



THE EU ICT SECTOR AND ITS R&D PERFORMANCE

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 2008-2012. 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 (2006-2012), 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 – Institute for Prospective Technological Studies (JRC-IPTS) calculations and estimates, based on Eurostat, the OECD's structural analysis database (STAN), EU-KLEMS data, and the JRC's PREDICT project.

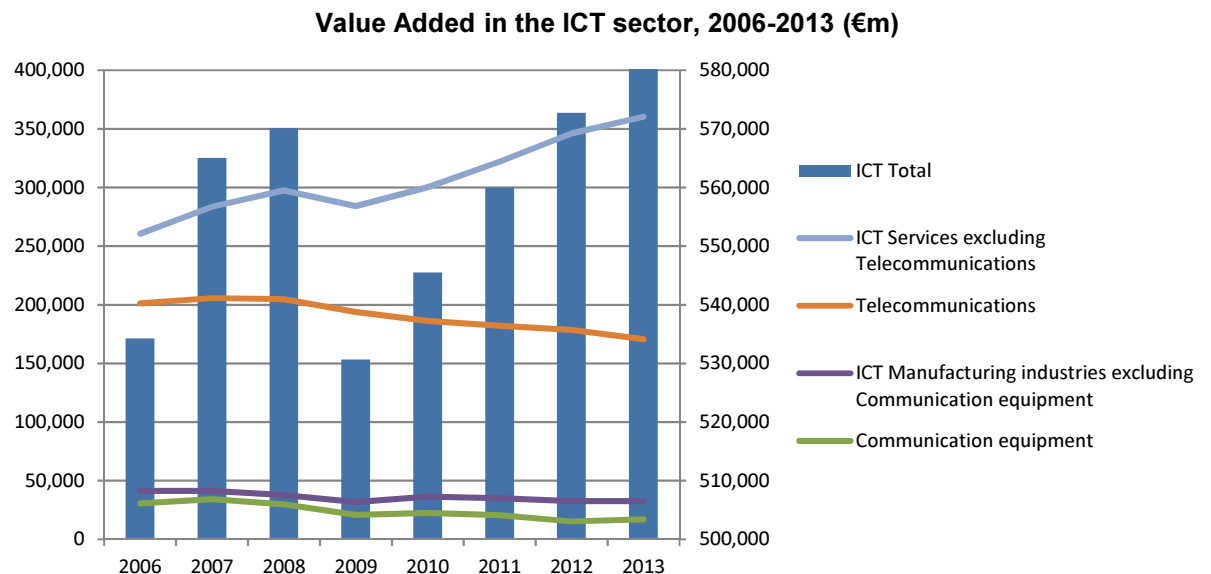
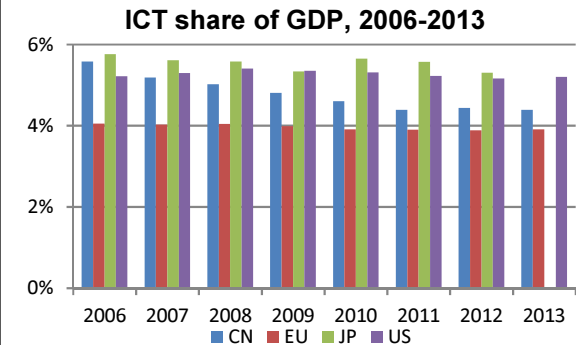
All data contained in these databases come from official sources (e.g. Eurostat, OECD, national statistical institutes). However, there may be some discrepancies with the original sources, e.g. owing to updates of the original data or the use of multiple auxiliary sources and variables.

VALUE ADDED IN THE ICT SECTOR at EU and global level

The ICT sector **value added** amounted to €581 bn in 2013. After a slowdown in 2009, the ICT sector experienced a recovery. A breakdown by sub-sector shows the predominance of ICT services (€531 bn and 91 % of total ICT value added in 2013) over ICT manufacturing industries (€50 bn and 9 % of total ICT value added in 2013). The ICT services sector (excluding telecommunications) is the only one that saw an increase in value added over the medium-term period (2006-2013) up to €360 bn. The communication equipment sector experienced the sharpest decline over the medium-term period (2006-2013). After peaking at €34 bn in 2007, it fell to €17 bn in 2013, indicating structural decline.

Value added in the ICT sector (comprehensive definition*) accounted for 4.3 % of EU GDP in 2013. However, value added in the ICT sector (operational definition*) in the EU (3.9 %) was behind China (4.4 %) and the US (5.2 %) in 2013 (no data for Japan in 2013, but Japan and the US had similar levels in 2012).

* See methodological note.

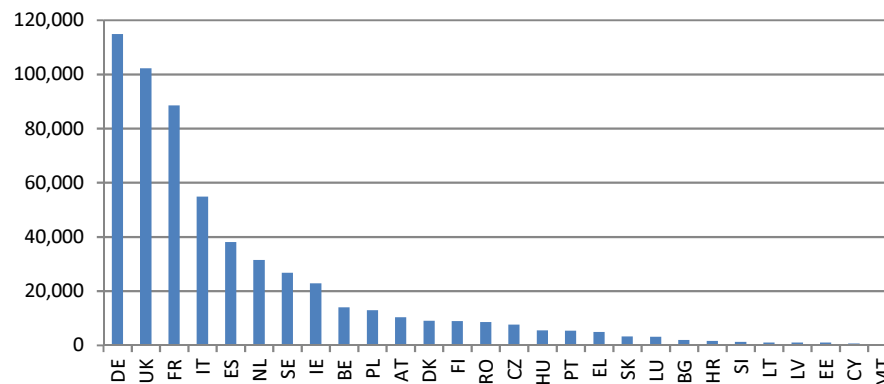


Source: JRC-IPTS calculations and estimates, based on EUROSTAT data, PREDICT project

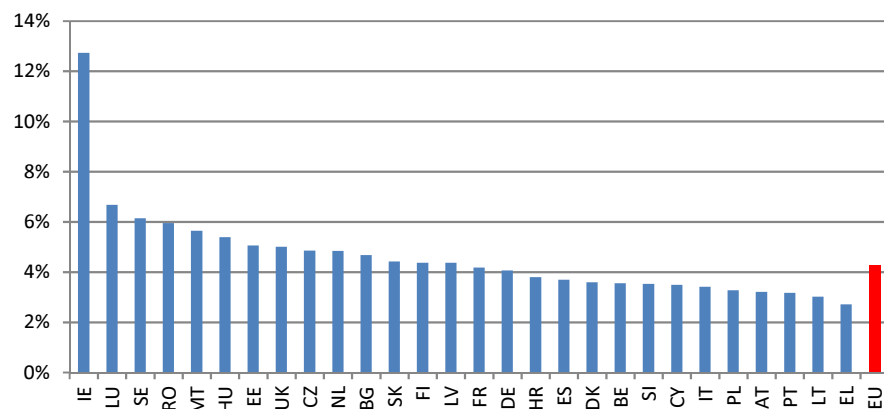
VALUE ADDED IN THE ICT SECTOR by Member State

Unsurprisingly, the five largest economies were also the **five biggest contributors** to ICT value added in 2013: Germany (€115 bn or 20 %), the United Kingdom (€102 bn or 18 %), France (€88 bn or 15 %), Italy (€55 bn or 9 %) and Spain (€38 bn or 7 %). Together, these five countries represented 69 % of total EU ICT value added in 2013.

