



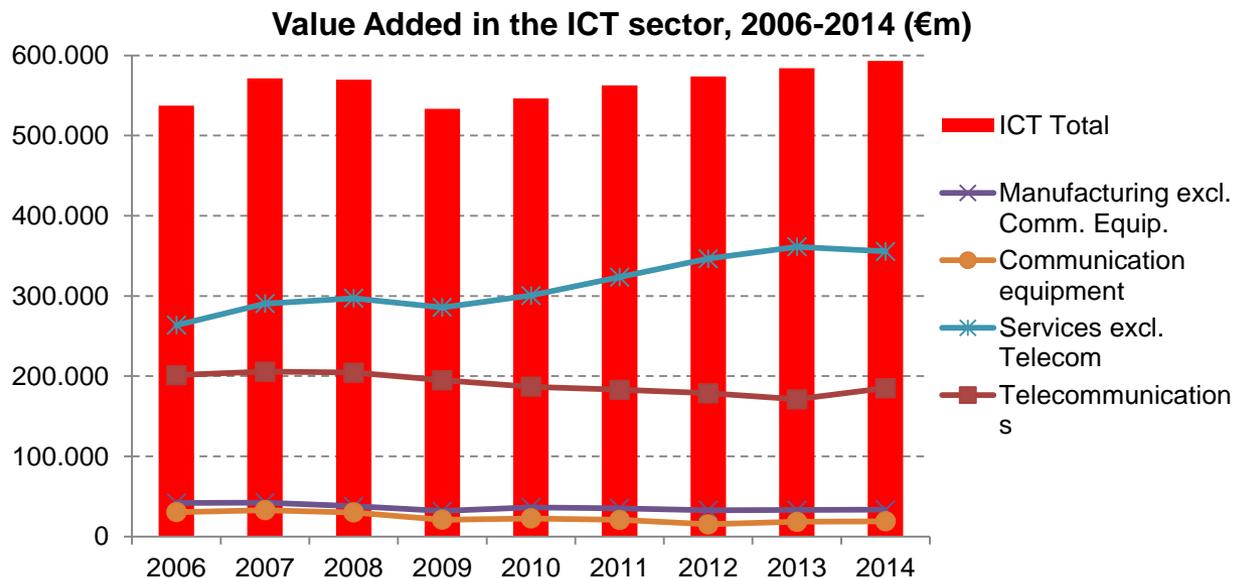
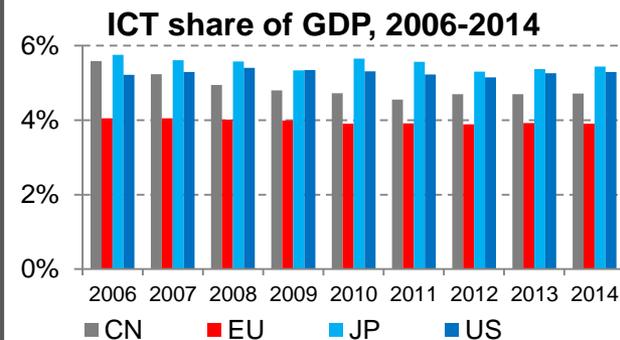
THE EU ICT SECTOR AND ITS R&D PERFORMANCE

The **Information and Communication Technologies (ICT)** sector value added amounted to EUR 593 billion in 2014. ICT services represented 91% of total ICT value added. ICT services (excluding telecoms) were the main sector and the only one to be expanding.

The EU ICT sector value added amounted to EUR 593 bn in 2014. After a slowdown in 2009, the ICT sector experienced a recovery. A breakdown by sub-sector shows the predominance of ICT services (EUR 541 bn and 91 % of total ICT value added in 2014) over ICT manufacturing industries (EUR 52 bn and 9 % of total ICT value added in 2014). The ICT services sector (excluding telecommunications) is the only one that saw an increase in value added over the medium-term period (2006-2014) up to EUR 356 bn. The communication equipment sector experienced the sharpest decline over the medium-term period (2006-2014). After peaking at EUR 33 bn in 2007, it fell to EUR 15 bn in 2012, but recovered to EUR 19 bn in 2014.

* See methodological note.

Value added in the ICT sector accounted for 4.2 % of EU GDP in 2014 (comprehensive definition*). However, according to the operational definition* which enables world comparisons, value added in the ICT sector in the EU (3.9 %) was behind Japan (5.4 %), the US (5.3 %) and China (4.7 %) in 2014.

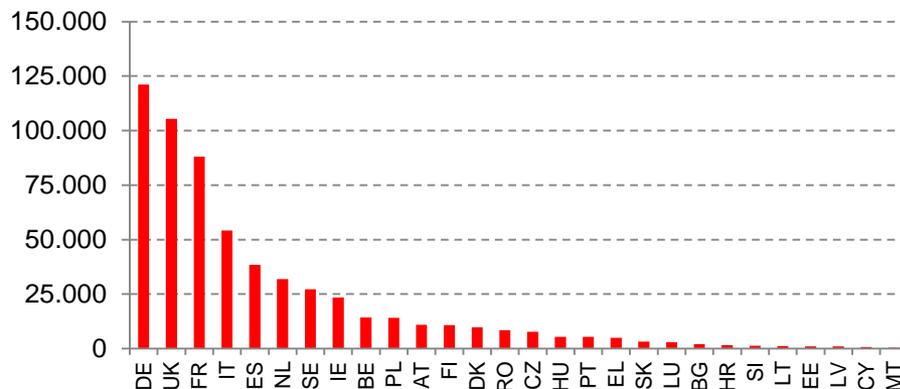


Source: JRC – Dir. B calculations and estimates, based on EUROSTAT data, PREDICT project

The five largest economies (Germany, the United Kingdom, France, Italy and Spain) are the five biggest contributors to ICT value added in 2014. However, a medium-sized country like Ireland has by far the highest ICT share of GDP (12.1 % in 2014).

Unsurprisingly, the five largest economies were also the five biggest contributors to ICT value added in 2014: Germany (EUR 121 bn or 20 %), the United Kingdom (EUR 105 bn or 18 %), France (EUR 88 bn or 15 %), Italy (EUR 54 bn or 9 %) and Spain (EUR 38 bn or 6 %). Together, these five countries represented 68 % of total EU ICT value added in 2014.

Value Added in the ICT sector, 2014 (€m)



ICT share of GDP, 2014



Ireland had by far the highest ICT share of GDP, with a rate of 12.1 % in 2014, while Greece was lagging behind with less than 3 %. After Ireland, countries with the highest share of ICT included Sweden (6.3 %) and Luxembourg (5.9 %). Some Member States (Romania, Hungary, and Estonia) also had a high rate (5 % or higher) of ICT as a share of GDP. In most other Member States, ICT remained broadly stable as a proportion of GDP over the medium-term period (2006-2014), except in Ireland where the rate increased by 4.2 pp. and in Finland where the rate fell by 3.3 pp. .

