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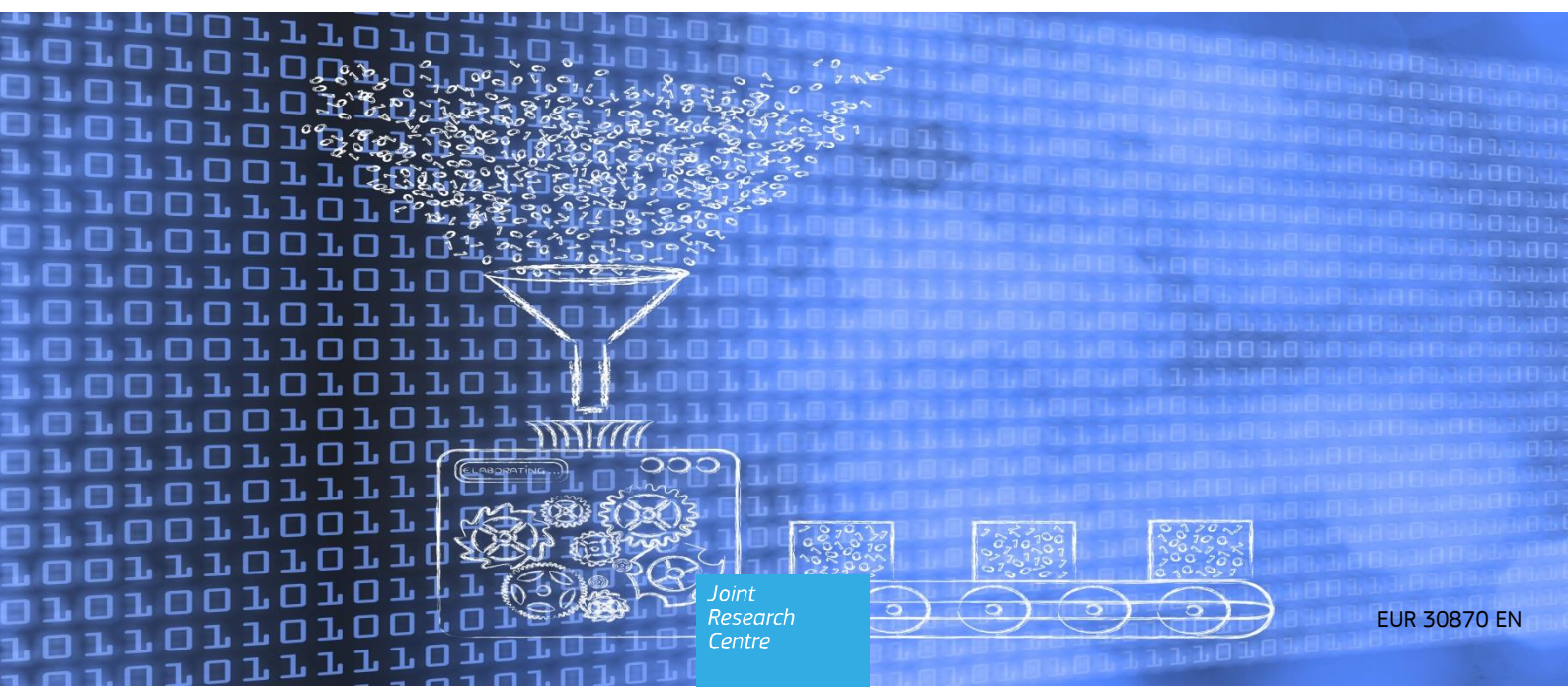
## The 2021 PREDICT Key Facts Report

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

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## **Foreword**

### **PREDICT: Prospective Insights on R&D in ICT**

PREDICT has been producing statistics and analyses on Information and Communication Technologies (ICTs) industries and their R&D in Europe since 2006. The project covers major world competitors including 40 advanced and emerging countries – the EU27 plus Norway, Russia, Switzerland and the United Kingdom in Europe; Canada, the United States and Brazil in the Americas; China, India, Japan, South Korea and Taiwan in Asia; and Australia. It also covers a growing array of indicators related to the ICT content of economic activities.

### **Rationale**

ICTs determine competitive power in the knowledge economy. For the aggregate of the 40 economies under scrutiny in the project, almost one fourth of total Business expenditure in R&D (BERD) originates in the ICT sector alone. Besides the impact that ICT uptake has on the organisation of businesses, this sector also plays an important enabling role for innovation in other technological domains. This is reflected at the EU policy level, where “A Europe fit for the digital age” was identified as one of the six European Commission priorities in 2019. Digitalisation is also a core part of the post-COVID-19 European recovery plan and the driver of the Digital Decade ambitious vision for a successful digital transformation of the European Union by 2030.

### **Statistics and indicators**

PREDICT provides indicators in a wide variety of topics, including value added, employment, labour productivity and BERD, distinguishing fine grain economic activities in ICT and Media and Content industries (up to 22 individual activities, 14 of which are at the class level, i.e. at 4 digits in the ISIC classification) and at a higher level of aggregation for all the other industries in the economy. It also produces data on government financing of R&D in ICT, and total R&D expenditure at the country level. Now-casting of more relevant data in these domains has also been performed for 2019 and 2020, and time series go back to 1995.

### **Team**

PREDICT is a collaboration between the Joint Research Centre (JRC) and the European Commission Communications Networks, Content and Technology (CNECT) Directorate General. Since 2013, data collection and analysis has been carried out jointly by the JRC and the Valencian Institute of Economic Research (Instituto Valenciano de Investigaciones Económicas - Ivie).

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## **Abstract**

The 2021 PREDICT Key Facts Report provides a detailed analysis of the state of ICT R&D activities in the European Union (EU27) and 13 further economies worldwide. This is the 14<sup>th</sup> edition of a series that is published annually. Like the previous editions, an online version is available at: <https://ec.europa.eu/jrc/en/predict>. The report covers the period between 1995 and 2018, providing a long-term analysis of the EU ICT sector and its R&D, covering a whole cycle from the initial expansion years to the double recession that began in early 2008, and the most recent evolution up to 2018. For the EU aggregate the report includes nowcasted data for 2019 and 2020. Therefore, it offers a glimpse of the effects of COVID-19. The statistical information provided by the figures allows the comparison between: the ICT sector and the total economy; the ICT manufacturing sector and the ICT services sector; the four ICT manufacturing sectors, two ICT services sectors, and Media and content and Retail sale via mail order houses or via Internet sectors; EU countries; the EU and the international context (including the most relevant countries in the world economy). The report focuses especially on the ICT R&D macroeconomic dynamics.

## **Keywords**

R&D, ICT, innovation, statistics, digital economy, ICT industry analysis, ICT R&D and innovation

## Executive Summary

ICTs have created new business models, new competitors, new markets and have transformed the production processes, eased the diffusion of new phenomena such as robotisation, automation and artificial intelligence, and have paved the way to the international fragmentation of value chains. The COVID-19 pandemic has accelerated the digital transformation of the economy as it has been a catalyst of these trends. In fact, the pandemic has revealed the potential of ICT and its R&D to mitigate the impact of the restrictions imposed as a result of the pandemic on many areas, such as education, health care, teleworking, e-commerce and so on.

ICTs have been at the core of the European Commission (EC) policies for many years. Already before the outbreak of COVID-19, the EC already had aimed for a Europe fit for the digital age establishing it as one of its six priorities. This was the continuation of a strategy previously initiated more than a decade ago with the Digital Agenda for Europe, the Europe 2020 Strategy for Growth, and the Digital Single Market. The policy response to the challenges of COVID-19 such as the Recovery Plan for Europe have, once again, stressed the importance of ICTs and the digitalisation of Europe's economies, placing it as a top priority. The Next Generation EU recovery instrument aims to reduce the impact of the coronavirus pandemic making European economies more sustainable, resilient, and better prepared for the future. In this context, ICTs and digital transformation are key aspects needed to achieve this goal.

Based on this, the Key Facts Report monitors the evolution of the ICT sector and its R&D in the European Union<sup>1</sup> and its Member States, as well as in other key players in the international ICT markets. It covers with a detailed disaggregation the evolution of value added, employment, labour productivity, and the R&D intensity (business expenditures of R&D, R&D personnel and researchers) of ICT industries. The report tracks the series starting in 1995 up to the year 2018 and offers some nowcasted values for the years 2019 and 2020. **The report is based on the operational definition of the ICT sector, which allows for international comparability with non-EU countries.**

The PREDICT dataset and its accompanying reports provide a permanent monitoring tool of the ICT sector. Since 2006, they serve to develop the [Digital Economy and Society Index](#) (DESI) horizontal chapter on 'The EU ICT Sector and its R&D Performance'. Unlike the Key Facts Report, which uses exclusively the operational definition, the DESI horizontal chapter presents PREDICT data using both the operational definition –when presenting the EU in comparison with non-EU countries–, and the comprehensive definition –when presenting overall results for the EU and its Member States–. This explains the differences that can be observed between this report and the DESI horizontal chapter.

### Highlights of the analysis

- It is confirmed that the ICT sector remains being a very dynamic sector of the economy, outperforming the whole economy in relative measures as R&D intensity or productivity.
- The evolution of the ICT sector in the period 1995-2018 is far more positive than that of the whole economy, showing higher cumulated growth rates in value added, employment, productivity, and business expenditure on R&D (BERD). However, BERD intensity (BERD/GDP in nominal terms) evolved more negatively for ICT (decreased) than for total economy (increased).
- While the ICT sector is estimated to have suffered the effects of the COVID-19 pandemic, it has been less affected than the total economy. ICT value added decreased, ICT employment increased, which implied a reduction of labour productivity in the ICT sector in 2020.
- In the 2006-2018 period, the ICT sector had a positive VA growth in most of the countries of the EU27, with the highest growth rates in real terms shown by Estonia, Austria, Luxembourg, Bulgaria, Cyprus, Czechia and Malta (all above 10% in annual terms).
- In the global context, Asian countries are improving their position, with China and India showing an important improvement between 2006 and 2018. While leadership remains in the US, it is being challenged by China. The EU is not improving its overall position in the international context, what calls for a reflection on the future relative position of the EU's ICT sector in the global landscape.

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<sup>1</sup> Since 2020, the official code used to refer to the EU composition with 27 Member States, without the United Kingdom, is EU27, according to the [Interinstitutional style guide](#) of the Communication department of the European Commission. In addition, EU27\_2020 is the official code used in the reference databases (Eurostat) and also in the PREDICT 2021 Dataset.

## Analysis of the EU27 ICT Sector

The ICT sector is one of the most dynamic sectors in the EU27 economy, as it evolves and develops following the economic cycle and often outperforming many other economic sectors. It stands out for its **high R&D intensity** and for a **productivity** that is higher than that of the whole economy. The size of the EU ICT sector in **2018** amounted to EUR 541 bn value added (VA), employed 5.4 million people and spent EUR 29 bn on R&D business expenditure. The ICT sector represented **4.0% of the EU total value added, 2.6% of total employment, 14.9% of total BERD**, and 18.7% and 21.3% of the R&D personnel and researchers in the EU, respectively.

The **development from 1995 until 2018** shows that the EU ICT sector multiplied its value added in real terms by a factor of 4.0, while the one of the total economy<sup>2</sup> increased by 1.5. The growth of employment was much more moderate: the number of persons employed in ICT in 2018 is 1.6 times the number of persons employed in the same sector in 1995. Labour productivity in the ICT sector grew much faster than labour productivity in the total economy. The value reached in 2018 is 2.6 times the value of 1995 and, according to the estimations carried out in this project, the same trend continued in 2019 but suffered a fall in 2020 as a result of the COVID-19 pandemic. BERD in the ICT sector presents a behaviour that is more dynamic than the one of the total economy. From 1995 to 2018 its value multiplied by a factor of 4.5, and estimated values indicate that this trend has continued in 2019. In the same period, the BERD of the total economy only grew 2.0 times. Nevertheless, BERD intensity presents a decrease in the period 1995–2018 for the ICT sector, while it increases for the total economy.

The estimations for 2020 show that the ICT sector has suffered the effects of the COVID-19 pandemic but has been less affected than the total economy. Value added decreased by only 0.6% in the ICT sector, while 6.2% in the EU economy. Employment in the ICT sector increased by 2.0%, while decreasing by 1.5% in the EU economy. The reduction of labour productivity in the ICT sector in 2020 has been caused by the greater effect of COVID-19 on value added (reduction) than on employment (increase). Public funding of R&D is measured through GBARD. The part of GBARD devoted to funding ICT-related expenditures, i.e., ICT GBARD, grew in the ICT sector by 4.0% annually in nominal terms between 2006 and 2019, whereas in the total economy, it grew at an annual rate of 3.2% (in nominal terms).

Analysing the **ICT sub-sectors** reveals that the more dynamic behaviour of the ICT sector in the EU is mostly due to the ICT services sector. ICT manufacturing experienced a sharp contraction from the beginning of the economic crisis of 2007 in VA and BERD. In the ICT manufacturing sector, employment halved between 1995 and 2020. The combined trends of VA and employment produced a higher growth rate of ICT manufacturing labour productivity than what is observed in ICT service sectors. Regarding research expenditure, in the last two years before the economic crisis, the ICT manufacturing sector had a share (11.5%) of total BERD higher than the one of ICT services (7.1%). Since the beginning of the crisis, ICT manufacturing has followed a continuous declining path, while ICT services sector has shown an increase.

**The pandemic has had a very uneven impact on the ICT manufacturing and ICT services sectors** according to the nowcasted data. ICT manufacturing sector value added maintained the levels of the previous year, but employment plunged by 8.4%, with the subsequent increase of labour productivity. On the other hand, in 2020, ICT services sector value added decreased marginally, while its employment increased, mainly driven by the computer and related activities subsector. In sum, these trends imply a reduction in labour productivity in ICT services.

The most important ICT sub-sectors presenting the highest shares over the total economy are two ICT services sub-sectors -*Computer and related activities* and *Telecommunications*-, and the *Media and content* (MC) sector. In terms of research activity, the subsector *Computer and related activities* is always the one showing, by far, the highest amount of private business expenditure (BERD), but the subsector *Manufacture of computers and peripheral equipment* has the highest research intensity. *Telecommunications* is the subsector with the highest labour productivity, it is around 2.5 times higher than in the overall economy.

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<sup>2</sup> Throughout the text, the term “total economy” includes the ICT sector. The interest lies in the comparison, in relative terms, of the performance of the ICT sector with that of the whole economy, which in turn can be interpreted as an average sector.



## The ICT sector in the EU27 Member States

In 2018 the countries with **largest ICT VA share** (ICT sector VA/GDP) in the EU27 were Ireland<sup>3</sup>, Malta, Luxembourg, Sweden, Estonia, Cyprus, Czechia, Romania and Bulgaria, all above 5.0%. In terms of employment, the largest EU ICT sectors in relative size were Estonia, Malta, Hungary, Luxembourg, Ireland, Finland and Latvia, with a share over total employment higher than 3.5%. On the other hand, ICT sector BERD intensity (measured as ICT sector BERD/ICT sector VA) is very high in Finland (the only country with more than 10%) in 2018 (13.2%), followed by Sweden, Austria, Belgium and France (all above 6%). The countries with the highest values of public funding of R&D (GBARD) in the ICT sector over VA are Belgium, Finland, Italy and Spain. Finally, the weight of ICT GBARD over total GBARD is especially high in Cyprus, Ireland, Latvia, Sweden, Finland and Hungary.

In the **2006-2018 period**, the ICT sector had a positive VA growth in most of the countries of the EU27 (with the only exceptions of Italy and Finland), with the highest growth rates in real terms shown by Estonia, Austria, Luxembourg, Bulgaria, Cyprus, Czechia and Malta (all above 10% in annual terms). Regarding employment growth the countries presenting the most positive growth are Croatia, Cyprus, Lithuania and Portugal. On the opposite end, Romania is the only country with a decrease in ICT employment. In the same period, Estonia, Austria, Czechia, Malta and Luxembourg were the EU countries with the highest growth rate in labour productivity. Croatia, Hungary, Estonia, Poland and Latvia presented the highest growth rates of BERD.

According to the PREDICT estimations, the ICT sector has been less affected by the COVID-19 pandemic than the rest of the economy in almost all the Member States. The ICT sector outperformed the total economy in both value added and employment. In 2020, the ICT sector VA grew in some countries and its employment increased in the majority of EU countries. During 2020, labour productivity in general fell in the European Member States due to a slow and even negative evolution of value added in some countries. However, the evolution of employment was more robust as a result of the policies implemented by all the countries to support employment and to the aid provided by EU funds.

## The EU27 ICT sector in the international context

This section compares 13 major ICT economies<sup>4</sup> with the EU27. The US and China have the largest ICT sectors amounting to EUR 801 bn and EUR 706 bn value added (VA) respectively in 2018. Europe ranks third with EUR 541 bn. India and China are the countries showing the **most dynamic behaviour during the 2006-2018** period. Specifically, both countries presented the largest growth rates in VA. In terms of employment, India shows the largest growth, followed by Australia, Switzerland and Brazil. In labour productivity growth China stands out, followed by Taiwan, India and South Korea. China had also the most dynamic behaviour in research expenditure (BERD). Compared with those of the Asian countries, the ICT sector of the EU and the US has shown modest growth rates in all dimensions. Only regarding public funding of R&D (GBARD and ICT GBARD) in ICT, the EU has been more dynamic than the US.

Taiwan is the country in which the ICT sector has the **highest share** over the total economy (16.7%) in VA. Taiwan presents the largest ICT shares for most measures, usually followed by South Korea. The third position is claimed by the US for ICT sector share of VA, Canada in BERD and the United Kingdom in employment. The **EU's position** varies, for VA the EU occupies the 8<sup>th</sup> position and in BERD it is 9<sup>th</sup>, behind China in both dimensions. The ICT sector in the US has a higher share than in the EU in all dimensions. The country with the largest labour **productivity** per hour worked in the ICT sector is the US followed by Taiwan and South Korea. The US also takes the lead in labour productivity in ICT services. However, South Korea is the country with the largest labour productivity in ICT manufacturing. The lowest level of productivity per hour is observed in China, Brazil and India. However, India is the country in which the ICT sector has the highest ratio of labour productivity per hour worked as compared to labour productivity in the total economy (almost 3.5 times higher). Brazil, South Korea and China follow. For the EU, the same ratio is slightly lower than the one of the US (1.46 for the EU and 1.69 for the US), meaning that in the EU the gap between ICT sector productivity and total productivity is lower.

The US has the highest ICT sector **research expenditure** (BERD) of 85 bn EUR PPS in 2018, followed by China with 44 bn EUR PPS and Europe takes third place with 29 bn EUR PPS. South Korea has the highest **BERD intensity** (ICT sector BERD/ ICT sector VA), followed by Taiwan, the US, Norway and Japan. The EU occupies the ninth position. In South Korea and Taiwan, the ICT manufacturing sub-sector is the one with the highest BERD

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<sup>3</sup> Ireland has not published official data for VA since 2014 and this last available data year is used for country comparisons.

<sup>4</sup> Australia, Brazil, Canada, China, India, Japan, Norway, Russia, South Korea, Switzerland, Taiwan, the United Kingdom and the United States.

intensity, when compared to ICT services or the rest of the economy, while in Japan and in the US, the non-ICT sector is the one with the highest BERD intensity.

The distinction by **ICT sub-sectors** makes it possible to confirm that the strength of Taiwan and South Korea relies on *Manufacture of electronic components*. Additionally, the ICT sector in Japan, China and Russia is concentrated in manufactures. For the rest of countries, including the EU and the US, the most important sub-sector being *Computer and related activities*. In the US, public research funding (GBARD) is concentrated exclusively in *Telecommunications*, while in the EU and the United Kingdom it is more focused on *Computer and related activities*. Labour productivity per employed person in the US is higher than in the EU for all sub-sectors considered.

The evidence presented here confirms that the centre of gravity of ICT is moving towards the East. China and India had been showing a very dynamic behaviour in the 2006-2018 period, challenging the traditional view of those countries as the *factories of the world*. The information provided in this report indicates that China is quickly moving to a new scenario betting hard on higher value added activities –such as those within the ICT producing sector- as well as investing an increasing amount of resources in R&D. The data for R&D indicate that China wants to play a prominent role in the world economy. Up to now the US is still the leading country, but China (due to the size of its economy) is already threatening a leading position. The EU is not improving its overall position in the international context. The results presented here call for a reflection on the future relative position of the EU's ICT sector in the international landscape.

# 1 Introduction and definitions

The 2021 edition of the PREDICT Key Facts Report 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).<sup>5</sup> The 2021 PREDICT Report covers the period between 1995 and 2018. It provides a long-term analysis of the European Union (EU) ICT sector and its Research and Development (R&D), covering a whole cycle from the initial expansion years, to the double recession that began in early 2008, and the most recent evolution up to 2018.

The analyses developed in this report make possible to answer questions as, for instance, the following ones. Is the ICT sector still a highly dynamic economic sector in the sense that it outperforms many other economic sectors in its evolution following the economic cycle? Which is its role in the creation of employment? Is ICT manufacturing still the key sector for R&D expenditures? In which sector is productivity increasing faster? Within the EU, which country is taking the lead? Which ones are falling behind? Is the US still the leading country in terms of innovation and technological progress? Has the gravitational centre of the world economy moved towards Asia, and away from the EU?

Whenever possible, the report includes nowcasted data for 2019 and 2020. Consequently, the report includes some information related to the effect of the COVID-19 on the EU ICT sector, which will imply a structural break in the series. The COVID-19 crisis represents an unprecedented shock to the economy and consequently increases noise and uncertainty for the nowcasting predictions. Therefore this report only presents nowcasted values for the EU aggregate, which can be confirmed in its trend by available short-term statistics to give a more reliable glimpse of the ICT sector in 2020<sup>6</sup>.

