



# **Digital Economy and Society Index (DESI) 2021**

## **The EU ICT Sector and its R&D Performance**

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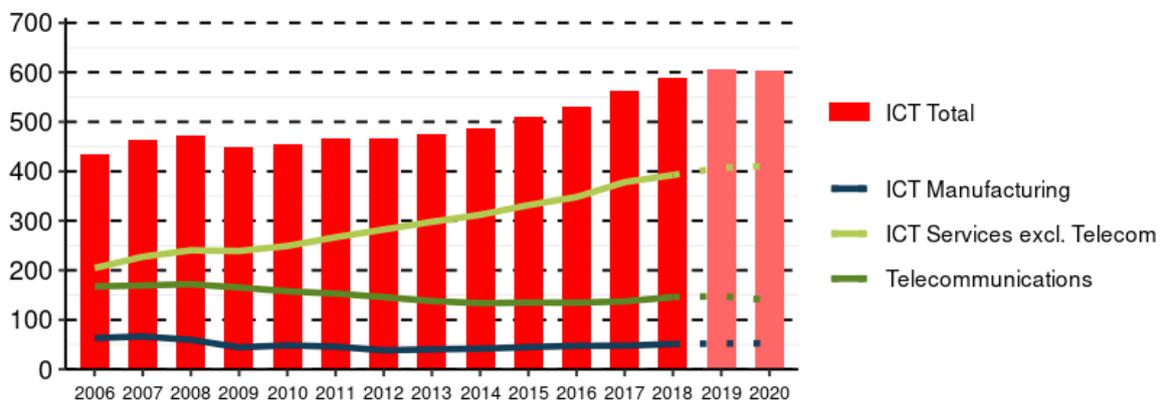
# 1 The EU ICT Sector and its R&D Performance

## 1.1 Value added

The value added of the EU27 ICT sector was EUR 590 billion in 2018<sup>1</sup>, and it is expected to continue to have grown in 2019, although it should probably have stagnated in 2020 due to the COVID-19 crisis impact. A breakdown by sub-sector shows, as in previous years, the predominance of ICT services (EUR 537 billion and 91% of total ICT sector value added in 2018) over ICT manufacturing.

The ICT services sub-sector (excluding telecommunications) was the only ICT sub-sector that saw an increase in value added between 2006 and 2018, growing to EUR 390 billion. Both the telecommunications and ICT manufacturing sub-sectors experienced a decline in the same period, only slightly recovering some of this decline in the last 3 years.

Figure 1 ICT sector Value Added, EUR billion, 2006-2020

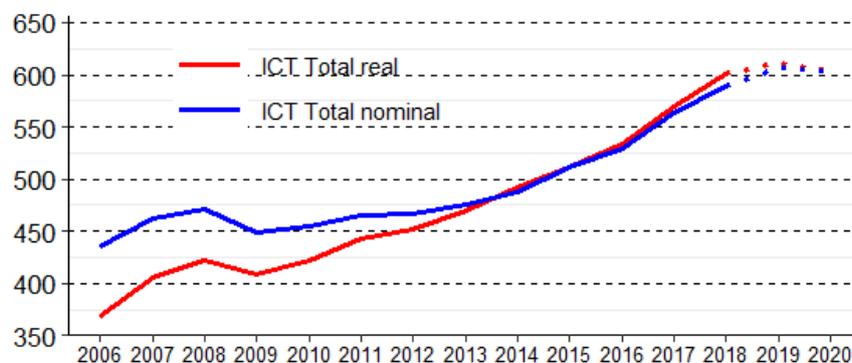


Note: Values for the years 2019 and 2020 are nowcasted data.

Source: Commission calculations and estimates based on PREDICT project.

The value added of the ICT sector grew much faster in real terms than the rest of the economy. Although the value added of the ICT sector increased by 35% in nominal terms (in line with GDP, which grew by 34%), it increased by 60% in real terms in 2006-2018 (while GDP grew by 14% in real terms). However, this difference was more accentuated until 2013. These trends are expected to have decreased in 2019 and 2020 due to the stagnation of the value added in 2020 and the increase in prices in the ICT sector in 2019 and 2020 (see *Prices*).

Figure 2 ICT sector Value Added, nominal and deflated, EUR billion, 2006-2020



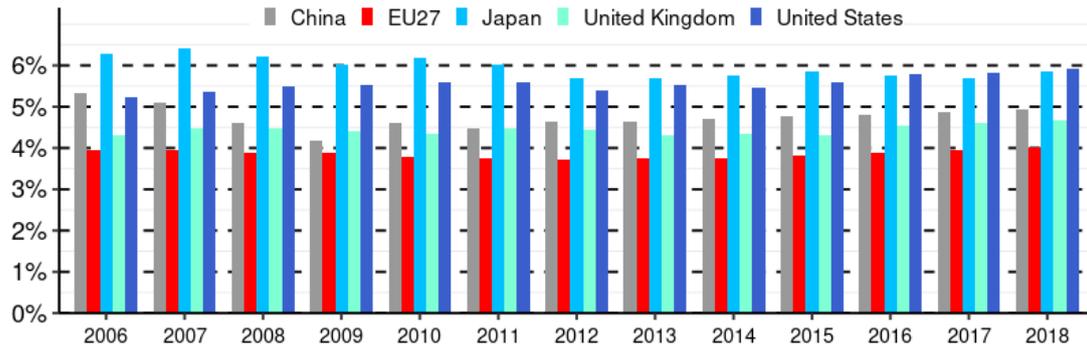
Note: Values for the years 2019 and 2020 are nowcasted data.

<sup>1</sup> All the EU indicators and time series have been calculated based on 27 countries. Therefore, the values presented are not directly comparable with the DESI 2020 report that is based on 28 countries for the EU.

Source: Commission calculations and estimates based on PREDICT project.

The value added of the ICT sector accounted for 4.4% of EU GDP in 2018 according to the comprehensive definition (see *Methodological note*). According to the operational definition (see *Methodological note*), which enables world comparisons, the value added of the ICT sector in the EU27 (4.0%) was lower than that of the US (5.9%), Japan (5.8%), China (4.9%) and the UK (4.7%) in 2018. The EU's ICT sector only grew marginally as a percentage of GDP in 2018 compared to 2016, but so did most of its competitors. The exception were China and Japan where the ICT sector as a percentage of GDP decreased. Already in 2017, Japan was surpassed by the US as the country where the ICT sector accounts for the highest percentage of GDP.

