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ICT Employment Statistics in Europe: Measurement Methodology

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List of Acronyms

ANBERD – Analytical Business Enterprise Research and Development Database

HRST - Human Resources for Science and Technology

ICT – Information and Communication Technologies

ILO – International Labour Organization

ISCED – International Standard Classification of Education

ISCO – International Standard Classification of Occupations

ISIC – International Standard Industrial Classification

LFS – Labour Force Survey

NA – National Accounts

OECD – Organization of Economic Development

SBS – Structural Business Statistics

SOC - Standard Occupational Classifications

STAN – Structural Analysis Database

1. Introduction

The employment shifts associated with Information and Communication Technologies (ICT) have had a ground-breaking impact on economies all over the world and have been a major concern for policymakers and private business in recent decades. Though the need to precisely capture and carefully analyze the employment effects associated with the production and deployment of ICT has been widely recognized, policy debate about ICT-related employment has not been well-informed by good quality statistical information on the structure of the ICT labour market. In part, this has been due to the absence of an agreed terminology for describing and quantifying ICT occupations both inside and outside the ICT sector.

This paper aims to supply an empirical researcher with some methodological insights on how to describe the ICT employment landscape in the EU countries. It provides background information on the different taxonomies used to capture ICT employment dynamics, and summarises the opportunities and challenges related to the data. This paper's primary objective is to stimulate and promote discussion rather than to provide a definitive solution. This is not a research paper but rather a technical note, intended for empirical economists dealing with the employment statistics.

2. Working taxonomies

This chapter provides an overview of international practices relevant to ICT jobs classification. In the absence of a unified and internationally accepted definition of ICT employment, we offer several working taxonomies developed by contrasting approaches used by, on the one hand, the ILO, the OECD and other competent technical bodies, and on the other, reputable researchers who tackle employment and ICT-related issues empirically at the international level. Flexibility in defining ICT employment allows us to choose an appropriate definition with the data at hand.

There are several important dimensions of skills and industry structure that may help in a descriptive analysis of ICT employment dynamics. In this paper, the following three groups of taxonomies are considered:

1. *ICT sector taxonomy* groups industries based on whether they produce ICT goods and services, or whether or not they use ICT intensively.
2. *ICT occupations taxonomy* concentrates on the use of ICT by skilled labour.
3. *ICT skills taxonomy* focuses on general labour force skills, defined by educational attainment.

This threefold approach allows us to capture different aspects of ICT employment dynamics fairly precisely. This approach was mainly motivated by the incompatibility between the pervasive and highly-dynamic nature of ICT economic impact on the one hand, and by an absence of an official ICT employment definition and the restrictive character of the available official data-sets on the other.

2.1 ICT sector taxonomy

Though hypothetically there is no linear relation between the size of the ICT sector and the dynamics of ICT-related employment in a broad sense, the question of the role of the ICT-producing sector has been intensively debated, in particular from the perspective of a comparison of European economies in terms of ICT specialisation with that of other regions of the world. The legitimate concern as to whether the ICT sector fully captures the total employment engaged in production of ICT goods and services is based on the fact that, in practice, ICT production can be found everywhere in the economy. However, the identification of employment in the sectors whose *main activity* is to produce or distribute ICT products constitutes *a first-order approximation of the ICT employment*.

The ICT sector is identified according to the OECD definition, first released in 1998 and further revised in 2002 and in 2007.²

The original OECD definition of the ICT sector included a combination of manufacturing and services industries that capture, transmit and display data and information electronically (OECD, 2002a). The definition was based on an international standard classification of activities (ISIC Rev. 3) and acted as a first attempt to break the traditional ISIC dichotomy between manufacturing and services activities. The 1998 definition was a compromise, limited to those industries which facilitate, by electronic means, the processing, transmission and display of information. It excluded those industries that create information: the “content” industries.

² See OECD 2011 and Annex 1.

The 2002 revision considered country experiences in ICT specialisation ratios and as a result, the definition was amended, as shown in Annex 1, Box 4. The main difference between the 2002 OECD definition and the previous one is in the refinement of ICT wholesaling that became possible because of changes in the 2002 revision of ISIC.