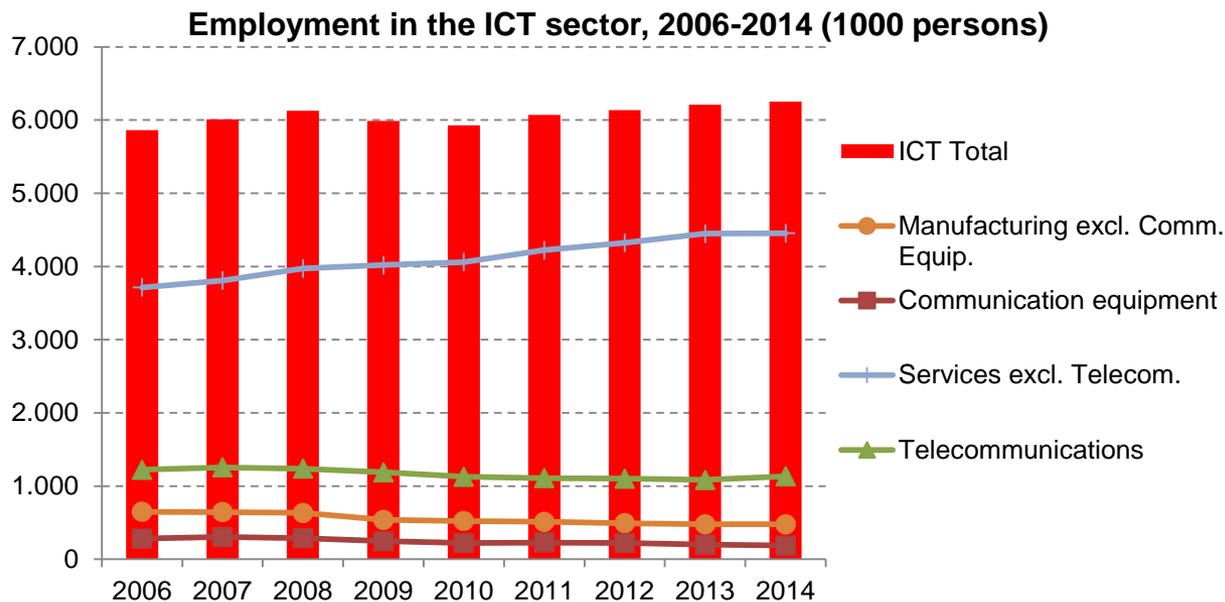
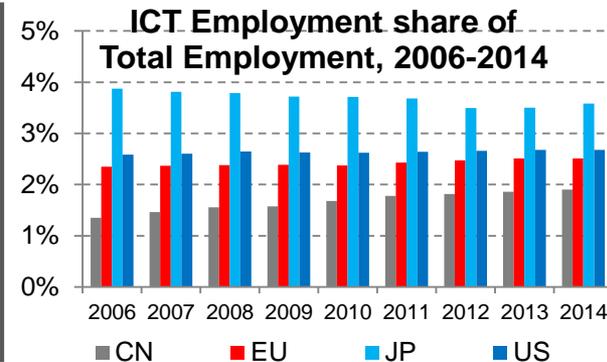
Source: JRC – Dir. B calculations and estimates, based on EUROSTAT data, PREDICT project

The ICT sector **employed 6.3 m people in 2014**. The **main employer** was the ICT services sector (excluding telecommunications) with 4.5 m people in 2014. The share of **employment** in the ICT sector relative to total employment was **2.8 % in Europe in 2014**.

The ICT sector employed 6.3 m people in 2014, the highest in the observed period. The ICT services sector (excluding telecommunications) employed 4.5 m people and accounted for 71 % of total ICT employment in 2014. It is the only sector that recorded a structural increase (of 20 %) over the medium-term period (2006-2014). The telecommunications sector employed 1.1 m people in 2014, a number which fell over the medium-term period by 7 %. The ICT manufacturing industries sector (excluding communication equipment) employed 477 000 people in 2014 and this number fell since 2006 by 26%. The communication equipment sector recorded the sharpest structural decline in 2014, falling to 186 000 people (-34 %).

* See methodological note

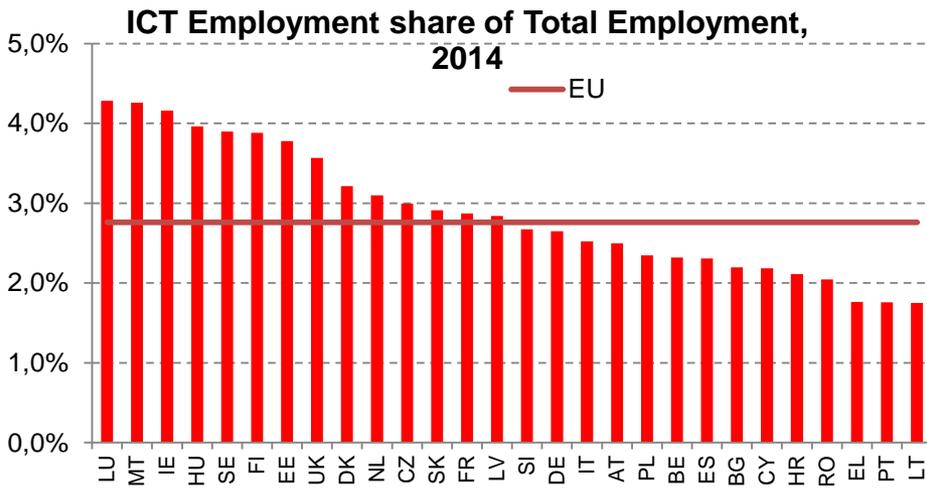
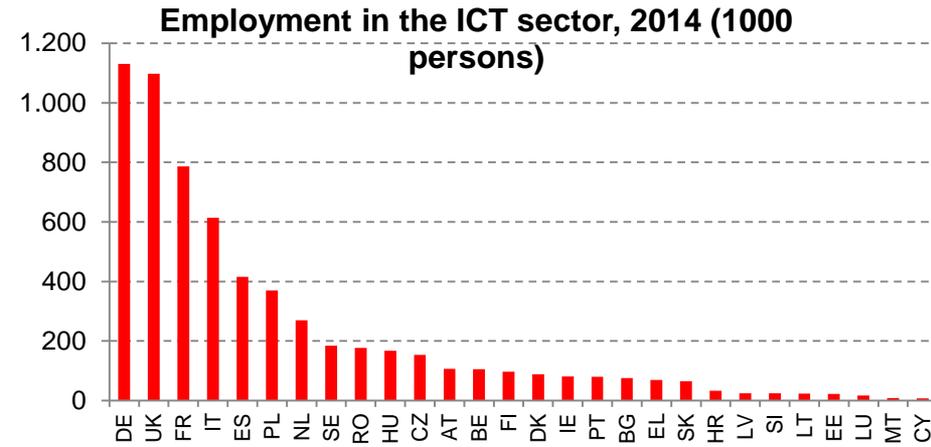
Employment in the ICT sector represented 2.8 % of EU total employment in 2014 (comprehensive definition*), remaining stable over the medium-term period. According to the operational definition* which enables world comparisons, in comparison with the US (2.7 %), the EU (2.5 %) fared better than China (1.9 %), but all three lagged markedly behind Japan (3.6 %) in 2014.



Source: JRC – Dir. B calculations and estimates, based on EUROSTAT data, PREDICT project

The five largest economies (Germany, the United Kingdom, France, Italy and Spain) are the five biggest **employers** in the ICT sector in 2014. However, small countries like Luxembourg and Malta had the highest rate of ICT **employment** as a share of **total employment** in 2014.

As in the case of value added, the five largest economies were also the **five largest employers** in the ICT sector in 2014: Germany (over 1.1 m people or 18 %), the United Kingdom (1.1 m people or 17 %), France (787 000 people or 13 %), Italy (614 000 people or 10 %) and Spain (416 000 people or 7 %). Together, the five largest employers represented 64 % of total ICT employment in 2014.