The EU aggregate (EU27) in the PREDICT Dataset refers to the 27 countries that are part of the EU for the entire year 2020, as the United Kingdom withdrew from the EU on 1 February 2020. The data for this aggregate are presented for the period from 1995 to 2020, regardless of the legal status of all the 27 countries as Member State of the EU in the respective year. This is implemented to allow a comparison of the same aggregate over time.

In order to provide statistical support for the comprehension of main economic ICT trends, this report focuses on the dynamics of corresponding economic processes of production. Hence, the collected data refers to the *production* of ICT goods and services, and of related R&D activities. However, the report does not address the analysis about the use that is made of ICT goods and services by the society. In addition to the ICT sector, the report also provides information for two additional sectors that are closely related: *Media and content (MC)* and *Retail sale via mail order houses or via Internet (RS)*.

The main body of the report presents a selection of figures and tables accompanied by short comments summarizing the main findings. The report is structured in three additional sections. Section 2 focuses on the analysis of the EU ICT sector and presents the evolution of the EU ICT sector, including its R&D expenditures since 1995. In section 3, the ICT sector and sub-sectors of EU Member States are compared, starting from 2006. In section 4, the analysis is extended to non-EU countries, therefore considering the position of the EU in the international landscape. The Annex provides additional information for readers interested in getting a deeper insight.

The information in the three sections is organized in a way that makes possible to follow the track of the most relevant facts for each of the variables which integrate the PREDICT Dataset. These variables are: (i) Value added (VA); (ii) Employment; (iii) Labour productivity, both in terms of persons and of hours worked; (iv) Business expenditure on R&D (BERD); (v) BERD intensity (BERD/GDP); (vi) R&D Researchers (RERD); (vii) R&D personnel (PERD); (viii) Public funding of R&D (GBARD), and (ix) ICT GBARD, which is the part of GBARD devoted to fund ICT-related expenditures in any industry of the economy (see Box 1). Throughout the report the term *billion* refers to a one thousand million.

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<sup>5</sup> OECD Information Economy–Sector definitions based on the international classification equivalent to European NACE Rev. 2, the International Standard Industry Classification (ISIC 4), Annex 1, p.15, available at: <https://www.oecd.org/sti/38217340.pdf>

<sup>6</sup> The full set of nowcasted values are available from the 2021 PREDICT Dataset at <https://ec.europa.eu/jrc/en/predict>.

## Box 1. Definition of GBARD and ICT GBARD

### GBARD and ICT GBARD

**GBARD** (Government budget allocations for R&D) is –according to Frascati Manual (OECD, 2015)- an approach for measuring government funding of R&D using data from government budgets. This type of funder-based approach for reporting R&D involves identifying all the budget items that may support R&D activities and measuring, or estimating, their R&D content.

**ICT sector GBARD** is the part of total GBARD assigned to ICT producing industries

**ICT GBARD** is the part of GBARD devoted to fund ICT-related expenditures in any industry of the economy, not only those belonging to the ICT producing sector.

**ICT sector ICT GBARD** is the part of ICT GBARD assigned to ICT producing industries.

## Comprehensive and operational definitions of the ICT sector

PREDICT analyses follow the OECD definition of the ICT sector (OECD, 2007)<sup>7</sup>, the *comprehensive definition*, which is based on the Statistical Classification of Economic Activities in the European Community (NACE) Rev. 2<sup>8</sup>. This definition of the ICT sector was adopted in 2006, and since 2008 all Member States have been required to refer to it when reporting ICT sector data. Regarding the *Media and content* sector<sup>9</sup>, which has been included both in the dataset and in the report because of its relevancy and its increasing inter-relation with the ICT sector, PREDICT also follows the OECD definition (OECD, 2011). **PREDICT also considers an operational definition, shown in Box 2, to enable the comparison of data over a long-term period and with non-EU countries.** It differs from the OECD definition, as it does not include the ICT trade industry (NACE Rev. 2 465) and *Manufacture of magnetic and optical media* (NACE Rev. 2 268). The adoption of the *operational definition* Full comparability would not have been possible with the comprehensive definition, due to lack of data for the two above mentioned sectors (especially for non-EU countries). **The 2021 edition of the PREDICT Key Facts Report is based on the operational definition.** The 2021 PREDICT Dataset provides data according to both the comprehensive OECD definition and the operational definition for the EU27 and its Member States, and for the operational definition for non-EU countries.

## Box 2. List of NACE Rev. 2 ICT sub-sectors. Operational definition

Nace Rev. 2	Description
<b>261-264, 582, 61, 62, 631, 951</b>	<b>ICT total (operational)</b>
<b>261-264</b>	<b>ICT manufacturing industries ((operational)</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
<b>582, 61, 62, 631, 951</b>	<b>ICT services industries</b>
61	Telecommunications
582, 62, 631, 951	Computer and related activities

<sup>7</sup> OECD Information Economy–Sector definitions based on the international classification equivalent to European NACE Rev. 2, the International Standard Industry Classification (ISIC 4), Annex 1, p.15, available at: <https://www.oecd.org/sti/38217340.pdf>

<sup>8</sup> The period covered in the PREDICT database required the development of a methodology to reclassify NACE Rev. 1.1 data for ICT R&D over the period 1995-2007 according to NACE Rev. 2 classification. This methodology is provided in Mas, Robledo, Pérez, Stančík, Turlea and Desruelle (2012).

<sup>9</sup> The Media and content industries are those “engaged in the production, publishing and/or the electronic distribution of content products”, OECD (2011).

Unlike the Key Facts Report, which uses exclusively the operational definition, the [DESI](#) horizontal chapter on 'The EU ICT Sector and its R&D Performance' presents PREDICT data using both the operational definition – when presenting the EU in comparison with non-EU countries-, and the comprehensive definition –when presenting overall results for the EU and its Member States-. This explains the differences that can be observed between this report and the DESI horizontal chapter.

### **ICT sector breakdown**

This report considers data for different levels of sectoral disaggregation. The total economy<sup>10</sup> and the following sectors are considered: *ICT*, *Media and content*, and *Retail sale via mail order houses or via Internet*. For the ICT sector, the distinction between ICT manufacturing and ICT service sectors is considered. In addition, ICT manufacturing is further disaggregated into four sub-sectors: (i) *Electronic components and boards*, (ii) *Computers and peripheral equipment*, (iii) *Communication equipment*, and (iv) *Consumer electronics*. Moreover, the ICT services sector is disaggregated into two sub-sectors: (i) *Telecommunications* and (ii) *Computer and related activities*.

Whenever possible, the information provided in the report allows to easily compare: (i) the ICT sector with the total economy; (ii) the ICT manufacturing sector with the ICT services sector; (iii) each of the four ICT manufacturing, two ICT services, MC and RS sectors' performance; (iv) the pace of EU countries; and (v) the position of the EU in the international context (including the role of the most relevant countries in the current worldwide economy landscape).

The main body of the report contains 25 figures (including detailed information for each variable) and 3 tables summarizing the main statistical information. The Annex offers 74 additional figures providing more detailed information about the EU ICT sector and its R&D. It is organized in four sub-sections: sub-section A.1 refers to the ICT sector and its R&D in the EU; sub-section A.2 provides an analysis of the EU ICT sub-sectors. Sub-section A.3 offers the information by EU Member State. Sub-section A.4 offers the comparison with other non-EU economies.

Details regarding the development of the 2021 PREDICT Dataset are contained in the 2021 PREDICT Dataset Methodology report, available at <https://ec.europa.eu/jrc/en/predict>.

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<sup>10</sup> Throughout the text, the term "total economy" includes the ICT sector. The interest lies in the comparison, in relative terms, of the performance of the ICT sector with that of the whole economy, which in turn can be interpreted as an average sector.

## 2 The EU27 ICT sector

In 2018 the EU27 ICT sector VA was EUR 541 bn, it employed 5.4 million people and devoted EUR 29.3 bn on R&D business expenditure (BERD). The ICT sector represented 4.0% of the EU value added in 2018, 2.6% of the employment, 14.9% of total BERD, and 18.7% of the R&D personnel and 21.3% of the researchers. The ICT GBARD in the EU was EUR 6.1 bn, which represented 7.0% of total public funding in R&D (total GBARD) and 0.04% of total GDP (Table 1).

The ICT sector in 2018 was more dynamic than the whole EU economy, outperforming it in all PREDICT variables: VA (5.5% annual real growth rate), employment (3.1%), BERD (5.9%), GBARD (13.4%), ICT GBARD (9.20%), RERD (8.8%) and PERD (7.7%). The higher dynamism of the ICT sector in comparison to the total economy can be observed since 1995. The gap is especially noticeable for VA and BERD.

From 1995 until 2018, the EU ICT sector multiplied its VA in real terms by a factor of 4.0, while the one of the total economy increased by 1.5 (Figure 1). The growth of employment was much more moderate: the number of persons employed in ICT in 2018 was 1.6 times the number of persons employed in the same sector in 1995. According to PREDICT estimates, both variables showed decreased growth rates since 2019, and especially in 2020 because of the COVID-19 pandemic, which has severely affected almost every country in the world. Labour productivity in the ICT sector (both in terms of persons and hours worked) grew much faster than labour productivity in the total economy. The value reached in 2018 was 2.6 times the value of 1995 and, according to the estimations carried out in this project, remained stable in 2019, yet suffered a fall in 2020 due to COVID-19. Business expenditure in R&D in the ICT sector presents a behaviour that is more dynamic than the total economy. From 1995 to 2018, its value multiplied by a factor of 4.5. In the same period, the BERD of the total economy only grew 2.0 times. On the other hand, BERD intensity (measured as the BERD/GDP ratio in nominal terms) presents a decrease in the period 1995-2018 for the ICT sector while it increases for the total economy.. In turn, the number of researchers evolved at a similar rate in the ICT sector as in the total economy, increasing by a factor of 2.6 since 1995, while the number of R&D personnel increased, once again, at a faster rate in the ICT sector. Public funding of R&D is measured through GBARD. The part of GBARD devoted to funding ICT-related expenditures, i.e., ICT GBARD, grew in the ICT sector by 4.0% annually in nominal terms between 2006 and 2019, whereas in the total economy, it grew at an annual rate of 3.2% (in nominal terms).

**Table 1. Summary table of ICT indicators by sub-sector. Operational definition. EU27**

**a) 2018**

NACE Rev. 2	Description	VA		Employment		BERD		GBARD		ICT GBARD		RERD		PERD	
		(Millions of current EUR)	% over Total	(thousand persons employed)	% over Total	(Millions of current EUR)	% over Total	(Millions of current EUR)	% over Total	(Millions of current EUR)	% over Total	(thousand full-time equiv.)	% over Total	(thousand full-time equiv.)	% over Total
<b>261-264</b>	<b>ICT manufacturing industries</b>	<b>50,977.6</b>	<b>0.38</b>	<b>592.3</b>	<b>0.29</b>	<b>9,373.4</b>	<b>4.78</b>	<b>360.5</b>	<b>0.41</b>	<b>72.8</b>	<b>1.19</b>	<b>48.8</b>	<b>4.96</b>	<b>71.6</b>	<b>4.25</b>
261	Manufacture of electronic components and boards	26,811.6	0.20	304.4	0.15	4,824.7	2.46	169.5	0.19	17.9	0.29	24.1	2.45	34.1	2.02
262	Manufacture of computers and peripheral equipment	4,781.4	0.04	74.5	0.04	1,036.6	0.53	59.7	0.07	23.3	0.38	5.6	0.57	8.5	0.51
263	Manufacture of communication equipment	15,138.8	0.11	156.4	0.08	3,123.6	1.59	109.7	0.12	28.6	0.47	17.0	1.73	25.5	1.52
264	Manufacture of consumer electronics	4,245.7	0.03	57.0	0.03	388.4	0.20	21.6	0.02	2.9	0.05	2.1	0.21	3.5	0.21
<b>582, 61, 62, 631, 951</b>	<b>ICT services industries</b>	<b>489,523.3</b>	<b>3.62</b>	<b>4,794.1</b>	<b>2.32</b>	<b>19,904.5</b>	<b>10.15</b>	<b>3,611.8</b>	<b>4.09</b>	<b>1,778.7</b>	<b>28.97</b>	<b>160.8</b>	<b>16.33</b>	<b>242.7</b>	<b>14.41</b>
61	Telecommunications	145,841.4	1.08	863.8	0.42	2,439.7	1.24	1,742.1	1.97	526.3	8.57	19.2	1.95	24.6	1.46
582, 62, 631, 951	Computer and related activities	343,681.9	2.54	3,930.3	1.90	17,464.7	8.91	1,869.8	2.12	1,252.4	20.40	141.6	14.38	218.1	12.95
<b>261-264, 582, 61, 62, 631, 951</b>	<b>ICT total</b>	<b>540,500.9</b>	<b>4.00</b>	<b>5,386.5</b>	<b>2.61</b>	<b>29,277.9</b>	<b>14.94</b>	<b>3,972.3</b>	<b>4.50</b>	<b>1,851.5</b>	<b>30.15</b>	<b>209.6</b>	<b>21.28</b>	<b>314.3</b>	<b>18.67</b>
	<b>Total economy</b>	<b>13,517,906</b>	<b>100</b>	<b>206,651</b>	<b>100</b>	<b>196,007</b>	<b>100</b>	<b>88,308</b>	<b>100</b>	<b>6,140</b>	<b>100</b>	<b>985</b>	<b>100</b>	<b>1,684</b>	<b>100</b>

**b) Annual growth rates (%), 2017-2018**

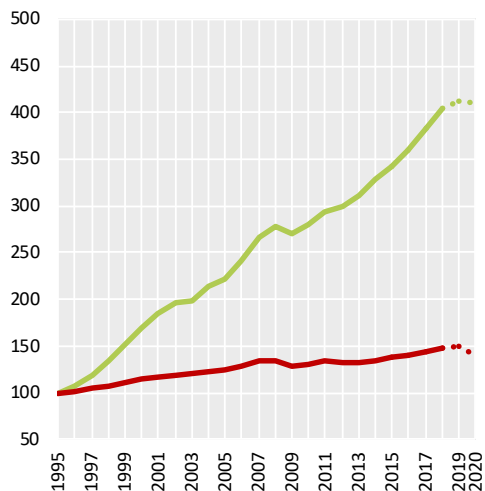
NACE Rev. 2	Description	VA	Employment	BERD	GBARD	ICT GBARD	RERD	PERD
<b>261-264</b>	<b>ICT manufacturing industries</b>	<b>8.1</b>	<b>1.9</b>	<b>6.5</b>	<b>3.1</b>	<b>2.6</b>	<b>6.5</b>	<b>8.6</b>
261	Manufacture of electronic components and boards	8.4	0.3	6.6	3.3	3.2	5.6	5.9
262	Manufacture of computers and peripheral equipment	-1.9	-5.0	8.6	2.0	1.5	4.3	5.5
263	Manufacture of communication equipment	16.8	10.6	5.8	3.3	3.3	8.4	14.4
264	Manufacture of consumer electronics	-7.1	-1.8	6.3	2.7	1.1	9.2	3.4
<b>582, 61, 62, 631, 951</b>	<b>ICT services industries</b>	<b>5.2</b>	<b>3.2</b>	<b>5.6</b>	<b>14.6</b>	<b>9.5</b>	<b>9.5</b>	<b>7.5</b>
61	Telecommunications	9.7	6.5	3.3	30.7	31.2	8.5	1.0
582, 62, 631, 951	Computer and related activities	3.2	2.5	5.9	1.6	1.6	9.6	8.3
<b>261-264, 582, 61, 62, 631, 951</b>	<b>ICT total</b>	<b>5.5</b>	<b>3.1</b>	<b>5.9</b>	<b>13.4</b>	<b>9.2</b>	<b>8.8</b>	<b>7.7</b>
	<b>Total economy</b>	<b>2.1</b>	<b>1.4</b>	<b>3.5</b>	<b>2.2</b>	<b>3.0</b>	<b>6.5</b>	<b>6.9</b>

Note: Monetary variables are expressed in real terms.

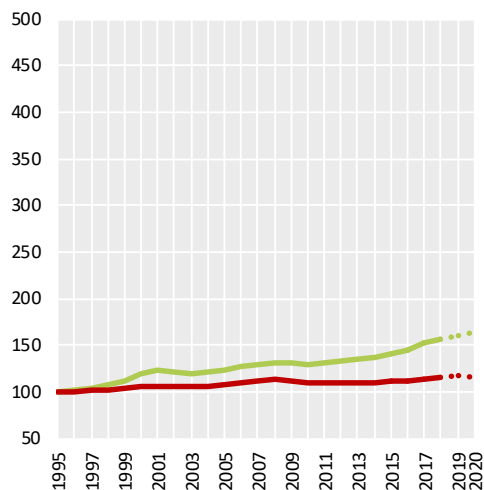
Source: 2021 PREDICT Dataset

**Figure 1. Total economy and ICT sector: VA, employment, labour productivity, BERD, BERD intensity, RERD and PERD in the EU27 (1995-2020, Index 1995=100)**

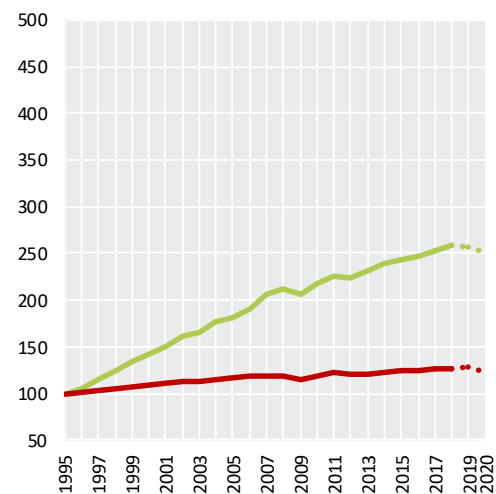
a) Value added



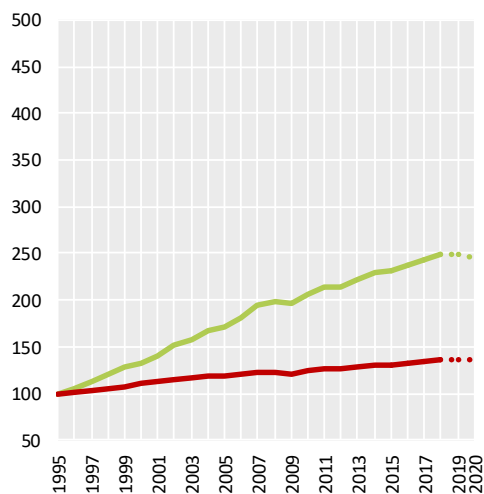
b) Employment



c) Productivity per person employed



d) Productivity per hour worked



— Total ICT — Total economy

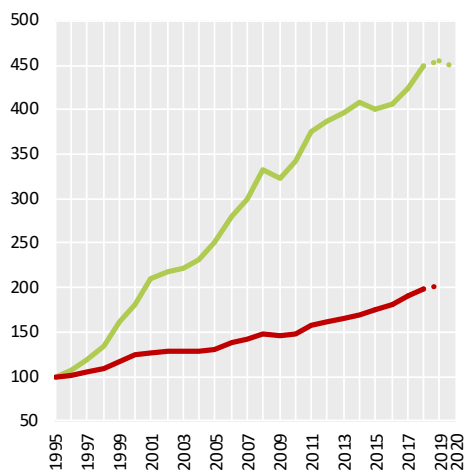
Note: Monetary variables are expressed in real terms. Dashed lines indicate nowcasted data.

Source: 2021 PREDICT Dataset and Eurostat.

