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Employment of ICT Specialists in the EU (2000-2012)

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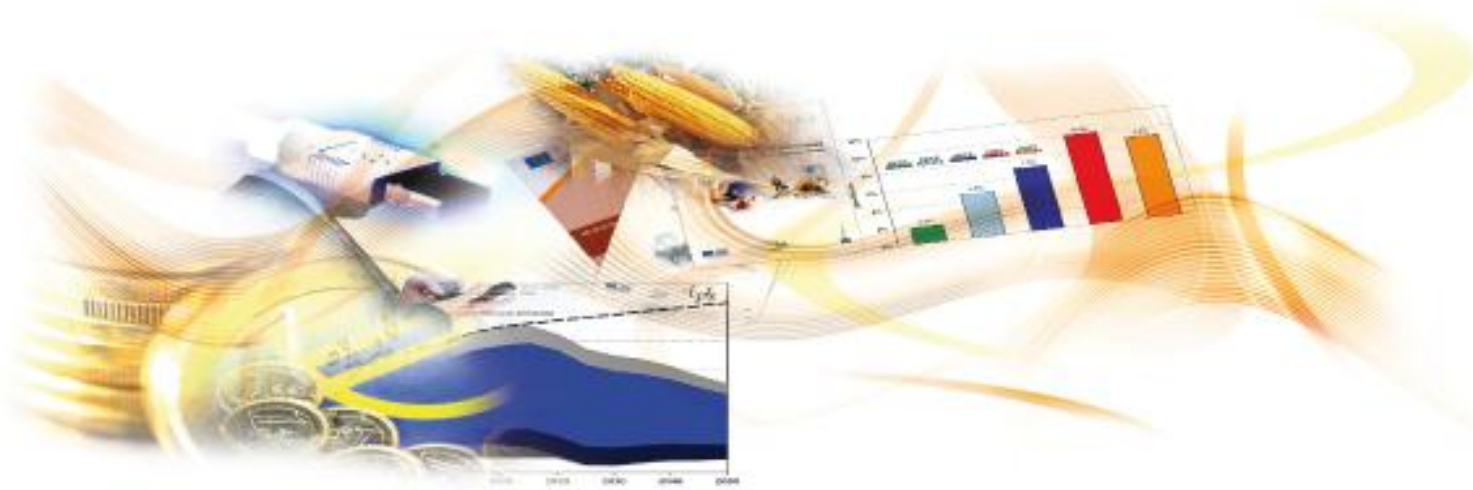
Employment of ICT Specialists in the EU (2000-2012)

Anna Sabadash

2014



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ABSTRACT

This study examines the evolution of the number of ICT-skilled workers employed in industry sectors in the EU28 over the period 2000-2012. Data are taken from the Eurostat Labour Force Statistics. It introduces a novel definition of ICT specialists that combines occupations and skills taxonomies. For the period prior to the introduction of the Standard Classification of Occupations (ISCO-08) it starts from the OECD definition but includes a wider range of ICT occupations. From 2011 onwards it adopts the thematic view for ICT occupations proposed by the ILO (2012). It confirms that employment of ICT specialists in the EU27 has been resilient to the economic downturn and uncertainty in global labour markets, and was able to maintain a growth path of 4.3% per year over the period 2000-2012, more than 7 times higher than average growth of total employment over the same period. Though ICT employment evolved cyclically it never turned negative. This rapid growth in ICT employment confirms the increasing importance of ICT technologies in the global economy.

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List of Acronyms

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

OECD – Organization of Economic Development

1 Introduction

Labour market statistics are crucial for monitoring EU employment policies. However, it is only in recent years that attention has been drawn to ICT skills and the employment of ICT specialists. The *Agenda for New Skills and Jobs (2010)*[2] – part of the *Europe 2020* overall strategy – addresses structural change in the labour market and suggests concrete actions to adapt European workers' e-skills to the changing working environment. In April 2012, the European Commission presented new measures and identified key opportunities for a job-rich recovery in its *Employment package*[3]. One of the objectives is to ensure that EU workers acquire the necessary higher-end skills in order to prevent the loss of key ICT jobs to other regions of the world[4]. The growing awareness of policy-makers of the importance of employment of ICT specialists was reflected in *the Grand Coalition for Digital Jobs*[5], launched by the European Commission in April 2013. This multi-stakeholder partnership aims to address the shortfall in the number of European citizens with ICT professional skills. Other EU policies also recommended intensification of efforts, for example, the Digital Agenda for Europe[6], the e-Skills Strategy[7], the Employment Package[8], the Opening up Education Initiative[9], the Rethinking Education Strategy[10], the Youth Opportunities Initiative[11], and the EU Skills Panorama[12].

In order to ensure that EC policies have an effective impact and take full advantage of the investments into ICT professional skills, policy initiatives need to be supported by reliable official data-based evidence and a well-grounded conceptual framework to define and measure employment dynamics for ICT specialists in Europe. This study is an attempt to further refine the definition of ICT specialists in the data and to monitor its dynamics in the EU27. It proposes a novel methodological approach that allows to better capture ICT professional skills (i.e. ICT specialists) in the EU Labour Force Survey (LFS) data.

While ICT is often used in relation to skills and employment in policy and research papers, it is easy to get confused between different terms and definitions. This paper operates with the definitions adopted by the Organization of Economic Development (OECD) and the International Labour Organization (ILO), and in doing so offers a clear distinction between several categories that – if used carelessly – may create conceptual and methodological misunderstandings.

By *ICT employment* we mean persons employed in occupations where they use ICT skills to various degrees and across all industries (as opposed to employment in the ICT sectors only). ICT employment consists of two sub-categories, ICT specialists and ICT users. In our study, we focus *exclusively on ICT specialists* (as opposed to the wider category of ICT users).

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2 EC (2010b), http://ec.europa.eu/social/main.jsp?catId=958&langId=en
3 EC COM(2012d) http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52012DC0173:EN:NOT
4 SWD(2012) 96 final
5 http://ec.europa.eu/digital-agenda/en/digital-jobs-0
6 http://ec.europa.eu/digital-agenda/
7 http://ec.europa.eu/enterprise/sectors/ict/e-skills/index_en.htm
8 http://ec.europa.eu/commission_2010-2014/andor/headlines/news/2012/04/20120418_en.htm
9 http://europa.eu/rapid/press-release_SPEECH-12-933_en.htm
10 http://ec.europa.eu/education/news/rethinking_en.htm
11 http://ec.europa.eu/social/main.jsp?catId=1006
12 http://euskillspanorama.ec.europa.eu/

This study further develops the approach described in Sabadash (2012) to operationalize the definition of ICT specialists and to combine occupations and skills taxonomies. In order to capture ICT specialists for the period prior to the introduction of the latest International Standard Classification of Occupations (ISCO-08) occupations, we build our definition on the official OECD (2004) definition. However, compared to the OECD (2004, 2010 and 2012) we depart from a narrow definition of ICT specialists and include a wider range of ICT occupations as recommended by Hunter (2006). For the period from 2011 onwards, in the absence of an official definition of ICT specialists in terms of ISCO-08 occupations, this study adopts the thematic view for ICT occupations proposed by ILO (2012). To our knowledge, this paper is the first attempt to carry out an empirical application of the latest ILO thematic view on ICT occupations.

2 Defining ICT specialists

2.1 Definition

To our knowledge, the most widely accepted official definition of ICT employment is the one introduced by OECD (2004). The OECD (2004) distinguishes between two types of ICT employment: employment in the ICT sector and ICT-skilled employment. The concept of ICT skilled employment is further developed by discriminating between its several components: ICT specialists, advanced users, and basic users (see Box1). The first category of ICT-skilled employment covers those who *supply* ICT tools, and is used by the OECD studies for what they call *narrow measure of ICT-skilled employment.* The second and third categories of the ICT-skilled employment cover those who *use* ICT tools. The sum of all three categories is used in the OECD studies for the *broad measure of ICT-skilled employment.*

Box 1. OECD Definition of ICT Employment and ICT specialists

ICT employment

1. *ICT sector employment*, defined as "employment in industries traditionally identified as belonging to the ICT sector (all occupations, even those with no use of ICTs)"; and

2. *ICT skilled employment*, defined as "employment in occupations that use ICTs to various degrees across all industries".

ICT-skilled employment

1. *ICT specialists,* who have the ability to develop, operate and maintain ICT systems. ICTs constitute the main part of their job.

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.

Source: OECD (2004)

The OECD definition of ICT skilled employment (and its different components) has been applied in several studies which aim to capture the dynamics of ICT-specific labour: for example, the OECD (2004, 2010, and 2012) applied it to the ISCO-88 occupations and Empirica (2013) applied it to the ISCO-08 occupations.

We use the same general approach, i.e. work with occupations that use ICTs to various degrees across industries (as opposed to ICT sector employment only[13]).

This study focuses exclusively on ICT specialists as defined by the OECD (2004) (Box 1). The distinction between ICT specialists and ICT users is important from both the conceptual and the methodological standpoint. Conceptually, these two categories capture two different aspects of the need for ICT skills: ICT specialists are involved in the production of ICT goods and services, while ICT users enable diffusion of ICT-based technological innovations across all economic sectors (and also all spheres of consumption).

Methodologically, these two types of skills are not equally reflected in the primary sources of European employment statistics regulated by international standard classifications. While ICT specialists can be identified with a fair degree of accuracy using ISCO on its own (see for example

[13] See OECD (2004) for a definition and Predict project of JRC-IPTS http://is.jrc.ec.europa.eu/pages/ISG/PREDICT.html for an operationalization of the definition.

OECD, 2004 and 2010, Empirica, 2013), or in combination with International Standard Classification of Education, ISCED (as in this study), ICT users can be identified in ISCO occupations only in those exceptional cases where technological developments have led to new ways of organizing work (Hunter, 2006). This happens mainly because the need for ICT-using skills among the general workforce not only varies significantly from one job to another (even within the same ISCO occupational category), but also evolves swiftly over time. For example, as described in Hunter (2006), though nursing professionals had little requirement for general skills in the use of ICT in the past, nowadays they are often required to exchange patient and diagnostic information electronically within and between hospitals and are increasingly more involved in the advanced use of ICT and ICT-enabled tools.

We diverge from OECD (2004 and 2010) by extending the range of occupations included into the definition of ICT specialists. In doing so, we build our method on Hunter (2006) for the data prior to 2011 and on the thematic view for ICT occupations proposed by the ILO (2012) for the data from 2011 onwards. We further develop the methodology described in Sabadash (2013) in combining ICT occupations and ICT skills taxonomies[14]. The *ICT occupations taxonomy* is based on the concept of job, defined as a set of tasks and duties executed by a person. The primary underlying data for the ICT occupations taxonomy are supplied by the ISCO. *The ICT skills taxonomy* is based on the ICT-related field of formal education, defined in terms of ISCED. Obviously, there are connections between ISCO occupations and ISCED fields but it should be remembered that they classify different statistical units using different criteria. ISCO classifies occupations using the set of tasks and duties while ISCED classifies educational programs by subject content. The method that allows applying our definition of ICT specialists using the combined ISCO-based occupations and ISCED-based skills taxonomies on the LFS data is described in Section 3 of this study.

2.2 Operationalization of the definition in ISCO occupations.

ISCO-88

A methodology to measure ICT specialists based on ISCO-88 was initially devised by the OECD (2004) and implemented to generate employment estimates in OECD (2004 and 2010). This methodology uses four ISCO-88 occupations*: Computing professionals (213), Computer associate professionals (312), Optical and electronic equipment operators (313), and Electrical and electronic equipment mechanics and fitters (724).*

To our knowledge, the only other attempt to lay methodological grounds for defining ICT specialists in ISCO-88 was made in the 2006 ILO Discussion Paper by D. Hunter. On top of the OECD (2004) measure, Hunter (2006) recommends including the ISCO-88 group *Computing services department managers (1236),* and indicates a number of other groups in ISCO-88 that can be considered ICT occupations such as Information technology trainers (*2359), Electronics fitters (7242) and Electronics mechanics and servicers (7243).*

Recently, another attempt to estimate ICT specialists using ISCO-88 was undertaken by Empirica (2013). This study applied a rather restricted measure to monitor the dynamics of what they call "core ICT employment"[15] in the 27 EU Member States, which included two ISCO-88 occupations, *Computer professionals (213)* and *Computer associate professionals (312).*

[14] See more in Sabadash (2013).
[15] Empirica (2013), p. 22

Table 1: Definition of ICT specialists across studies (ISCO-88)

	This study	OECD (2004)	Hunter (2006)	Empirica (2013)
Terminology used:	ICT specialists	ICT specialists	ICT occupations	Core ICT employment
1236 Computing services managers	x		x	
213 Computing professionals	x	x	x	x
2144 Electronics and telecommunications engineers	x			
2359 Information technology trainers	x		x	
3114 Electronics and telecommunications engineering technicians	x			
312 Computer associate professionals	x	x	x	x
313 Optical and electronics equipment operators	x	x	x	
724 Electrical and electronic equipment mechanics and fitters		x		
7241 Electrical mechanics, fitters and services				
7242 Electronics fitters		x		
7243 Electronics mechanics and servicers	x	x	x	
7244 Telegraph and telephone installers and servicers	x	x	x	
7245 Electrical line installers, repairers and cable jointers		x		
8283 Electronic equipment assemblers		x		
	x			

Though we use the OECD (2004) definition of ICT specialists, in this study we depart from a narrow OECD measure and include a wider range of ICT occupations from ISCO-88, mainly based on Hunter (2006). Additionally, unlike the OECD (2004), we exclude *Telegraph and telephone installers and servicers (7244)* and *Electrical line installers, repairers and cable jointers (7245).* A comparison of our suggested definition of the ICT specialists against the definitions applied in other studies are presented in Table 1.

ISCO-08

In July 2012, the ILO released *the International Standard Classification of Occupations (ISCO-08) Volume 1: Structure, Group Definitions and Correspondence Tables*. This document introduces thematic views for certain groups of occupations (including ICT) where there is a need for a standardized approach to the aggregation of occupational data according to a particular theme. The ILO thematic views represent an alternative way of aggregating data, according to an aspect of skills specialization, independently from the skills level and other criteria used to design the main structure of ISCO. More specifically, in Chapter 3.3, the ILO (2012) thematic views for ICT occupations identify *professional and associate professional occupations* in ICT as major sub-groups, and suggest the inclusion of a number of *other unit groups* that primarily involve the production of ICT goods and services (see Box A1 in Annexe).

