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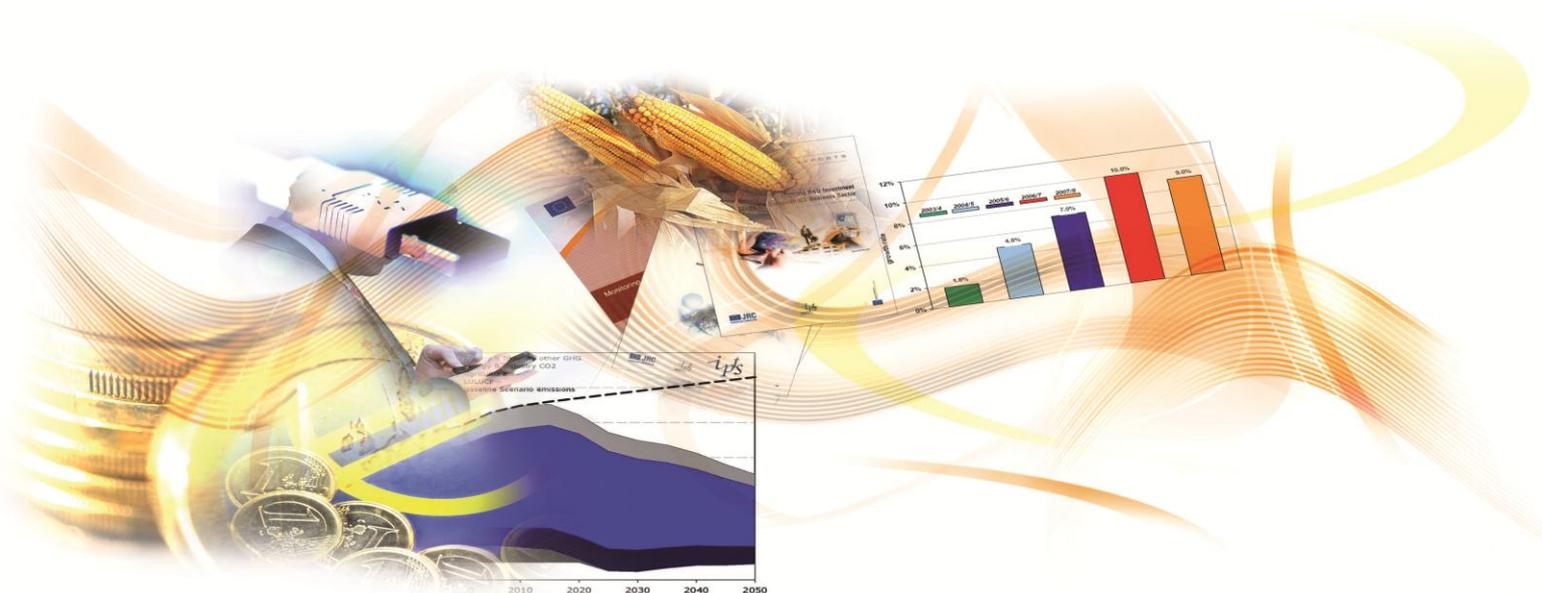
# THE 2014 PREDICT REPORT

## An Analysis of ICT R&D in the EU and Beyond

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**Abstract**

The 2014 PREDICT report covers the period 2006-2011 analysing the consequences of the deep recession that began in early 2008 which impacts the first most severe downturn in 2009 for the European Union (EU) ICT sector and its R&D performance. The report found that the EU ICT sector continued losing share in total value added, but gaining the share in terms of employment and BERD intensity. The share of ICT R&D public funding (GBAORD) on total GBAORD also increased in 2010 and 2011. However, as a result of the reverse progress on the value added and employment, ICT sector's labour productivity showed a downward trend during the observed periods. In terms of sub-sector analysis, the ICT manufacturing and services have both recovered to create additional employment in 2011 even though the impact is less profound for the latter. On international comparison, the US still led in ICT sector productivity and value added in 2011. However, in BERD activities, they are being challenged by four Asian countries: Japan, China, Korea and Taiwan.

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# Executive summary

## Introduction

The 2014 PREDICT report provides a detailed descriptive analysis of the state of the Information and Communication Technologies (ICT) sector and its Research and Development (R&D) in the European Union and beyond.

This analysis has been carried out by the *Valencian Institute of Economic Research* (Ivie) and the Information Society Unit of the *Institute for Prospective Technological Studies* (JRC-IPTS) under the *Prospective Insights on R&D in ICT* (PREDICT) project. PREDICT is being run by JRC-IPTS for the Directorate General for Communications Networks, Content and Technology (DG CONNECT) of the European Commission.

This is the seventh in a series of annually published reports, and it is the third web-based edition. Like the previous reports, this one is based on the latest data available from official sources such as the Statistical Office of the European Communities (Eurostat) and the Organisation for Economic Co-operation and Development (OECD). The 2014 PREDICT covers the period 2006-2011, and as such includes an analysis of the consequences for the European Union (EU) ICT sector and its R&D of the deep recession that began in early 2008, but had its first most severe downturn in 2009. This is the third year in which the PREDICT analysis has followed the NACE Rev 2 definition of the ICT sector.<sup>1</sup> According to this definition the ICT sector is composed of the sub-sectors described in Table 1.

**Table 1: The ICT sector (2007 OECD definition)**

Nace Rev. 2	Description
<b>261-264, 268</b>	<b>ICT manufacturing industries</b>
261	Manufacture of electronic components and boards
262	Manufacture of computers and peripheral equipment
263	Manufacture of communication equipment
264	Manufacture of consumer electronics
268	Manufacture of magnetic and optical media
<b>465, 582, 61, 62, 631, 951</b>	<b>ICT total services</b>
<b>465</b>	<b>ICT trade industries</b>
4651	Wholesale of computers, computer peripheral equipment and software
4652	Wholesale of electronic and telecommunications equipment and parts
<b>5820, 61, 62, 631, 951</b>	<b>ICT services industries</b>
5820	Software publishing
61	Telecommunications
62	Computer programming, consultancy and related activities
631	Data processing, hosting and related activities; web portals
951	Repair of computers and communication equipment

The analysis first provides an overview of the importance of the EU ICT sector and its R&D. It then gives detailed information, by ICT manufacturing and service sub-sectors and by EU Member State, and in comparison with other non-EU economies that are currently taking the lead in the world economy, including both developed and emerging economies.

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<sup>1</sup> See: OECD Information Economy–Sector definitions based on the International Standard Industry Classification (ISIC 4) available at <http://www.oecd.org/science/scienceandtechnologypolicy/38217340.pdf>, Annex 1, pg. 15. More details on methodology are provided in Mas, Robledo and Pérez (2012): *ICT sector definition transition from NACE Rev. 1.1 to NACE Rev. 2: A methodological note*, available at <http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=5919>.

The report confirms some of the trends observed in previous PREDICT analyses but it also shows some improvements that will need confirmation in the coming years. The main observations made in this year's report are the following:

- The EU ICT sector continued losing share in total value added from 4.10% in 2006 to 4.02% in 2010 and 3.99% in 2011. The EU ICT sector share in terms of employment increased from 2.66% in 2010 to 2.72% in 2011, as job creation in the ICT sector has been stronger. The combination of the movements of both variables (higher reduction in Gross Value Added –GVA– than employment in 2006-2009 and slower recovery in 2010-11) translated in a continuous fall in the EU ICT sector labour productivity.
- ICT Business Enterprise Expenditure on R&D (BERD) intensity (ICT BERD/ICT value added) has experienced an increase between 2010 (5.30%) and 2011 (5.50%).
- The share of ICT R&D public funding (ICT GBAORD, Government Budget Appropriations or Outlays on R&D) of total GBAORD also increased in these two years from 6.52% in 2010 to 6.63% in 2011, although ICT GBAORD intensity (defined as ICT GBAORD/GDP –Gross Domestic Product) has decreased slightly.
- The EU ICT manufacturing sector slowly recovered in 2011. For the first time since the onset of the crisis the EU ICT manufacturing sector showed in 2011 a positive employment growth rate (1.03%), BERD (3.76%) and R&D personnel (3.62%) but not in labour productivity (-6.70%) because of the slowdown in ICT value added (-5.75%).
- The US is the ICT productivity leader increasing the size of its ICT sector in terms of VA in 2011. However, it is being challenged in terms of BERD by four Asian countries: Japan, China, Korea and Taiwan according to two indicators. First, the US lost weight in the ICT BERD world share between 2010 and 2011 while the Asian countries gained positions. Second, the US BERD intensity and ICT BERD intensity (ICT BERD/ICT VA) kept practically constant in this period while it increased in the other four countries.

### ***The impact of the crisis on the ICT sector***

The EU ICT sector value added (ICT VA) showed a stable share of GDP between 4.10% and 4.09% in 2006 and 2007, before the onset of the crisis. In the following four years it experienced a slight but steady decrease, falling to 4.02% in 2010 and to 3.99% in 2011. The opposite trend was seen in ICT sector employment which has resisted more successfully than total employment. In 2011 it represented 2.72% of total EU employment, a higher share than in 2006 (2.62%) and that in 2010 (2.66%). The combined movements of VA and employment translated into a continuous fall in the ICT sector labour productivity. The ICT sector labour productivity was a 56.57% higher than the total in 2006. This advantage fell to 50.95% in 2010 and to 46.62% in 2011, as ICT sector VA slowed down whereas employment proved to be more resilient.

The ICT sub-sectors with the highest weight in GDP and employment in the EU –*Telecommunications* and *Computer programming*– belong to the ICT service sector. The former sub-sector experienced a reduction in 2011 in terms of both variables, especially in VA. For this reason its labour productivity –which is the highest of all the ICT sub-sectors– decreased (-2.41%).

Overall, the available information indicates that the EU ICT sector lost weight in VA from 2008 to 2011, the last year analysed, but it gained weight in terms of employment. As a consequence, ICT sector labour productivity has continued decreasing in 2011 with respect to 2006, and also to 2010, both in absolute and relative terms.

### ***R&D in the EU ICT sector shows positive signs***

The ICT sector is one of the most research-intensive sectors in the EU economy. Thus, the ICT sector is a key contributor to the EU's target to reach 3% of GDP invested in R&D by 2020. BERD intensity

was 1.29% of GDP in 2011 while ICT BERD intensity reached 5.50%. That is, it was 4.27 times higher than total BERD intensity. Furthermore, this ratio was higher than in 2010 (5.30%).

Estimated public funding of R&D in the ICT sector ICT GBAORD (Government Budget Appropriations or Outlays on R&D) in 2011 represented 6.63% of total EU public funding of R&D (total GBAORD). This percentage has been increasing steadily since 2008 (6.36%), and more noticeable between 2010 (6.52%) and 2011.

Total economy and specially ICT manufacturing sectors have an important role to play within total BERD. While manufacturing represents around 14% of VA and employment, its weight in terms of BERD is much higher at around 64%. A similar –although less pronounced– pattern can be seen in ICT service sectors. Their share in terms of BERD is 9.80% while the corresponding figures for VA and employment are 3.65% and 2.35%, respectively. Thus, ICT sub-sectors –especially manufacturing– absorb a much higher proportion of BERD than their weight in the economy.

The two ICT sub-sectors with the highest BERD share of total BERD are *Computer programming*, belonging to the ICT service sector, and *Manufacturing of communication equipment*, belonging to ICT manufacturing. Of the selected non-ICT manufacturing sectors<sup>2</sup> with close relations to ICT and/or R&D, the highest shares in total BERD correspond to *Manufacture of motor vehicles, trailers and semi-trailers*, and *Manufacture of machinery and equipment*.

The EU ICT R&D personnel and researchers maintained their positive rates of growth in 2010 and 2011 but experienced a slowdown between these two years. The reason for the slowdown of the former is due to the deceleration of the ICT services sector personnel since R&D personnel in the ICT manufacturing sector presented a positive growth rate although not high enough to compensate the slowdown in the ICT service sector.

### ***The EU ICT manufacturing sector slowly recovered in 2011***

The first years of the crisis hit the EU's ICT manufacturing sector more severely than its services sector. The ICT manufacturing sector share of total ICT VA came down from 12.18% in 2006 to 8.56% in 2009. In 2010 it experienced a recovery due to a stronger ICT manufacturing VA growth in comparison to ICT services or the whole economy, reaching 9.34%, which slowed down in 2011 (8.71%). ICT manufacturing employment share dropped 3.86 percentage points from 17.64% in 2006 to 13.78% in 2011. However, in 2011 –and for the first time after the onset of the crisis– it presented a positive rate of growth of 1.03%.

The slight recovery of the ICT manufacturing sector is confirmed by the BERD variable which, also for the first time since 2007, showed a positive growth (3.76%) in 2011. The recovery of the number of ICT manufacturing personnel is another positive sign. In 2011 the rate of growth of ICT manufacturing personnel (3.62%) was higher than in ICT service sectors (2.67%).

The weakness shown by the EU ICT sector during the first years of crisis was due to the slowdown in the ICT manufacturing sector and not in the service sector. However, the most recent data seems to indicate that the ICT manufacturing sector might have changed the downward tendency in 2011.

### ***The EU ICT sector is concentrated in a number of Member State (MS) countries***

In 2011 ICT sector value added was highly concentrated in the five largest EU countries: Germany (17.03%), the United Kingdom (UK) (16.95%), France (15.95%), Italy (11.26%) and Spain (7.16%).

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<sup>2</sup> The selected non-ICT manufacturing sectors are: manufacture of chemicals and chemical products; manufacture of pharmaceuticals, medicinal chemical and botanical products; manufacture of machinery and equipment; manufacture of motor vehicles, trailers and semi-trailers and manufacture of other transport equipment.

These five countries together generated 68.35% of total EU ICT VA, and 64.66% of total ICT sector employment.

The picture for ICT BERD at national level is rather different from that of employment or VA. Germany had the highest share (22.26%) of total ICT BERD for the European Union in 2011, followed by France (17.11%), the UK (11.68%), Finland (9.92%) and Sweden (7.62%). The differences between the VA and BERD shares originate in the sectoral specialisation between manufacturing and services: the higher the share of manufacturing, the higher the share in terms of BERD, and also in terms of R&D personnel. This is the case of Finland, whose share in terms of ICT VA was 1.63%, compared with 9.92% for ICT BERD. But it is not the case for countries that host the production of ICT goods –such as Hungary or Ireland– since in those cases R&D is usually carried out in the home country. In 2011 Finland had the highest BERD intensity in the ICT sector, followed by the other two Nordic countries, Sweden and Denmark. Finland also had the highest share of ICT sector R&D personnel of the total ICT sector employment and, together with Sweden, was the country with the highest share of ICT manufacturing personnel. Finally, Sweden, Finland and Denmark present also the highest share of public funding of ICT R&D (ICT GBAORD) in GDP of all the EU MS. Thus, the Nordic countries, especially Finland and Sweden, have a weight in ICT R&D that goes well beyond their economic size.

### ***The US leadership keeps being challenged by the Asian countries***

The US has kept the leadership in 2011 in terms of the size of its ICT sector and labour productivity, but is losing positions in terms of BERD. The US was almost the only country, of the thirteen analysed, which experienced an increase in the ICT VA share of GDP in 2011. It is the leading country in ICT sector labour productivity, both in ICT manufacture and services sectors. Norway takes the second place –due to its prominent position in ICT manufacturing– and Australia the third one. While these three countries experienced ICT sector labour productivity gains, the EU had a slight contraction between 2010 and 2011. Furthermore, the EU ICT sector labour productivity falls behind that of the US, Norway, Australia, Canada and Switzerland.

The US leadership in terms of R&D has been somehow challenged by some Asian countries. The US and the EU lost weight in the ICT BERD world share between 2010 and 2011 while Japan, China, Korea and Taiwan gained positions. In the EU total BERD intensity increased slightly but it kept constant in the ICT sector. The US BERD intensity kept constant in this period while it increased in Korea, Japan, Taiwan and China.

In terms of total R&D public funding (GBAORD) as a share in GDP, available data shows that the differences between countries are not very significant. However, the gap in terms of ICT R&D public funding (ICT GBAORD) is more marked. In this case, the share of ICT R&D public funding in the US and Japan almost doubles that of the EU.

The main lessons to be learnt from the international perspective keep being the same that the 2013 PREDICT, namely having a large ICT manufacturing sector –like China, Taiwan and Korea– is an important lever for growth, especially when it is combined with important resources devoted to R&D, both in terms of expenditures and of qualified personnel. The strength of the US, as compared with the EU, lies in its high productivity levels, the defence of its ICT manufacturing sector, and high R&D resources committed to improve its competitiveness in the world markets. Some of the trends of previous PREDICT reports are confirmed –the loss of weight of ICT sector value added in the EU, the increase of labour productivity due to the more resilience of EU employment, or lower BERD intensity that in the US and in other emerging economies–. However, in the PREDICT 2013 some changes can also be observed in comparison with the previous edition: increase in the EU BERD intensity, increase of ICT GBAORD, and the growth of manufacturing employment in 2011, among others.

## Introduction

The 2014 PREDICT Report: “An Analysis of ICT R&D in the EU and beyond” provides a detailed analysis of the state of Information and Communication Technologies (ICT) Research and Development (R&D) activities in the European Union. This is the seventh edition of a series that is published annually. As in the 2012 and 2013 editions, the 2014 edition has also been published in an online version available at: <http://is.jrc.ec.europa.eu/pages/ISG/PREDICT.html>.

This edition is based on the latest data available from official sources, such as Eurostat and OECD. It covers the years 2006 to 2011, a period marked by a deep financial and economic crisis.

This analysis was carried out by the *Valencian Institute of Economic Research* (Ivie) and the Information Society Unit of the *Institute for Prospective Technological Studies* (JRC-IPTS) under the *Prospective Insights on R&D in ICT* (PREDICT) project, a research project analysing R&D in ICT in Europe. PREDICT is being run by JRC-IPTS for the Directorate General for Communications Networks, Content and Technology (DG CONNECT) of the European Commission.

The PREDICT analysis provided here is structured as follows:

- An initial overview of the importance of the EU ICT sector and of its R&D.
- Detailed information by ICT manufacturing and services sub-sectors, by EU Member State, and compared with twelve leading ICT countries from the five continents.

The data and analyses are provided according to the following categories: size of the ICT sector value added in terms of its share of GDP, ICT sector employment and labour productivity, ICT sector Business Enterprise Expenditure on R&D (ICT BERD), Public Funding of ICT sector R&D (ICT GBAORD) and ICT sector R&D personnel and researchers.

### **Methodological note**

The data and analyses provided here are based on data from National Accounts and R&D statistics. PREDICT analyses follow the NACE Rev 2 definition of the ICT sector.<sup>3</sup> Since the adoption in 2006 of this new definition of the ICT sector, it must now be applied by all Member States when reporting ICT sector data, starting with year 2008.<sup>4</sup> Data was downloaded between January and April 2014 covering the period up to 2011.

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<sup>3</sup> OECD Information Economy–Sector definitions based on the International Standard Industry Classification (ISIC 4), Annex 1, p.15, available at: <http://www.oecd.org/science/scienceandtechnologypolicy/38217340.pdf>. The industry classification used appears in Box 1 (chapter 2).

<sup>4</sup> More details on methodology are provided in Mas, Robledo and Pérez (2012), *ICT sector definition transition from NACE Rev. 1.1 to NACE Rev. 2: A methodological note*, Ivie.

# 1. Overview of the EU ICT sector and its R&D

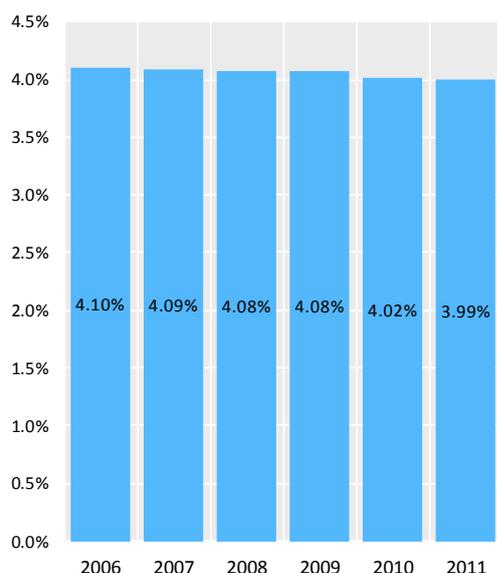
This chapter provides an overview of the importance of the EU ICT sector and its R&D by presenting the main indicators for period 2006-2011, offering a general perspective which will be analysed in depth in the following three chapters.

## 1.1 ICT sector value added

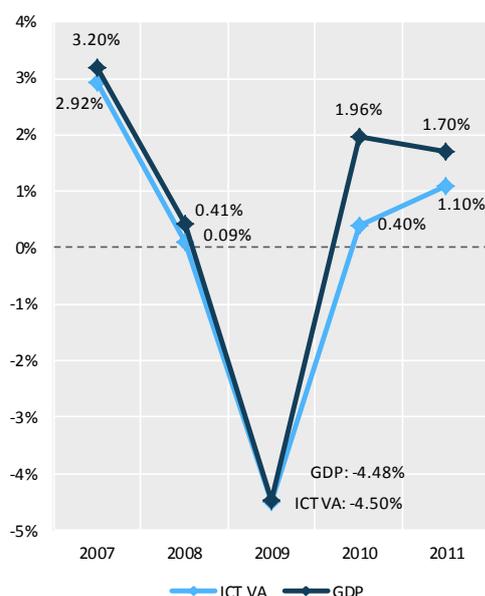
EU ICT sector value added (ICT VA) amounted to 482.87 billion euros in 2006. Five years later it had increased by 24.74 billion euros, reaching a value of 507.61 billion euros. The EU ICT VA represents around 4% of total GDP. Figure 1a shows a slight reduction in this share from 4.10% in 2006 to 3.99% in 2011 during the most recent years of economic recession. Figure 1b shows a very similar annual growth rate<sup>5</sup> in both variables, especially in the first part of the period. Between 2006 and 2007, ICT VA and GDP grew at a rate of 2.92% and 3.20% in real terms, respectively. However, during the first year of recession ICT VA growth rate fell to 0.09% and GDP to 0.41%. Both variables experienced a drop (around -4.5%) in 2009, to recover again in 2010. This recovery continued for ICT VA in 2011, from an annual growth rate of 0.40% in 2010 to 1.10% in 2011. However, in the same period, the GDP annual growth rate followed the opposite path, reducing the growth rate from 1.96% in 2010 to 1.70% in 2011.

**Figure 1:**

**a: ICT sector value added share of total value added. European Union (2006-2011)**



**b: ICT sector value added and GDP real annual growth rates. European Union (2006-2011)**



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

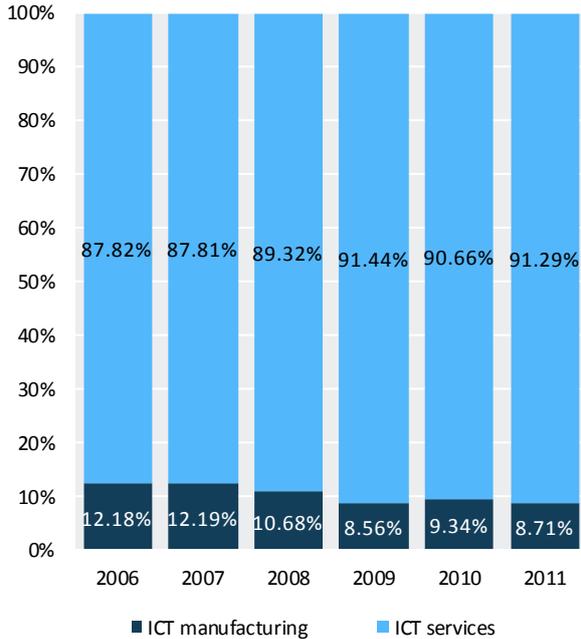
ICT VA is concentrated in the ICT services sectors as Figure 2a illustrates. ICT manufacturing's VA represents throughout the period analysed around 10.3% of total ICT sector value added. However a distinct feature is that it has been losing share since the beginning of the recession. While in 2006 ICT manufacturing VA represented 12.18% of total VA, in 2011 this share had decreased by almost 3.5 percentage points, to 8.71%. This result indicates that ICT manufacturing has suffered more

<sup>5</sup> All growth rates are computed in real terms using the implicit GDP deflator (chained volume estimates or fixed-base volume estimates, depending on countries).

from the downturn of economic activity than ICT services, as confirmed by Figure 2b. ICT manufacturing experienced a contraction of its VA of -12.36% in 2008 and -23.43% in 2009. However, it recovered in 2010 when it grew at a rate of 9.53% and contracted again in 2011 at a rate of -5.75%. Compared to these figures, the pattern of growth in ICT services VA was much more stable, decreasing only by -2.23% in the most severe drop which took place in 2009 and growing between 2010 and 2011 at a rate of 1.80%.

**Figure 2**

**a: Distribution of VA shares for ICT manufacturing and ICT services. European Union (2006-2011)**



**b: Annual real growth rates of ICT manufacturing and ICT services value added. European Union (2006-2011)**

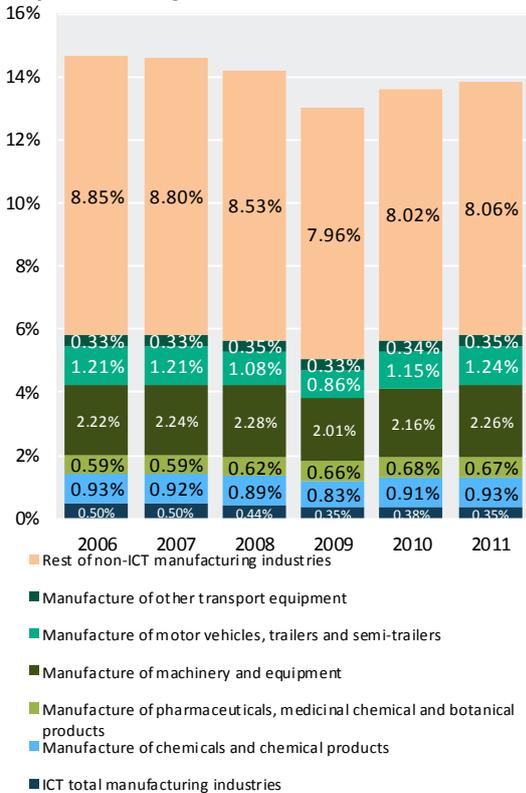


Source: Eurostat, elaborated by Ivie and JRC-IPTS.

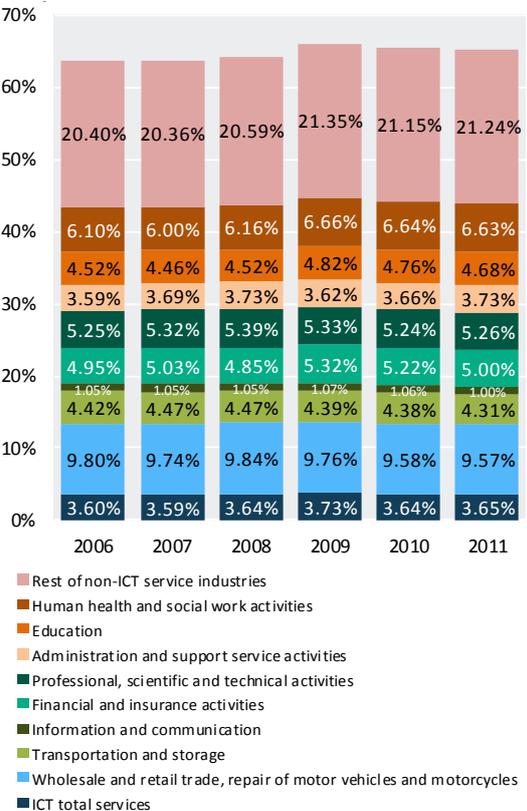
The value added generated by the whole manufacturing sector (including ICT and non ICT industries) represents around 14% of total GDP in the EU. Figure 3a shows how this percentage is split among ICT and some selected non-ICT sub-sectors that in some way have a closer relation with ICT and/or R&D. ICT manufacturing sectors represented 0.3%-0.5% of total GDP. Other sectors with an important relation with ICT and/or R&D also have a small share of GDP, with *Manufacture of machinery and equipment* having the highest share (around 2.2%).

**Figure 3: ICT sector value added share of GDP and comparison with non-ICT economic activities. European Union (2006-2011)**

**a) Manufacturing**



**b) Services**



Note: Agriculture, forestry and fishing; mining and quarrying; electricity, gas, steam and air conditioning supply; water supply, sewerage, waste management and remediation activities; and construction are not included in either manufacturing or services industries.

Source: Eurostat, elaborated by Ivie and JRC-IPTS.

Figure 3b provides similar information but related to the services VA share of GDP. Services VA represents around 65% of total GDP in the EU. ICT services sectors account for 3.65% in 2011. Wholesale and retail trade, repair of motor vehicles and motorcycles (9.57%), Human health and social work activities (6.63%) and Professional, scientific and technical activities (5.26%) are the non-ICT services sectors with the highest shares of GDP. Overall, the information confirms that services sectors are more closely related to ICT than manufacturing sectors as ICT services sector represents 5.6% of total VA whereas ICT manufacturing only 2.6%. Now, the share of the group termed “rest of non-ICT services industries”<sup>6</sup>– which gathers the non-ICT sectors with lower presence of ICT- is lower than that of manufacturing, representing around one third of total service VA share. At the same time, the share of ICT sectors is higher in service sectors than in manufacturing.

<sup>6</sup> This group includes accommodation and food service activities; real estate activities; public administration and defence; compulsory social security and other service activities; activities of households as employers and extraterritorial organisations and bodies (except repair of computers and communication equipment).

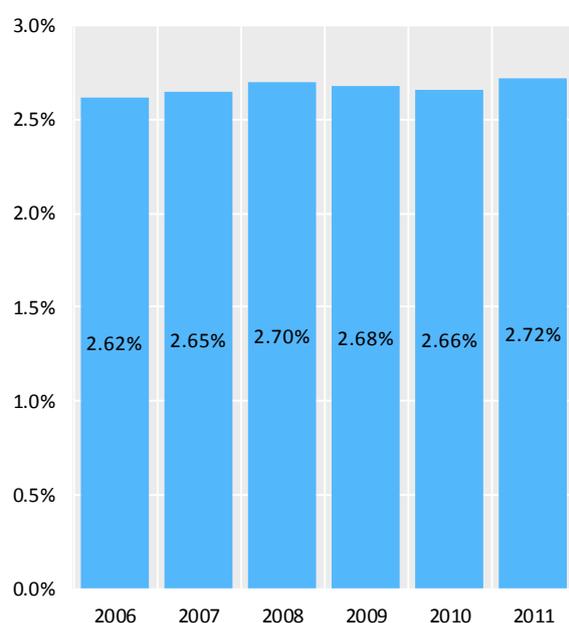
## 1.2 ICT sector employment and ICT sector labour productivity

### 1.2.1 ICT sector employment

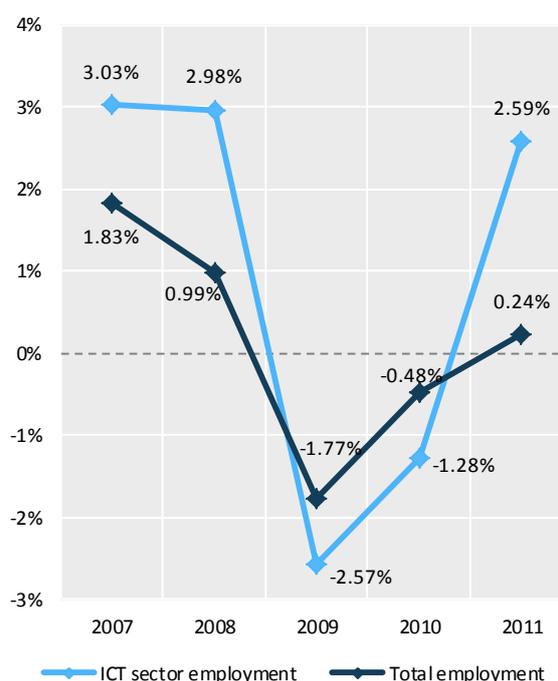
Total ICT sector employment in the EU amounted to 5.86 million people in 2006 and 6.13 million people in 2011, a positive variation of around 274.40 thousand workers. The ICT sector employment share of total EU employment is lower than that of VA, around 2.7%. This percentage has also remained fairly stable over the six years analysed, oscillating very slightly between 2.62% in 2006 and 2.70% in 2008 as indicated in Figure 4a. In contrast to the case of VA, ICT sector employment share increased during the first years of the recession that started in 2008, falling since this year until 2011, when this share increased to 2.72%. Figure 4b illustrates the pattern for the annual rate of growth of ICT sector and total employment in the EU. In 2007 ICT sector employment grew at an annual rate of around 3%, almost doubling total employment growth. ICT sector employment did not suffer the deceleration that ICT VA experienced in 2008, the first year of recession, since it continued to grow at an annual rate of 2.98%, tripling total employment growth. By contrast, the fall in the rate of growth of ICT sector employment in the following two years was more severe than for the total economy. In 2011, the last year for which information is available, ICT sector employment reversed this contraction growing at a rate of 2.59% in contrast to the 0.24% rate of total employment.

**Figure 4**

**a: ICT sector employment share of total employment. European Union (2006-2011)**



**b: ICT sector employment and total employment annual growth rates. European Union (2006-2011)**



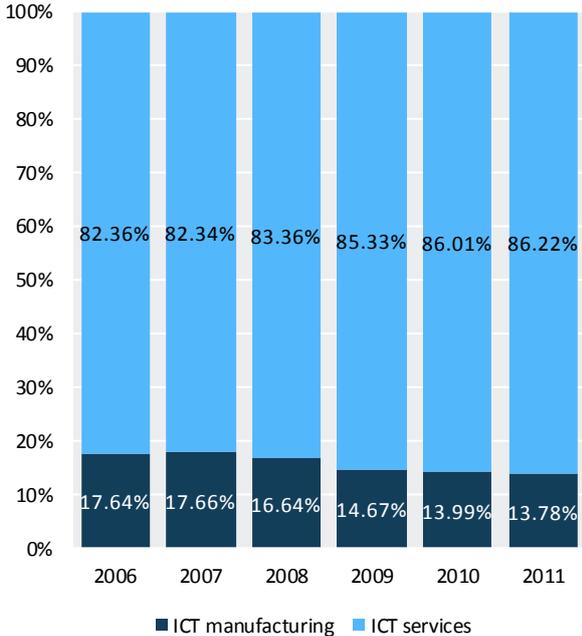
Source: Eurostat, elaborated by Ivie and JRC-IPTS.

The share of ICT manufacturing employment on total ICT sector employment is higher than its share in terms of VA. Figure 5a indicates that –as in the case of VA– this share fell throughout the period from 17.64% in 2006 to 13.78% in 2011. It is interesting to note, in Figure 5b, that

employment in the ICT service sectors did not suffer the adverse effect of the economic crisis to the same extent as ICT manufacturing employment or total employment. In fact, while manufacturing experienced a drop of -14.10% in 2009, ICT service employment only contracted by -0.27%. In 2011, both ICT manufacturing and ICT services employment began to grow at a positive rate, especially ICT services, whose annual growth rate (2.85%) was almost three times higher than in ICT manufacturing (1.03%).