Value Added in the ICT sector, 2013 (€m)



ICT share of GDP, 2013



Ireland had — by far — the highest ICT share of GDP, with a rate of 12.7 % in 2013, while Greece was lagging behind with less than 3.0 %. After Ireland, countries with the highest share of ICT included Luxembourg (6.7 %) and Sweden (6.1 %). Some eastern Member States (Romania, Hungary, and Estonia) also had a high rate 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 (2006-2013), except in Finland, where the rate fell by 4.2 pp. in 2006-2013.

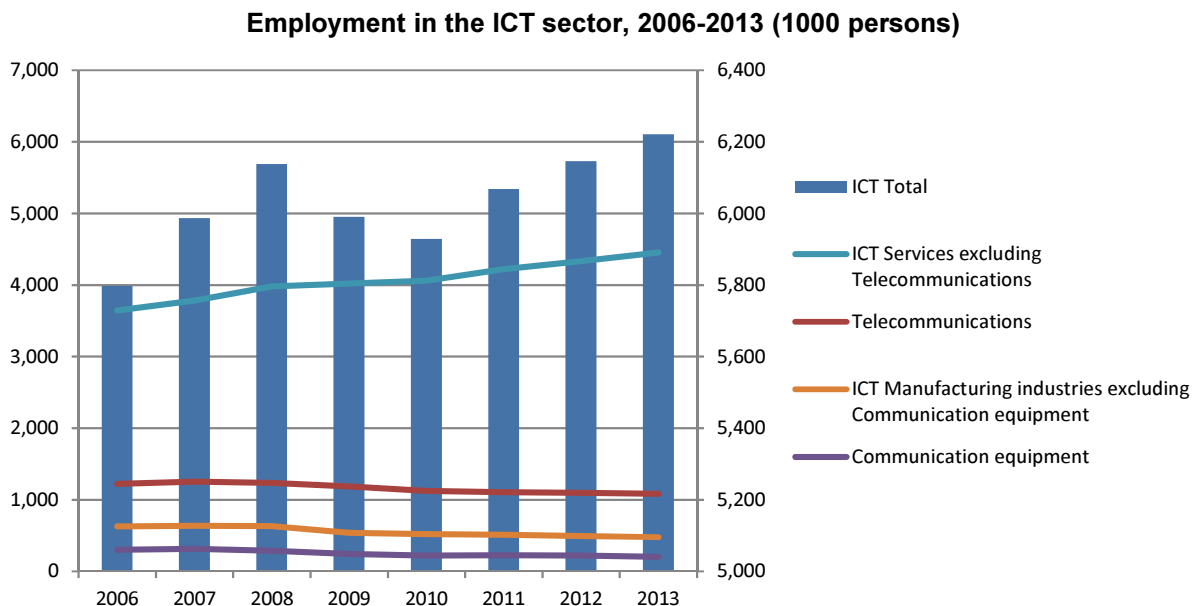
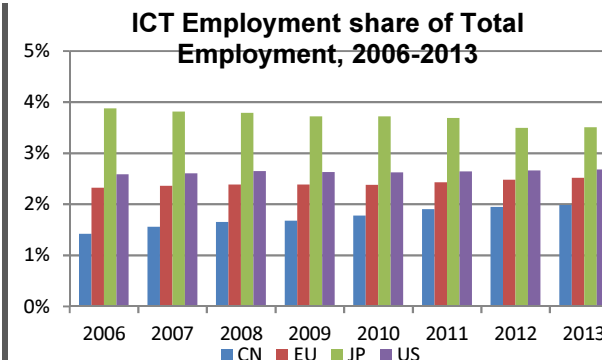
Source: JRC-IPTS calculations and estimates, based on EUROSTAT data, PREDICT project

EMPLOYMENT IN THE ICT SECTOR at EU and global level

The ICT sector **employed** a just over 6.2 m people in 2013, close to its peak of 6.2 m in 2008. The ICT services sector (excluding telecommunications) employed 4.5 m people and accounted for 70 % of total ICT employment in 2013. It is the only sector that recorded a structural increase over the medium-term period (2006-2013). The telecommunications sector employed over 1 m people in 2013, a number which fell over the medium-term period. The ICT manufacturing industries sector (excluding communications equipment) employed 478 000 people in 2013 and this number was falling. The communication equipment sector recorded the sharpest structural decline in 2013, falling to 204 000 people.

Employment in the ICT sector (comprehensive definition*) represented 2.8 % of EU total employment in 2013, remaining stable over the medium-term period. In comparison with the US (2.7 %), the EU (2.5 %) fared better than China (2.0 %), but all three lagged markedly behind Japan (3.5 %) in 2013 (comparable operational definition*)

* See methodological note

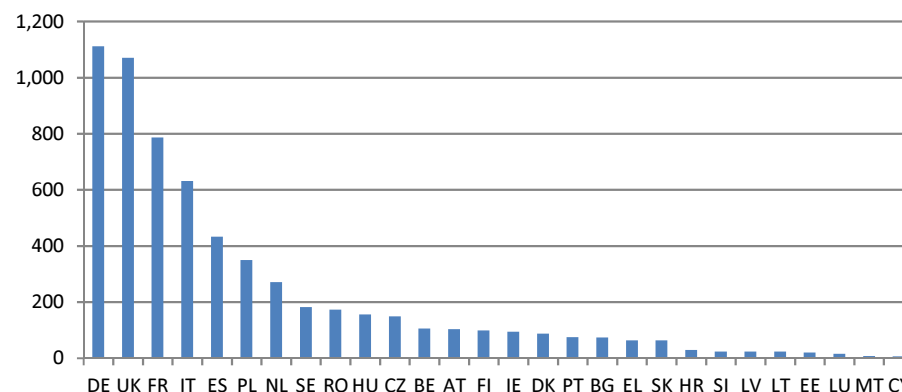


Source: JRC-IPTS calculations and estimates, based on EUROSTAT data, PREDICT project