Following the agreement on the classification of ICT goods in 2003 and on ICT services in 2006, and the 2007 update of the ISIC to Rev. 4 (which was effectively completed by March 2006), the OECD further revised its definition of the ICT sectors and released its *complete* 2006-07 definition.³ The main changes to the 1998 and 2002 definitions discussed and finalised by the OECD can be summarized as follows.⁴ Thanks to the ISIC's Rev. 4 better focus on identifying the ICT industries, it became possible to make the OECD definition more precise. In *ICT manufacturing*, five ICT subsectors⁵ were added. At the same time, it was decided to exclude sectors that produce measurement and control instruments, appliances, and equipment.⁶ The argumentation behind exclusion the above sectors was based on the fact that ICT is embedded into a growing number of products that are manufactured using electronic processing to perform some detection, recording or process control, and it would become increasingly difficult to distinguish industries that do use electronic processing in a significant way from those that do so in an incidental way. The *ICT services* grew up to twelve subsectors.⁷ According to the Working Party on Indicators for the Information Society (WPIIS), such narrowing of the definition will lead to a clearer message, and therefore useful analysis.

Empirical literature on economic growth and productivity often divides the economy into segments depending on the extent to which single industrial sectors are involved in the production or use of ICT goods and services. Thus, some authors (like Inklaar et al, 2005) group sectors into *three* aggregate categories – ICT-producing sectors, ICT-using sectors and non-ICT-using sectors. O'Mahony and van Ark (2003) apply a more detailed approach and divide industries into the following *seven* groups:

- ICT-producing manufacturing,
- ICT-producing services,
- ICT-using manufacturing,
- ICT-using services,
- Non-ICT manufacturing,
- Non-ICT services,
- Non-ICT other services.

This latter categorization is based on the OECD classification⁸ and aims to both distinguish the ICT-producing sectors and separate industries that make intensive use of ICT from those that do not. This methodology follows Stiroh (2002) and uses the share of ICT capital

³ OECD, 2011

⁴ See OECD, 2006 for a more technical discussion

⁵ 261 *Manufacture of electronic components*, 262 *Manufacture of computers and peripheral equipment*, 263 *Manufacture of communication equipment*, and 264 *Manufacture of consumer electronics*, 268 *Manufacture of magnetic and optical media*

⁶ In ISIC Rev.3.1 these correspond to 3312 *Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment* and 3313 *Manufacture of industrial process control equipment*.

⁷ 9511 *Repair of computers and peripheral equipment* and 9512 *Repair of communication equipment*

⁸ OECD, 2002a.

in total capital services in the US as a measure of ICT intensity. O'Mahony and van Ark (2003) list two reasons for applying the classification based on ICT intensity in the US to all countries. The first has to do with the very limited availability of data on ICT investment by detailed industry outside the US. The second reason is based on the assumption that, given the leading role of the US as regards the distribution of ICT, use in the US presents a set of technological opportunities, which may or may not have been taken up in other countries.⁹ Van Ark *et al.* (2002) show that the ranking of ICT intensity across industries is reasonably similar in the US and the EU.

Some may argue that sector classification by ICT use intensity is not a straightforward approach since nearly every part of the economy uses ICT nowadays. However, since the bulk of studies report estimates that distinguish different groups of sectors as determined above in terms of productivity and innovativeness, we believe that checking whether employment dynamics for these industries delivers any interesting messages about the relation between ICT and employment is a valid methodological framework.

2.2 ICT occupations taxonomy

Unfortunately, there is no ready-to-use internationally agreed list of ICT-related occupations within the existing European Standard Classification of Occupations (ISCO-88 and ISCO-08).

ISCO, which is a product of the harmonization of national occupational classifications across the European Union,¹⁰ groups jobs together in occupational units and more aggregate occupational groups mainly on the basis of the similarity of skills required to fulfil the tasks and duties of the jobs. The framework for constructing ISCO-88 has been mainly based on the concept of the kind of work performed (job) and the concept of skill. *Job* is defined as a set of tasks and duties executed by a person.¹¹ A set of jobs whose main tasks and duties are characterised by a high degree of similarity constitutes an occupation. People are classified by occupation through their relationship to a past, present or future job. *Skills* are defined as the ability to carry out the tasks and duties of a given job. Two dimensions of the skills concept are used in the definition of ISCO groups:

- skills level, which is a function of the range and complexity of the tasks involved, where the complexity of tasks has priority over the range; and
- skills specialization, which reflects type of knowledge applied, tools and equipment used, materials worked on, or with, and the nature of the goods and services produced.

