occupations: 4.7%)
<b>Professional</b>		
Computer engineers (except software engineers)	6.9	4.1
Information systems analysts and consultants	26.6	3.3
Database analysts and data administrators	3.5	4.0
Software engineers	6.7	3.9
Computer programmers and interactive media developers	24.9	5.4
Web designers and developers	5.7	8.4
<b>Technical</b>		
Computer and network operators and Web technicians	11.8	4.9
User support technicians	12.1	5.2
Systems testing technicians	1.7	6.4

**Appendix Table 7: Occupational classification in ITAA (2003)**

Job	Net total job count 2003
Programming/Software engineering	2.144.377
Technical support personnel	1.904.842
Other	1.290.719
Enterprise systems specialists	1.113.883
Database development / administration	1.011.331
Web development / administration	885.070
Network design / administration	729.417
Digital media	694.251
Technical writing	538.759
Total	10.312.650

**Appendix Table 8: Occupational classification (UK, SOC1990) in Mason *et al* (2002)**

<b>IT/computing</b>
126 Computer systems managers
214 Software engineers
320 Computer analysts, programmers ( <i>incl. robot programmers</i> )
490 Computer operators ( <i>incl. 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

Note: The decision to include electrical occupations with electronic occupations throughout was guided by the fact that there are many occupational categories where the two types of occupation cannot be distinguished. Furthermore, this category also includes many higher-level telecommunications occupations which cannot be separately identified.

**Appendix Table 9: Occupational classification in the United States (Census Occupational Classification –1980) in Mason *et al* (2002)**

<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

**Appendix Table 10: Occupational classification in Millar (2001)**

UK SOC 90 Code	Occupational category	ISCO 88	Occupational category
126	Computer systems and data processing managers	213	Computing professionals
212	Electrical engineers	214	Architects, engineers and related professionals
213	Electronic engineers	311	Physical and engineering science technicians
214	Software engineers	312	Computer associated professionals
302	Electrical / electronic technicians	313	Optical and electronic equipment operators
320	Computer analysts, programmers	724	Electrical and electronic equipment mechanics and fitters
523	Telephone fitters		
524	Cable jointers, line repairers		
525	Radio, TV and video engineers		
526	Computer engineers		

## ICT-skilled employment: sectoral results

Appendix Table 11: United States industries with a share &gt; 30% of broad ICT-skilled employment in total employment (2002)