The guiding principle for inclusion of occupations into this thematic view is their *primary involvement in the production of ICT goods and services.* On the other hand, it is proposed that occupations which require specialized skills in using ICT only as a tool, not involved in the production of ICT goods and services, be excluded. This reasoning further reinforces our belief that ICT users (either advanced or basic) cannot be accurately identified through the ISCO-based occupations.

Based on the ILO thematic views for ICT occupations, we develop our measure of ICT-skilled employment by including three occupations in addition to the ones recommended by ILO: *Electronics*

engineering technicians (3114), Electronics Mechanics and Servicers (7421)[16]*, Electrical and Electronic Equipment Assemblers (8212).*

Table 2: Definition of ICT specialists (ISCO-08)

	This study	OECD (2013)	ILO (2012)	Empirica (2013)
Terminology used:	ICT specialists	ICT-related occup-s	Occup-s involved in the provision of goods and services related to ICT	ICT workforce
133 ICT Service Managers	x	x	x	x
2152 Electronic Engineers	x	x	x	x
2153 Telecommunication Engineers	x	x	x	x
2166 Graphic and multimedia designers	x		x	
2356 Information Technology Trainers	x		x	x
2421 Management and organisation analysts				x
2434 ICT Sales Professionals	x		x	x
25 ICT professionals	x	x	x	x
251 Software and multimedia developers and analysts	x	x	x	x
2511 Systems analysts	x	x	x	x
2512 Software developers	x	x	x	x
2513 Web and multimedia developers	x	x	x	x
2514 Application programmers	x	x	x	x
2519 Software and multimedia developers and analysts not elsewhere classified	x	x	x	x
252 Database specialists and systems administrators	x	x	x	x
2521 Database designers and administrators	x	x	x	x
2522 Systems administrators	x	x	x	x
2523 Computer network professionals	x	x	x	x
2529 Database and network professionals not elsewhere classified	x	x	x	x
3114 Electronics engineering technicians	x			x
3139 Process control technicians not elsewhere classified				x
3155 Air traffic safety electronics technicians				
3211 Medical imaging and therapeutic equipment technicians				x
3252 Medical records and health information technicians				x
35 Information and communications technicians				x
351 ICT operations and user support technicians				
3511 ICT operations technicians		x		x
3512 ICT user support technicians	x	x	x	x
3513 Computer network and systems technicians	x	x	x	x
3514 Web technicians	x	x	x	x
352 Communications technicians	x	x	x	x
3521 Broadcasting and audio-visual technicians	x	x	x	x
3522 Telecommunications engineering technicians	x	x	x	x
742 Electronics and Telecommunications Installers	x	x	x	x
and Repairers	x	x	x	x
7421 Electronics Mechanics and Servicers	x	x	x	
7422 ICT installers and servicers				
8212 Electrical and electronic equipment assemblers	x	x		
	x	x		
	x	x	x	
	x			

[16] In a majority of countries, the numbers of workers reported in the EU LFS for the ISCO-08 occupation *742 Electronics and Telecommunications Installers and Repairers* (which includes two subgroups, *7421 Electronics Mechanics and Servicers and 7422 ICT installers and servicers*) is rather high compared both to other ICT occupations in ISCO-08 and to the corresponding occupational group in ISCO-88. In order to reduce the overestimation bias, we include into our definition of the ICT specialists only those workers in occupation 742 who have a relevant field of education (Computer Science or Computer Use)

3 Data and Method

3.1 Method based on combining occupations and education data

Applying the definition of ICT specialists that contains ISCO occupations at the 4-digit level of aggregation to data on employment at EU level inevitably leads to an important practical problem: about one third of the EU Member States does not collect data on occupations at the 4-digit level of aggregation.

One way to get round this practical problem is to limit the definition of ICT specialists to the 3-digit ISCO codes, provision of which is mandatory for EU Member States. This approach would achieve comparability between countries but it would inevitably lead to under-estimation (when some ICT-relevant 4-digit occupations are left out) or over-estimation (when the whole 3-digit group containing both ICT and non-ICT occupations is included).

Another way of dealing with the problem is to produce estimates for the missing data based on the available country-year observations. However, country- and year-specific aspects (reflecting both labour demand and supply factors that influence the employment dynamics of these specific occupations) would need to be carefully taken into account to ensure reliable results. While methodologically interesting, this approach could turn into a very challenging task due to the lack of a comprehensive set of variables capable of fully capturing country- and year-specific factors of labour demand and supply. Moreover, this approach may still produce inconsistent estimates of total ICT-skilled employment if the share of the missing occupations is significant.

We therefore suggest a third way of applying a definition of ICT specialists to European harmonized data. When information on the occupation of a person is not available at 4-digit level, we propose using the corresponding 3-digit group and filtering it by the variable that captures the field of education. For example, in order to identify the 4-digit occupations group *3114 (Electronics Engineering Technicians)* in ISCO-08, we use the 3-digit ISCO-08 code *311 (Physical and engineering technicians)* and select only those workers from this group who have ICT-specific education.

This method has the virtue of being easily applied to data without involving the need for complex estimation techniques. It could, however, be criticized on the grounds that there is no perfect match between field of education and type of occupation. Indeed, one's choice of occupation can be influenced by many factors besides education: competition on the labour market (Peri and Sparber, 2011), availability of vacancies, monetary and non-monetary benefits (Xu, 2013), family socio-economic background (Weidman, 1984), personal aptitudes, life context and social contacts (Bentolila et al, 2010), spatial segregation (Mookherjee et al, 2010), and others. Besides, occupational trajectories may be affected by on-the-job and off-the-job training.

However, educational attainment still remains a key variable in all empirical studies looking at occupational outcomes. Moreover, it is reasonable to assume that in a highly specialized segment of the labour market such as ICT, the field of education is instrumental in the occupational choices. Moreover, as has been shown in Ahola (1999), there is a fair degree of compatibility between educational and occupational structures in European countries at aggregate level.

We believe that the methodology that we suggest provides a straightforward and reliable way of detecting ICT occupations at the finest level of ISCO aggregation using the available harmonized official data on EU employment and taking into account its constraints.

3.2 EU LFS

The data used in this report comes from the EU Labour Force Survey (LFS), which is the main source for labour market statistics in Europe[17]. Our analysis covers *27 EU countries*: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.

The EU LFS is survey-based and uses only a sample of population. As a result, LFS data are subject to the usual types of errors associated with sampling techniques and interviews[18]: sampling errors, non-sampling errors, measurement errors, processing errors and non-response are calculated for each country and documented in Eurostat (2009). Subject to Eurostat's quality screening, figures on employment fulfil the Eurostat requirements concerning reliability. Regardless of the sampling method or which age groups are interviewed, the data records at Eurostat are representative for the population aged 15-74 (16-74 in Iceland, Italy, Norway, Spain, and the UK)[19].

While, as a rule, perfect comparability between countries would be difficult to achieve, even if there was a single direct survey (carried out at the same time, using the same questionnaire and a single method of recording), the degree of comparability of the EU LFS results is considerably higher than that of any other existing set of individual-level statistics on employment in the EU. This is due to the recording of the same set of characteristics in each country, a close correspondence between the EU list of questions and the national questionnaires, the use of the same definitions for all countries, the use of common classifications (NACE for economic activity, ISCO for occupations, and ISCED for education) and the data being centrally processed by Eurostat.

The data extractions were provided by Eurostat and are based on the quarterly sample survey. The extractions are based on the best sample available for a given year and the variables requested and correspond either to one single quarter (generally second quarter), or to a sub-sample distributed along the year (sample size is usually equivalent to one reference quarter). The inclusion of the variable that describes the field of education among the employment characteristics of the respondents (which is collected only on an annual basis) resulted in the use of the yearly data in this report. The EU LFS achieved sample sizes of approximately 1.8 million individuals each quarter, with the quarterly sampling rates varying between 0.2% and 1.5% in each country. The data extractions cover the population in private households in the EU and candidate countries, and provide employment characteristics of people aged 15 and over.

We provide the *main set of estimates of ICT specialists using occupations/education data* for the 9 year *period* from 2004 till 2012. The lower bound of our timeframe is determined by the availability of data in the field of education based on the International Standard Classification of Education (ISCED)[20]. However, for the sake of comparison with other similar studies (OECD, 2010, and Empirica, 2013), we also provide *estimates based on the OECD narrow measure of ICT-skilled employment*[21] starting from 2000. All data tables and charts run to 2012, which was the most recent year for which data was available when the present analysis was conducted.

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17 Two other frequently used source for employment statistics are national accounts and enterprise statistics.

18 "EU labour force survey" - Statistics Explained (2013/12/0) http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/EU_labor_force_survey

19 http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/lfsq_esms.htm

20 http://www.uis.unesco.org/Education/Pages/international-standard-classification-of-education.aspx

21 OECD *narrow measure* of ICT-skilled employment covers those who supply the ICT tools (ICT specialists in Box 1); OECD *broad measure* of ICT-skilled employment covers those who supply and those who use ICT tools (the sum of ICT specialists, ICT advanced and ICT basic users in Box1). See OECD (2004) for more details.

3.3 Measure of ICT specialists using occupations/education methodology

In order to highlight the main employment trends of ICT specialists per country and over the whole sample, we use the number of people working in local units (number of persons employed, weighted per 1000 workers). *Persons in employment* are defined based on the ILO international standards and comprise people:

- aged 15 year and over;
- who during the reference week worked, even if they did so for just one hour a week, for pay, profit or family gain;
- who were not at work but had a job or business from which they were temporarily absent because of, e.g., illness, holidays, industrial dispute or education and training.

The number of ICT specialists and their share in total employment were constructed using the occupational and educational level of disaggregation over one- and two-digit industries using the method described above.

ISCO-based occupations

Information on occupations was drawn from the ISCO classification[22] which is the only standardised classification of occupations implemented in the EU Labour Force Survey. ISCO provides comparable data for most European countries. However, usage of ISCO introduces several drawbacks when applied to mapping of ICT specialists.

The first drawback is related to the fact that it is less detailed than the classifications available for countries such as, for example, the United States or Australia. This shortcoming is specifically referred to in OECD (2004), and resulted in the exclusion of occupations such as electronic engineers from the OECD narrow definition, despite the fact that these workers may be heavily involved in jobs relating to production of ICT hardware. As a result, studies based on the OECD narrow definition of ICT occupations are likely to underestimate the number of ICT specialists[23].

The second drawback is related to the break in the time series. Two versions of ISCO were applied for the corresponding sub-periods, ISCO-88 until 2010 and ISCO-08 from 2011 onwards. Since the transition of the EU Labour Force Survey to ISCO-08 in the first quarter of 2011, the national statistical offices stopped collecting ISCO-88-based information for reasons of survey cost. At the same time, due to the absence of one-to-one correspondence tables between ISCO-88 and ISCO-08, the new classification was not applied by the LFS Unit of Eurostat to re-construct the old series retrospectively. For this reason, mapping between the two categories of ICT specialists based on different ISCO classifications is not advisable. While we favour the use of two separate measures constructed as described in the previous chapter (Table 1 and 2) corresponding to two sub-periods (2004-1010 and 2011-2012), we provide a tentative re-construction of the series of ICT specialists for the period 2004-2010 in terms of ISCO-08 occupations. To this end, we use the ILO official correspondence tables between ISCO-88 and ISCO-08, and perform estimations where one-to-one correspondence between the two versions of ISCO is absent.

ISCED-based education

In order to capture ICT specialists in the occupational groups that include both ICT and non-ICT occupations, we select workers that categorise their education in the field defined in ISCED-97 as *Computing (48).* This category comprises two sub-groups, *Computer science (481)* and *Computer use (482),* and covers all types of education related to computer system design, computer

[22] http://www.ilo.org/public/english/bureau/stat/isco/isco08/index.htm

[23] See OECD (2004), p. 220 for several more examples of the shortcomings related to the use of ISCO-88.

programming, data processing, networks, and operating systems dealing with software development (those related to the hardware development are classified with the engineering fields).

While implementing the ISCED 1997 classification in the LFS started in 1998, many countries were still not collecting information in the field of education in 2003 (Austria, Belgium, Hungary, Ireland, Latvia, Malta, Poland, Portugal, Romania, Sweden, the UK). From 2004 onwards, the majority of countries provided information on the field of education in their national Labour Force Surveys, with only several breaks in series in specific years: in 2004 for Czech Republic, Hungary, Malta and Turkey, in 2005 for Czech Republic, Malta and Spain, and in 2007 for Ireland.

4 Results

4.1 Note on the terminology: narrow and broad definitions of ICT specialists

For the sake of comparison with other studies that estimate employment of ICT specialists we start our analysis by applying a *narrow definition of ICT specialists (ICT-1).* By a narrow definition, we mean the following measures of ICT specialists:

- for 2000-2010 (ISCO-88), we use an adapted OECD (2004) definition of ICT-specialists (groups 213, 312, and 313). Unlike the OECD (2004) definition, we do not include group *724 Electrical and electronic equipment mechanics and fitters.* This group contains a considerable number of electrical equipment mechanics and fitters who have little use for ICT-specific skills in their work (the need for these skills is especially high in sectors such as mining and electricity production). Inclusion of the entire group 724 would therefore lead to a serious overestimate of the number of ICT workers.
- for 2011-2012 (ISCO-08) we apply the ILO (2012) thematic view on ICT professionals and associated professional occupations (groups 251, 252, 351 and 352), augmented by ICT service managers (occupation 133).

We then estimate the number of ICT specialists by applying the *occupations/education methodology* as described in the previous Section. By applying this methodology, we restrict the period of analysis to 9 years, from 2004 till 2012. However, we believe that this measure captures ICT specialists better from the data and reflects the dynamics of ICT professionals with greater accuracy. We refer to this measure as a *broad definition of ICT specialists (or ICT-3)*

The impact of applying ICT-specific education filters on the estimates of ICT specialists can be seen in Table 4. Here, employment of ICT specialists (as the number of persons employed and as a share of total employment) is calculated in three different ways. Construction of the estimates for the *ICT-1 (a narrow definition)* is explained above: it includes the narrow OECD (2004) definition[24] (excluding group 724) for 2004-2010 data and ILO (2012) thematic views for 2011-2012 (augmented by group 133). *ICT-2* is estimated using the broad OECD (2004) definition[25] for 2004-2010 data and ILO (2012) thematic views for 2011-2012 data, both augmented by applying an ICT-specific education filter. The purpose of reporting the ICT-2 estimates is to show the added value of using our methodology in applying the existing OECD and ILO approaches to the LFS data at 4-digit level of aggregation. Finally, *ICT-3* is estimated by including all ICT professional occupations from ISCO-88 and ISCO-08 using our occupation/education methodology (as described in the previous chapter, see Table 1-2 column "This study" for the list of occupations included).