**Figure 5**

**a: Distribution of employment shares for ICT manufacturing and ICT services. European Union (2006-2011)**



**b: Annual growth rates of ICT manufacturing and ICT services employment. European Union (2006-2011)**



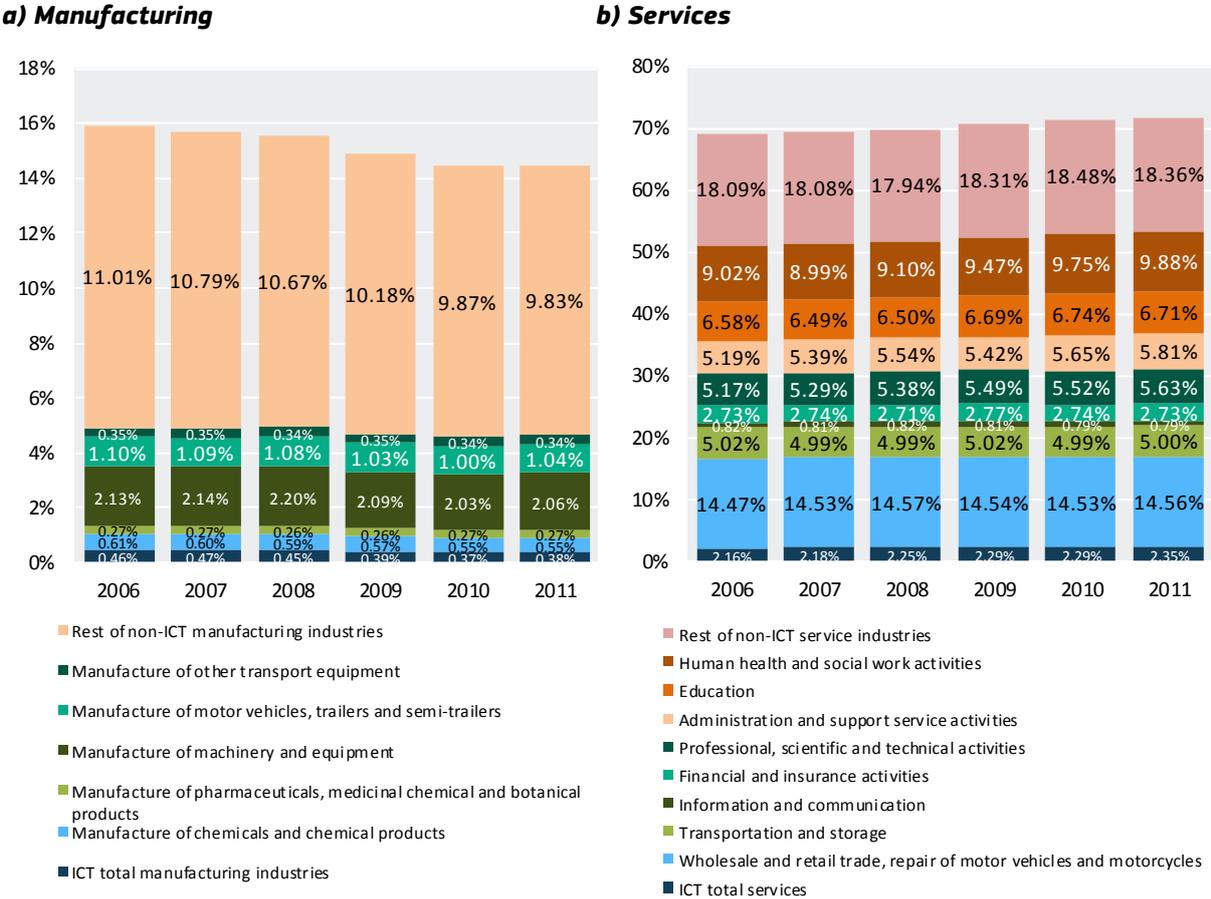
Source: Eurostat, elaborated by Ivie and JRC-IPTS.

Figure 6a shows that employment in the EU manufacturing sectors represents around 14%-16% of total employment, a slightly higher share than the 13% - 15% for VA (see Figure 3a). Employment in ICT manufacturing sectors represents around 0.4% of total employment, a percentage similar to that of VA. *Manufacture of machinery and equipment* has the highest share (2.06%) in 2011, as already seen in terms of VA. The non-ICT sub-sectors that are not closely related to ICT and/or R&D (“rest of non-ICT manufacturing industries”<sup>7</sup> in Figure 6a) represent more than half of total manufacturing employment. Employment in services sectors represents around 70% of total employment while in the ICT services sectors this figure stands at around 2.3% (Figure 6b). As

<sup>7</sup> Rest of non-ICT manufacturing industries includes: manufacture of food products, beverages and tobacco products; manufacture of wood and paper products, and printing; manufacture of coke, and refined petroleum products; manufacture of rubber and plastics products, and other non-metallic mineral products; manufacture of basic metals and fabricated metal products, except machinery and equipment; manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks; manufacture of irradiation, electro-medical and electro-therapeutic equipment; manufacture of optical instruments and photographic equipment; and other manufacturing, and repair and installation of machinery and equipment.

before, the sectors with the highest share are *wholesale and retail trade, repair of motor vehicles and motorcycles* (14.56%) and *Human health and social work activities* (9.88%).

**Figure 6: ICT sector employment share on total employment and comparison with non-ICT economic activities. European Union (2006-2011)**



Note: Agriculture, forestry and fishing; mining and quarrying; electricity, gas, steam and air conditioning supply; water supply, sewerage, waste management and remediation activities; and construction are not included in either manufacturing or services industries.

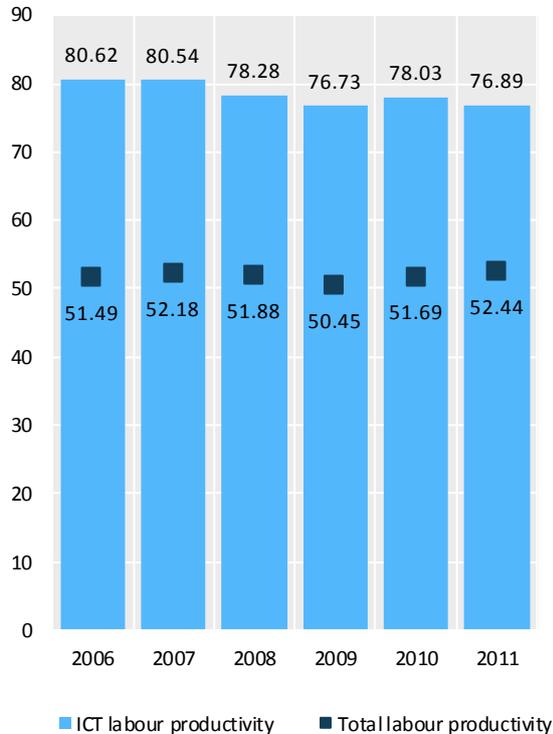
Source: Eurostat, elaborated by Ivie and JRC-IPTS.

### 1.2.2 ICT sector labour productivity

Labour productivity in the ICT sector (ICT VA/ICT employment) amounted to around 76.9 thousand euros per person in 2011, 46.64% higher than total labour productivity (total VA/total employment) (Figure 7a). Before the onset of the economic crisis, labour productivity in the ICT sector grew at a lower rate than in the total economy. In 2010 both variables had recovered a similar rate (2.45% for total labour productivity and 1.70% for ICT sector labour productivity) (Figure 7b), basically due to the recovery of VA growth together with the fall in employment. However, in 2011 these rates have dropped again, especially for ICT sector labour productivity (-1.46% vs 1.45% for total labour productivity).

**Figure 7:**

**a: ICT sector labour productivity. European Union (thousand constant [base year 2005] EUR per person; 2006-2011)**



**b: ICT sector labour productivity and total productivity annual real growth rates. European Union (2006-2011)**

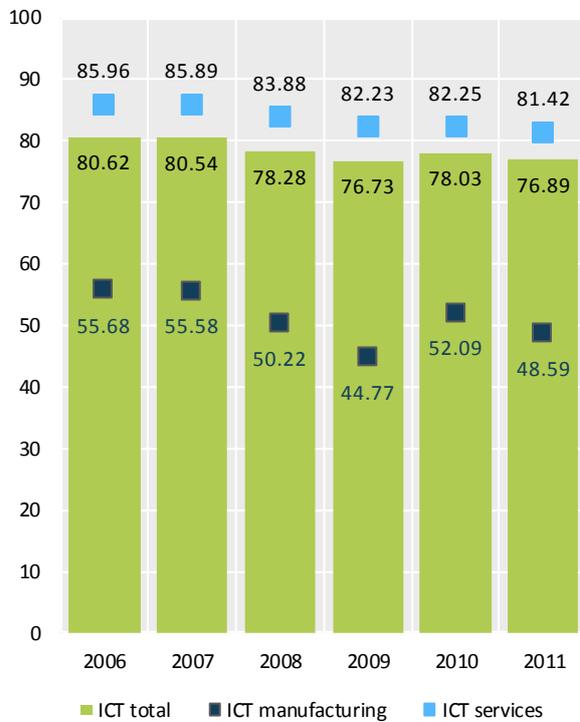


Source: Eurostat, elaborated by Ivie and JRC-IPTS.

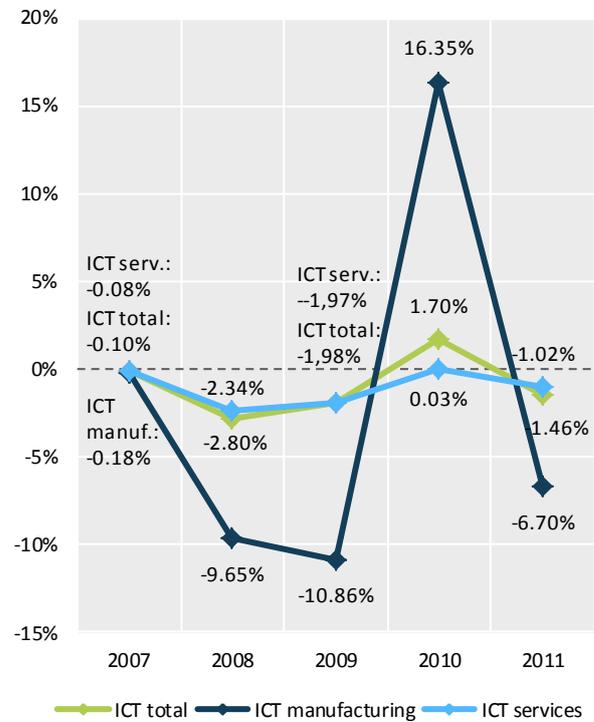
Figure 8a shows that labour productivity is higher in the ICT services sector than in manufacturing. In 2011, labour productivity in manufacturing amounted to 48.59 thousand euros per person, while in services the corresponding figure was 67.57% higher at 81.42 thousand euros. Figure 8b reports the time profile for labour productivity growth throughout the period 2006-2011. ICT services sector labour productivity presented a very similar pattern to total ICT sector labour productivity due to its high share in the aggregate. Its growth was almost 0% in 2007, the last year of the expansion period preceding the crisis. In the first two years of recession, 2008 and 2009, ICT sector labour productivity experienced a drop, especially intense in the ICT manufacturing sector and in 2009 when its annual contraction was -10.86%. In 2010, it experienced a notable increase, growing at an annual rate of 16.35%, due to the combination of a manufacturing VA growth of 9.53% (Figure 2b) and a drop of -5.86% in manufacturing employment (Figure 5b). In 2011, however, ICT sector labour productivity suffered a general decrease of -1.46%, especially intense in ICT manufacturing (-6.70%). Taken all together, labour productivity in the EU presented a much more cyclical pattern in ICT manufacturing than in ICT services sectors.

**Figure 8:**

**a: ICT sector labour productivity. Manufacturing and services. European Union (thousand constant [base year 2005] EUR per person; 2006-2011)**



**b: ICT sector labour productivity annual real growth rates. Manufacturing and services. European Union (2006-2011)**



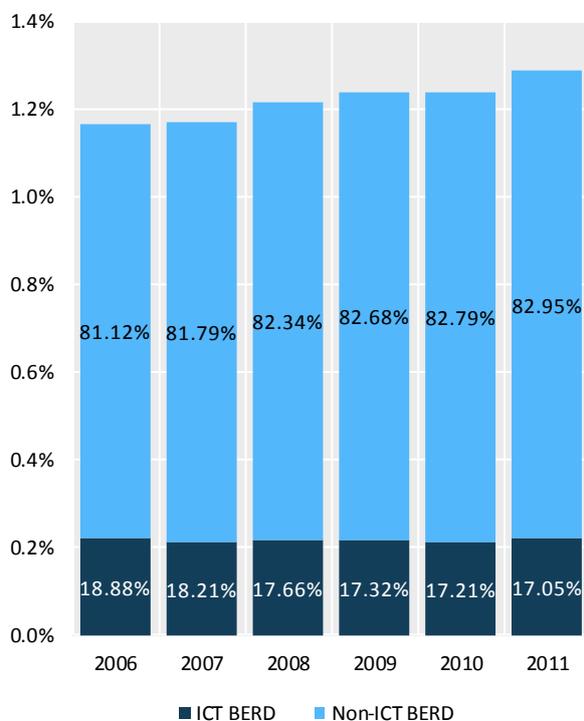
Source: Eurostat, elaborated by Ivie and JRC-IPTS.

### 1.3 ICT sector business enterprise expenditure on R&D (ICT BERD)

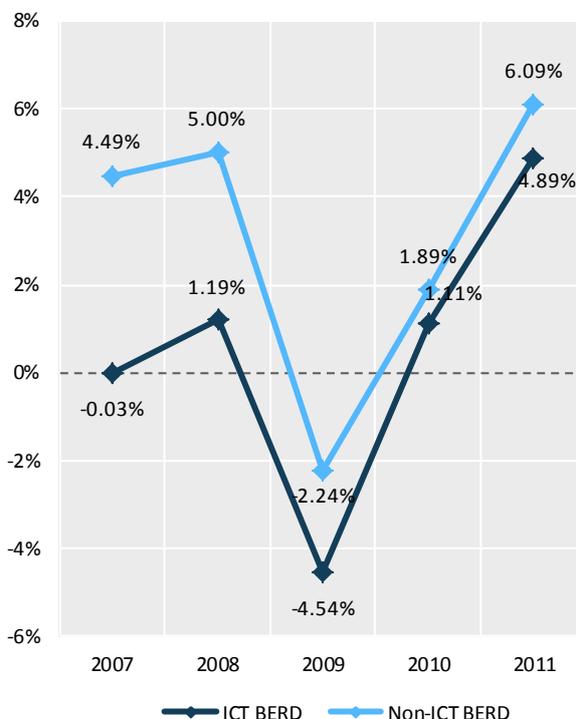
ICT BERD amounted to 25.89 billion euros in the EU in 2006. In 2011, it had increased by 2.02 billion euros. The weight of BERD on GDP –or BERD intensity (BERD/GDP)– was around 1.22% over the period. Figure 9a shows how this percentage was split between ICT and non-ICT sector. While ICT VA represented around 4% of total VA, and ICT sector employment around 2.7%, ICT BERD had a higher share of total BERD, around 17.7%. However, these last years have seen a continuous fall in the ICT BERD share from 18.88% in 2006 to 17.05% in 2011. This reduction is the consequence of the lower rate of growth of ICT BERD than total BERD, together with a more severe contraction in 2009, when ICT BERD experienced a -4.54% annual rate of variation while the fall in non-ICT BERD was less pronounced, -2.24% (Figure 9b).

**Figure 9:**

**a: Contribution of ICT and non-ICT BERD to total BERD intensity (BERD/GDP). European Union (2006-2011)**



**b: ICT BERD and non-ICT BERD annual real growth rates. European Union (2006-2011)**

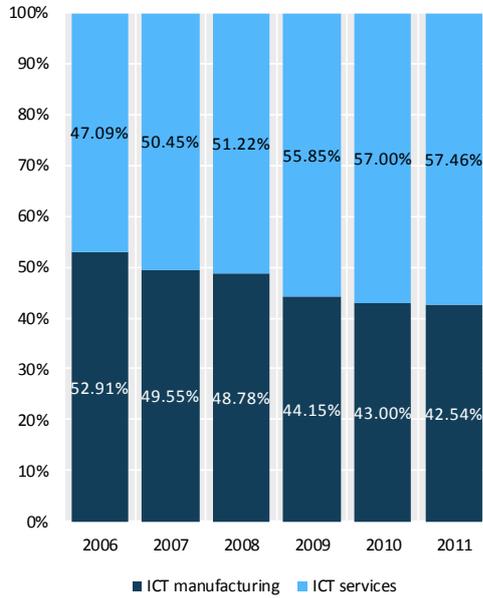


Source: Eurostat, elaborated by Ivie and JRC-IPTS.

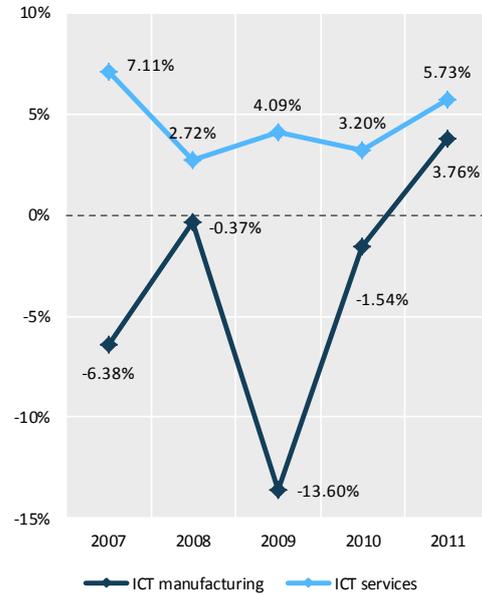
ICT manufacturing has a higher share in terms of BERD than VA or employment. As Figure 10a shows, ICT BERD in manufacturing has a share on total ICT BERD of around 47%. However, it is important to note that this share has gone down quite sharply, from 52.91% to 42.54%, in six years. This reduction is the result of a continuous decline of ICT manufacturing BERD in absolute terms, as illustrated in Figure 10b by the negative rates of growth shown throughout the period until 2010. However, in 2011, it began to grow at a rate of 3.76%. This pattern contrasts sharply with the trend in ICT BERD services, which even in the worst year of the crisis, 2009, presented a positive growth rate of 4.09%.

Figure 11a shows that the ratio of ICT sector BERD to ICT sector VA –termed ICT BERD intensity– remained fairly stable at around 5.30% over the period 2006-2011, which is on average 4.3 times higher than the same ratio for the total economy (1.22 on average over the period). In 2011 it reached a maximum of 5.50 %. However, the range of fluctuation is small. Real growth rates, shown in Figure 11b, reveal that in 2007 ICT BERD moved at an annual rate of -0.03%, around three percentage points lower than ICT VA (2.92%). From 2008 to 2010 both variables grew at a similar path, but in 2011 the growth rate of ICT BERD was more than four times higher than ICT VA. The combination of these movements is what explains the relatively mild oscillations shown on the left hand side of Figure 11.

**Figure 10:**  
**a: ICT manufacturing and ICT services BERD. Share of total ICT BERD. European Union (2006-2011)**

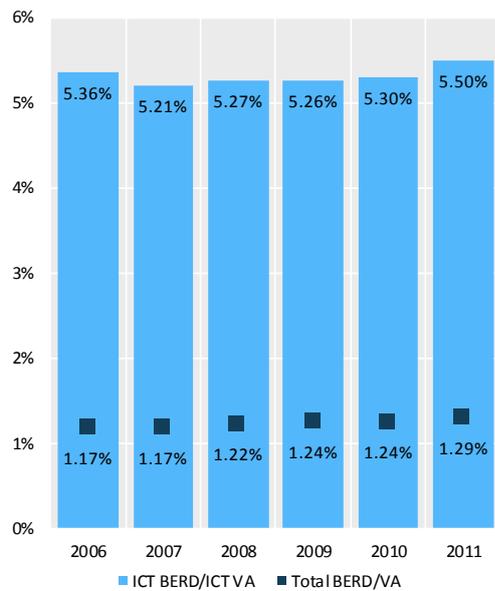


**b: ICT manufacturing and ICT services BERD annual real growth rates. European Union (2006-2011)**

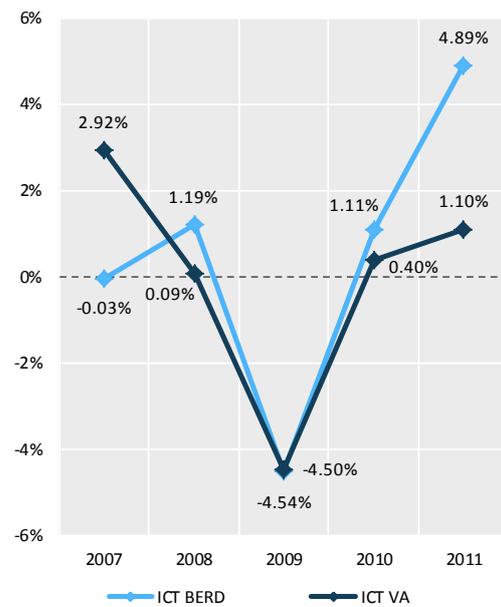


Source: Eurostat, elaborated by Ivie and JRC-IPTS.

**Figure 11:**  
**a: ICT sector BERD share of ICT sector value added. European Union (2006-2011)**



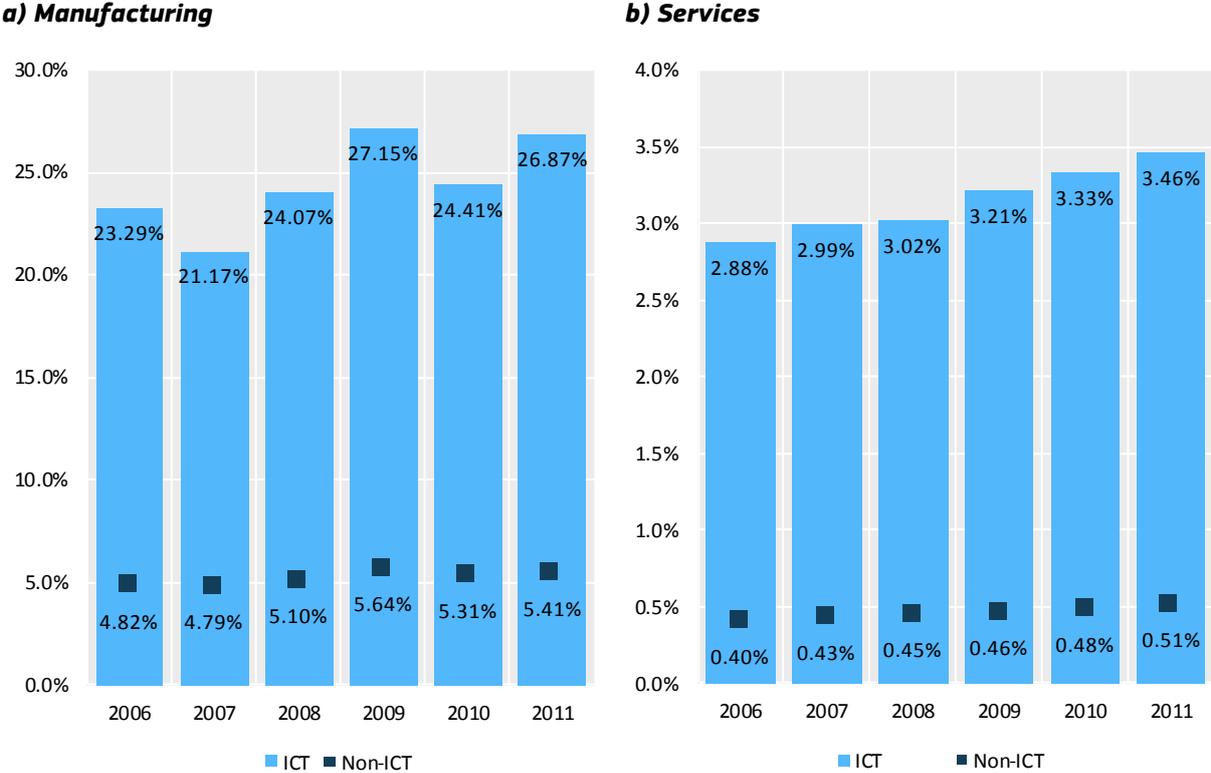
**b: ICT BERD annual real growth rates. European Union (2006-2011)**



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

Figure 12 completes the information related to BERD intensity, showing that ICT manufacturing sectors have higher BERD intensity than ICT services. BERD intensity in ICT manufacturing sectors (26.87% in 2011) is 7.8 times higher than in ICT services (3.46%) and 22 times higher than total BERD intensity (1.22). The differences remain when we look at non-ICT BERD intensity (5.41% for non-ICT manufacturing and 0.51% for non-ICT services).

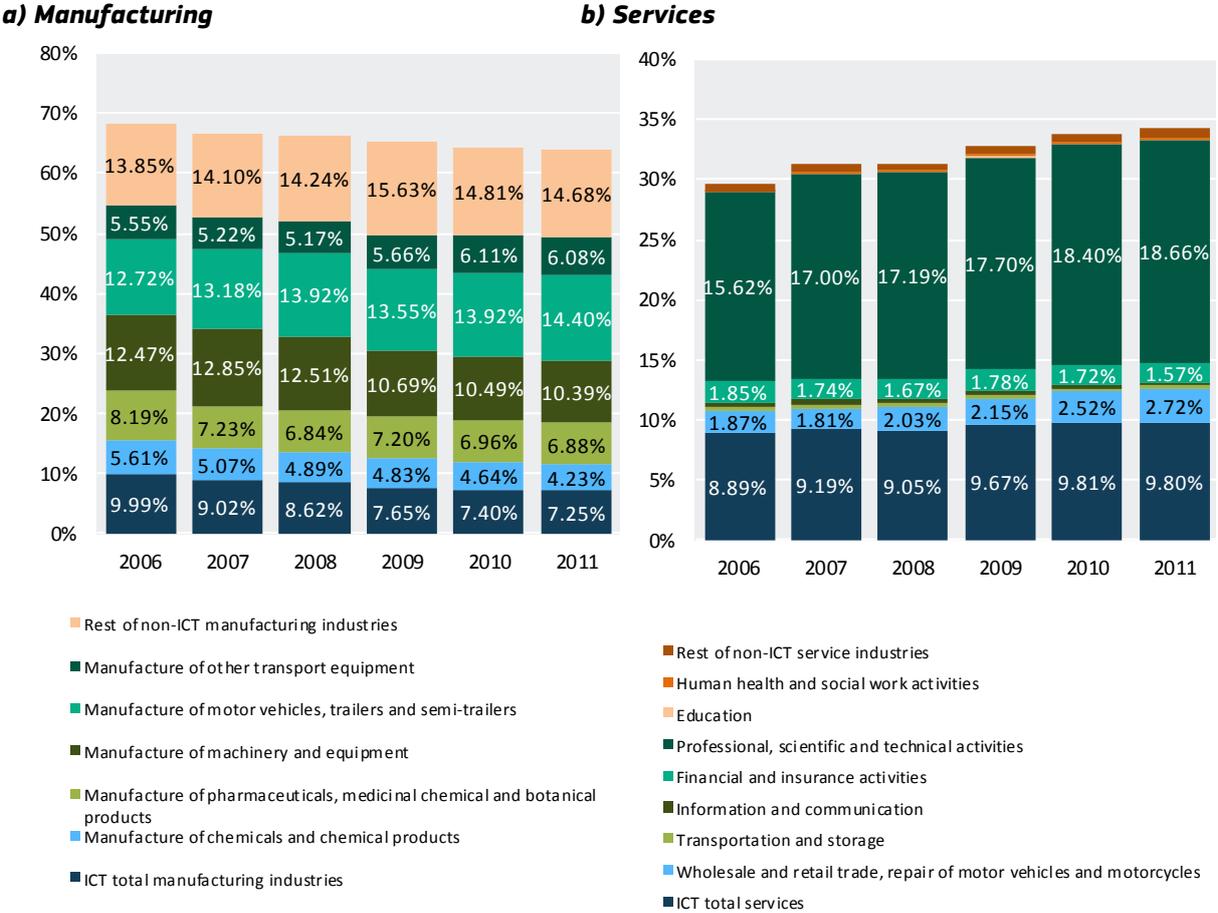
**Figure 12: ICT and non-ICT BERD intensity (BERD/VA). European Union (2006-2011)**



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

Figure 13 shows how total BERD is split among selected economic sectors. Figure 13a provides the information for total manufacturing share as well as the share of the same selected sectors previously analysed. The first thing to note is that while manufacturing represents around 14% in terms of VA (Figure 2) and 15.2% in terms of employment (Figure 6), it accounted for around 64% in terms of BERD in 2011. However, it must be highlighted that, as with most variables, it also lost share over the period. On the other hand, ICT manufacturing sectors represent around 8.3% of total BERD on average, while their weight in terms of VA and employment is a scant 0.4% - 0.5%. Again, it should be noted that this share also fell over the period, from 9.99% in 2006 to 7.25% in 2011. The two manufacturing sectors with the highest BERD share are *Manufacture of motor vehicles, trailers and semi-trailers* (14.40%), which gained share over the period, and *Manufacturing of machinery and equipment*, whose share fell.

**Figure 13: ICT BERD share of total BERD and comparison with non-ICT economic activities. European Union (2006-2011)**



Note: Agriculture, forestry and fishing; mining and quarrying; electricity, gas, steam and air conditioning supply; water supply, sewerage, waste management and remediation activities; and construction are not included in either manufacturing or services industries.

Source: Eurostat, elaborated by Ivie and JRC-IPTS.

Figure 13b provides the same information but referring to services, which represent around 34% of total BERD in the EU. ICT services sectors account for around 9.4% of total BERD but reflect an upward trend, which contrasts with the downward trend shown by ICT manufacturing. Besides ICT, the non-ICT sector with the highest, and continuously increasing, share on total BERD is *Professional, scientific and technical activities*, which rose from 15.62% in 2006 to 18.66% in 2011. In the interpretation of the low shares corresponding to *Human health and social work activities*, together with *Education*, it is important to bear in mind that the BERD variable refers strictly to the business sector and not to the non-market economy, which has a significant weight in those two activities. Finally, it is interesting to note that, in contrast to the case of VA (Figure 3) and employment (Figure 6), the selected sectors absorb almost all BERD leaving practically no room for the other non-ICT sub-sectors (termed “rest of non-ICT industries”).

## 1.4 Public Funding of ICT R&D

In 2011, estimated ICT GBAORD in the EU amounted to 6.12 billion euros – 6.63% of the total EU GBAORD. In this analysis, the estimated ICT public funding of R&D is extracted from Government Budget and Appropriations or Outlays for R&D (GBAORD),<sup>8</sup> which is reported for 14 NABS-2007 chapters, being ICT and related R&D included in several NABS chapters. – For this reason, the estimation is carried out based on the assumption that the share of ICT R&D expenditures in GBAORD is similar to the share of ICT R&D labour costs (from total R&D labour costs). Once a correspondence that links NABS chapters to NACE codes has been created, the Labour Force Survey (LFS) and the Structure of Earnings Survey (SES) are used to calculate ICT R&D labour shares separately for each NABS category, country and year. These shares are used to obtain an estimation of ICT GBAORD<sup>9</sup> for each country and year.

Figure 14a shows ICT GBAORD intensity (defined as ICT GBAORD/GDP in the right scale of the figure) in the EU for the years 2006-2011. It remained fairly stable at around 0.044%, with a maximum in 2009 of 0.050%. However, from 2009 it has decreased slightly reaching the share of 0.048% in 2011. Figure 14a also shows the share of ICT GBAORD in total GBAORD, which amounted to around 6.5% during the period analysed. However, it went from 6.46% in 2006 to 6.63% in 2011, recovering from the drop suffered in 2008.

Figure 14b provides the annual real growth rates of ICT GBAORD and total GBAORD. Both variables followed similar paths, especially after 2008. In the years 2007 and 2008 total GBAORD showed higher growth rates than ICT GBAORD. However, in 2009, ICT GBAORD experienced an acceleration reaching a growth rate of 6.04% whereas total GBAORD began to slowdown. 2010 showed a significant decline with negative growth rates for both variables. In 2011, total GBAORD (-1.68%) kept the negative records of the previous year, whereas ICT GBAORD reached almost a 0% growth rate (-0.09%).

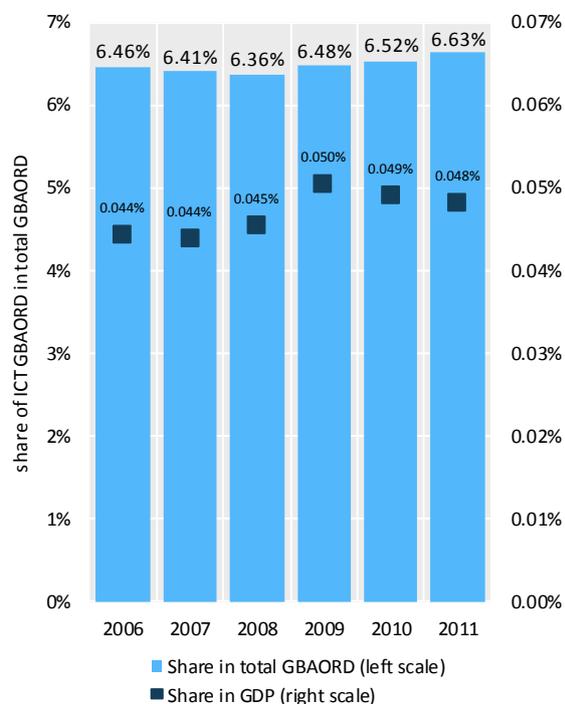
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<sup>8</sup> Government Budget Appropriations or Outlays for R&D by Socio-economic Objectives (GBAORD) is a budget-based data, which allows government support for R&D to be measured. Essentially, this involves identifying all the budget items with an R&D component and measuring or estimating their R&D content in terms of funding. These estimates are less accurate than performance-based data but as they are derived from the budget, they can be linked to policy through classification by “objectives” or “goals”. GBAORD series cover R&D in natural sciences, engineering, social sciences and humanities and in both current and capital expenditures. They include R&D performed on national territory as well as payments to foreign performers, including international organisations. GBAORD, however, covers only R&D financed by central government. Local government, and sometimes also provincial government, are excluded.

<sup>9</sup> For more detailed information on this estimation see Stančík, J., & Rohman, I. K. (2014). Public ICT R&D funding in the European Union. Forthcoming. JRC Scientific and Policy Report.

**Figure 14:**

**a: ICT GBAORD share in GDP and in total GBAORD. European Union (2006-2011)**



**b: ICT GBAORD and total GBAORD annual real growth rates. European Union (2006-2011)**



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

## 1.5 ICT sector R&D personnel

In 2006, R&D personnel in the EU ICT sector amounted to 233.63 thousand workers and in 2011, 263.08 thousand, reflecting an increase of 29.45 thousand. At the same time, in 2006 the number of researchers in the EU ICT sector was 151.93 thousand, rising to 165.40 thousand in 2011, representing an increase of 13.47 thousand researchers in these two years. Figure 15a indicates that R&D personnel in the ICT sector accounts for around 4.1% of total ICT sector employment<sup>10</sup> in the EU for the period analysed (see the right hand side for the scale of this variable). This share increased from 3.99% in 2006 to 4.29% in 2011. The sharpest growth was seen in 2010 which maintained in 2011. On the other hand, Figure 15a also shows the share of ICT sector R&D researchers on ICT personnel (scale on the left hand side). This ratio has fluctuated around a range of 63%-65%. The highest share, 65.03%, occurred in 2006, while a minimum was reached in 2009 (62.76%), from which it recovered slightly in the two following years, rising to 62.87% in 2011.