Luxembourg and Malta were in pole position with 4.3 % of ICT employment as a share of total employment in 2014, and Lithuania had the lowest rate of only 1.8 %. Other countries that were performing well in 2014 included Ireland (4.2 %) and Hungary (4.0 %). Sweden and Finland followed closely behind with 3.9 % rates. Over the medium-term period (2006-2014), the share of ICT employment as a proportion of total employment remained stable in most countries, but small countries like Latvia, Estonia and Luxembourg made significant progress, increasing by more than 1 p.p..

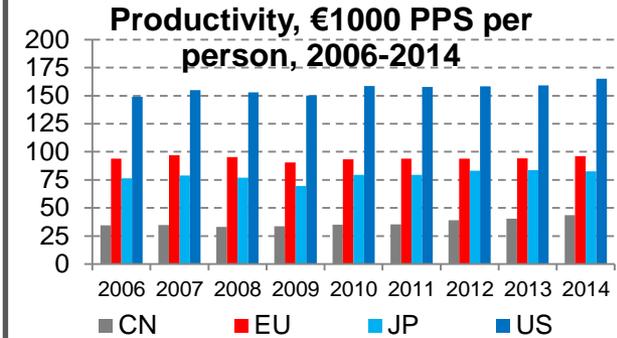
Source: JRC – Dir. B calculations and estimates, based on EUROSTAT data, PREDICT project

Productivity in the ICT sector amounted to EUR 95 000 per person in 2014. **Productivity** in the telecommunications sector is by far the highest. However, as regards **productivity** in the ICT sector, the EU compares with Japan but lagged markedly behind the US.

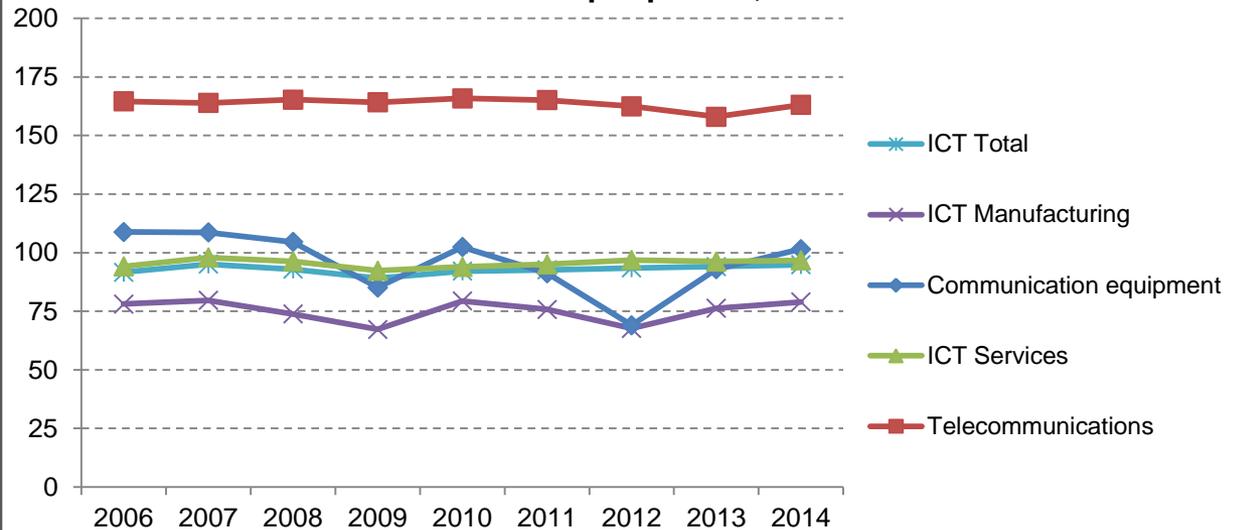
Productivity in the ICT sector (comprehensive definition*) amounted to EUR 95 000 per person in 2014, remaining broadly stable over the medium-term period (2006-2014). In the ICT manufacturing sector, productivity was below average (EUR 79 000 per person in 2014); moreover, it is volatile and pro-cyclical in relation to the business cycle. The communication equipment sector is even more sensitive to the business cycle. Unlike the manufacturing sector, productivity in the ICT services sector as a whole (i.e. services and trade), which stood at EUR 97 000 per person in 2014, is not sensitive to business cycles. Productivity in the telecommunications sector is by far the highest (at EUR 163 000 per person in 2014).

* See methodological note.

Regarding the productivity of the ICT sector (according to the operational definition* which enables world comparisons), the EU (EUR PPS 96 000 per person) is markedly behind the US (EUR PPS 165 000 per person), higher than Japan (EUR PPS 83 000 per person), but far higher than China (EUR PPS 44 000 per person), which in this respect is still an emerging country.



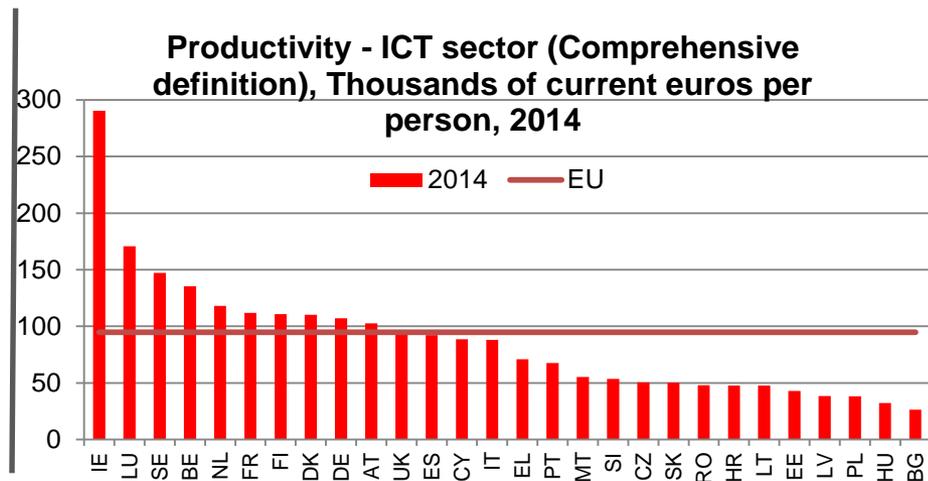
Productivity - ICT sector (Comprehensive definition), Thousands of current euros per person, 2006-2014



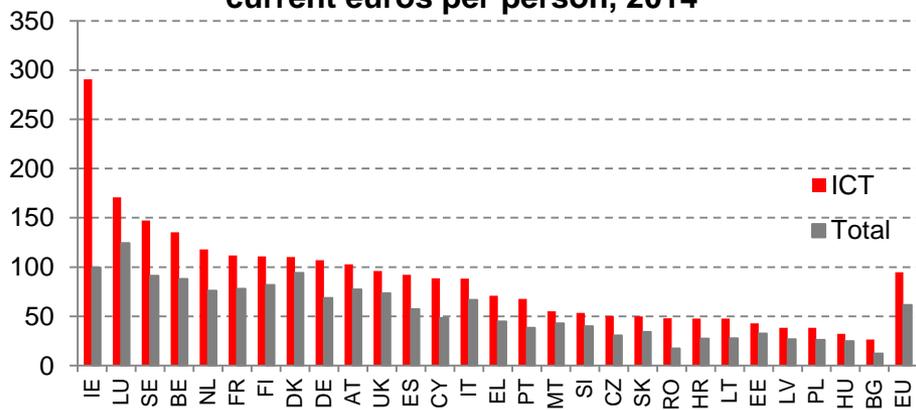
Source: JRC – Dir. B calculations and estimates, based on EUROSTAT data, PREDICT project

As for **labour productivity**, the highest score was registered by Ireland followed by Luxembourg, Sweden and Belgium. Poland, Hungary, and Bulgaria had the weakest performance in this indicator.