The focus in ISCO is on the skills required to carry out the tasks and duties of an occupation and not on whether a worker in a particular occupation is more or less skilled than another worker in the same or other occupations.

When the latest version of ISCO-08 was developed, the ILO decided to construct a number of thematic groupings, which would allow standardised definition and aggregation of data according to a particular theme independently of skills level and other criteria used to design the main structure of the classification. One of the proposed thematic views was *ICT*

⁹ O'Mahony and van Ark, 2003.

¹⁰ The current version, ISCO-08, was adopted in 2008 and is the fourth iteration of the classification, following ISCO-88, ISCO-58 and ISCO-66.

¹¹ See Eurostat Manual by Andersson, R. and A-K. Olsson, 1999, for more details.

occupations, defined as "all occupations that require skills in the production of ICT goods and services."¹² Whilst formal agreement on the content of this thematic view has not taken place, candidate occupations for inclusion in the ICT group included the ISCO-08 occupational units as presented in Annex 2, Table 4. To our knowledge, the only publicly available documentation of an attempt made by the ILO to broadly define ICT occupations throughout all ISCO groups was the ILO Discussion Paper by D. Hunter. It lists the ICT-specific groups in ISCO-88, overviews the conceptual model to be used for ISCO-08, describe policy and data problems with ICT occupations, identifies the ISCO occupations that produce ICT goods and services and suggests a thematic grouping for ICT occupations for ISCO-08.¹³

In July 2012 ILO released the International Standard Classification of Occupations (ISCO-08). Volume 1: Structure, Group Definitions and Correspondence Tables,¹⁴ where the ICT occupations were defined within Professionals and Technical occupations. More specifically, it identifies *professional and associate professional occupations* in ICT as sub-major groups at the second level of the classification as shown in Annex 2, Box 9. Additionally, ILO (2012) suggests that the thematic view for ICT occupations will also include a number of other unit groups that primarily involve the production of ICT goods and services such as:

- 1330 ICT Service Managers
- 2152 Electronic Engineers
- 2153 Telecommunication Engineers
- 2166 Graphic and Multimedia Designers
- 2356 Information Technology Trainers
- 2434 ICT Sales Professionals
- 7422 ICT Installers and Servicers

The above ILO classification of ICT occupations refer to ISCO-08, which will apply to the LFS data starting from 2011.

There has been a great deal of variety in ICT occupations as classified by researchers in different countries, partly because of the different official Standard Occupational Classifications (SOC) in each country and partly because of changes over time in occupational structures. According to the US Career Guide to Industries¹⁵ and the US Occupational Outlook Handbook,¹⁶ which provides information on careers from an occupational perspective, ICT occupations can be found in the following occupational groups:

1. Computer scientists and database administrators,
2. Software Publishers,
3. Wholesale Trade,
4. Scientific Research and Development Services,
5. Computer Systems Design and Related Services.

¹² This is an unofficial and unpublished working definition, obtained from the ILO

¹³ Hunter, 2006.

¹⁴ ILO (2012)

¹⁵ <http://www.bls.gov/oco/cg/>

¹⁶ <http://www.bls.gov/oco/oco1002.htm>

Another approach was developed by Mason et al (2002) who defined ICT occupations based on the UK SOC in use in 2000 to comprise the following three categories (see the detailed break-down of occupations in Annex 3, Table 5):

1. IT/computing occupations,
2. Electronic/electrical occupations,¹⁷
3. Telecommunications and broadcasting occupations not elsewhere specified.

For the time being, in the absence of an official definition of ICT occupations throughout all ISCO major groups, we favour the ICT occupations classification based on the ILO Discussion Paper by D. Hunter¹⁸ for the ISCO-88 and by ILO (2012) for the ISCO-08. However, official data from ISCO at a 4-digit disaggregation level is scarce, which forces the imposition of certain restrictive assumptions when producing descriptive statistics. Owing to data availability, only 3-digit ISCO occupational classes could be selected. This working definition identifies total employment in the ICT work force from an occupational rather than an industry perspective and allows us to capture ICT employment outside the ICT sector (for example, ICT employment in the automotive sector).