[24] Remember, that OECD *narrow measure* of ICT-skilled employment covers those who supply the ICT tools (ICT specialists in Box 1); OECD *broad measure* of ICT-skilled employment covers those who supply and those who use ICT tools (the sum of ICT specialists, ICT advanced and ICT basic users in Box1). See OECD (2004) for more details.

[25] Idem

Table 4: Measure of ICT specialists using different estimation approaches

year	ICT employment, 1000s				share in total, %		
	ICT-1 (narrow)	ICT-2	ICT-3 (broad)	diff-ce between ICT-1 and ICT-3	ICT-1	ICT-2	ICT-3
2004	3,744.4	3771.0	3967.7	223.3	1.8	1.8	1.9
2005	4,073.2	4103.8	4370.1	296.9	1.9	2.0	2.1
2006	4,274.3	4317.5	4632.4	358.2	2.0	2.0	2.2
2007	4,465.3	4499.8	4835.4	370.1	2.0	2.1	2.2
2008	4,568.7	4609.3	4958.4	389.7	2.1	2.1	2.2
2009	4,609.7	4650.7	5023.8	414.1	2.1	2.1	2.3
2010	4,676.1	4713.4	5066.0	389.9	2.2	2.2	2.4
2011	4,944.9	5276.2	5748.1	803.2	2.3	2.4	2.7
2012	5,154.4	5676.3	6124.7	970.3	2.4	2.6	2.8

Analysis in the remainder of the report is based on the broad definition of ICT specialists (ICT-3).

Additionally, in Section 4.2, we estimate the number of ICT specialists by applying the definition based on ISCO-08 to the ISCO-88 occupations, i.e. we re-construct the series of ICT specialists for the period 2004-2010 in terms of ISCO-08 occupations. To this end, we use the ILO correspondence tables between ISCO-08 and ISCO-88 at 4-digit level of aggregation[26] and perform estimations where one-to-one correspondence between the two versions of ISCO is not possible. This approach makes the jump in the time series in 2011 somewhat smoother (see Table A8 in Annex). However, we would like to stress that this exercise may be subject to critics from the methodological point of view because change of ISCO to a newer version does not simply changes the names of the similar ICT occupational groups but performs a deeper restructuring of the classifications which involves regrouping of old occupations and introduction of the new ones. For this reason, we believe that the use of two separate measures corresponding to two sub-periods (2004-1010 and 2011-2012) is a more reliable approach compared to the mapping between the two categories of ICT specialists based on different ISCO classifications (see more discussion on this issue on p.16, and in the note to Table A8 in Annex).

4.2 ICT specialists in total economy

Changes in the employment of ICT specialists as a number of persons employed and as a share in total employment

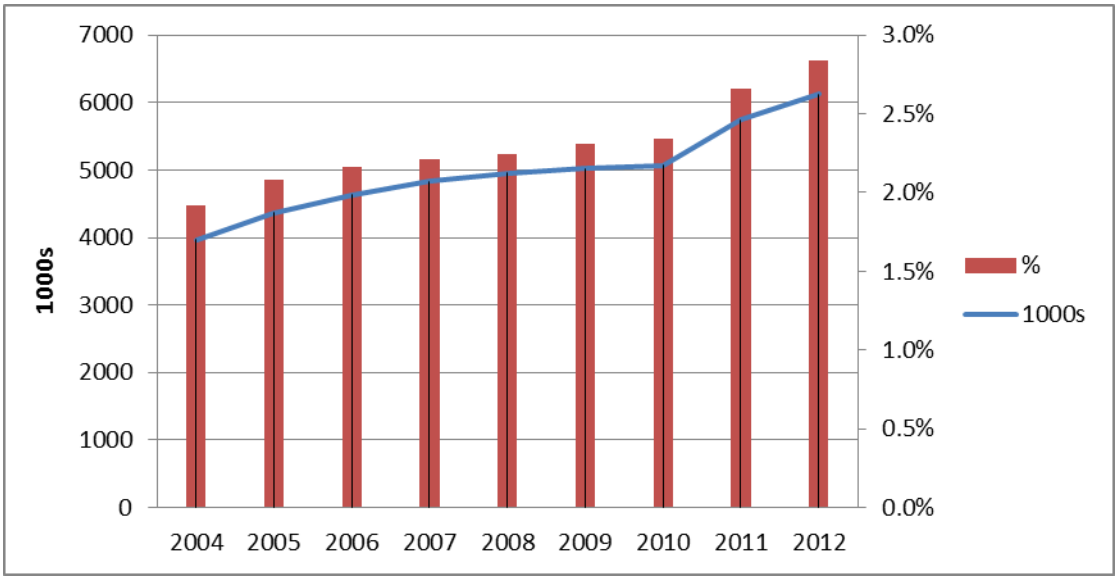
Over the period 2000-2012, employment of ICT specialists in the EU-27 grew significantly (see Table A2 in Annex). The narrow definition (ICT-1) provides an estimate of an increase of 2 million (from 3.1 million in 2000 to 5.1 million in 2012). This corresponds to a 64% increase in the total number of workers with professional ICT skills. Moreover, employment of ICT specialists increased not only in absolute figures but also as a share of total employment: from 1.6% in 2000 to 2.4% in 2012.

In order to get a *more precise estimate of the actual number of people employed as ICT specialists*, we need to refer to a broad definition, ICT-3 (Table A3 in Annex). This approach gives an estimate of 6.1 million ICT specialists in 2012, which corresponds to 2.8% of total employment. Employment of ICT specialists has been growing steadily since 2004 (Figure 1), and has risen by 54% over a 9 year

[26] ISCO-08 Structure and correspondence with ISCO-88, http://www.ilo.org/public/english/bureau/stat/isco/isco08/index.htm

period. It has increased by 2 million people since 2004 which corresponds to an increase in the share of ICT specialists in total employment from 1.9% in 2004 to 2.8% in 2012.

Figure 1: Employment of ICT specialists in absolute terms and as a share of the total employment (broad definition), 2004-2012

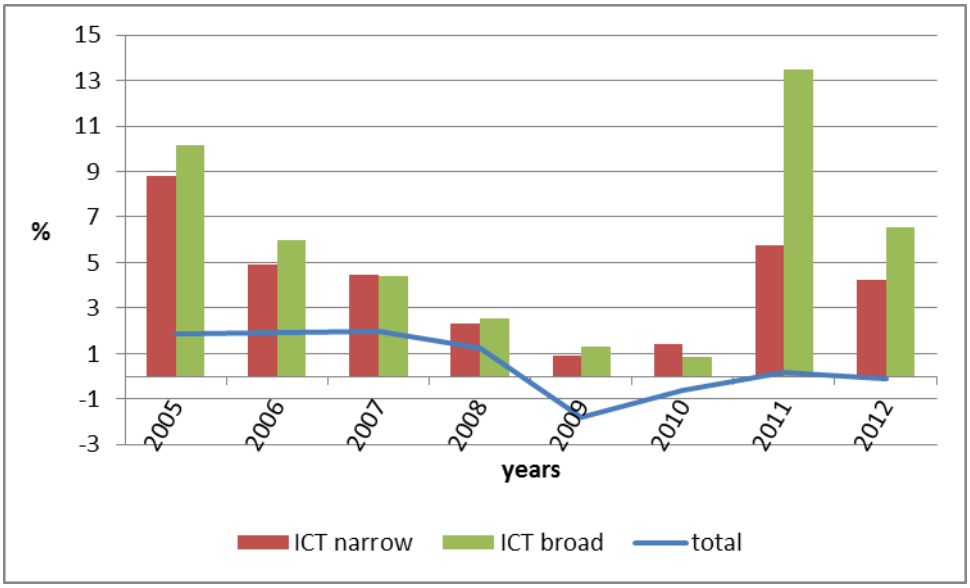


Changes in the employment of ICT specialists in terms of employment growth

Over the period 2000-2012, the labour dynamics of ICT specialists was characterised by rapid employment growth. This tendency is even more remarkable in the context of the fairly modest growth in total employment in the EU over the same period. On average, growth in the employment of ICT specialists over the 12 year period was 4.3%, which is more than 7 times higher than the average growth of total employment over the same period. Similarly to total employment, employment of ICT specialists evolved cyclically, with the highest growth rates occurring in the years 2001 and 2005. The two dips in employment, in 2002 and in 2009, reflect two periods of recession, the dot.com crisis of 2001 and the financial crisis of 2007-2008. However, though the growth of the numbers of ICT specialists reflected the general trend of the cyclical fluctuations in total employment, it never turned negative.

For the sake of comparison, Figure 2 shows the growth of ICT-specialised employment estimates over the period 2004-2012, using both the narrow (ICT-1) and the broad measure (ICT-3). Growth rates appear to be higher if the broader measure of ICT specialists is used. The difference is especially evident in the last two years. We attribute the latter to the fact that ISCO-08 provides a more precise definition of ICT occupations, which improves the matching between the educational and occupational structures of employment and allows applying our measure of ICT-skilled employment (ICT-3, or a broad definition) with a better degree of accuracy. This latter definition is used in the reminder of the Section.

Figure 2: ICT specialists and total employment growth in 2005-2012, %



Source: EU LFS

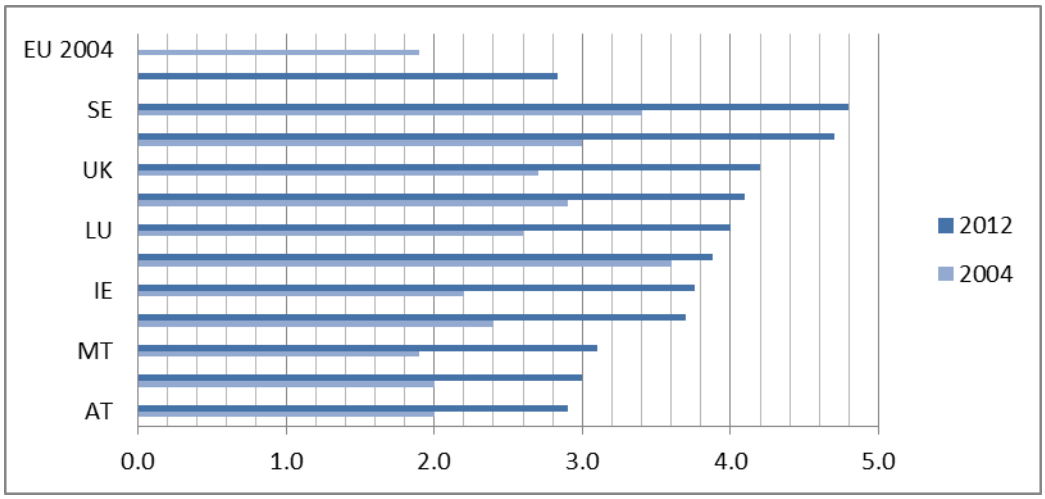
Ranking of countries with respect to the share of ICT specialists in total employment

At the EU-27 level, countries can be grouped into three categories with respect to the share of ICT specialists in total employment:

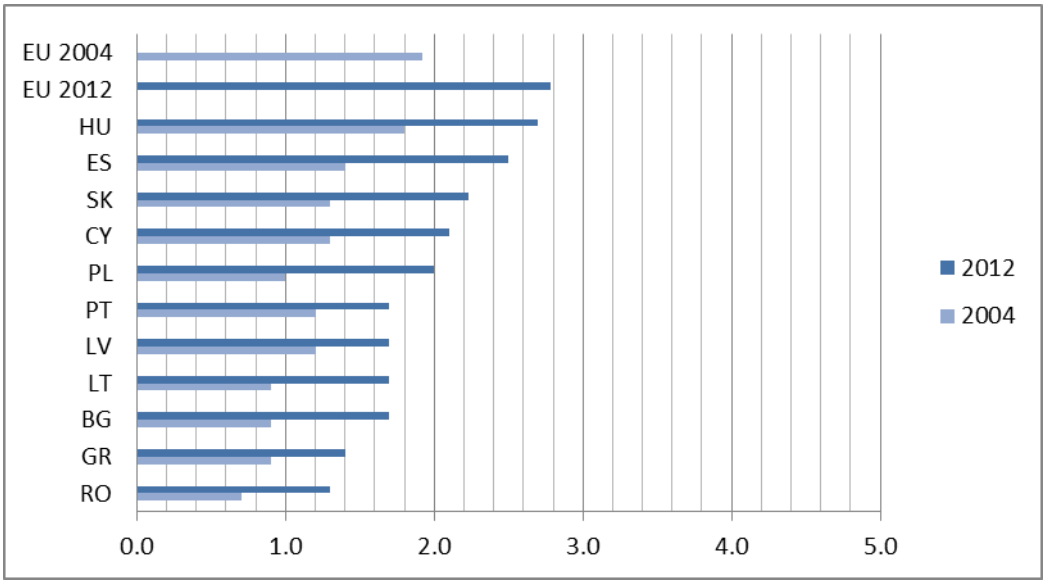
- those with an above average share of ICT specialists in total employment at the beginning and at the end of the 2004-2012 period (Figure 3, panel a),
- those with a below average share of ICT specialists in total employment at the beginning and at the end of the 2004-2012 period (Figure 3, panel b),
- those whose ICT share in total employment was below average in 2004 but above average in 2012, or vice versa (Figure 3, panel c1 and c2).