In terms of labour productivity in the ICT sector, Ireland (EUR 291 000 per person) by far led the way in 2014, but Luxembourg (EUR 171 000 per person) and Sweden (EUR 147 000 per person) fared well too. At the opposite end of the scale were Bulgaria (EUR 27 000 per person), Hungary (EUR 32 000 per person) and Poland (EUR 38 000 per person).



Productivity - ICT and Total, Thousands of current euros per person, 2014



The picture for labour productivity in the economy as a whole was broadly similar. Luxembourg (EUR 125 000 per person) and Ireland (EUR 100 000 per person) were the best-performing countries, while Bulgaria (EUR 12 000 per person) and Romania (EUR 17 000 per person) were at the bottom of the table.

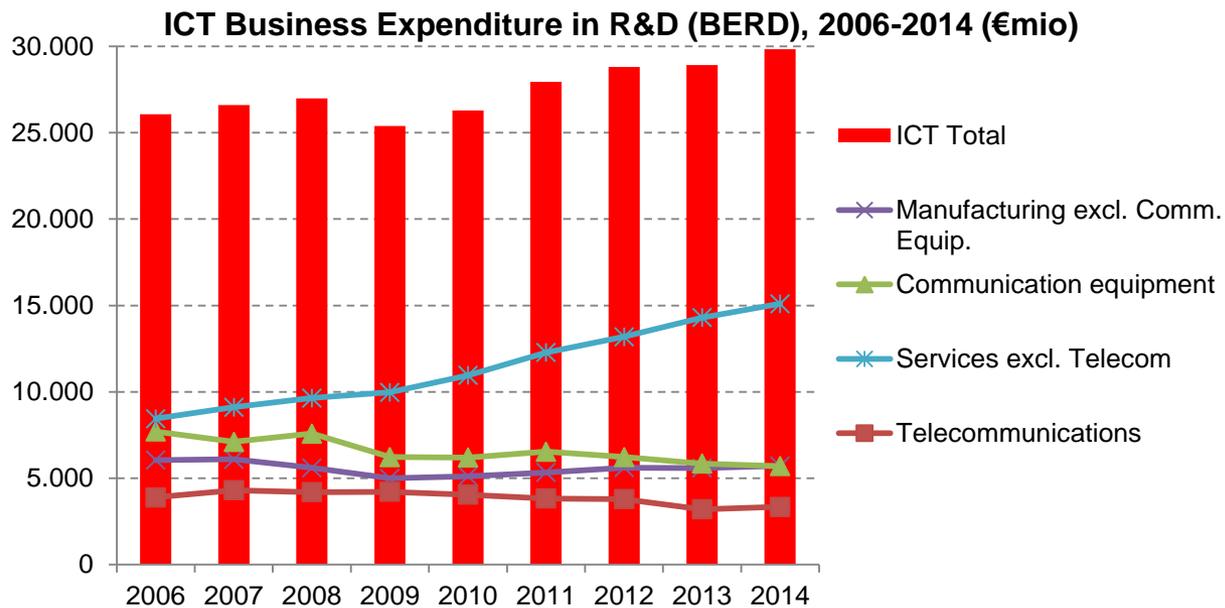
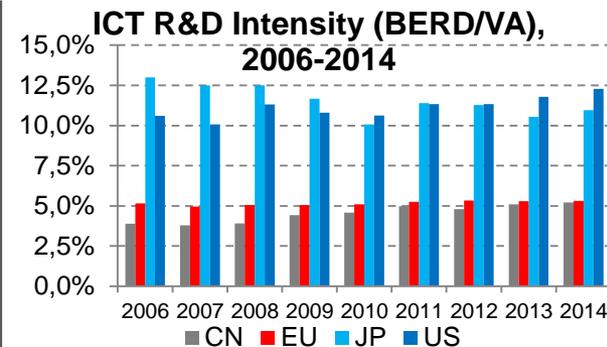
Source: JRC – Dir. B calculations and estimates, based on EUROSTAT data, PREDICT project

Business Enterprise R&D expenditure (BERD) in the ICT sector amounted to EUR 30 bn in 2014. The ICT services sector was responsible for 62 % (EUR 18 bn) of ICT BERD in 2014. ICT R&D intensity amounted to 5 % in 2014 in the EU, markedly behind the US and Japan.

Business Enterprise R&D expenditure (BERD) in the ICT sector amounted to EUR 30 bn in 2014, its highest point over the medium-term period (2006-2014), an improvement on its lowest point of EUR 25 bn reached in 2009. A breakdown by sub-sector reveals a more balanced situation for BERD than for value added – despite accounting for only 9 % of ICT value added, the ICT manufacturing sector was responsible for 38 % of total ICT BERD (EUR 11 bn) while the ICT services sector was responsible for 62 % (EUR 18 bn) of ICT BERD in 2014. Over the medium-term period (2006-2014), the situation was quite different. The ICT manufacturing sector saw a structural decline (falling by 17 % from 2006 to 2014), whereas the ICT services sector saw a structural increase (rising by 49 % over 2006-2014), particularly in the ICT services sector excluding telecoms, which saw an increase of 79 % from 2006 to 2014.

* See methodological note

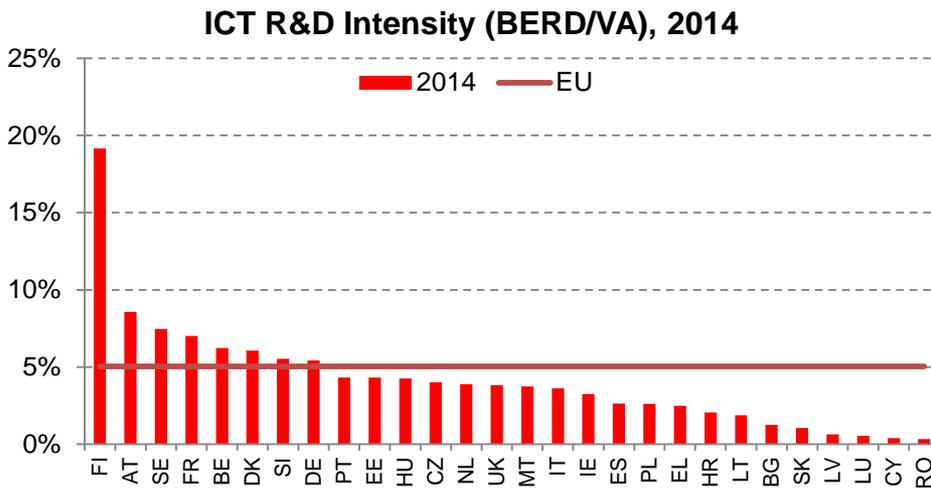
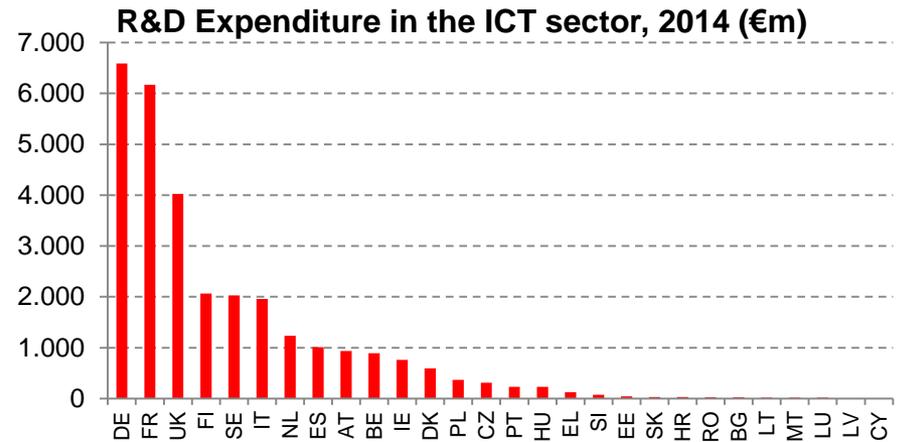
R&D intensity in the ICT sector (comprehensive definition*) amounted to 5 % in 2014. According to the operational definition* which enables world comparisons, although the EU (5.3 %) compares to China (5.2 %), both the EU and China lagged behind the US (12.3 %) and Japan (11 %) in 2014.