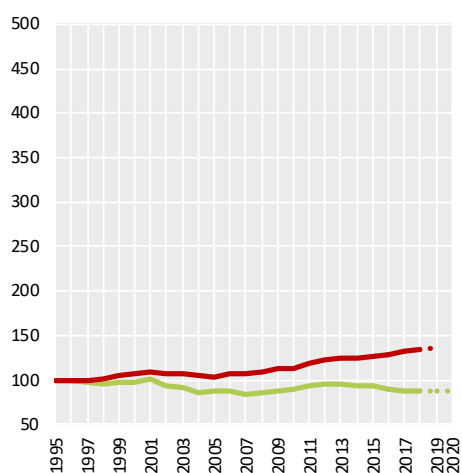


**Figure 1 (cont.) Total economy and ICT sector: VA, employment, labour productivity, BERD, BERD intensity, RERD and PERD in the EU27 (1995-2020, Index 1995=100)**

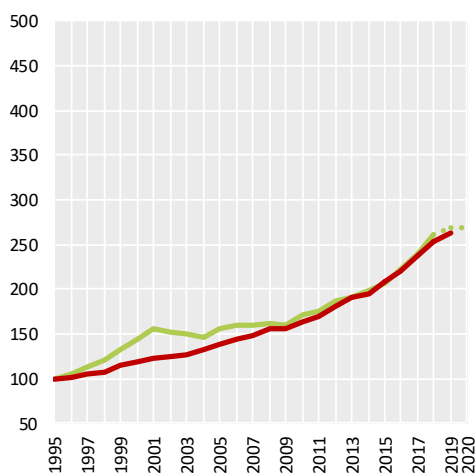
e) BERD



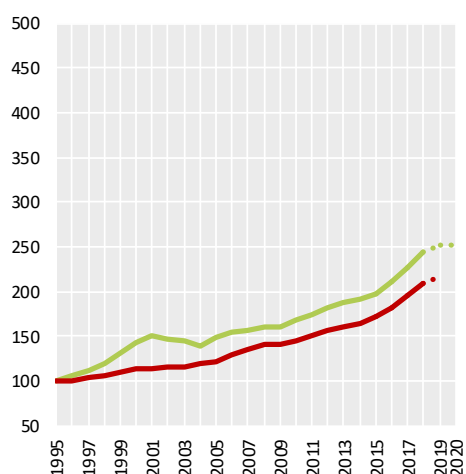
f) BERD intensity (BERD/VA)



g) RERD



h) PERD

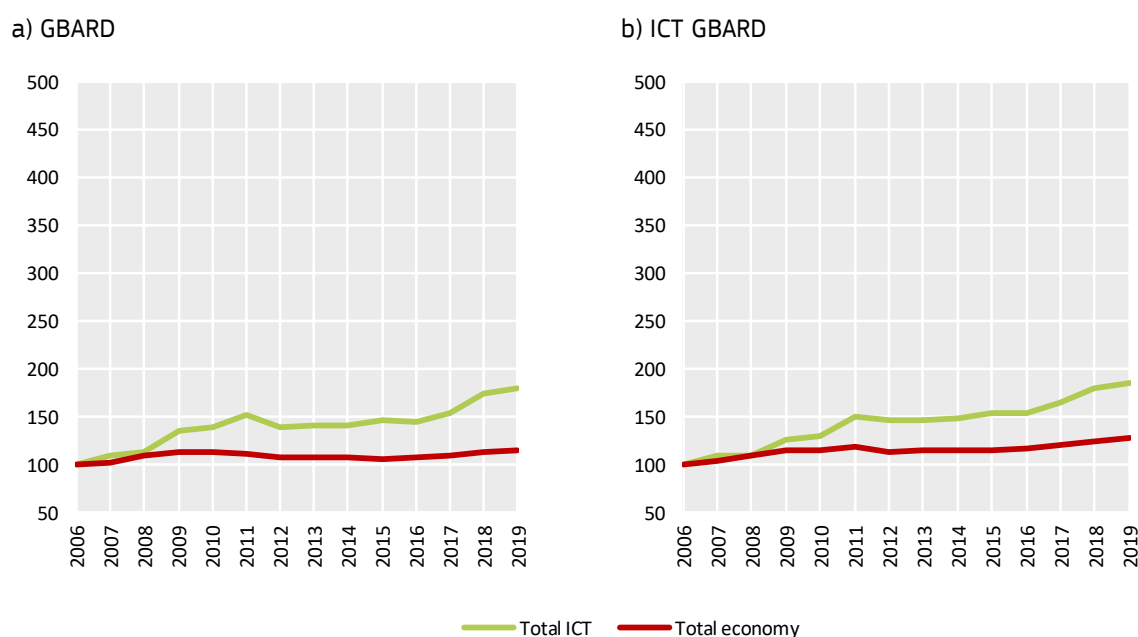


— Total ICT — Total economy

Note: Monetary variables are expressed in real terms. Dashed lines indicate nowcasted data.

Source: 2021 PREDICT Dataset and Eurostat.

**Figure 2. Total economy and ICT sector: GBARD and ICT GBARD in the EU27 (2006-2019, Index 2006=100)**

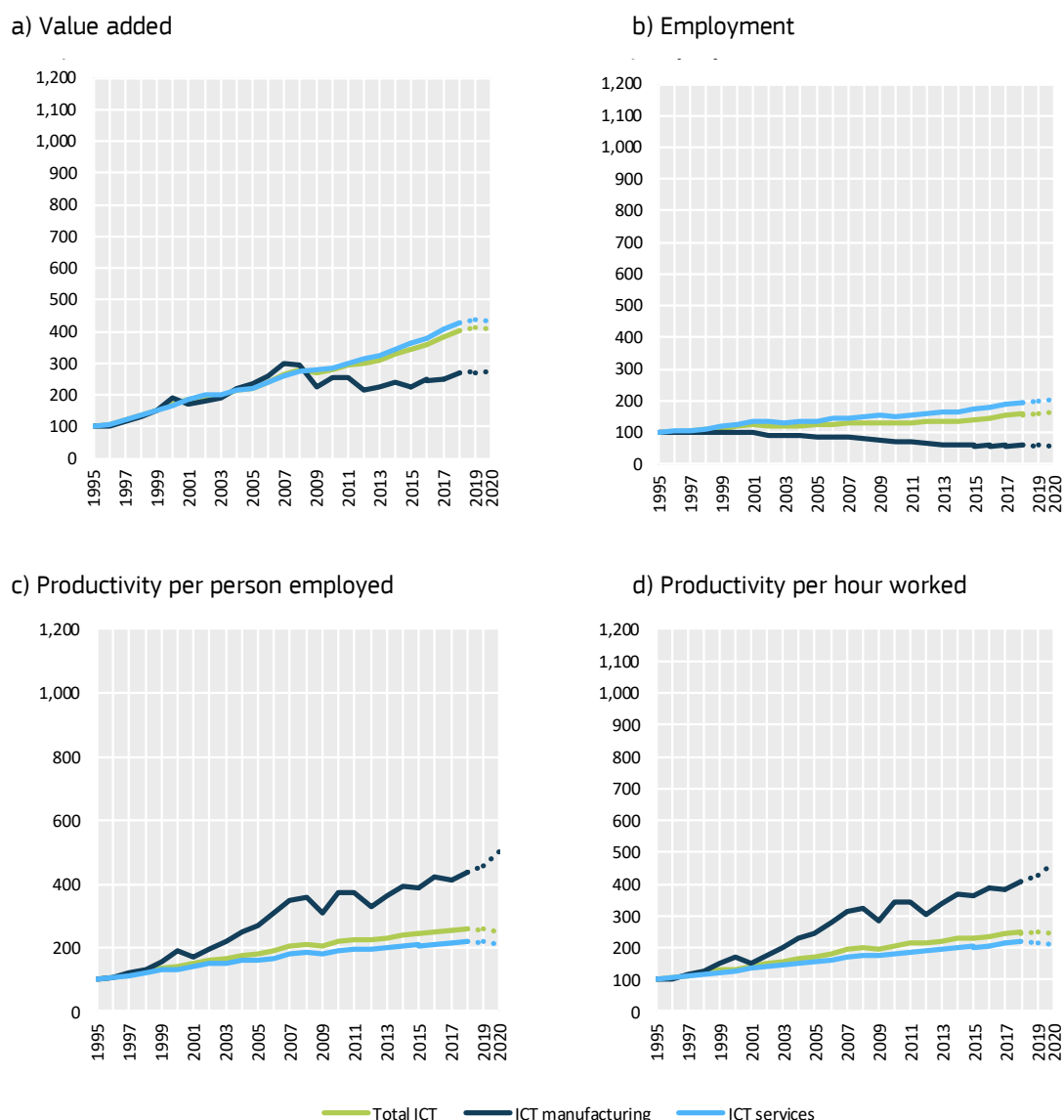


Note: GBARD and ICT GBARD are expressed in real terms. ICT GBARD is the part of GBARD (Government budget allocations for R&D) devoted to fund ICT assets in all industries of the economy. ICT GBARD is allocated to all sectors in the economy, not only the ICT sector (see Box 1 in the Introduction).  
Source: 2021 PREDICT Dataset.

Public funding in R&D also had shown a more dynamic behaviour in the ICT sector than in the total economy. This result applies to both total GBARD assigned to ICT producing industries as well as to ICT GBARD for the ICT sector (Figure 2) (see Box 1 in the introduction for the definition of GBARD and ICT GBARD). GBARD allocated to the ICT sector multiplied its level between 2006 and 2019 by a factor of 1.8, while for the total economy it did so by only 1.2. In the case of ICT GBARD, the corresponding values are 1.8 and 1.3.

The estimations for 2020 show that the ICT sector has suffered the effects of the COVID-19 pandemic but has been less affected than the total economy. Value added decreased by only 0.6% in the ICT sector, while it decreased by 6.2% in the EU economy. Employment in the ICT sector increased by 2.0%, while in the EU economy it reduced by 1.5%. The reduction of labour productivity in the ICT sector in 2020 has been driven by the greater effect of the COVID-19 pandemic on value added than on employment.

**Figure 3. ICT sector, ICT manufacturing and ICT services: VA, employment, labour productivity, BERD, BERD intensity, RERD and PERD in the EU27 (1995-2020, Index 1995=100)**



Note: Monetary variables are expressed in real terms. Dashed lines indicate nowcasted data.

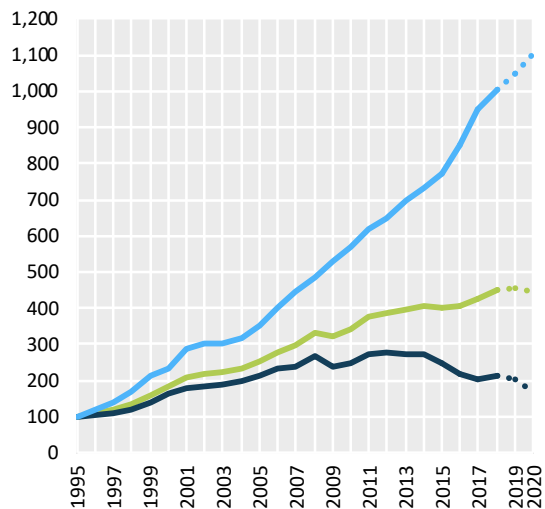
Source: 2021 PREDICT Dataset and Eurostat.

The more dynamic behaviour shown by the ICT sector has its origin in the performance of the ICT services sector (Figure 3). From 1995 to the aftermath of the economic crisis, value added in ICT manufacturing and ICT services sectors grew at similar rate. Since then, ICT manufacturing has slowed down, while ICT services VA have continued growing. In the case of BERD, the increase in ICT services also surpasses that of ICT manufacturing. In terms of labour, while employment growth in the ICT services sector was higher than for the total economy, ICT manufacturing employment suffered an almost continuous fall, at least since 1999. As a result, labour productivity in ICT manufacture presented a much higher growth rate than in ICT services.

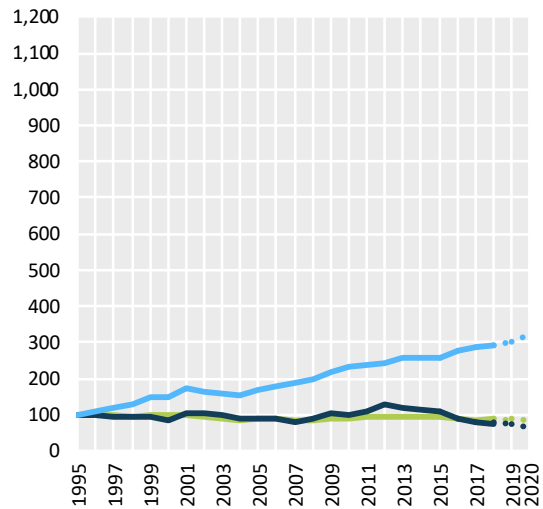
The pandemic has had a very uneven impact on the ICT manufacturing and ICT services sectors according to the nowcasted data. In manufacturing, value added maintained the levels of the previous year, but employment plunged by 8.4%. As a result, productivity soared in terms of employment and of hours worked. On the other hand, in 2020, ICT services sector value added decreased by 0.7%, but its employment increased by 3.3%. Therefore, productivity dropped in terms of headcounts and in terms of hours worked.

**Figure 3 (cont.) ICT sector, ICT manufacturing and ICT services: VA, employment, labour productivity, BERD, BERD intensity, RERD and PERD in the EU27 (1995-2020, Index 1995=100)**

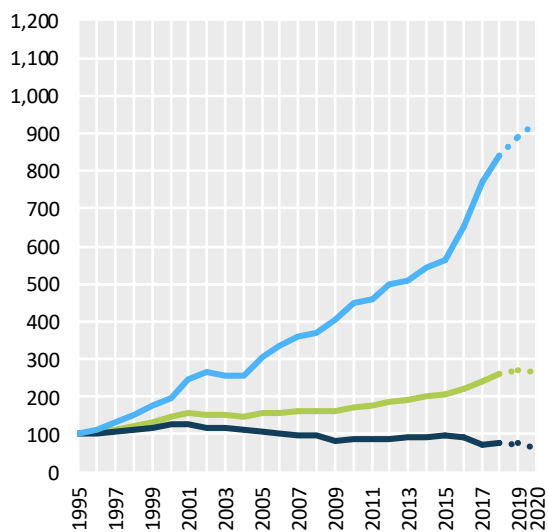
e) BERD



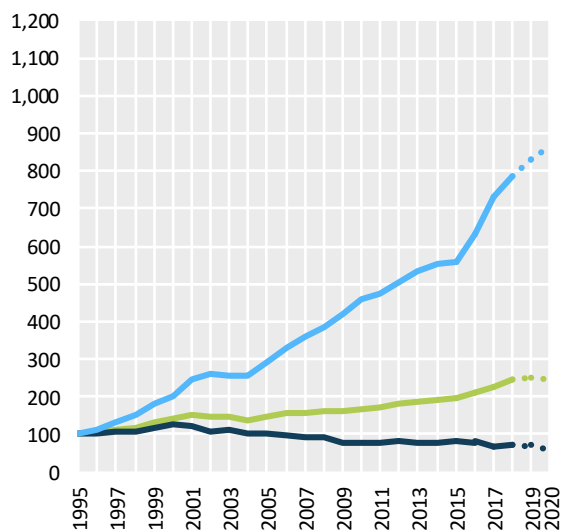
f) BERD intensity (BERD/VA)



g) RERD



h) PERD



— Total ICT — ICT manufacturing — ICT services

Note: Monetary variables are expressed in real terms. Dashed lines indicate nowcasted data.  
Source: 2021 PREDICT Dataset and Eurostat.

**Figure 4. Total economy and ICT sector: VA, employment, labour productivity, BERD, BERD intensity, RERD and PERD in the EU27. Annual growth rates (1995-2020)**

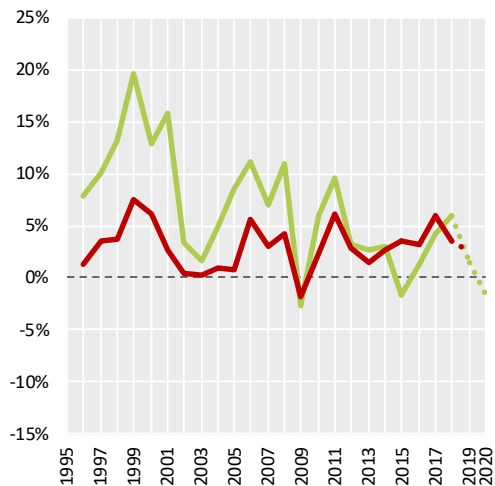


Note: Monetary variables are expressed in real terms. Dashed lines indicate nowcasted data.  
 Source: 2021 PREDICT Dataset and Eurostat.

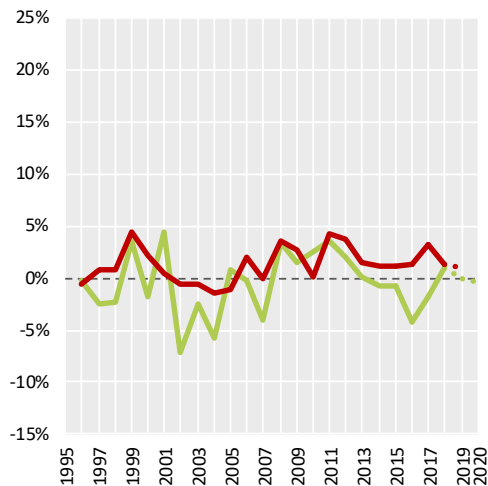
In terms of annual rates of change, all variables grew at a faster rate in the ICT sector than in the total economy, especially between 1995 and 2008 (Figure 4). The only exceptions were R&D researchers and R&D personnel, which presented lower rates during the first years of the century. Since the economic crisis of 2007, the dynamics of the ICT sector have been similar to the total economy. In 2018 all PREDICT variables registered an accelerated growth both in ICT sector and total economy. In 2020, the ICT sector suffered a downturn due to the COVID-19 pandemic in all variables except employment, which was driven by an increase of employment in ICT services. In summary, the first data from the impact of COVID-19 shows that, despite the strong impact of the pandemic on the economy as a whole, the ICT sector has been less affected as a whole.

**Figure 4 (cont.) Total economy and ICT sector: VA, employment, labour productivity, BERD, BERD intensity, RERD and PERD in the EU27. Annual growth rates (1995-2020)**

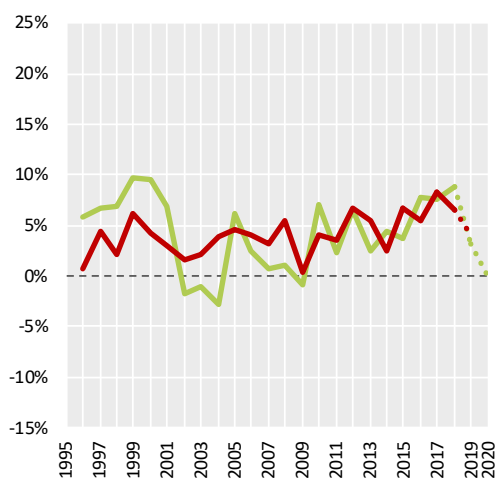
e) BERD



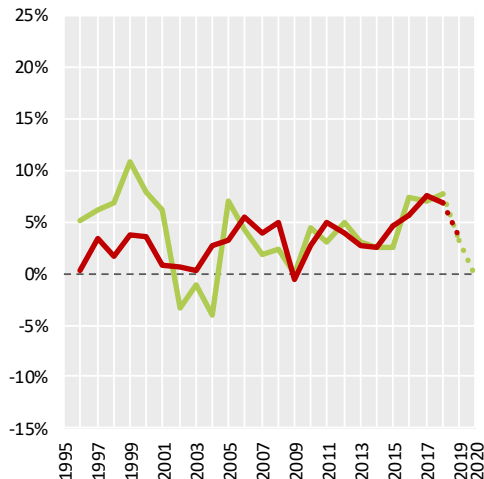
f) BERD intensity (BERD/VA)



g) RERD



h) PERD



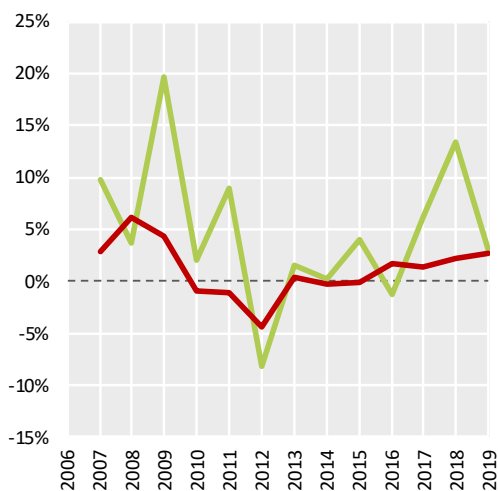
— Total ICT — Total economy

Note: Monetary variables are expressed in real terms. Dashed lines indicate nowcasted data.

Source: 2021 PREDICT Dataset and Eurostat.

**Figure 5. Total economy and ICT sector: GBARD and ICT GBARD in the EU27. Annual real growth rates (2006-2019)**

a) GBARD



b) ICT GBARD



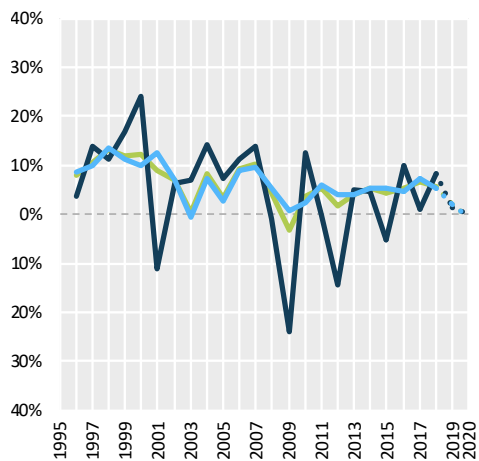
— Total ICT — Total economy

Source: 2021 PREDICT Dataset.

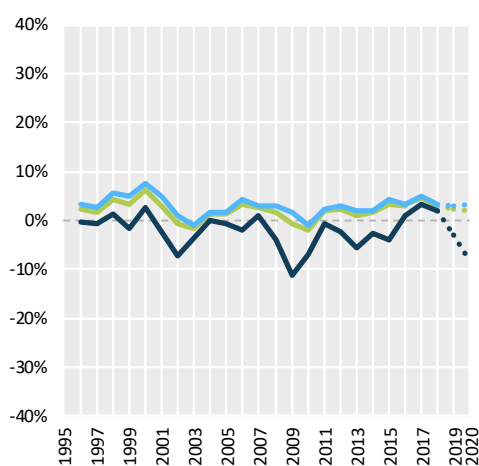
The real growth rate of GBARD in the ICT sector (Figure 5) has been higher (albeit more volatile) than for the total economy throughout the period, with the only exceptions being 2008, 2012 and 2016. In the case of ICT GBARD, the year 2019 is included as another exception. After an upturn in the ICT sector of both GBARD and ICT GBARD during 2017 and 2018, it grew at a similar rate than the total economy.