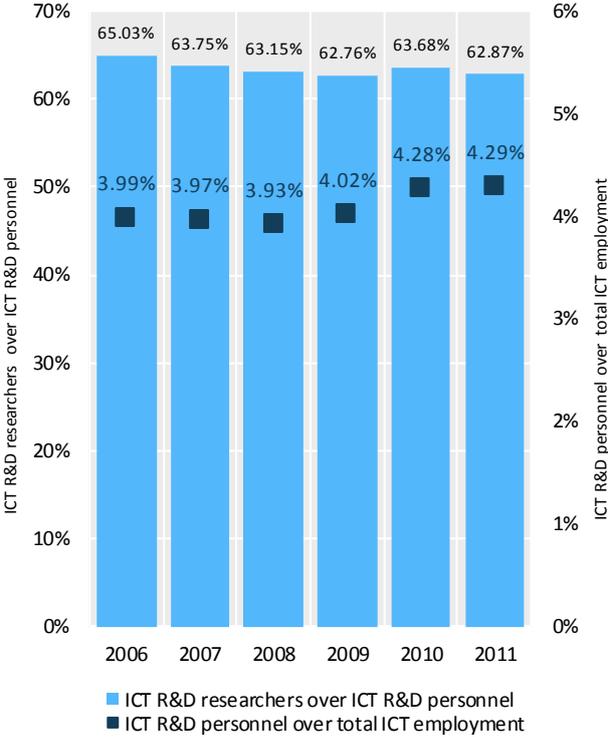
In the ICT sector, employment grew at a faster pace (around 3%) than R&D personnel (around 2.2%) or R&D researchers (around 0.7%) between 2006 and 2008, as Figure 15b indicates. With the onset of the recession, ICT sector employment contracted by -2.57%, while ICT sector R&D personnel (-0.33%) and researchers (-0.94%) defended their positions more successfully. In 2010, ICT sector employment began to recover but the growth rate was still negative (-1.28%), whereas ICT R&D researchers (6.59%) and personnel (5.04%) witnessed an upturn. In 2011, however, ICT

<sup>10</sup> The statistics available for all the countries provides the data for personnel in full-time equivalent (FTE) terms while employment is measured in terms of *headcounts*.

employment recovered and grew at a 2.59%, whereas ICT R&D personnel slowed down to 2.96% and ICT R&D researchers to 1.65%.

**Figure 15:**

**a: ICT sector R&D personnel share on total ICT sector employment, and ICT sector R&D researchers share on ICT R&D personnel. European Union (2006-2011)**



**b: Annual growth rates of ICT sector employment, ICT sector R&D personnel and ICT sector R&D researchers. European Union (2006-2011)**

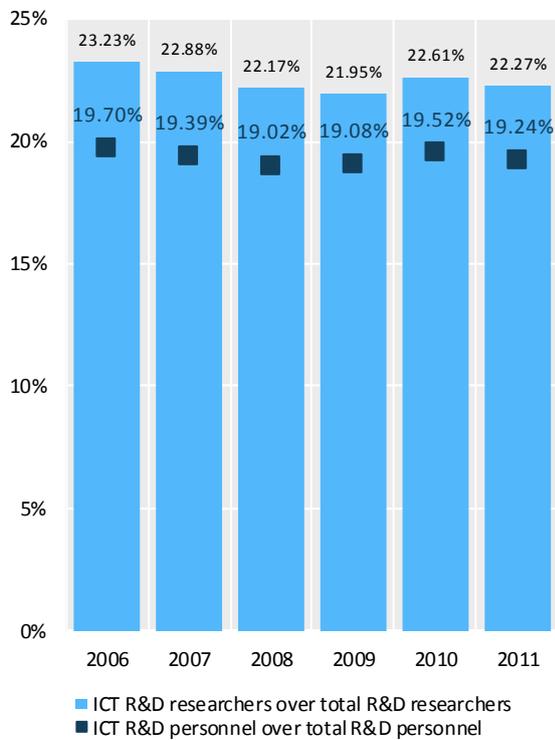


Source: Eurostat, elaborated by Ivie and JRC-IPTS.

ICT R&D personnel accounts for 19.24% of total R&D personnel in 2011 (Figure 16a). This share peaked in 2006 (19.70%) and then fell reaching its lowest level in 2008 (19.02%). Since then, it remained fairly stable. Figure 16a also contains information on ICT sector researchers. During the entire period, the share of ICT R&D researchers on total R&D researchers was higher than the share of ICT R&D personnel. The evolution of the ICT R&D researchers and personnel has been similar. Both of them only present negative growth rates between 2008 and 2009, being positive for the rest of the years (Figure 16b). Thus, the fall in the ICT sector shares in the two variables are due to the greater dynamism registered in total R&D personnel and researchers.

**Figure 16:**

**a: ICT R&D personnel share on total R&D personnel, and ICT R&D researchers share on total R&D researchers. European Union (2006-2011)**



**b: Annual growth rates of R&D personnel and researchers, ICT R&D personnel and ICT R&D researchers. European Union (2006-2011)**



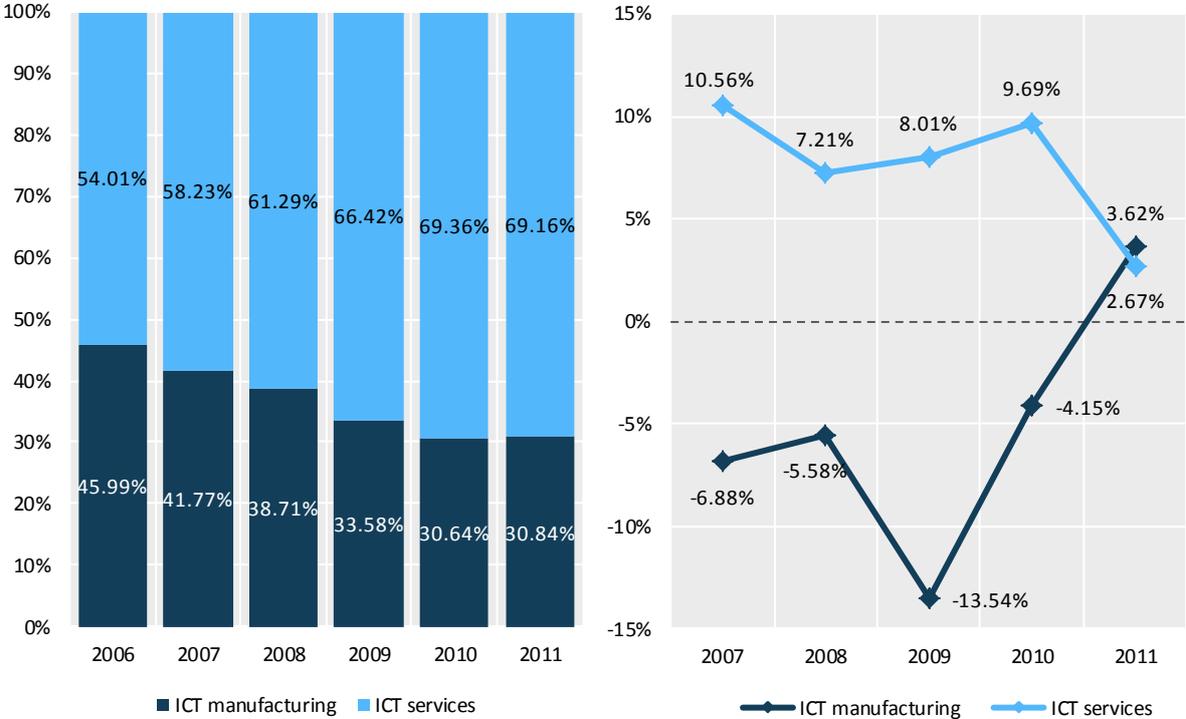
Source: Eurostat, elaborated by Ivie and JRC-IPTS.

Figure 17a shows how R&D personnel is split between ICT manufacturing and services sectors. Again, it is interesting to note that ICT manufacturing has declined in almost all variables. While ICT sector R&D personnel in manufacturing represented 45.99% of total ICT sector R&D personnel in 2006, six years later this figure had fallen by around 15.2 percentage points to 30.84%. The reason for this decline can be seen in the annual growth rates plotted in Figure 15b. The striking fact is that while R&D personnel in the ICT services sectors retained its positive annual growth rates, even in the years of deep recession, the same cannot be said for ICT manufacturing sectors. In this case, the annual variation rate has always been negative, except in 2011. In that year, ICT manufacturing showed a positive growth rate of 3.62%, higher than the ICT services growth rate of 2.67%.

**Figure 17:**

**a: Share of ICT manufacturing R&D personnel and ICT services R&D personnel. European Union (2006-2011)**

**b: Annual growth rates of ICT manufacturing R&D personnel and ICT services R&D personnel. European Union (2006-2011)**



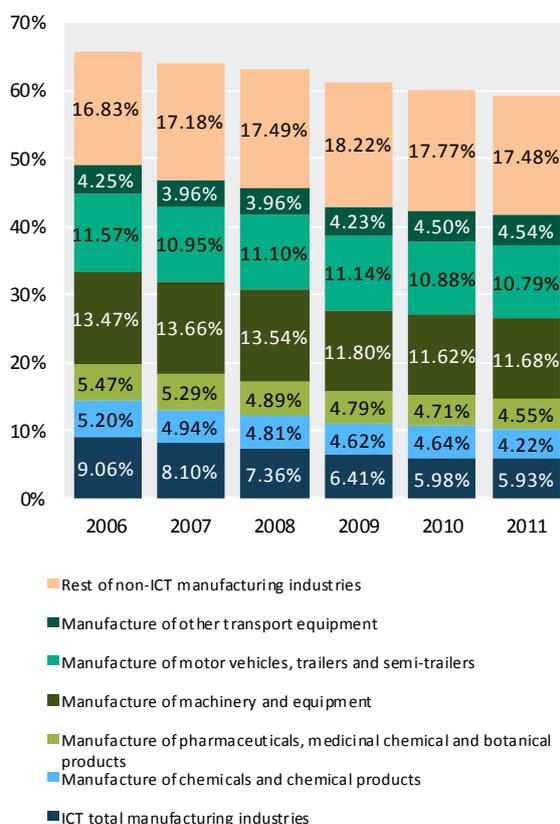
Source: Eurostat, elaborated by Ivie and JRC-IPTS.

Finally, Figure 18 shows the share of R&D personnel of the total for ICT and non-ICT sector, differentiated according to manufacturing and services. As with BERD, the share of R&D personnel in manufacturing is higher than the shares in VA or employment (Figures 3a and 6a), but it showed a downward tendency. ICT sector R&D personnel in manufacturing fell from 9.06% in 2006 to 5.93% in 2011. As for BERD, the two manufacturing sectors with the highest share of R&D personnel are *Manufacture of machinery and equipment* and *Manufacture of motor vehicles, trailers and semi-trailers*, both of which lost share over the period.

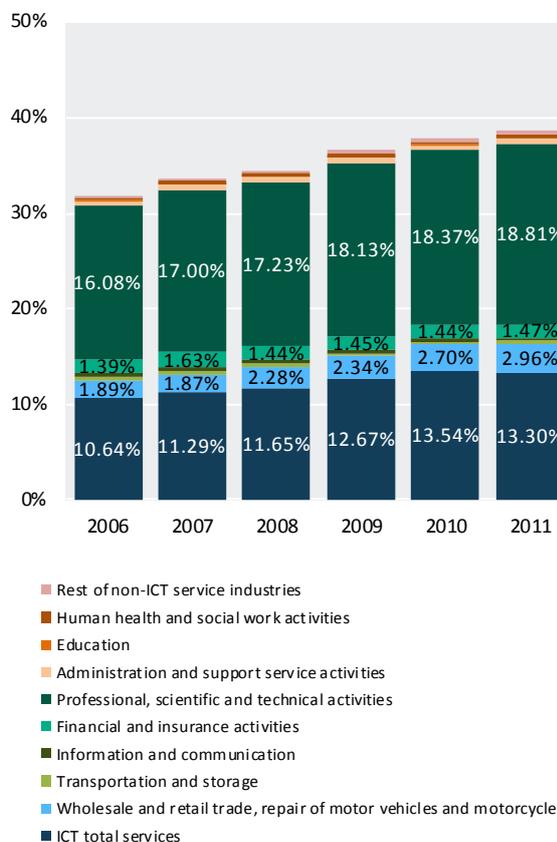
R&D personnel in the services sector showed an upward trend that was very pronounced in the two sectors with the highest weight: *ICT services* R&D personnel share on total went up from 10.64% in 2006 to 13.30% in 2011, and *Professional, scientific and technical activities* rose from 16.08% in 2006 to 18.81% in 2010. Thus, as with almost all variables, the services sector has shown remarkable resilience even in the most difficult years of the economic recession.

**Figure 18: ICT sector R&D personnel share of total R&D personnel and comparison with non-ICT economic activities. European Union (2006–2011)**

**a) Manufacturing**



**b) Services**



Note: Agriculture, forestry and fishing; mining and quarrying; electricity, gas, steam and air conditioning supply; water supply, sewerage, waste management and remediation activities; and construction are not included in either manufacturing or services industries.

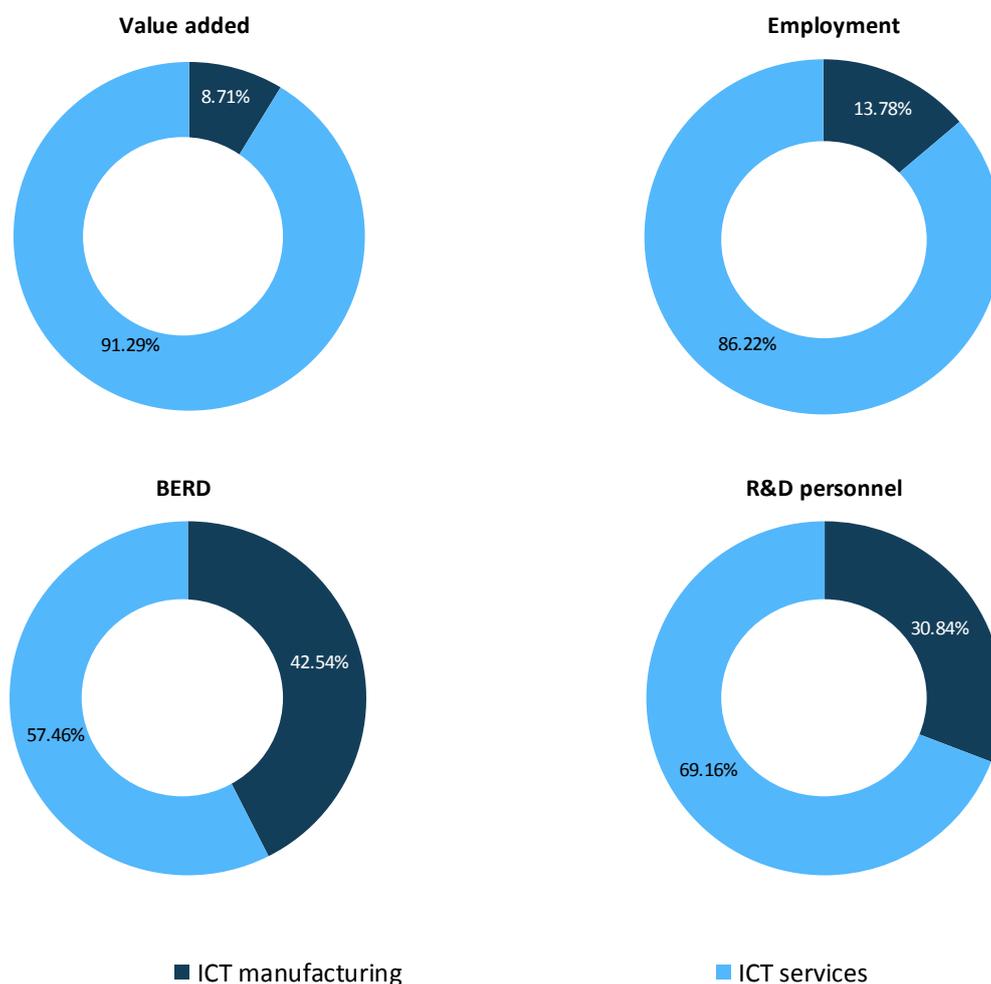
Source: Eurostat, elaborated by Ivie and JRC-IPTS.

## 1.6 Comparison of indicators and data summary

Figure 19 provides a comparison of the ICT manufacturing and ICT services sectors distribution of the four main indicators analysed in this section –value added, employment, BERD and R&D personnel– for the European Union in 2011. The data summary for those variables is provided in Table 2. The main results of this comparison can be summarised as follows:

- ICT VA and ICT sector employment are concentrated in the ICT services sectors, especially in ICT VA, representing 91.29% of total ICT VA and 86.22% of total ICT sector employment.
- ICT manufacturing has a higher share in terms of BERD and R&D personnel than VA or employment. ICT BERD in manufacturing represents 42.54% of total ICT BERD, while the share of ICT manufacturing R&D personnel on total amounted to 30.84%.
- ICT GBAORD grew between 2006 and 2011 both in terms of its share in GDP (from 0.044% to 0.048%) and especially in its share on total GBAORD (from 6.46% to 6.63%).

**Figure 19: Comparison of ICT manufacturing and services for value added, employment, BERD and R&D personnel. European Union (2011)**



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

Table 2 summarizes the main variables reviewed in this chapter.

**Table 2: Summary table of ICT indicators by broad sectors. European Union (2011)**

	ICT sector Value added	ICT sector Employment	ICT sector BERD	ICT GBAORD	ICT sector R&D personnel
	(Millions of current EUR)	(thousand persons employed)	(Millions of current EUR)	(Millions of current EUR)	(thousand full-time equivalent)
ICT total manufacturing	44,192.89	844.40	11,875.12	-	81.13
ICT total services	463,412.36	5,284.97	16,041.56	-	181.95
<b>ICT total</b>	<b>507,605.25</b>	<b>6,129.37</b>	<b>27,916.68</b>	<b>5,961.96</b>	<b>263.08</b>

Source: Eurostat, elaborated by Ivie and JRC-IPTS.

## 2. Analysis by ICT sub-sector

### 2.1 ICT sector value added

ICT sector value added (VA) amounted to 507.61 billion euros in 2011. This represented a share of 3.99% of EU GDP, a share that has reduced slightly over the last few years. ICT services contributed by far the largest share of ICT VA (91.29%, or 463.41 billion euros in 2011), accounting for 3.65% of EU GDP, while ICT manufacturing VA contributed 8.71% of ICT VA (44.19 billion euros), totalling 0.35% of GDP.

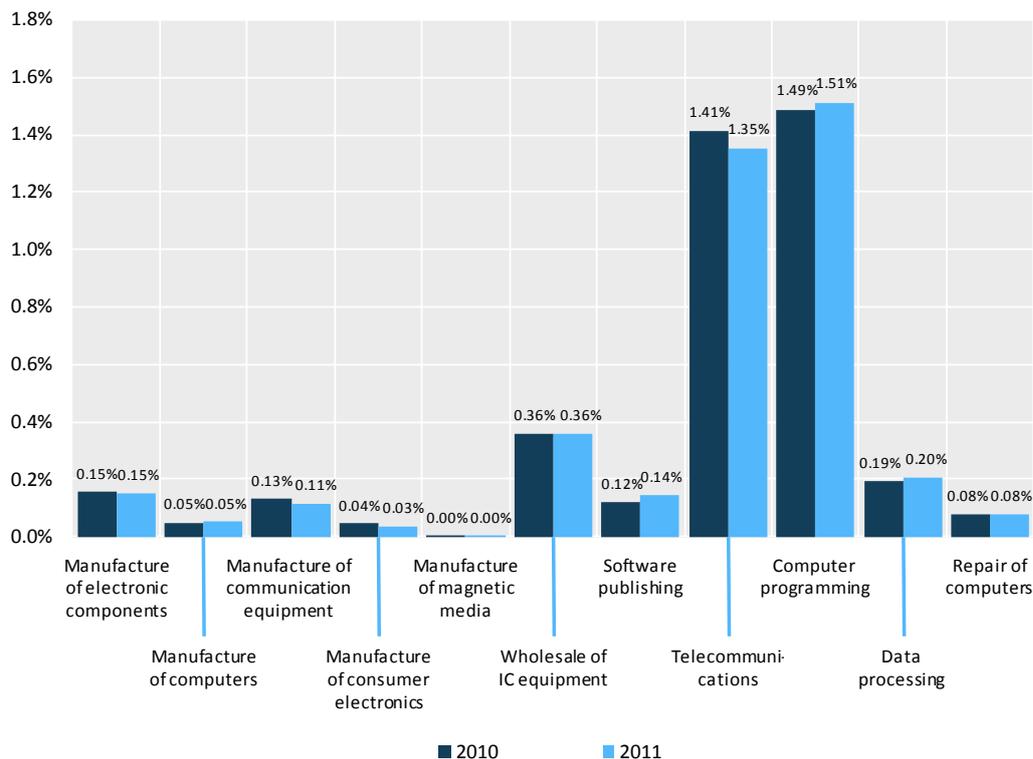
Figure 20 plots the ICT VA share of GDP by ICT sub-sectors. By far the two largest ICT services sub-sectors in the EU are *Computer programming, consultancy and related activities*, which generated a VA of 192.21 billion euros in 2011 (1.51% of EU GDP) and *Telecommunications*, producing a VA of 171.89 billion euros in 2011 (1.35% of EU GDP). These two sub-sectors represented almost 72% of the total VA produced by the ICT sector in 2011. ICT trade activities –*Wholesale of computers, computer peripheral equipment and software* and *Wholesale of electronic and telecommunications equipment and parts*– generated a VA of 45.50 billion euros in 2011, or 0.36% of EU GDP. In 2011, the value added created in ICT manufacturing was lower than the VA produced in ICT trade services. From 2010 to 2011, the value added generated by ICT services increased by 14.11 billion euros (a 3.14% increase).

#### Box 1: List of NACE Rev. 2 ICT sub-sectors:

Nace Rev. 2	Description
<b>261-264, 268</b>	<b>ICT manufacturing industries</b>
261	Manufacture of electronic components and boards
262	Manufacture of computers and peripheral equipment
263	Manufacture of communication equipment
264	Manufacture of consumer electronics
268	Manufacture of magnetic and optical media
<b>465, 582, 61, 62, 631, 951</b>	<b>ICT total services</b>
<b>465</b>	<b>ICT trade industries</b>
4651	Wholesale of computers, computer peripheral equipment and software
4652	Wholesale of electronic and telecommunications equipment and parts
<b>5820, 61, 62, 631, 951</b>	<b>ICT services industries</b>
5820	Software publishing
61	Telecommunications
62	Computer programming, consultancy and related activities
631	Data processing, hosting and related activities; web portals
951	Repair of computers and communication equipment

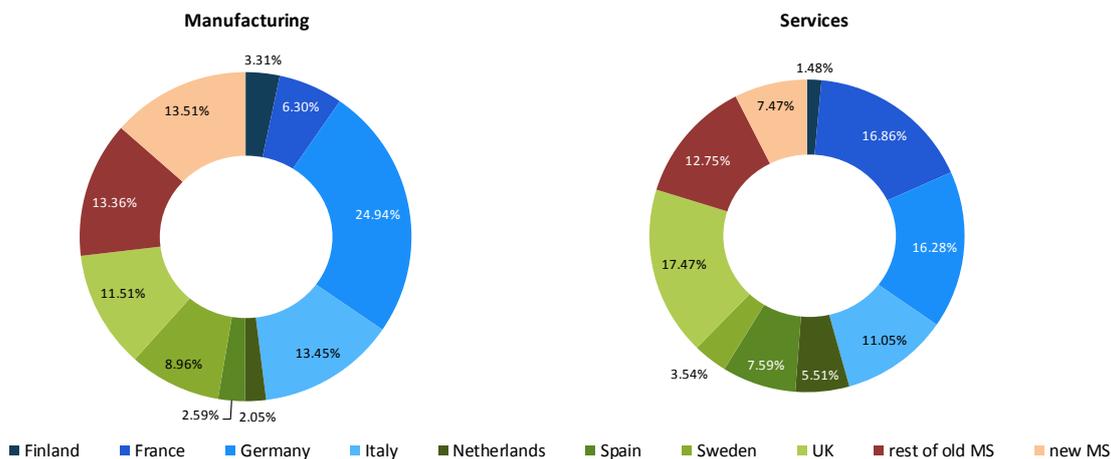
The two largest ICT manufacturing sub-sectors in the EU are *Manufacturing of electronic components and boards* and *Manufacturing of communication equipment*. Their cumulative contribution to EU GDP was, however, only 0.26% in 2011. From 2010 to 2011, value added produced by ICT manufacturing decreased by 2.08 billion euros (-4.50%). It is also noticeable the joint weight that two of the key ICT subsectors, *Telecommunications* and *Communication equipment* jointly represented, 1.46% of GDP.

**Figure 20: ICT VA share of GDP by sub-sector (2010, 2011)**



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

**Figure 21: Comparison of ICT manufacturing and services: distribution of VA among the biggest Member State contributors (2011)**



Note: New MS are Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia. Rest of old MS comprise Austria, Belgium, Denmark, Greece, Ireland, Luxembourg and Portugal.

Source: Eurostat, elaborated by Ivie and JRC-IPTS.

Figure 20 provides a comparison of ICT manufacturing and services sectors in terms of Member State contributions to ICT VA in 2011. On the one hand, Germany dominated ICT manufacturing (contributing 24.94% of EU ICT manufacturing VA), followed by Italy (13.45%) and the UK (11.51%), Sweden and France, which contributed 8.96% and 6.30% respectively. On the other hand, the ICT

services sector was dominated by a group of four countries (the UK, France, Germany and Italy) that represented 61.66% of the total EU ICT services VA. Thus there are noticeable differences between countries according to different specialization patterns. Some countries play a leading role in ICT manufacturing while having less importance in terms of ICT services. These differences can have important implications for each country, as ICT services have proved to be more resilient during the recession, but on the other hand, higher shares of ICT manufacturing imply generally higher shares in terms of BERD. The biggest differences in Member States' contributions can be seen in Germany (24.94% in manufacturing vs. 16.28% in services), Sweden (8.96% vs. 3.54%), France (6.30 vs 16.86%), the UK (11.51 vs 17.47) and Spain (2.59% vs 7.59%). The thirteen new Member States<sup>11</sup> contributed more to ICT VA in ICT manufacturing (13.51%) than in ICT services (7.47%).

## **2.2 ICT sector employment and ICT sector labour productivity**

### *2.2.1 ICT sector employment*

In 2011, 6.13 million people worked in the EU ICT sector, representing 2.72% of total employment. ICT sector employment is highly concentrated in ICT services: 5.28 million people worked in ICT services (86.22%) whereas 0.84 million worked in ICT manufacturing (13.78%). Overall ICT sector employment increased by 2.59% –in absolute terms, almost 155 thousand people– from 2010 to 2011. This figure comprised 8.6 thousand people in manufacturing (1.03%) and 146.4 thousand people in services (2.85%). The increase in employment in ICT manufacturing was therefore lower than in ICT services in both relative and absolute terms.

Figure 21 plots the ICT sector employment share of total employment by ICT sub-sectors. As in the case for VA, ICT sector employment in the EU is concentrated in just two service sectors, *Computer programming, consultancy and related activities*, with 2.87 million people (1.28% of total employment), and *Telecommunications* with 1.04 million people (0.46% of total employment). In 2011, these two sub-sectors represented 63.85% of total ICT sector employment. In the same year, ICT trade services employed 0.60 million people (0.26% of total employment).

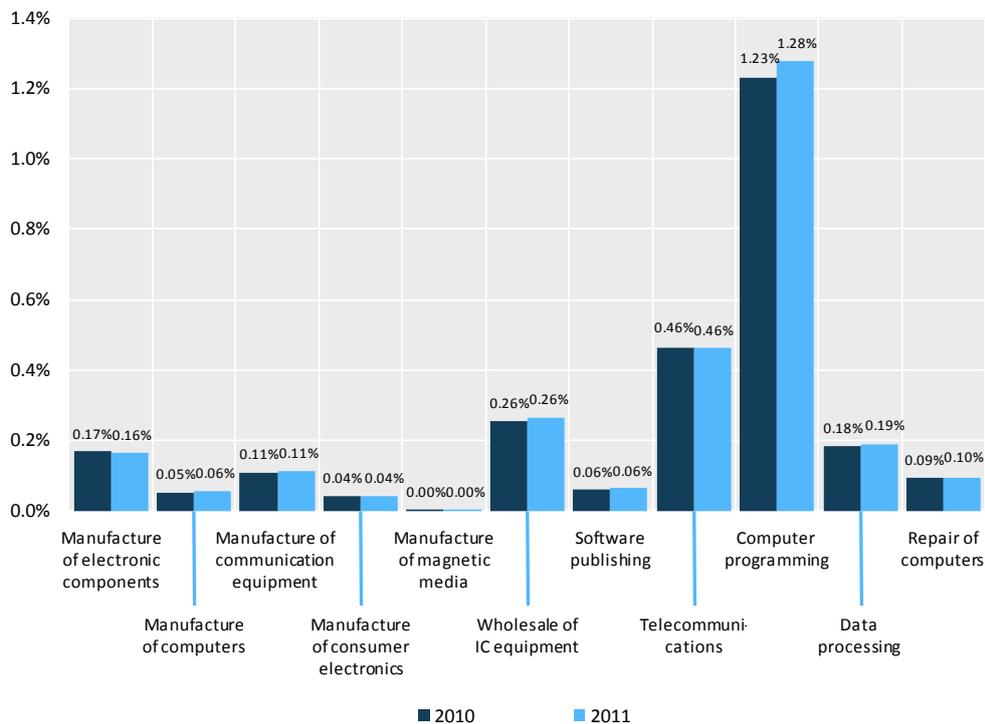
In ICT manufacturing, most employment is provided by two sub-sectors: *Manufacturing of electronic components and boards* employs 0.37 million people (0.16% of total employment) and *Manufacturing of communication equipment* employs 0.25 million people (0.11% of total employment).

From 2010 to 2011, ICT services employment increased in *Computer programming, consultancy and related activities* by 3.79% and decreased by 0.15% in *Telecommunications*, the only ICT services sub-sector that showed a negative growth. Employment increased by 5.45% (7.30 thousand people) in *Software publishing* and also increased by 3.88% (8 thousand people) in *Repair of computers* in 2011. In ICT manufacturing, employment decreased by 2.34% in *Manufacture of computers* and by 1.85% in *Manufacture of magnetic media*. On the other hand, it increased by 7.94% in *Manufacture of computers*.

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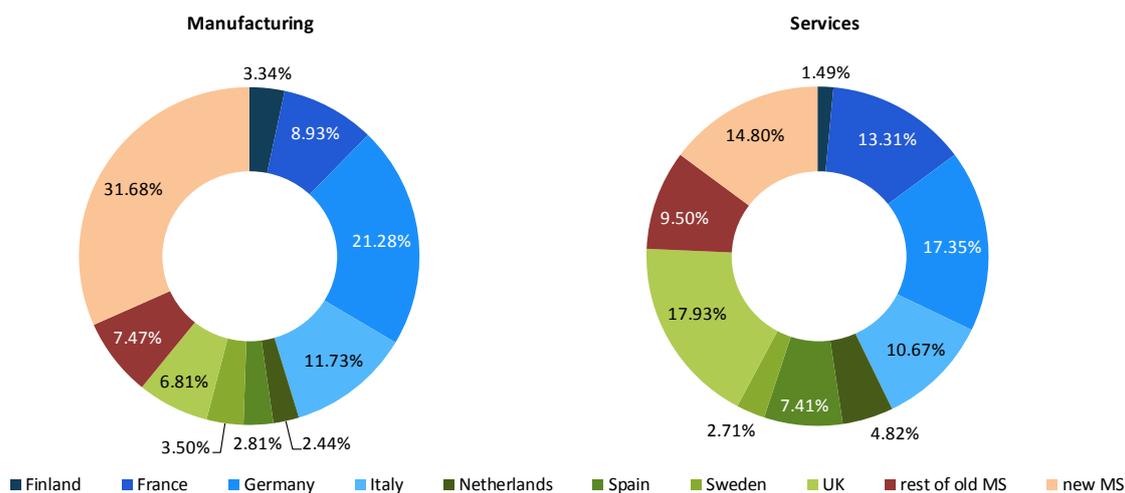
<sup>11</sup> New Member States: Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia.

**Figure 22: ICT sector employment share of total employment by sub-sector (based on head counts; 2010, 2011)**



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

**Figure 23: Comparison of ICT manufacturing and services: distribution of ICT sector employment among the biggest Member State contributors (2011)**



Note: New MS are Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia. Rest of old MS comprise Austria, Belgium, Denmark, Greece, Ireland, Luxembourg and Portugal.

Source: Eurostat, elaborated by Ivie and JRC-IPTS.

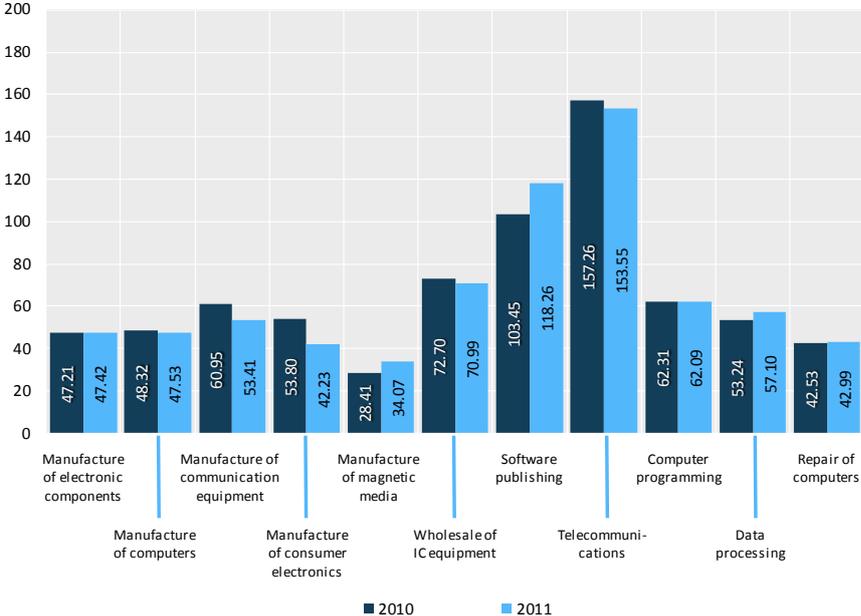
Figure 23 provides a comparison of employment in the ICT manufacturing and services sectors by MS in 2011. The most striking observation is the contribution of the new Member States. These 13

countries together employed 31.68% of all employees from the EU ICT manufacturing sector, significantly above the 21.28% employed by Germany. One of the explanations of this fact is the relocation<sup>12</sup> of production activities, especially in manufactures, from the EU-15 to newer Member States. In services, however, their contribution was only half that value (14.80%). In terms of single-country contributions, Germany dominated both ICT manufacturing and services (providing 21-17% of EU ICT sector employment). France, Italy and the UK together contributed 27.48% and 41.91% to total EU ICT manufacturing and services employment, respectively. Compared to other indicators analysed, the differences between individual country shares (manufacturing vs. services) remained quite stable, except for the UK, with a 6.81% share in ICT manufacturing and a 17.93% share in ICT services employment.

### 2.2.2 ICT sector labour productivity

In 2011, labour productivity per person in ICT manufacturing in the EU was 52.34 thousand euros, while the figure for ICT services was 87.68 thousand euros. The highest labour productivity was achieved in *Telecommunications*, rising to more than 153 thousand euros (see Figure 24). Between 2010 and 2011, ICT sector labour productivity in the EU decreased by -1.46% in real terms. This decrease was more intense in ICT manufacturing (-6.70%) than in services (-1.02%). The biggest rise was recorded in *Manufacture of magnetic and optical media*, 19.90%, while the biggest drop was in *Manufacture of consumer electronics*, which fell around 21.50%. In the *Manufacture of communication equipment* labour productivity dropped from 60.95 thousand constant euros per person in 2010 to 53.41 one year later.

**Figure 24: ICT sector labour productivity by sub-sector (thousand constant [base year 2005] EUR per person; 2010, 2011)**



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

<sup>12</sup> See Timmer, Marcel P., Bart Los, Robert Stehrer, and Gaaitzen J. de Vries (2013). ‘Fragmentation, Incomes and Jobs. An Analysis of European Competitiveness’, *Economic Policy*, 28(76), 613– 61; and Marin, D. (2006). ‘A new international division of labor in Europe: outsourcing and offshoring to Eastern Europe’, *Journal of the European Economic Association*, 4(2–3), 612–22.