Source: JRC – Dir. B calculations and estimates, based on EUROSTAT data, PREDICT project

The six main contributors in terms of **ICT R&D expenditure** in 2014 were the four largest economies in the EU: Germany, France, the United Kingdom and Italy, together with two Nordic countries: Finland and Sweden.

The six main contributors in terms of R&D expenditure in the ICT sector in 2014 were the four largest economies in the EU – Germany (EUR 6.6 bn or 22 %), France (EUR 6.2 bn or 21 %), the United Kingdom (EUR 4.0 bn or 13 %) and Italy (EUR 2.0 bn or 7 %), together with two Nordic countries – Finland (EUR 2.1 bn or 7 %) and Sweden (EUR 2.0 bn or 7 %), confirming the importance of Nordic countries for ICT R&D. Together, the six largest contributors represented 77 % of total ICT Business R&D expenditure in 2014.



Finland was by far leading the way in the EU with a 19.2 % ICT BERD intensity rate in 2014. Romania was the poorest performer with a rate of 0.3 %. Of the Nordic countries, Sweden had a rate of 7.5 % and Denmark had a rate of 6.1 %. Other strong performers include Austria (8.6 %), France (7 %), and Belgium (6.2 %). Over the medium-term period (2006-2014), ICT R&D intensity remained broadly stable, but some eastern countries (Poland, Hungary, and Lithuania) made significant progress.

Source: JRC – Dir. B calculations and estimates, based on EUROSTAT data, PREDICT project

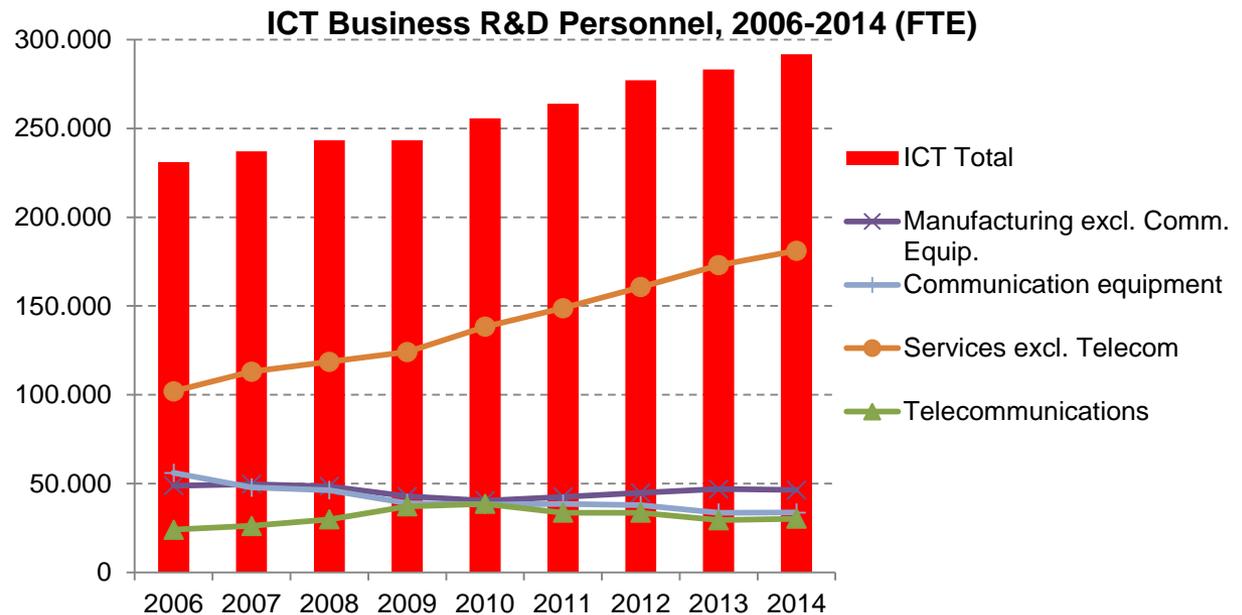
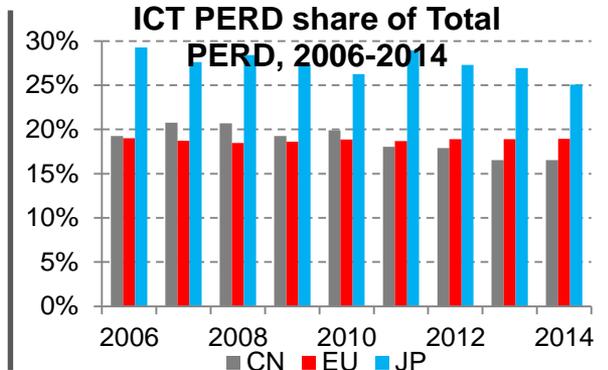
ICT R&D personnel included 292 000 full-time equivalents (FTEs) in 2014. The top employer was the ICT services sector (excluding telecoms), employing 181 000 FTEs in 2014 (62 % of ICT R&D personnel). **ICT R&D personnel** made up 20 % of total R&D personnel in 2014.

R&D personnel in the ICT sector included 292 000 full-time equivalents (FTEs) in 2014, a figure which rose over the medium-term period (2006-2014), growing faster after 2009. The ICT services sector (excluding telecommunications) employed 181 000 FTEs in 2014 (62 % of R&D personnel in the ICT sector, making it the top employer), with a rising trend. The ICT manufacturing sector (excluding communications equipment) employed 46 000 FTEs in 2014, representing a slight fall over the medium-term (2006-2014) despite signs of recovery after 2010. The communication equipment sector stabilized in 2014. The telecommunications sector employed 30 000 FTEs in 2014 (10 % of R&D personnel in the ICT sector), and was on a downward trend (falling about 22 % from its peak of 39 000 FTEs in 2010).

* See methodological note.