Figure 3: Share of ICT specialists in total employment in 27 EU countries, %

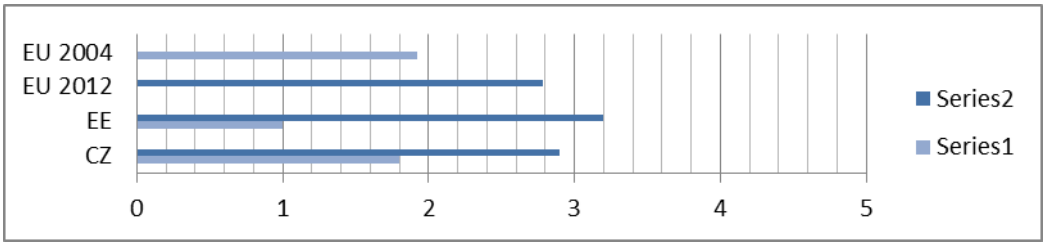
(a) leaders



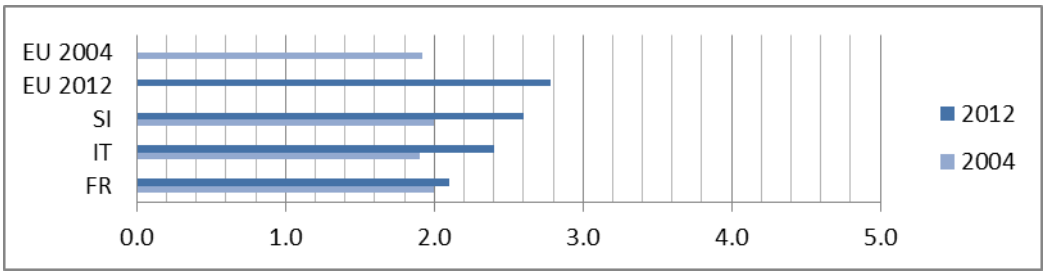
(b) followers



c1) fluctuating around average: improving



c2) fluctuating around average: deteriorating



Note: For Romania, the estimate corresponds to 2005 instead of 2004.

As can be seen from Figure 3, panel a, in 2004, the Netherlands led the ranking of countries with respect to the share of ICT specialists in total employment (with the ICT specialists corresponding to 3.9% of total employment). However, in 2012, the Netherlands lost its position to Sweden. According to the latest data available, Sweden (4.8%) is the absolute leader with regards to the share of ICT specialists in total employment, closely followed by Finland (4.7%) and the UK (4.2%).

In 2004, countries with the smallest share of ICT specialists in total employment (below 1%) were Romania (0.7%), Greece (0.9%), Bulgaria (0.9%) and Lithuania (0.9%). Though these countries had increased their shares of ICT specialists in total employment over the 9 years, they still remained in the bottom part of the ranking compared to other Member States (Figure 3, panel b).

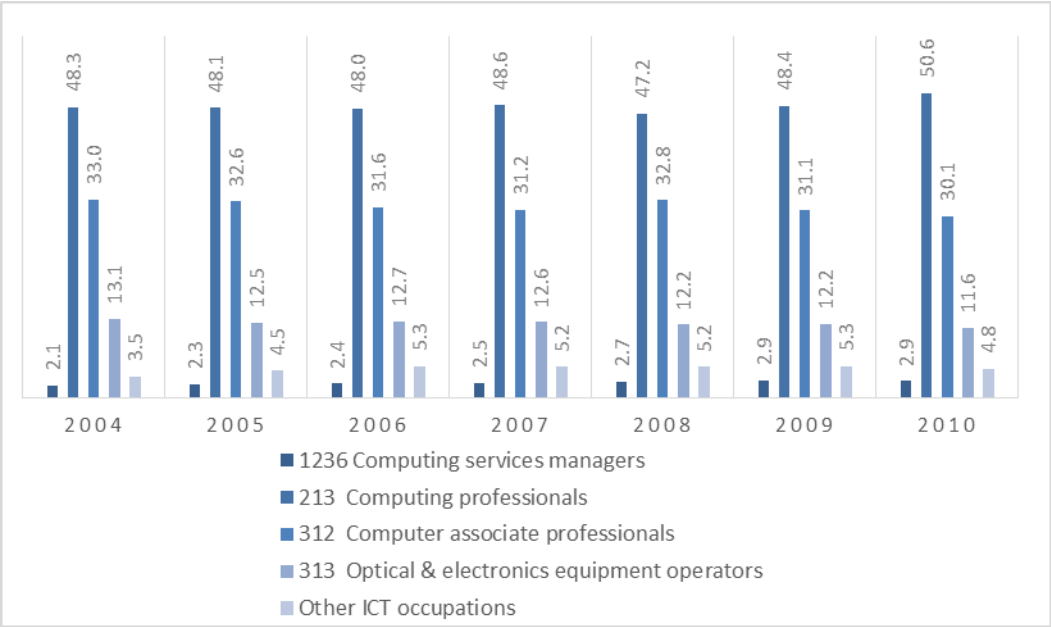
Panels c1 and c2 report the estimates for countries whose share of ICT specialists in total employment was either below or above the EU-27 average at different points in time. The first group of countries (Estonia and Czech Republic) showed an improvement and increased their share of ICT specialists by 2012 to overcome the EU average (panel c1). In particular, Estonia managed to increase its share of ICT specialists in total employment more than 3-fold over the 9 year period, and in 2012 it reached 3.3% (which is 15% above the EU-27 average). The second group of countries (Slovenia, France and Italy) showed a deterioration against the EU average: their corresponding shares of ICT specialists in total employment were above the EU-27 average in 2004, and fell below the EU-27 average in 2012 (panel c2). While the situation in France could be classified as stagnating (its ICT share in total employment has increased by only 0.1 p.p.), Slovenia and Italy increased the shares of their ICT specialists by 0.6 p.p. and 0.5 p.p. correspondingly.

4.2 Distribution of workers among ICT-specialised occupations

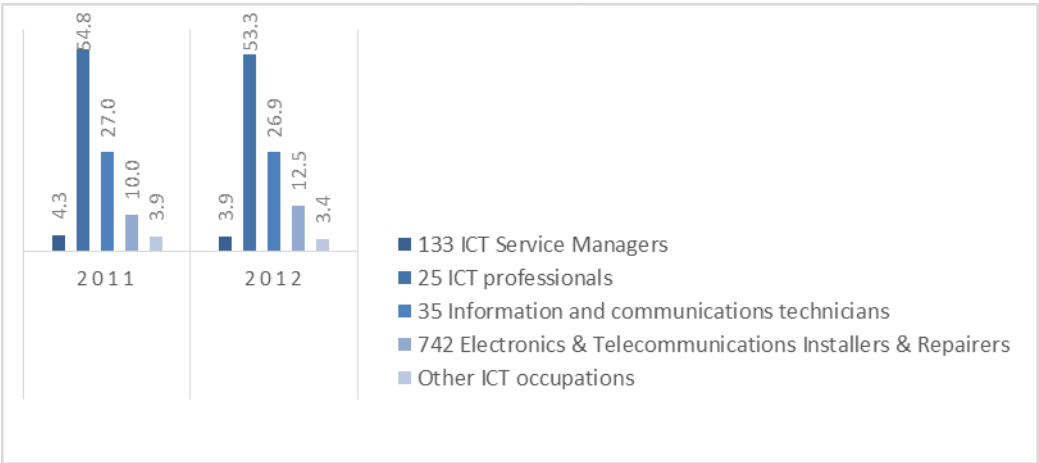
ICT occupational design in the EU-27 has been driven by the frequent emergence of new technologies requiring new skills and new ways of working. Overall, the distribution of workers among ICT occupations was stable throughout the whole 9 year period from 2004 (Figure 4). Due to the break in the time series caused by the implementation of the new ISCO-08 ranking of occupations in the EU Labour Force Survey in 2011, we could not monitor the exactly same occupations throughout the whole period, and had to look at two subsets of ICT occupations for the separate periods 2004-2010 and 2011-2012.

Figure 4: Distribution of workers among ICT occupations, 2004-2012, %

(a) ISCO-88 ICT occupations



(b) ISCO-08 ICT occupations



In 2004-2010, the biggest share among ICT specialists was occupied by computing professionals or computing associate professionals: these two groups accounted for over 80% of all ICT specialists in our sample. The third biggest occupational group was optical and electronic equipment operators with an average of 12% of all ICT specialists over a period of 2004-2010.

In 2011-2012, the absolute majority of ICT specialists were employed as ICT professionals. Among the two other major ICT specialist occupational groups, the share of information and communication technicians remained stable over the two year period and amounted to 27%. The share of electronics and telecommunications installers and repairers increased from 10% in 2011 to 12.5% in 2012

One general observation of the dynamics of the ICT occupational groups is that when looking at the shares of three major subgroups of ICT specialists the occupational design remained remarkably

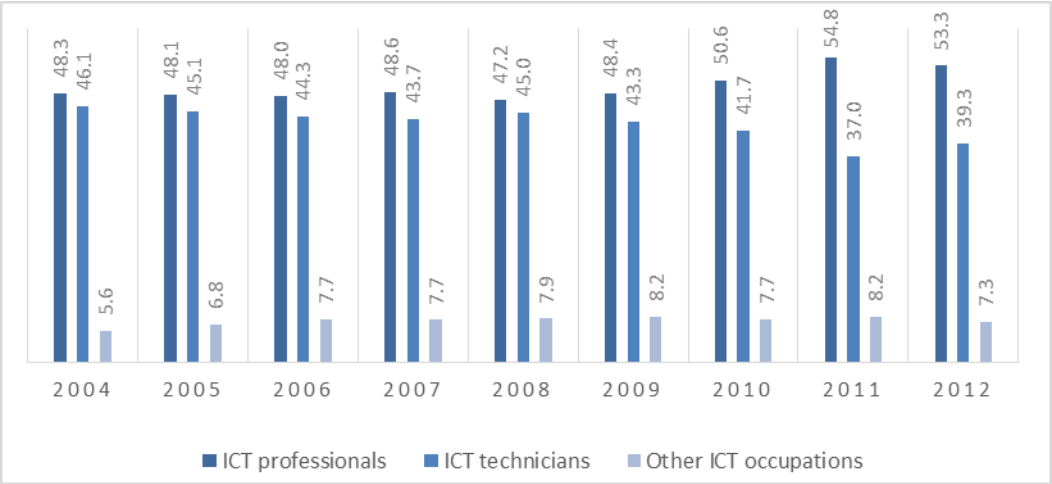
stable over the 9 years independently from the classification applied. Another observation is that, independently from the version of ISCO applied, the biggest share of the ICT specialists in our sample (almost half of all workers) is employed in high-skilled jobs: computing professionals or computing associate professionals in ISCO-88, and ICT professionals in ISCO-08.

As explained in sections 3.3 and 4.1, there is no one-to-one correspondence between two versions of ISCO, which makes a re-construction of the old series (prior to 2011) by applying the latest ISCO classification a rather challenging task.

However, mapping between the two definitions of ICT specialists based on different ISCO classifications is highly desirable for policy advising as it provides a consistent picture of the distribution of the ICT specialists between different professional groups. We suggest to map ICT specialists group of occupations in different ISCO versions by sorting of the most represented ICT occupations into two broader groups – ICT professionals and ICT technicians – based on the description of tasks and duties defined by ILO[27]. We construct these groups as follows:

- ICT professionals correspond to the occupational group *213 Computing professionals* in ISCO-88 and to the occupational group *205 ICT professionals* in ISCO-08.
- ICT technicians correspond to groups *312 Computer associate professionals* and *313 Optical and electronics equipment operators* in ISCO-88 and to groups *350 Information and communication technicians* and *742 Electronics and telecommunication installers and repairers*.

Figure 5: ICT professionals and ICT technicians in ISCO-88 and ISCO-08, %



While providing a rather aggregated view on the distribution of ICT specialists between specific occupations, this approach allows to conclude that higher skilled ICT professionals are steadily growing in number, while the groups of ICT technicians is decreasing during the period of observation.

4.3 ICT specialists in sector groups

Grouping sectors into ICT-producing and ICT-using

In order to monitor distribution of ICT specialists among sectors and groups of sectors, we use 1- and 2-digit NACE classification.

[27] http://www.ilo.org/public/english/bureau/stat/isco/intro.htm

First, we present the distribution of ICT specialists among 1-digit NACE sectors aggregated into seven sectors. We further amended this grouping to include the NACE Rev. 2, which allows us to cover the years after 2008 (Table 3).

Table 3: Grouping of 1-digit NACE industries into seven major sector groups

	Sector groups	NACE Rev.1	NACE Rev.2
1	Agriculture, Forestry, Fishing	A, B	A
2	Mining and Electricity, Water Supply (and Waste management from 2008 onwards)	C, E	B, D, E
3	Manufacturing	D	C
4	Construction	F	F
5	Trade, Tourism, Transport	G, H, I	G, H, I
6	Business services	J, K	J, K, M, N
7	Other services	L, M, N, O, P, Q	O, P, Q, R, S, T, U

Note: correspondence with NACE Rev.2 is compiled using Eurostat aggregate tables, http://ec.europa.eu/eurostat

Second, we report ICT employment separately in the ICT sector, and sectors that use ICT more and less intensively.

Grouping of industries into ICT sector (with the distinction between manufacturing and services) is based on the 2002 OECD definition for the NACE Rev.1.1 and on the 2006-07 OECD definition for the NACE Rev. 2 (OECD 2011), adapted to the data aggregation requirements (See Box A2 in Annex). In this report, we use the operational definition devised in Turlea et al (2011) for the period 2004-2008 (based on NACE Rev.1.1) and in PREDICT Project of JRC-IPTS[28] for the period 2009-2011 (based on NACE Rev.2). This includes sectors as described in Box 3 below.

Box 3. The ICT sector operational definition adopted by the PREDICT Project at JRC-IPTS*

(a) based on NACE Rev.1.1

ICT Manufacturing
30: Manufacture of office, accounting and computing machinery
32: Manufacture of radio, television and communication equipment and apparatus
33: Manufacture of medical, precision and optical instruments, watches and clocks
ICT Services
64: Post and telecommunications
72: Computer and related activities

(b) based on NACE Rev. 2

ICT Manufacturing
261 Manufacture of electronic components and boards
262 Manufacture of computers and peripheral equipment
263 Manufacture of communication equipment
264 Manufacture of consumer electronics
ICT Services
582 Software publishing
610 Telecommunications
620 Computer programming, consultancy and related activities
631 Data processing, hosting and related activities; web portals
951 Repair of computers and communication equipment
*Prospective Insights on R&D in ICT (PREDICT) is a research projects financed by the DG CONNECT and carried out by the Information Society Unit of the JRC-IPTS.