**Figure 6. ICT sector, ICT manufacturing and ICT services: VA, employment, labour productivity, BERD, BERD intensity, RERD and PERD in the EU27. Annual growth rates (1995-2020)**

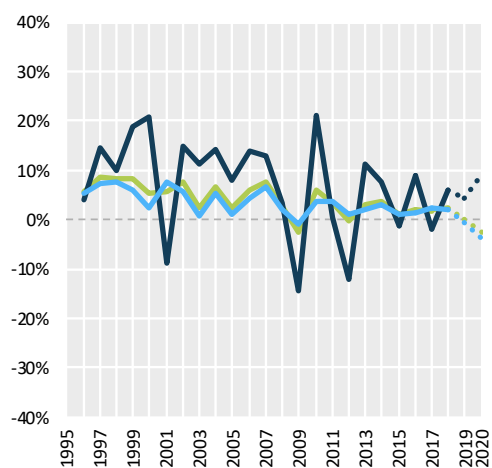
a) Value added



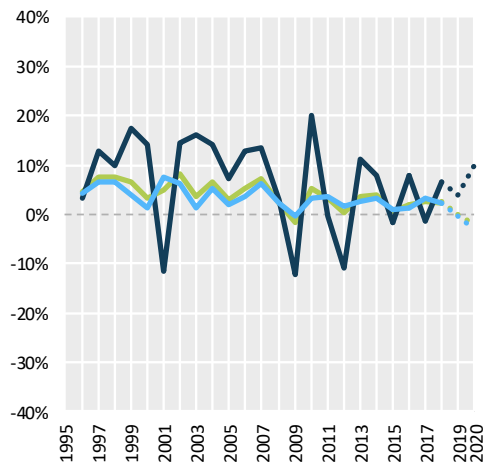
b) Employment



c) Productivity per person employed



d) Productivity per hour worked

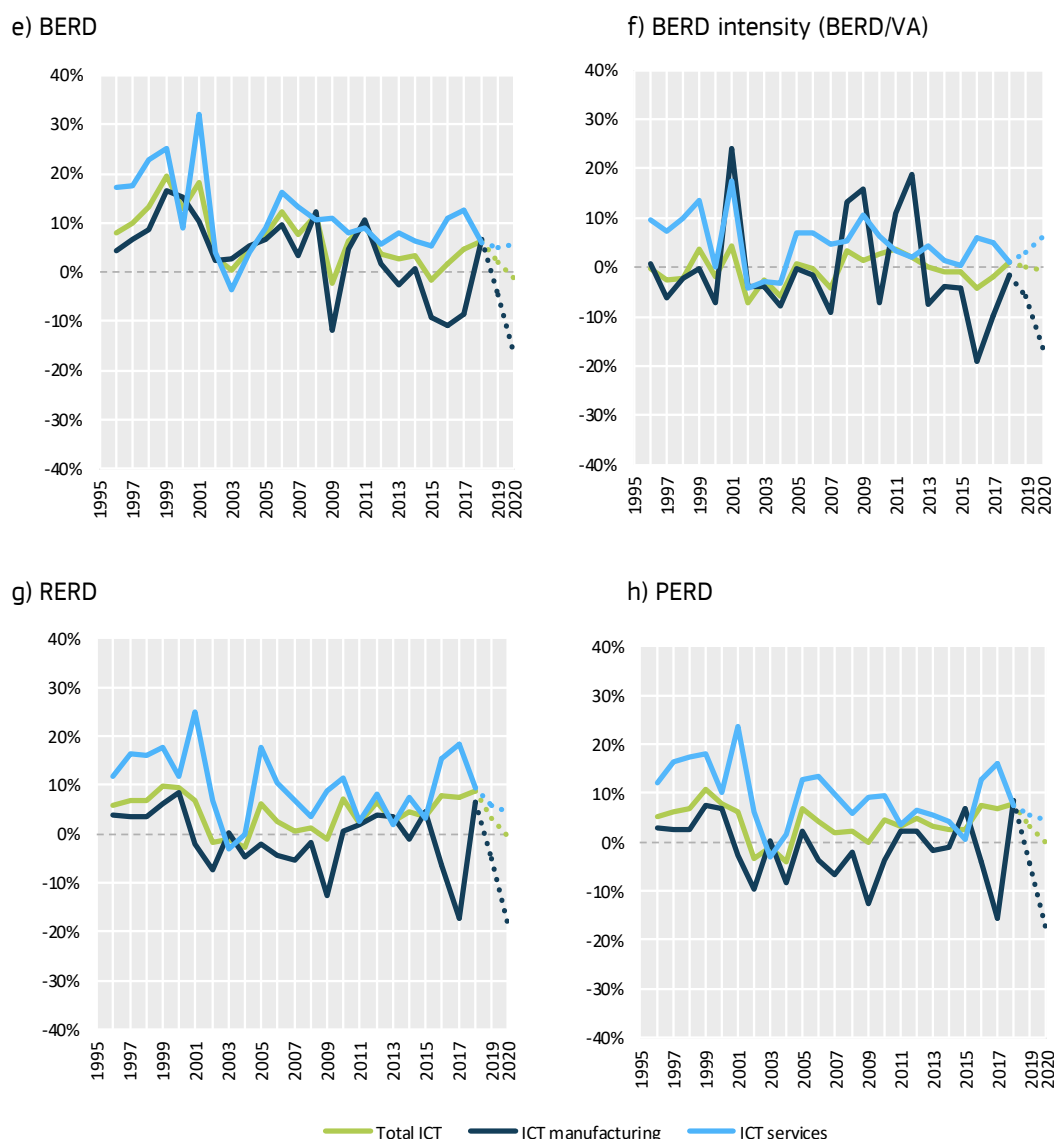


— Total ICT — ICT manufacturing — ICT services

Note: Monetary variables are expressed in real terms. Dashed lines indicate nowcasted data.  
Source: 2021 PREDICT Dataset and Eurostat.



**Figure 6 (cont.) ICT sector, ICT manufacturing and ICT services: VA, employment, labour productivity, BERD, BERD intensity, RERD and PERD in the EU27. Annual growth rates (1995-2020)**

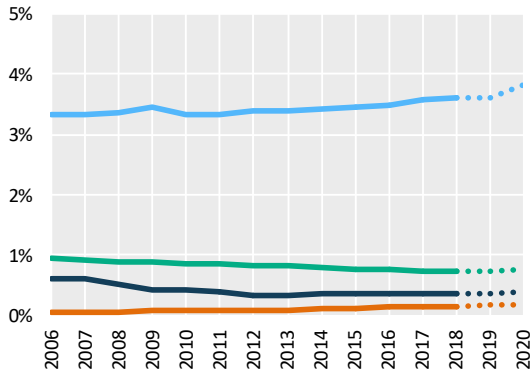


Note: Monetary variables are expressed in real terms. Dashed lines indicate nowcasted data.  
Source: 2021 PREDICT Dataset and Eurostat.

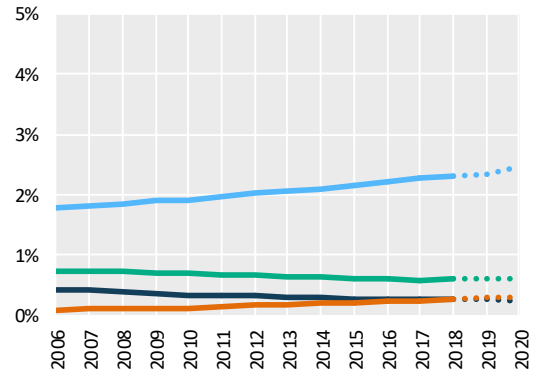
The cyclical profile (as measured by the annual growth rates) for the ICT sector follows that of ICT services due to their higher weight in the aggregate. The latter shows a much more stable growth rate than the ICT manufacturing producing sector. This result holds for VA, employment, labour productivity, BERD and BERD intensity, but is less apparent for R&D researchers and personnel. In the case of these two variables, volatility applies to both, ICT services and ICT manufacturing. However, the growth rate is always higher for ICT services (Figure 6). In 2018, all PREDICT variables showed positive growth rates both in ICT manufacturing and ICT services, with the only exception of the negative growth of BERD intensity (measured as sector BERD/sector VA) in the ICT manufacturing sector (Figure 6). For 2019, the provisional estimates point to a positive growth for both ICT sub-sectors in the case of VA only. The rest of PREDICT variables show a negative growth in one of the ICT sub-sectors. In 2020, the negative growth in ICT sub-sectors affects all the variables. In ICT services, employment shows positive growth rates, although productivity decreased. The effects of COVID-19 have been more severe in the ICT manufacturing industry than in ICT services in almost all variables, particularly in terms of employment. Productivity in the ICT manufacturing sector increased due to the higher reduction in employment in comparison with value added.

**Figure 7. ICT manufacturing, ICT services, MC and RS sectors share of the total economy in the EU27 (percentages, 2006-2020)**

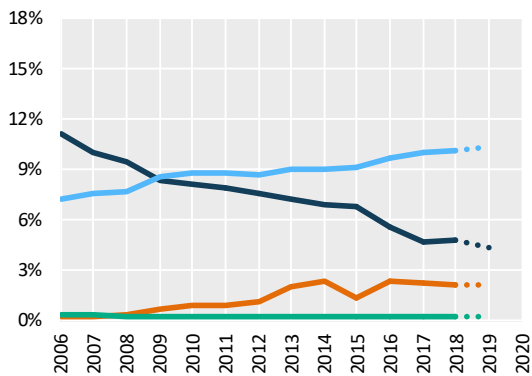
a) Value added



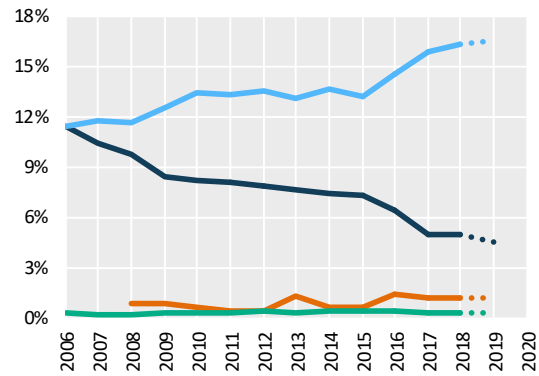
b) Employment



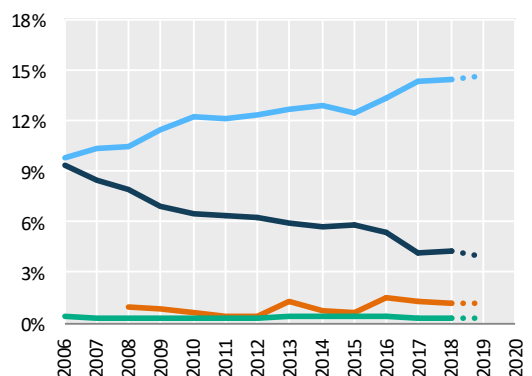
c) BERD



d) RERD



e) PERD



— ICT manufacturing  
— ICT services  
— RS  
— MC

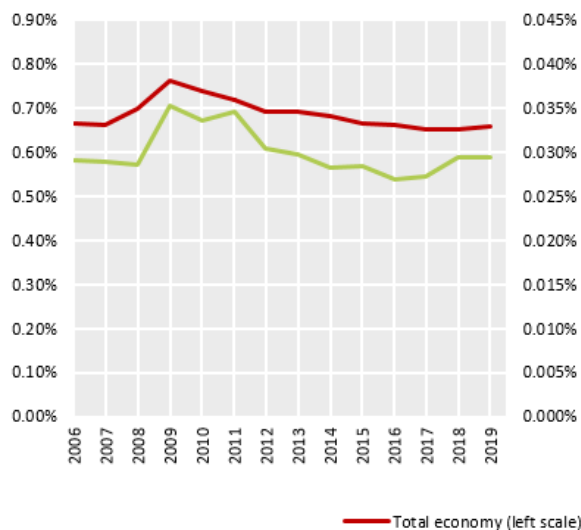
Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.  
 Source: 2021 PREDICT Dataset and Eurostat.

In 2018, the VA generated by the ICT service sector represented 3.8% of GDP, following a slightly positive trend, while ICT manufactures only reaches 0.4%, showing a declining evolution (Figure 7). The ICT producing sectors altogether amounted to 4.0% of GDP. The weight of the MC sector in GDP is almost twice that of ICT manufactures and also shows a declining trend. The share of the RS sector is almost negligible in the EU27 but shows a positive trend in the most recent years. In terms of employment, the weight of all ICT-related sectors is lower (2.6%). In line with other variables already analysed, ICT manufacturing has suffered a severe fall in terms of R&D researchers, R&D personnel and also BERD. It is interesting to observe how the share of the RS sector is relatively higher in BERD than in other variables.

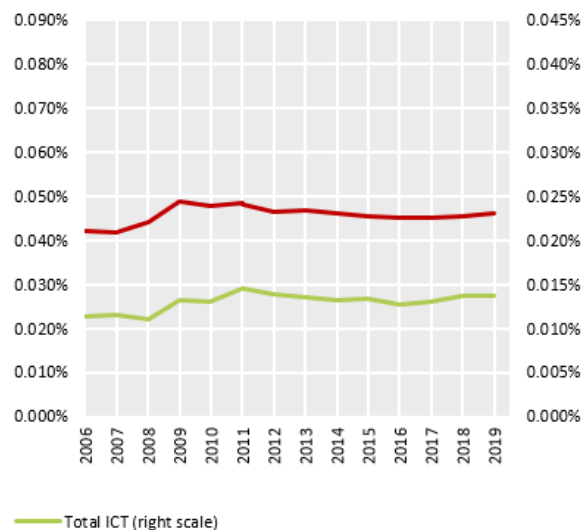
According to the nowcasted data for 2019 and 2020, the share of the ICT sector in value added and employment increased its share in GDP, since the ICT sector was affected by COVID-19, but not as severely as the total economy. In fact, the contribution of VA increased in all subsectors included in Figure 7, particularly in ICT services. The share in total economy also increased in employment, except in the ICT manufacturing industries and the MC sector. All this evidence shows again the importance of the ICT industry during the pandemic crisis.

**Figure 8. Total economy, ICT sector, ICT manufacturing, ICT services and MC sector. GBARD and ICT GBARD intensities in the EU27 (percentages, 2006-2019)**

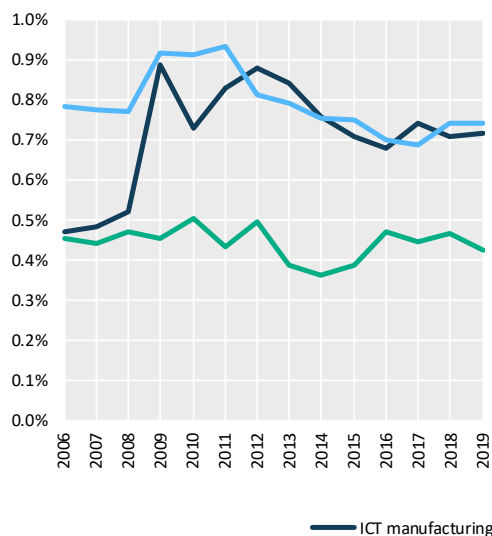
a) GBARD/GDP



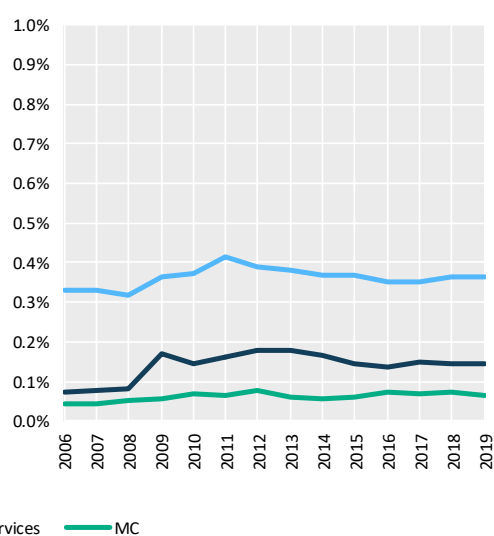
b) ICT GBARD/GDP



c) subsector GBARD/subsector VA



d) subsector ICT GBARD/subsector VA

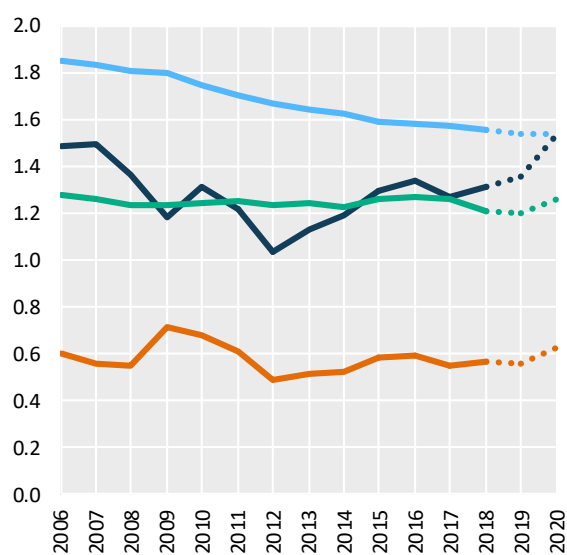


Note: MC: Media and Content. GDP nowcasted for 2019.  
Source: 2021 PREDICT Dataset and Eurostat.

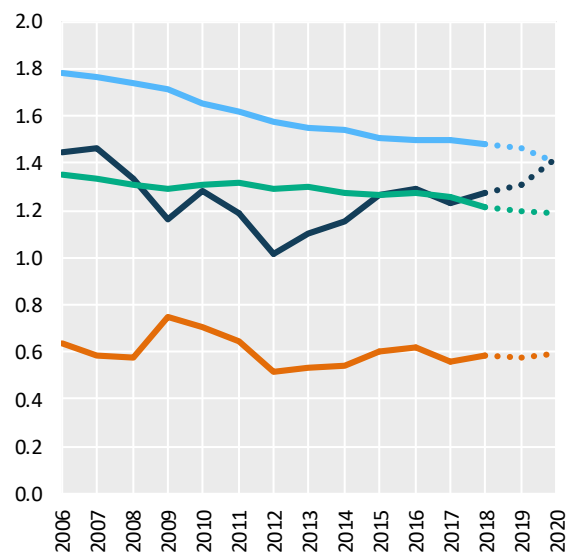
Total GBARD represented 0.66% of GDP in 2019 and 0.029% in the ICT sector. The first one suffered a severe downturn since 2009, year in which it was equal to 0.76% (Figure 8). This decline is also observed (especially after 2011) for the ICT sector. ICT GBARD presents a similar evolution. In 2019 GBARD in the ICT services sector amounted to 0.74% of its value added, a percentage slightly higher than in ICT manufacturing, and almost twice that of the MC sector. For ICT GBARD, the ICT services sector clearly dominates. The RS sector does not receive any GBARD or ICT GBARD funding.

**Figure 9. ICT manufacturing, ICT services, MC and RS sectors productivity as a ratio over total economy productivity in the EU27 (2006-2020)**

a) Productivity per person employed



b) Productivity per hour worked



— ICT manufacturing — ICT services — RS — MC

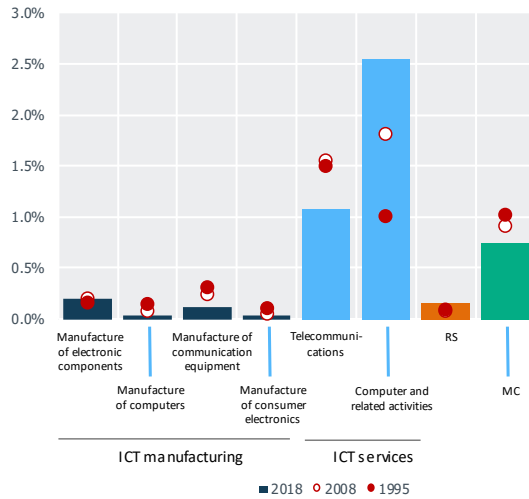
Note: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.

Source: 2021 PREDICT Dataset and Eurostat.

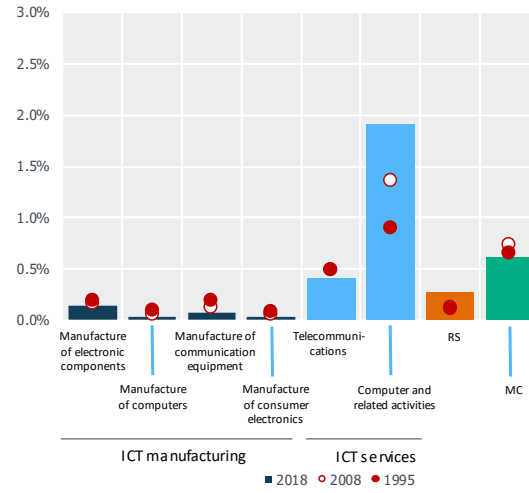
Labour productivity is higher in the ICT service sector than in total economy, and similar in ICT manufacturing and MC sectors. In all three cases, it is higher than in the RS sector. This result applies to both productivity in terms of persons and in terms of hours worked (Figure 9). It is worth noting that all the sectors have followed a declining path since 2006. The estimations for 2019 and 2020 show that the downward trend observed in previous years is maintained, even in the year of the pandemic, for MC sector (in terms of hours worked) and ICT services sectors, while RS sector and ICT manufacturing have increased in 2020. In the latter case, the intense employment reduction in 2020 was the main driver of the increase in productivity, as described before.