Figure 3 ICT sector share of GDP 2006-2018

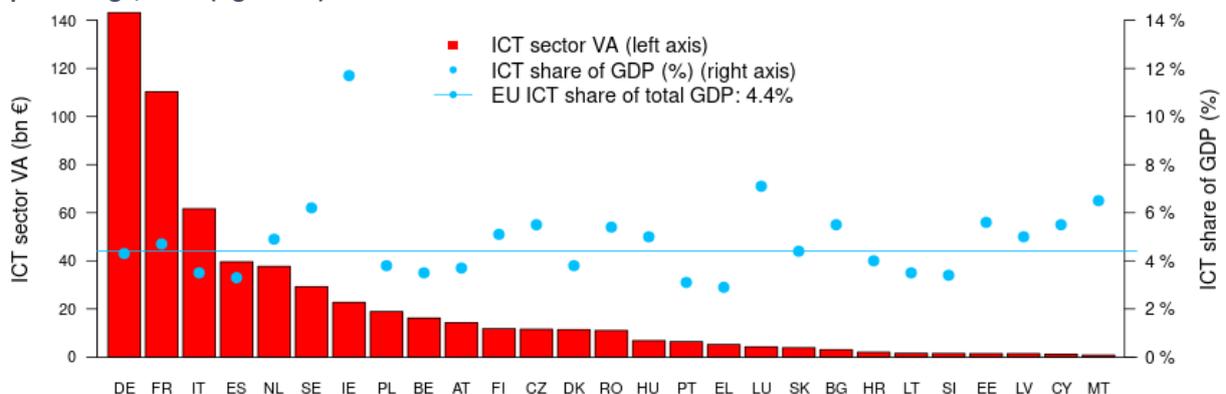


Source: Commission calculations and estimates based on PREDICT project.

In the EU27, Germany, France, Italy, Spain and the Netherlands were the five biggest contributors to ICT sector value added in 2018: Germany (EUR 143 billion or 24% of EU value added in ICT), France (EUR 110 billion or 19%), Italy (EUR 62 billion or 10%), Spain (EUR 40 billion or 7%) and the Netherlands (EUR 38 billion or 6%). Together, these five countries accounted for 66% of total EU ICT sector value added in 2018.

However, Ireland had the largest ICT sector as percentage of GDP, at 11.6% in 2014 (the latest year for which data were available), while Greece lagged behind at 2.9%. After Ireland, the countries with the largest ICT sector as percentage of GDP were Luxembourg (7%), Malta (6.5%), Sweden (6.2%), Estonia (5.6%), and Cyprus, Czechia and Bulgaria (all at 5.5%). Romania, Finland, Hungary and Latvia also had a large ICT as percentage of GDP (5% or higher). ICT as a percentage of GDP remained broadly unchanged between 2006 and 2018, except in Ireland where it grew by 3.7 percentage points and in Finland, where it fell by 3.5 percentage points.

Figure 4 ICT sector Value Added, EU27, EUR billion, 2018 (left axis) and ICT sector share of GDP, EU27, percentage, 2018 (right axis)



Note: Data for Ireland refers to 2014.

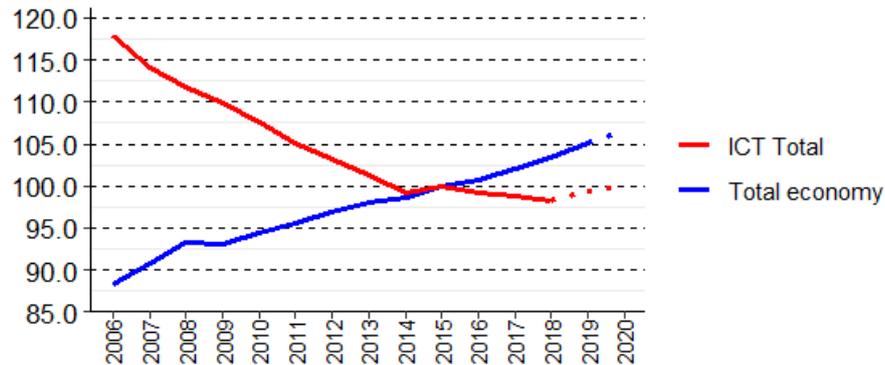
Source: Commission calculations and estimates based on PREDICT project.

## 1.2 Prices

ICT prices continued to fall in 2016-2018 after a spike in 2015. However, the decline in prices is forecasted to have slowed down in 2018 to start increasing in 2019 and 2020.

Prices in the ICT sector fell by 16.5% between 2006 and 2018, while prices in general grew by 17% over the same period. This highlights the particular nature of product prices in the ICT sector, which also incorporates improvements in the quality of products.

**Figure 5 Price index, ICT sector and overall economy, index base 2015=100, 2006-2020**

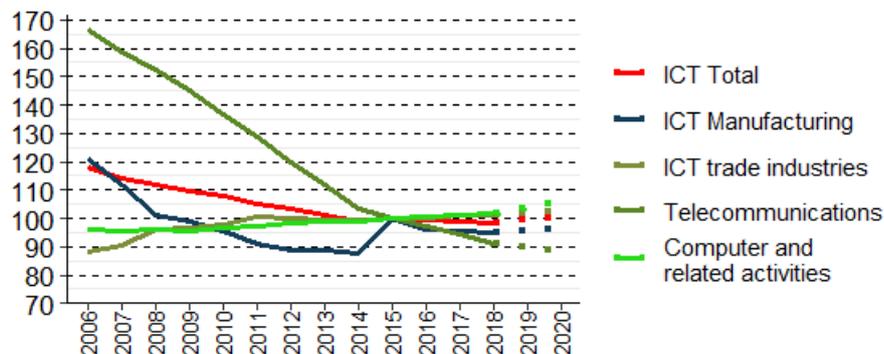


Note: Values for the year 2020 and ICT sector in 2019 are nowcasted data.

Source: Commission calculations and estimates based on PREDICT project.

An analysis by sub-sector shows a contrast: while some sub-sectors experienced a dramatic drop in prices (the percentage drop in telecommunications was double than in ICT manufacturing), others saw growth (prices in the ICT trade industry increased 15%; in computer and related activities, they increased 6%) between 2006 and 2018. However, following the general trend of the ICT sector, the prices in all sub-sectors except in telecommunications are expected to have increased in 2019 and 2020.