rank	industry		%
1	Accounting, auditing, and bookkeeping services	890	82.7
2	Savings institutions, including credit unions	701	72.3
3	Computer and data processing services	732	70.6
4	Legal services	841	70.1
5	Security, commodity brokerage, and investment companies	710	66.8
6	Banking	700	61.3
7	Credit agencies, n.e.c.	702	60.5
8	Engineering, architectural, and surveying services	882	60.3
9	Insurance	711	58.4
10	Management and public relations services	892	57.0
11	Telegraph and miscellaneous communications services	442	57.0
12	Radio, TV, and communication equipment	341	56.4
13	Telephone communications	441	54.9
14	Computers and rel. equipment	322	53.0
15	Guided missiles, space vehicles, and parts	362	50.5
16	Office and accounting machines	321	49.6
17	Not specified electrical machinery, equipment, and supplies	350	48.8
18	Photographic equipment and supplies	380	48.1
19	Liquor stores	650	47.6
20	Miscellaneous vehicle dealers	622	47.5
21	Stores, dairy products	602	47.5
22	Fuel dealers	672	45.3
23	Environmental quality and housing programs administratio	930	44.6
24	Stores, Retail nurseries and garden	582	44.2
25	Libraries	852	43.6
26	Real estate, including real estate-insurance offices	712	43.6
27	Scientific and controlling instruments	371	43.1
28	Not specified utilities	472	43.0
29	Food stores, n.e.c.	611	42.5
30	Public finance, taxation, and monetary policy	921	42.4
31	Research, development, and testing services	891	41.6
32	Electrical machinery, equipment, and supplies, n.e.c.	342	41.1
33	Not specified wholesale trade	571	40.4
34	Catalog and mail order houses	663	40.0
35	Farm supplies	561	39.9
36	Misc wholesale, nondurable goods	562	39.7
37	Variety stores	592	39.4
38	Electric light and power	450	39.0
39	Mobile home dealers	590	38.9
40	Metals and minerals, except petroleum	511	38.3
41	Motor vehcls and equipment	500	37.9
42	Stores, radio, TV, and computer	633	37.9
43	Stores, apparel and accessory, except shoe	623	37.9
44	Petroleum products	552	37.8
45	Machinery, equipment, and supplies	530	37.7
46	Jewelry stores	660	37.3
47	Professional and commercial equipment and supplies	510	36.9
48	Not specified retail trade	691	35.9
49	Stores, Miscellaneous retail	682	35.9
50	Scrap and waste materials	531	35.9
51	Furniture and home furnishings	501	35.7
52	Electrical goods	512	35.5
53	Miscellaneous wholesale, durable goods	532	35.3
54	Screw machine products	290	35.3
55	Electrical repair shops	752	35.3
56	Not specified machinery	332	35.3
57	Hardware stores	581	35.3
58	Gift, novelty, and souvenir shops	661	34.9
59	Music stores	640	34.8
60	Economic programs administration	931	34.2
61	Gasoline service stations	621	34.1
62	Stores, Book and stationery	652	34.0
63	Petroleum refining	200	33.2
64	Aircraft and parts	352	32.5
65	Lumber and building material retailing	580	32.2
66	Apparel, fabrics, and notions	542	32.1
67	General government, n.e.c.	901	31.5
68	Paper and paper products	540	30.5
69	Advertising	721	30.4
70	Stores, furniture and home furnishings	631	30.3

Source: OECD, based on CPS (2003).

**Appendix Table 12. Canada: industries with a zero share of ICT-skilled employment**

Farming (N.E.C.)	110
Crop Production	111
Animal Production	112
Forestry and Logging	113
Fishing, Hunting and Trapping	114
Support Activities for Agriculture and Forestry	115
Mining (n.e.c.)	210
Mining (except Oil and Gas)	212
Textile Mills	313
Leather and Allied Product Manufacturing	316
Petroleum and Coal Products Manufacturing	324
Farm Product Wholesaler-Distributors	411
Petroleum Product Wholesaler-Distributors	412
Wholesale Agents and Brokers	419
Furniture and Home Furnishings Stores	442
Health and Personal Care Stores	446
Gasoline Stations	447
Clothing and Clothing Accessories Stores	448
Non-Store Retailers	454
Rail Transportation	482
Water Transportation	483
Transit and Ground Passenger Transportation	485
Pipeline Transportation	486
Scenic and Sightseeing Transportation	487
Motion Picture and Sound Recording Industries	512
Rental and Leasing Services	532
Management of Companies and Enterprises	55
Waste Management and Remediation Services	562
Nursing and Residential Care Facilities	623
Performing Arts, Spectator Sports and Related Industries	711
Heritage Institutions	712
Personal and Laundry Services	812
Private Households	814
Aboriginal Public Administration	914
International and Other Extra-Territorial Public Administration	919

**ICT-producing and ICT-using sectors in other work****Appendix Table 13: High and low ICT industries in the US<sup>1</sup> (Arnal et al., 2001)**

High ICT intensity	Low ICT intensity
Chemical and petroleum (28, 29)	Food and tobacco (20, 21)
Machinery and instruments (35, 36, 38)	Primary metals (33)
Transportation equipment (37)	Textile and apparel (22, 23)
Printing and publishing (27)	Lumber and paper (26)
Other and miscellaneous manufactured products (25, 30, 31, 32)	Fabricated metals (34)

Note: 1. The proportion of non-supervisory workers using computers is used to classify these 10 U.S. manufacturing industries into high- and low- ICT intensity, where high-ICT intensity is defined as the proportion being greater than the average ratio (> 52.07%).