**Figure 10. ICT sector, MC and RS sector share of total economy by sub-sector in the EU27 (percentage, 1995, 2008, 2018)**

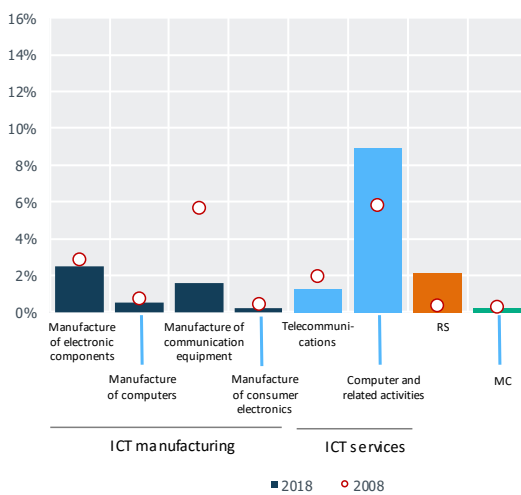
a) Value added



b) Employment



c) BERD

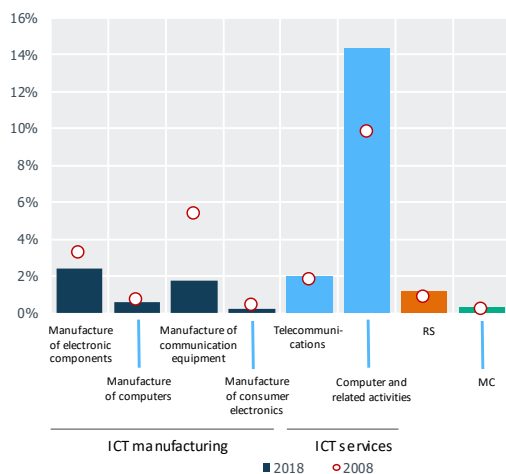


Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet.

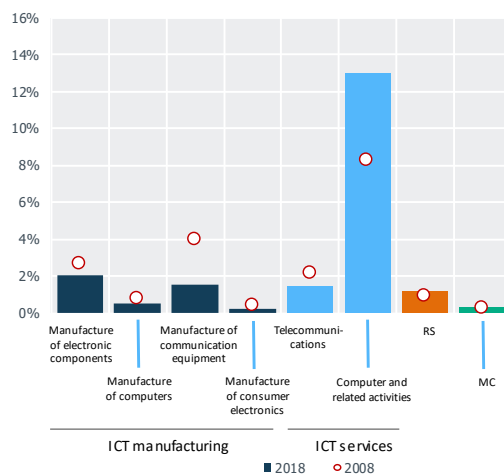
Source: 2021 PREDICT Dataset.

**Figure 10 (cont.) ICT sector, MC and RS sector share of total economy by sub-sector in the EU27 (percentages, 1995, 2008, 2018)**

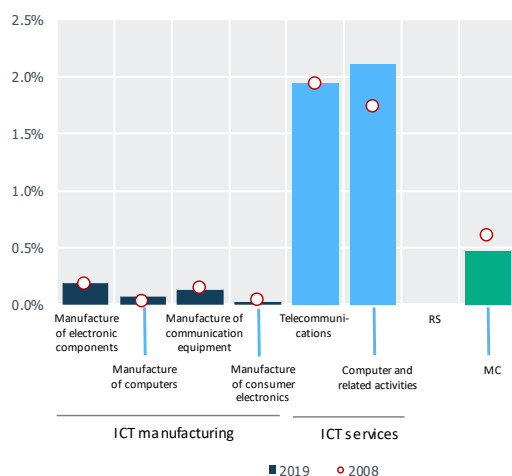
d) RERD



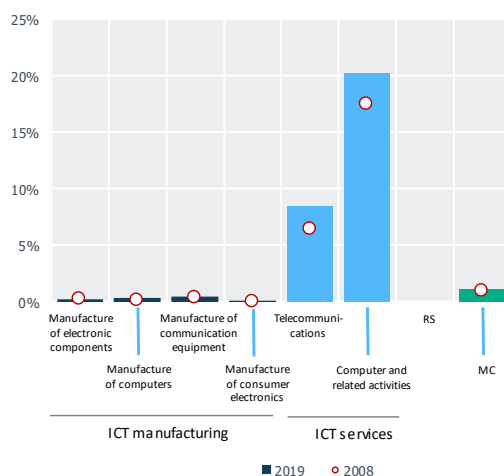
e) PERD



f) GBARD



g) ICT GBARD

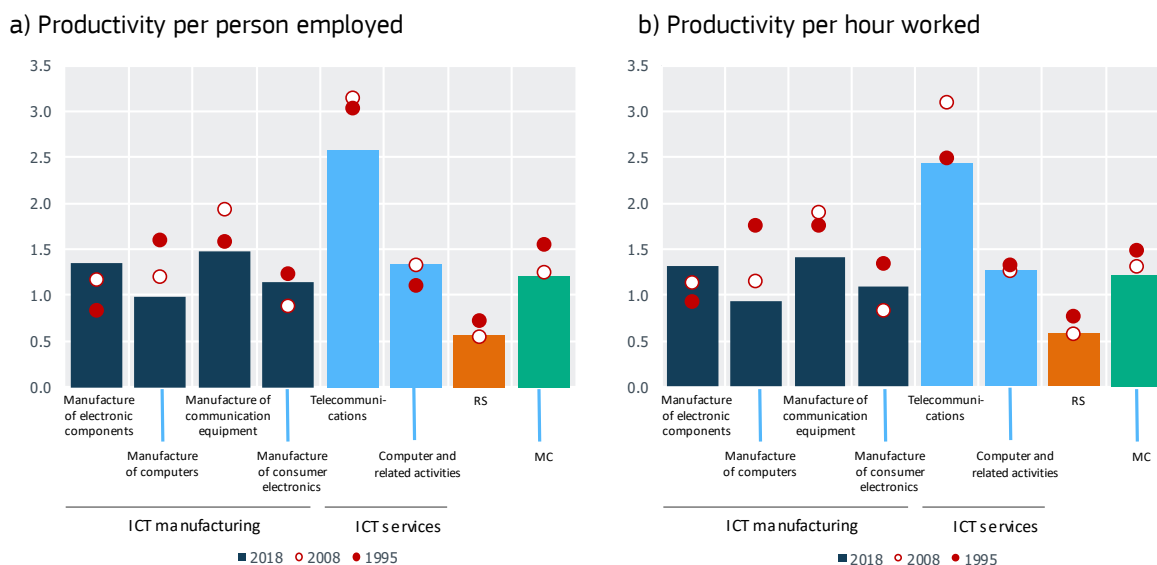


Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. 2017 for GBARD and ICT GBARD. RS sector is not available.

Source: 2021 PREDICT Dataset.

*Computer and related activities* was the ICT services sector with the highest weight over the total economy in all PREDICT variables in 2018 (2019 for GBARD and ICT GBARD) (Figure 10): VA (2.5%), employment (1.9%), public funding (GBARD) (2.1%) and BERD (8.9%), and especially ICT GBARD (20.2%), R&D researchers (14.4%) and R&D personnel (13.0%). *Telecommunications* was the second in importance in the case of VA, employment, public funding (GBARD), and ICT GBARD. *Manufacture of electronic components* was second in importance in BERD, R&D researchers and R&D personnel. The *Media and content* sector had important shares in terms of VA and employment (0.75% and 0.62% respectively) in 2018. However, these values were higher in 1995. Its weight in terms of R&D variables is almost negligible.

**Figure 11. ICT sub-sectors, MC and RS sector productivity as a ratio over productivity in total economy in the EU27 (1995, 2008, 2018)**



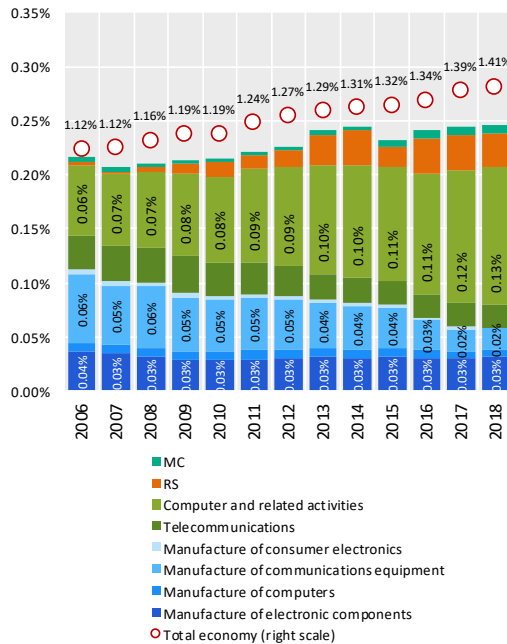
Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet.  
Source: 2021 PREDICT Dataset.

In the years analysed, all ICT sub-sectors had higher labour productivity than the total economy, both in terms of persons and hours worked, with the only exception of *RS* and *Manufacture of computers*. *Telecommunications* had the highest ratio, followed by *Manufacture of communication equipment*, *Manufacture of electronic components* and *Computers and related activities* (Figure 11). However, only the sectors *Manufacturing of electronic components* and *Computer and related activities* (in terms of persons employed) increased the gap since 1995, while for the rest it narrowed.

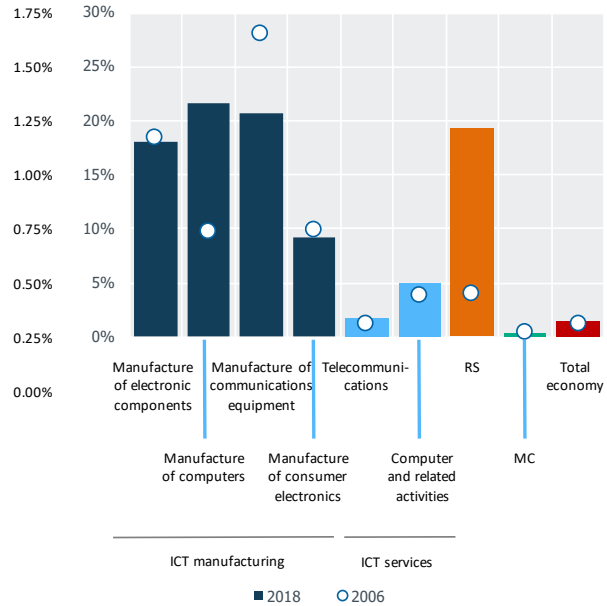


**Figure 12. Total economy, ICT manufacturing, ICT services, RS and MC sectors BERD intensity in the EU27 (percentages, 2006-2018)**

a) BERD/GDP



b) Subsector BERD/subsector VA (2006, 2018)

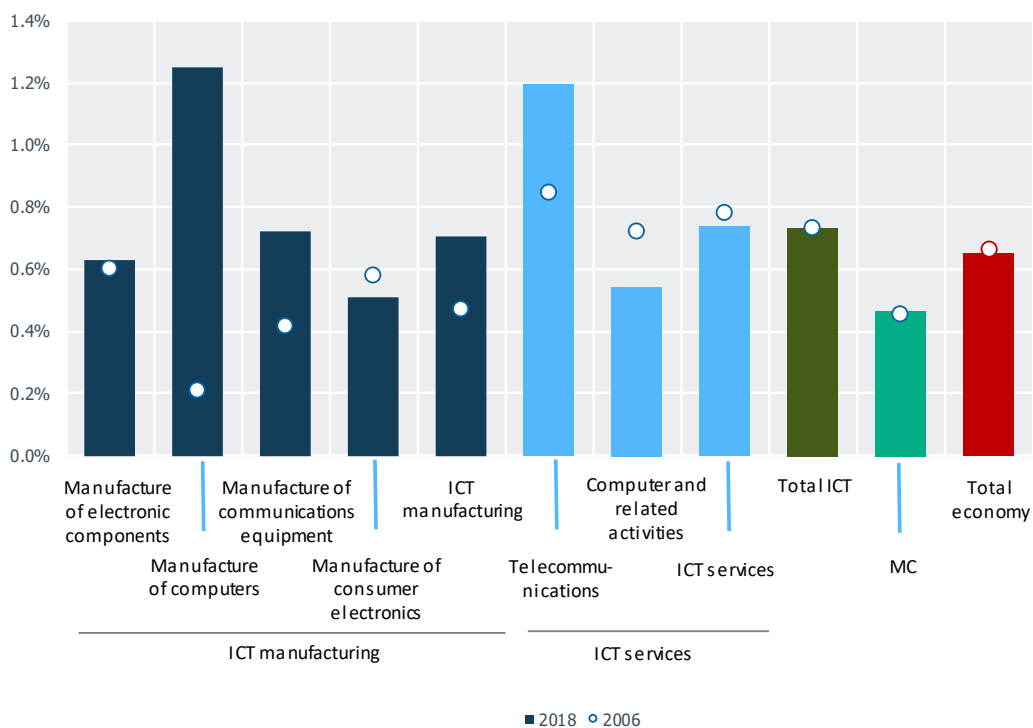


Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet.  
Source: 2021 PREDICT Dataset.

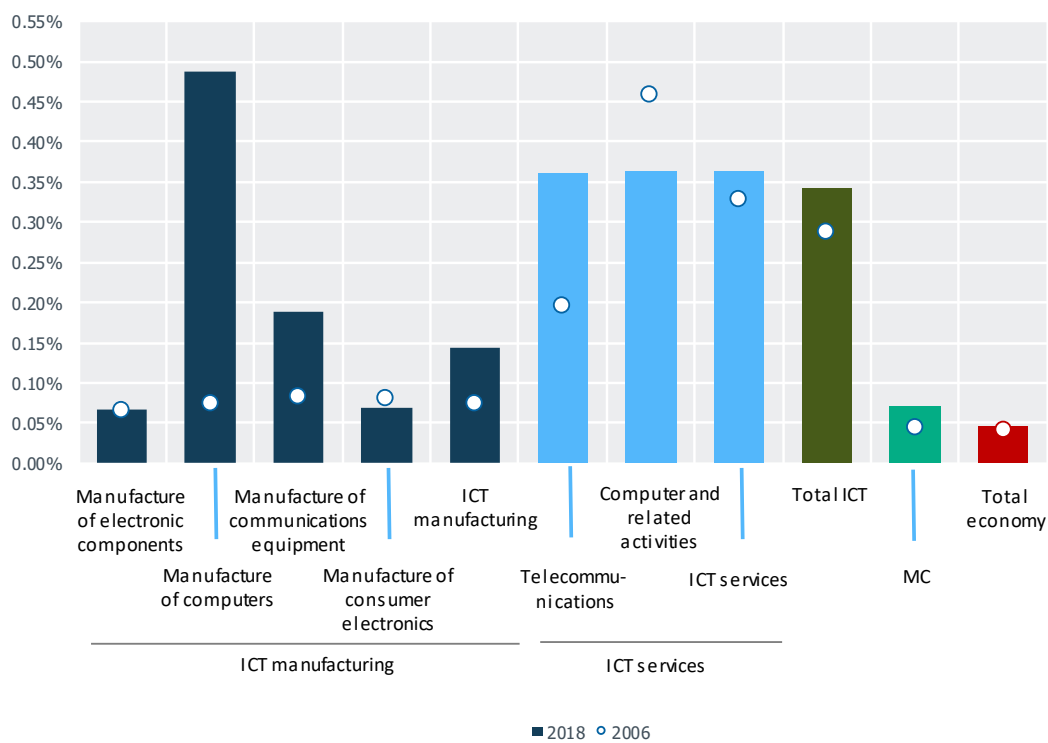
In 2018 the share of BERD over GDP amounted to 1.41% for the total economy and 0.21% in ICT, 0.01% in MC and 0.03% in RS sectors. The highest share was the one of *Computer and related activities* (0.13%) (Figure 12). BERD intensity for each sub-sector (sub-sector BERD/sub-sector VA) was higher in *Manufacture of computers* (21.7%), followed by *Manufacture of communications equipment* (20.6%), *RS sector* (19.4%) and *Manufacture of electronic components* (18.0%). For almost all sub-sectors, BERD intensity was higher in 2018 than in 2006, with the only exception of *Manufacture of communications equipment*, *Manufacture of consumer electronics* and *Manufacture of electronic components*.

**Figure 13. ICT manufacturing and ICT services, GBARD and ICT GBARD in the EU27 (percentages, 2006, 2018)**

a) GBARD intensity (sub-sector GBARD/sub-sector VA)



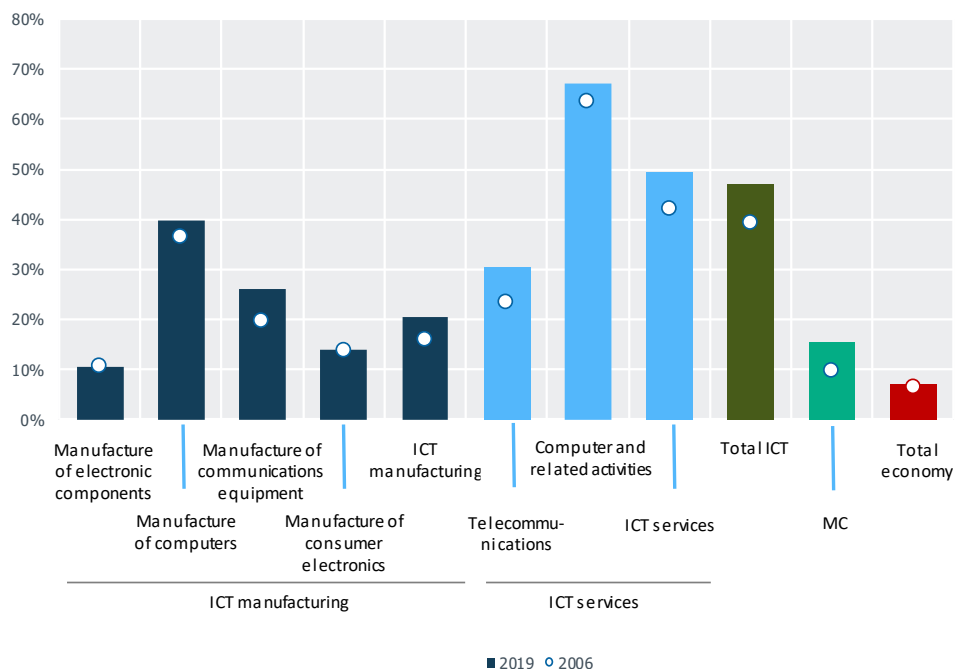
b) ICT GBARD intensity (sub-sector ICT GBARD/sub-sector VA)



Note: MC: Media and Content.  
Source: 2021 PREDICT Dataset.

**Figure 13 (cont.) ICT manufacturing and ICT services, GBARD and ICT GBARD in the EU27 (percentages, 2006, 2018)**

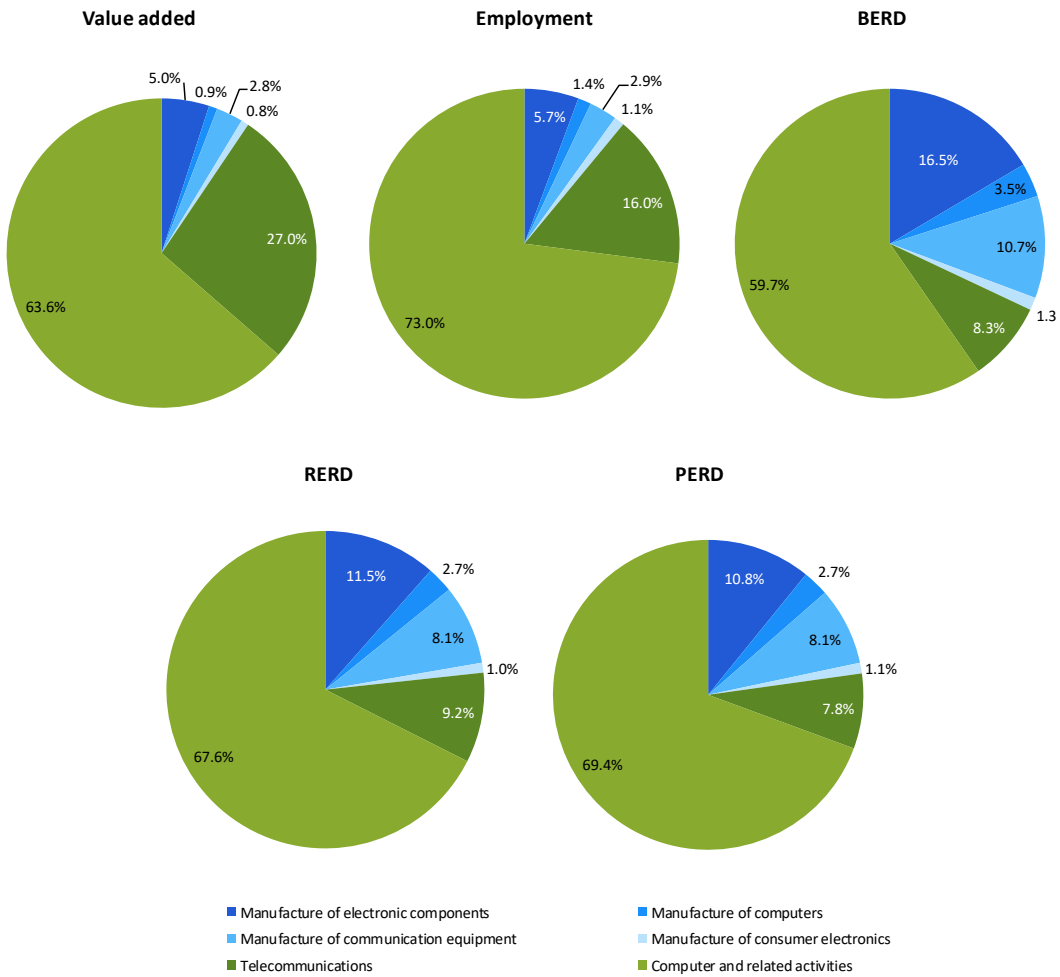
c) Sub-sector ICT GBARD / sub-sector GBARD



Note: 2019 for GBARD and ICT GBARD.  
Source: 2021 PREDICT Dataset.