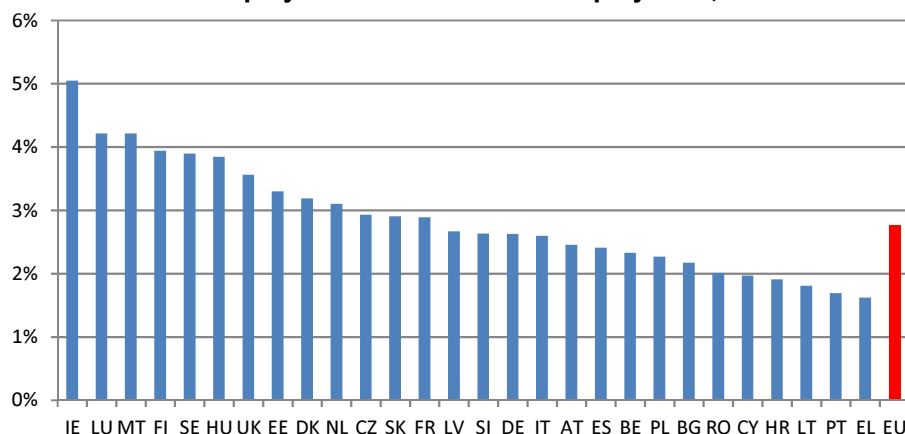
EMPLOYMENT IN THE ICT SECTOR by Member State

As in the case of value added, the five largest economies were also the **five largest employers** in the ICT sector in 2013: Germany (1.1 m people or 18 %), the United Kingdom (1.1 m people or 17 %), France (0.78 m or 13 %), Italy (0.63 m or 10 %) and Spain (0.43 m or 7 %). Together, the five largest employers represented 65 % of total ICT employment in 2013.

Employment in the ICT sector, 2013 (1000 persons)



ICT Employment share of Total Employment, 2013



Ireland was in pole position with 5.1 % ICT employment as a share of total employment in 2013, and Greece had the lowest rate of only 1.6 %. Other countries that were performing well include Luxembourg and Malta (4.2 % in 2013). Finland, Sweden and Hungary followed closely behind with rates of between 3.8 % and 3.9 %. Over the medium-term period (2006-2013), the share of ICT employment as a proportion of total employment remained stable in most countries.

Source: JRC-IPTS calculations and estimates, based on EUROSTAT data, PREDICT project

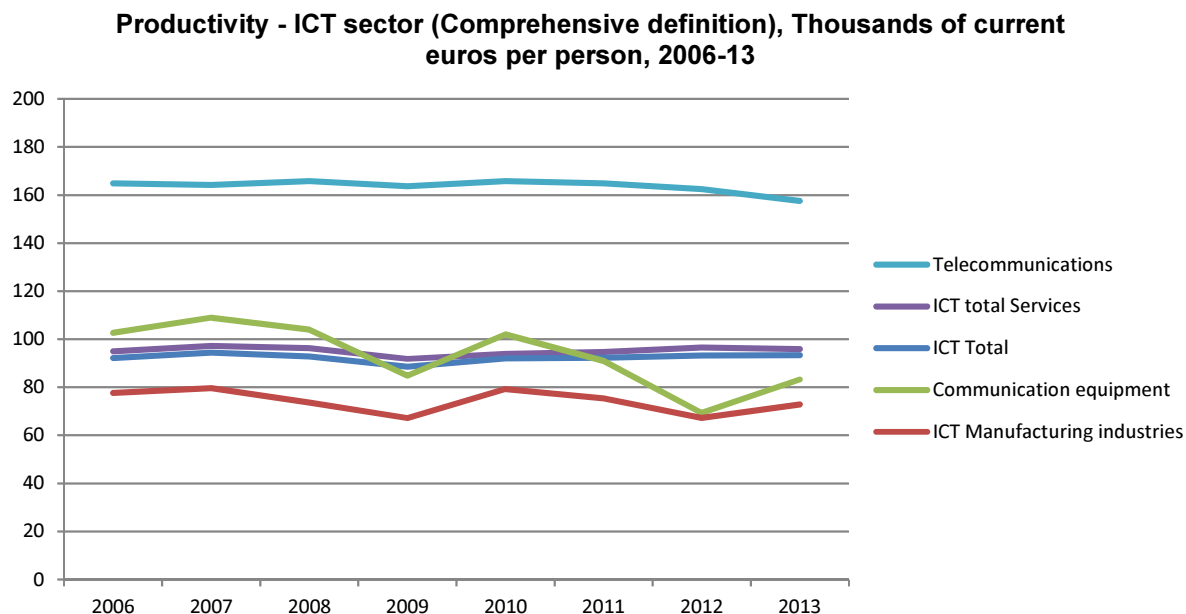
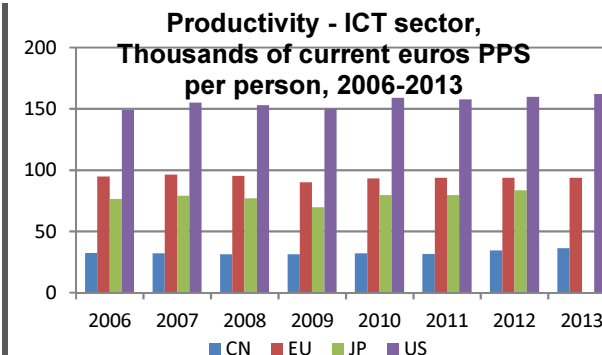
PRODUCTIVITY IN THE ICT SECTOR at EU and global level

Productivity in the ICT sector (comprehensive definition*) amounted to €93 000 per person in 2013, remaining broadly stable over the medium-term period. In the ICT manufacturing sector, productivity was below average (€73 000 per person in 2013); moreover, it is volatile and pro-cyclical in relation to the business cycle. The communications 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 €96 000 per person in 2013, is not sensitive to business cycles. Although productivity in the telecommunications sector is very high (at €158 000 per person in 2013), wholesale trade productivity is average (at €92 000 per person in 2013).

* See methodological note.

Regarding the **productivity** of the ICT sector (operational definition*), the EU is somewhat behind the US (€162 000 per person), but far higher than China (€36 000 per person), which in this respect still an emerging country (no data are available for Japan in 2013, but Japan and the EU had similar ICT productivity levels in 2012).