**Figure 6 Price index, ICT by sub-sector, index base 2015=100, 2006-2020**



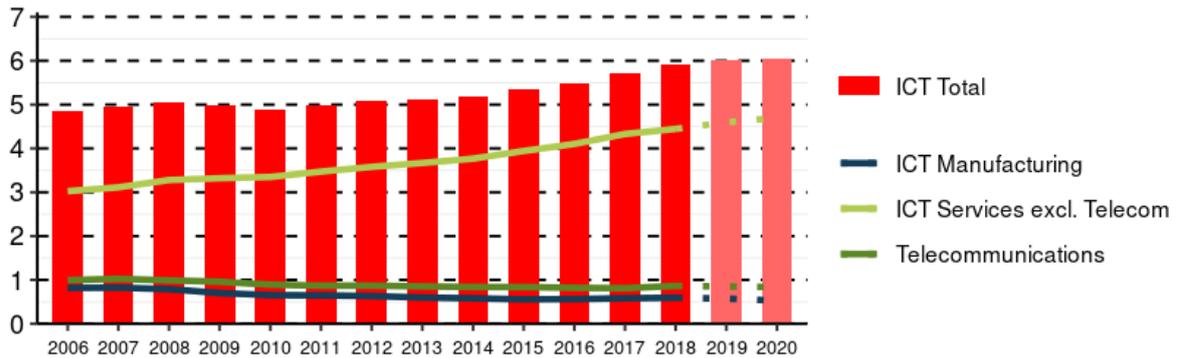
Note: Values for the years 2019 and 2020 are nowcasted data.

Source: Commission calculations and estimates based on PREDICT project.

## 1.3 Employment

The EU27 ICT sector employed 5.9 million people in 2018, continuing an upward trend since 2010. The ICT services sub-sector (excluding telecommunications) was the main employer with 4.4 million people in 2018, accounting for 75% of total ICT employment. This is the only sub-sector that recorded growth (of 47%) between 2006 and 2018. The telecommunications sub-sector employed 864,000 people in 2018, down by 13% since 2006. The ICT manufacturing sub-sector employed 593,500 people in 2018, a drop of 27% since 2006.

Figure 7 Employment in the ICT sector, million individuals, 2006-2020

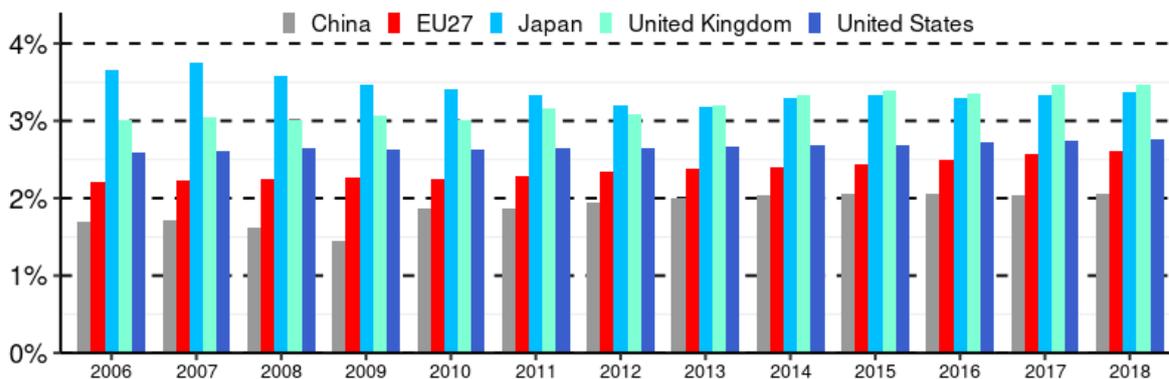


Note: Values for the years 2019 and 2020 are nowcasted data.

Source: Commission calculations and estimates based on PREDICT project.

The EU27 employment of the ICT sector accounted for 2.9% of EU total employment in 2018 according to the comprehensive definition (see *Methodological note*). In the operational definition (see *Methodological note*), which makes it possible to compare with non-EU countries, the US (where the ICT sector accounts for 2.7% of total employment) was slightly ahead of the EU (2.6%), which in turn was ahead of China (2.1%). However, all three lagged well behind Japan (3.3%) and the UK (3.4%) in 2018.

Figure 8 ICT sector share of total employment, percentage, 2006-2018

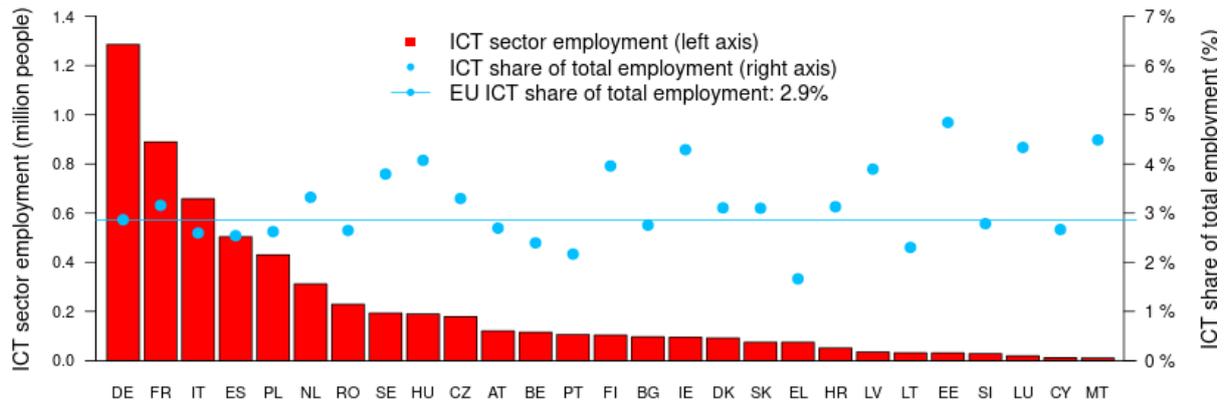


Source: Commission calculations and estimates based on PREDICT project.

The five largest employers in the EU27 ICT sector in 2018 were Germany, France, Italy, Spain and Poland. Germany (over 1.3 million people, or 22% of total EU ICT sector employment), France (889,000 people or 15%), Italy (658,000 people or 11%), Spain (504,000 people or 9%) and Poland (430,000 people or 7%). Together, the five largest employers accounted for 64% of total ICT sector employment in the EU in 2018.

In 2018, Estonia had the largest ICT sector share over total employment (4.8%) and Greece the smallest (1.7%). Other countries that performed well in 2018 included Malta (4.5%) and Luxembourg (4.3%). Ireland and Hungary were close behind at around 4%. Between 2006 and 2018, ICT sector employment as a share of total employment remained stable in most countries, although, small countries like Estonia and Latvia made significant progress, showing growth of 2.3 percentage points each.