**Appendix Table 14: Definition of the ITEC<sup>1</sup> sector in the UK (Millar, 2001)**

UK SIC (92) (3-digit)	Description	NACE (Rev. 1) (2 digit)	Description
IT services			
72.1	Hardware consultancy	72	Computer and related activities
72.2	Software consultancy and supply		
72.3	Data processing		
72.4	Data base activities		
72.5	Maintenance and repair of office, accounting and computing machinery		
Telecommunications services			
64.1	Telecommunications	64	Post and telecommunications
64.2	Postal and courier services		
Broadcasting services			
92.20	Radio and television activities		
Electronics manufacturing			
30.0	Manufacture of office machinery, computers and other information processing equipment	30	Manufacture of office machinery and computers
32.1	Manufacture of electronic valves, tubes and other electronic components	31	Manufacture of electrical machinery and apparatus
32.20/1	Manufacture of telegraph and telephone apparatus and associated goods	32	Manufacture of radio, television and communication equipment and apparatus
32.20/2	Manufacture of radio and electronic capital goods	33	Manufacture of medical, precision and optical instruments, watches and clocks
32.3	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods		
33.30/1	Manufacture of electronic industrial process control equipment		

Note: 1. ITEC stands for Information Technology, Electronics and Communication technologies.



Classification obtained in Peneder's study:

**Appendix Table 15: Classification of industries in Peneder (2003)**  
(NACE codes in brackets)

<b>IT producer - services</b>
Computer and related activities (72)
<b>IT producer - manufacturing</b>
Computers and office machinery (30)
<b>Dynamic IT users with a high and growing IT-labour intensity</b>
Mining and quarrying (10-14)
Mineral oil refining, coke and nuclear fuel (23)
Chemical (24)
Electrical machinery and apparatus (31)
Radio, television and communication (32)
Instrument engineering (33)
Motor vehicles (34)
Other transport equipment (35)
Electricity, gas and water supply (40-41)
Air transport (62)
Telecommunications (642)
Financial intermediation (65, 67)
Insurance and pension funding (66)
Research and development (73)
Other business services (71, 74)
Public administration and defence, incl. compulsory social security (75)
Education (80)
<b>Other IT-user industries</b>
Agriculture, forestry and fishing (01-15)
Food, drink and tobacco (15-16)
Textiles, leather, footwear and clothing (17-19)
Wood, products of wood and cork; pulp, paper and paper products, printing publishing (20-22)
Rubber and plastics (25)
Non-metallic mineral products, furniture, miscellaneous manufacturing (26, 36-37)
Basic metals and fabricated metal products (27, 28)
Mechanical engineering (29)
Construction (45)
Sale, maintenance and repair of motor vehicles and motorcycles (50)
Wholesale trade (50)
Retail trade (52)
Hotels and catering (55)
Railways (601)
Other inland transport, water transport (602-603, 61)
Supporting and auxiliary transport activities, activities of travel agencies (63)
Post and courier activities (641)
Real estate (70)
Health and social work (85)
Other community, social and personal services (90-93)

**ICT-skilled employment and productivity results****Appendix Table 16: Summary results from simple productivity regressions**

Dependent variable: gross value added per employee	ICT employment	P-value	Adjusted R <sup>2</sup>	Number of observations
Austria	0.48	0.0313	0.13	30
Germany	0.90	0.0104	0.17	33
Spain	0.91	0.0155	0.12	40
Finland	0.67	0.0442	0.12	26
France	0.66	0.0016	0.24	36
<i>Italy</i>	<i>0.39</i>	<i>0.0933</i>	<i>0.05</i>	<i>41</i>
Portugal	0.91	0.0171	0.26	18
United Kingdom	0.18	0.0102	0.19	30

Notes: The productivity data refer to 2001 and the employment data to 2003. Some outliers have been removed. Results in italics are significant at the 10% level.

Source: OECD, based on EULFS and NewCronos (2004).