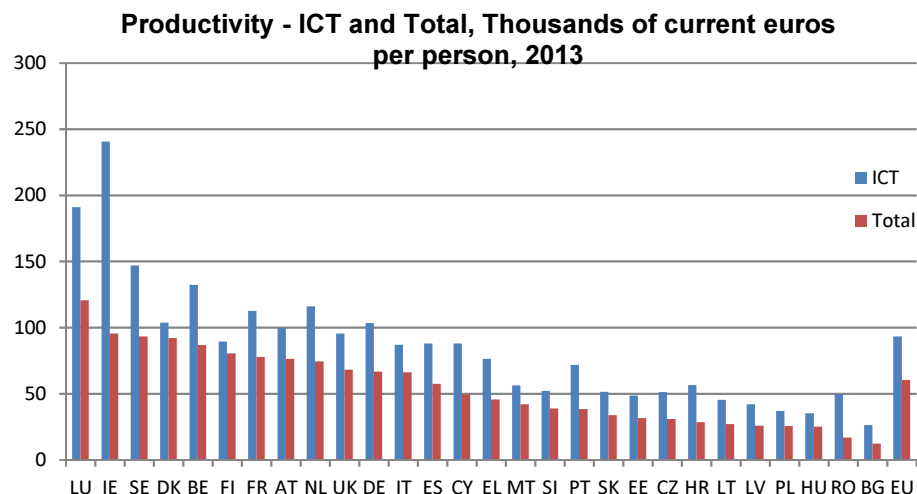
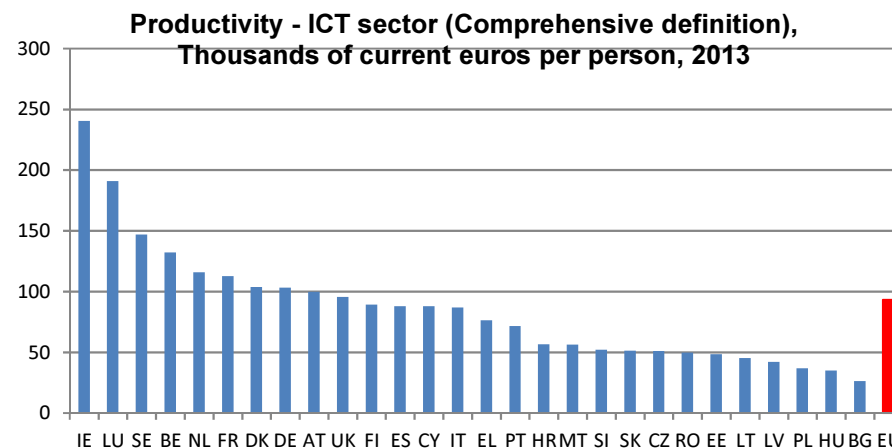
* See methodological note.



Source: JRC-IPTS calculations and estimates, based on EUROSTAT data, PREDICT project

PRODUCTIVITY IN THE ICT SECTOR by Member State

In terms of **labour productivity** in the ICT sector, Ireland (€240 000 per person), Luxembourg (€191 000 per person) and Sweden (€147 000 per person) led the way in 2013. At the opposite end of the scale were Poland (€37 000 per person), Hungary (€35 000 per person) and Bulgaria (€26 000 per person).



The picture for **labour productivity** in the economy as a whole was broadly similar. Luxembourg (€121 000 per person), Ireland (€95 000 per person) and Sweden (€93 000 per person) were still the best-performing countries, while Hungary (€25 000 per person), Romania (€17 000 per person) and Bulgaria (€12 000 per person) were at the bottom of the table.

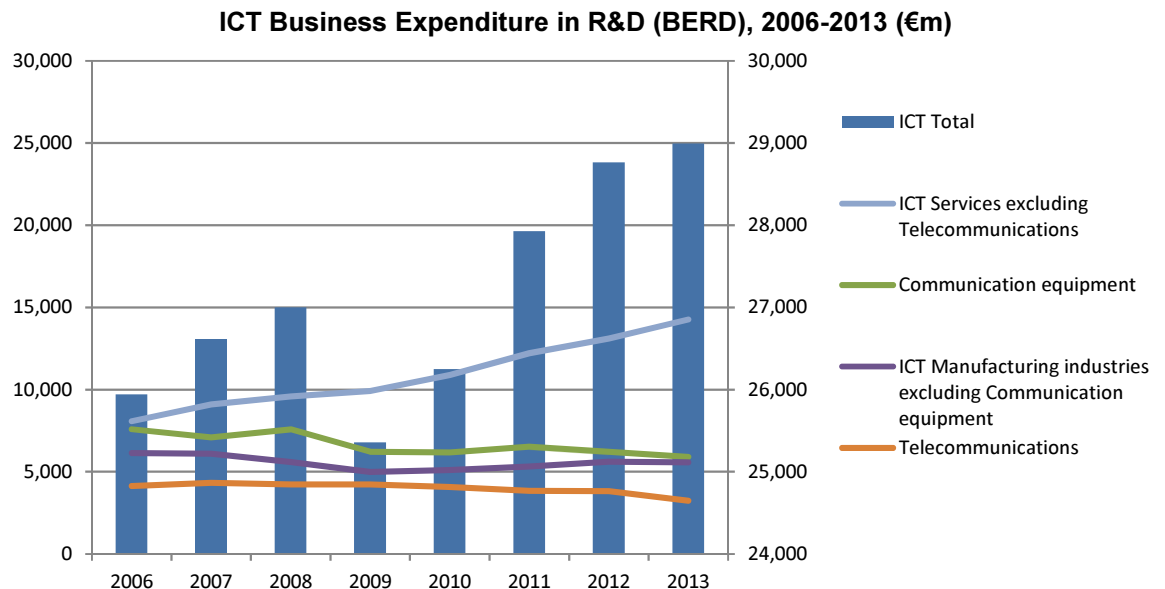
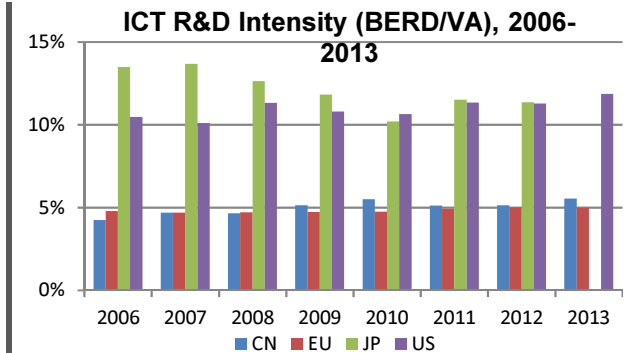
Source: JRC-IPTS calculations and estimates, based on EUROSTAT data, PREDICT project

BUSINESS ENTERPRISE R&D (BERD) EXPENDITURE IN THE ICT SECTOR at EU and global level

Business enterprise R&D (BERD) expenditure in the ICT sector amounted to €29 bn in 2013, its highest point over the medium-term period (2006-2013), an improvement on its lowest point of €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 40 % of total ICT BERD spending (€11 bn) while the ICT services sector was responsible for 60 % (€18 bn) of ICT BERD spending in 2013. Over the medium-term period (2006-2013), the situation was quite different. The ICT manufacturing sector saw a structural decline (falling by 16 % from 2006 to 2013), whereas the ICT services sector saw a structural increase (rising by 43 % over 2006-2013), particularly in the ICT services sector (excluding telecommunications), which saw an increase of 77 % from 2006 to 2013.

R&D intensity in the ICT sector (comprehensive definition*) amounted to 5.0 % in 2013. Although the EU compares therefore favourably to China (5.5 %), both the EU and China lagged behind the US (11.8 %) in 2013 (comparable operational definition*, no rate available for Japan in 2013, but Japan and the US were at a comparable level in 2012).

* See methodological note.