Figure 9 Employment in the ICT sector, EU27, million individuals, 2018 (left axis) and ICT sector share of total employment, EU27, percentage, 2018 (right axis)

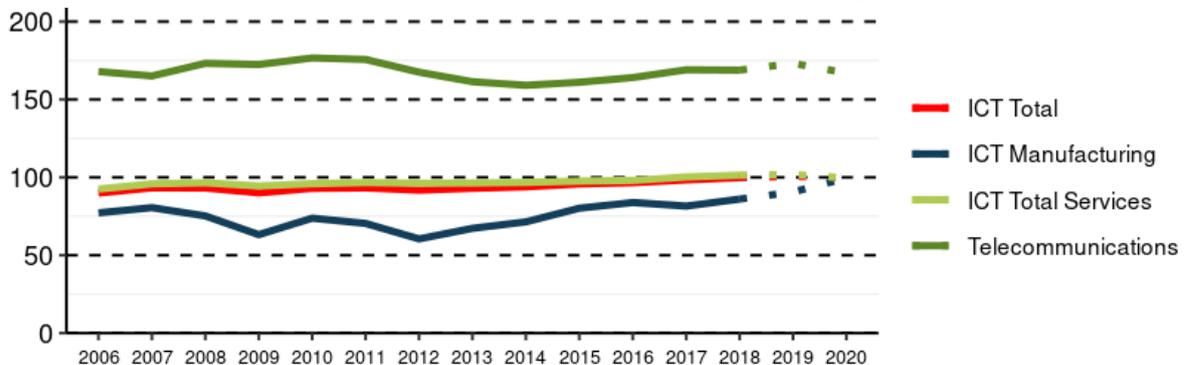


Source: Commission calculations and estimates based on PREDICT project.

#### 1.4 Productivity

Labour productivity in the EU27 ICT sector (for a comprehensive definition - see *Methodological note*) was EUR 100,000 per person employed in 2018, an 11% increase compared to 2006. Labour productivity in the ICT manufacturing sub-sector (EUR 86,000 per person employed in 2018) was below the average for the broader ICT sector. However, it is expected to have increased closer to the broader ICT sector in 2019 and 2020. Labour productivity in ICT services (i.e. services and trade), which was EUR 101,000 per person employed in 2018, is less sensitive to business cycles and was closer to the total ICT sector average than that of ICT manufacturing. Labour productivity in the telecommunications sub-sector was by far the highest (at EUR 169,000 per person employed in 2018), but it is on a downward trend that is expected to have continued in 2019 and 2020.

Figure 10 Productivity in the ICT sub-sector, thousand EUR per individual employed, 2006-2020



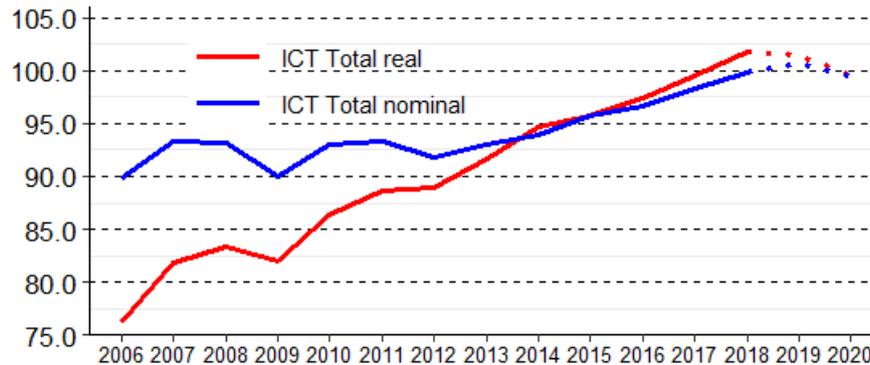
Note: Values for the years 2019 and 2020 are nowcasted data.

Source: Commission calculations and estimates based on PREDICT project.

The ICT sector had higher labour productivity (in nominal terms) and grew faster (in real terms) between 2006 and 2018 than the overall economy. Labour productivity in the ICT sector was greater than in the rest of the economy (EUR 100,000 per person employed versus EUR 65,000 per person employed in 2018). Although it grew less quickly in nominal terms (up 11% against 26% nominal growth between 2006 and 2018), labour productivity in the ICT sector grew faster than that of the overall economy in real terms (up 33% against 8% real growth between 2006 and 2018). However, this trend is expected to have decreased in 2019 and 2020, explained by the negative impact of the COVID-19 crisis on value added and the increase in prices in the ICT sector over the same period (see

Prices ). Likewise, the trend in nominal terms is expected to have decreased, mainly explained by the increase of employment, especially in ICT services.

Figure 11 Productivity, nominal and deflated, thousand EUR per individual employed, 2006-2020

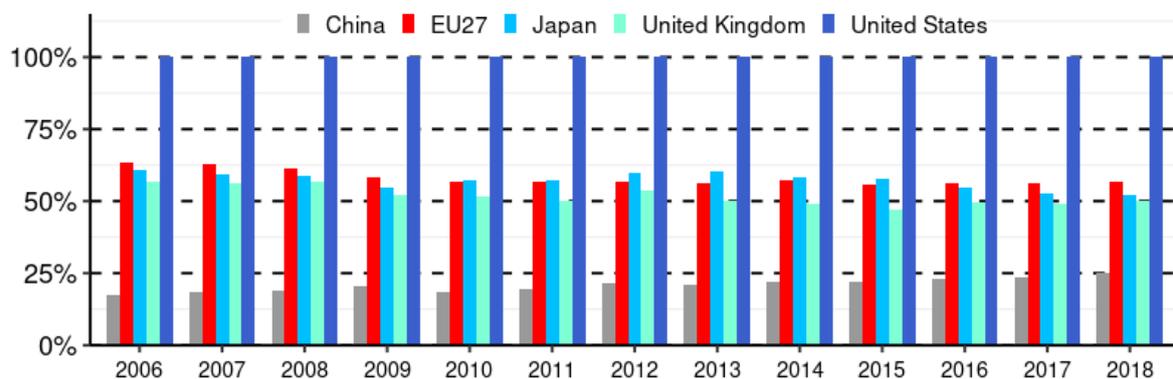


Note: Values for the years 2019 and 2020 are nowcasted data.

Source: Commission calculations and estimates based on PREDICT project.

According to the operational definition (see *Methodological note*), which makes it possible to compare with non-EU countries, labour productivity in the EU27 ICT sector is considerably below that of the US (the EU index is 57 against the US index of 100). Labour productivity in the EU ICT sector is ahead of Japan (which has an index of 52) and the UK (which has an index of 50) and far ahead of China (index of 25).