Source: Turlea et al (2011) and PREDICT

[28] http://is.jrc.ec.europa.eu/pages/ISG/PREDICT.html

Grouping of sectors into more and less ICT-intensive can be done by adopting one of several possible measures of ICT use by industry known in economic literature[29]: the ratio of ICT capital to a number of workers, share of ICT investment in total investment, share of ICT capital in output, share of ICT capital in total capital, and the share of the flow of capital services from ICT in total capital services. The latter measure has an advantage over the others as the service flow per unit of ICT capital can be quite different from the flow from a unit of non-ICT capital. As explained in van Ark and McGuckin (2003a), the flow of capital services is calculated by estimating the user cost for each type of capital. These can be relatively high for ICT capital because of high rates of depreciation. Thus a simple measure of ICT's share of total assets may understate the flow of services from it, and will not take into account possibly high returns on ICT capital in particular industries (like, for example, the oil extraction industry, where a small investment in ICT has fundamentally changed the technology of exploring oil reserves).

Following Stiroh (2002), Inklaar et al (2003), van Ark et al (2003a and 2003b), and O'Mahony and van Ark (2003), we use the ranking of sectors with respect to the share of the flow of capital services from ICT in total capital services by applying an arbitrary cut-off point at the median point of ICT use distribution.

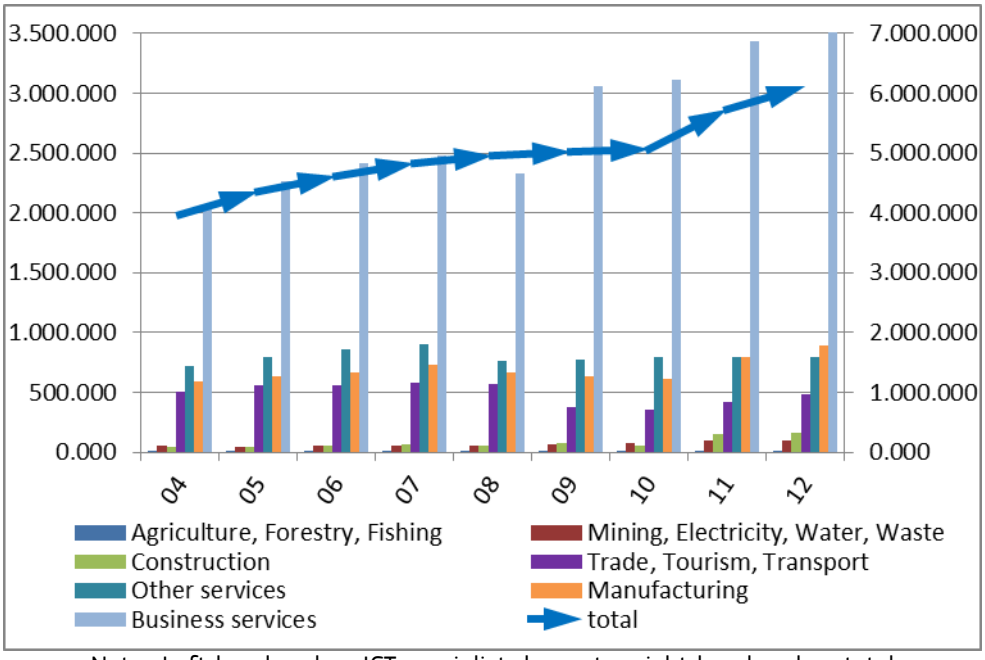
We base our grouping on van Ark et al. (2003a), who provide a more refined classification of ICT-using industries compared to Stiroh (2002) and Inklaar et al (2003)[30]. We depart from their approach on two points. First, we define ICT-producing manufacturing and services based on the operational definition adopted by the PREDICT Project of the JRC-IPTS (Box 8). Following the terminology applied by PREDICT (which is based on the OECD official definition), we call these sectors *ICT manufacturing* and *ICT services*. Second, we include education, health and social work sectors in the analysis. Unlike Stiroh (2002), who also considers these sectors but allocates them to the group that uses ICT more intensively, we include them in the group that uses ICT less intensively. This choice is based on the reasoning provided in van Ark et al (2003a): even though education, health and social work sectors are above the median share of ICT services in total capital services, they use little capital and their value added largely consists of labour income[31].

Distribution of ICT specialists among sector groups

In 2004-2012, the industries that employed the largest numbers of ICT specialists in EU-27 were *business services*. This group of industries employed over half of all ICT-skilled specialists during the whole period; in 2012, the share of business services in total employment of ICT specialists reached 60.5%. The share of business industries showed a marked growth tendency over the 9 year period from 2004. The only deviation from this trend occurred in 2008, when ICT specialists in business sectors contracted by 6%[32]. However, this share expanded by 24% the year after.

[29] van Ark and McGuckin (2003a).
[30] van Ark et al. (2003a), pp. 6-7.
[31] van Ark et al. (2003a).
[32] This can be attributed to the break in series due to the application of NACE Rev.2

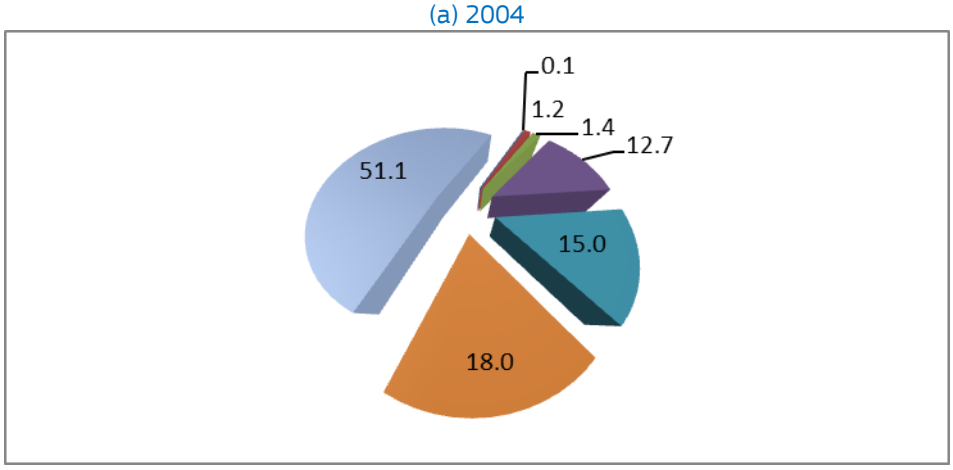
Figure 6: Distribution of the ICT specialists in the EU-27 among sector groups, 2004-2012 (1000s)



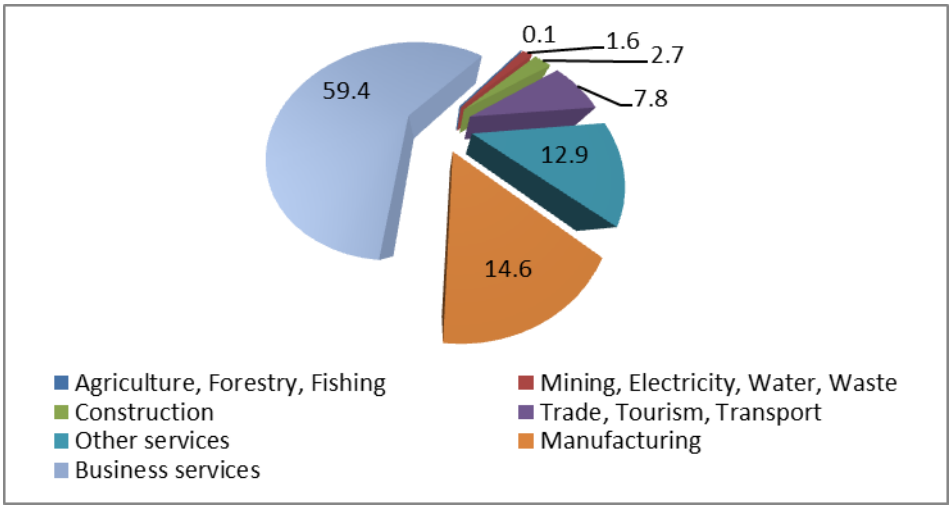
Note: Left-hand scale = ICT specialists by sector; right-hand scale = total

Figure 7: Distribution of the ICT specialists in the EU-27 among sector groups, %

(a) 2004



(b) 2012

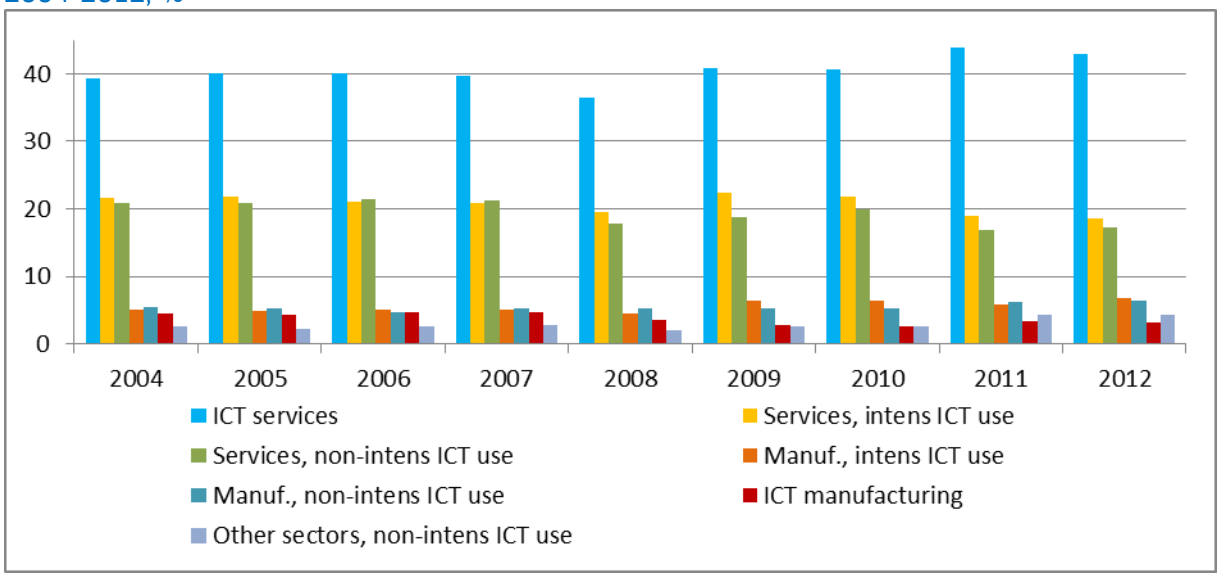


The share of manufacturing in total employment of ICT specialists remained stable over the whole period and fluctuated around 15%. The share of ICT specialists in the group of sectors classified as "other services" (public administration, health, education, activities of households and extra-territorial organisations) was relatively high, 13% in 2012. Though numbers of ICT specialists in trade, tourism and transport declined, they remained at a relatively high level (at around 8%). Agriculture, mining, electricity, water and waste management sectors overall employed a negligible share of ICT-specific employment compared to other sectors.

The EU-27 aggregate numbers (Figures 6-7) hide the country differences in the distribution of ICT specialists among groups of sectors (see Table A2, in Appendix). Thus, while business sectors invariably show the highest share of ICT employment in all countries, country-specific estimates range from 48.8% in Romania to 69.8% in France. A remarkable diversity in the share of ICT specialists in total employment is observed in manufacturing: it is quite high in countries such as Germany (23.8%), Romania (20.3) and Italy (19.9%), while it is insignificant in Cyprus (1.9%) and Luxembourg (5.1%). In part, such country differences in distributing the ICT specialists among groups of sectors are related to the sectorial composition of national economies, and in part they can be attributed to the country position in the general ICT advancement compared to other Member States.

If we look at the distribution of ICT specialists in the EU-27 among *sectors with different intensity of ICT use* (Figure 8), we find that the biggest share of ICT specialists is employed in the service sectors, while the manufacturing industries clearly lag behind. The absolute leader among this group of sectors is *ICT services*, where the share of ICT specialists reached 55% in 2012. These figures point to the service-oriented composition of the EU economy, where services provide employment to the majority of ICT professionals (as well as to workers with other occupations).

Figure 8: Distribution of ICT specialists among sector groups with different ICT intensities, EU-27 in 2004-2012, %

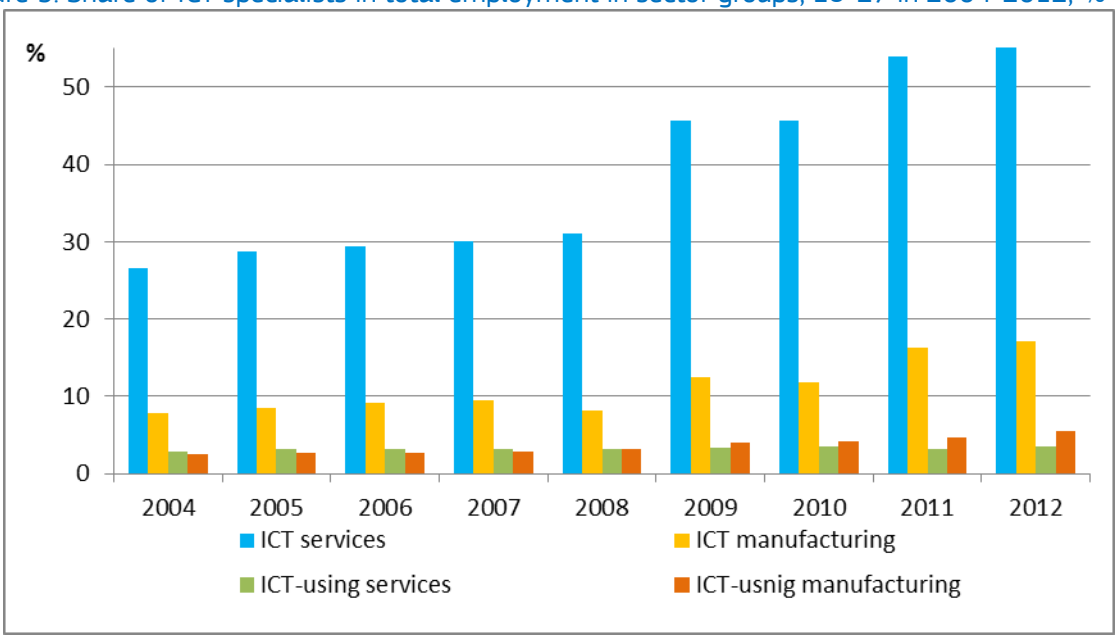


Source: EU LFS

Additionally, we look at the share of ICT specialists in the total number of workers employed in each of the above sectors (Figure 9). We look at four sector groups: ICT services, ICT manufacturing, ICT-suing services and ICT-using manufacturing[33].