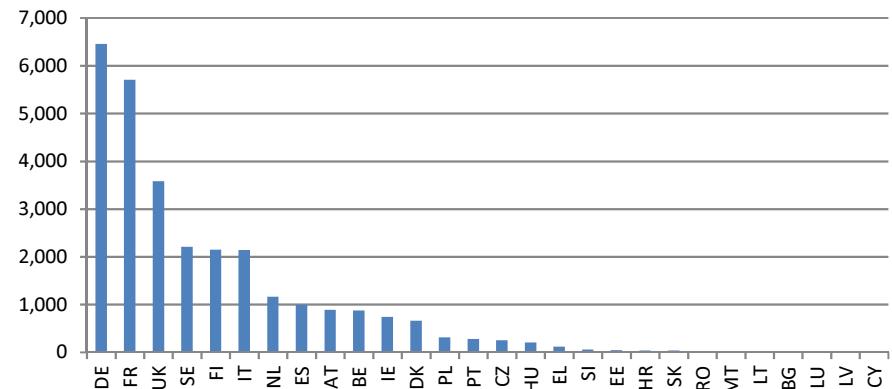


Source: JRC-IPTS calculations and estimates, based on EUROSTAT data, PREDICT project

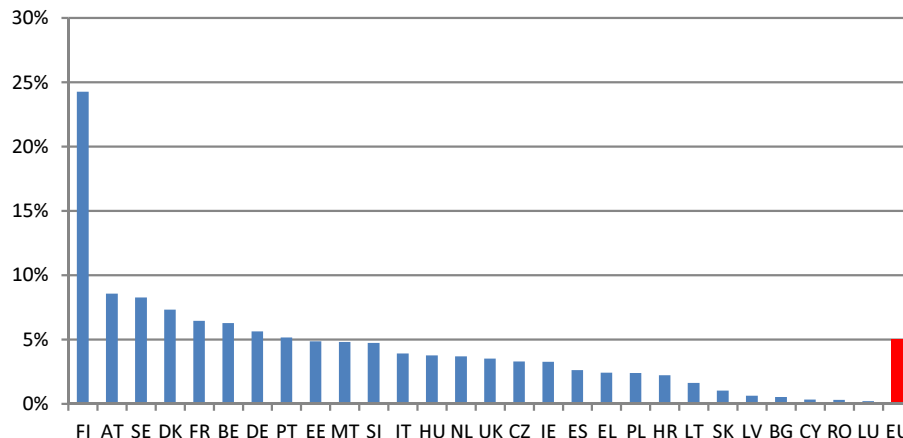
R&D EXPENDITURE IN THE ICT SECTOR by Member State

The **six main contributors** in terms of R&D expenditure in the ICT sector in 2013 were the four largest economies in the EU – Germany (€6.5 bn or 22 %), France (€5.7 bn or 20 %), the United Kingdom (€3.6 bn or 12 %) and Italy (€2.1 bn or 7.4 %), together with two Nordic countries – Sweden (€2.2 bn or 7.6 %) and Finland (€2.1 bn or 7.4 %), confirming the importance of Nordic countries for ICT R&D. Together, the six largest contributors represented 77 % of total ICT R&D expenditure in 2013.

R&D Expenditure in the ICT sector, 2013 (€m)



ICT R&D Intensity, 2013



Source: JRC-IPTS calculations and estimates, based on EUROSTAT data, PREDICT project

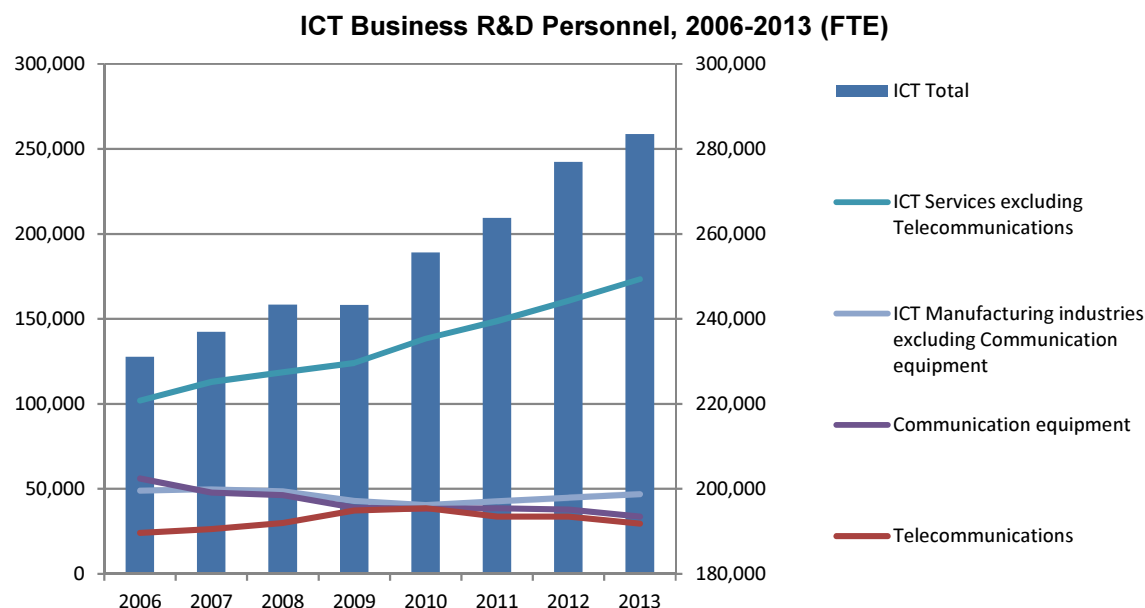
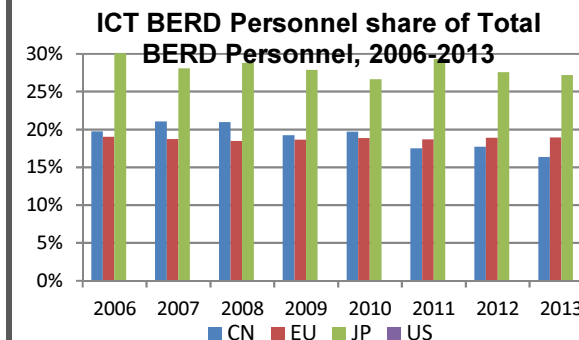
Finland was leading the way in the EU with a 24 % ICT R&D intensity rate in 2013. Luxembourg was the poorest performer with a rate of 0.2 %. Of the Nordic countries, Sweden had a rate of 8.3 % and Denmark had a rate of 7.3 %. Other strong performers include Austria (8.6 %), France (6.4 %), Belgium (6.3 %) and Germany (5.6 %). Over the medium-term period (2006-2013), ICT R&D intensity remained broadly stable with the notable exception of Finland which saw an increase of about 8.2 pp. (from 2013-2016) owing to a sharp decline in its value added (denominator of the rate).

R&D PERSONNEL IN THE ICT SECTOR at EU and global level

R&D personnel in the ICT sector included 284 000 full-time equivalents (FTEs) in 2013, a figure which rose over the medium-term period (2006-2013), recovering after 2009. The ICT services sector (excluding telecommunications) employed 173 000 FTEs in 2013 (61 % 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 47 000 FTEs in 2013, representing a fall over the medium-term (2006-2013) with signs of recovery after 2010. The communication equipment sector was in constant decline. The telecommunications sector employed 29 000 FTEs in 2013 (10 % of R&D personnel in the ICT sector), and was on a downward trend (falling 24 % from its peak of 39 000 FTEs in 2010).