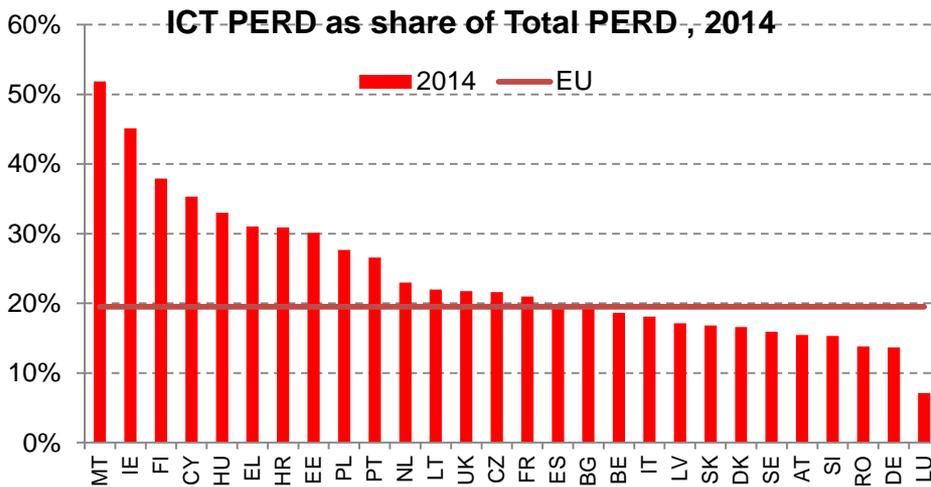
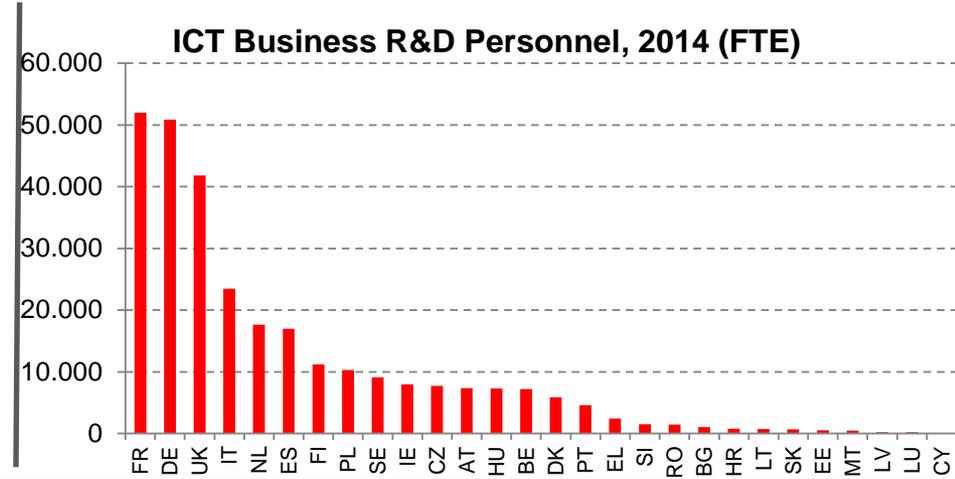
Source: JRC – Dir. B calculations and estimates, based on EUROSTAT data, PREDICT project

R&D personnel in the ICT sector (comprehensive definition*) made up 20 % of total R&D personnel in 2014, a figure which remained stable over the medium-term period. However, according to the operational definition* which enables world comparisons, the EU (19 %) and China (17 %) were behind Japan (25 %) in 2014 and over the medium-term period (no data available for the US).



The four largest economies were also the four biggest **employers of ICT Business R&D personnel** in 2014: France, Germany, the United Kingdom and Italy. Malta and Ireland were the two countries with the highest concentration of **ICT Business R&D personnel** in 2014.

The four largest economies were also the **four biggest employers** of R&D personnel in the ICT sector in 2014 – France (52 000 or 18 %), Germany (51 000 or 17 %), the United Kingdom (42 000 or 14 %) and Italy (23 000 or 8 %). Together, the four biggest employers represented 58 % of total R&D personnel in the ICT sector in 2014.



Malta (52 %) and Ireland (45 %) were the two countries with the highest concentration of R&D personnel in the ICT sector in 2014. Luxembourg had the lowest concentration (7 %).

Other strong performers were Finland (38 %), Cyprus (35 %) and Hungary (33 %).

Source: JRC – Dir. B calculations and estimates, based on EUROSTAT data, PREDICT project

The estimated level of **publicly funded expenditure on ICT R&D** in the EU reached EUR 6.3 bn in 2015. Estimated **public ICT R&D expenditure** was more than 20 % below the necessary trend line for doubling **publicly funded R&D in ICT** between 2007 and 2020.

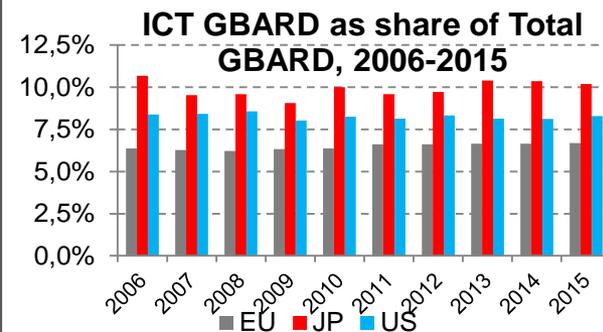
After rising for several years, the estimated level of publicly funded expenditure on ICT R&D in the EU fell in 2012, but recovered in 2013, and by 2015 had exceeded its historical peak of EUR 6.2 bn in 2014, reaching EUR 6.3 bn.

The Digital Agenda target of doubling publicly funded R&D in ICT between 2007 and 2020 requires an annual growth rate of 5.5 % (assuming constant annual growth rate). Estimated public ICT R&D expenditure was below the necessary trend line in 2015, with a gap of more than 20 %.

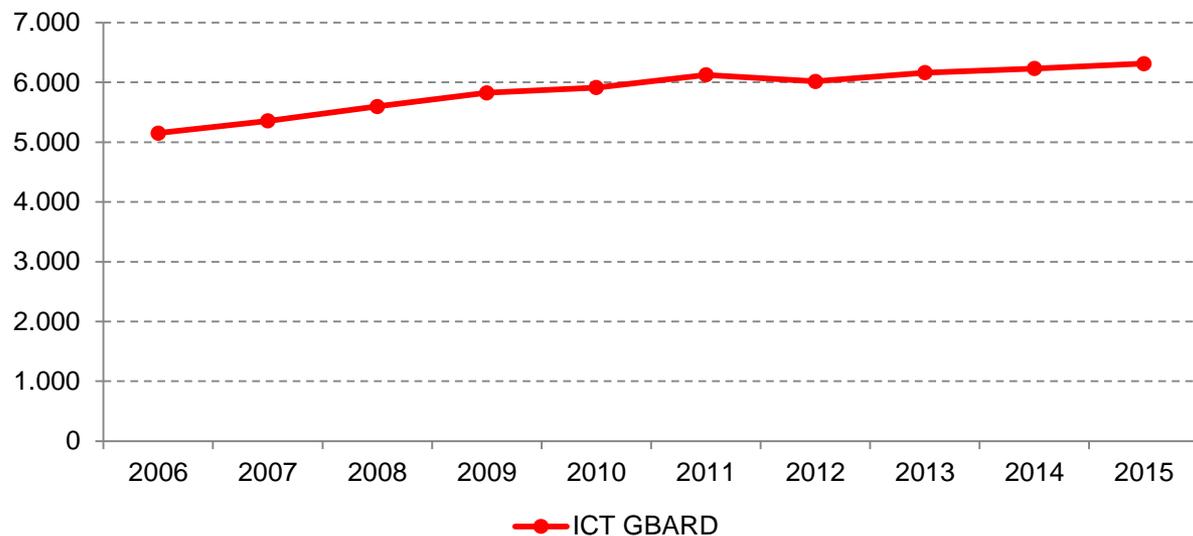
* Official statistics on public expenditure are available one year before business statistics.

In 2015*, ICT public funding represented 6.7 % of EU total 'government budget allocations for R&D' (GBARD), a figure which remained broadly stable over the medium-term period.

The EU was lagging behind the US (8.3 %) and Japan (10.2 %), a relative position that remained stable over the medium-term period (no data available for China).