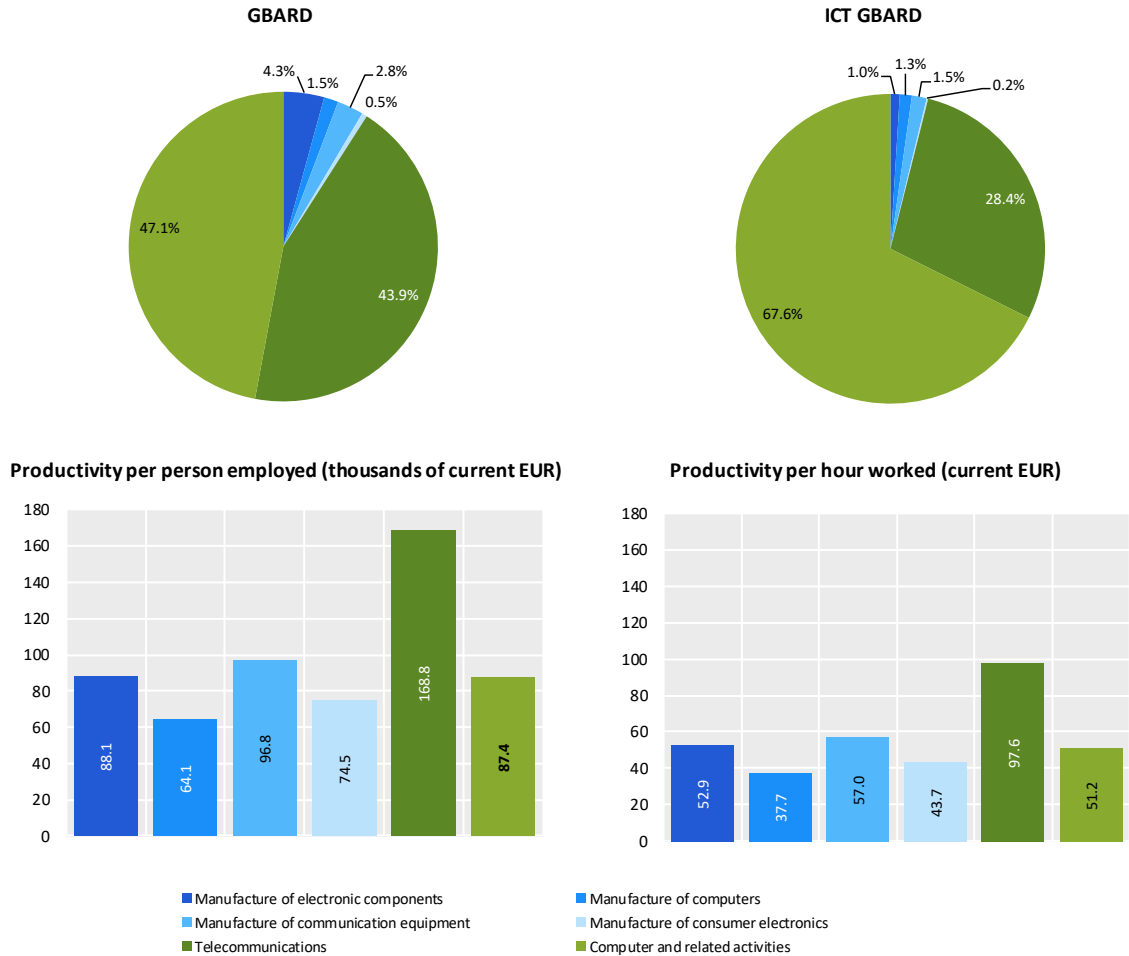
In 2018 GBARD intensity (defined as sub-sector GBARD/sub-sector VA) was lower in ICT manufacturing (0.71) than in ICT services (0.74) (Figure 13). In addition, while in the former it had increased since 2006, in the latter it had decreased. For the MC sector, this ratio was much lower and remained stable. *Manufacture of computers* and *Telecommunications* were the sub-sectors with the highest ratio. ICT GBARD intensity was also higher in ICT services, more than twice that of ICT manufacturing, about five times higher than that of the MC sector and eight times that of the total economy. The highest value for this variable was reached by *Manufacture of computers*, followed by *Computer and related activities* and *Telecommunications*. Finally, ICT GBARD over GBARD in the ICT sector amounted to 47.0% in 2019, a percentage almost seven times higher than for the total economy. *Computer and related activities* was, again, the sub-sector with the highest ratio.

**Figure 14. Overview of PREDICT variables: value added, employment, BERD, RERD, PERD, GBARD, ICT GBARD and labour productivity by ICT sub-sector in the EU27 (2018)**



Source: 2021 PREDICT Dataset.

**Figure 14 (cont.) Overview of PREDICT variables: value added, employment, BERD, RERD, PERD, GBARD, ICT GBARD and labour productivity by ICT sub-sector in the EU27 (2018)**



Note: ICT GBARD is the part of GBARD (Government budget allocations for R&D) devoted to fund ICT assets in all industries of the economy. ICT GBARD is allocated to all sectors in the economy, not only the ICT sector (see Box 1 in the introduction).  
Source: 2021 PREDICT Dataset.

The *Computer and related activities* sub-sector presented the largest share in the ICT sector in the seven indicators, with values between 47.1% (GBARD) and 73.0% (employment) in 2018 (Figure 14). The *Telecommunications* sub-sector led labour productivity, both productivity per person employed and productivity per hour worked.

### 3 The ICT sector in the EU27 Member States

Table 2. Summary table of total ICT sector by EU27 Member States

a) 2018

	VA	Employment	BERD	GBARD	ICT GBARD	RERD	PERD		
	ICT sector (Millions of current EUR PPS)	ICT sector (1000 persons employed)	ICT sector (Millions of current EUR PPS)	ICT sector (Millions of current EUR PPS)	Total Economy (Millions of current EUR PPS)	ICT sector (Millions of current EUR PPS)	Total Economy (Millions of current EUR PPS)	ICT sector (1000 Full Time Equivalent)	ICT sector (1000 Full Time Equivalent)
Austria	11,655.3	111.5	1,047.5	81.0	2,585.2	35.9	218.6	6.5	9.5
Belgium	13,896.5	107.5	1,125.5	231.0	2,575.6	115.4	253.5	6.1	11.1
Bulgaria	5,673.6	92.4	227.3	10.6	221.9	7.3	16.4	2.7	3.4
Croatia	2,976.8	49.8	101.4	7.0	602.0	4.9	51.6	0.4	1.6
Cyprus	1,281.8	10.5	31.5	0.1	74.7	0.0	21.9	0.2	0.2
Czechia	15,446.0	167.2	734.8	82.8	1,829.4	51.6	167.7	6.3	10.1
Denmark	7,239.0	79.3	383.5	52.2	2,002.3	29.7	123.8	3.4	4.6
Estonia	1,763.0	30.7	101.9	14.8	229.0	9.6	21.6	0.7	0.8
Finland	9,012.3	98.8	1,185.6	110.6	1,553.3	60.1	192.6	8.0	10.5
France	93,234.9	824.4	5,797.6	649.0	12,527.0	187.4	618.5	53.2	61.0
Germany	119,541.1	1,149.4	6,349.6	965.5	28,985.0	401.6	1,705.1	28.7	49.2
Greece	5,525.0	65.7	206.5	55.2	1,343.6	20.6	95.5	2.6	3.5
Hungary	10,314.8	183.5	275.4	43.4	630.0	18.8	72.0	3.9	4.9
Ireland	17,715.3	85.8	790.3	54.8	656.2	19.6	100.2	4.8	7.2
Italy	56,163.3	600.5	2,478.6	686.4	8,983.5	254.5	595.9	15.6	37.8
Latvia	1,878.6	32.4	13.9	3.2	88.2	1.8	11.5	0.2	0.3
Lithuania	2,153.9	28.4	39.2	4.5	202.8	2.3	8.6	0.5	0.7
Luxembourg	2,868.0	17.7	20.0	20.7	301.4	8.0	28.1	0.1	0.2
Malta	897.6	10.3	27.5	0.6	30.1	0.3	0.5	0.2	0.5
Netherlands	27,429.4	262.7	1,498.3	159.6	4,825.2	82.9	416.1	13.4	23.4
Poland	29,337.8	415.1	1,581.5	92.5	2,349.1	41.1	93.5	19.6	26.7
Portugal	7,030.2	99.7	398.4	19.1	841.7	7.7	37.7	5.4	6.7
Romania	20,112.9	221.7	154.5	35.2	664.4	18.3	42.8	0.3	2.2
Slovakia	4,814.6	71.7	75.2	18.2	427.3	11.0	17.1	0.9	1.4
Slovenia	1,745.7	27.3	64.1	5.5	228.7	2.3	13.1	0.9	1.3
Spain	37,966.6	440.8	1,161.9	433.1	6,725.5	191.5	561.8	10.2	19.3
Sweden	21,110.9	173.8	1,982.5	46.1	2,868.2	23.9	362.4	14.9	16.3
<b>EU27-2020</b>	<b>540,500.9</b>	<b>5,386.5</b>	<b>29,277.9</b>	<b>3,972.3</b>	<b>88,308.3</b>	<b>1,851.5</b>	<b>6,140.5</b>	<b>209.6</b>	<b>314.3</b>

Note: 2014 for Ireland ICT sector VA  
Source: 2021 PREDICT Dataset

**Table 2 (cont.) Summary table of total ICT sector by EU27 Member States**

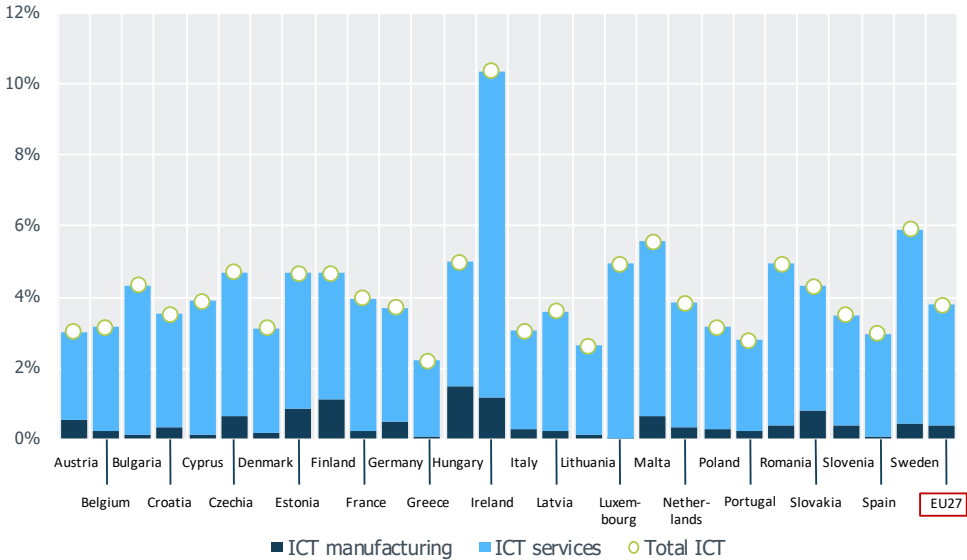
**b) Annual growth rates (%), 2017-2018**

	VA	Employment	BERD	GBARD		ICT GBARD		RERD	PERD
	ICT sector	ICT sector	ICT sector	ICT sector	Total Economy	ICT sector	Total Economy	ICT sector	ICT sector
Austria	13.5	5.0	7.7	4.8	-0.4	4.3	-2.1	6.2	6.2
Belgium	7.5	2.7	3.3	1.3	7.1	0.4	9.7	8.4	8.2
Bulgaria	11.9	6.4	9.3	5.5	10.0	5.9	1.2	27.3	22.8
Croatia	6.5	23.8	68.4	59.3	0.9	56.5	6.0	6.7	88.0
Cyprus	11.6	16.6	12.7	-0.8	3.4	-0.8	3.5	49.5	57.6
Czechia	11.0	3.9	19.0	14.3	8.1	15.3	9.7	9.3	11.8
Denmark	4.9	4.0	0.7	6.9	0.7	6.0	8.7	2.1	2.1
Estonia	18.5	6.0	30.5	23.6	-4.4	20.9	-2.6	10.4	12.6
Finland	-3.5	5.4	-5.6	12.7	1.9	12.8	3.1	0.4	-1.5
France	7.3	5.4	1.0	88.1	-3.6	67.8	-7.4	5.6	0.1
Germany	7.5	3.9	6.9	12.7	5.0	13.5	3.7	3.8	3.6
Greece	1.0	2.6	4.4	146.5	-6.9	223.4	-17.3	3.9	7.2
Hungary	1.8	1.8	62.5	6.0	-6.4	-4.4	-4.4	27.0	31.1
Ireland	10.6	2.4	3.8	-3.4	1.1	-2.9	1.5	-3.0	-3.0
Italy	-0.7	0.9	5.6	-8.1	-0.1	-13.2	5.7	19.7	10.0
Latvia	5.7	8.4	21.1	-30.2	10.8	-30.4	25.1	0.6	22.5
Lithuania	8.6	14.2	-7.7	-21.0	3.8	-22.0	3.6	14.2	-12.3
Luxembourg	13.4	6.2	-12.8	-12.6	7.4	-8.7	11.1	-12.5	-6.3
Malta	10.6	3.6	11.0	90.7	2.8	68.0	83.6	-11.4	-3.6
Netherlands	6.7	5.2	2.9	30.0	-0.6	30.9	-0.7	6.2	4.9
Poland	9.8	8.6	23.7	-52.7	15.4	-60.1	69.7	13.5	23.9
Portugal	5.8	10.8	14.0	6.4	-0.9	5.1	-1.6	19.6	13.8
Romania	3.8	-1.1	16.2	-5.6	-28.0	-4.7	-26.9	-57.5	6.7
Slovakia	0.0	4.9	2.1	21.9	0.2	23.2	13.4	36.9	34.8
Slovenia	5.1	5.3	-12.4	23.1	3.2	22.2	-0.1	-14.2	-17.9
Spain	6.1	5.5	19.4	17.7	-2.2	12.0	0.3	26.3	18.0
Sweden	7.1	1.6	15.1	2.6	4.4	2.5	0.3	12.7	14.8
<b>EU27</b>	<b>5.5</b>	<b>3.1</b>	<b>5.9</b>	<b>13.4</b>	<b>1.4</b>	<b>9.2</b>	<b>2.2</b>	<b>8.8</b>	<b>7.7</b>

Note: Monetary variables are expressed in real terms. 2013-2014 for Ireland ICT sector  
Source: 2021 PREDICT Dataset

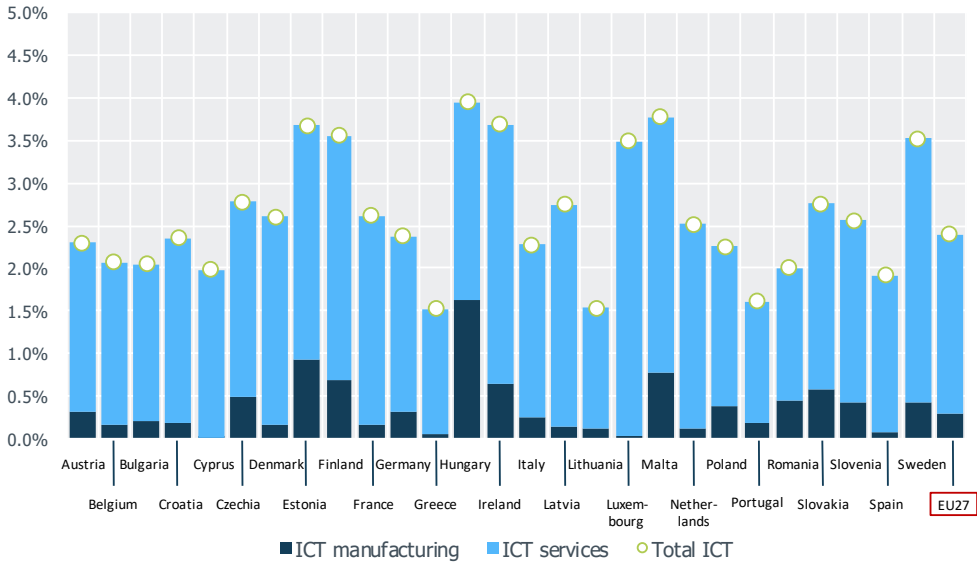
**Figure 15. ICT sector, ICT manufacturing and ICT services: VA, employment, labour productivity, BERD, BERD intensity, RERD, PERD, GBARD and ICT GBARD by EU27 Member State (2018)**

a) ICT sector VA share of GDP



Note: 2014 for Ireland.

b) ICT sector employment share of total employment



Source: 2021 PREDICT Dataset.



In 2018 the largest ICT sectors in the EU in relative size (ICT sector VA / GDP) were Ireland<sup>11</sup>, which is, by far, the EU country with the highest share (10.4%), multiplying the EU average by a factor of 2.6 (Figure 15). Malta, Luxembourg, Sweden, Estonia, Cyprus, Czechia, Romania and Bulgaria, all above 5.0% also stand out. In terms of employment, the largest EU ICT sectors in relative size were Estonia, Malta, Hungary, Luxembourg, Ireland, Finland and Latvia, with a share over total employment higher than 3.5%. Ireland also had the highest ratio of productivity in the ICT sector over total productivity. Overall, the productivity of EU countries in the ICT service sector was higher than in ICT manufactures. On the other hand, Finland was the country with the highest ICT sector BERD intensity in 2018 (13.2% of ICT sector VA), followed by Sweden, Austria, Belgium, France and Estonia.

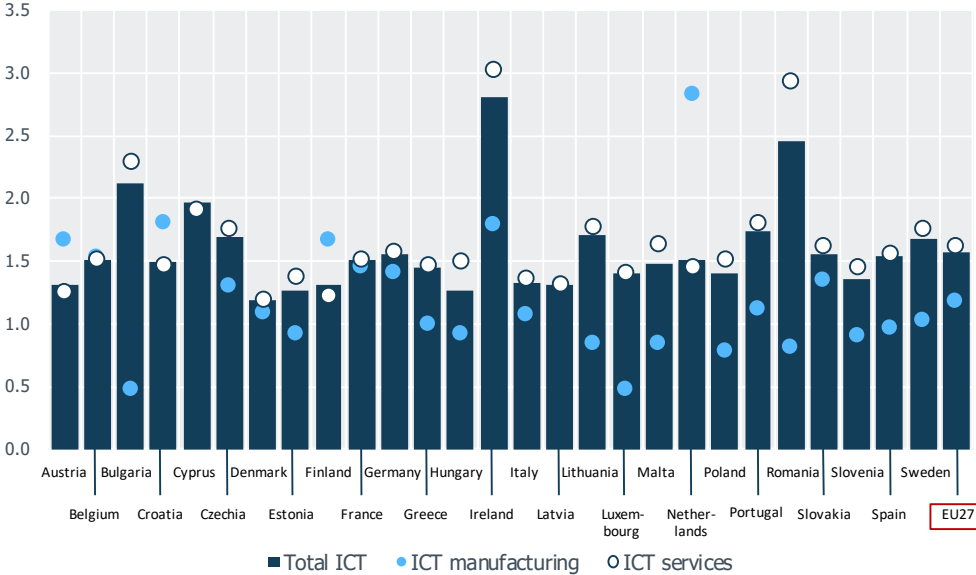
The most dynamic European countries in 2018 were: Estonia, Austria, Luxembourg, Bulgaria, Cyprus, Czechia and Malta in VA; Croatia, Cyprus, Lithuania, and Portugal in employment; and Croatia, Hungary and Estonia in BERD. The share of BERD in the ICT sector over total BERD was very uneven among EU countries. Besides Cyprus and Estonia, two countries stood out in this variable: Portugal and Malta. In the case of RERD and PERD, Malta, Cyprus, Ireland, Finland and Estonia were the countries with the highest share (above 35%) of the ICT sector over the total. The countries with the highest ICT GBARD in relation to GDP were Finland and Sweden, where it represented 0.1%. In terms of ICT GBARD, the largest EU ICT sectors in relative size were Slovakia, Malta, Belgium and Estonia. The share of the ICT sector GBARD over total GBARD was also very uneven among EU countries; Cyprus, Ireland, Latvia, Sweden, Finland and Hungary showed the highest shares.

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<sup>11</sup> Ireland has not published official data for VA since 2014.