R&D personnel in the ICT sector (comprehensive definition*) made up 19 % of total R&D personnel in 2013, a figure which remained stable over the medium-term period. However, the EU (19 %) and China (16 %) were behind Japan (28 %) in 2013 (comparable operational definition*, no data available for the US but the ICT/total rate for R&D researchers stood at nearly 40 %, compared with 30 % for Japan and 21 % for the EU) and over the medium-term period.

* See methodological note.

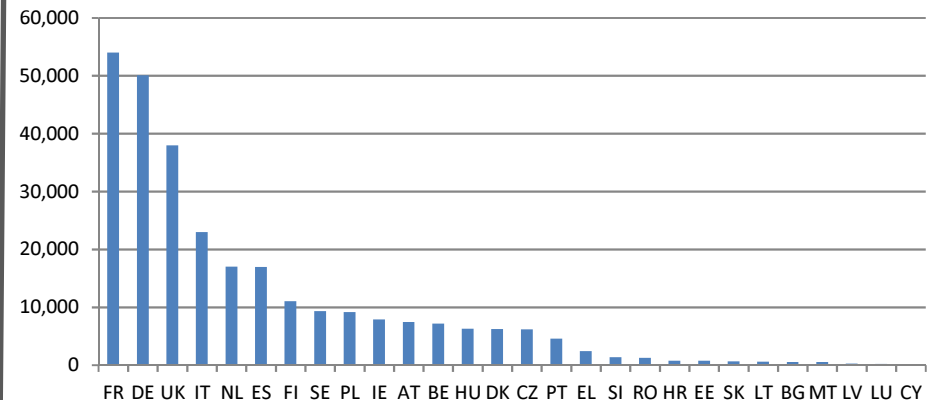


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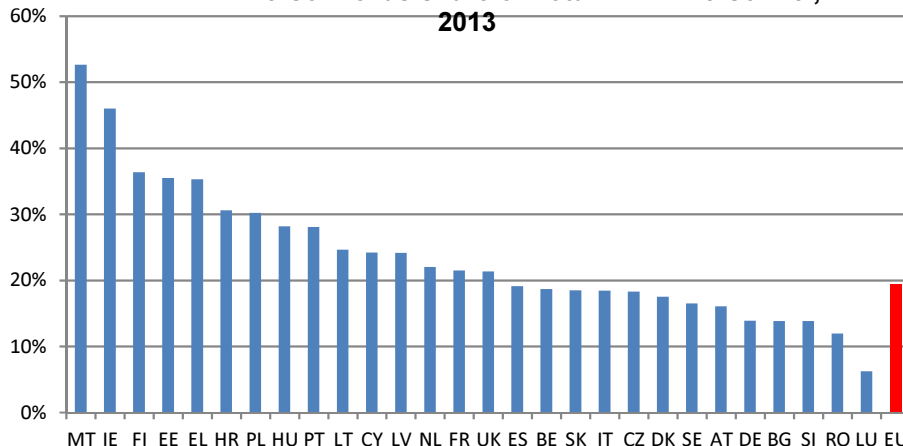
R&D PERSONNEL IN THE ICT SECTOR by Member State

The four largest economies were also the **four biggest employers** of R&D personnel in the ICT sector in 2013 – France (54 000 or 19 %), Germany (50 000 or 18 %), the United Kingdom (38 000 or 13 %) and Italy (23 000 or 8 %). Together, the four biggest employers represented 58 % of total R&D personnel in the ICT sector in 2013.

R&D Personnel in the ICT sector, 2013 (FTE)



ICT BERD Personnel as share of Total BERD Personnel,
2013



Malta (53 %) and Ireland (46 %) were the two countries with the highest concentration of R&D personnel in the ICT sector in 2013. Luxembourg had the lowest concentration (less than 10 %).

Other strong performers (with between 35 % and 40 % of R&D personnel in the ICT sector in 2013) were Finland (36 %), Estonia (36 %) and Greece (35 %).

Source: JRC-IPTS calculations and estimates, based on EUROSTAT data, PREDICT project

PUBLIC FUNDING ICT R&D EXPENDITURE at EU and global level

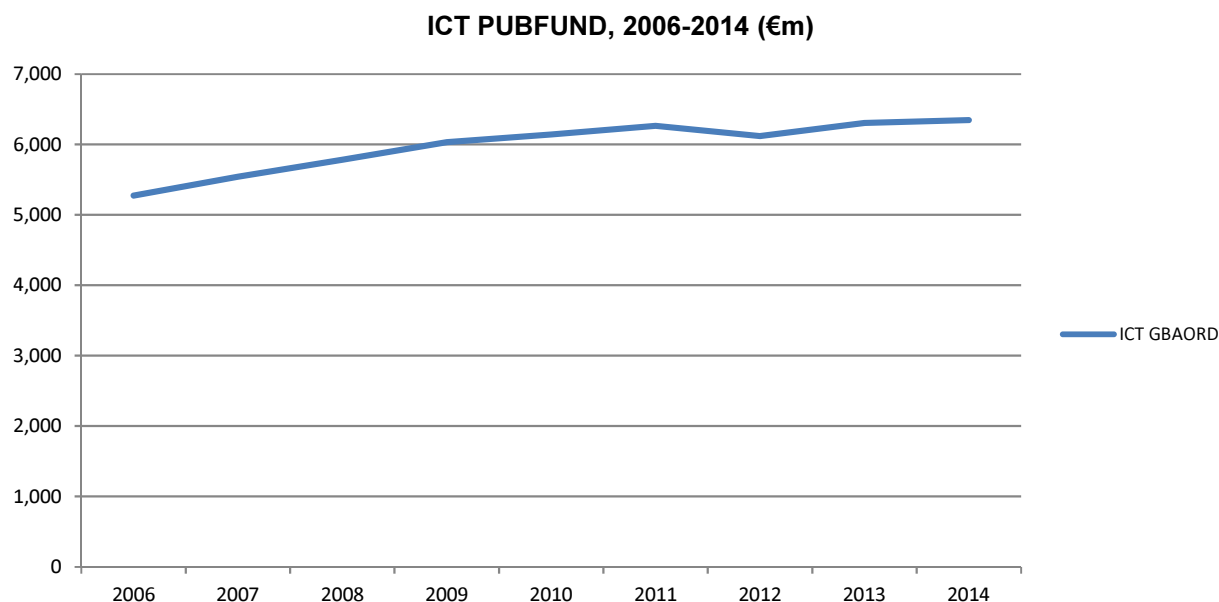
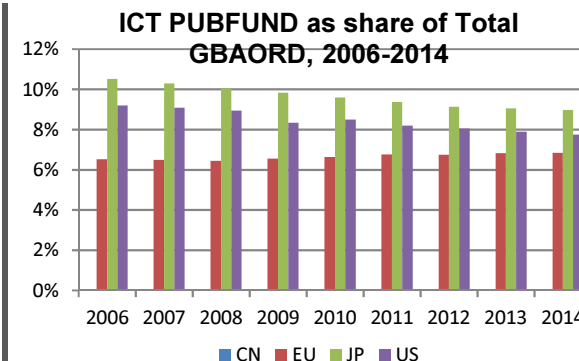
After rising for several years, the estimated level of publicly funded expenditure on ICT R&D in the EU fell in 2012, but recovered in 2013, and by 2014 had exceeded its historical peak of €6.2 bn in 2011, reaching €6.3 bn.