Figure 12 ICT sector productivity, EUR PPS per individual employed, index US=100, 2006-2018

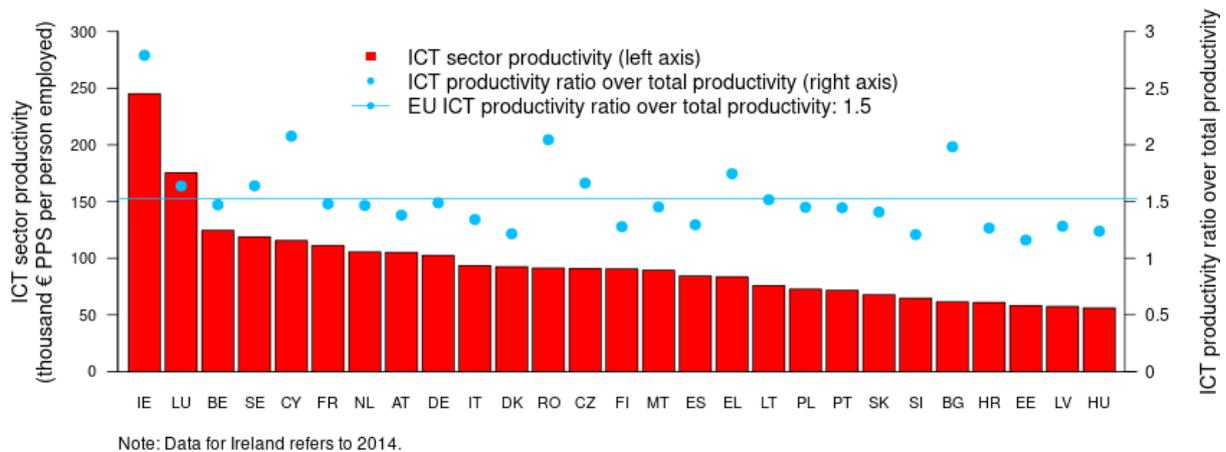


Source: Commission calculations and estimates based on PREDICT project.

In terms of labour productivity in the ICT sector, Ireland (PPS EUR 254,000 per person employed) by far led the way in 2014 (the latest year for which data were available), but Luxembourg (PPS EUR 175,000 per person employed) and Belgium (PPS EUR 125,000 per person employed) also fared well in 2018. At the opposite end of the scale were Hungary (PPS EUR 56,000 per person employed), Latvia (PPS EUR 57,000 per person employed), and Estonia (PPS EUR 58,000 per person employed).

The picture for labour productivity in the economy was similar. Ireland (PPS EUR 127,000 per person employed), Luxembourg (PPS EUR 107,000 per person employed) and Belgium (PPS EUR 84,500 per person employed) were the best-performing countries, while Bulgaria (PPS EUR 31,000 per person employed) and Romania (PPS EUR 45,000 per person employed) were at the bottom of the scale. However, the ratio of labour productivity in the ICT sector over the economy indicated a good performance of countries at the bottom of the scale (e.g. Bulgaria).

Figure 13 Productivity in the ICT sector, EU27, thousand EUR PPS per individual employed, 2018 (left axis) and ratio of ICT productivity over total productivity, EU27 (right axis)



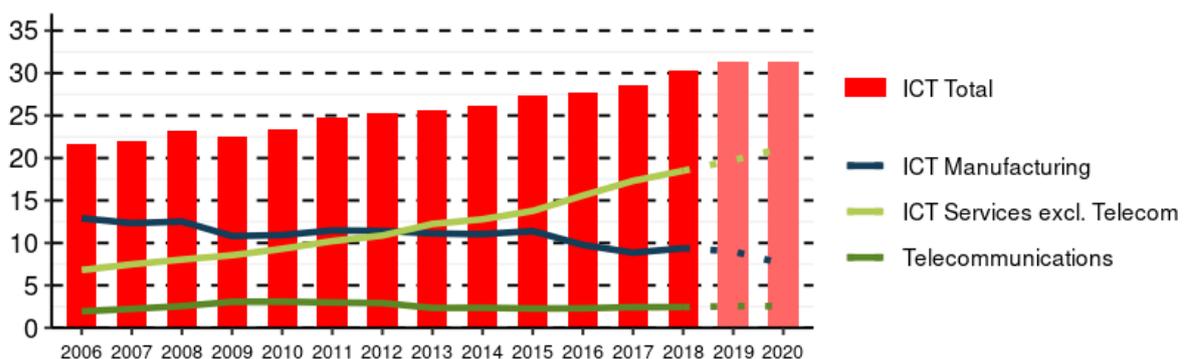
Source: Commission calculations and estimates based on PREDICT project.

### 1.5 R&D expenditure

R&D expenditure by business enterprises (BERD) in the EU27 ICT sector amounted to EUR 30 billion in 2018, its highest value in the 2006-2018 period, and well above its low point of EUR 22 billion in 2006. A breakdown by sub-sector reveals a more balanced situation for BERD than for value added. Despite accounting for only 9% of ICT sector value added, the ICT manufacturing sub-sector was responsible for 30% of total ICT BERD (EUR 9 billion), while the ICT services sub-sector was responsible for 70% (EUR 21 billion) of ICT BERD in 2018.

Between 2006 and 2018, there was a divergence in R&D expenditure in the ICT sector. The ICT manufacturing sub-sector experienced structural decline in R&D expenditure over this period (falling by 27% between 2006 and 2018), whereas the ICT services sub-sector saw a structural increase in R&D expenditure (rising by 139% between 2006 and 2018). The ICT services sub-sector excluding telecommunications saw particularly strong growth with R&D expenditure between 2006 and 2018.

Figure 14 R&D expenditure by business enterprises (BERD) in the ICT sector, EUR billion, 2006-2020

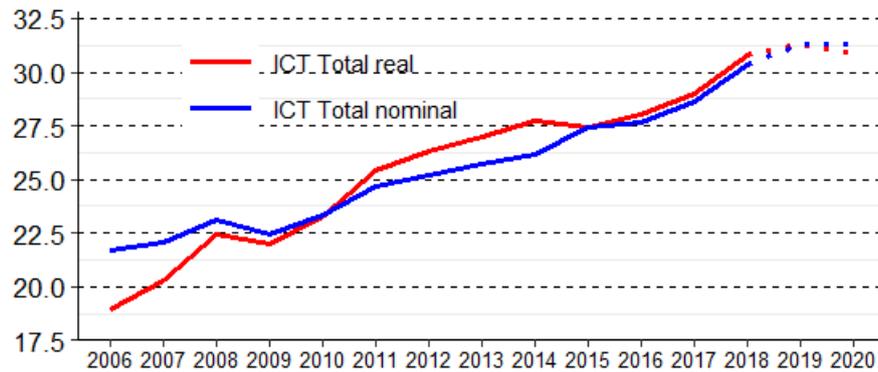


Note: Values for the years 2019 and 2020 are nowcasted data.