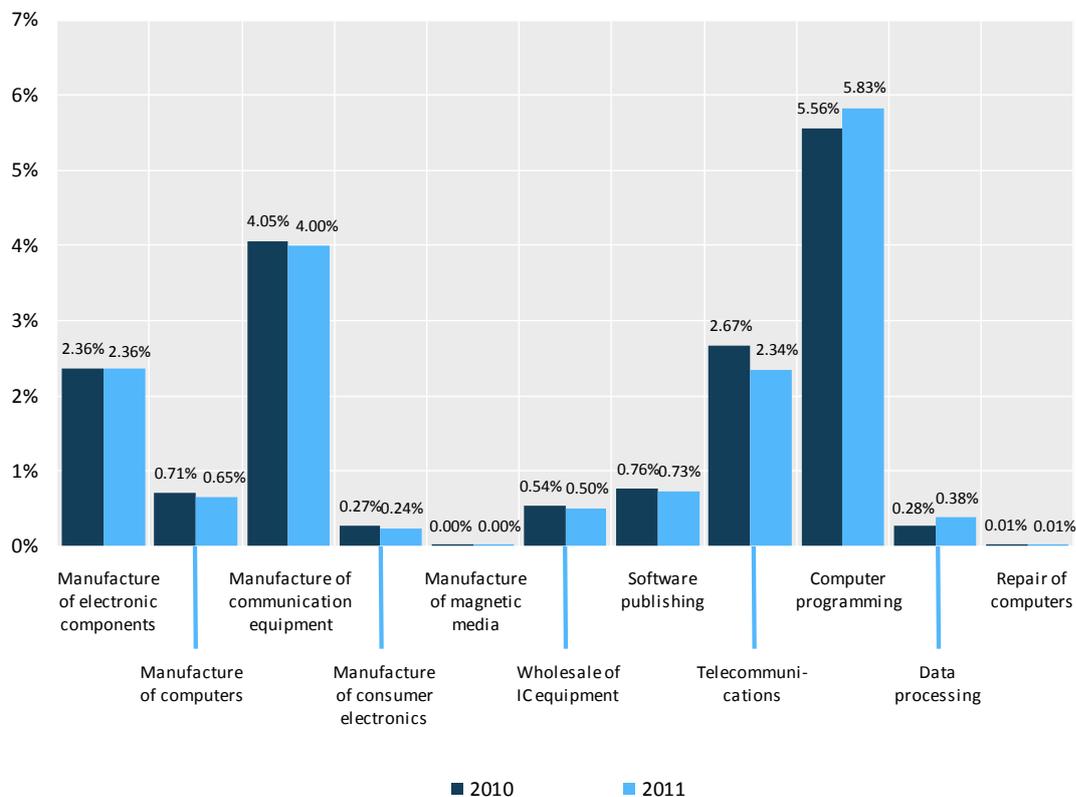
### 2.3 ICT sector business enterprise expenditure on R&D (ICT BERD)

Analysing ICT sector business enterprise expenditure on R&D (ICT BERD) across ICT sub-sectors provides a quite different perspective to the picture resulting from a comparison of value added or employment (see Figure 25).

In 2011, ICT BERD amounted to 27.92 billion euros, 6.27% more than in 2010 in nominal terms, which meant a growth of 4.89% in real terms. This amount was divided between manufacturing (11.88 billion euros) and services (16.04 billion euros).

In 2011, more than half ICT manufacturing BERD (55.10%) was invested in *Manufacturing of communication equipment* (6.54 billion euros, or 4.00% of total BERD in the EU economy), and 32.51% in *Manufacturing of electronic components and boards* (3.86 billion euros). More than half ICT services BERD (59.56%) was invested in *Computer programming, consultancy and related activities* (9.55 billion euros), and 23.94% in *Telecommunications* (3.84 billion euros).

**Figure 25: ICT BERD share in total BERD by sub-sector (2010, 2011)**

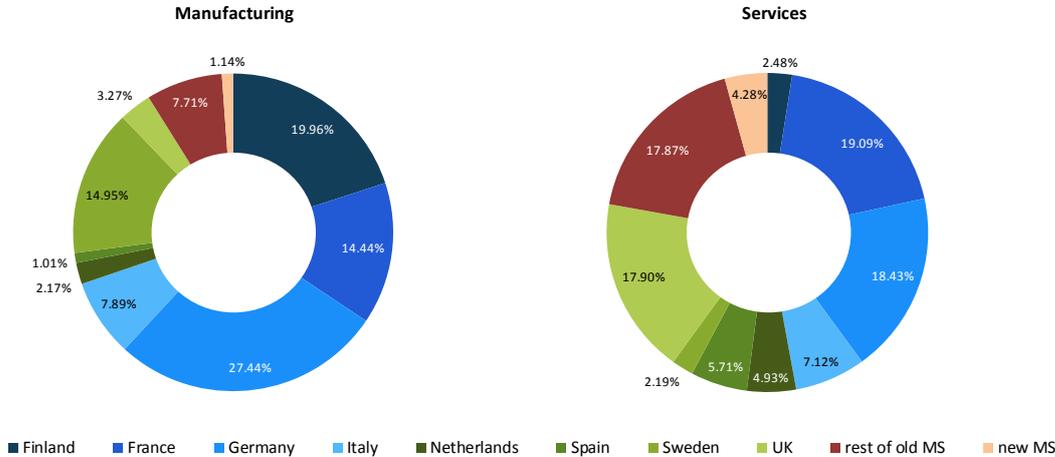


Source: Eurostat, elaborated by Ivie and JRC-IPTS.

From 2010 to 2011, ICT BERD invested in ICT manufacturing grew at a rate of 5.13% in nominal terms, which meant a growth of 3.76% in real terms. *Manufacturing of magnetic and optical media* experienced the biggest rise in nominal terms (30.27%). In absolute terms, the ICT manufacturing sectors with higher rises were *Manufacture of communication equipment*, by 0.36 billion euros, and *Manufacture of electronic components*, by 0.25 billion. In ICT services, ICT BERD grew less than in ICT manufacturing, by 7.12% in nominal terms (5.73% in real terms), mostly in *Computer programming, consultancy and related activities* (by 1.07 billion euros) and *Data processing, hosting and related activities; web portals*, by 44.64% in real terms.

Figure 26 provides a comparison of the ICT manufacturing and services sectors in terms of Member States' contributions to ICT BERD in 2011. ICT manufacturing was dominated by Germany (27.44% of EU ICT manufacturing BERD) and Finland (19.96%). Sweden and France then followed with 14.95% and 14.44%, respectively. These four countries represented 76.80% of the total EU ICT manufacturing BERD. However, when ICT services BERD is considered, Finland and Sweden contributed 2.48% and 2.19% each, in sharp contrast to their contribution to ICT manufacturing BERD, which was 34.92% in total. In contrast, France and Germany held leading positions in services (19.09% and 18.43%, followed by the UK with 17.90%). The UK, France and Spain are among the Member States with larger ICT BERD contributions in services than in manufacturing: the UK (3.27% vs. 17.90%), France (14.44% vs. 19.09% and Spain (1.01% in manufacturing vs. 5.71% in services).

**Figure 26: Comparison of ICT manufacturing and services: distribution of ICT BERD among the biggest Member State contributors (2011)**



Note: New MS are Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia. Rest of old MS comprise Austria, Belgium, Denmark, Greece, Ireland, Luxembourg and Portugal.

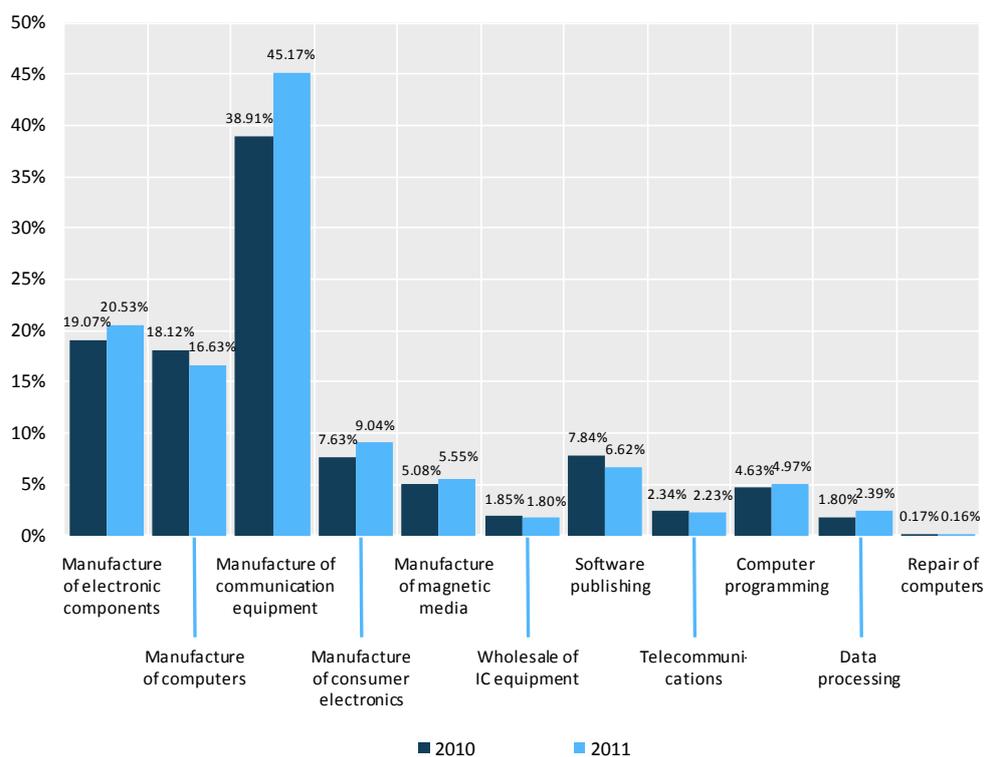
Source: Eurostat, elaborated by Ivie and JRC-IPTS.

The ICT sector is one of the most R&D-intensive sectors in the EU economy. In 2011, ICT BERD made up 17.05% of total BERD, while ICT VA represented only 3.99% of GDP. In the same year, ICT BERD intensity, measured by the ratio of ICT BERD to ICT VA, was, at 5.50%, 0.20 percentage points higher than its 2010 value of 5.30%. In the meantime, total BERD intensity increased only by 0.05 percentage points in 2011, from 1.24% in 2010 to 1.29% (see Figure 11a).

In 2011, although ICT manufacturing sub-sectors produced only 8.71% of ICT sector value added, they accounted for 42.54% of ICT BERD. ICT manufacturing sub-sectors are thus much more R&D intensive than ICT services sub-sectors. In fact, ICT BERD intensity is 7.76 times higher in ICT manufacturing (26.87%) than in ICT services (3.46%).

Figure 27 provides a comparison of BERD intensity among ICT sub-sectors. ICT BERD intensity was particularly high, especially in one manufacturing sub-sector: 45.17% in *Manufacturing of communication equipment*. From 2010 to 2011, ICT manufacturing BERD increased by 3.76% in real terms, and ICT manufacturing VA decreased by -5.75% in real terms. This difference resulted in an increase in ICT BERD intensity in manufacturing from 24.41% in 2010 to 26.87% in 2011.

**Figure 27: ICT BERD intensity (ICT BERD/ICT VA) by sub-sector (2010, 2011)**



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

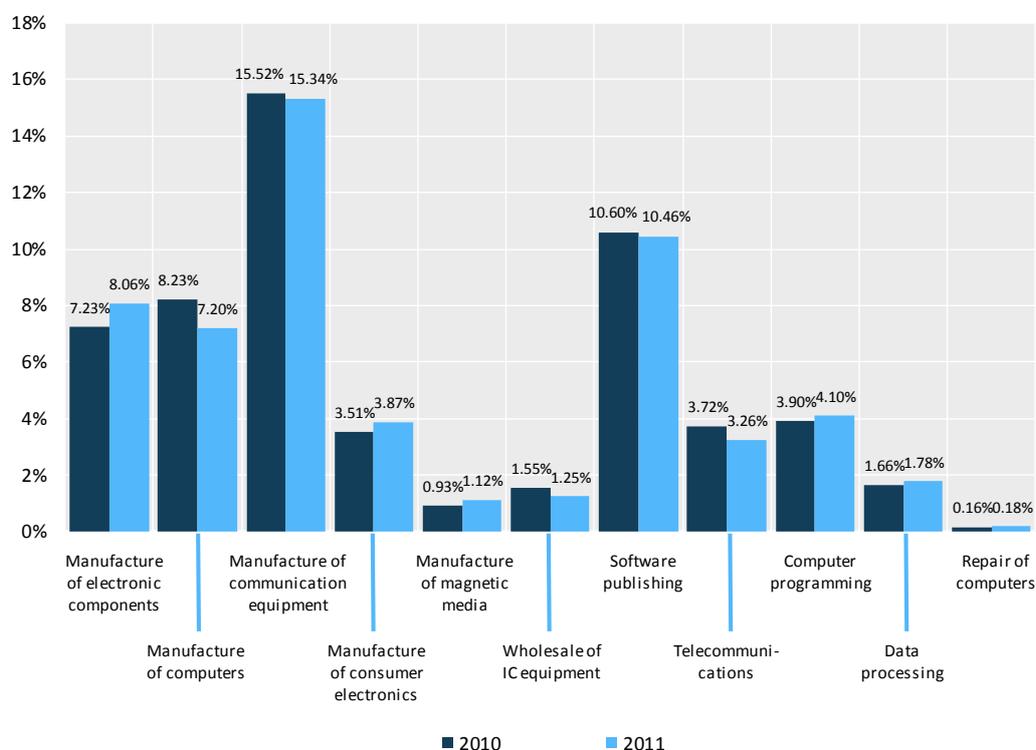
From 2010 to 2011, BERD in ICT services increased by 5.73% in real terms. In 2011 more than half BERD in ICT services (59.56%) corresponds to *Computer programming, consultancy and related activities* (9.55 billion euros), and 23.94% in *Telecommunications* (3.84 billion euros). ICT BERD intensity (ICT BERD/ICT VA) in services increased slightly between 3.33% and 3.46%, although it was significantly lower in ICT services than in most ICT manufacturing sub-sectors. This indicator reached 6.62% in *Software publishing*, 4.97% in *Computer programming, consultancy and related activities*, 2.39% in *Data processing* and 2.23% in *Telecommunications*.

In terms of variation, ICT BERD increased mostly in *Computer programming, consultancy and related activities* (by 11.14% in real terms) and in *Data processing* (by 44.64%) and decreased in *Telecommunications* by -6.97% in real terms.

## 2.4 ICT sector R&D personnel

ICT sector R&D personnel (including both researchers and R&D supporting staff) made up 4.29% of total ICT sector employment in the EU in 2011. In this year, 9.61% of employees in the EU ICT manufacturing sub-sectors were R&D personnel, whereas the figure for ICT services was only 3.44%. According to Figure 28, the ICT sub-sectors with the highest share of R&D personnel were *Manufacture of communication equipment* and *Software publishing* (15.34% and 10.46%, respectively). In contrast, the ICT sub-sectors with the lowest shares of R&D personnel were *ICT trade industries*, *Manufacture of magnetic media*, *Data processing, hosting and related activities; web portals* and *Repair of computers and communication equipment*—each employing less than 2%. *Telecommunications* also showed low shares (3.26% in 2011).

**Figure 28: ICT sector R&D personnel share of total ICT sector employment by sub-sector (based on FTE; 2010, 2011)**

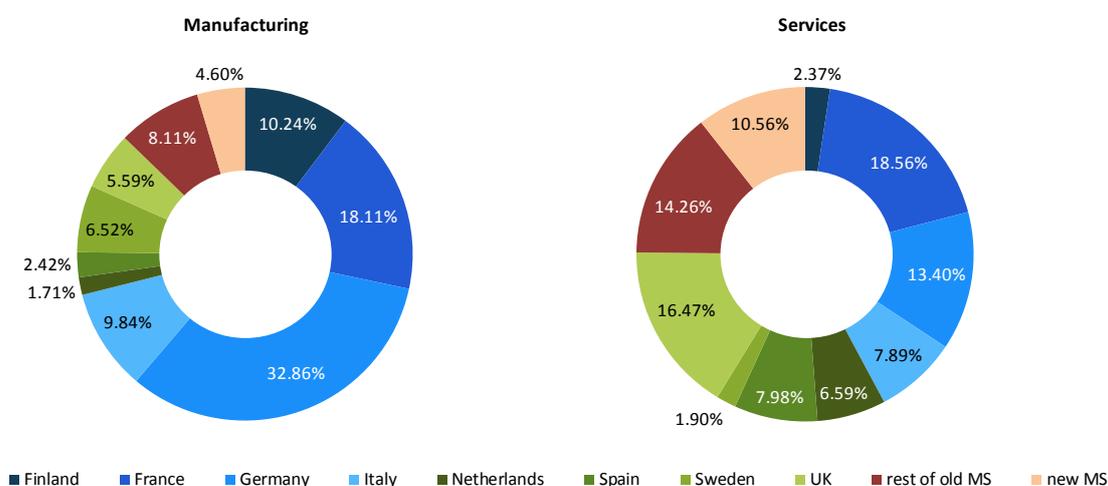


Source: Eurostat, elaborated by Ivie and JRC-IPTS.

There were around 263.08 thousand R&D employees working in the EU ICT sector in 2011, 2.96% more than in 2010. This is the result of a 3.62% increase in ICT manufacturing R&D employment (from around 78.30 thousand employees in 2010 to 81.13 thousand in 2011) and a 2.67% increase in ICT services employment (from 177.21 thousand employees in 2010 to 181.95 thousand in 2011). The increase in ICT manufacturing personnel occurred mainly in the *Manufacture of electronic components*, *Manufacture of consumer electronics* and *Manufacture of magnetic media* sub-sectors, while the largest increases in ICT services personnel occurred in *Repair of computers and communication equipment*, *Data processing* and *Computer programming*. Similar trends are observed in the numbers of ICT researchers.

Figure 29 provides a comparison between the share of ICT sector R&D personnel employed in the ICT manufacturing sector and the ICT services sector by Member State in 2011. On the one hand, similarly to previous indicators, Germany has the highest share: 32.86% of EU ICT manufacturing R&D personnel followed by 18.11% in France and 10.24% in Finland. These three countries alone account for 61.21% of the total EU ICT manufacturing R&D personnel. On the other hand, in ICT services, the highest share corresponds to France (18.56%), followed by the UK (16.47%) and Germany (13.40%). Finland, which employs a significant portion of EU ICT manufacturing R&D personnel, accounts only for 2.37% of ICT services R&D personnel. A large difference in ICT sector R&D personnel employment figures can also be observed in Spain (2.42% in manufacturing vs. 7.98% in services), the Netherlands (1.71% in manufacturing vs. 6.59% in services), the UK (5.59% in manufacturing vs. 16.47% in services) and Sweden (6.52% in manufacturing vs. 1.90% in services).

**Figure 29: Comparison of ICT manufacturing and services: distribution of ICT sector R&D personnel among the biggest Member State contributors (2011)**



*Note:* New MS are Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia. Rest of old MS comprise Austria, Belgium, Denmark, Greece, Ireland, Luxembourg and Portugal.

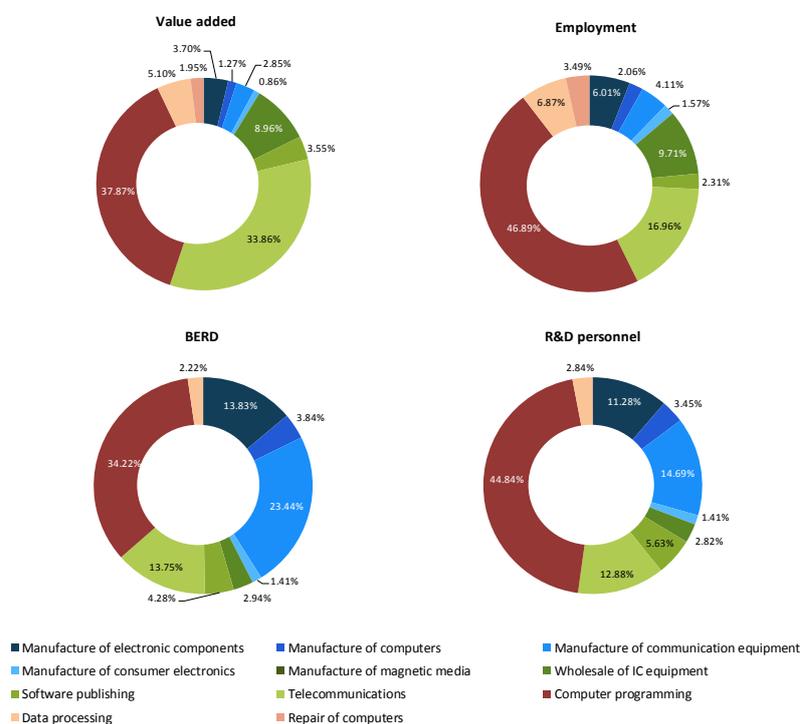
*Source:* Eurostat, elaborated by Ivie and JRC-IPTS.

## 2.5 Comparison of indicators and data summary

Figure 30 provides a comparison by ICT sub-sectors of the four main indicators –value added, employment, BERD and R&D personnel– for 2011. The main results of this comparison can be summarised as follows:

- The *Computer programming, consultancy and related activities* sub-sector consistently scored the highest in all four indicators, with shares between 34.22% and 46.89%.
- *Manufacturing of communication equipment* is a highly R&D-intensive sub-sector. While it produced only 2.85% of the total ICT VA in 2011 and employed only 4.11% of the total ICT workers, it invested 23.44% of the total ICT BERD and employed 14.69% of ICT sector R&D personnel. Similar characteristics can be seen also in *Manufacture of electronic components and boards*.
- A different situation is observed in the *Telecommunications* sub-sector. On the one hand, this sub-sector produced 33.86% of the total EU ICT VA. On the other hand, it represented only half this share in terms of ICT sector employment (16.96%), ICT BERD (13.75%) and ICT sector R&D personnel (12.88%). A similar pattern was seen in ICT trade industries, with 8.96% of the total ICT sector value added, and only 2.94% of the total ICT BERD.

**Figure 30: Comparison of value added, employment, BERD, and R&D personnel by ICT sub-sectors (2011)**



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

Table 3 shows the data for the main variables analysed in this chapter.

**Table 3: Summary table of ICT indicators by sub-sectors. European Union (2011)**

NACE Rev. 2	Description	Value added (Millions of current EUR)	Employment (thousand persons employed)	BERD (Millions of current EUR)	R&D personnel (thousand full-time equivalent)
<b>261-264, 268</b>	<b>ICT total manufacturing industries</b>	<b>44,192.89</b>	<b>844.40</b>	<b>11,875.12</b>	<b>81.13</b>
261	Manufacture of electronic components and boards	18,803.39	368.18	3,860.59	29.69
262	Manufacture of computers and peripheral equipment	6,448.60	125.98	1,072.09	9.07
263	Manufacture of communication equipment	14,486.51	251.84	6,542.89	38.64
264	Manufacture of consumer electronics	4,365.66	95.99	394.63	3.71
268	Manufacture of magnetic and optical media	88.74	2.42	4.93	0.03
<b>465, 582, 61, 62, 631, 951</b>	<b>ICT total services</b>	<b>463,412.36</b>	<b>5,284.97</b>	<b>16,041.56</b>	<b>181.95</b>
<b>465</b>	<b>ICT trade industries</b>	<b>45,499.58</b>	<b>595.11</b>	<b>819.36</b>	<b>7.42</b>
4651	Wholesale of computers, computer peripheral equipment and software	28,075.40	358.30	-	-
4652	Wholesale of electronic and telecommunications equipment and parts	17,424.18	236.81	-	-
<b>5820, 61, 62, 631, 951</b>	<b>ICT services industries</b>	<b>417,912.78</b>	<b>4,689.86</b>	<b>15,222.20</b>	<b>174.53</b>
5820	Software publishing	18,030.98	141.56	1,193.82	14.81
61	Telecommunications	171,886.60	1,039.41	3,839.89	33.90
62	Computer programming, consultancy and related activities	192,207.17	2,874.08	9,554.20	117.96
631	Data processing, hosting and related activities; web portals	25,878.73	420.79	618.39	7.48
951	Repair of computers and communication equipment	9,909.31	214.01	15.89	0.38
<b>261-264, 268, 465, 5820, 61, 62, 631, 951</b>	<b>ICT total</b>	<b>507,605.25</b>	<b>6,129.37</b>	<b>27,916.68</b>	<b>263.08</b>

Note: There is no data available for BERD and R&D personnel in the Statistics on Research and Development (Eurostat) for the ICT trade industries sub-sectors (NACE 4651, NACE 4652).

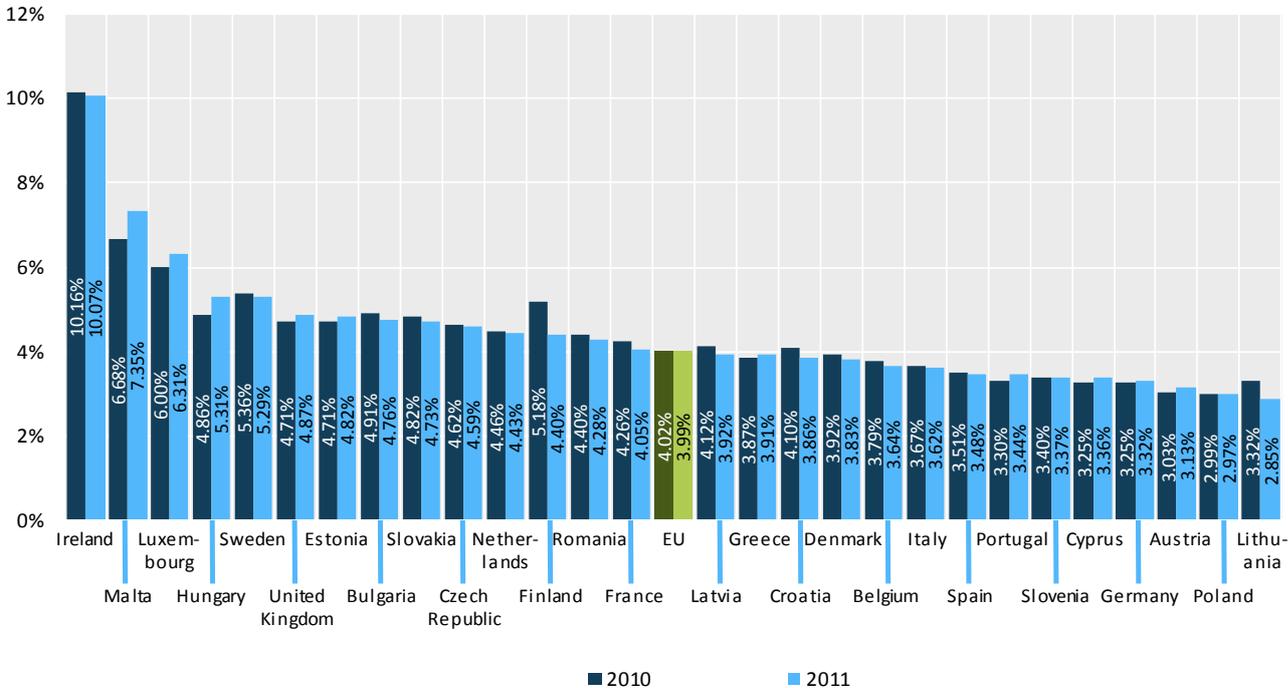
### 3. Analysis by Member State

#### 3.1 ICT sector value added

ICT sector value added (ICT VA) in the EU amounted to 507.61 billion euros in 2011. This represented a share of around 4% of EU GDP that has reduced slightly over the last few years.

From the individual country perspective, in 2011 the share of ICT sector ranged from 10.07% of total VA for Ireland down to 2.85% for Lithuania and 2.97% for Poland (see Figure 31). Ireland maintained the leading position with a slight reduction in the ICT sector share in VA from 10.16% to 10.07%. In 2011, Malta<sup>13</sup> and Luxembourg came next with a share 3 percentage points lower (7.35% and 6.31%, respectively). Three other countries had shares above or around 5% (Hungary, Sweden and the United Kingdom) and fourteen countries had shares below the EU level (3.99%). Newer Member States as a whole achieved a share below the EU average in 2011 (3.92%), but it is worth saying that seven of these thirteen countries (Malta, Hungary, Estonia, Bulgaria, Slovakia, Czech Republic and Romania) have ratios of ICT VA to GDP above the EU level.

Figure 31: ICT VA share of GDP by Member State (2010, 2011)



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

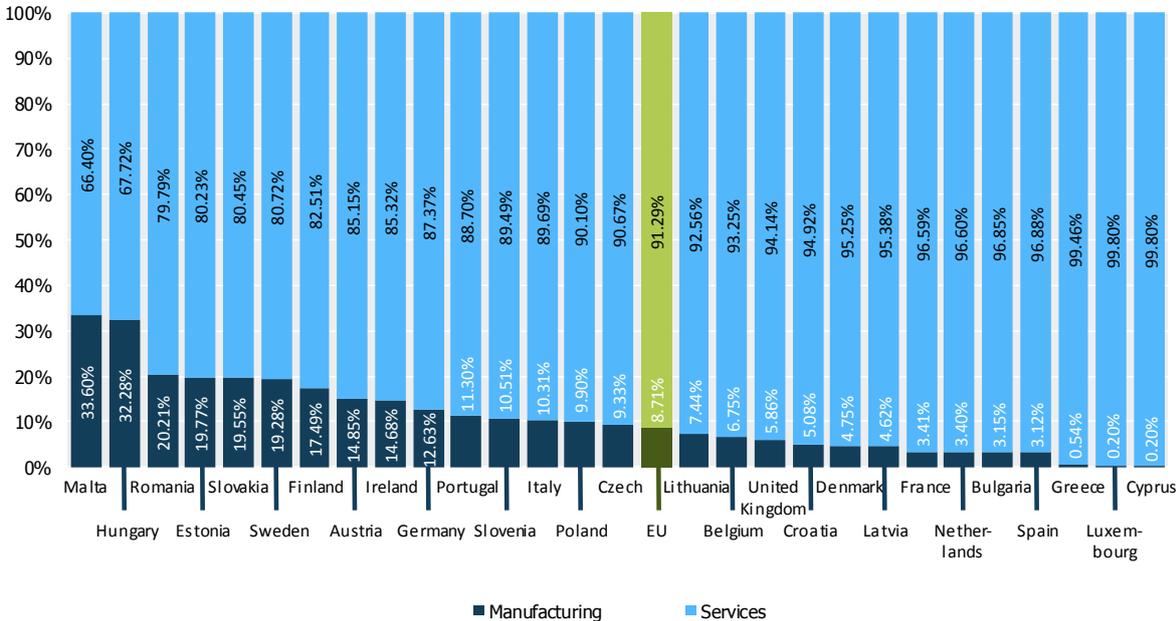
In almost all countries the ICT VA share of GDP remained fairly stable from 2010 to 2011. The United Kingdom, Portugal, Cyprus, Estonia and Austria experienced moderate increases between 2010 and 2011, between 0.15 and 0.09 percentage points, whereas Finland and Lithuania saw falls of -0.77 and -0.46 percentage points respectively. Here, however, it should be stressed that these falls and increases are relative to GDP, and consequently they depend both on ICT VA as well as on GDP evolution of each country. In this sense, for instance, the ratios of some countries like, for

<sup>13</sup> Greece, Luxembourg, Croatia and especially Malta lack official data, therefore we recommend taking the results with caution. The missing data not covered with sources mentioned above has been estimated using NACE Rev. 1.1 data, correspondence table between NACE Rev. 1.1 and NACE Rev. 2, European averages ICT shares, and turnover/GVA ratio.

example, Sweden or Latvia experienced a decline in 2011 due to a significant increase in GDP (in current terms), which exceeded ICT VA growth. At the EU level, ICT services contributed by far the largest share of ICT VA (91.29% in 2011), while ICT manufacturing VA contributed only 8.71%.

Figure 32 shows the distribution of VA shares for ICT manufacturing and ICT services by country in 2011. The two most ICT manufacturing-oriented countries in the EU are Malta (its ICT manufacturing industries produced 33.60% of total ICT VA) and Hungary (32.28%). Other countries with ICT manufacturing sectors that produced relatively high percentages of ICT VA were Romania (20.21%), Estonia (19.77%), Slovakia (19.55%), Sweden (19.28%), Finland (17.49%, although this share was much higher in 2010(30.92%), Austria (14.85%) and Ireland (14.68%). As the countries with larger shares for ICT manufacturing correspond mainly to newer Member States, it is not surprising that their ICT manufacturing sector has a higher share on total VA (14.58%) compared with the EU average (8.71%).

**Figure 32: Distribution of VA shares for ICT manufacturing and ICT services by Member State (2011)**

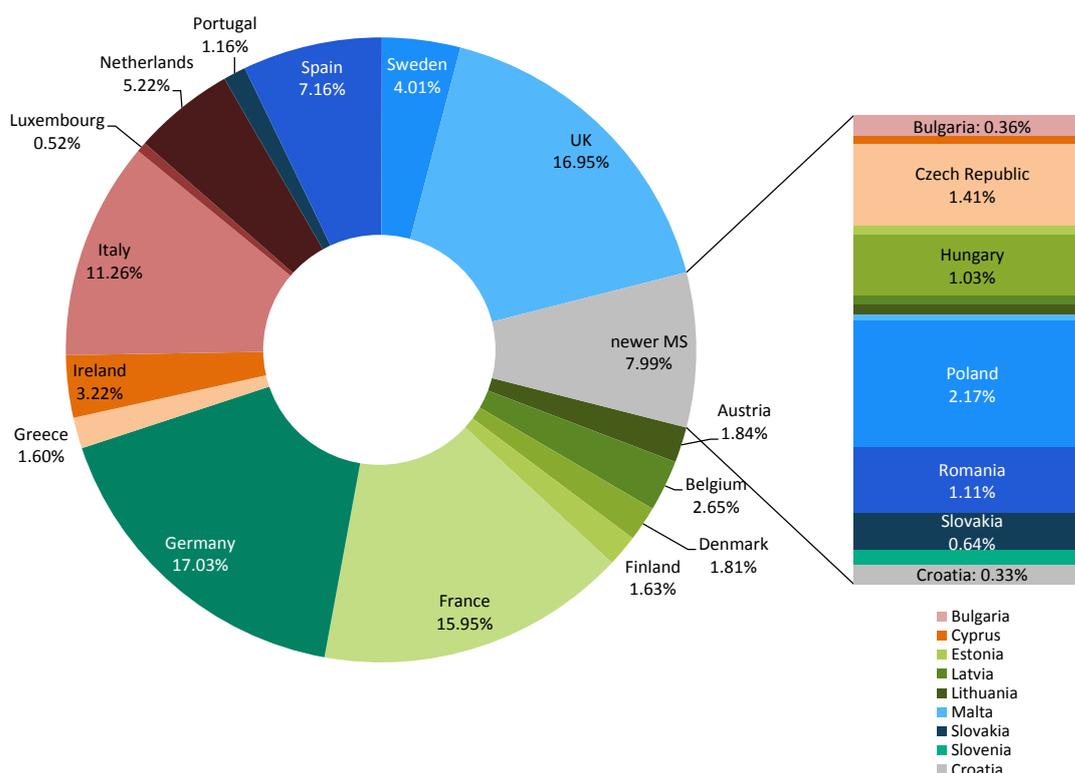


Source: Eurostat, elaborated by Ivie and JRC-IPTS.

Clearly, in terms of VA, the ICT sector of every EU Member State is dominated by ICT services. In 2011, the ICT services sectors of nine countries produced over 95% of total ICT sector VA: Cyprus (99.80%), Luxembourg (99.80%), Greece (99.46%), Spain (96.88%), Bulgaria (96.85%), the Netherlands (96.60%), France (96.59%), Latvia (95.38%) and Denmark (95.25%). Moreover, Croatia produced also almost 95% of its total ICT sector VA, namely 94.92%.