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 was below the necessary trend line in 2014, with a gap of about 20 %.

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

In 2014*, ICT public funding represented 6.8 % of EU total 'government budget appropriation or outlays for R&D' (GBAORD), a figure which remained broadly stable over the medium-term period.

The EU was lagging behind the US (7.7 %) and Japan (9.0 %), even though both those countries saw some decline in their rates (no data available for China).



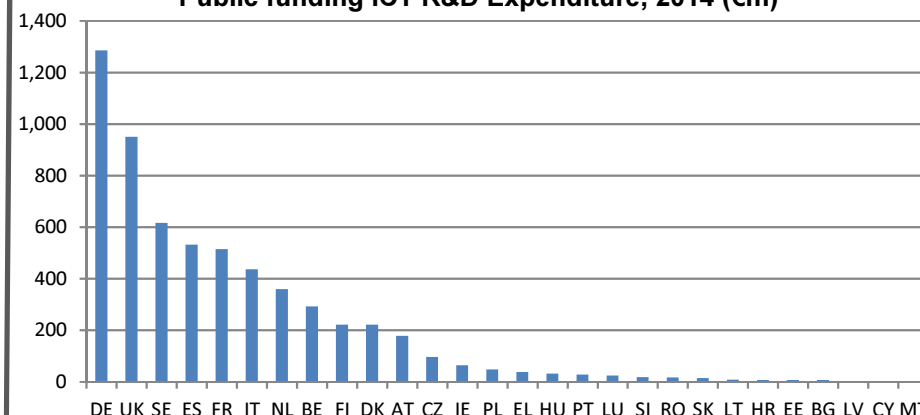
Source: JRC-IPTS calculations and estimates, based on EUROSTAT data, PREDICT project

PUBLIC FUNDING ICT R&D EXPENDITURE by Member State

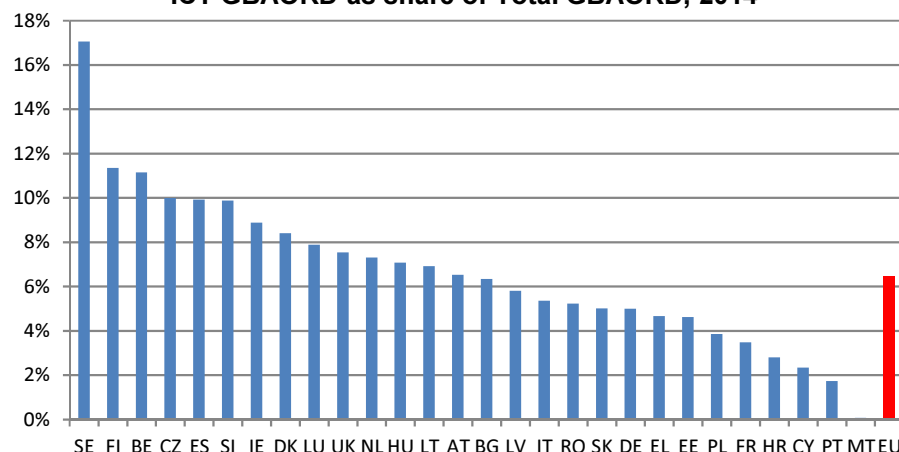
The **five biggest public funders** of R&D in ICT in 2014 were Germany (€1.3 bn or 21 %), followed by the United Kingdom (€0.95 bn or 16 %), Sweden (€0.62 bn or 10 %), Spain (€0.53 bn or 8.8 %) and France (€0.52 bn or 8.5 %).

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

Public funding ICT R&D Expenditure, 2014 (€m)



ICT GBAORD as share of Total GBAORD, 2014



The ranking of ICT GBAORD as a proportion of total GBAORD in 2014 again reveals a strong performance by Nordic countries with Sweden in first place at 17 % and Finland in second place with 11 %.

However, other countries also attribute special importance to ICT in their R&D public spending, such as Belgium (ranked third with 11 %), the Czech Republic (fourth with 10 %) and Slovenia and Spain (in joint fifth position with 9.9 %).

Source: JRC-IPTS calculations and estimates, based on EUROSTAT data, PREDICT project

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 contribution of the trade balance of high-tech and medium-tech products to the total trade balance.

SERV: Knowledge-intensive services as a share of the total services exports.

- DYN_{ICT} : employment in fast-growing firms of innovative sectors.

DYN is a measure of fast-growing firms based on the growth in the number of employees (all employees, with no distinction according to education)