ICT GBARD, 2006-2015 (€m)

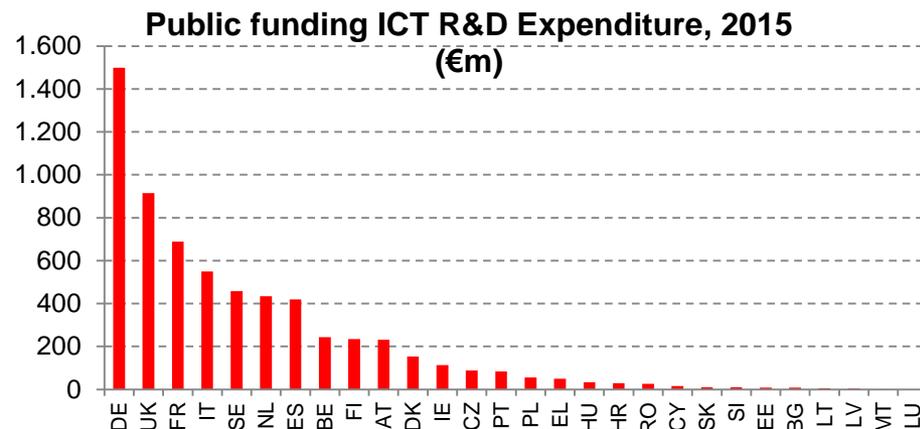


Source: JRC – Dir. B calculations and estimates, based on EUROSTAT data, PREDICT project

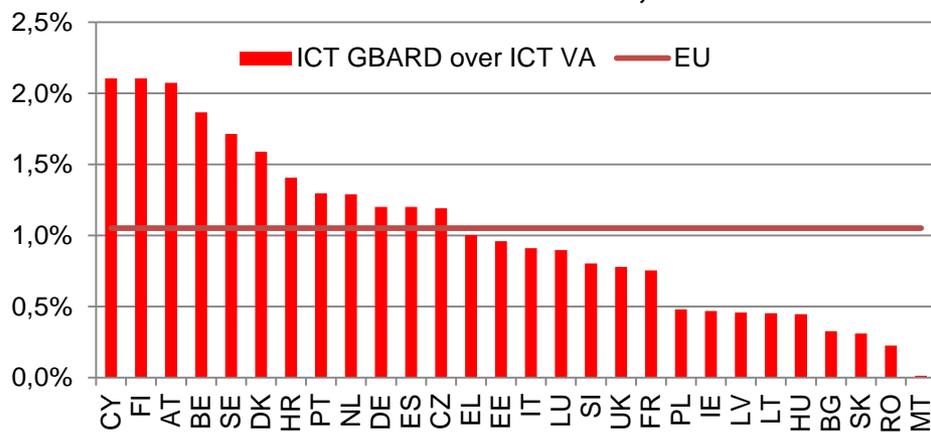
The five biggest **public funders of R&D in ICT** in 2015 were Germany, followed by the United Kingdom, France, Italy and Sweden. Cyprus was surprisingly leading the way in the EU with a **2.11 % ICT GBARD as a proportion of ICT VA** in 2014.

The **five biggest public funders** of R&D in ICT in 2015 were Germany (EUR 1.5 bn or 24 %), followed by the United Kingdom (EUR 915 m or 15 %), France (EUR 689 m or 11 %), Italy (EUR 550 m or 9 %) and Sweden (EUR 458 m or 7 %).

Together, those five countries represented 65 % of total public funding for R&D in ICT.



ICT GBARD share of ICT VA, 2014



Cyprus was surprisingly leading the way in the EU with a 2.11 % ICT GBARD as a proportion of ICT VA in 2014. Unsurprisingly, the ranking in 2014 again reveals a strong performance by Nordic countries: Finland (2.10 %), Sweden (1.71 %) and Denmark (1.59 %).

However, some other countries also attribute special importance to ICT in their R&D public spending, such as Austria (2.07 %) and Belgium (1.87 %).

Source: JRC – Dir. B calculations and estimates, based on EUROSTAT data, PREDICT project

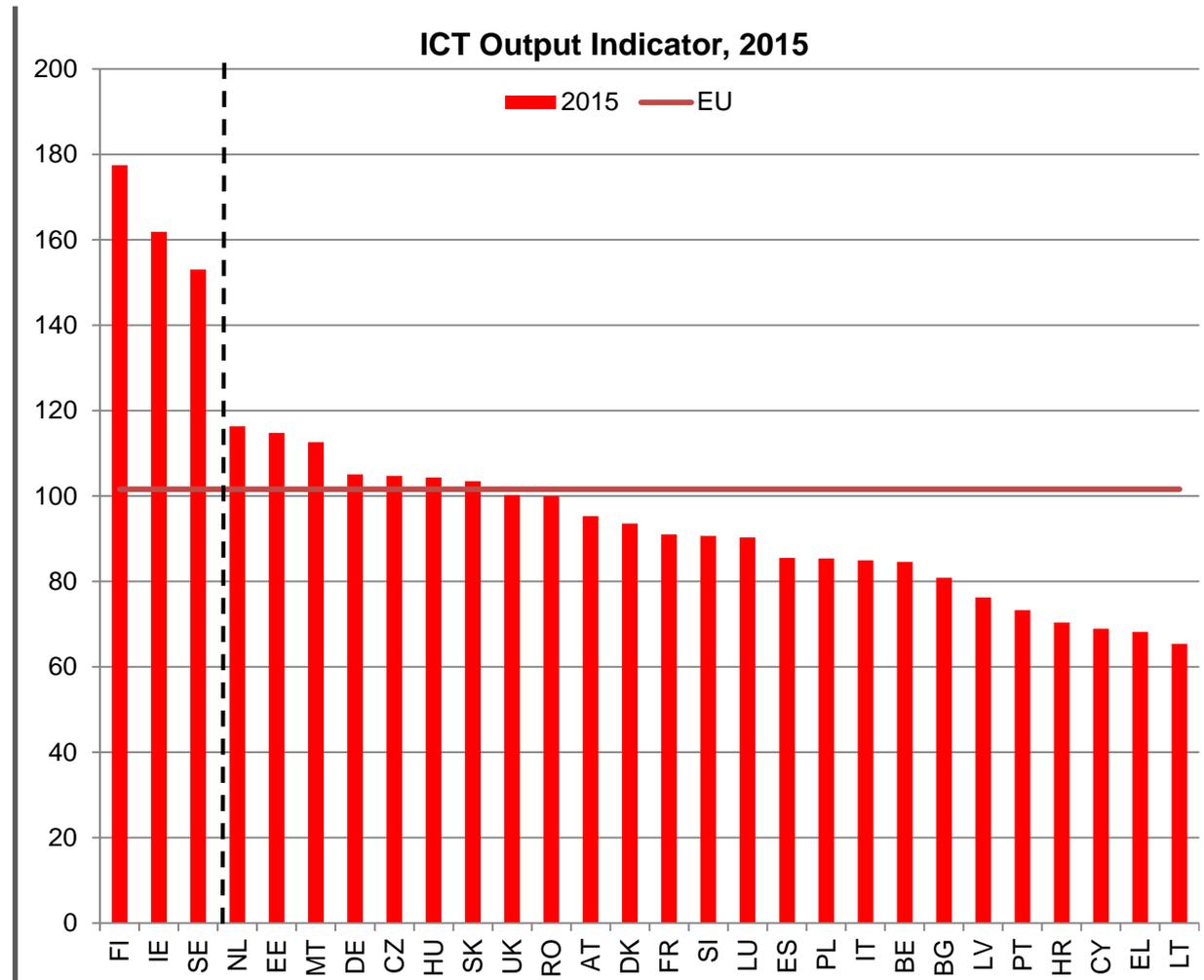
A group of three countries takes a significant lead with scores above 150 (the benchmark has been set to equal 100 for Europe in 2011) in the **innovation output indicator : Finland (177), Ireland (162) and Sweden (153).**

The innovation output indicator is a composite indicator that focuses on four output-oriented innovation measures (see methodological note).