Additionally, we suggest grouping ICT occupations into high- and low-skilled categories. One of the ways to do this is applied by the OECD (2002a), which groups ICT occupations as follows:

- the *high-skill* ICT occupations:
 - computing professionals (213, including computer systems designers and analysts, computer programmers, computer engineers);
 - computer associate professionals (312, including photographers and image and sound recording equipment operators, broadcasting and telecommunications equipment operators);
 - optical and electronic equipment operators (313, including computer assistants, computer equipment operators, Industrial robot controllers).
- the low-skill ICT occupations:
 - electrical and electronic equipment mechanics and fitters (724);
 - computer workers defined as the sum of 213 and 312.

An alternative way of discriminating between high- and low-skilled ICT employment is to look directly at the level of education for each occupation. This grouping is particularly useful in view of the analysis of the impact of ICT on employment dynamics and structure. It is often believed that when new technologies are introduced into the production process, demand drops for low-skilled workers and rises for high-skilled workers. Recently, a more nuanced way to look at the employment dynamics was considered in academic literature: production and deployment of ICT is expected to increase demand for non-routine jobs, both skilled and unskilled, and to reduce demand for routine jobs, both skilled and unskilled. This type of employment dynamics was called job polarization.

¹⁷ They 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.

¹⁸ The basis for the ICT group is provided by the 4-digit ISCO classification (i.e. unit groups) as presented in Annex 2, Box 6 and Box 7.

2.3 ICT skills taxonomy

ICT skills, knowledge and competencies are the outcome of many factors, but the most important and also the most exploited in research, is formal education and training. Real skills are difficult to measure, and proxies are often needed to capture observable characteristics such as educational attainment. Here by "skills" we understand the field and the level of formal education defined in terms of the International Standard Classification of Education (ISCED-97). Obviously, there are connections between ISCED-97 fields and ISCO-88, but it should be remembered that they classify different statistical units using different criteria. Fields of education classify educational programmes by subject content and ISCO-88 classifies occupations using the set of tasks and duties executed by a person.

Two different outcomes can be derived from using educational data. The first is the allocation of ICT occupations based on the educational attainment of the worker. This approach can be seen as a robustness check on the ICT occupational taxonomy and would capture those ICT jobs that do not directly appear among official ICT occupations. The second is a division of ICT employment into skill-groups based of the level of educational attainment. One can think of three such groups: high-, medium- and low-skilled intensive occupations.

Two basic approaches can be used to form *skill groups*. The first is a manual grouping system, based on simple criteria: the average proportion of each skill category with respect to total employment is taken for each industry or occupation sub-group. The second is based on a wage-weighted grouping: the employment data is weighted by the relative wages of each skill group.

By allocating employment units according to the skill levels reported in the official Eurostat data and based on the ISCED-97, the low, medium and high skilled groups can be, for example, defined as follows:¹⁹

- low: pre-primary, primary and lower secondary education (ISCED 0-2),
- medium: upper secondary education (ISCED 3),
- high: total tertiary education (ISCED 5-6).

¹⁹ O 'Mahony and B. Van Ark, eds, (2003).

3. Data sources

3.1 ICT sector taxonomy

The underlying data to which this taxonomy should be applied can be obtained from the Eurostat National Account (NA), Eurostat Structural Business Statistics (SBS), OECD Structural Analysis Statistics (STAN), and partly from the Labour Force Survey (LFS).

The main data source that should primarily be considered is the Eurostat NA data, NACE Rev.2 (1000s of people employed, including employed and self-employed people).

The level of aggregation available in the NA is 2-digit, which means that the precise application of the OECD definition is problematic. In particular, the ICT sector definition using the 2-digit aggregation incorporates the following imprecision (see Box 1 for details):

- 26 instead of 2610, 2620, 2630, 2640 and 2680,
- not possible to account for ICT trade,
- not possible to account for 5820,
- 61 instead of 6110, 6120, 6130, 6190,
- 62 and 63 appear as one aggregate sector,
- 95 instead of 9511 and 9512.