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

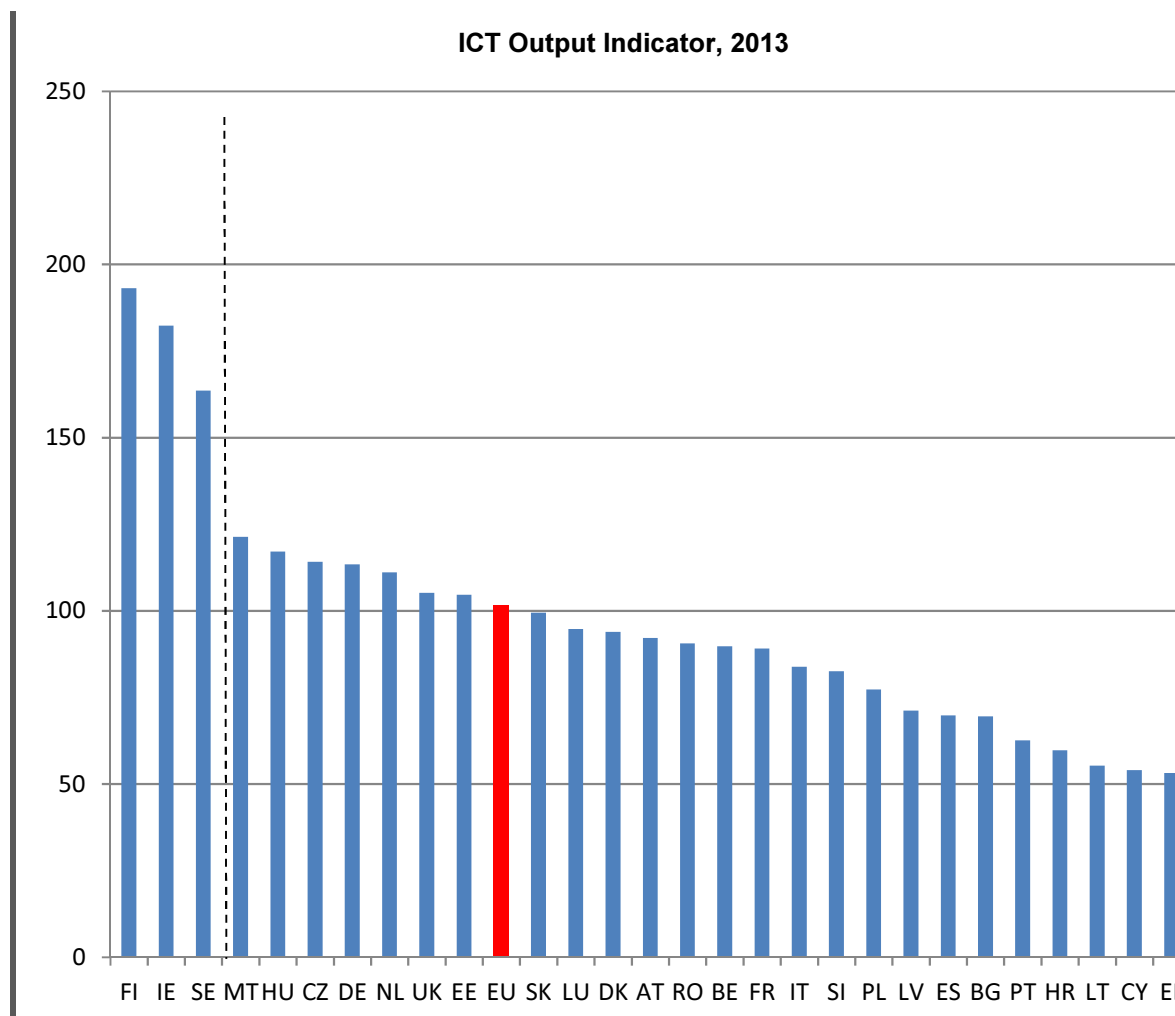
'Developing an indicator of innovation output', Commission Staff Working Document – SWD (2013) 325 final.

ICT INNOVATION OUTPUT INDICATOR by Member State

A group of three countries takes a significant lead with scores above 150 (the benchmark was been set to equal 100 for Europe in 2011): Finland (193), Ireland (182) and Sweden (164).

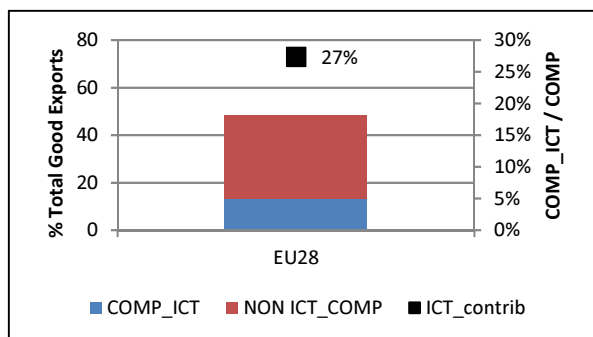
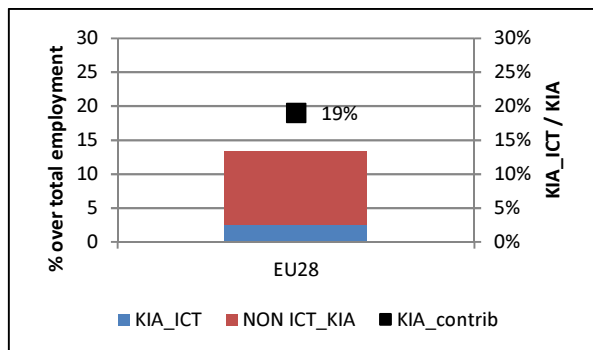
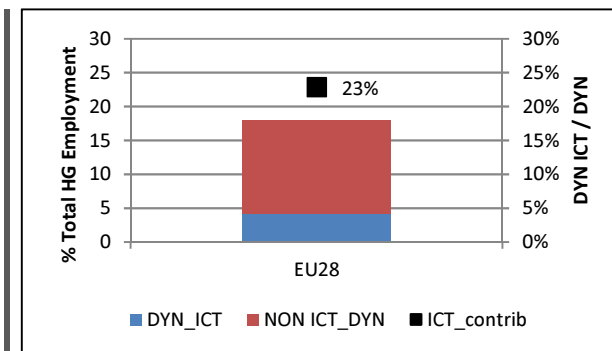
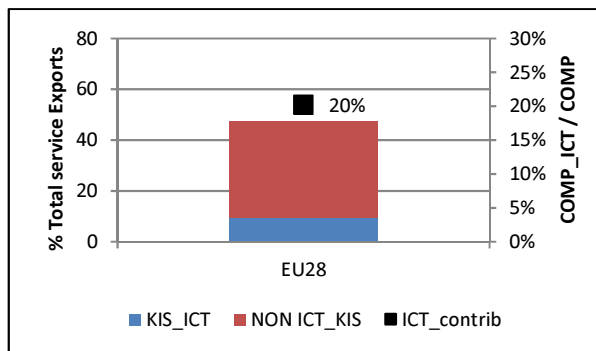
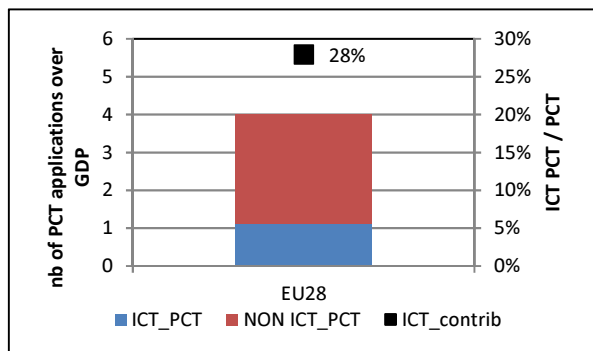
The three top scores in ICT innovation output result from very high ICT contributions in the trade of knowledge-intensive services, above average levels of fast-growing innovative ICT employment for Ireland and remarkable results for ICT patenting in Finland and Sweden.

At the lowest end of the scale are Lithuania (with a score of 55), Cyprus (54) and Greece (53).



Source: JRC-IPTS calculations and estimates, based on EUROSTAT data, PREDICT 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_IGF).
2. 19 % in absorption of skills as measured by employment in knowledge-intensive activities (KIA_IGF).
3. 27 % in competitiveness of knowledge goods as measured by exports of medium-high-tech goods (COMP_GOOD_IGF).
4. 20 % in competitiveness of knowledge services as measured by exports of knowledge-intensive services (KIS_IGF).
5. 23 % in innovative firms' dynamics as measured by employment of innovative fast-growing firms (DYN_IGF)