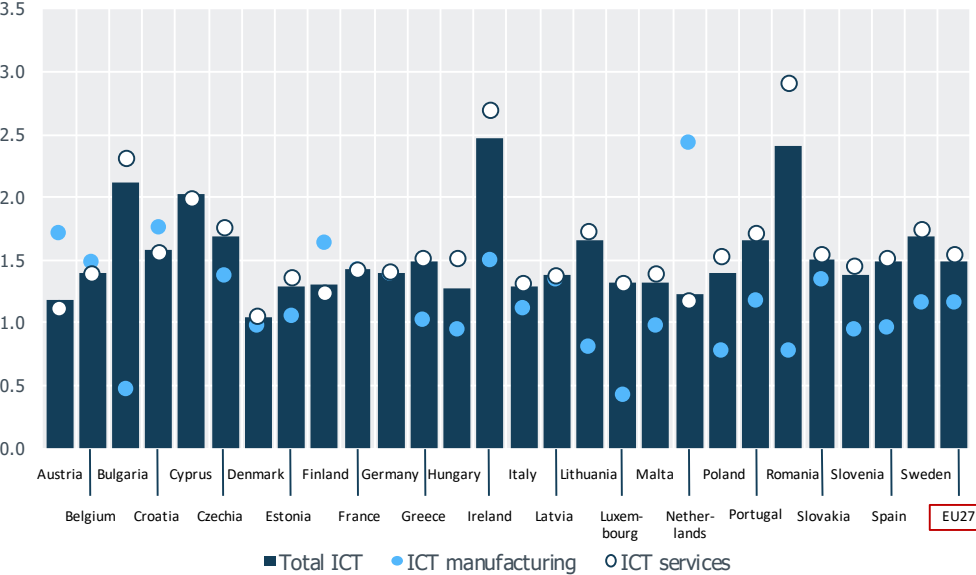
**Figure 15 (cont.) ICT sector, ICT manufacturing and ICT services: VA, employment, labour productivity, BERD, BERD intensity, RERD, PERD, GBARD and ICT GBARD by EU27 Member State (2018)**

c) ICT sector productivity per person employed ratio over total economy productivity



Note: 2014 for Ireland. ICT manufacturing for Cyprus is available but has been excluded due to high value (6.9)

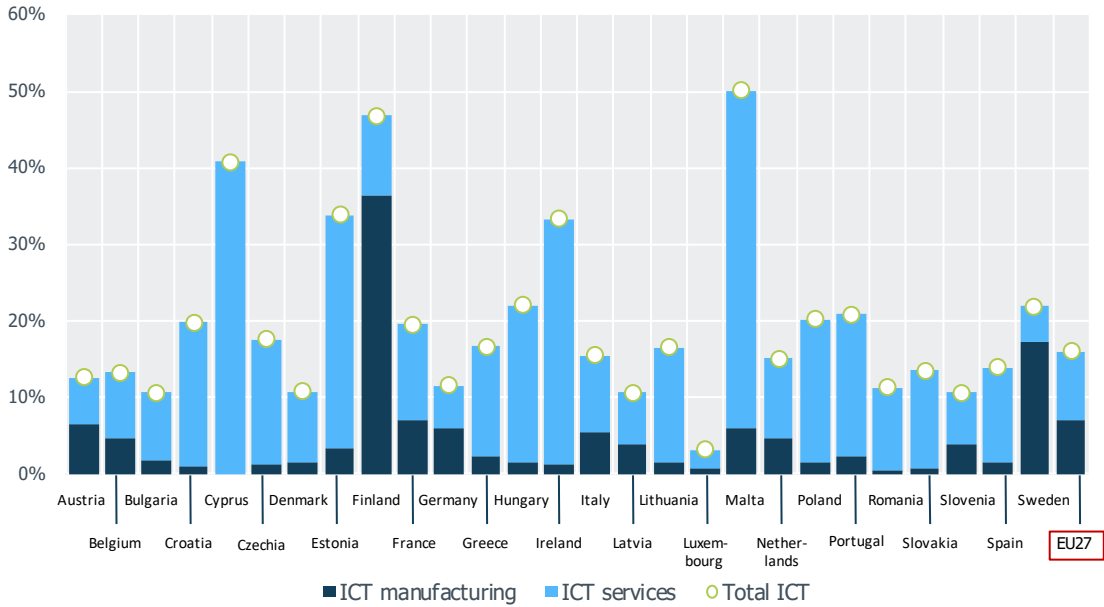
d) ICT sector productivity per hour worked ratio over total economy productivity



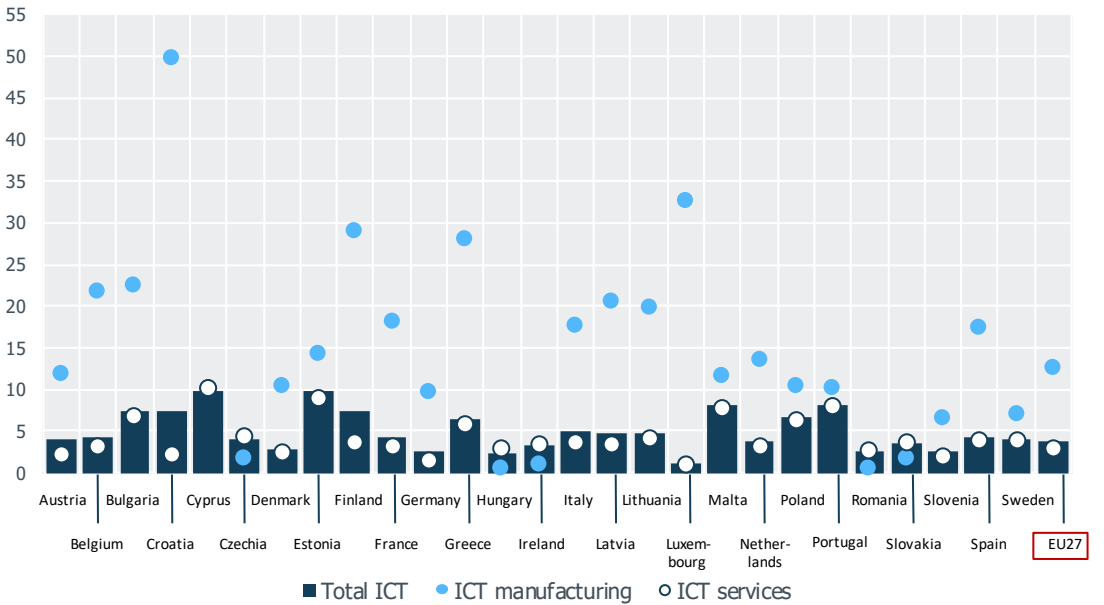
Note: 2014 for Ireland. ICT manufacturing for Cyprus is available but has been excluded due to high value (7.1)  
Source: 2021 PREDICT Dataset.

**Figure 15 (cont.) ICT sector, ICT manufacturing and ICT services: VA, employment, labour productivity, BERD, BERD intensity, RERD, PERD, GBARD and ICT GBARD by EU27 Member State (2018)**

e) Share of ICT sector BERD on total BERD



f) ICT sector BERD intensity (BERD/VA) ratio over total BERD intensity

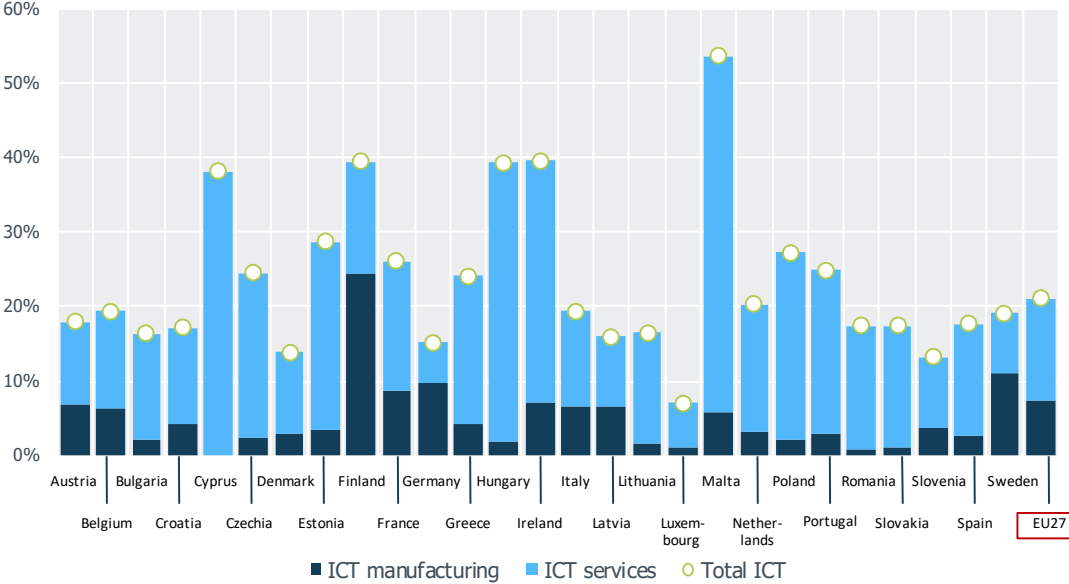


Note: 2014 for Ireland.

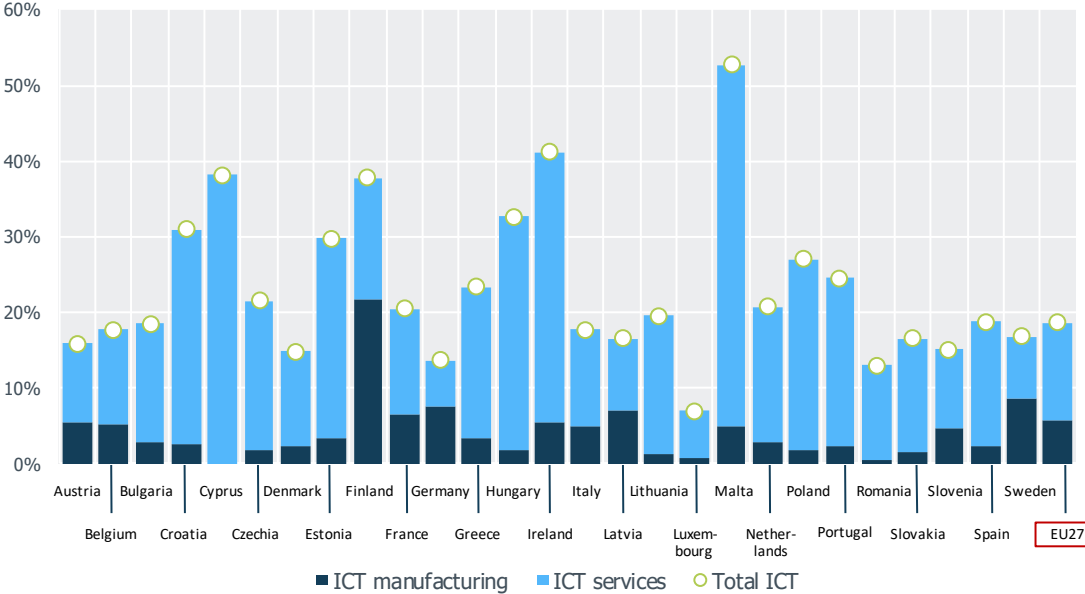
Source: 2021 PREDICT Dataset.

**Figure 15 (cont.) ICT sector, ICT manufacturing and ICT services: VA, employment, labour productivity, BERD, BERD intensity, RERD, PERD, GBARD and ICT GBARD by EU27 Member State (2018)**

**g) ICT sector RERD share of total RERD**



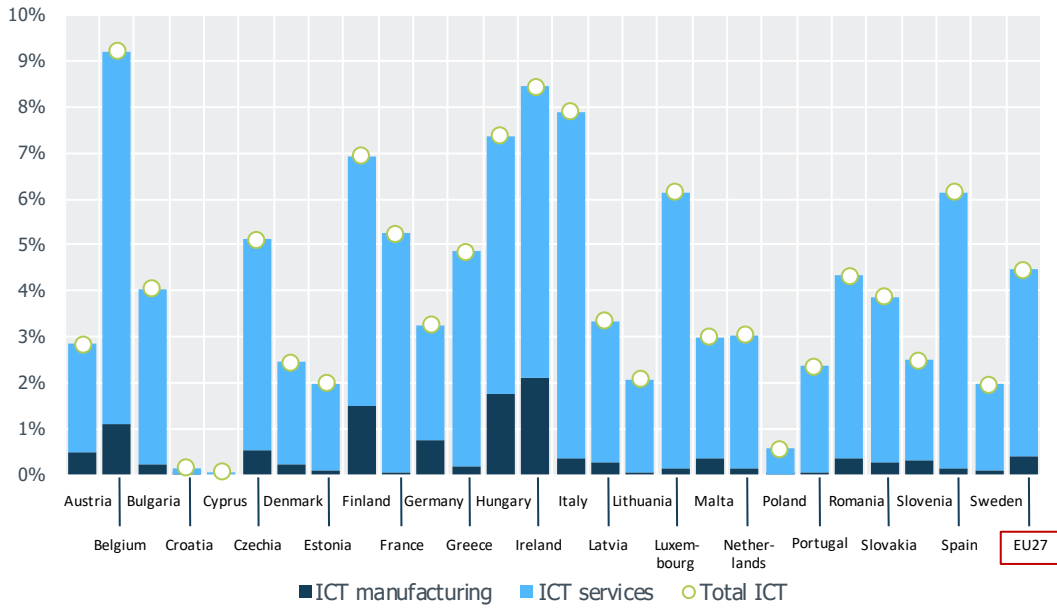
**h) ICT sector PERD share of total PERD**



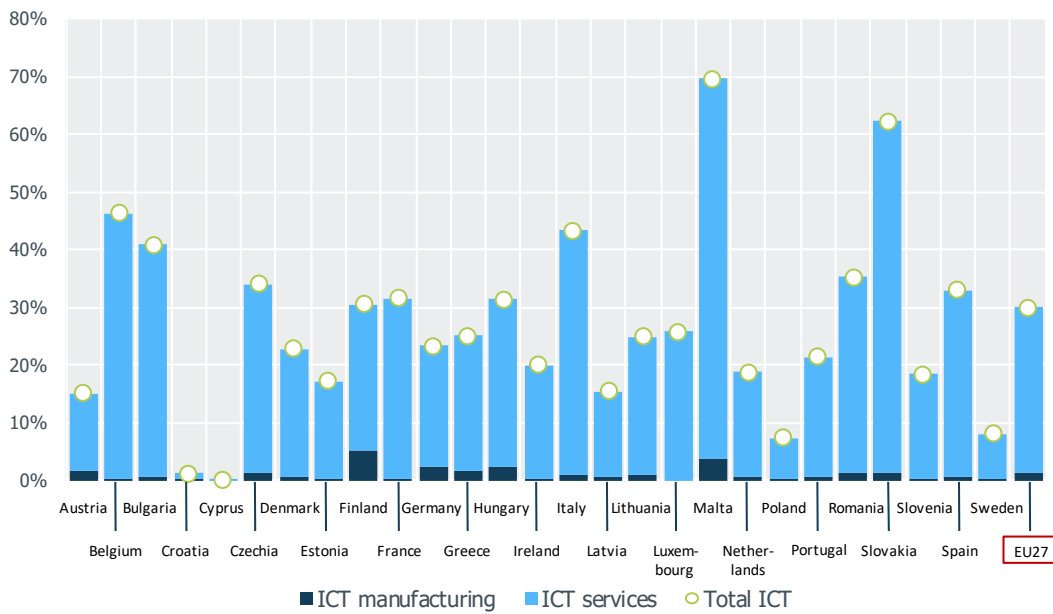
Source: 2021 PREDICT Dataset.

**Figure 15 (cont.) ICT sector, ICT manufacturing and ICT services: VA, employment, labour productivity, BERD, BERD intensity, RERD, PERD, GBARD and ICT GBARD by EU27 Member State (2018)**

i) ICT sector GBARD share of total GBARD



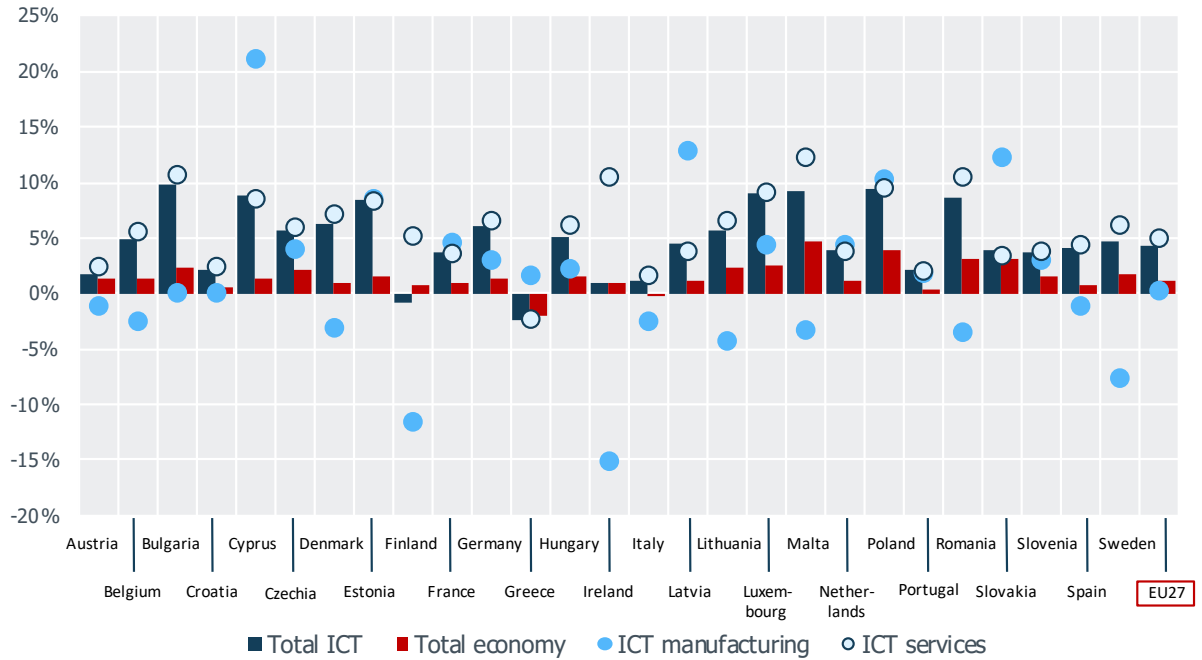
j) ICT sector ICT GBARD share of total ICT GBARD



Note: 2019 for GBARD and ICT GBARD.  
Source: 2021 PREDICT Dataset.

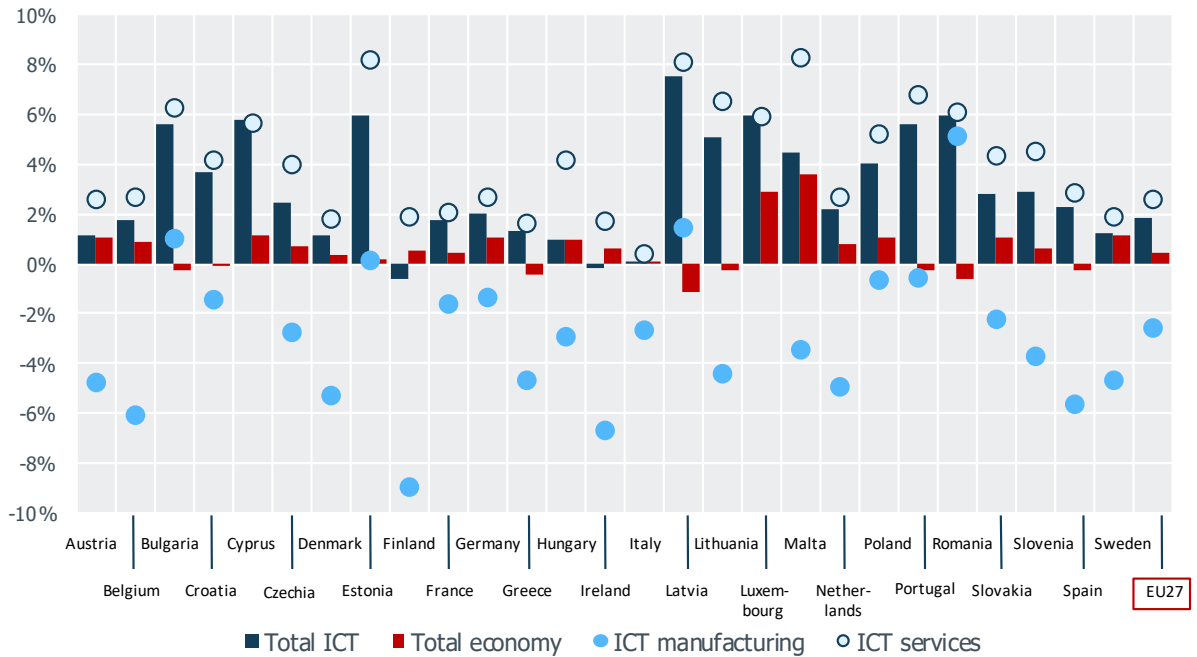
**Figure 16. Total economy, ICT sector, ICT manufacturing and ICT services: VA, employment, productivity, BERD, RERD, PERD, GBARD and ICT GBARD by EU27 Member State. Mean annual growth rates (%) (2006-2018)**

a) VA



Note: 2006-2014 for Ireland.

b) Employment

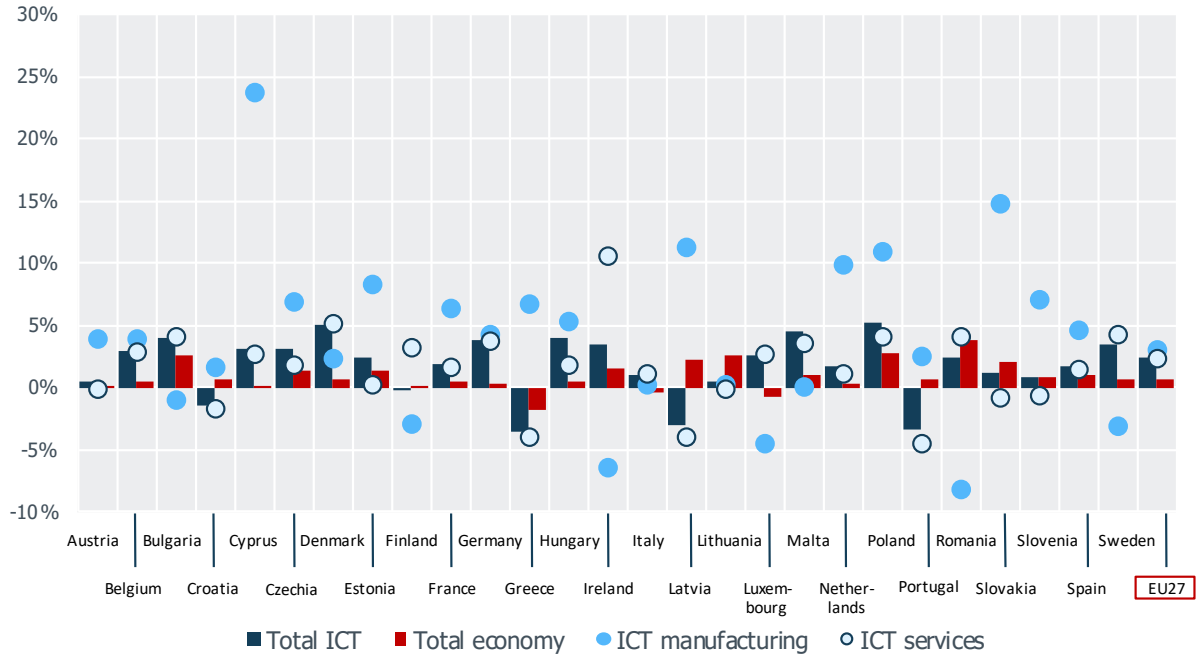


Note: Monetary variables are expressed in real terms.