Box 1. Adopted version of the 2006-07 definition of the ICT sector subject to the NA data constraints (sectors that are not available are shaded)

ICT manufacturing industries

26	Manufacture of computer, electronic and optical equipment
2610	Manufacture of electronic components and boards
2620	Manufacture of computers and peripheral equipment
2630	Manufacture of communication equipment
2640	Manufacture of consumer electronics
2680	Manufacture of magnetic and optical media

ICT trade industries

465	Wholesale of information and communication equipment
4651	Wholesale of computers, computer peripheral equipment and software
4652	Wholesale of electronic and telecommunications equipment and parts

ICT services industries

	5820	Software publishing
61		Telecommunications
	6110	Wired telecommunications activities
	6120	Wireless telecommunications activities
	6130	Satellite telecommunications activities
	6190	Other telecommunications activities
62		Computer programming, consulting and information service activities
	6201	Computer programming activities
	6202	Computer consultancy and computer facilities management activities
	6209	Other information technology and computer service activities
631		Data processing, hosting and related activities, and web portals
	6311	Data processing, hosting and related activities
	6312	Web portals
95		Repair of computers and personal and household goods
951		Repair of computers and communication equipment
	9511	Repair of computers and peripheral equipment
	9512	Repair of communication equipment

Another drawback to the NA data is that up to 20% of data entries are missing. In particular, the following data are not present in the NA:²⁰

- data for Iceland,
- sector-specific data for Bulgaria, Luxembourg, Malta, Poland, Romania, Lichtenstein, the Former Yugoslavia (only totals are available for these countries),
- sector 26 for Former Yugoslavia,
- sector 61 for Former Yugoslavia, Estonia,
- sector 95 for Former Yugoslavia, Estonia, Switzerland, Portugal.

One way to overcome these data constraints is to fill in the missing entries using the sub-sector weight derived from the SBS or LFS data. However, one should bear in mind that employment reported in SBS and in LFS refers to different statistical units and is hence not fully comparable to the NA, which may produce statistical errors.

3.2 ICT occupations taxonomy

The primary underlying data suitable for the ICT occupations taxonomy are supplied by the LFS, which gives information on those employed in ICT occupations. A well-known limitation of this type of data is that they are based on self-declared occupations.

We favour building an ICT occupations' taxonomy as defined by the ILO discussion paper by D. Hunter (2006) for ISCO-88. A more updated, but still unpublished ILO definition, discussed in the previous chapter, is based on ISCO-08 and could only be applied to the LFS data from 2011 onwards. The LFS provides ISCO classifications of occupations at the 3-digit level of disaggregation. See Box 2 for the detailed information on the data available for reproducing the ILO definition of ICT occupations.

Additionally, for a more complete mapping of the ICT occupations, the following sub-groups could be added up to the ILO taxonomy presented in Box 2:

1236 Computing services department managers

2356 Information technology trainers

8283 Electronic-equipment assemblers

Starting from the year 2011, ISCO-08 was applied to the EU LFS data, which made it possible to construct the ICT-occupations group applying one of the approaches presented in Boxes 7-9 in Annex 2.

²⁰ Apart from Poland and Romania, missing of the above data may not seem dramatic since other countries are not part of the EU.

Box 2. ICT occupations in ISCO-88 subject to LFS data constraints

21 Physical, mathematical and engineering science professionals

213 Computing professionals

- 2131 Computer systems designers and analysts
- 2132 Computer programmers
- 2139 Computing professionals not elsewhere classified

31 Physical and engineering science associate professional

312 Computer Associate Professionals

- 3121 Computer assistants
- 3122 Computer equipment operators
- 3123 Industrial robot controllers

74 Electro-technology trade workers

742 Electronics and telecommunications installers and repairers

- 7421 Electronics fitters
- 7422 Electronics mechanics and servicers
- 7423 Information and communications technology installers and servicers
- 7244 Telegraph and telephone installers and servicers
- 7245 Electrical line installers, repairers and cable jointers

3.3 ICT skills taxonomy

The primary underlying data suitable for this taxonomy are supplied by the LFS, which distinguishes between the levels of educational attainment officially obtained according to the ISCED-97 classifications.

LFS data provides information on ICT skills proxied by ICT-related education (independently from the official allocation to any specific industry of occupation). This data is available from 2003 onwards. LFS provides detailed information on field of education according to the ISCED, on the basis of uniform and internationally-agreed definitions. The ISCED that is currently in use by the official statistical authorities was adopted by UNESCO in 1997.²¹

ISCED distinguishes between 25 fields of education that are grouped into broader categories based on similarities. ICT education falls into the category 48 "Computing" and is represented by two sub-groups, 481 "Computer science" and 482 "Computer use" (see Annex 4, Box 8 for more details on ISCED-97 grouping of ICT fields of education).

"Computer science"²² is the study of the design and development of computer systems and computing environments. It includes the study of the system design, computer programming, data processing, networks, and operating systems - i.e. design, maintenance and integration of software applications. Programmes with the following main content are classified here:

- Computer programming,
- Computer science,

²¹ A new ISCED-2011 will be implemented on the data started from 2014.