Source: Commission calculations and estimates based on PREDICT project.

In real terms, R&D expenditure by business enterprises in the ICT sector grew faster than in the general economy (by 62% versus 44% in 2006-2018). Like productivity, this trend is expected to have decreased in 2019 and 2020, explained by the negative impact of the COVID-19 crisis and the increase in prices in the ICT sector over the same period (see *Prices*).

Figure 15 R&D expenditure by business enterprises (BERD) in the ICT sector, nominal and deflated, EUR billion, 2006-2020

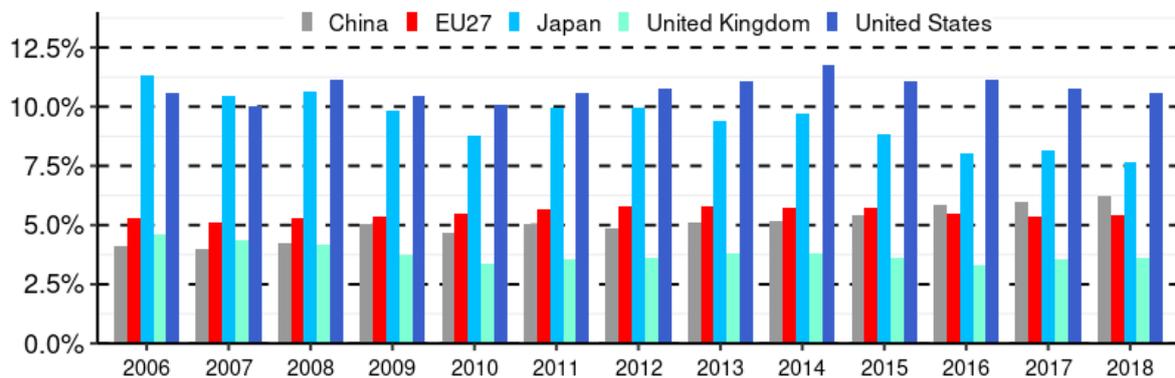


Note: Values for the years 2019 and 2020 are nowcasted data.

Source: Commission calculations and estimates based on PREDICT project.

R&D intensity (BERD/VA) in the ICT sector (for a comprehensive definition - see *Methodological note*) was 5.1% in 2018. According to the operational definition (see *Methodological note*), which makes it possible to compare with non-EU countries, the EU (at 5.4% R&D intensity) lagged behind China (at 6.2%) but gained over the UK (at 3.6%). While the EU, the UK and China, lagged behind the US (10.6%) and Japan (7.7%) in R&D intensity in 2018.

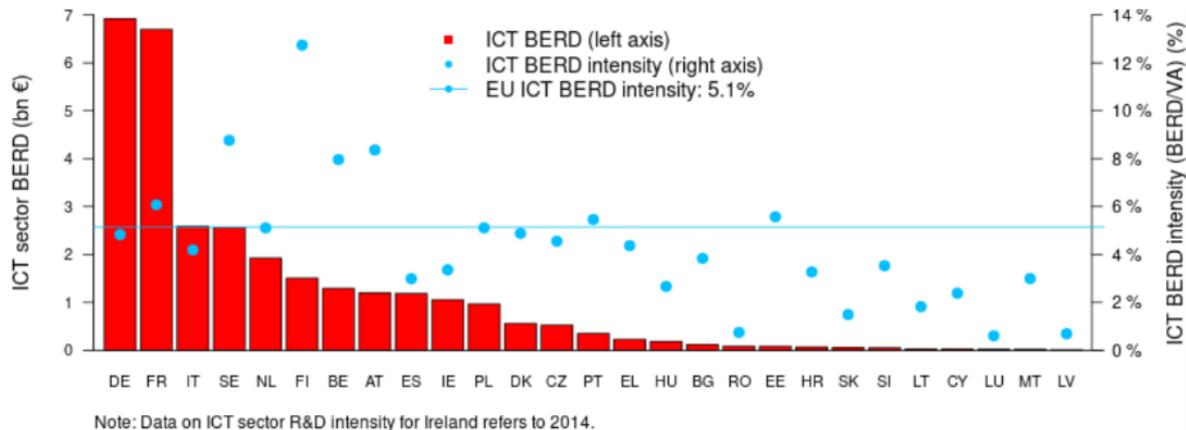
Figure 16 ICT sector R&D Intensity (BERD/VA), percentage, 2006-2018



Source: Commission calculations and estimates based on PREDICT project.

The EU's six main contributors in terms of R&D expenditure by business enterprises in the ICT sector in 2018 were Germany, France, Italy, Sweden, the Netherlands and Finland. R&D expenditure in Germany was EUR 6.9 billion or 23% of the EU total; in France was EUR 6.7 billion or 22% of the EU total; in Italy it was EUR 2.6 billion or 9% of the EU total; and in Sweden it was EUR 2.5 billion or 8% of the EU total. In the Netherlands, R&D expenditure in the ICT sector was EUR 1.9 billion or 6% of the total, and in Finland it was EUR 1.5 billion or 5% of the total. Together, these six countries accounted for 73% of total R&D expenditure by business enterprises in the ICT sector in the EU.

Figure 17 R&D expenditure by business enterprises (BERD) in the ICT sector, EU27, EUR billion, 2018 (left axis) and ICT sector R&D intensity (BERD/VA), EU27, percentage, 2018 (right axis)



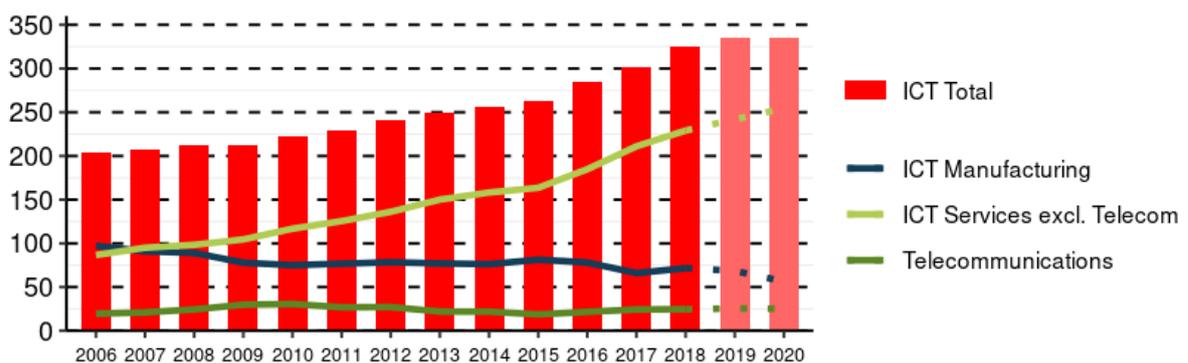
Source: Commission calculations and estimates based on PREDICT project.