Here, again, *ICT services* appear to be the most intensive users of ICT-specialised employment. Moreover, the share of ICT specialists in ICT services employment was growing rapidly from a little over a quarter in 2004 to more than half of total employment in that sector in 2012. However the annual growth pattern came in two growth spurts: a 15 percentage point jump in 2009 and another 8 percentage point jump in 2011. These growth spurts may be attributed to the breaks in series in the NACE and ISCO classifications. *ICT manufacturing* also increased its share of ICT specialists, though at a slower pace than ICT services. In 2012, 17% of all employed in ICT manufacturing had ICT-specific occupations.

Figure 9: Share of ICT specialists in total employment in sector groups, EU-27 in 2004-2012, %



Source: EU LFS.

In the remaining sector groups, the share of ICT specialists averaged around 1.5%. The share of ICT specialists in *ICT-using services* grew moderately from 2.9% in 2004 to 3.4% in 2012. By 2012 it reached 2.4% in more intensively *ICT-using services* and 1% in less intensively *ICT-using services*. In *ICT-using manufacturing*, however, the share of ICT specialists doubled over 9 years (from 2.5% in 2004 to 5.5% in 2012) and in 2012 reached 3.8% for the manufacturing sectors that use ICT *more intensively* and 1.7% in manufacturing sectors that used ICT *less intensively*. These observations indirectly support the findings of Sabadash and Hagsten (2014) who showed that ICT-specialised human capital became relatively more important for productivity gains in manufacturing, while generally skilled workers are relatively more important in services.

The fact that the share of ICT specialists appears to be relatively low in the ICT-using sectors can be attributed to the fact that ICT has become a general purpose technology, and that most of the ICT

[33] Due to the relatively small share of ICT specialists (around 1.5%) in the total employment of the ICT-using sectors we re-aggregate the sector groups as following: Services that use ICT intensively and Services that use ICT less intensively are aggregated into the group *ICT-using services;* Manufacturing that use ICT intensively and Manufacturing that use ICT less intensively are aggregated into the group *ICT-using manufacturing*; the group of Other sectors that use ICT less intensively is omitted.

innovations in production and business procedures can now be operated by generally skilled workers. While the general level of ICT literacy is becoming increasingly important at practically all stages of production and distribution, it is often acquired through learning-by-doing and, as a rule, it is resistant to measurement in official statistics. In particular, general ICT literacy remains beyond the ISCO-based classification of occupations and, hence, is not reflected in our estimates. As explained in Section 2.1 of this study, we do not aim to estimate all ICT-skilled employment but only the ICT-specialized workforce, and we believe that the EU Labour Force Survey is not the right tool to capture general ICT skills in data. A similar line of reasoning is adopted in Hagsten and Sabadash (2014). They distinguished between ICT-specialised and generally skilled human capital when studying the factors that contribute to productivity gains at firm level, and showed that the productivity gains from ICT-specific and general skills differ between countries and sectors.

Conclusions

This paper builds on existing studies that define and measure ICT employment in the EU. It proposes a new methodology and insights for defining and measuring employment of ICT specialists. Based on ILO (2012), we develop a definition of ICT specialists that includes ICT-specific occupations based on their primary involvement in the production of ICT goods and services. It excludes those occupations which require skills in using ICT only as a tool, and which are not involved in the production of ICT goods and services. We believe that the ISCO-based design of the EU LFS can accurately identify ICT specialists but not ICT users, either advanced or basic. While several ways of operationalizing the OECD (2004) definition of ICT specialists have already been applied to the EU LFS data (see for example, OECD, 2004 and 2010, and Empirica, 2013), the novelty of our approach consists in combining ISCO and ISCED categories – a tool that allows to map the ICT-specialist workforce with greater precision.

We believe that the methodology we suggest provides a straightforward and reliable way of detecting ICT occupations at the finest level of ISCO aggregation, using the available harmonized official data on EU employment and taking into account its constraints.

Estimates of ICT-specialised employment generated using our approach confirm the findings of previous studies. Employment of ICT specialists in the EU27 has been resilient to the downturn and uncertainty in global labour markets, and seems to be able to maintain a growth path. On average, growth in the employment of ICT specialists over the 12-year period 2000-2012 was 4.3%, which is more than 7 times higher than average growth of total employment over the same period. Similarly to total employment, ICT employment has evolved cyclically. However, ICT employment growth never turned negative. The rapid growth in total ICT employment (which to some extent reflects the total number of job vacancies) confirms the increasing importance of ICT technologies in the global economy.

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Annex

Table A1: Grouping of 2- and 3-digit NACE industries with respect to the use of ICT

ISIC Rev.3		NACE Rev.1.1		NACE Rev.2
ICT-using manufacturing				
Wearing apparel, dressing and dying of fur	18	Manufacture of wearing apparel; dressing and dyeing of fur	18	13.2, 14.1, 14.2
Printing and publishing	22	Publishing, printing and reproduction of recorded media	22	18, 58.1, 59.2
Machinery and equipment	29	Manufacture of machinery and equipment n.e.c.	29	332
Electrical machinery and apparatus, excluding insulated wire*	31	Manufacture of electrical machinery and apparatus n.e.c.	31	332
Manufacture of other transport equipment	35	Manufacture of other transport equipment	35	30
Miscellaneous manufacturing and recycling	36-37	Manufacture of furniture; manufacturing n.e.c.	36	332
		Recycling	37	383
ICT-using services				
Wholesale trade	51	Wholesale trade and commission trade, except of motor vehicles and motorcycles	51	46
Retail trade	52	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	52	47, 95.2, 13.3
Financial intermediation	65	Financial intermediation, except insurance and pension funding	65	64
Insurance and pension funding	66	Insurance and pension funding, except compulsory social security	66	65
Activities related to financial intermediation	67	Activities auxiliary to financial intermediation	67	66
Renting of machinery and equipment	71	Renting of machinery and equipment without operator and of personal and household goods	71	77
Research and development	73	Research and development	73	72
Professional business services	741-743	Other business activities	74	02.4, 64.2, 69, 70, 71, 74.2, 74.9, 85.6
Less-intensive ICT-using manufacturing				
Food products, beverages and tobacco	15-16	Manufacture of food products and beverages	15	10 11
		Manufacture of tobacco products	16	12
Textiles	17	Manufacture of textiles	17	13, 32.5
Leather, leather products and footwear	19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	19	15.1
Wood and products of wood and cork	20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	20	16, 41.2
Pulp, paper and paper products	21	Manufacture of pulp, paper and paper products	21	17
Coke, refined petroleum products and nuclear fuel	23	Manufacture of coke, refined petroleum products and nuclear fuel	23	19, 21.2
Chemicals and chemical products	24	Manufacture of chemicals and chemical products	24	19.1, 20, 26.8
Rubber and plastic products	25	Manufacture of rubber and plastic products	25	22, 32.5, 33.2, 41.2

Non-metallic mineral products	26	Manufacture of other non-metallic mineral products	26	23, 33.2, 23.4
Basic metals	27	Manufacture of basic metals	27	24.1, 24.2, 24.3, 24.4
Fabricated metal products	28	Manufacture of fabricated metal products, except machinery and equipment	28	33.2
Motor vehicles, trailers and semi-trailers	34	Manufacture of motor vehicles, trailers and semi-trailers	34	33.2
Less-intensive ICT-using services				
Repairs	50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel	50	45
Hotels and restaurants	55	Hotels and restaurants	55	55 56
Transport and storage	60-63	Land transport; transport via pipelines	60	49
		Water transport	61	50
		Air transport	62	51
		Supporting and auxiliary transport activities; activities of travel agencies	63	52, 79, 74.9
Real estate activities	70	Real estate activities	70	41, 68
Public administration and defense; compulsory social security	75	Public administration and defence; compulsory social security	75	84, 81.1
Education	80	Education	80	85
Health and social work	85	Health and social work	85	86, 87, 88, 75
Other community, social and personal services	90-93	Sewage and refuse disposal, sanitation and similar activities	90	37, 38.1, 38.2, 39
		Activities of membership organizations n.e.c.	91	94
		Recreational, cultural and sporting activities	92	1.62, 59, 60, 90, 91, 92, 93, 74.2, 78.1, 79.9
		Other service activities	93	96
Private households with employed persons	95	Activities of households as employers of domestic staff	95	97
Extra-territorial organizations and bodies	99	Extra-territorial organizations and bodies	99	99
Less-intensive ICT-using other sectors				
Agriculture, hunting, forestry and fishing	01-05	Agriculture, hunting and forestry; Fishing	01-02, 05	01-03
Mining and quarrying	10-14	Mining and quarrying	10-14	05-09
Electricity, gas and water supply	40-41	Electricity, gas, steam and air conditioning supply	40-41	35, 36
Construction	45	Construction	45	41-43

Source: groups based on ISIC Rev.3 are adopted from van Ark et al. (2003a), correspondence to the NACE Rev.1.1 and NACE Rev.2 is based on the Eurostat official classifications and correspondence tables.

Table A2: ICT specialists and total employment in 2000-2012 (narrow definition, ICT-1)

year	employment, 1000s		share of ICT. in total, %	employment growth, %	
	total	ICT		total	ICT
2000	202,019.2	3,140.0	1.6		
2001	204,314.5	3,602.2	1.8	1.1	14.7
2002	204,396.2	3,614.2	1.8	0.0	0.3
2003	205,734.2	3,638.5	1.8	0.7	0.7
2004	206,518.6	3,744.4	1.8	0.4	2.9
2005	210,340.4	4,073.2	1.9	1.9	8.8
2006	214,416.6	4,274.3	2.0	1.9	4.9
2007	218,645.8	4,465.3	2.0	2.0	4.5
2008	221,306.8	4,568.7	2.1	1.2	2.3
2009	217,282.3	4,609.7	2.1	-1.8	0.9
2010	215,989.3	4,676.1	2.2	-0.6	1.4
2011	216,346.1	4,944.9	2.3	0.2	5.7
2012	216,082.0	5,154.4	2.4	-0.1	4.2

Note: employment of ICT specialists is calculated based on the narrow definition for the sake of longer time series.

Source: EU LFS

Table A3. ICT specialists and total employment in 2000-2012 (broad definition, ICT-3)

year	employment, 1000s		share of ICT in total, %	employment growth, %	
	total	ICT		total	ICT
2004	206,518.60	4,102.25	2.0	0.0	0.0
2005	210,340.40	4,526.85	2.2	1.9	10.4
2006	214,416.60	4,813.67	2.2	1.9	6.3
2007	218,645.80	5,029.45	2.3	2.0	4.5
2008	221,306.80	5,159.84	2.3	1.2	2.6
2009	217,282.30	5,234.86	2.4	-1.8	1.5
2010	215,989.30	5,277.22	2.4	-0.6	0.8
2011	216,346.10	5,748.11	2.7	0.2	8.9
2012	216,082.00	6,124.71	2.8	-0.1	6.6

Source: EU LFS

Table A4. ICT specialists, 1000s (ICT-1, narrow definition)

country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
EU27	3140.027	3602.157	3614.24	3638.53	3744.439	4073.232	4274.28	4465.302	4568.695	4609.698	4676.128	4944.9	5154.421
AT	64.95288	70.13387	76.57655	75.46852	70.31646	78.10772	78.76176	78.4312	85.56327	90.58898	88.79971	105.1555	107.3606
BE	66.72568	81.23671	83.45366	74.14079	93.35759	90.03761	94.28255	105.5683	98.26498	104.4098	122.4447	137.3881	145.9175
BG	20.13948	24.12222	23.49255	22.77137	27.52559	29.99047	32.65731	35.0834	35.98058	37.61574	35.24205	47.03652	40.95543
CY	2.81276	3.82928	3.33225	4.12002	4.02456	4.499215	4.514573	5.719162	5.565272	4.65252	4.832005	5.58154	6.070175
CZ	78.1567	86.9995	95.73686	94.71308	82.65799	94.85211	104.7152	115.9344	129.8478	131.3828	138.8951	118.6906	121.6646
DE	625.5527	695.7768	671.1928	685.4869	664.6215	754.358	753.0237	822.6132	813.1547	830.379	875.6479	846.4409	891.6021
DK	72.04022	69.4594	75.00155	82.20278	77.60118	75.37959	83.62251	85.33064	92.2338	88.74753	92.25079	96.21077	105.8262
EE	5.2147	5.21547	11.42126	5.60793	5.08512	5.429862	8.430058	10.24381	10.88239	10.81981	12.67516	15.83266	17.90411
ES	194.0546	222.3282	232.2534	217.5273	257.6103	300.203	333.572	395.4355	400.0988	366.2386	384.8368	365.1426	335.0904
FI	50.41029	56.31381	61.25105	64.54225	65.18888	67.901	70.60376	71.59113	82.43996	77.40791	75.92106	85.18836	96.63439
FR	412.177	486.256	485.166	468.666	471.083	531.8205	562.447	483.621	531.529	555.411	546.932	508.368	505.359
GR	23.88116	22.58968	31.13396	28.46641	33.93555	32.97156	34.43633	37.86951	39.02403	46.13527	47.10885	36.51315	37.44442
HU	39.35369	53.23924	57.47097	68.04096	65.66565	62.69621	70.79494	67.57475	70.69074	68.34574	67.97619	65.35717	79.05527
IE	23.65211	25.69281	28.78023	29.06282	29.51186	28.48731	28.13468	27.15509	27.33616	32.49919	33.81123	52.36466	55.43447
IT	241.3223	277.9786	311.4181	316.5356	394.8558	401.5753	441.2555	453.4873	468.434	461.4722	444.8581	438.3727	457.7154
LT	10.32668	10.09416	6.10107	8.68441	12.47904	9.703629	10.38948	10.53384	14.68318	15.73117	12.96354	14.81091	16.13979
LU	2.94942	4.11798	3.49965	3.5417	4.77167	4.42408	4.42113	4.768815	6.50734	7.34397	7.77572	6.83442	8.4552
LV	10.13758	9.13186	10.26995	11.85629	12.28032	14.43338	13.83957	14.39482	14.7194	14.18141	14.41051	16.79822	14.41038
MT	0	0	3.271	1.962	2.702	2.98725	2.496	3.31375	3.28425	3.08625	3.2495	4.2095	4.75375
NL	280.2122	285.5137	282.0772	296.7799	287.7793	297.8594	268.5858	289.9019	298.4424	299.6443	307.4966	299.915	303.0068
PL	122.7722	135.2127	140.8846	149.7769	138.6178	173.8121	204.5324	224.5336	228.3772	242.0615	231.1848	224.7833	255.6644
PT	45.93631	59.51556	56.64383	55.0541	56.84979	62.78339	67.66926	72.75646	63.48536	66.80079	69.46127	58.01605	65.83807
RO	0	0	0	0	0	46.77065	68.45031	74.90906	77.22074	80.98266	75.3983	79.11204	84.54317
SE	153.5914	166.9664	165.0873	149.5448	145.9974	160.5821	164.7062	171.9907	178.9868	185.8997	190.5114	185.7686	195.8712
SI	12.52069	11.78289	13.7688	18.19408	18.73156	18.78782	21.70141	20.45742	21.15952	21.13944	21.6113	22.05776	19.46152
SK	23.25805	27.45255	28.12389	27.37845	28.32213	38.42961	46.8596	52.29367	46.62317	48.55469	45.70471	50.78111	44.86286
UK	557.876	711.198	656.832	678.405	692.867	684.349	699.377	729.79	724.16	718.1661	724.1291	1058.17	1137.38