²² Andersson, R. and A-K. Olsson, 1999.

- Computer system analysis,
- Computer system design,
- Informatics,
- Network administration,
- Operating systems,
- Programming languages (Visual Basic, C++ etc.).

"Computer use"²³ is the study of using computers and computer software and applications for different purposes. These programmes are generally of short duration. Programmes with the following main content are classified here:

- Computer use,
- Software for calculating (spreadsheets),
- Software for data processing,
- Software for desk top publishing,
- Software for word processing,
- Use of Internet.

Computer engineering (hardware) falls outside these two fields though it is included in field 523 "Electronics and automation". Electronics and automation is the study of planning, designing, developing maintaining and monitoring electronic equipment, machinery and systems. It includes designing computers and equipment for communication. Unfortunately, LFS does not include this code in the set of categories used to capture fields of education.

Additionally, LFS provides detailed information on level of education according to the ISCED-97. The notion of "levels" of education is related to the degree of complexity of the content of the programme. LFS provides 2-digit levels of education for all 7 ISCED categories (from ISCED-0 to ISCED-6).

As a first approximation of ICT occupations grouping into 3 skill-groups, one can use the ready-made classification incorporated in the LFS: low, medium and high level of education categories for a 1-digit variable "Level of education".

Alternatively, ISCED-97 levels of education can be allocated to low-, medium- and high-skilled groups using approaches described in the previous Chapter.

²³ Idem.

4. Conclusions

This technical note suggests that the ICT employment landscape can be captured from three different angles: employment in ICT-intensive sectors, employment in ICT-intensive occupations and people employed with ICT-specific skills. This 3-fold approach to ICT employment taxonomies also reflects the logic followed in the literature and policy discussion on the relation between ICT and employment. That is to say, it goes from a relatively static sector approach to a more flexible framework that allows us to capture ICT-related labour outside the ICT sector and, furthermore, outside standard ICT occupations, as follows.

The ICT sector taxonomy can be related to neoclassical growth accounting literature and also to those EC policy initiatives that focus on the production of ICT goods and services and ICT capital deepening. *The ICT occupations taxonomy* goes beyond the ICT-producing sector and reflects the employment dynamics determined by the deployment of ICT-enabled innovations in an economy-wide context. These two taxonomies identify ICT employment in its official manifestation in either industry or occupational frameworks and capture those workers directly involved with ICT hardware and software design, production and maintenance. The third, *ICT skills taxonomy*, goes further and attempts to capture labour input from those workers who have ICT-related education but do not necessarily belong to the ICT sector or occupy ICT jobs.

Each of the above three taxonomies has its drawbacks and unavoidably leaves out certain aspects of ICT employment. In order to capture ICT employment with greater precision, it is recommended to mix industry, occupations and skills in generating a cross-tabulation (when the data allows doing so).

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Annexes

Annex 1: OECD definition of the ICT sector²⁴

Box 3. The 1998 definition of the ICT sector (based on ISIC Rev. 3)

Manufacturing

- 3000 Manufacture of office, accounting and computing machinery
- 3130 Manufacture of insulated wire and cable
- 3210 Manufacture of electronic valves and tubes and other electronic components
- 3220 Manufacture of television and radio transmitters and apparatus for line telephony
- 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 control equipment

Services – goods related

- 5150 Wholesale of machinery, equipment and supplies*
- 7123 Renting of office machinery and equipment (including computers)

Services – intangible

- 6420 Telecommunications**
- 7200 Computer and related activities

Notes:

* Countries were asked to include only those sub-sectors that directly provide ICT wholesaling services.

** 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.

Box 4. The 2002 definition of the ICT sector (based on ISIC Rev. 3.1)

ICT Manufacturing

- 3000 Manufacture of office, accounting and computing machinery
- 3130 Manufacture of insulated wire and 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 control equipment

ICT Services

- 5151 Wholesale of computers, computer peripheral equipment and software
- 5152 Wholesale of electronic and telecommunications parts and equipment
- 6420 Telecommunications
- 7123 Renting of office machinery and equipment (including computers)
- 72 Computer and related activities

²⁴ OECD 2011 Guide to measuring the information society.