Figure 33 provides a comparison of contributions by Member State to EU ICT VA in 2011. It comes as no surprise that the largest EU economies contributed the most –Germany (17.03%), the United Kingdom (16.95%), France (15.95%), Italy (11.26%) and Spain (7.16%). Together, these five countries produced 68.35% of total EU ICT VA. The Netherlands followed with 5.22%. Overall, the thirteen newer Member States contributed 8.15% to total EU GDP in 2011, a figure similar to their ICT sector contribution of 7.99% to EU ICT VA. In 2011, the six EU economies that are most specialised in ICT (Ireland, Malta, Luxembourg, Hungary and Sweden –see Figure 31) together produced only 8.88% of the EU ICT VA, i.e., less than the share of Italy and around 1.7 percentage points more than the share of Spain.

**Figure 33: Distribution of ICT VA among Member States (2011)**



Note: Newer MS are Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia.

Source: Eurostat, elaborated by Ivie and JRC-IPTS.

### 3.2 ICT sector employment and ICT sector labour productivity

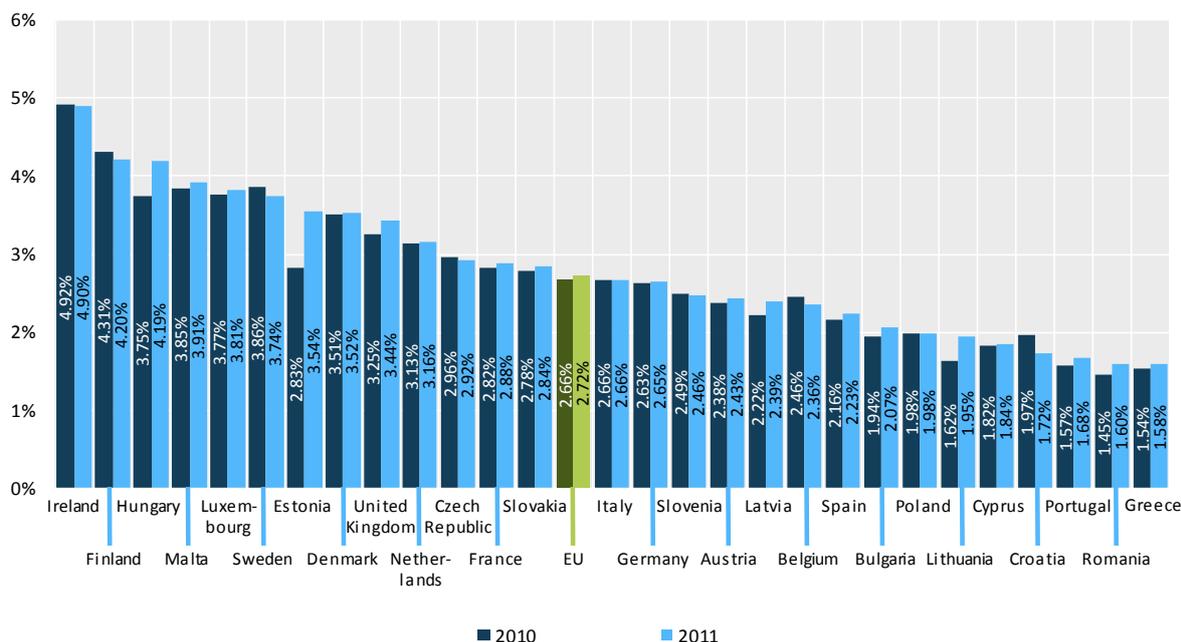
#### 3.2.1 ICT sector employment

In 2011, 6.13 million people worked in the EU ICT sector, representing 2.72% of employment in the EU. This percentage was 2.66% in 2010.

Figure 34 compares the ICT sector employment shares of total employment by Member State (based on head counts). As with ICT sector value added in GDP, the leading country in 2010 and 2011 was Ireland with a share of almost 5% in both years (4.92% in 2010 and 4.90% in 2011). Only Finland (4.20%) and Hungary (4.19%) exceeded a 4% share in 2011 (4.31% for Finland in 2010 and 3.75% for Hungary). At the other end of the scale, seven countries –Poland, Lithuania, Cyprus, Croatia,<sup>14</sup> Portugal, Romania and Greece– had shares below 2% in 2011.

<sup>14</sup> Recall that Greece, Luxembourg, Croatia and especially Malta lack official data, therefore we recommend taking the results with caution. The missing data for ICT sector employment has been estimated using some alternative methods like NACE Rev. 1.1 data, correspondence table between NACE Rev. 1.1 and NACE Rev. 2, and European average ICT shares.

**Figure 34: ICT sector employment share of total employment by Member State (% of head counts; 2010, 2011)**

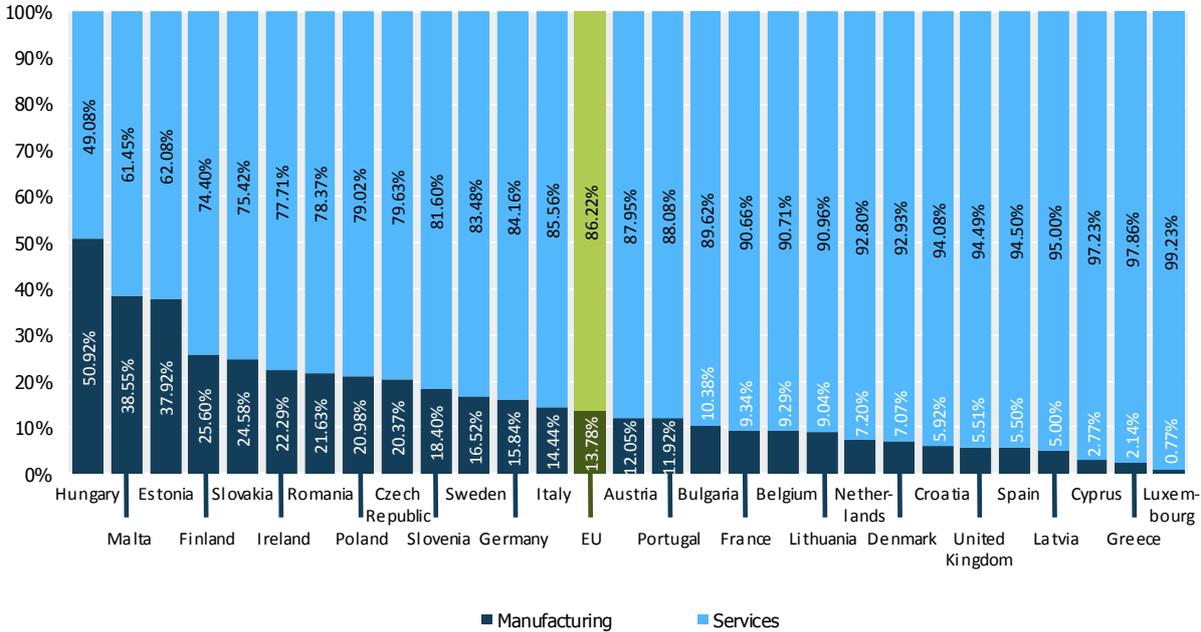


Source: Eurostat, elaborated by Ivie and JRC-IPTS.

Between 2010 and 2011, the EU ICT sector gained around 155 thousand workers. The largest increases were in the United Kingdom with around 59.70 thousand workers, Germany (around 22.18 thousand workers), France (around 20.65 thousand workers) and Hungary (around 18.68 thousand workers) (jointly, 78.22% of the total EU rise). In general, all countries experienced a rise in ICT employment, while Croatia experienced a fall of around 4.42 thousand workers, Belgium of around 2.93 thousand, Greece 2.08 thousand, Ireland around 1.90 thousand, Sweden around 1.78 thousand, the Czech Republic around 1.70 thousand, Finland around 1.14 thousand and Slovenia of around 0.59 thousand. Thus, these eight countries accounted for -10.68% of the shrinkage in EU ICT sector employment.

At the EU level in 2011, ICT manufacturing employed 13.78% of the ICT sector workforce. There is considerable variation between Member States in the distribution of labour between the two ICT sub-sectors (manufacturing and services). A large number of newer EU Member States have become important ICT manufacturing countries, and have relatively high employment in ICT manufacturing (see Figure 35). This was the case for Hungary (50.92% of ICT sector employment in manufacturing), Malta (38.55%), Estonia (37.92%), Slovakia (24.58%), Romania (21.63%), Poland (20.98%), the Czech Republic (20.37%) and Slovenia (18.40%). Other EU countries with a relatively high share of ICT manufacturing employment were Finland (25.60%) and Ireland (22.29%). On the other hand, countries with the biggest share of ICT services employment in 2011 were Luxembourg (99.23%), Greece (97.86%), Cyprus (97.23%), Latvia (95.00%), Spain (94.50%) and the United Kingdom (94.49%).

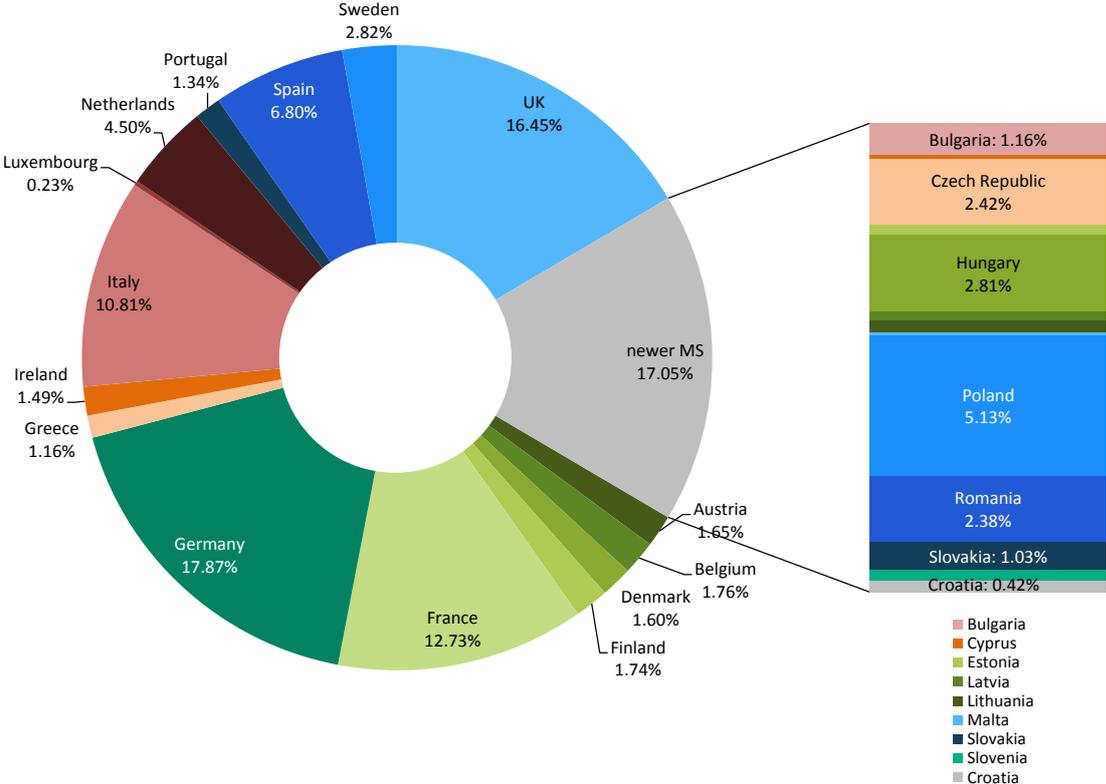
**Figure 35: Distribution of employment shares between ICT manufacturing and ICT services by Member State (% of head counts, 2011)**



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

Figure 36 compares Member State contributions to EU ICT sector employment in 2011. As can be expected, EU ICT sector employment was concentrated in the five largest EU economies. Germany came first with 17.87% of total ICT sector employment in 2011. The UK was second with 16.45%, followed by France (12.73%), Italy (10.81%), and Spain (6.80%). Thus, 64.66% of EU ICT sector employment is concentrated in these five countries. Other EU countries with fairly high shares of ICT sector employment relative to their economic size are Poland (5.13%) and the Netherlands (4.50%). Sweden is next with 2.82%, followed by three newer Member States with high contributions relative to their economic size: Hungary (2.81%), the Czech Republic (2.42%), and Romania (2.38%). Overall, newer Member States contributed 17.05% to ICT sector employment.

**Figure 36: Distribution of ICT sector employment among Member States (head counts, 2011)**



Note: Newer MS are Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia.

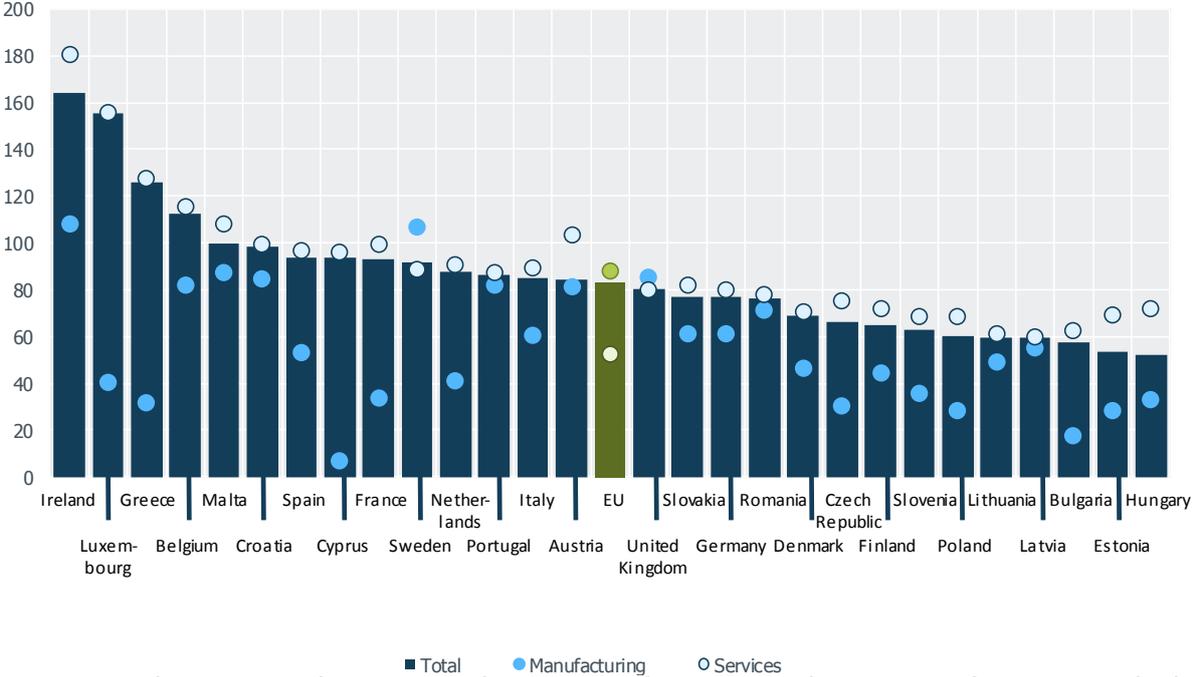
Source: Eurostat, elaborated by Ivie and JRC-IPTS.

**3.2.2 ICT sector labour productivity**

Figure 37 shows that the EU ICT sector labour productivity level in 2011 was around 82.8 thousand euros per person. Ireland had the highest level (164.22), followed by Luxembourg (155.03), then Greece (125.63) and Belgium (112.51). All the newer Member States (except Malta, Cyprus, Slovakia and to a lesser extent Romania and the Czech Republic) had the lowest levels of ICT sector labour productivity. It is also interesting to note that ICT services in almost all countries (25 out of 28) had a higher labour productivity than the total and, therefore, than ICT manufacturing.<sup>15</sup> The only exceptions were Sweden, Austria and to a lesser extent the United Kingdom.

<sup>15</sup> The bright blue bubbles in Figure 37 indicate the value of ICT sector labour productivity in the manufacturing sector whereas the light blue bubbles indicate the value of ICT sector labour productivity in the services sector.

**Figure 37: ICT sector labour productivity by Member State (thousands of EUR PPS [Purchase Power Standard] per person, 2011)**



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

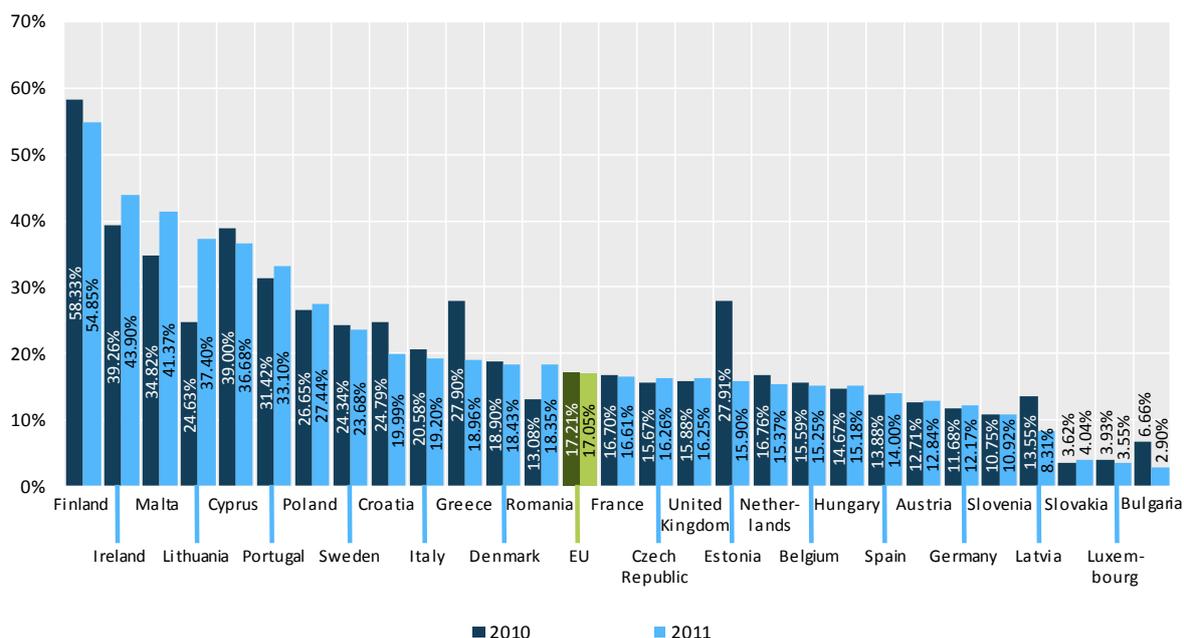
**3.3 ICT sector business enterprise expenditure on R&D (ICT BERD)**

In 2011, EU ICT sector Business Enterprise Expenditure on R&D (ICT BERD) amounted to 27.92 billion euros, 6.27% more than in 2010 (26.27 billion euros). This represented 17.05% of the total EU BERD in 2011.

Figure 38 presents ICT BERD shares of total BERD by Member State. Of total BERD in the ICT sector in 2011, Finland spent 54.85%, 10.95 percentage points more than the next country, Ireland (43.90%). Malta, Lithuania, Cyprus and Portugal followed with shares between 41.37% and 33.10%. Poland and Sweden, whose ICT sector spent between 20% and 30% of total BERD, were next. In 2011 the country with by far the lowest share of ICT BERD in total BERD was Bulgaria, with 2.90%.

In 2011, half of the twenty-eight countries had a higher ICT BERD share of total BERD than in 2010. This group consisted of six countries belonging to the former EU15 (Ireland, Portugal, the United Kingdom, Spain, Austria and Germany) and eight countries that entered the EU in recent years (Malta, Lithuania, Poland, Romania, the Czech Republic, Hungary, Slovenia and Slovakia). The biggest jump took place in Lithuania, from 24.63% in 2010 to 37.40% in 2011. In the remaining countries, the ICT BERD share of total BERD dropped. The sharpest drop occurred in Estonia, from 27.91% in 2010 to 15.90% in 2011, mostly due to the significant growth of total BERD, far exceeding the increase of ICT BERD.

**Figure 38: ICT BERD share of total BERD by Member State (2010, 2011)**



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

At EU level in 2011, ICT BERD (27.92 billion euros) was divided between manufacturing (11.88 billion euros) and services (16.04 billion euros), with a higher presence of ICT services.

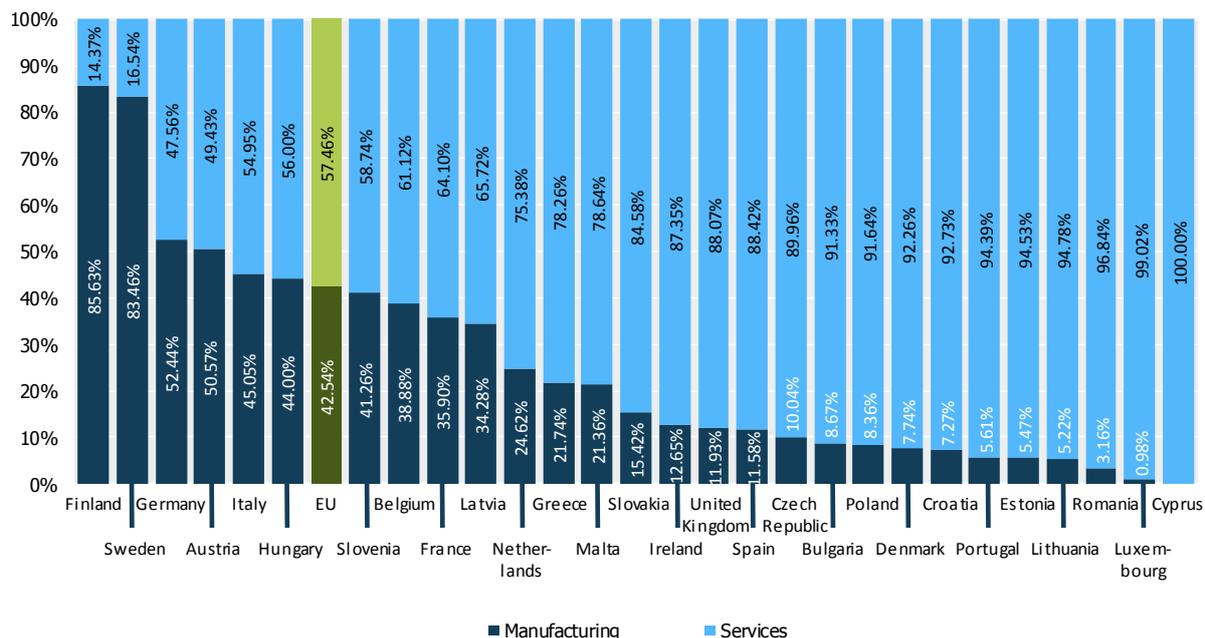
Figure 39 shows the distribution of ICT BERD between ICT manufacturing and ICT services by Member State in 2011. Only four EU countries recorded more ICT BERD in manufacturing than in services. Finland led with a share of 85.63%, followed by Sweden (83.46%). The remaining two countries in this group were Germany (52.44%) and Austria (50.57%).

On the other hand, shares of ICT BERD in services were especially important in Cyprus (100.00%), Luxembourg (99.02%),<sup>16</sup> Romania (96.84%), Lithuania (94.78%), Estonia (94.53%), and Portugal (94.39%).

In 2011, the largest contributors to EU ICT BERD (Figure 40) were Germany and France (22.26% and 17.12%, respectively). These two countries alone constituted for 39.38% of total EU ICT BERD. They were followed, albeit at a certain distance, by the United Kingdom (11.68%), Finland (9.92%), Sweden (7.62%) and Italy (7.45%). These six countries together spent 76.04% of total EU ICT BERD in 2011. On the other hand, in the case of BERD, the newer Member States had a smaller contribution to EU aggregate (2,94%) when compared with ICT VA and employment, as these countries have benefitted from the relocation process in the production but not in the R&D activities, which remain in the home country.

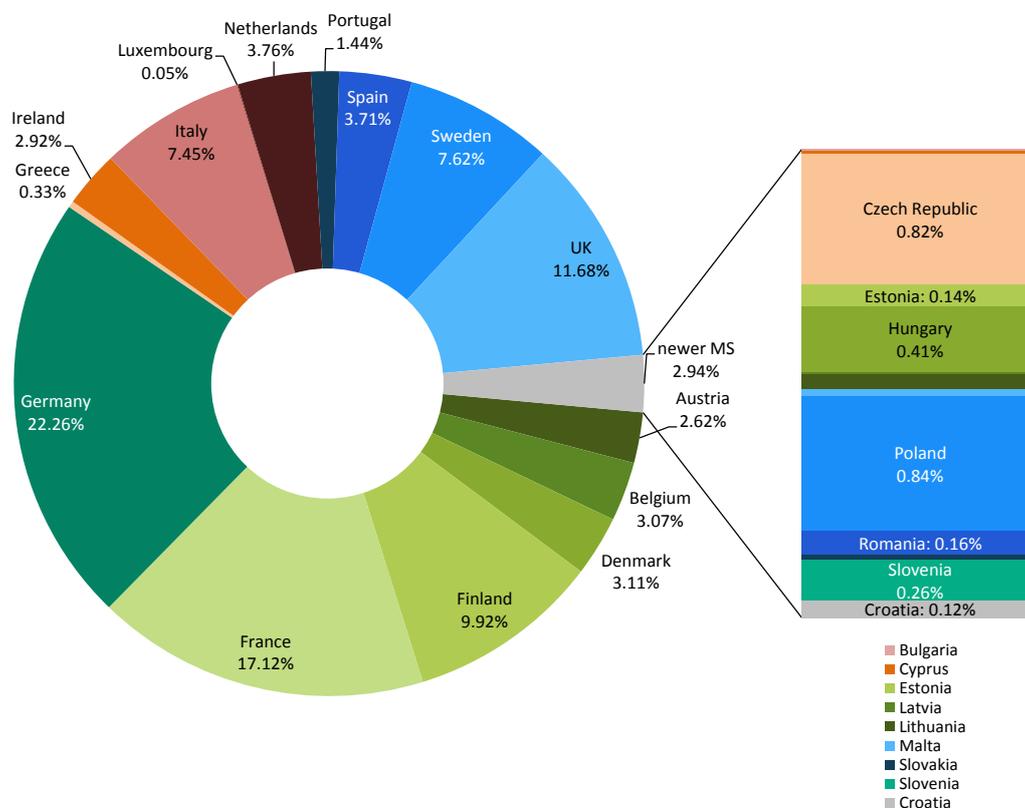
<sup>16</sup> Greece and Luxembourg lack official data, therefore we recommend taking the results with caution. The missing data has been estimated using some alternative methods like NACE Rev. 1.1 data and correspondence table between NACE rev. 2 and NACE Rev 1.1 or percentage structure of turnover.

**Figure 39: Distribution of ICT BERD between ICT manufacturing and ICT services by Member State (2011)**



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

**Figure 40: Distribution of ICT BERD among Member States (2011)**



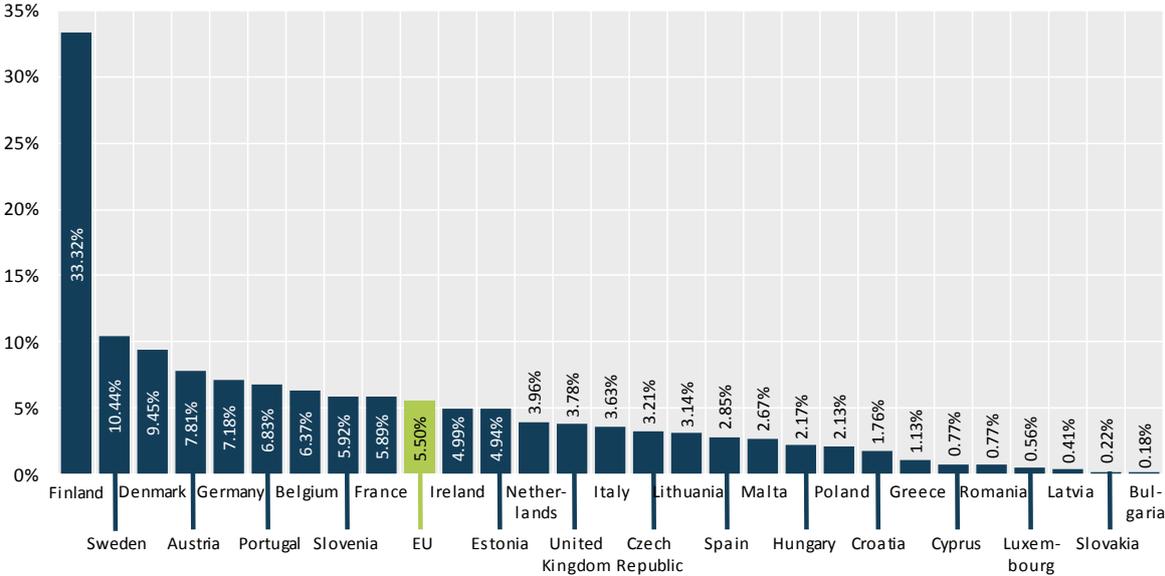
Note: Newer MS are Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia.

Source: Eurostat, elaborated by Ivie and JRC-IPTS.

ICT BERD intensity (defined as the ratio of ICT BERD to ICT VA) in the EU in 2011 amounted to 5.50%. Finland, despite being a small economy in terms of GDP and even in terms of absolute ICT VA, had by far the highest ICT BERD intensity, 33.32% (see Figure 41). Sweden and Denmark also had relatively high ICT BERD intensities, but only less than a third that of Finland. In the same year, ICT BERD intensity in Sweden amounted to 10.44% and in Denmark, 9.45%. Six other countries had ICT BERD intensities above the EU level: Austria (7.81%), Germany (7.18%), Portugal (6.83%), Belgium (6.37%), Slovenia (5.92%) and France (5.89%). Some of the newer Member States – Bulgaria (0.18%), Slovakia (0.22%) and Latvia (0.41%) together with Luxembourg (0.56%) - had the lowest levels.

ICT BERD intensity increased slightly in the EU as a whole between 2010 and 2011 (from 5.30% to 5.50%). The countries where it increased include Finland, Slovenia, Lithuania, the Netherlands, Belgium, Malta, Ireland, the Czech Republic, Germany, Poland, France, Romania, the United Kingdom and Estonia. Hungary, Slovakia and Spain remained stable, whereas Greece, Latvia, Denmark, Croatia and Cyprus experienced the highest drops, comprised between 0.44 and 0.25 percentage points.

**Figure 41: ICT BERD intensity (ICT BERD/ICT VA) by Member State (2011)**



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

**3.4 Public funding of ICT R&D**

In 2011, estimated public ICT R&D funding in the EU amounted to 6.12 billion euros – 6.63% of the total EU public funding of R&D. In this analysis, public ICT R&D funding is obtained by estimating<sup>17</sup> the share of total EU GBAORD that is allocated to ICT R&D.

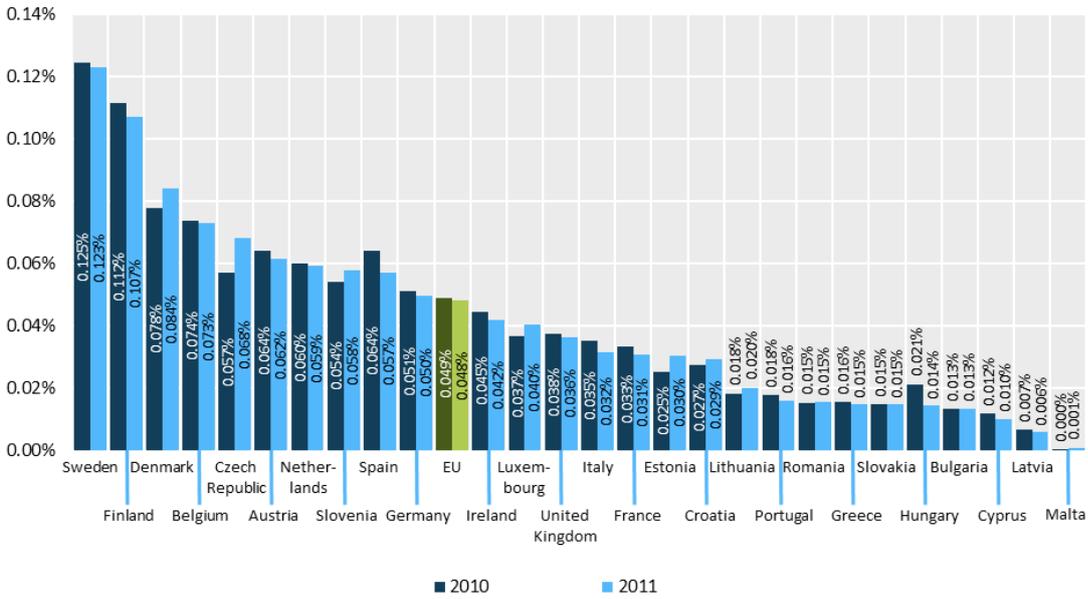
Figure 42 shows public ICT R&D funding intensity (defined as public funding of ICT R&D / GDP) in EU Member States in 2010 and 2011. In both years, Sweden led (with 0.123% in 2011), followed by Finland (0.107%) and Denmark (0.084%). With the exception of the Czech Republic, Denmark, Slovenia, Luxembourg, Estonia, Croatia and Lithuania that experienced increases in their shares; and

<sup>17</sup> Stančík, J., & Rohman, I. K.(2014). Public ICT R&D funding in the European Union. Forthcoming. JRC Scientific and Policy Report.

Malta, Romania, Greece and Bulgaria which remained stable, all other EU Member States experienced decreases in their shares of public funding of ICT R&D in GDP in the period 2010 to 2011.<sup>18</sup>

It is also interesting to note that between 2010 and 2011, the same ten countries were above the EU level, namely Sweden, Finland, Denmark, Belgium, the Czech Republic, Austria, Slovenia, the Netherlands, Spain and Germany. However, five of them changed their relative positions. The most remarking cases are the Czech Republic, which went from the eight to the fifth position, being the country with the highest increase (0.011 percentage points), and Spain, which went from the sixth to the ninth position.

**Figure 42: Share of ICT GBAORD in GDP by Member State (2010-2011)**



Note: Data not available for Poland for the period 2009-2011.

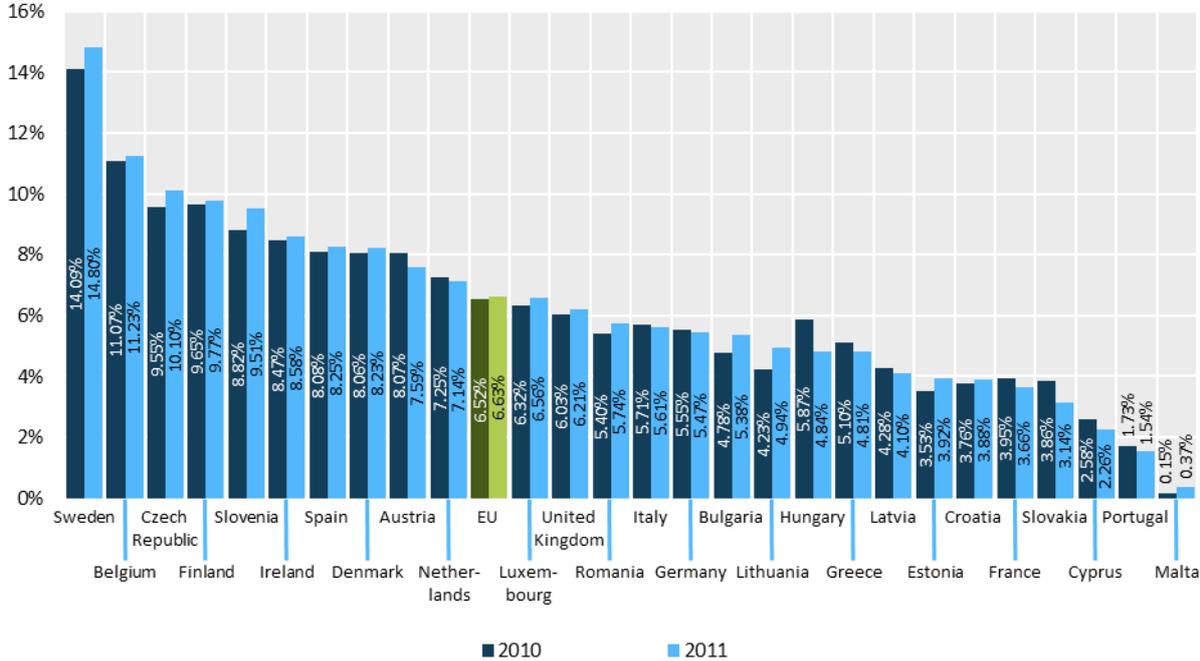
Source: Eurostat, elaborated by Ivie and JRC-IPTS.