Table A5: ICT specialists, % of total employment (ICT-1, narrow definition)

country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
EU27	1.6	1.8	1.8	1.8	1.8	1.9	2.0	2.0	2.1	2.1	2.2	2.3	2.4
AT	1.8	1.9	2.1	2.0	1.9	2.0	2.0	1.9	2.1	2.2	2.2	2.5	2.6
BE	1.6	2.0	2.1	1.8	2.3	2.1	2.2	2.4	2.2	2.4	2.7	3.0	3.2
BG	0.7	0.9	0.8	0.8	0.9	1.0	1.1	1.1	1.1	1.2	1.2	1.6	1.4
CY	1.0	1.2	1.1	1.3	1.2	1.3	1.3	1.5	1.5	1.2z	1.2	1.4	1.6
CZ	1.7	1.9	2.0	2.0	1.8	2.0	2.2	2.4	2.6	2.7	2.8	2.4	2.5
DE	1.7	1.9	1.9	1.9	1.9	2.1	2.0	2.2	2.1	2.2	2.3	2.1	2.2
DK	2.7	2.6	2.7	3.0	2.8	2.7	3.0	3.0	3.2	3.2	3.4	3.6	3.9
EE	0.9	0.9	2.0	1.0	0.9	0.9	1.3	1.6	1.7	1.8	2.2	2.6	2.9
ES	1.3	1.4	1.4	1.3	1.4	1.6	1.7	1.9	2.0	1.9	2.1	2.0	1.9
FI	2.1	2.3	2.5	2.7	2.7	2.8	2.9	2.9	3.3	3.2	3.1	3.4	3.9
FR	1.8	2.1	2.0	1.9	1.9	2.1	2.2	1.9	2.1	2.2	2.1	2.0	2.0
GR	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.8	0.9	1.0	1.1	0.9	1.0
HU	1.0	1.4	1.5	1.7	1.7	1.6	1.8	1.7	1.8	1.8	1.8	1.7	2.0
IE	1.4	1.5	1.6	1.6	1.6	1.5	1.4	1.3	1.3	1.7	1.8	2.8	3.0
IT	1.2	1.3	1.4	1.4	1.8	1.8	1.9	2.0	2.0	2.0	1.9	1.9	2.0
LT	0.7	0.7	0.4	0.6	0.9	0.7	0.7	0.7	1.0	1.1	1.0	1.2	1.3
LU	1.6	2.2	1.9	1.9	2.5	2.3	2.3	2.4	3.2	3.4	3.5	3.0	3.6
LV	1.1	0.9	1.0	1.2	1.2	1.4	1.3	1.3	1.3	1.4	1.5	1.9	1.6
MT	0.0	0.0	2.2	1.3	1.9	2.0	1.6	2.1	2.1	1.9	2.0	2.5	2.8
NL	3.6	3.5	3.4	3.7	3.6	3.7	3.3	3.5	3.5	3.5	3.7	3.6	3.6
PL	0.8	0.9	1.0	1.1	1.0	1.2	1.4	1.5	1.4	1.5	1.5	1.4	1.6
PT	0.9	1.2	1.1	1.1	1.1	1.2	1.3	1.4	1.2	1.3	1.4	1.2	1.4
RO	0.0	0.0	0.0	0.0	0.0	0.5	0.7	0.8	0.8	0.9	0.8	0.9	0.9
SE	3.7	3.8	3.8	3.4	3.4	3.7	3.7	3.8	3.9	4.1	4.2	4.0	4.2
SI	1.4	1.3	1.5	2.0	2.0	2.0	2.3	2.1	2.1	2.2	2.2	2.4	2.1
SK	1.1	1.3	1.3	1.3	1.3	1.7	2.0	2.2	1.9	2.1	2.0	2.2	1.9
UK	2.0	2.6	2.4	2.4	2.5	2.4	2.4	2.5	2.5	2.5	2.5	3.6	3.9

Table A6: ICT specialists, 1000s (ICT-3, broad definition)

country	2004	2005	2006	2007	2008	2009	2010	2011	2012
EU27	3967.719	4370.1	4632.439	4835.381	4958.432	5023.826	5066.017	5748.104	6124.714
AT	72.0263	79.61093	81.01803	81.05103	87.71588	92.88749	92.29151	124.2146	123.2392
BE	101.0535	98.3546	103.6526	115.7081	107.8568	113.883	134.425	159.3833	167.2961
BG	27.75602	30.5225	33.19235	36.23707	36.87178	38.75091	36.43752	54.19414	49.77945
CY	4.38497	4.720965	5.033605	6.11498	5.909203	5.211392	5.369483	8.054635	8.209476
CZ	82.65799	94.85211	106.7482	117.5901	131.7999	133.4383	141.0318	142.4014	141.7485
DE	704.7892	807.0936	812.9024	884.4048	891.7913	900.4797	931.8273	1027.517	1217.769
DK	78.66894	78.07279	86.16681	88.30502	95.47173	91.84866	93.88745	99.52592	109.1773
EE	6.19716	5.910105	8.502442	11.16528	12.00028	11.8447	13.34367	17.56098	20.20508
ES	257.6103	300.203	366.0405	431.0969	436.5027	411.0707	418.4531	468.5801	423.7083
FI	71.5569	74.37767	77.21358	77.24919	88.69805	86.57716	82.55235	103.9427	117.3105
FR	497.115	568.0637	598.482	526.689	561.285	605.241	597.564	556.95	549.127
GR	39.20132	38.20338	40.81244	45.25572	46.18571	53.47945	53.77972	50.54002	51.15189
HU	70.8933	69.60354	77.65086	73.95917	76.91373	76.37366	75.4071	87.26875	103.1875
IE	40.9338	41.0434	30.78982	27.15509	37.95636	41.83759	42.09522	68.708	69.1271
IT	416.4944	427.5435	469.0736	483.1506	493.2622	484.5124	469.2164	533.811	555.7639
LT	12.89069	10.7889	11.19808	11.87405	17.22199	18.01393	14.94668	20.09004	21.86358
LU	4.98086	4.55689	4.59502	4.887745	6.576925	7.54018	8.1541	7.55126	9.46337
LV	12.28032	15.2735	14.80659	15.4883	15.40733	15.00996	15.47991	17.72358	15.19407
MT	2.765	3.414	2.796	3.427	3.79475	3.51125	3.72625	4.77375	5.3095
NL	295.335	305.7352	278.3853	300.1261	307.9541	307.366	319.5357	322.3166	326.9969
PL	140.3242	191.0847	225.2875	244.1546	253.8991	271.5234	256.7199	281.9589	316.0058
PT	63.72671	68.33652	70.9639	78.98888	70.85436	72.82878	76.49275	70.42097	78.86416
RO	0	60.0786	90.34509	99.45437	103.0639	94.25561	88.56143	105.5672	121.0893
SE	148.1611	163.0265	168.781	176.9704	185.0132	191.1591	195.4848	215.9979	224.6254
SI	19.02556	19.01795	21.91985	20.91186	22.39879	22.40028	22.66396	26.51981	23.97786
SK	28.93843	38.988	48.00684	53.51651	47.3171	48.63786	46.30304	58.51247	52.02866
UK	767.952	771.623	798.075	820.449	814.7094	824.1432	830.2664	1113.928	1222.495

Source: EU LFS

Table A7: ICT specialists, % of total employment (ICT-3, broad definition)

country	2004	2005	2006	2007	2008	2009	2010	2011	2012
EU27	1.9	2.1	2.2	2.2	2.2	2.3	2.3	2.7	2.8
AT	2.0	2.1	2.1	2.0	2.1	2.3	2.3	3.0	2.9
BE	2.4	2.3	2.4	2.6	2.4	2.6	3.0	3.5	3.7
BG	0.9	1.0	1.1	1.1	1.1	1.2	1.2	1.8	1.7
CY	1.3	1.4	1.4	1.6	1.5	1.4	1.4	2.0	2.1
CZ	1.8	2.0	2.2	2.4	2.6	2.7	2.9	2.9	2.9
DE	2.0	2.2	2.2	2.3	2.3	2.3	2.4	2.6	3.0
DK	2.9	2.8	3.1	3.1	3.3	3.3	3.5	3.7	4.1
EE	1.0	1.0	1.3	1.7	1.8	2.0	2.3	2.9	3.2
ES	1.4	1.6	1.9	2.1	2.2	2.2	2.3	2.6	2.5
FI	3.0	3.1	3.1	3.1	3.5	3.5	3.4	4.2	4.7
FR	2.0	2.3	2.4	2.1	2.2	2.4	2.3	2.2	2.1
GR	0.9	0.9	0.9	1.0	1.0	1.2	1.2	1.2	1.4
HU	1.8	1.8	2.0	1.9	2.0	2.0	2.0	2.3	2.7
IE	2.2	2.1	1.5	1.3	1.8	2.1	2.2	3.7	3.8
IT	1.9	1.9	2.0	2.1	2.1	2.1	2.1	2.3	2.4
LT	0.9	0.7	0.7	0.8	1.1	1.3	1.2	1.6	1.7
LU	2.6	2.4	2.4	2.4	3.3	3.4	3.7	3.3	4.0
LV	1.2	1.5	1.4	1.4	1.4	1.5	1.6	2.1	1.7
MT	1.9	2.3	1.8	2.2	2.4	2.2	2.3	2.8	3.1
NL	3.6	3.8	3.4	3.6	3.6	3.6	3.8	3.9	3.9
PL	1.0	1.4	1.5	1.6	1.6	1.7	1.7	1.8	2.0
PT	1.2	1.3	1.4	1.5	1.4	1.4	1.5	1.5	1.7
RO	0.0	0.7	1.0	1.1	1.1	1.0	1.0	1.2	1.3
SE	3.4	3.8	3.8	3.9	4.0	4.2	4.3	4.7	4.8
SI	2.0	2.0	2.3	2.1	2.2	2.3	2.3	2.8	2.6
SK	1.3	1.8	2.1	2.3	1.9	2.1	2.0	2.5	2.2
UK	2.7	2.7	2.8	2.8	2.8	2.8	2.9	3.8	4.2

Source: EU LFS

Table A8: ICT specialists, 1000s (ICT-3, broad definition based on ISCO-08 and applied to ISCO-88 using ILO correspondence tables and own estimation)

country	2004	2005	2006	2007	2008	2009	2010	2011	2012
EU-27	4102.253	4526.85	4813.672	5029.454	5159.842	5234.863	5277.219	5748.105	6124.714
AT	74.81746	84.50122	83.5444	83.31411	90.60799	96.87934	94.97186	124.2146	123.2392
BE	103.1022	100.9874	107.2997	118.0129	111.5839	117.3311	137.5938	159.3833	167.2962
BG	28.19023	30.99334	34.17128	37.26288	37.6229	39.25799	38.38375	54.19414	49.77945
CY	4.69115	4.984272	5.221245	6.570783	6.796602	5.81689	5.88783	8.054635	8.209475
CZ	82.65799	94.85212	108.6106	118.0477	132.9352	135.0554	142.9402	142.4014	141.7485
DE	714.424	818.9503	825.2189	899.7272	903.8181	913.4447	946.0288	1027.517	1217.769
DK	80.58854	78.88034	87.84332	89.71987	97.24924	93.40825	95.09914	99.52593	109.1773
EE	7.76771	6.675738	9.319243	11.45328	12.9659	12.99353	14.06164	17.56098	20.20508
ES	257.6103	300.203	383.2202	448.4701	463.6285	439.1814	437.4358	468.5801	423.7083
FI	73.12639	75.68719	79.49952	80.3009	91.7512	88.54718	84.98967	103.9427	117.3105
FR	519.637	589.5197	622.69	555.086	581.871	629.685	627.497	556.95	549.127
GR	42.42447	42.73897	46.08543	50.26693	52.68075	59.10986	61.09105	50.54002	51.15189
HU	74.1743	74.18512	82.74128	81.474	83.85774	82.3664	82.47479	87.26875	103.1875
IE	47.16023	46.64206	31.58231	27.15509	41.74377	45.04216	45.31258	68.708	69.1271
IT	442.4486	452.0902	496.7585	506.7946	518.9925	507.7939	490.6449	533.811	555.7638
LT	13.24296	10.90886	12.62027	12.65476	18.88017	18.77621	15.63143	20.09004	21.86358
LU	5.07034	4.82754	4.69965	4.981005	6.723713	7.7051	8.42796	7.55126	9.46337
LV	13.56211	15.77255	16.09269	15.99171	15.68622	15.5574	15.87703	17.72358	15.19407
MT	2.916	3.60075	2.86475	3.45475	3.96575	3.59225	3.87525	4.77375	5.3095
NL	301.5433	311.3661	285.0322	307.9185	316.6682	318.2652	329.6946	322.3166	326.9968
PL	141.442	201.1295	236.8372	262.0195	270.5081	290.9185	278.2526	281.9589	316.0058
PT	70.57758	75.07128	76.28623	81.89149	74.94105	78.1866	81.41833	70.42097	78.86416
RO		66.533	96.3185	106.1384	109.9213	99.06202	92.15772	105.5672	121.0893
SE	149.9656	165.2109	172.3096	181.3291	189.4535	195.5677	199.781	215.9979	224.6254
SI	19.02556	19.3516	22.78468	21.52045	22.67905	22.46692	22.9448	26.51981	23.97786
SK	29.17213	39.49453	48.293	54.39819	48.23941	49.4924	47.83962	58.60445	52.02866
UK	802.915	811.692	835.727	863.5	854.0699	869.3595	876.9056	1113.928	1222.495

Note: This Table represents the re-construction of the series of ICT specialists for the period 2004-2010 in terms of ISCO-08 occupations based on the ILO official correspondence tables between ISCO-88 and ISCO-08, and on our own estimations where one-two-one correspondence between the two versions of ISCO is absent. An exact correspondence is available only for the ISCO-08 occupational group *250 ICT professionals* (which maps exactly to the ISCO-88 group *213 Computing professionals*). Correspondence between other ICT occupations is less straightforward. Thus, for example ISCO-08 group *35 Information and communication technicians* corresponds to two (out of three) occupations from the ISCO-88 group *312 Computer associate professionals*, to two (out of four) occupations from the ISCO-88 group *313 Optical and electronic equipment operators*, and to one (out of nine) occupation from the ISCO-88 group *311 Physical and engineering science technicians*.