Box 5. The 2006-07 definition of the ICT sector (based on ISIC Rev. 4 or NACE Rev.2)

ICT manufacturing industries

- 26 Manufacture of computer, electronic and optical equipment
 - 2610 Manufacture of electronic components and boards
 - 2620 Manufacture of computers and peripheral equipment
 - 2630 Manufacture of communication equipment
 - 2640 Manufacture of consumer electronics
 - 2680 Manufacture of magnetic and optical media

ICT trade industries

- 4651 Wholesale of computers, computer peripheral equipment and software
- 4652 Wholesale of electronic and telecommunications equipment and parts

ICT services industries

- 5820 Software publishing
- 61 Telecommunications
 - 6110 Wired telecommunications activities
 - 6120 Wireless telecommunications activities
 - 6130 Satellite telecommunications activities
 - 6190 Other telecommunications activities
- 62-63 Computer programming, consulting and information service activities
 - 6201 Computer programming activities
 - 6202 Computer consultancy and computer facilities management activities
 - 6209 Other information technology and computer service activities
- 631 Data processing, hosting and related activities, and web portals
 - 6311 Data processing, hosting and related activities
 - 6312 Web portals
- 95 Repair of computers and personal and household goods
- 951 Repair of computers and communication equipment
 - 9511 Repair of computers and peripheral equipment
 - 9512 Repair of communication equipment

Note:

* From OECD (2006a). The codes and titles were checked against the final (November 2008) version of ISIC Rev. 4.

Annex 2: ILO definition of the ICT employment

Box 6. Sub-major, minor and unit groups containing ICT occupations in ISCO-88

12 Corporate managers

123 Other department managers

1236 Computing services department managers

21 Physical, mathematical and engineering science professionals

213 Computing professionals

2131 Computer systems designers and analysts

2132 Computer programmers

2139 Computing professionals not elsewhere classified

31 Physical and engineering science associate professional

312 Computer Associate Professionals

3121 Computer assistants

3122 Computer equipment operators

3123 Industrial robot controllers

Source: D. Hunter (2006)

Box 7. Sub-major, minor and unit groups containing ICT occupations in ISCO-08

13 Production and operations managers

133 Information and communications technology services managers

1330 Information and communications technology services managers

23 Teaching professionals

235 Other Teaching professionals

2356 Information technology trainers

25 Information and communications technology (ICT) professionals

251 Software and multimedia developers and analysts

2511 Systems analysts

2512 Software developers

2513 Web and multimedia developers

2519 Software and multimedia developers and analysts not elsewhere classified

252 Database specialists and systems administrators

2521 Database designers and administrators

2522 Systems administrators

253 ICT network and hardware professionals

2531 Computer network professionals

2532 Telecommunications engineering professionals

2529 ICT network and hardware professionals not elsewhere classified

35 Information and communications technicians

351 ICT operations and user support technicians

3511 ICT operations technicians

3512 ICT user support technicians

352 Web technicians

3520 Web technicians

353 Applications development and testing technicians

3531 Applications programmers

3532 Systems testing technicians

354 Communications Technicians

- 3541 Broadcasting and recording technicians
- 3542 Telecommunications engineering technicians

74 Electrotechnology trades workers**742 Electronics and telecommunications installers and repairers**

- 7421 Electronics fitters
- 7422 Electronics mechanics and servicers
- 7423 Information and communications technology installers and servicers

Source: D. Hunter (2006)

Box 8. Sub-major, minor and unit groups containing ICT occupations in ISCO-08**24 Business and Administration Professionals****243 Sales, Marketing and Public Relations Professionals**

- 2434 Information and communications technology sales professionals

25 Information and communications technology professionals**251 Software and multimedia developers and analysts**

- 2511 Systems analysts
- 2512 Software developers
- 2513 Web and multimedia developers
- 2514 Application programmers
- 2519 Software and multimedia developers and analysts not elsewhere classified

252 Database specialists and systems administrators

- 2521 Database designers and administrators
- 2522 Systems administrators
- 2523 Computer network professionals
- 2529 Database and network professionals not elsewhere classified

35 Information and communications technicians**351 ICT operations and user support technicians**

- 3511 ICT operations technicians
- 3512 ICT user support technicians
- 3513 Computer network and systems technicians
- 3514 Web technicians

352 Communications technicians

- 3521 Broadcasting and audio-visual technicians
- 3522 Telecommunications engineering technicians