A group of three countries takes a significant lead with scores above 150 (the benchmark has been set to equal 100 for Europe in 2011): Finland (177), Ireland (162) and Sweden (153).

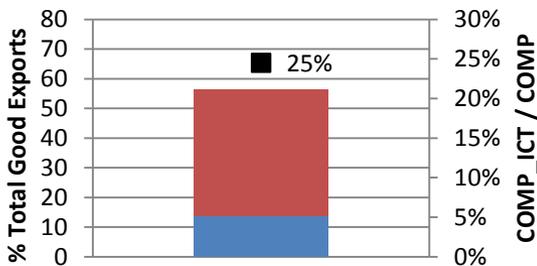
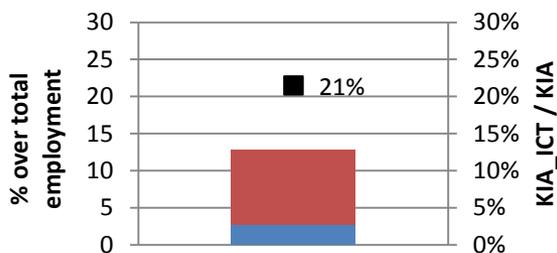
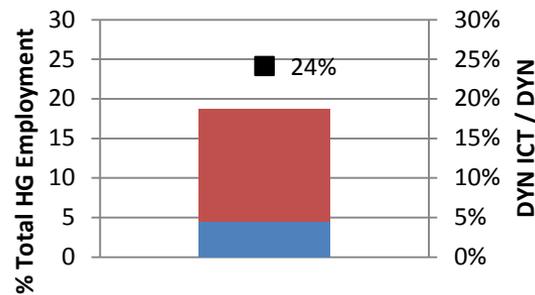
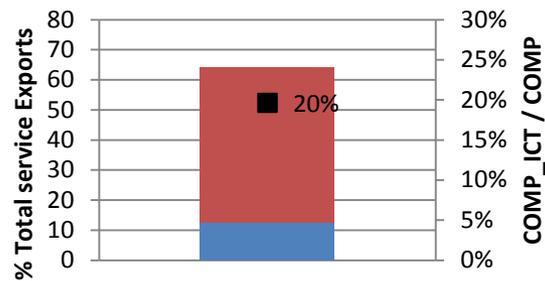
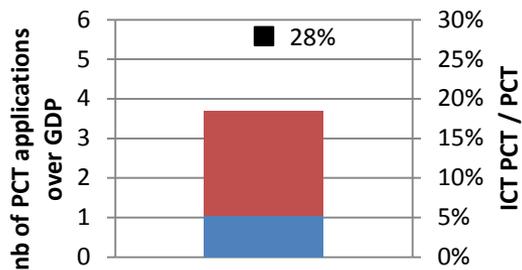
The three top scores in ICT innovation output result from very high ICT contributions in the trade of knowledge-intensive services, above average levels of fast-growing innovative ICT employment for Ireland and remarkable results for ICT patenting in Finland and Sweden.

At the lowest end of the scale are Cyprus (69), Greece (68) and Lithuania (65).



Source: JRC calculations and estimates, based on EUROSTAT/OECD data, RISES project

ICT INNOVATION OUTPUT INDICATOR by Component



The contribution of ICT has been calculated for each underlying component of the innovation output indicator. The ICT contributions for Europe are:

1. 28 % in technological innovation as measured by patents (PCT_ICT).
2. 21 % in absorption of skills as measured by employment in knowledge-intensive activities (KIA_ICT).
3. 25 % in competitiveness of knowledge goods as measured by exports of medium-high-tech goods (COMP_GOOD_ICT).
4. 20 % in competitiveness of knowledge services as measured by exports of knowledge-intensive services (KIS_ICT).
5. 24% in innovative firm's dynamics as measured by average innovativeness scores (employment-weighted) of fast-growing firms (DYN_ICT)

METHODOLOGICAL NOTE

Definition of the ICT sector

In this section, the ICT sector is defined according to the definition provided by the OECD on the basis of the NACE (Statistical Classification of Economic Activities in the European Community) Rev.2 (2008) nomenclature. The ICT sector has 12 sub-sectors:

ICT manufacturing

C261	Manufacture of electronic components and boards
C262	Manufacture of computers and peripheral equipment
C263	Manufacture of communication equipment
C264	Manufacture of consumer electronics
C268	Manufacture of magnetic and optical media

ICT services

G4651	Wholesale of computers, computer peripheral equipment and software
G4652	Wholesale of electronic and telecommunications equipment and parts
J5820	Software publishing
J61	Telecommunications
J62	Computer programming, consultancy and related activities
J631	Data processing, hosting and related activities; web portals
S951	Repair of computers and communication equipment

METHODOLOGICAL NOTE

Comprehensive vs operational definition

The **comprehensive definition** of the ICT sector applies to EU Member States for the period 2008-2014. It corresponds to the definition provided by the OECD in 2007.

The **operational definition** of the ICT sector enables an international comparison with non-EU countries over a longer period (2006-2014), as some of these countries do not have the necessary disaggregated information to estimate all the ICT sub-sectors included in the comprehensive definition. The operational definition does not include the following sectors: manufacture of magnetic and optical media (268) and ICT trade industries (465).

Sector analysis

In the following section, a sector analysis is made for each indicator. The 12 sub-sectors are aggregated into four sectors: ICT manufacturing (excluding communication equipment), communication equipment, ICT services (excluding telecommunications) and telecommunications.

Source

Joint Research Centre – Dir. B Growth and Innovation (JRC – Dir. B) calculations and estimates, based on Eurostat, the OECD's structural analysis database (STAN), EU-KLEMS data, and the JRC's PREDICT and RISES projects.

All data contained in these databases come from official sources (e.g. Eurostat, OECD, national statistical institutes). However, there may be some discrepancies with the original sources, e.g. owing to updates of the original data or the use of multiple auxiliary sources and variables.

ICT INNOVATION OUTPUT INDICATOR

Methodology

The innovation output indicator is a composite indicator that focuses on four output-oriented innovation measures (see list).

$$I_{ICT} = w_1 PCT_{ICT} + w_2 KIA_{ICT} + w_3 COMP_{ICT} + w_4 DYN_{ICT}$$

The weights w_1 , w_2 , w_3 , w_4 are the weights of the component indicators, fixed by time and country.

The weights are calculated in such a way that the linear correlations between each single component and the final scores of the composite indicator are almost the same (i.e. balanced). Each single weight is different from the other but the correlation coefficients are the same (or very close).

See sources (below) for further details on the methodology.

- PCT_{ICT} : patent applications per billion GDP;
- KIA_{ICT} : employment in knowledge-intensive activities in business industries as a % of total employment
KIA measures the percentage of educated (degree level) employees in each sector (i.e. is a proxy of employees' skills efficiency).
- $COMP_{ICT} = 0.5 * GOOD + 0.5 * SERV$
GOOD: The share of medium-tech and high-tech products in total goods exports.
SERV: Knowledge-intensive services as a share of the total services exports.
- DYN_{ICT} : average (employment-weighted) innovativeness scores of fast-growing firms.
DYN is a measure of fast-growing firms based on the average innovativeness scores of fast-growing enterprises

Sources: JRC Technical report – *How much does ICT contribute to innovation output? An analysis of the ICT component in the innovation output indicator*, Annarosa PESOLE, 2015

'Developing an indicator of innovation output', Commission Staff Working Document – SWD (2013) 325 final.