As noted in the introduction to this subsection, another interesting figure that measures the intensity of ICT GBAORD is the ratio between the estimated ICT GBAORD and total GBAORD (Figure 43). In this case, Sweden ranked first again for both years 2010 and 2011, with 14.80% in 2011, followed by Belgium (11.23%), the Czech Republic (10.10%), Finland (9.77%) and Slovenia (9.51%). All countries, including the EU, which went from 6.52% in 2010 to 6.63 in 2011, increased their shares between 2010 and 2011 except for Hungary, Slovakia, Austria, Cyprus, France, Greece, Portugal, Latvia, the Netherlands, Italy and Germany.

It can be seen that countries with high ICT GBAORD shares in total GBAORD also have high ICT GBAORD shares in GDP and the contrary happens also in the opposite direction. The least ICT GBAORD intensive countries in terms of ICT GBAORD shares in total GBAORD 2011 were Malta, Portugal, Cyprus, Slovakia, France, Croatia and Estonia, all below 4%. These countries also devoted less or around 0.03% of their GDP to ICT GBAORD.

<sup>18</sup> Please note that data from Poland are missing for 2010 and 2011. For illustration, in the last available year, 2008, the estimate of publicly-funded ICT R&D expenditures in Poland was 64.61 million euros.

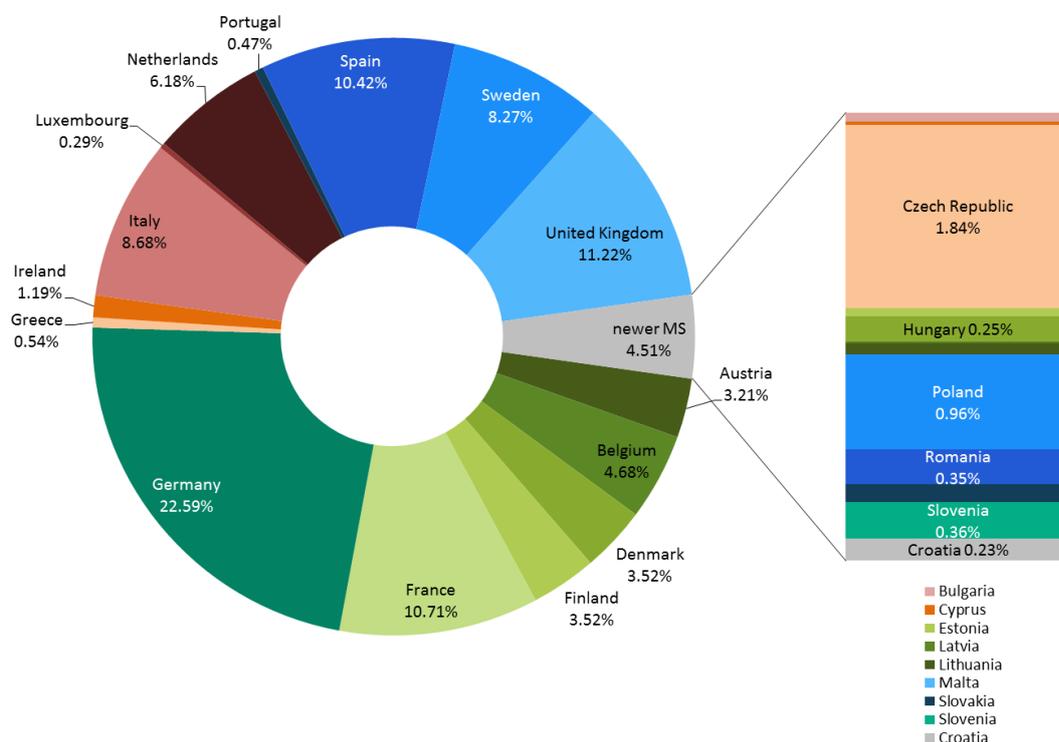
**Figure 43: Share of ICT GBAORD in total GBAORD by Member State (2010-2011)**



Note: Data not available for Poland for the period 2009-2011.  
 Source: Eurostat, elaborated by Ivie and JRC-IPTS.

In 2011, the EU’s five largest economies –plus Sweden – provided the largest contributions to total public funding of ICT R&D in the EU: Germany (22.55%), the UK (11.20%), France (10.69%), Spain (10.40%), Italy (8.67%) and Sweden (8.25%). These six countries together accounted for 71.76 % of total ICT GBAORD in the EU. Next came the Netherlands (6.17%), Belgium (4.68%), Finland (3.52%) and Austria (3.20%). The newer Member States together accounted for only 4.67% of the total ICT GBAORD, a contribution that was significantly below their economic weight (8.15% of the total EU GDP).

**Figure 44: Distribution of ICT GBAORD among Member States (2011)**



Note: New MS are Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia.

Note: 2012 for Poland.

Source: Eurostat, elaborated by Ivie and JRC-IPTS.

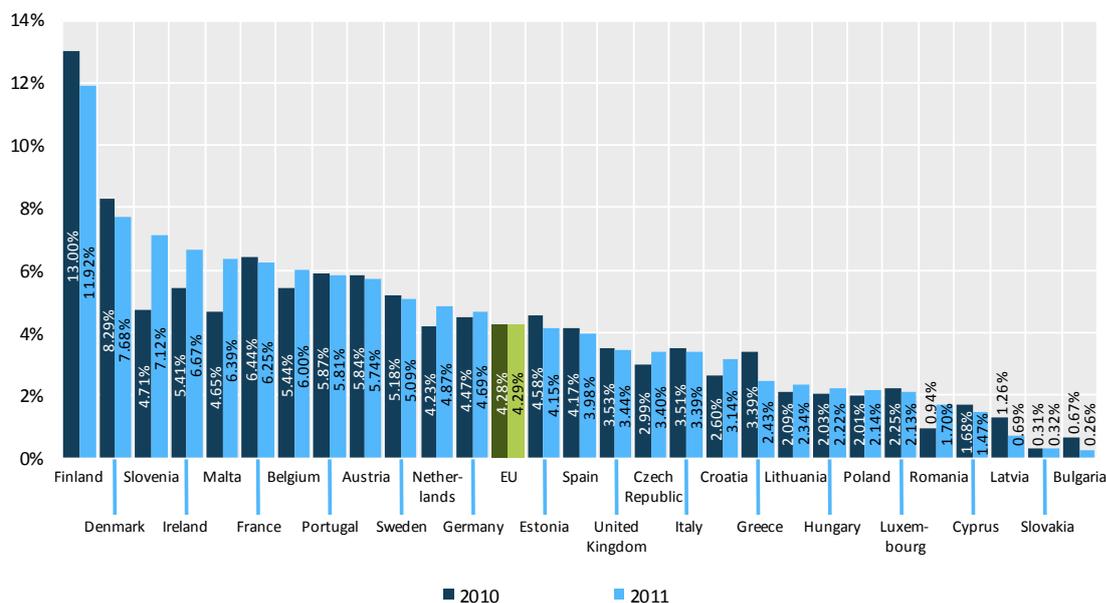
### 3.5 ICT sector R&D personnel

In 2011, ICT sector R&D personnel (including both researchers and R&D supporting staff) made up 4.29% of total ICT sector employment in the EU. This share remained constant between 2010 and 2011 (4.28% in 2010).

Figure 45 presents ICT sector R&D personnel shares of total ICT sector employment by Member State. During the analysed period (2010-2011), Finland led the EU Member States with a share of 13.00% in 2010 and 11.92% in 2011. At a distance of more than 4 percentage points was Denmark with a 7.68% share in 2011, followed by Slovenia (7.12%). Nine other countries scored above the EU level. The lowest ranking countries were mostly newer Member States (the Czech Republic (3.40%), Croatia (3.14%), Lithuania (2.34%), Hungary (2.22%), Poland (2.14%), Romania (1.70%), Cyprus (1.47%), Latvia (0.69%), Slovakia (0.32%) and Bulgaria (0.26%)), but also several important ICT R&D players like Spain (3.98%), the United Kingdom (3.44%), Italy (3.39%), Greece (2.43%)<sup>19</sup> and Luxembourg (2.13%).

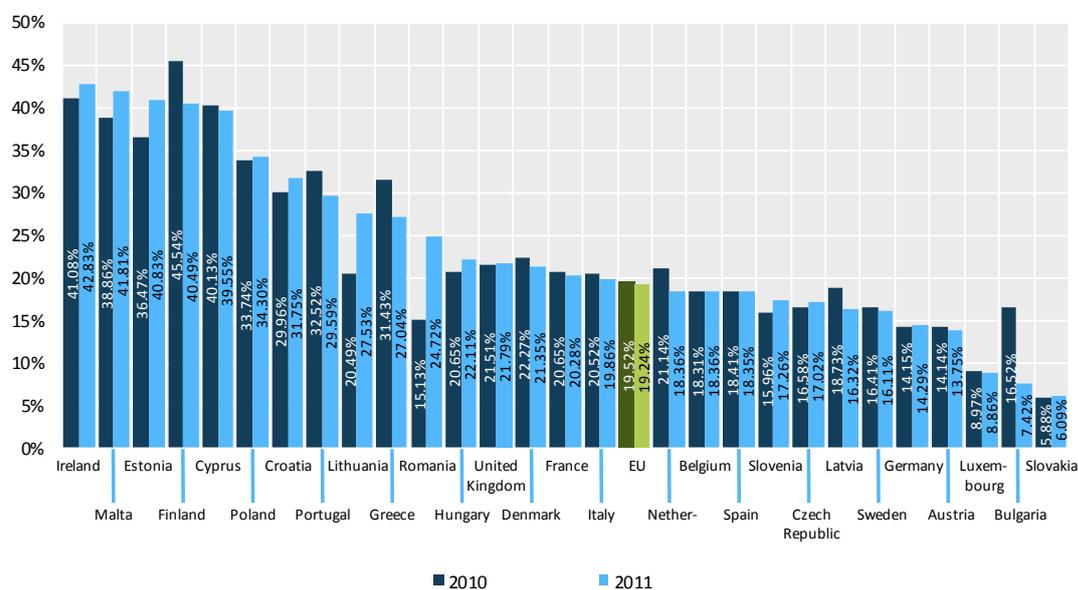
<sup>19</sup> Again, Greece and Luxembourg lack official data also for this variable, therefore we recommend taking the results with caution. The missing data has been estimated using some alternative methods like NACE Rev .1.1 data and correspondence table between NACE rev. 2 and NACE Rev 1.1 or percentage structure of Highly Qualified employment.

**Figure 45: ICT sector R&D personnel share of total ICT sector employment by Member State (based on FTE; 2010, 2011)**



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

**Figure 46: ICT sector R&D personnel share of total R&D personnel by Member State (based on FTE; 2010, 2011)**



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

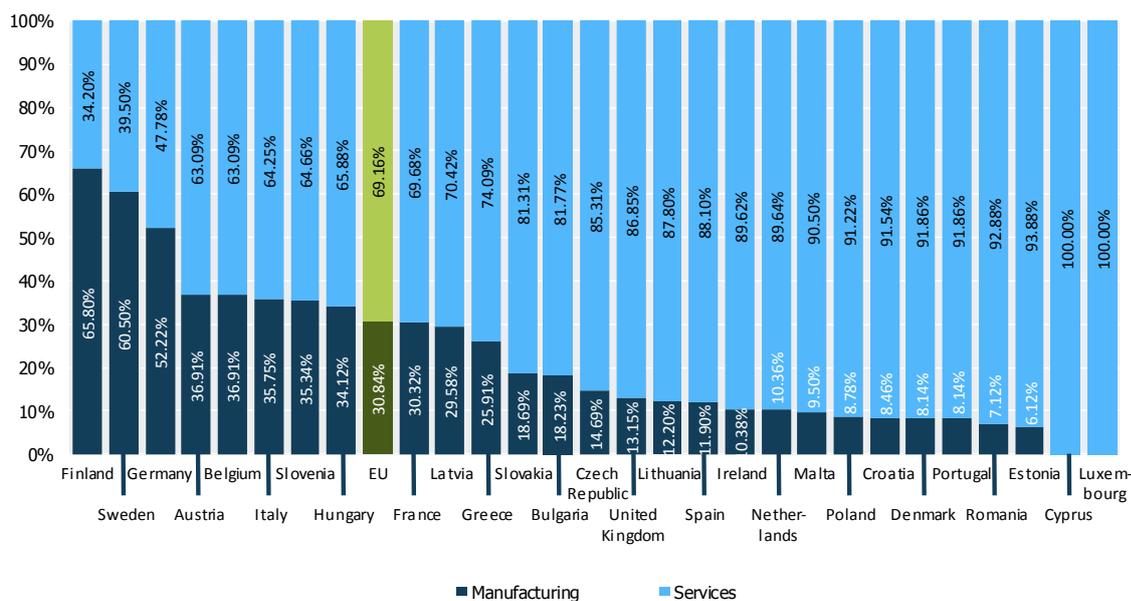
In terms of ICT R&D personnel over total R&D personnel, Ireland, Malta, Estonia and Finland are the leading countries with a share of more than 40% in 2011. Twelve other countries scored above the EU level, many of which belong to newer Member States. This is the case of Cyprus (39.55%), Poland (34.30%), Croatia (31.75%), Lithuania (27.53%), Romania (24.72%) and Hungary (22.11%). The other countries above EU level are Portugal (29.59%), Greece (27.04%), United Kingdom

(21.79%), Denmark (21.35%), France (20.28%) and Italy (19.86%). On the other hand, Slovakia, Bulgaria and Luxembourg show shares below 10%.<sup>20</sup>

Figure 47 provides a comparison of the distribution of ICT sector R&D personnel between manufacturing and services by Member State. In countries like Finland, Sweden and Germany, the manufacturing sector plays a major role in terms of ICT sector R&D personnel. In all three of these countries more than 50% of their ICT R&D employees were working in ICT manufacturing in 2011. In Finland, this ratio was as high as 65.80%. At the EU level, however, more than two thirds of ICT R&D jobs were in services in 2011. In fact in 2011, 25 EU countries had more ICT R&D jobs in services than in manufacturing, with over 90% shares in Malta, Poland, Croatia, Denmark, Portugal, Romania, Estonia, Cyprus and Luxembourg.

Figure 48 shows the distribution of ICT sector R&D personnel among Member States. As with other indicators, the largest EU economies took the lead in 2011. Germany and France led the field, each with shares of 19.40% and 18.42% respectively, followed by the United Kingdom (13.12%) and Italy (8.49%). These four countries together employed 50.44% of ICT R&D workers in the EU in 2011. What is also remarkable is Finland's relatively high share (4.80%). Among the main contributors, Spain- which employed almost 6.27% of ICT R&D employees- should also be mentioned, followed by the Netherlands (5.09%). It is also of interest that Germany, France and the UK, individually, employed more ICT R&D workers than the whole group of thirteen newer Member States (8.72%). In this group, Poland had the highest share (2.55%).

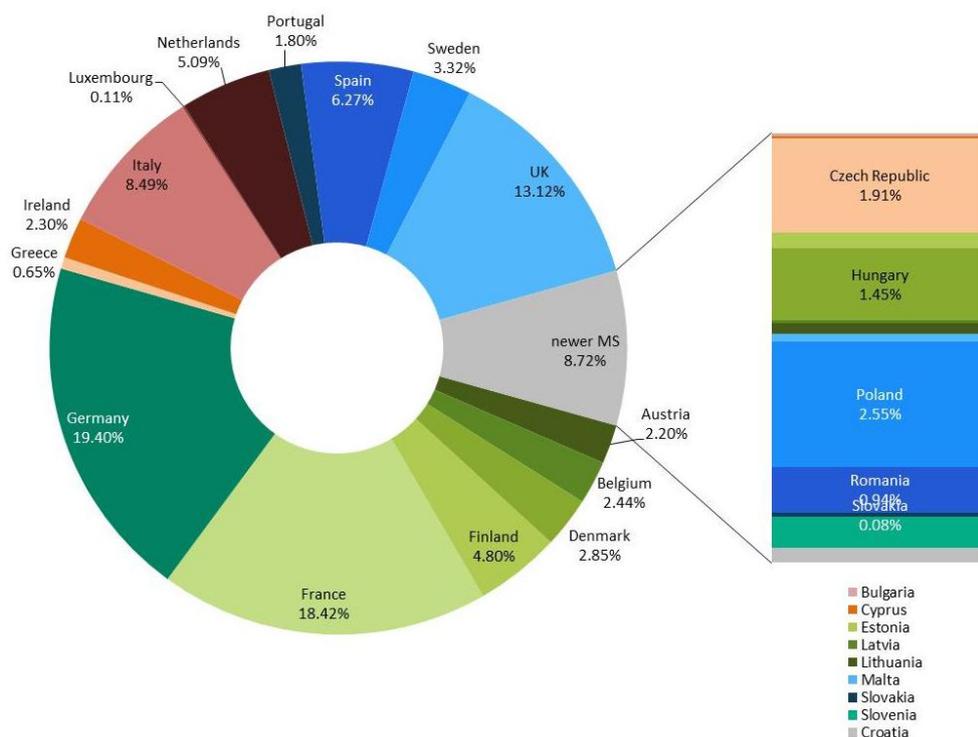
**Figure 47: ICT manufacturing/services distribution of countries' shares (based on FTE, 2011)**



Source: Eurostat, elaborated by Ivie and JRC-IPTS.

<sup>20</sup> Again, Greece and Luxembourg lack official data also for this variable, therefore their results should be taken with caution. The missing data has been estimated using some alternative methods like NACE Rev .1.1 data and correspondence table between NACE rev. 2 and NACE Rev 1.1 or percentage structure of Highly Qualified employment.

**Figure 48: Distribution of ICT sector R&D personnel among Member States (based on FTE, 2011)**



Note: New MS are Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia.

Source: Eurostat, elaborated by Ivie and JRC-IPTS.

### 3.6 Comparison of indicators and data summary

In this section, all five previously analysed indicators are compared in terms of Member State contributions (see Figure 49). Overall, due to the importance of their economies or to their particularly large ICT sector or strong ICT BERD intensities, only eight countries play significant roles in both ICT VA generation and ICT BERD in the EU according to this particular selection of indicators. This does not mean that important ICT activities do not take place in other Member States, but that a size effect makes these particular Member States stand out. A finer regional analysis would most certainly identify important ICT regions in other Member States.

These eight countries are analysed individually in this section. The other countries are grouped into *older MS* and *newer MS* categories.

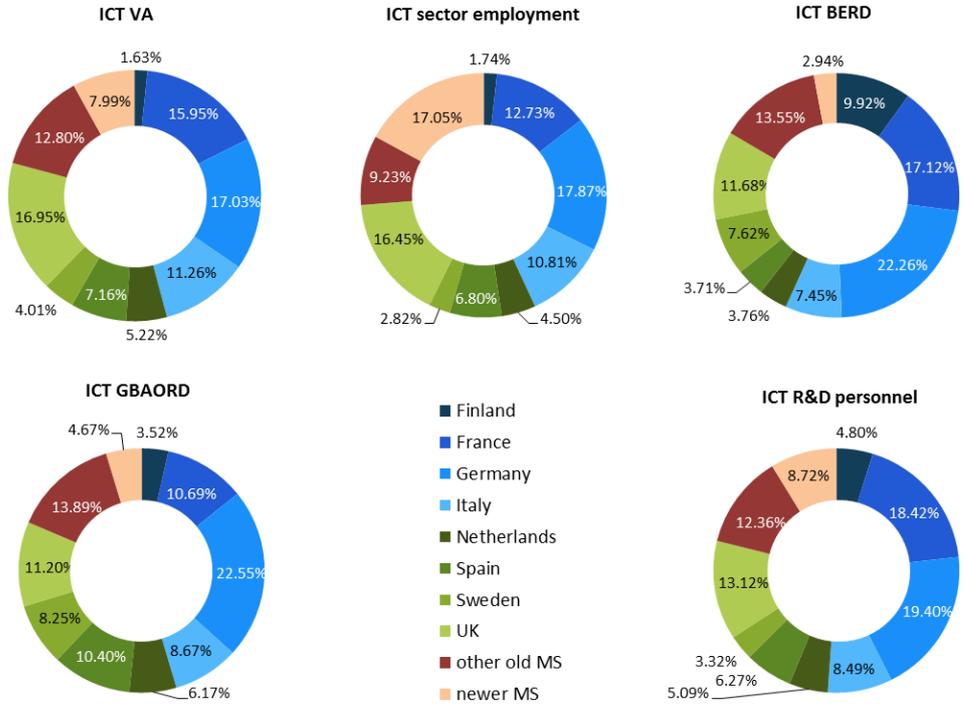
Unsurprisingly, the fact that emerges most clearly is the dominance of four major economies (France, Germany, Italy and the United Kingdom) in all five indicators. There are some exceptions (e.g., Finland in ICT BERD), but these four countries together systematically contributed around 60% in all indicators.

Other interesting facts (all related to 2011) can be summarised as follows:

- Finland produced 1.63% of total EU ICT VA and employed 1.74% of the total EU ICT sector employees, but invested 9.92% of total EU ICT BERD. Sweden was in a similar position, producing 4.01% and employing 2.82%, but investing 7.62% in ICT BERD and 8.25% in ICT GBAORD.

- The thirteen newer Member States together produced 7.99% of total EU ICT VA. For this, they needed 2.94% of total EU ICT BERD but employing 17.05% of the total EU ICT sector workforce and 8.72% of EU ICT sector R&D personnel.
- In terms of public funding of ICT R&D, it is interesting to note the case of Spain, with a share of 7.16% in EU ICT VA and 3.71% in EU ICT BERD, but with an ICT public funding share of 10.40% of EU ICT GBAORD. On the other hand, France showed a relatively lower share in EU ICT GBAORD as compared with the rest of indicators, always between 12.73% and 18.42%, but with an ICT GBAORD share of 10.40%.
- The contribution of Germany was very consistent across all four indicators (always between 17.03% and 22.60%). Similarly consistent patterns can be seen in Italy (always between 7.45% and 11.26%), the United Kingdom (always between 9.38% and 16.95%) and in the group of *other older* Member States (always between 9.23% and 14.89%).

**Figure 49: Comparison of ICT VA, ICT sector employment, ICT BERD, ICT GBAORD and ICT sector R&D personnel by Member State (2011)**



Note: ICT GBAORD, 2008 for Poland. Newer MS are Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia. Other old MS comprise Austria, Belgium, Denmark, Greece, Ireland, Luxembourg and Portugal.

Source: Eurostat, elaborated by Ivie and JRC-IPTS.

Table 4 summarizes the main information presented in this chapter.

**Table 4: Summary table of ICT indicators by European country. European Union (2011)**

	<b>ICT sector Value added</b>	<b>ICT sector Employment</b>	<b>ICT sector BERD</b>	<b>ICT GBAORD</b>	<b>ICT sector R&amp;D personnel</b>
	(Millions of current EUR)	(1000 persons employed)	(Millions of current EUR)	(Millions of current EUR)	(1000 Full Time Equivalent)
Finland	8,307.81	105.92	2,768.53	202.42	12.63
France	81,061.10	776.04	4,778.10	614.93	48.47
Germany	86,555.92	1,089.31	6,214.70	1,297.59	51.05
Italy	57,211.54	659.04	2,078.93	498.83	22.34
Netherlands	26,510.40	274.52	1,048.98	355.20	13.38
Spain	36,388.35	414.57	1,035.50	598.34	16.49
Sweden	20,385.92	171.82	2,127.85	474.82	8.74
United Kingdom	86,164.73	1,002.97	3,260.24	644.23	34.52
Other old Member States	65,065.08	562.58	3,782.33	799.01	32.52
Newer Member States	40,618.91	1,039.35	821.53	268.52	22.95
<b>European Union</b>	<b>507,605.25</b>	<b>6,129.37</b>	<b>27,916.68</b>	<b>6,118.39</b>	<b>263.08</b>

Note: ICT GBAORD, 2008 for Poland.

Source: Eurostat, elaborated by Ivie and JRC-IPTS.

## 4. Comparison with other economies

This section places the EU in the international context by comparing its ICT R&D position with the most relevant players in the world economy: the United States, Canada, Australia, five Asian countries (Taiwan, Korea, Japan, China and India); three European countries not belonging to the EU (Russia, Norway and Switzerland); and one Latin American country (Brazil). The comparison is made for the two most recent years for which information is available, 2010 and 2011. It uses the *ICT sector Operational Definition*<sup>21</sup> in the JRC-IPTS database, following the same structure as previous chapters.

### 4.1 ICT sector value added

The importance of the ICT sector is very uneven among the countries considered. Figure 50 plots the weight of the value added (VA) generated by the ICT sector on total GDP. The message it gives is clear: the five Asian countries, together with the US, have the highest share of ICT in their VA. Of those, the high share of the ICT sector in Taiwan and Korea –especially the former– is outstanding. While ICT VA represented 3.63% of VA in the EU<sup>22</sup> in 2011, it was 3.2 times higher in Taiwan, at 11.63%, and in Korea more than double (2.1 times higher) at 7.68%. These two countries are therefore the most ICT oriented in the world economy. However, this share decreased in all countries between 2010 and 2011, except for the United States and India, with small growths of 0.04 and 0.07 percentage points. On the other hand, Australia and Switzerland remained constant.

The share of one country in the total ICT VA depends on two conditions: 1. its ICT sector VA share on total VA; and 2. its economic size, as measured by total GDP or total employment. Figure 51 shows how total ICT VA is split among the different countries. As expected, due to their economic size, the US enjoys the highest share (30.51%), followed by the EU countries (25.08%), China (12.84%) and Japan (12.81%).<sup>23</sup> Thus, in 2011 these four players together represented 81.25% of total ICT VA produced by the thirteen countries selected for analysis.

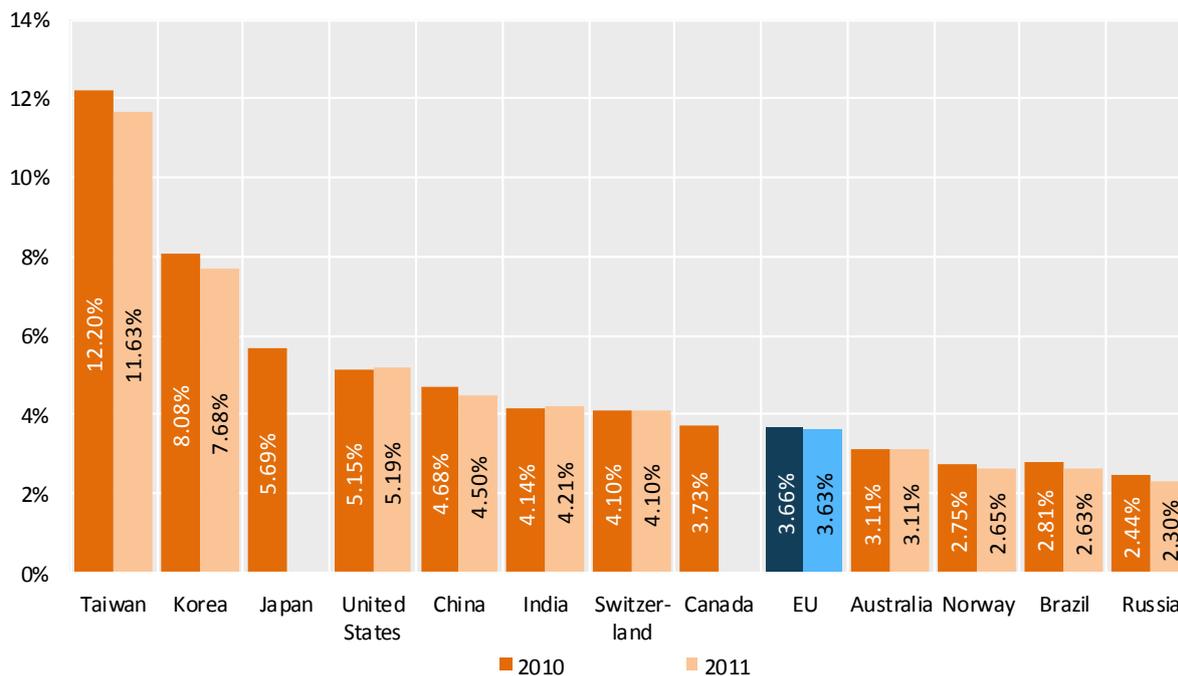
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<sup>21</sup> The *Comprehensive definition of ICT sector* is available mainly for EU Member States for the period 2008-2010. It corresponds to the definition given by the OECD in 2007. This definition includes ICT manufacturing industries, ICT trade industries and ICT services industries. Data in accordance with this classification are not available for some non-EU countries. See OECD definition: <http://www.oecd.org/science/sci-tech/38217340.pdf>. The *Operational definition of ICT sector* allows for an international comparison with non-EU countries over a longer period of time (2006-2011), as some of these countries do not have the necessary disaggregated information to estimate all the ICT sub-sectors included in the comprehensive definition. This definition takes into account the standard distinction between manufacturing and services, but does not include the following sectors: Manufacture of magnetic and optical media (268) and ICT trade industries (465). In addition, ICT services industries are only available for two sub-sectors: Telecommunication (61) and the aggregate Computer and related activities (5820, 62, 631, 951). See Technical report: <http://ftp.jrc.es/EURdoc/JRC77364.pdf>.

<sup>22</sup> Recall that in this chapter we are using the *Operational Definition*; some discrepancies may therefore arise between the figures provided in this chapter and in previous ones.

<sup>23</sup> Data for Japan refers to 2010.

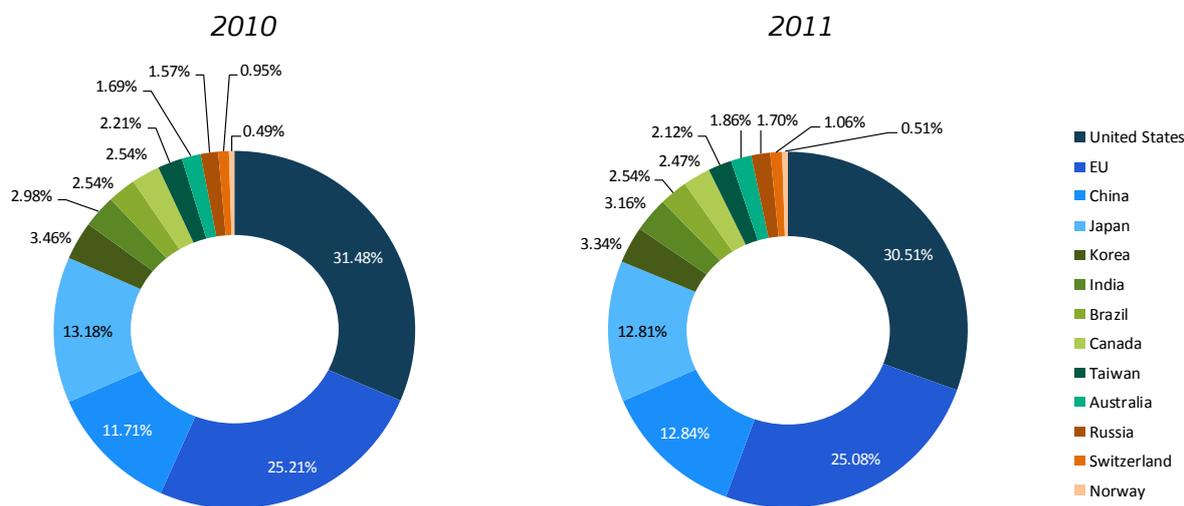
**Figure 50: ICT VA share of GDP for the European Union and other economies (2010, 2011)**



Note: ICT VA was not available for Canada and Japan in 2011.

Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

**Figure 51: Distribution of ICT sector VA among the European Union and other economies (2010, 2011)**

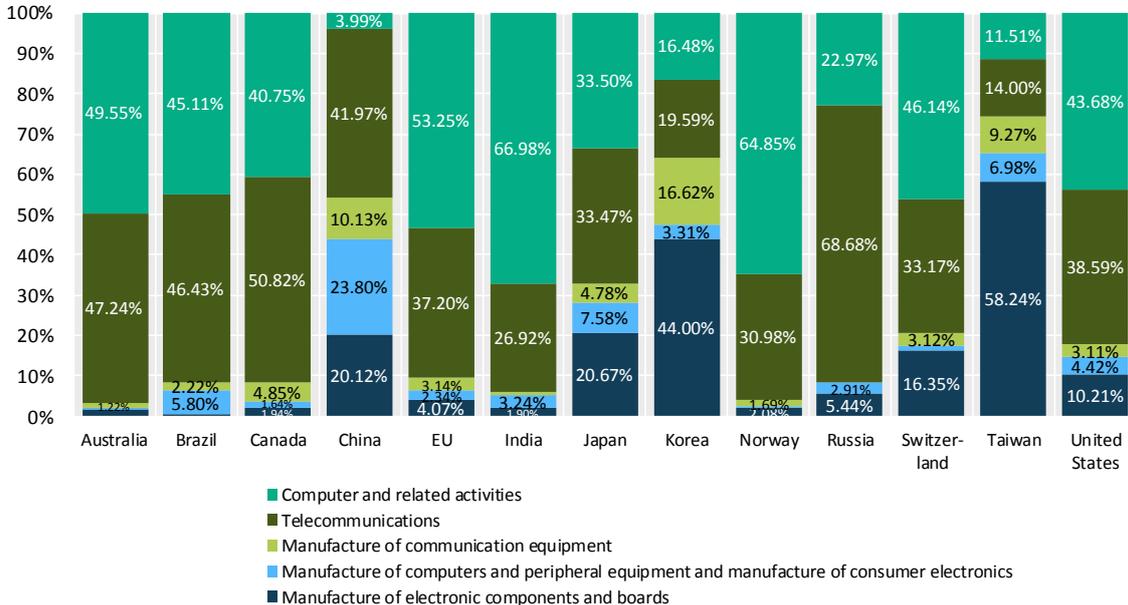


Note: 2010 for Canada and Japan for both years.

Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

Figure 52 reports the different ICT sub-sectors' share of total ICT VA.<sup>24</sup> Of the five ICT sub-sectors represented in the figure, three stand out for their importance, especially in four Asian countries (China, Japan, Korea and Taiwan): *Manufacture of electronic components and boards*; *Computer and related activities*; and *Telecommunications*. Both Taiwan and Korea have a very high share of the first sector, *Manufacture of electronic components and boards*; China has a relatively high share of *Manufacture of computers and peripheral equipment and Manufacture of consumer electronics*; India and Norway have high shares of *Computer and related activities*, while Brazil, Russia, Australia and Canada<sup>25</sup> present the highest *Telecommunications* share of the thirteen countries considered. The most remarkable difference between the EU and the US is the former's relatively high share in *Computer and related activities*, together with the relative low share in *Manufacture of electronic components and boards* as compared with the US.

**Figure 52: Distribution of ICT sector value added by manufacturing and services sub-sectors for the European Union and other economies (2011)**



Note: 2010 for Canada and Japan.