74 Electrical and electronic trades workers**742 Electronics and telecommunications installers and repairers**

- 7421 Electronics mechanics and servicers
- 7422 Information and communications technology installers and servicers

Source: ILO, "Updating the International Standard Classification of Occupations (ISCO). Draft ISCO-08 Group Definitions: Occupations in ICT" downloadable at www.ilo.org/public/english/bureau/stat/isco/docs/d2434.doc

Box 9. Professional and associate professional occupations in ICT as sub-major groups at the second level of the ISCO-08

25 Information and communications technology professionals

251 Software and multimedia developers and analysts

2511 Systems analysts

2512 Software developers

2513 Web and multimedia developers

2514 Application programmers

2519 Software and multimedia developers and analysts not elsewhere classified

252 Database specialists and systems administrators

2521 Database designers and administrators

2522 Systems administrators

2523 Computer network professionals

2529 Database and network professionals not elsewhere classified

35 Information and communications technicians

351 ICT operations and user support technicians

3511 ICT operations technicians

3512 ICT user support technicians

3513 Computer network and systems technicians

3514 Web technicians

352 Communications technicians

3521 Broadcasting and audio-visual technicians

3522 Telecommunications engineering technicians

Source: ILO (2012)

**Table 4: Occupational unit groups
considered by the ILO for inclusion into the ICT grouping, ISCO-08.**

1330	Information and Communications Technology Services Managers
2152	Electronics Engineers
2153	Telecommunications Engineers
2166	Graphic and Multimedia Designers
2356	Information Technology Trainers
2434	Information and Communications Technology Sales Professionals
2511	Systems Analysts
2512	Software Developers
2513	Web and Multimedia Developers
2514	Applications Programmers
2519	Software and Applications Developers and Analysts Not Elsewhere Classified
2521	Database Designers and Administrators
2522	Systems Administrators
2523	Computer Network Professionals
2529	Database and Network Professionals Not Elsewhere Classified
3114	Electronics Engineering Technicians
3511	Information and Communications Technology Operations Technicians
3512	Information and Communications Technology User Support Technicians
3513	Computer Network and Systems Technicians
3514	Web Technicians
3521	Broadcasting and Audiovisual Technicians
3522	Telecommunications Engineering Technicians
7421	Electronics Mechanics and Servicers
7422	Information and Communications Technology Installers and Servicers
8212	Electrical and Electronic Equipment Assemblers

Table 5: ICT occupations in the United Kingdom, based on Standard Occupational Classification 1990

IT/computing

- 126 Computer systems managers
- 214 Software engineers
- 320 Computer analysts, programmers
- 490 Computer operators
- 526 Computer engineers, installation and maintenance

Electronic/electrical

- 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)

Telecommunications and broadcasting equipment-related occupations (nes)

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

IT/computing

- 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

Electronic/electrical

- 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)

Telecommunications and broadcasting equipment-related occupations (not elsewhere specified)

- 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
-

Box 8: Extract from the ISCED-97

4 Science, Mathematics and Computing

42 Life science

421 Biology and biochemistry

422 Environmental science

44 Physical science

441 Physics

442 Chemistry

443 Earth science

46 Mathematics and statistics

461 Mathematics

462 Statistics

48 Computing

481 Computer science

482 Computer use

5 Engineering, Manufacturing and Construction

52 Engineering and engineering trades

521 Mechanics and metal work

522 Electricity and energy

523 Electronics and automation

524 Chemical and process

525 Motor vehicles, ships and aircraft

54 Manufacturing and processing

541 Food processing

542 Textiles, clothes, footwear, leather

543 Materials (wood, paper, plastic, glass)

544 Mining and extraction

58 Architecture and building

581 Architecture and town planning

582 Building and civil engineering

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Abstract

Despite the persistent need to precisely capture and carefully analyse the employment effects associated with the production and deployment of ICT, policy discussion has not been well-supported by good quality statistical information on ICT employment. In part, this has been due to the absence of an appropriate framework and agreed terminology for describing and quantifying ICT occupations both inside and outside the ICT sector. This paper aims to supply an empirical researcher with some methodological insights on how to describe the ICT employment landscape in the EU countries. It provides background information on the different taxonomies used to capture ICT employment dynamics and summarizes the opportunities and challenges related to the data. This is not a research paper but rather a technical note, intended for empirical economists dealing with employment statistics. Its primary objective is to stimulate and promote discussion rather than to provide a definitive solution.

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