Finland led the EU with a 12.7% R&D intensity rate (BERD/VA) in ICT in 2018. Sweden and Austria had rates close to 8.5%. Other strong performers included Belgium (8%) and France (6%). Between 2006 and 2018, R&D intensity in ICT remained broadly stable. However, some countries, such as Poland, Belgium and Bulgaria, made significant progress.

## 1.6 R&D personnel

R&D personnel in the EU27 ICT sector accounted for 325,000 full-time equivalents (FTEs) in 2018, a figure which rose between 2006 and 2018, with particularly strong growth after 2011. The ICT services sub-sector (excluding telecommunications) employed 229,000 FTEs in 2018 (accounting for 70% of R&D personnel in the ICT sector, making it the top employer), with a rising trend. The ICT manufacturing sub-sector employed 72,000 FTEs in 2018, fewer than in 2006 despite an increase in the number of people employed in 2015 and 2018. The telecommunications sub-sector employed 24,500 FTEs in 2018 (7.5% of R&D personnel in the ICT sector), down by about 20% from a peak of 30,500 FTEs in 2010.

Figure 18 R&D Personnel (PERD) in the ICT sector, thousand FTEs, 2006-2020



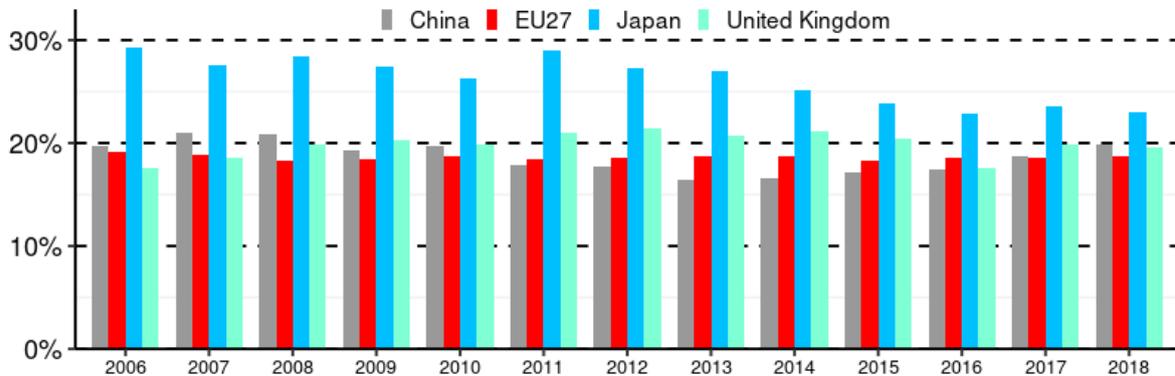
Note: Values for the years 2019 and 2020 are nowcasted data.

Source: Commission calculations and estimates based on PREDICT project.

R&D personnel in the ICT sector (for a comprehensive definition - see *Methodological note*) made up 19.3% of total R&D personnel in 2018, a figure roughly unchanged since 2006. However, according to the operational definition (see *Methodological note*) which makes it possible to compare countries, the EU (where R&D personnel in the ICT sector make up 19% of total R&D personnel), China (where they make up 20%) and the UK (19.5%) were behind Japan (23%) in 2018. China, the

UK and the EU also lagged behind Japan on this metric for every year from 2006 to 2016 (no data available for the US).

Figure 19 ICT sector share of total R&D personnel, percentage, 2006-2018

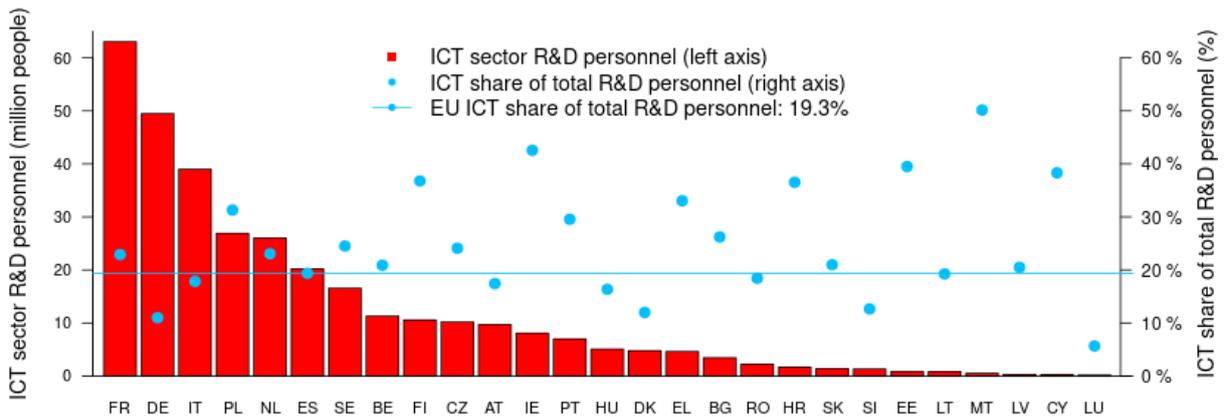


Source: Commission calculations and estimates based on PREDICT project.

The EU27 four biggest employers of R&D personnel in the ICT sector in 2018 were France (63,000 FTEs or 19.5% of R&D personnel in the EU ICT sector), Germany (49,500 FTEs or 15%), Italy (39,000 FTEs or 12%) and Poland (27,000 FTEs or 8.5%). Together, the four biggest employers represented 55% of total R&D personnel in the ICT sector in 2018.

Malta (50%) and Ireland (42.5%) were the two EU countries with the highest concentration of R&D personnel in the ICT sector in 2018. Luxembourg had the lowest concentration (5.6%). Other strong performers were Estonia (39%), Cyprus (38%), Finland (37%), and Croatia (36%).

Figure 20 R&D personnel (PERD) in the ICT sector, EU27, thousand FTEs, 2018 (left axis) and ICT sector share of total R&D personnel (PERD), EU27, percentage, 2018 (right axis)



Source: Commission calculations and estimates based on PREDICT project.