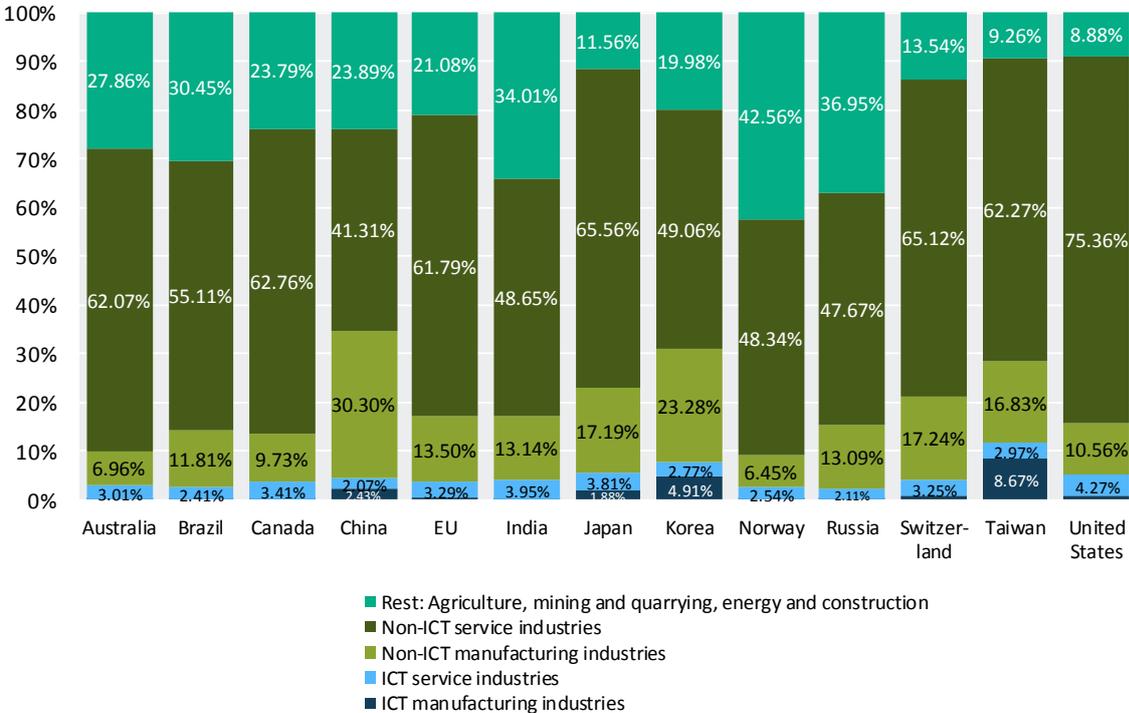
Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

Figure 53 offers a complementary perspective by plotting the ICT and non-ICT activities shares of GDP, differentiating between manufacturing and services industries. As we have already seen (Figure 50) ICT sector has a small share of GDP. ICT manufacturing sectors are relevant in terms of VA for only four Asian countries, Taiwan, Korea, Japan<sup>26</sup> and China, while for the remaining countries its presence is almost nil, below 1% (0.92% in the US) of total GDP. For all the countries the highest share of GDP corresponds to non-ICT services industries. This is especially true for the US (75.36%), Japan (65.56%), Switzerland (65.12%) and Canada (62.76%). Non-ICT manufacturing sectors are very relevant in China (30.30%) and also Korea (23.28%), while the sectors that fall under the "Rest" heading (agriculture, mining and quarrying, energy and construction) are relatively

<sup>24</sup> The figure represents five ICT sub-sectors instead of the six for which the database offers information. It combines *Manufacture of computers and peripheral equipment* with *Manufacture of consumer electronics* in order to make the information more easily readable.  
<sup>25</sup> Data for Canada refers to 2010.  
<sup>26</sup> Data for Japan refers to 2010.

more significant in Norway (42.56%), Russia (36.95%) and India (34.01%). A comparison of the EU and the US reveals the main difference as the relatively higher share in the US of non-ICT services and the lower share of the “Rest” component, together with the higher share of the ICT sector already highlighted.

**Figure 53: ICT sector value added share of GDP and comparison with non-ICT economic activities. European Union and other economies (2011)**



Note: 2010 for Canada and Japan. Non-ICT service industries include total Trade.

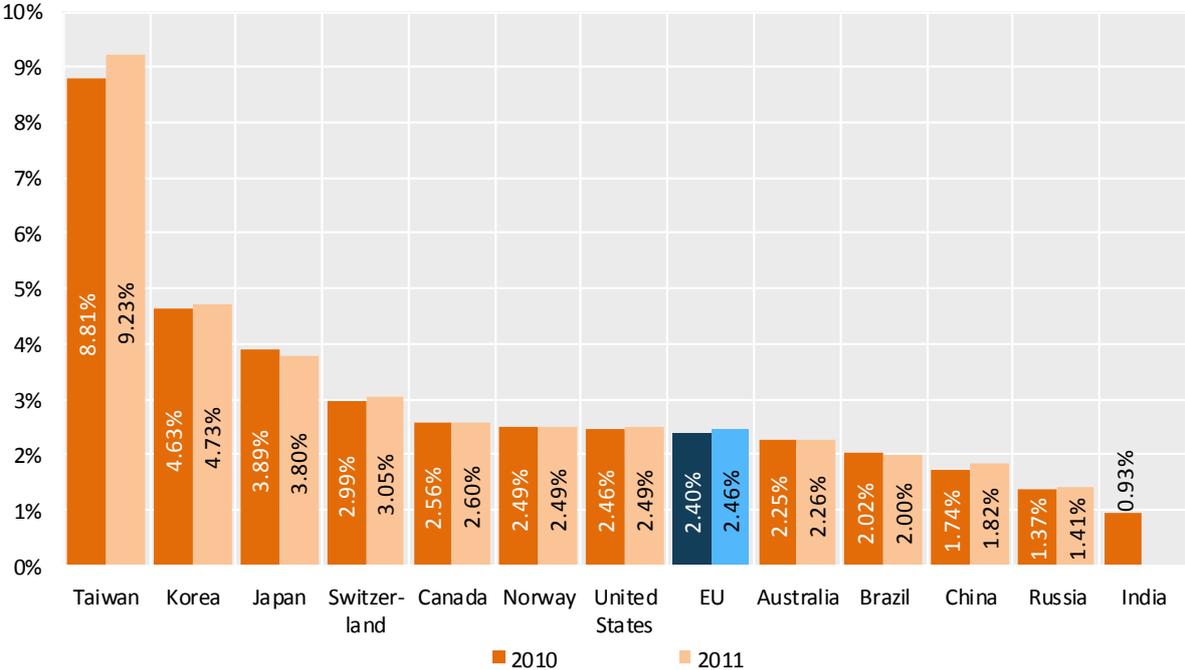
Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

## 4.2 ICT sector employment and ICT sector labour productivity

### 4.2.1 ICT sector employment

Figure 54 plots the ICT sector employment share of total employment. The picture reveals not so different findings from that for value added. Taiwan, Korea, and Japan are, again, the countries with the highest shares of ICT. The first two countries, and especially Taiwan, increased this share in 2011 compared to 2010. On the other hand, the EU had a similar share (2.46%) to Norway and the United States (2.49% for both of them).

**Figure 54: ICT sector employment share of total employment for the European Union and other economies (2010, 2011)**

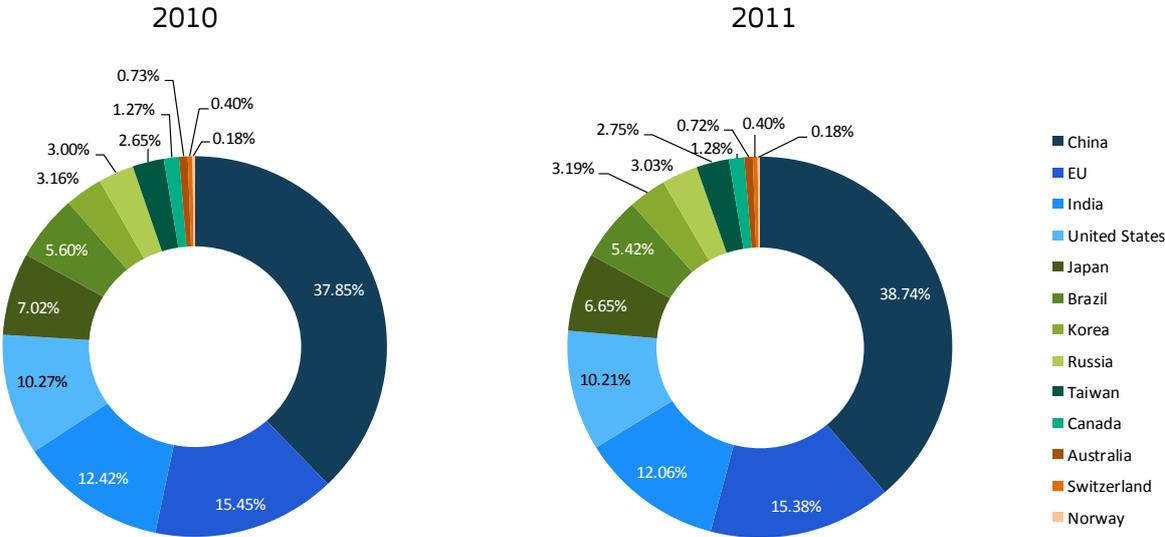


Note: 2011 data were not available for India.  
 Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

Figure 55 shows each country’s contribution to the aggregated employment of the thirteen selected countries.<sup>27</sup> Now the picture is rather different from that obtained for VA (Figure 51). The highest contribution to total ICT sector employment in 2011 corresponded to China (38.74%), followed at a large distance by the EU (15.38%, less than half of China’s contribution), India (12.06%), the United States (10.21%) and Japan (6.65%). The sum of these five shares amounts to 83.04% of ICT sector employment. It is interesting to recall that the share of the ICT sector in the EU represented 25.08% in terms of ICT aggregate VA, but only 15.38% in terms of ICT aggregated employment. For the US the gap is even more striking: 30.51% for VA and 10.21% for employment. On the other hand, the contribution of the different countries to aggregated ICT sector employment remained practically constant between 2010 and 2011, which was not the case for VA (see Figure 51).

<sup>27</sup> Recall that the information for India refers to 2010 instead of 2011.

**Figure 55: Distribution of ICT sector employment among the European Union and other economies (2010, 2011)**

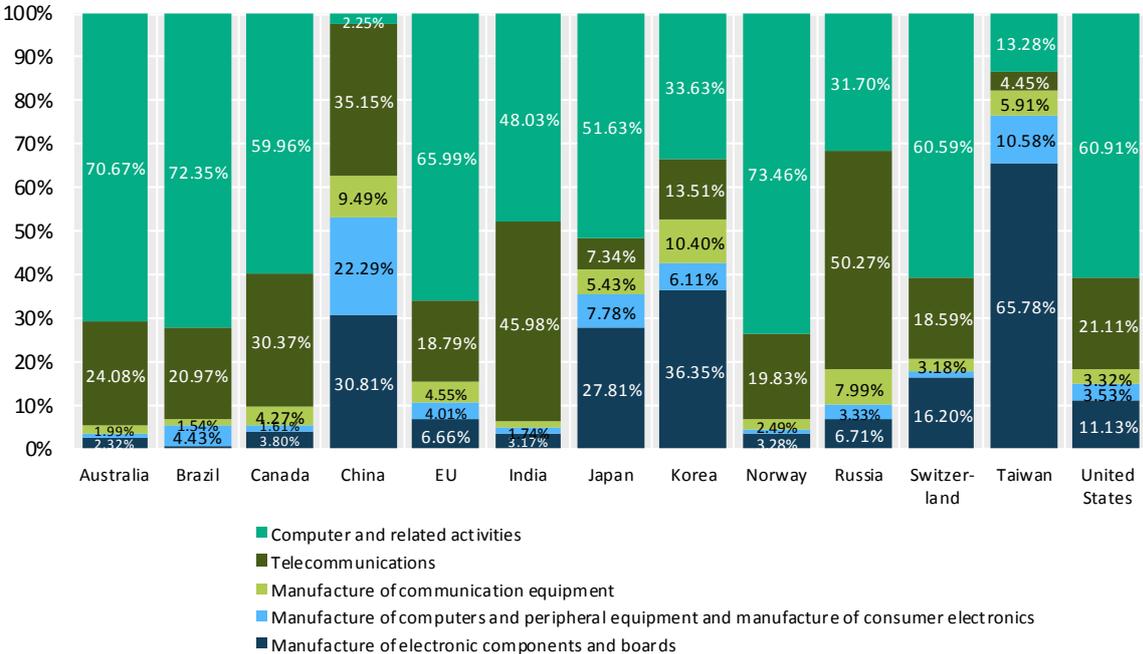


Note: 2010 for India for both years.  
 Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

Figure 56 plots the shares of the employment in five ICT sub-sectors on total ICT sector employment. The picture it reveals is similar to that provided by Figure 52, which gave the same information but in reference to VA rather than employment. As before, three ICT sub-sectors show the highest share: *Manufacture of electronic components and boards*, which is especially relevant for four Asian countries –Taiwan, Korea, China and Japan– and also for Switzerland. *Telecommunications* has a high share in total ICT sector employment in almost all countries, but it is especially high in India<sup>28</sup> and Russia. The *Computer and related activities* sub-sector is very relevant for Norway, Brazil and Australia, while for Taiwan and China the contribution of *Manufacture of computers and peripheral equipment and manufacture of consumer electronics* is also relevant. The main difference to emerge in a comparison of the EU and the US is the relatively high US share of the *Telecommunications* sub-sector and the low share of *Computer and related activities*, together with the higher share of *Manufacture of electronic components and boards*.

<sup>28</sup> Recall that the information for India refers to 2010 instead of 2011.

**Figure 56: Distribution of ICT sector employment by manufacturing and services sub-sectors for the European Union and other economies (2011)**

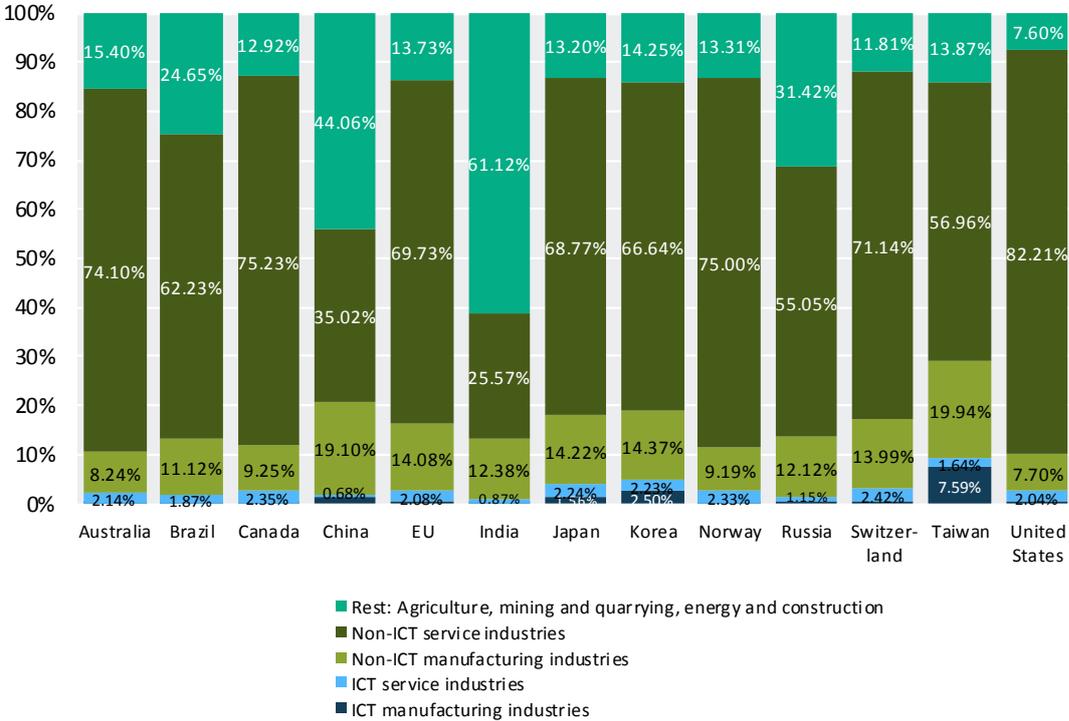


Note: 2010 for India.

Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

Figure 57 shows the distribution of total employment between ICT and non-ICT activities, as well as between manufacturing and services. The image this figure provides is very different from Figure 53, which contained similar information but for VA rather than employment. Generally speaking, in developed countries the contribution of non-ICT service industries VA to total GDP is lower than the contribution to total employment. For instance, in the EU the contribution of non-ICT service industries to GDP amounted to 61.79%, while for employment the percentage was 69.73%. A similar difference can be observed in the US with a 75.36% share in GDP, as compared with an 82.21% share in total employment. For less developed countries, and as expected, the contribution of the “Rest” industries (agriculture, mining and quarrying, energy and construction) is higher in terms of employment than in terms of GDP. This is especially true –also as expected– for India and China. The most notable fact when comparing the EU with the US is the higher share of non-ICT services industries and the lower share of non-ICT manufacturing industries in the US.

**Figure 57: Share of ICT sector employment in total employment and comparison with non-ICT economic activities. European Union and other economies (2011)**



Note: 2010 for India. Non-ICT service industries include total Trade.

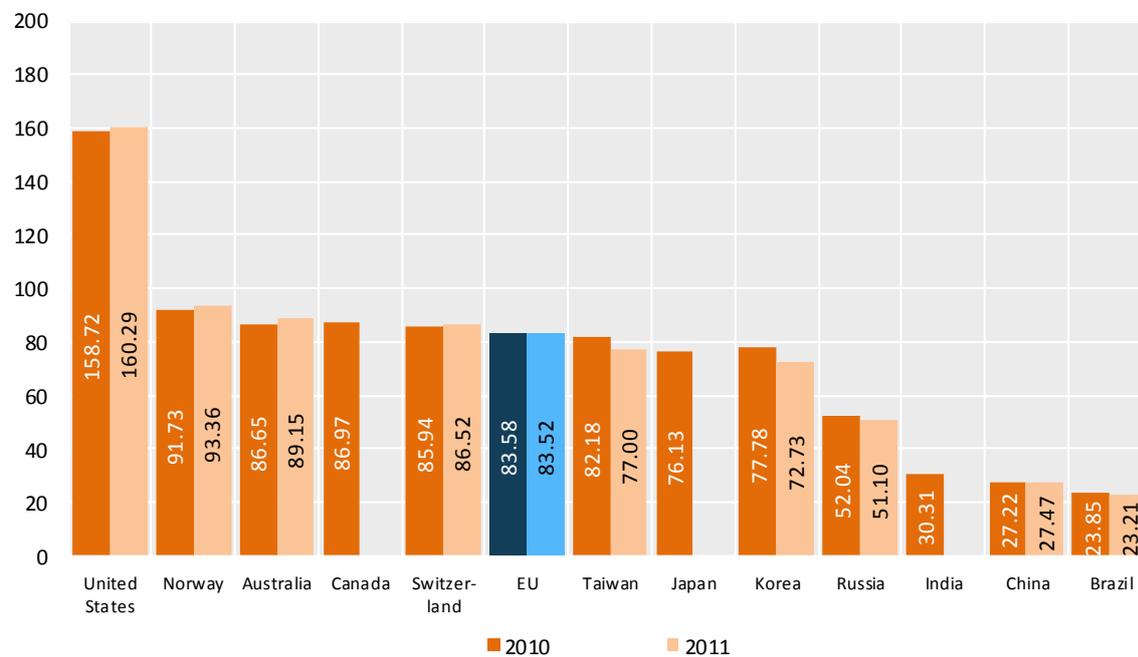
Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

### 4.2.2 ICT sector labour productivity

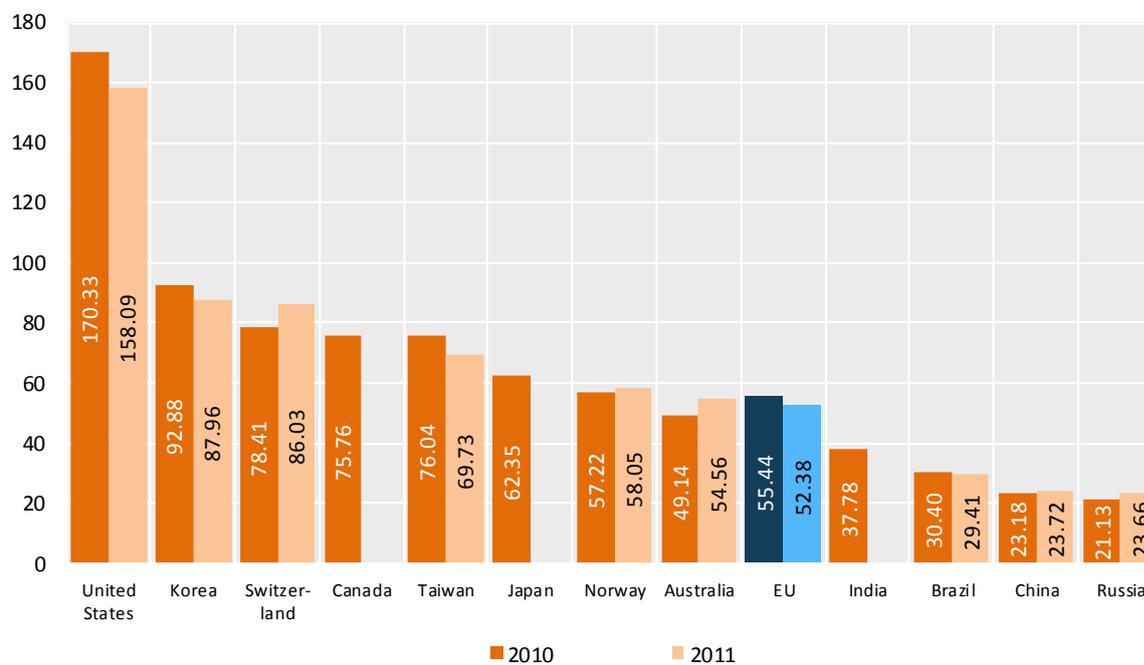
The profiles followed by GDP and employment in the different countries and sectors have their counterpart in the levels of labour productivity achieved, since this variable is the ratio between the two. Figure 58 shows the levels of labour productivity in the ICT sector (panel a), ICT manufacturing (panel b) and ICT services (panel c), expressed in thousands of euros PPS per worker. Now the picture is rather different from what we have reported in the previous sections. The United States leads in total ICT sector labour productivity, ICT manufacturing and ICT services. Norway lies in second position –due to its more productive ICT service sector – followed by Australia. Brazil, China, India and Russia can be found at the opposite side of the spectrum; while the three large ICT countries –Taiwan, Korea and Japan– have lower ICT sector labour productivity levels than the EU average.

**Figure 58: ICT sector labour productivity for the European Union and other economies (thousand EUR PPS per person; 2010, 2011)**

**a) ICT total**

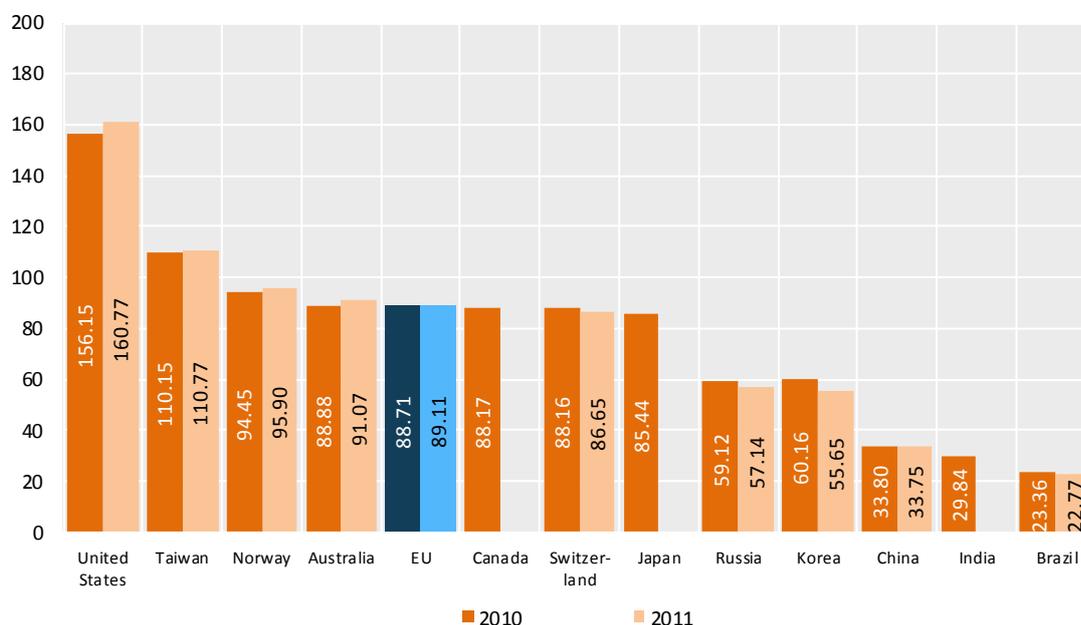


**b) ICT manufacturing**



**Figure 58 (cont.): ICT sector labour productivity for the European Union and other economies (thousand EUR PPS per person; 2010, 2011)**

c) ICT services



Note: 2010 data were not available for Canada, India and Japan.

Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

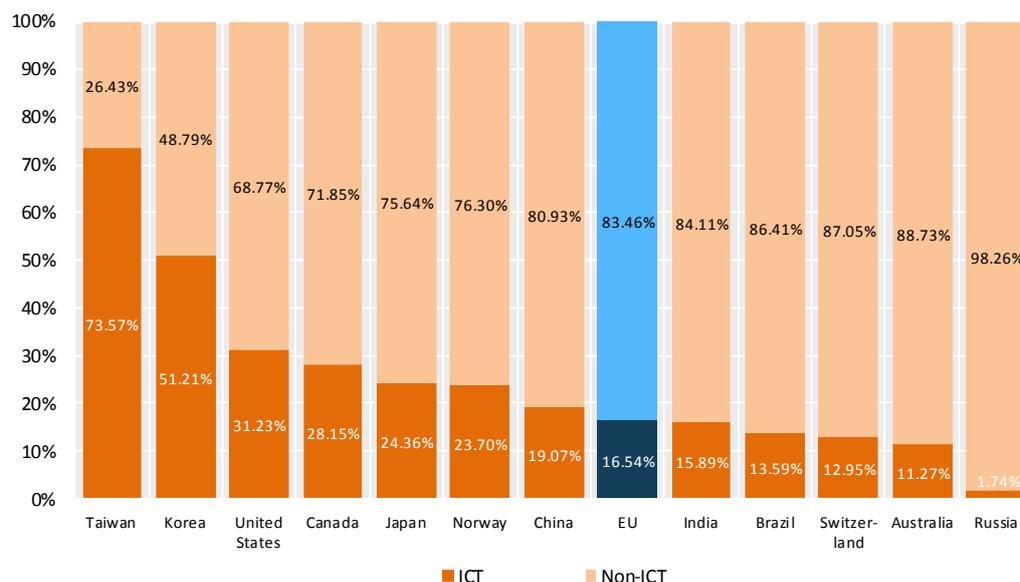
### 4.3 ICT sector business enterprise expenditure on R&D (ICT BERD)

Business enterprise expenditure on R&D (BERD) is very unevenly distributed among ICT and non-ICT sector in the countries investigated. As Figure 59 shows, in 2011, more than 70% of total BERD (73.57%) in Taiwan was devoted to the ICT sector, 51.21% in Korea and 31.23% in the US. In the EU the share was around half of that of the US (16.54%), and it was even lower in India (15.89%).<sup>29</sup> The other countries recorded different ratios: Brazil (13.59%), Switzerland (12.95%), Australia (11.27%) and Russia (1.74%).

ICT BERD is much more concentrated in a small number of countries than VA or employment. According to the information provided in Figure 60, 41.13% of total ICT BERD of the thirteen countries considered was made in the United States in 2011. The EU follows –but at a large distance – representing 16.89% of the total, close to the 16.80% contribution of Japan, and the even smaller Chinese and Korean contribution (8.69% and 7.91%, respectively). When Taiwan (3.37%) is also considered, these six countries represent 94.79% of total ICT BERD undertaken by the thirteen countries under consideration. Note also that while the contributions of the US, the EU and Switzerland decreased between 2010 and 2011, those of Taiwan, Korea and China increased.

<sup>29</sup> The figures for China, India and Russia should be interpreted with caution since the available information is scarce and not fully comparable. In the three countries the correspondence between the sector classification and the one followed in the PREDICT methodology is an approximation. Many sectors are estimated as there is not enough available official disaggregation. In China, for sectors 63 and 58 Korean weights are used. In India, for sectors 63 and 58 United Kingdom's weights are used. In Russia, only GERD (Gross domestic Expenditure on Research and Development) data are available, so this structure is applied to total BERD in order to estimate the sub-sectors. Besides, the Russian sector classification uses NACE Rev 1.1 and not NACE 2, so the sectoral correspondence is not exact.

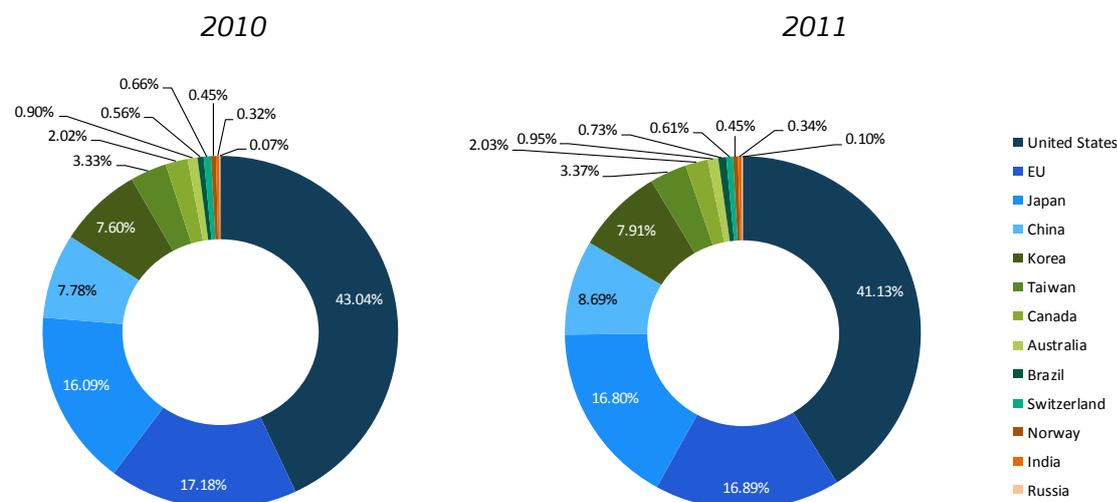
**Figure 59: Share of ICT and non-ICT BERD for the European Union and other economies (2011)**



Note: 2008 for Brazil and Switzerland.

Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

**Figure 60: Distribution of ICT BERD among the European Union and other economies (2010, 2011)**



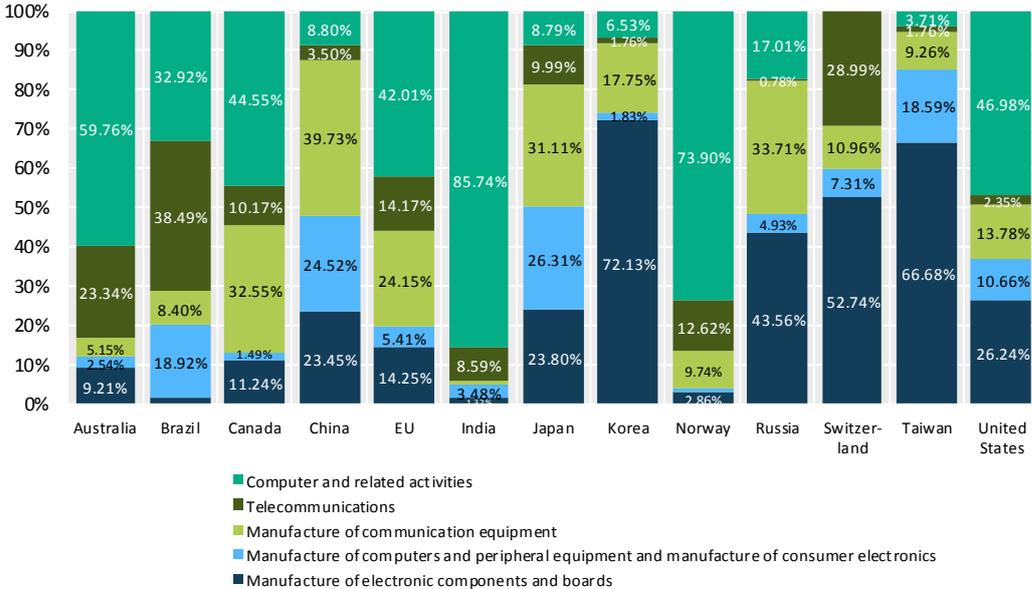
Note: 2008 for Switzerland for both years.

Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

Figure 61 plots the distribution of ICT BERD between ICT manufacturing and services sub-sectors in 2011. Now all the sub-sectors appear almost equally relevant in one way or another. *Manufacture of electronic components and boards* is very relevant for Korea, Taiwan, Switzerland, Russia, and to a lesser extent for the US and China. *Manufacture of computers and peripheral equipment*, together with *Manufacture of consumer electronics*, is relevant for Brazil, Taiwan, Japan, China, and to a lesser extent for the United States. *Manufacturing of communication equipment* has a high share in ICT BERD in the EU, Japan, Canada, China and Russia. For *Telecommunications* the highest shares are reflected for Brazil, Switzerland and Australia. Finally, *Computer and related activities* have a

very high presence in India, Norway and Australia. Overall, ICT BERD is more evenly distributed than ICT VA or ICT sector employment among the ICT sub-sectors. The main differences between the EU and the US is that the latter has a much higher share of *Manufacture of electronic components and boards* and *Manufacture of computers and peripheral equipment*, and a lower share in *Manufacture of communication equipment* and *Telecommunications*.

**Figure 61: Distribution of ICT BERD by manufacturing and services sub-sectors for the European Union and other economies (2011)**



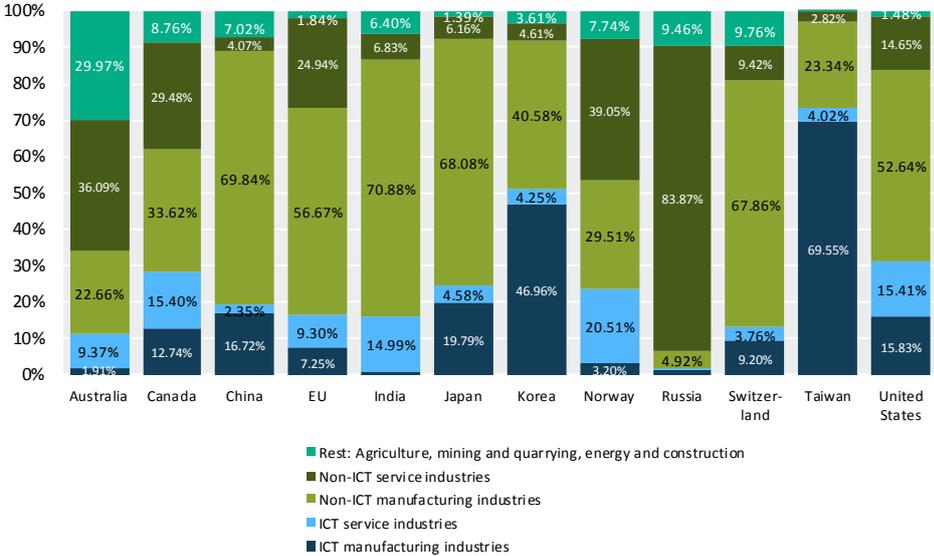
Note: 2008 for Switzerland.

Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

The distribution of ICT BERD by ICT and non-ICT sub-sectors, and between manufacturing and service industries, is shown in Figure 62.<sup>30</sup> As already highlighted, BERD in ICT manufacturing industries is very high in Taiwan and Korea and it is relatively higher in Japan, China and the US than in the other countries. BERD in non-ICT manufacturing industries is very important in all countries, except for Russia, but it is especially high in Japan, Switzerland, India and China. When the EU and the US are compared the most notable fact is the lower US share of non-ICT industries – both manufacturing and services– and thus, the higher share of ICT industries.