Source: EU LFS

Table A9. ICT specialists, 1000s (ICT-3, broad definition based on ISCO-08 and applied to ISCO-88 using ILO correspondence tables and own estimation)

country	2004	2005	2006	2007	2008	2009	2010	2011	2012
EU-27	2.0	2.2	2.2	2.3	2.3	2.4	2.4	2.7	2.8
AT	2.0	2.2	2.1	2.1	2.2	2.4	2.3	3.0	2.9
BE	2.5	2.4	2.5	2.7	2.5	2.7	3.1	3.5	3.7
BG	0.9	1.0	1.1	1.1	1.1	1.2	1.3	1.8	1.7
CY	1.4	1.4	1.5	1.7	1.8	1.5	1.5	2.0	2.1
CZ	1.8	2.0	2.2	2.4	2.7	2.7	2.9	2.9	2.9
DE	2.0	2.3	2.2	2.4	2.3	2.4	2.4	2.6	3.0
DK	2.9	2.9	3.1	3.2	3.4	3.4	3.5	3.7	4.1
EE	1.3	1.1	1.4	1.7	2.0	2.2	2.5	2.9	3.2
ES	1.4	1.6	1.9	2.2	2.3	2.3	2.4	2.6	2.5
FI	3.1	3.1	3.2	3.2	3.6	3.6	3.5	4.2	4.7
FR	2.1	2.4	2.5	2.2	2.2	2.5	2.4	2.2	2.1
GR	1.0	1.0	1.0	1.1	1.2	1.3	1.4	1.2	1.4
HU	1.9	1.9	2.1	2.1	2.2	2.2	2.2	2.3	2.7
IE	2.6	2.4	1.6	1.3	2.0	2.3	2.4	3.7	3.8
IT	2.0	2.0	2.2	2.2	2.2	2.2	2.1	2.3	2.4
LT	0.9	0.7	0.8	0.8	1.2	1.3	1.3	1.6	1.7
LU	2.7	2.5	2.4	2.5	3.3	3.5	3.8	3.3	4.0
LV	1.3	1.5	1.5	1.4	1.4	1.6	1.7	2.1	1.7
MT	2.0	2.4	1.9	2.2	2.5	2.2	2.4	2.8	3.1
NL	3.7	3.8	3.5	3.7	3.7	3.7	3.9	3.9	3.9
PL	1.0	1.4	1.6	1.7	1.7	1.8	1.8	1.8	2.0
PT	1.4	1.5	1.5	1.6	1.4	1.5	1.6	1.5	1.7
RO		0.7	1.0	1.1	1.2	1.1	1.0	1.2	1.3
SE	3.5	3.8	3.9	4.0	4.1	4.3	4.4	4.7	4.8
SI	2.0	2.0	2.4	2.2	2.3	2.3	2.4	2.8	2.6
SK	1.4	1.8	2.1	2.3	2.0	2.1	2.1	2.5	2.2
UK	2.8	2.8	2.9	3.0	2.9	3.0	3.0	3.8	4.2

Source: EU LFS

Table A10: Distribution of ICT specialists among sector groups, 2012, %

	Agriculture, Forestry, Fishing	Mining and Electricity, Water, Waste	Manufacturing	Construction	Trade, Transport, Tourism	Business services	Other services
EU27	0.00	0.05	0.41	0.08	0.22	1.65	0.36
AT	0.00	0.06	0.49	0.08	0.47	1.46	0.4
BE	0.00	0.05	0.47	0.09	0.36	2.2	0.52
BG	0.00	0.05	0.17	0.01	0.2	0.97	0.29
CY	0.00	0.01	0.04	0.09	0.31	1.37	0.3
CZ	0.00	0.02	0.5	0.05	0.15	1.77	0.4
DE	0.00	0.08	0.72	0.06	0.28	1.58	0.32
DK	0.00	0.04	0.43	0.04	0.36	2.61	0.59
EE	0.00	0.01	0.33	0.12	0.26	1.95	0.56
ES	0.00	0.01	0.24	0.13	0.13	1.58	0.36
FI	0.00	0.06	0.78	0.21	0.32	2.84	0.51
FR	0.00	0.03	0.25	0.03	0.19	1.48	0.14
GR	0.00	0.03	0.09	0.03	0.2	0.7	0.31
HU	0.00	0.04	0.39	0.03	0.17	1.56	0.46
IE	0.00	0.06	0.41	0.05	0.14	0.61	0.16
IT	0.00	0.02	0.48	0.05	0.15	1.47	0.25
LT	0.01	0.01	0.18	0.11	0.18	0.98	0.24
LU	0.00	0.02	0.2	0.06	0.4	2.25	1.01
LV	0.02	0.05	0.09	0.02	0.14	1.17	0.24
MT	0.00	0.08	0.17	0.04	0.23	2.22	0.32
NL	0.00	0.05	0.22	0.04	0.23	1.66	0.47
PL	0.00	0.05	0.31	0.06	0.16	1.15	0.3
PT	0.00	0.01	0.16	0.06	0.23	0.92	0.32
RO	0.00	0.05	0.27	0.07	0.16	0.64	0.13
SE	0.00	0.03	0.37	0.18	0.41	3.11	0.69
SI	0.00	0.03	0.42	0.01	0.19	1.54	0.39
SK	0.00	0.03	0.27	0.04	0.17	1.51	0.22
UK	0.00	0.06	0.41	0.16	0.23	2.59	0.68

Source: EU LFS

Table A12. ICT specialists in 2012, 1000s (ICT-3, broad definition)

	EU27	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HU
Agriculture, Forestry, Fishing	4.525	0.061	0.142	0	0	0.000	1.082	0	0	0.178	0	0.625	0	0.119
Mining and Electricity, Water Supply (Waste management)	99.168	2.31	2.266	1.608	0.042	0.999	30.295	0.978	0.078	2.022	1.56	8.722	1.313	1.538
Manufacturing	896.665	20.378	21.17	4.98	0.159	24.528	290.112	11.431	2.068	40.832	19.332	63.572	3.349	15.21
Construction	164.995	3.142	4.217	0.359	0.34	2.557	24.759	0.943	0.751	23.06	5.296	6.896	0.95	1.041
Trade, H&R, Transport, Tourism	480.375	19.467	16.218	5.754	1.194	7.280	113	9.716	1.645	22.933	7.829	49.124	7.498	6.717
Business services	3,639.789	61.246	99.633	28.425	5.321	86.874	631.855	70.053	12.194	273.084	70.433	383.07	26.464	60.639
Other services	792.096	16.636	23.651	8.655	1.153	19.509	126.666	15.823	3.469	61.599	12.61	36.378	11.579	17.924
No answer	47.101							0.232			0.251	0.74		
total	6,124.713	123.239	167.296	49.779	8.209	141.749	1,217.77	109.177	20.205	423.708	117.311	549.127	51.152	103.188

	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
Agriculture, Forestry, Fishing	0.135	0.136	0.105	0	0.194	0	0.270	0.254	0.097	0.276	0.171	0	0.046	0.634
Mining and Electricity, Water Supply (Waste management)	1.316	5.576	0.168	0.04	0.418	0.144	5.301	7.584	0.492	4.358	1.559	0.293	0.621	17.567
Manufacturing	13.525	110.478	2.293	0.483	0.821	0.299	23.071	48.213	7.195	24.629	17.185	3.846	6.24	121.265
Construction	1.023	10.67	1.359	0.133	0.159	0.075	4.190	8.825	2.99	6.234	8.288	0.113	0.843	45.782
Trade, H&R, Transport, Tourism	4.425	34.986	2.303	0.953	1.206	0.398	23.709	25.61	10.712	14.789	19.275	1.781	3.861	67.993
Business services	42.935	335.893	12.546	5.351	10.271	3.841	181.210	178.81	42.417	59.109	144.846	14.211	35.202	763.857
Other services	5.768	58.025	3.089	2.393	2.124	0.553	48.922	46.709	14.961	11.694	32.092	3.582	5.216	201.316
No answer				0.11			40.324				1.21	0.152	0	4.081
total	69.127	555.764	21.864	9.463	15.194	5.31	326.997	316.006	78.864	121.089	224.625	23.978	52.029	1,222.50

Source: EU LFS

Table A13. ICT specialists in 2012, 1000s (ICT-3, broad definition)

	EU27	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HU
Agriculture, Forestry, Fishing	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.1
Mining and Electricity, Water Supply (Waste management)	1.6	1.9	1.4	3.2	0.5	0.7	2.5	0.9	0.4	0.5	1.3	1.6	2.6	1.2
Manufacturing	14.6	16.5	12.7	10.0	1.9	17.3	23.8	10.5	10.2	9.6	16.5	11.6	6.5	12.3
Construction	2.7	2.5	2.5	0.7	4.1	1.8	2.0	0.9	3.7	5.4	4.5	1.3	1.9	0.8
Trade, H&R, Transport, Tourism	7.8	15.8	9.7	11.6	14.5	5.1	9.3	8.9	8.1	5.4	6.7	8.9	14.7	5.4
Business services	59.4	49.7	59.6	57.1	64.8	61.3	51.9	64.2	60.4	64.5	60.0	69.8	51.7	49.2
Other services	12.9	13.5	14.1	17.4	14.0	13.8	10.4	14.5	17.2	14.5	10.7	6.6	22.6	14.5
No answer	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.2	0.1	0.0	0.0

	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
Agriculture, Forestry, Fishing	0.2	0.0	0.5	0.0	1.3	0.0	0.1	0.1	0.1	0.2	0.1	0.0	0.1	0.1
Mining and Electricity, Water Supply (Waste management)	1.9	1.0	0.8	0.4	2.8	2.7	1.6	2.4	0.6	3.6	0.7	1.2	1.2	1.4
Manufacturing	19.6	19.9	10.5	5.1	5.4	5.6	7.1	15.3	9.1	20.3	7.7	16.0	12.0	9.9
Construction	1.5	1.9	6.2	1.4	1.0	1.4	1.3	2.8	3.8	5.1	3.7	0.5	1.6	3.7
Trade, H&R, Transport, Tourism	6.4	6.3	10.5	10.1	7.9	7.5	7.3	8.1	13.6	12.2	8.6	7.4	7.4	5.6
Business services	62.1	60.4	57.4	56.5	67.6	72.3	55.4	56.6	53.8	48.8	64.5	59.3	67.7	62.5
Other services	8.3	10.4	14.1	25.3	14.0	10.4	15.0	14.8	19.0	9.7	14.3	14.9	10.0	16.5
No answer	0.0	0.0	0.0	1.2	0.0	0.0	12.3	0.0	0.0	0.0	0.5	0.6	0.0	0.3

Source: EU LFS

Box A1. ILO thematic view for ICT occupations (based on ISCO-08)

(a) Professional and associate professional occupations

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

(b) Other unit groups that primarily involve the production of ICT goods and services
- 133 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

Source: ILO (2012)

Box A2. The OECD ICT sector definition

(a) 2002 definition (based on NACE Rev.1.1)

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

(b) 2006-07 definition (based on NACE Rev.2)

ICT manufacturing
– 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
– 4651 Wholesale of computers, computer peripheral equipment and software
– 4652 Wholesale of electronic and telecommunications equipment and parts

ICT services
– 5820 Software publishing
– 6110 Wired telecommunications activities
– 6120 Wireless telecommunications activities
– 6130 Satellite telecommunications activities
– 6190 Other telecommunications activities
– 6201 Computer programming activities
– 6202 Computer consultancy and computer facilities management activities
– 6209 Other information technology and computer service activities
– 6311 Data processing, hosting and related activities
– 6312 Web portals
– 9511 Repair of computers and peripheral equipment
– 9512 Repair of communication equipment

Source: OECD (2011)

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Abstract
This study examines the evolution of the number of ICT-skilled workers employed in industry sectors in the EU28 over the period 2000-2012. Data are taken from the Eurostat Labour Force Statistics. It introduces a novel definition of ICT specialists that combines occupations and skills taxonomies. For the period prior to the introduction of the Standard Classification of Occupations (ISCO-08) it starts from the OECD definition but includes a wider range of ICT occupations. From 2011 onwards it adopts the thematic view for ICT occupations proposed by the ILO (2012). It confirms that employment of ICT specialists in the EU27 has been resilient to the economic downturn and uncertainty in global labour markets, and was able to maintain a growth path of 4.3% per year over the period 2000-2012, more than 7 times higher than average growth of total employment over the same period. Though ICT employment evolved cyclically it never turned negative. This rapid growth in ICT employment confirms the increasing importance of ICT technologies in the global economy

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