### 1.7 Public funding of ICT R&D

The estimated level of publicly funded expenditure on ICT R&D in the EU27 increased between 2006 and 2019 interrupted only by a fall in 2012 and reached EUR 6.4 billion in 2019. The EU’s Digital Agenda target of doubling publicly funded ICT R&D between 2007 and 2020 requires an annual growth rate of 5.5% (assuming a constant rate of annual growth). Estimated public, ICT R&D expenditure was below the necessary trend line in 2019 but had still reached 4.8% annual growth. In

2019, public funding of ICT R&D represented 7% of EU total government budget allocations for R&D (GBARD), a percentage broadly unchanged since 2006.

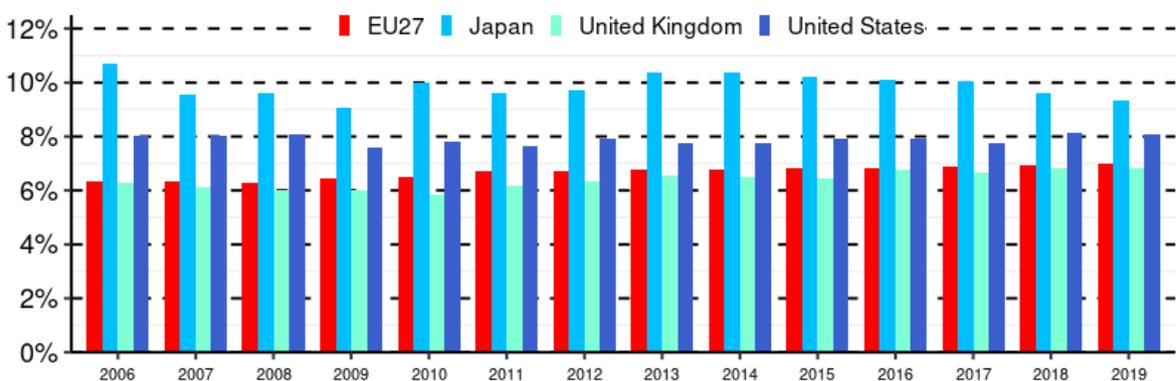
Figure 21 Public funding of ICT R&D (ICT GBARD), EUR billion, 2006-2019



Source: Commission calculations and estimates based on PREDICT project.

Since 2006, the EU has continuously lagged behind the US (where ICT accounted for 8.1% of GBARD in 2019) and Japan (where ICT accounted for 9.3% of GBARD in 2019) since 2006 (no data are available for China). The UK (where ICT accounted for 6.8% of GBARD in 2019) follows closely the EU (6.9%).

Figure 22 ICT GBARD share of total GBARD, percentage, 2006-2019

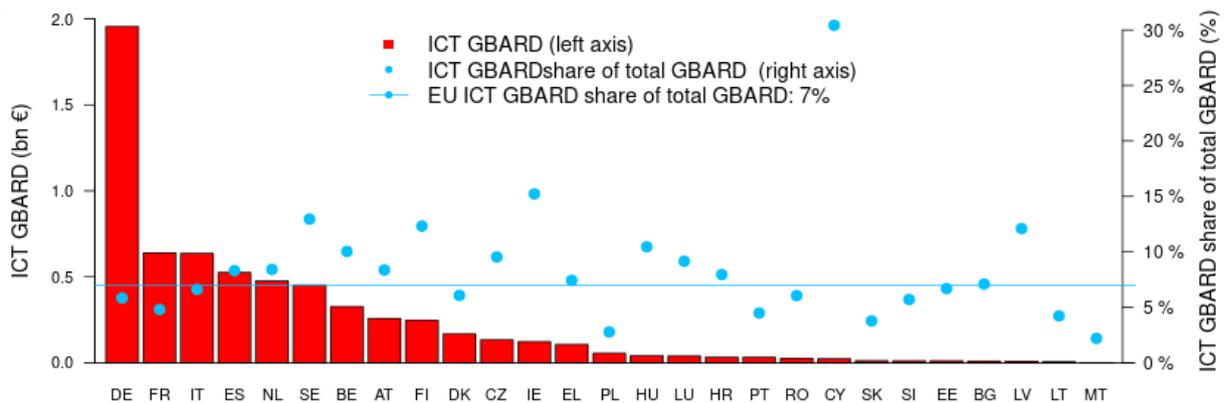


Source: Commission calculations and estimates based on PREDICT project.

The EU27's five biggest public funders of ICT R&D in 2019 were Germany (EUR 1.9 billion or 30.5% of public funding in the EU for ICT R&D), followed by France (EUR 639 million or 10%), Italy (EUR 636 million or 9.5%), Spain (EUR 525 million or 8%) and the Netherlands (EUR 476 million or 7%). Together, those five countries accounted for 65% of total public funding for ICT R&D in the EU.

As in previous years, Cyprus led the way in the EU with the highest rate (30%) of ICT GBARD as a proportion of total GBARD in 2019. The ranking in 2019 again reveals strong performances by Ireland (15%), Sweden (13%), and Finland and Latvia (both close to 12%). In addition, some other countries also pay special attention to ICT in their public spending on R&D, such as Hungary and Belgium (both close to 10%).

Figure 23 Public funding of ICT R&D (ICT GBARD), EU27, EUR billion, 2019 (left axis) and ICT GBARD as share of total GBARD, EU27, percentage, 2019 (right axis)



Source: Commission calculations and estimates based on PREDICT project.

## 1.8 Methodological note

### Definition of the ICT sector

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

#### 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

#### Comprehensive versus operational definition

The comprehensive definition of the ICT sector applies to EU Member States for the period 2008-2018. It corresponds to the definition provided by the OECD in 2007. The operational definition of the ICT sector enables the EU to be compared with non-EU countries over a longer period (2006-2018), as some of these countries do not have the necessary disaggregated information to estimate all the ICT industries included in the comprehensive definition.

The operational definition does not include the following industries: manufacture of magnetic and optical media (268) and ICT trade industries (465).

#### Sector analysis

In the previous section, an analysis by ICT sub-sectors is made for each indicator. The 12 industries are aggregated into two sub-sectors: ICT manufacturing and ICT services, the latter being subdivided into ICT services (excluding telecommunications) and telecommunications.

**Source**

Joint Research Centre – Dir. B Growth and Innovation (JRC– Dir. B). Calculations and estimates from the JRC’s PREDICT<sup>2</sup> project are based on Eurostat, the OECD’s structural analysis database (STAN), EU-KLEMS data and other national sources. All data contained in these databases come from official sources (e.g. Eurostat, OECD, national statistical institutes). Discrepancies with the original sources are due to updates of the original data or the use of multiple auxiliary sources and variables. For more details, see the 2021 PREDICT Dataset Methodology.

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<sup>2</sup> <https://ec.europa.eu/jrc/en/predict>