<sup>30</sup> Information for Brazil is not available due to lack of data for BERD in the service sector.

**Figure 62: ICT BERD share of total BERD and comparison with non-ICT economic activities. European Union and other economies (2011)**



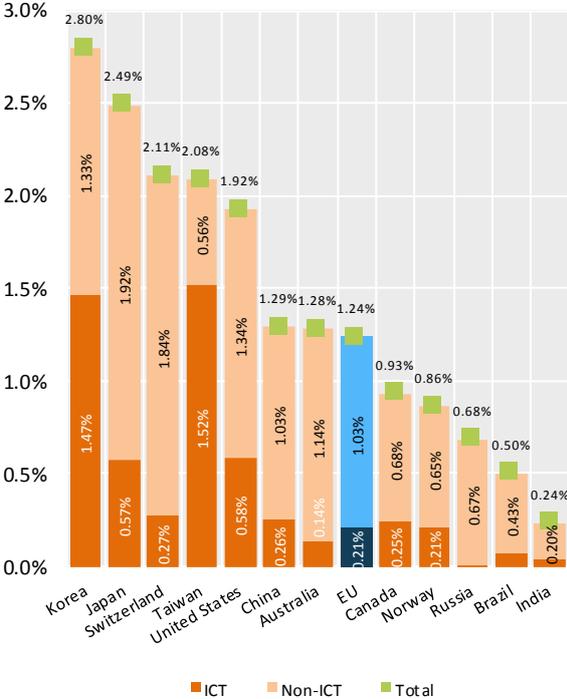
Note: 2008 for Switzerland. Data were not available for Brazil. Non-ICT service industries include total Trade.

Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

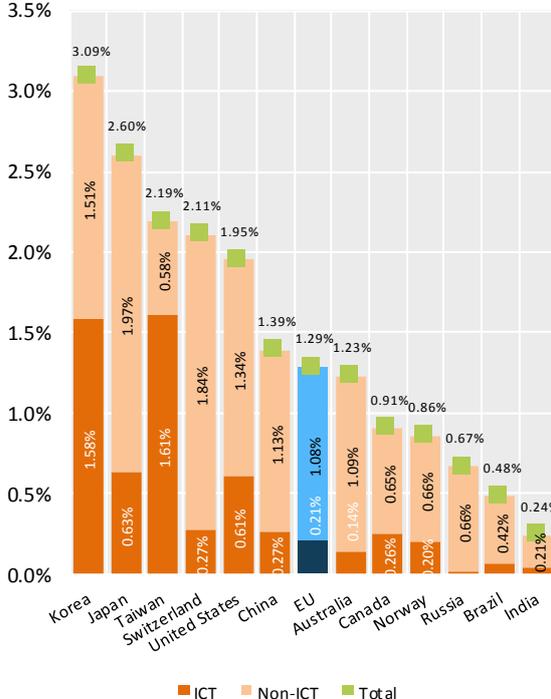
BERD intensity measures the weight of BERD in GDP. Figure 63 plots the BERD/GDP ratio for the years 2010 and 2011, distinguishing between ICT and non-ICT sector. The order of the countries remained almost constant in both years, with the exception of Switzerland and Taiwan, and Australia and the EU, which switched places between 2010 and 2011. The highest BERD intensity corresponded to Korea (3.09%) in 2011, and three other countries had BERD/GDP ratios above 2%: Japan (2.60%), Taiwan (2.19%) and Switzerland (2.11%). For the EU the corresponding figure was 1.29%, and in the US 1.95%. As expected, ICT BERD intensity was relatively very high in Taiwan and Korea, followed, at a significant distance, by the US and Japan. ICT BERD intensity accounted for a 0.21% in the EU, as compared with 1.58% in Korea and 1.61% in Taiwan, or 0.61% and 0.63% in the US and Japan, respectively.

**Figure 63: Contribution of ICT and non-ICT BERD to total BERD intensity (BERD/GDP). European Union and other economies (2010, 2011)**

**a) 2010**



**b) 2011**

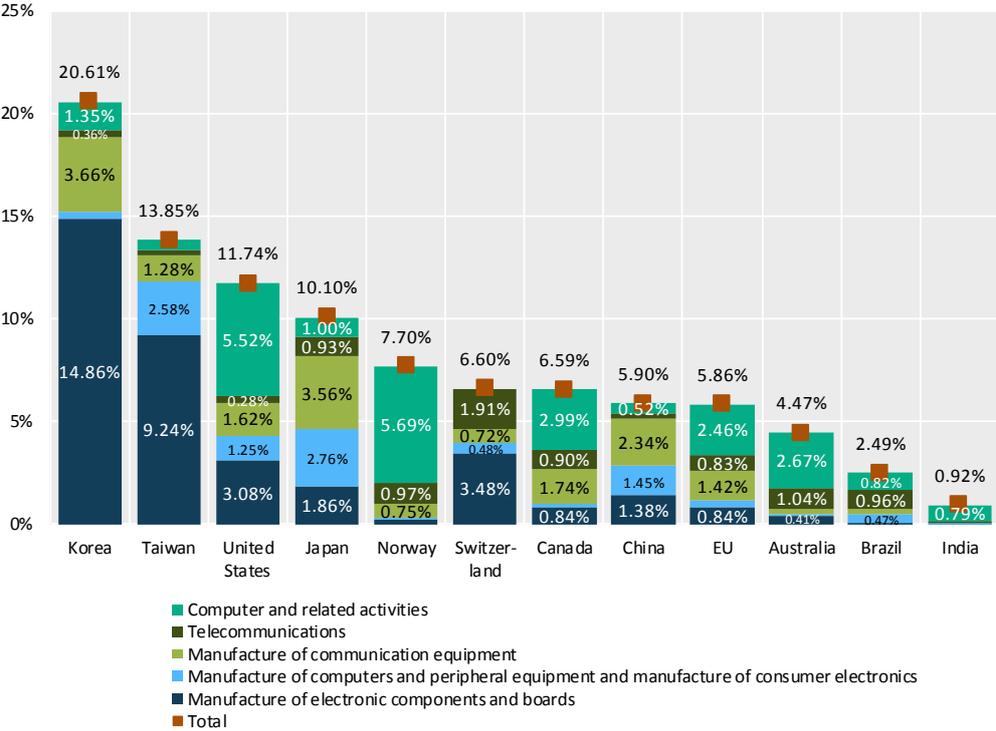


Note: 2008 for Switzerland for both years.

Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

Figure 64 plots ICT BERD intensity (ICT BERD/ICT VA) for the total ICT sector as well as for each of the five sub-sectors considered. As in the previous cases, Korea and Taiwan also stand out for this variable. ICT BERD intensity in Korea reached 20.61% in 2011, followed by Taiwan (13.85%) and the US (11.74%). Japan (10.10%) came next while the figure for the EU was 5.86%. Again, in Korea and Taiwan the sector with the highest ICT BERD intensity is *Manufacture of electronic components and boards*. This sub-sector is also important for Switzerland, Japan and the US. *Computer and related activities* is the most prominent sub-sector in the US, Norway and Australia. This sub-sector also has the highest ICT BERD intensity in the EU, followed by *Manufacture of communication equipment*.

**Figure 64: Contribution of ICT sub-sectors to ICT BERD intensity (ICT BERD/ICT VA). European Union and other economies (2011)**



Note: 2008 for Brazil. 2010 for Canada and Japan.

Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

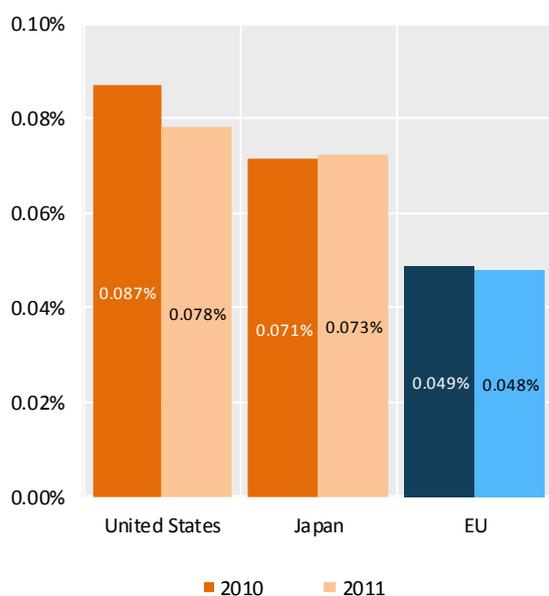
#### 4.4 Public funding of ICT R&D

Figure 65 shows ICT GBAORD as the share in GDP and in total GBAORD for the EU, Japan<sup>31</sup> and the United States in 2010 and 2011. In both years, the US and Japan led, with shares in total GDP of 0.078% and 0.073% in 2011, followed by the EU at a certain distance (0.048%). Regarding the share of ICT GBAORD with respect to total GBAORD in 2011, both Japan (9.37%) and the US (8.18%) were above the EU (6.63%), although in this case the difference is not as big as with the share in total GDP.

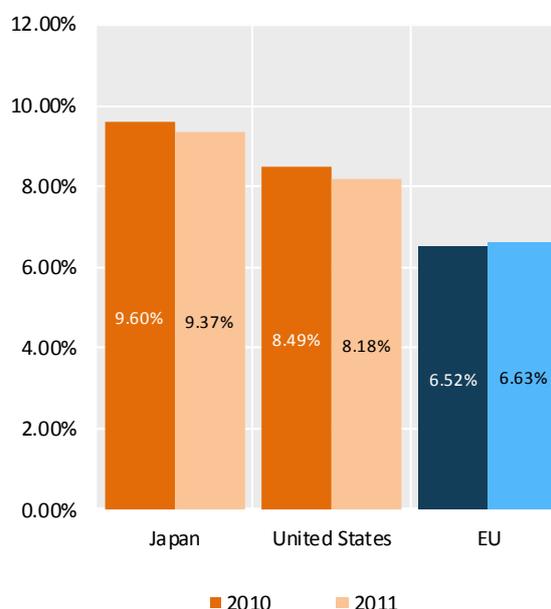
<sup>31</sup> Methodology for Japan is not fully homogeneous with the EU and the US due to lack of equivalent high level data disaggregation.

**Figure 65: Share of ICT GBAORD in GDP and total GBAORD for the European Union, the United States and Japan (2010, 2011)**

**a) Share in GDP**



**b) Share in total GBAORD**



Note: Figures for Japan not fully homogeneous with the EU and the United States (see methodology).

Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

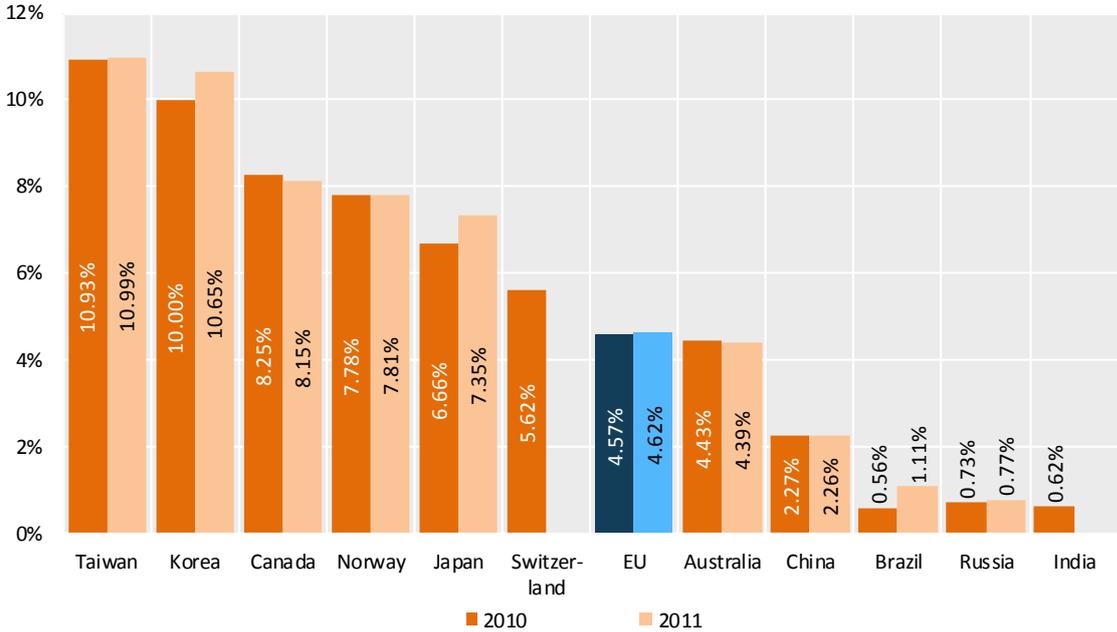
## 4.5 ICT sector R&D personnel<sup>32</sup>

Figure 66 plots the share of ICT sector R&D personnel (expressed in full-time equivalent terms) in total ICT sector employment (expressed in terms of headcounts). As in many other variables already reviewed, Taiwan and Korea take the lead. In Taiwan the share of ICT sector R&D personnel amounted to 10.99% in 2011, and in Korea it was 10.65%. It is interesting to note the high share for Canada (8.15%), and also for Norway (7.81%). By contrast, in the EU the equivalent percentage was less than half, 4.62%. Note that Taiwan, Korea,<sup>33</sup> Japan, Norway, but also the EU, showed increases in the ICT personnel ratio between 2010 and 2011.

<sup>32</sup> Data limitations impede inclusion of information for the ICT personnel variable for the US. Although the *Survey of Industrial Research and Development (SIRD)* and *Business R&D and Innovation Survey (BRDIS)* offer domestic R&D employment figures, these are not comparable with the definition of FTE R&D personnel used by OECD and Eurostat (following Frascati Manual), since they only include R&D scientists and engineers.

<sup>33</sup> As for the BERD variable, the figures for China, India, Russia, and also Korea should be interpreted with caution since the available information is scarce and not fully comparable. Chinese, Korean and Russian data are estimated (see methodological notes).

**Figure 66: ICT sector R&D personnel (FTE) share of total ICT sector employment for the European Union and other economies (2010, 2011)**



Note: 2011 data were not available for India and Switzerland . 2010: 2008 for Brazil and Switzerland. Data were not available for the United States.

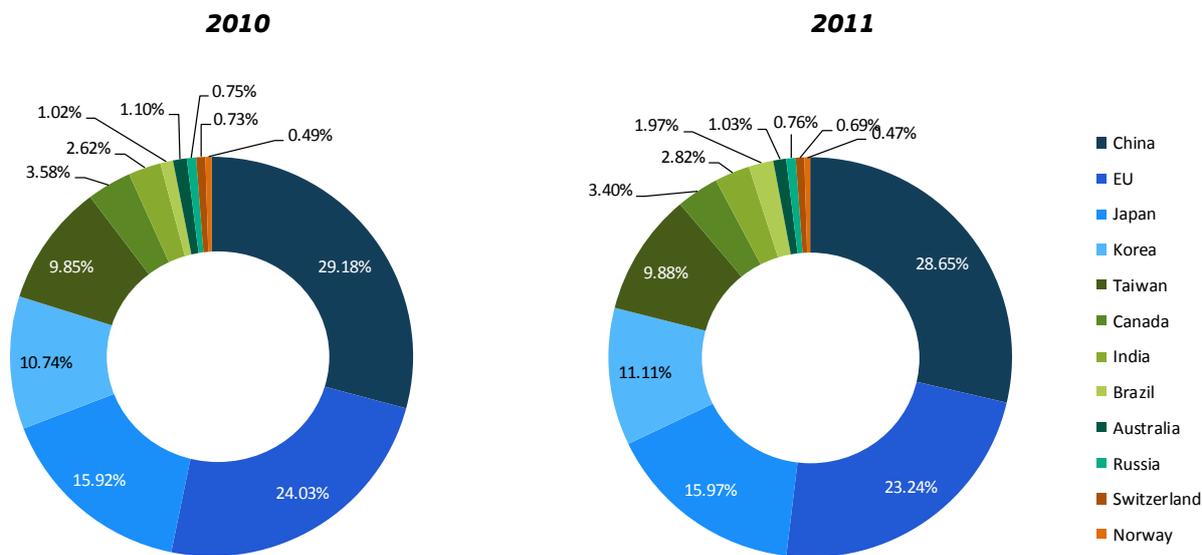
Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

The absence of reliable data for the US limits the interest of the information in Figure 67, which shows the contribution of the twelve remaining countries to total ICT sector R&D personnel (excluding the US). For those countries the EU presents the second highest share in 2011, only behind China, followed by Japan, Korea, Taiwan and Canada. China, the EU and Canada decreased its share between 2010 and 2011, whereas the other three leading countries, Japan, Korea and Taiwan, gained weight.

The ICT and non-ICT share of total R&D personnel is shown in Figure 68. Taiwan (68.40% of R&D personnel assigned to the ICT sector) and Korea (48.06%) are the leading countries. Japan (29.17%), Norway (28.25%), Canada (26.66%), Brazil (21.01%) and Switzerland (18.91%) have higher shares than the EU (18.69%).

Finally, Figure 69 shows the distribution of ICT sector R&D personnel in manufacturing and services sectors. The overwhelming superiority of manufacturing in the Asian countries is striking, but the position of Russia and Switzerland is also noteworthy. 91.75% of Taiwan’s ICT sector R&D personnel worked in manufacturing, the share was also high in Russia (89.02%), Japan (84.64%), China (83.71%) and Korea (80.47%). Compared with these percentages the share of ICT sector R&D personnel in the EU ICT manufacturing sector is very modest (31.73%). These figures again highlight the prominence of the ICT sector in the Asian countries –especially in their manufacturing sub-sectors– and the opposite situation of the EU, with a lower presence of the ICT sector, and its higher specialisation in ICT service sub-sectors.

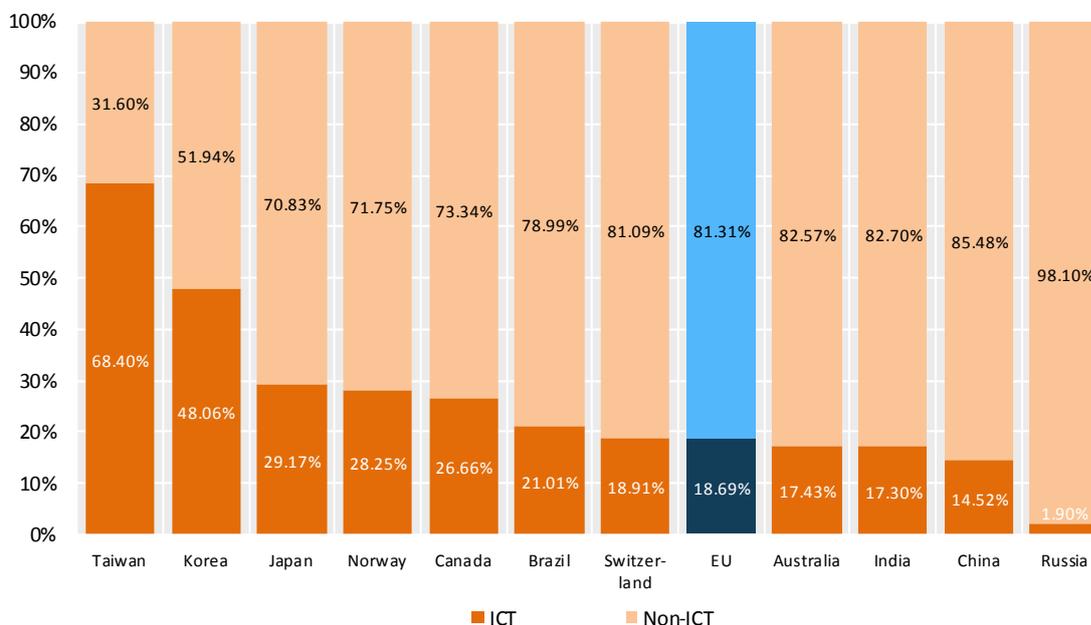
**Figure 67: Distribution of ICT sector R&D personnel (FTE) among the European Union and other economies (2010, 2011)**



Note: 2008 Switzerland for both years. 2008 for Brazil for 2010. Data were not available for the United States.

Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

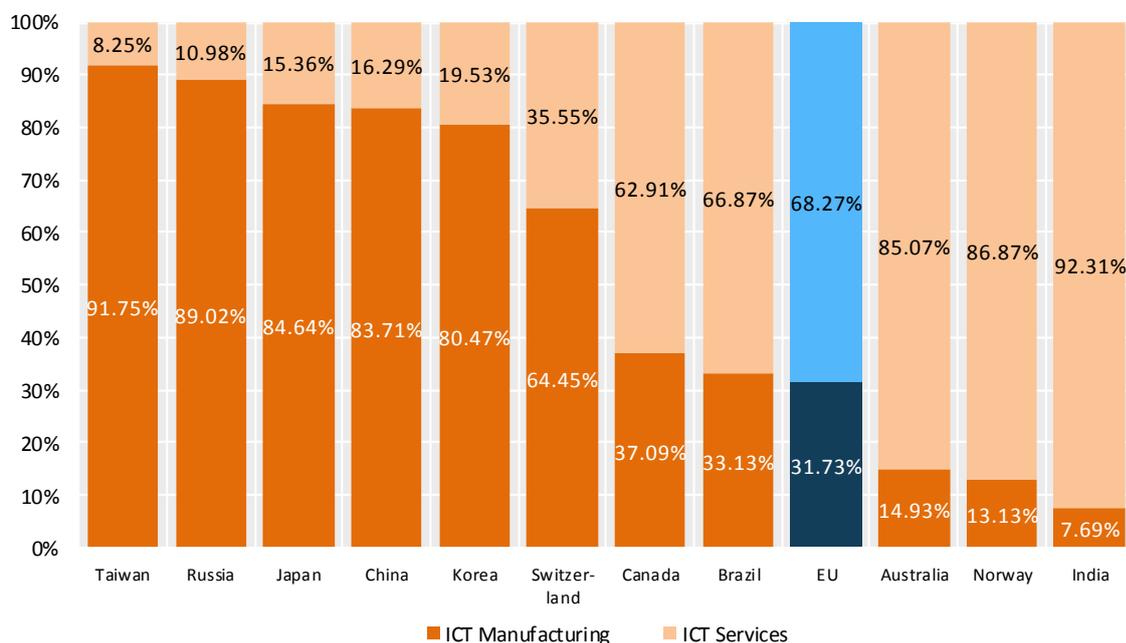
**Figure 68: Share of ICT and non-ICT sector R&D personnel (FTE) for the European Union and other economies (2011)**



Note: 2008 for Switzerland. Data were not available for the United States.

Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

**Figure 69: Distribution of ICT sector R&D personnel (FTE) by manufacturing and services for the European Union and other economies (2011)**



Note: 2008 for Switzerland. Data were not available for China, India and the United States.

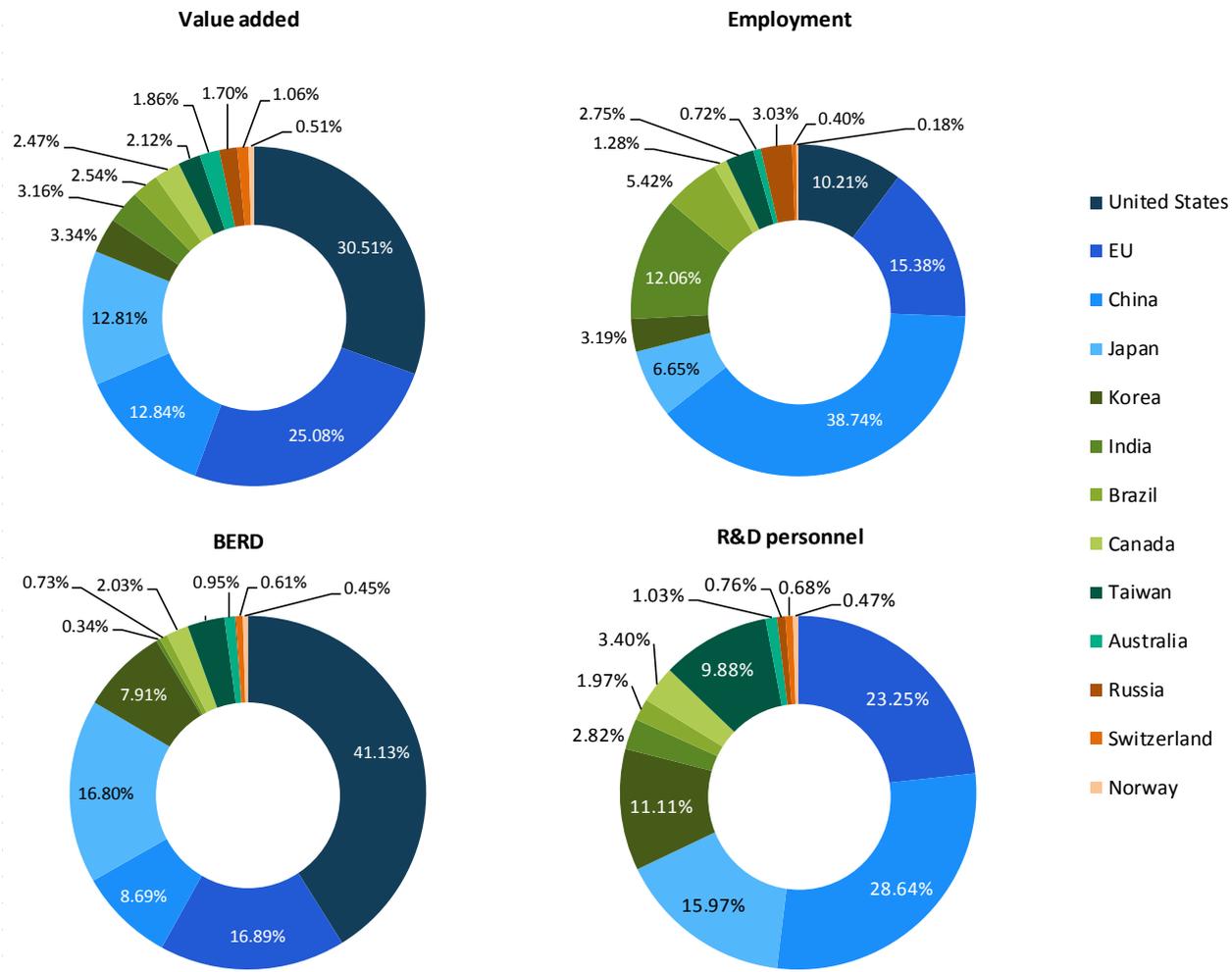
Source: See methodology (hyperlink), elaborated by Ivie and JRC-IPTS.

## 4.6 Comparison of indicators and data summary

Figure 70 summarizes ICT sector value added, employment, BERD and R&D personnel in terms of the countries' contributions in 2011.

- The US enjoyed the highest share in ICT VA (30.51%) in 2011, followed by the EU (25.08%), China (12.84%), Japan (12.81%) and Korea (3.34%). These five players together represent 84.59% of the total ICT VA produced by the thirteen countries selected.
- In terms of ICT sector employment, the picture is rather different from that obtained for ICT VA. The highest contribution to total ICT sector employment in 2011 corresponded to China (38.74%), followed by the EU (15.38%, less than half of China's contribution), India (12.06%), the United States (10.21%) and Japan (6.65%). The sum of these five shares amounts to 83.04% of ICT sector employment in the thirteen countries analysed.
- The share of the ICT sector in the EU represents 25.08% in terms of ICT aggregate VA, but only 15.38% in terms of ICT sector employment. For the US the gap is even more striking: 30.51% for VA and 10.21% for employment.
- ICT BERD is much more concentrated in a small number of countries than value added or employment: 41.13% of total ICT BERD is made in the United States. The EU follows representing 16.89% of the total, close to the 16.80% contribution of Japan, and the even smaller contribution of China (8.69%) and Korea (7.91%). These five countries represent 91.42% of total ICT BERD undertaken by the thirteen countries under consideration.
- The absence of reliable data for the US limits the interest of the information of the contribution of the twelve remaining countries to total ICT sector R&D personnel (excluding the US). For those countries the EU presents the second highest share in 2011, only behind China, followed by Japan, Korea, Taiwan and Canada.

**Figure 70: Comparison of ICT sector value added, employment, R&D personnel and BERD for other economies and the EU (2011)**



Note: ICT totals correspond to the operational definition of ICT sector.

Value added: Value added: 2010 for Canada and Japan. Employment: 2009 for India. R&D personnel and BERD: 2008 for Switzerland. Data not available for R&D personnel for the United States.

Source: Eurostat, elaborated by Ivie and JRC-IPTS.

Finally, Table 5 presents the main variables analysed in this chapter.

**Table 5: Summary table of ICT indicators for the European Union and other economies (2011)**

ICT total:	ICT sector Value added	ICT sector Employment	ICT sector BERD	ICT GBAORD	ICT sector R&D personnel
	(Millions of current EUR)	(thousand persons employed)	(Millions of current EUR)	(Millions of current EUR)	(thousand full-time equivalent)
European Union	462,016.93	5,531.84	27,092.39	5,961.96	255.64
United States	562,067.83	3,670.67	65,988.18	8,695.56	0.00
Japan	235,986.21	2,391.09	26,945.29	3,270.62	175.68
Norway	9,366.47	65.55	721.15	-	5.12
Switzerland	19,462.15	144.69	977.70	-	7.53
Australia	34,238.11	257.90	1,531.85	-	11.31
Brazil	46,833.73	1,950.22	1,165.99	-	21.71
Canada	45,413.02	459.23	3,264.30	-	37.44
China	236,545.35	13,935.10	13,947.30	-	315.06
India	58,169.58	4,338.65	537.83	-	31.06
Korea	61,558.29	1,147.33	12,686.22	-	122.22
Russia	31,301.85	1,088.63	158.57	-	8.37
Taiwan	38,992.31	988.18	5,402.25	-	108.64

*Note:* ICT totals correspond to the operational definition of ICT sector.

Value added: 2010 for Canada and Japan. Employment: 2010 for India. R&D personnel and BERD: 2008 for Switzerland. Data not available for R&D personnel for the United States.

*Source:* Eurostat, elaborated by Ivie and JRC-IPTS.

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## List of abbreviations used

BERD:	Business Expenditure on Research and Development
BRDIS:	Business R&D and Innovation Survey
DG CONNECT:	Directorate General for Communications Networks, Content and Technology
EU:	European Union
EUR:	Euros
Eurostat:	<i>Statistical Office of the European Communities</i>
FTE:	Full-time equivalent
GBAORD:	Government Budget Appropriations or Outlays on Research and Development
GDP:	Gross domestic product
GERD:	Gross domestic Expenditure on Research and Development
ICT:	Information and Communication Technologies
ISIC:	International Standard Industry Classification
Ivie:	Valencian Institute of Economic Research
JRC-IPTS:	Institute for Prospective Technological Studies
MS:	Member State
NACE:	Nomenclature statistique des activités économiques dans la Communauté européenne
OECD:	Organisation for Economic Co-operation and Development
PPS:	Purchase Power Standard
PREDICT:	Prospective Insights on R&D in ICT
R&D:	Research and Development
SIRD:	Survey of Industrial Research and Development
SNA:	System of National Accounts
US:	United States
VA:	Value added

## List of definitions

**BERD:** Intramural expenditures on R&D performed within business enterprise sector during a specific period, whatever the source of funds (Frascati Manual).

**BERD intensity:** BERD/GDP.

**Business R&D personnel:** All persons employed directly on R&D by business enterprise sector, as well as those providing direct services such as R&D managers, administrators and clerical staff. Those providing indirect services, such as canteen and security staff, should be excluded (Frascati Manual).

**Business R&D researchers:** Business enterprise sector's professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned (Frascati Manual).

**Full-time equivalent (FTE):** A full-time equivalent corresponds to one year's work by one person. Consequently, someone who normally spends 40% of his or her time on R&D and the rest on other activities (e.g. teaching, university administration or counselling) should be counted as only 0.4 FTE.

**Employment:** Number of persons employed. In the SNA is defined as all persons, both employees and self-employed, engaged in some productive activity that falls within the production boundary of the SNA and that is undertaken by a resident institutional unit.

**GBAORD:** Government Budget Appropriations or Outlays on Research and Development are a way of measuring government support for research and development activities. GBAORD include all appropriations (government spending) given to R & D in central (or federal) government budgets. Provincial (or State) government posts are only included if the contribution is significant. Local government funds are excluded.

**GDP:** Measures the total final market value of all goods and services produced within a country during a given period. GDP is the most frequently used indicator of economic activity and is most often measured on an annual or quarterly basis to gauge the growth of a country's economy between one period and another.

**GERD:** Gross domestic expenditure on research and development (GERD) is total intramural expenditure on research and development performed on the national territory during a given period.

**GDP deflator:** Implicit price deflator for GDP is calculated as GDP at current prices divided by GDP at "constant prices" (chained volume estimates or fixed-base volume estimates, depending on countries).

**ICT BERD intensity:** ICT BERD/ICT VA.

**ICT manufacturing industries:** Manufacture of electronic components and boards (NACE 261), Manufacture of computers and peripheral equipment (NACE 262), Manufacture of communication equipment (NACE 263), Manufacture of consumer electronics (NACE 264), Manufacture of magnetic and optical media (NACE 268).

**ICT sector comprehensive definition:** this definition is available mainly for EU Member States for the period 2008-2010. It corresponds to the definition given by the OECD in 2007. This definition includes ICT manufacturing industries, ICT trade industries and ICT services industries.

Data in accordance with this classification are not available for some non-EU countries. See OECD definition: <http://www.oecd.org/science/sci-tech/38217340.pdf>.

**ICT sector employment:** all employed people in the ICT sector definition given by the OECD in 2007.

**ICT sector operational definition:** this definition allows for an international comparison with non-EU countries over a longer period of time (2006-2011), as some of these countries do not have the necessary disaggregated information to estimate all the ICT sub-sectors included in the comprehensive definition. This definition takes into account the standard distinction between manufacturing and services, but does not include the following sectors: Manufacture of magnetic and optical media (268) and ICT trade industries (465). In addition, ICT services industries are only available for two sub-sectors: Telecommunication (61) and the aggregate Computer and related activities (5820, 62, 631, 951). See Technical report: <http://ftp.jrc.es/EURdoc/JRC77364.pdf>.

**ICT services industries:** Software publishing (NACE 5820), Telecommunications (NACE 61), Computer programming, consultancy and related activities (NACE 62), Data processing, hosting and related activities; web portals (NACE 631), Repair of computers and communications equipment (951).

**ICT trade industries:** Wholesale of computers, computer peripheral equipment and software (NACE 4651), Wholesale of electronic and telecommunications equipment and parts (NACE 4652).

**ICT total services:** ICT trade industries and ICT services industries.

**Labour productivity:** Is defined as value added per unit of labour input (persons employed).

**Member States:** Member States of the European Union up to 2012: 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, United Kingdom.

**New Member States:** 2004 and 2007 European Union Eastern enlargements consisting of Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia.

**Other economies:** countries included for the non-European comparison using the ICT sector operational definition (see definition above), consisting of: Australia, Canada, China, Brazil, India, Japan, Korea, Norway, Russia, Switzerland, Taiwan, United States.

**Purchasing Power Standard (PPS):** The artificial currency unit in which the PPPs and real expenditures for the European Union are expressed – namely, euros at average EU price levels. Euros at average EU price levels are euros that have the same purchasing power over the whole of the European Union. Their purchasing power is a weighted average of the purchasing power of the national currencies of EU Member States. As such they reflect the average price level in the European Union or, more precisely, the weighted average of the price levels of EU Member States. PPS are defined by equating the total real expenditure of the European Union on a specific basic heading, aggregation level or analytical category to the total nominal expenditure of the European Union on the same basic heading, aggregation level or analytical category.

**Value added:** In the SNA is defined as the value of output less the value of intermediate consumption; it is a measure of the contribution to GDP made by an individual producer, industry or sector.

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