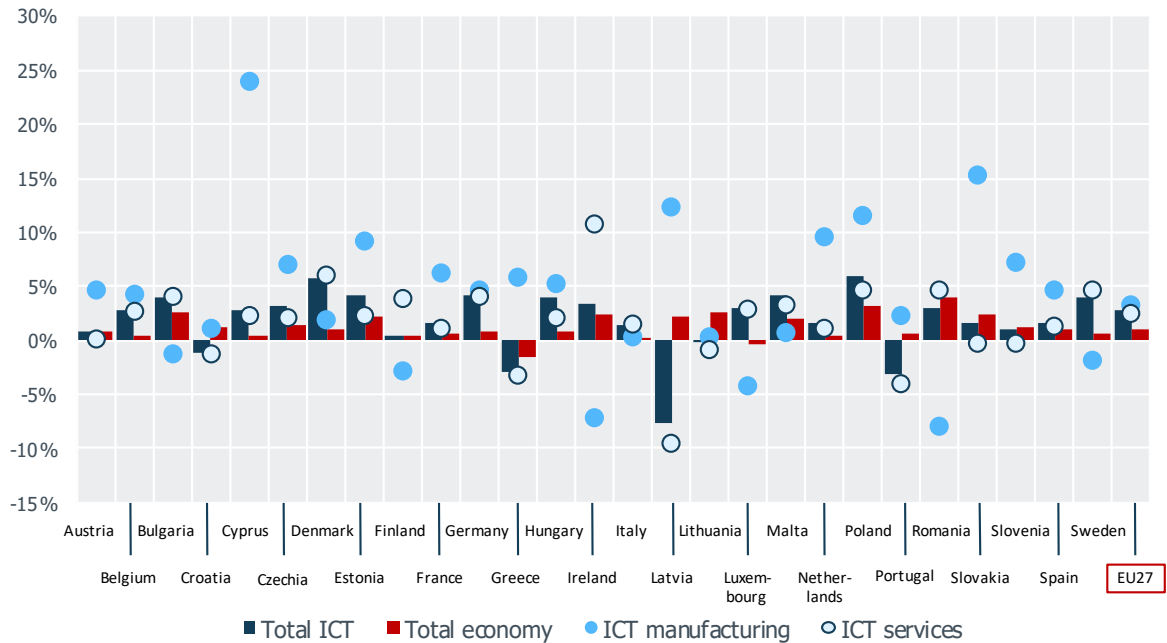
Source: 2021 PREDICT Dataset.

**Figure 16 (cont.) Total economy, ICT sector, ICT manufacturing and ICT services: VA, employment, productivity, BERD, RERD, PERD, GBARD and ICT GBARD by EU27 Member State. Mean annual growth rates (%) (2006-2018)**

c) Productivity per person employed



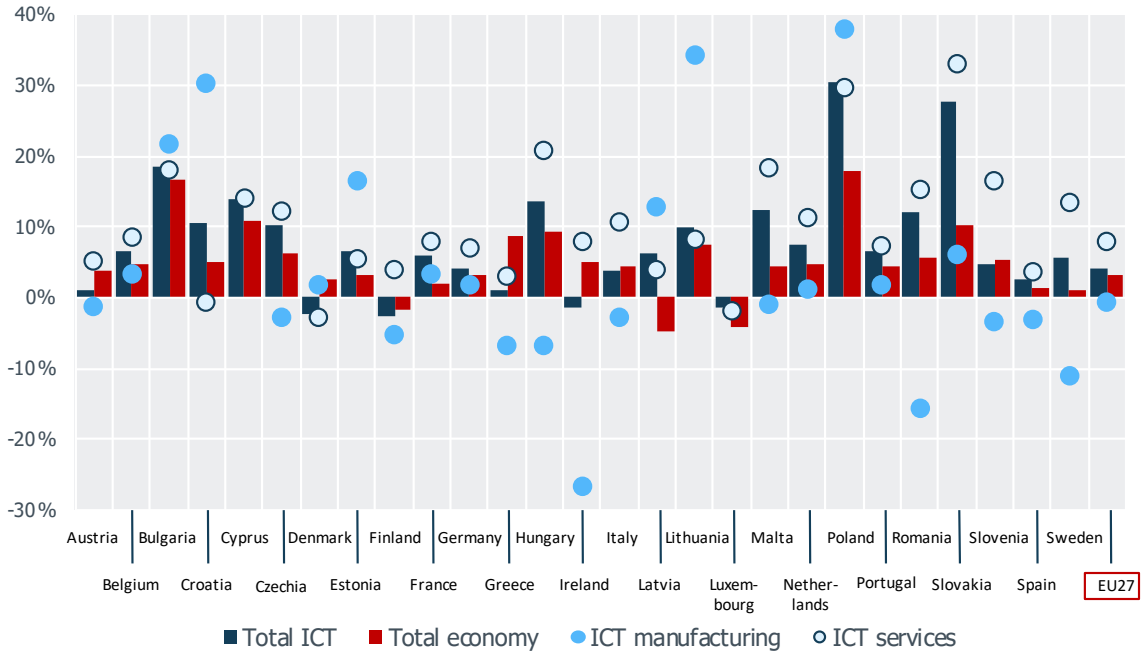
d) Productivity per hour worked



Note: Monetary variables are expressed in real terms. 2006-2014 for Ireland.  
Source: 2021 PREDICT Dataset.

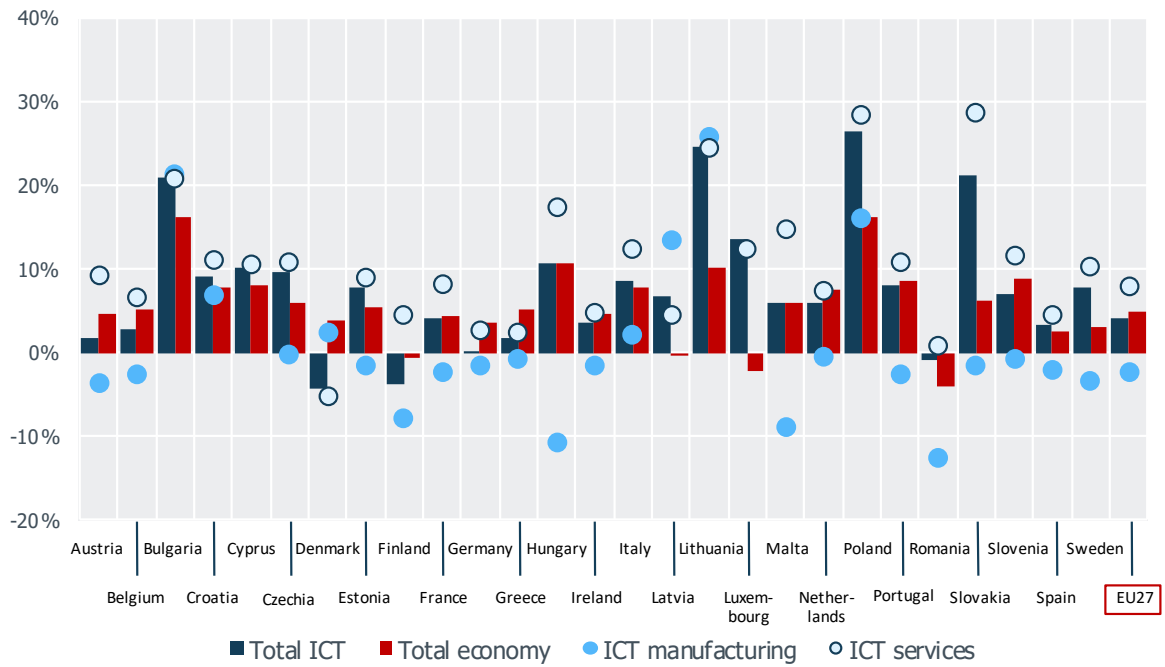
**Figure 16 (cont.) Total economy, ICT sector, ICT manufacturing and ICT services: VA, employment, productivity, BERD, RERD, PERD, GBARD and ICT GBARD by EU27 Member State. Mean annual growth rates (%) (2006-2018)**

e) BERD



Note: 2006-2014 for Ireland.

f) RERD

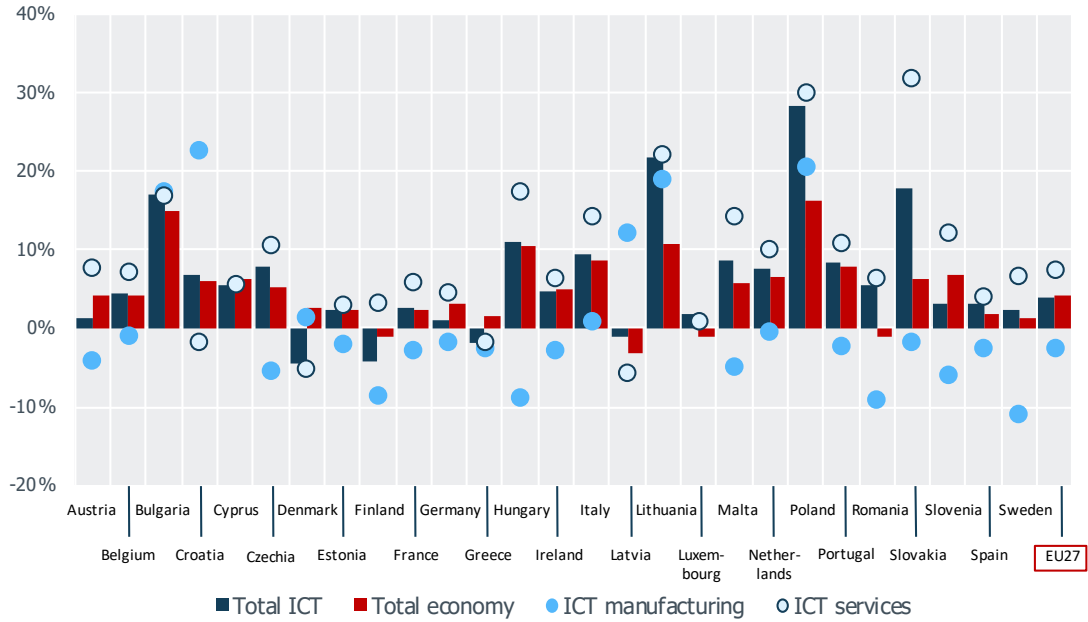


Note: Monetary variables are expressed in real terms.  
Source: 2021 PREDICT Dataset.

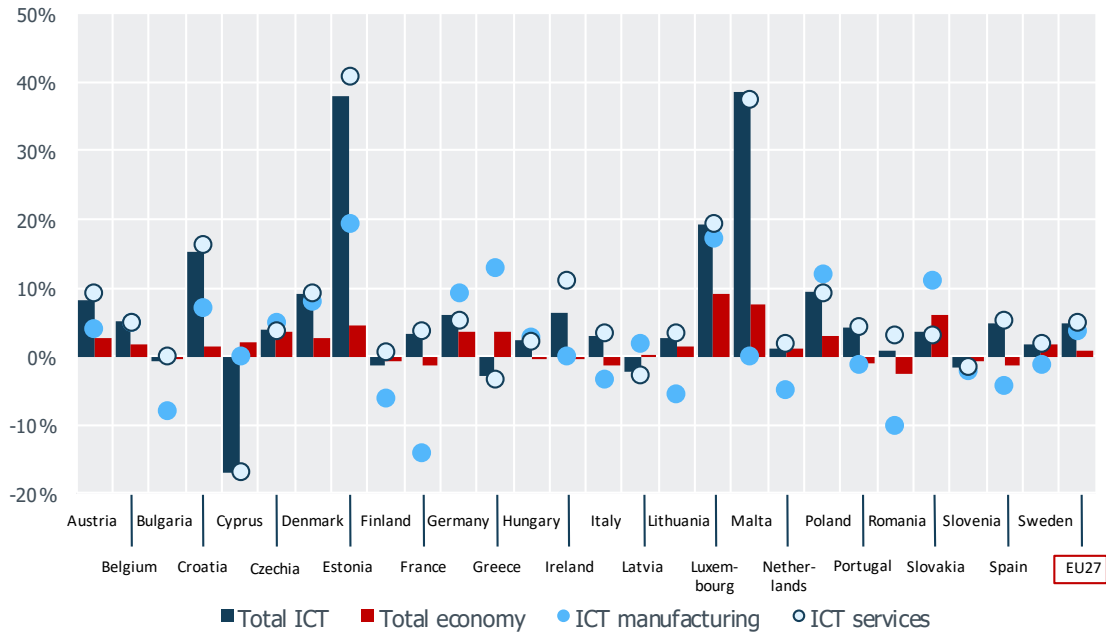


**Figure 16 (cont.) Total economy, ICT sector, ICT manufacturing and ICT services: VA, employment, productivity, BERD, RERD, PERD, GBARD and ICT GBARD by EU27 Member State. Mean annual growth rates (%) (2006-2018)**

g) PERD



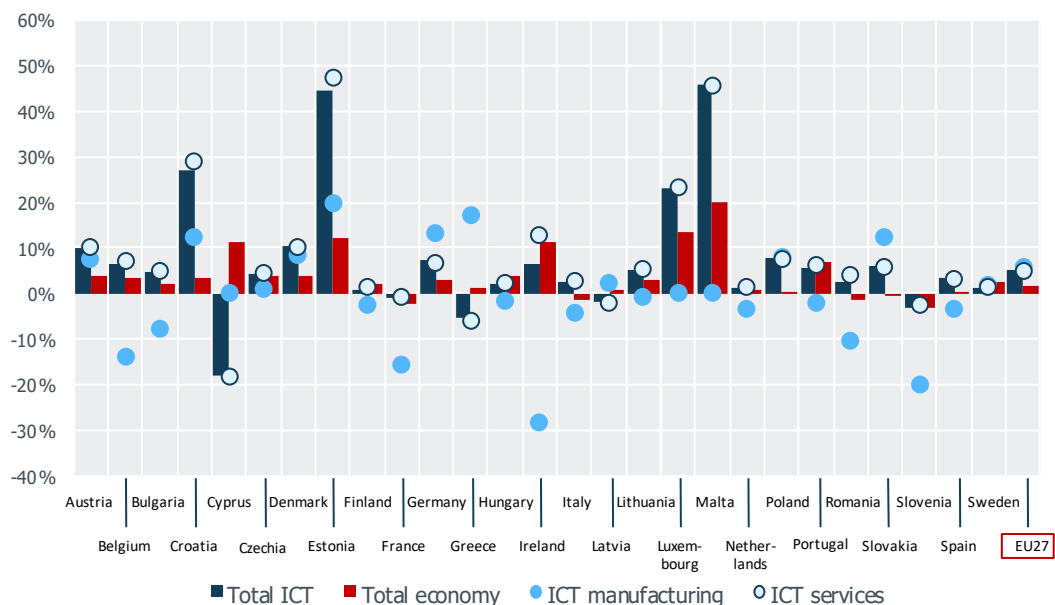
h) GBARD



Note: Monetary variables are expressed in real terms. 2008-2017 for Croatia and 2006-2014 for Ireland.  
Source: 2021 PREDICT Dataset.

**Figure 16 (cont.) Total economy, ICT sector, ICT manufacturing and ICT services: VA, employment, productivity, BERD, RERD, PERD, GBARD and ICT GBARD by EU27 Member State. Mean annual growth rates (%) (2006-2018)**

i) ICT GBARD

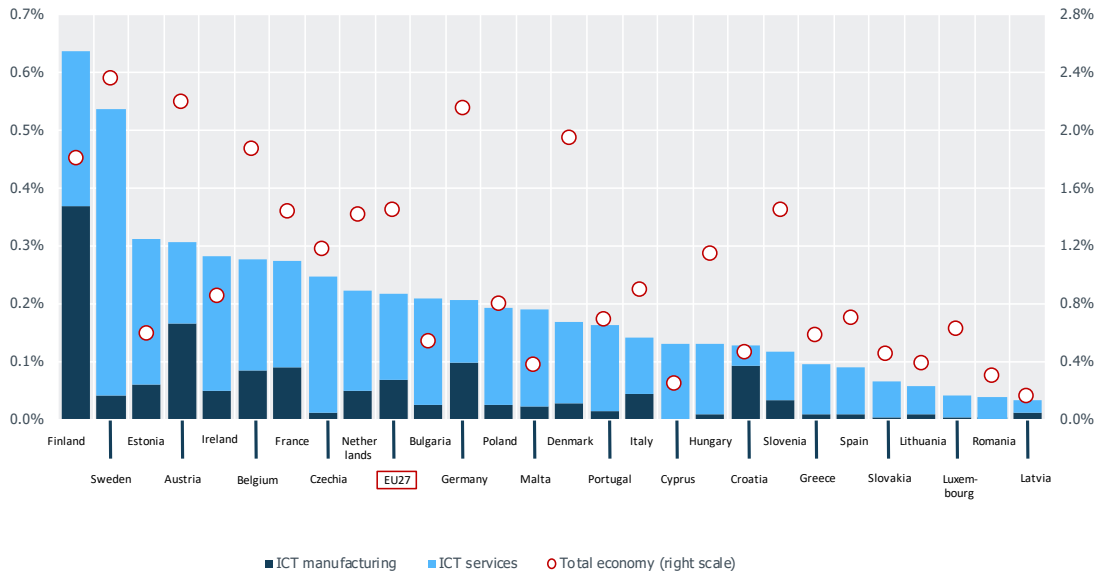


Note: Monetary variables are expressed in real terms. 2008-2018 for Croatia and 2006-2014 for Ireland.  
Source: 2021 PREDICT Dataset.

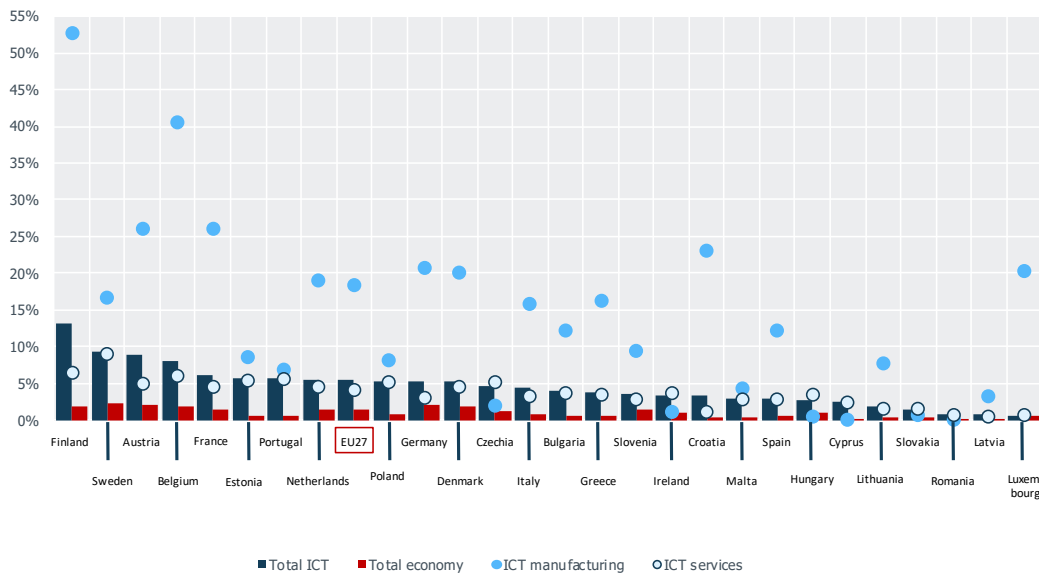
In all EU countries (with the sole exceptions of Greece and Finland), ICT sector VA growth was higher than GDP growth during the 2006-2018 period (Figure 16). Twelve, out of the 27 EU countries, experienced a negative change in ICT manufacturing, and only Greece also suffered a negative change in ICT services VA. Most of the countries experienced positive growth rates in the ICT sector employment, and higher than in total employment. However, for the ICT manufacturing sector the fall in employment was general. Labour productivity also grew at a faster rate in the ICT sector than in the total economy in almost all EU countries, both in terms of persons and per hour worked. For most of the countries analysed, labour productivity growth was higher in ICT manufacturing than in ICT services. For the EU, growth of BERD in the ICT sector was faster than for the total economy, and also faster in ICT services than ICT manufactures. The countries with the highest growth rate of BERD in the ICT sector were Poland and Slovakia, while Denmark, Ireland, Finland and Luxembourg showed a negative change. Growth rates in R&D researchers (RERD) and R&D personnel (PERD) in the ICT sector were especially high in Lithuania, Poland, Bulgaria and Slovakia. GBARD in the ICT sector grew at the fastest rate in Luxembourg, Malta, Croatia and Estonia, and sharply decreased in Cyprus and Greece.

**Figure 17. BERD intensity by EU27 Member State (2018)**

**a) BERD/GDP**



**b) ICT sector BERD/ICT sector VA**

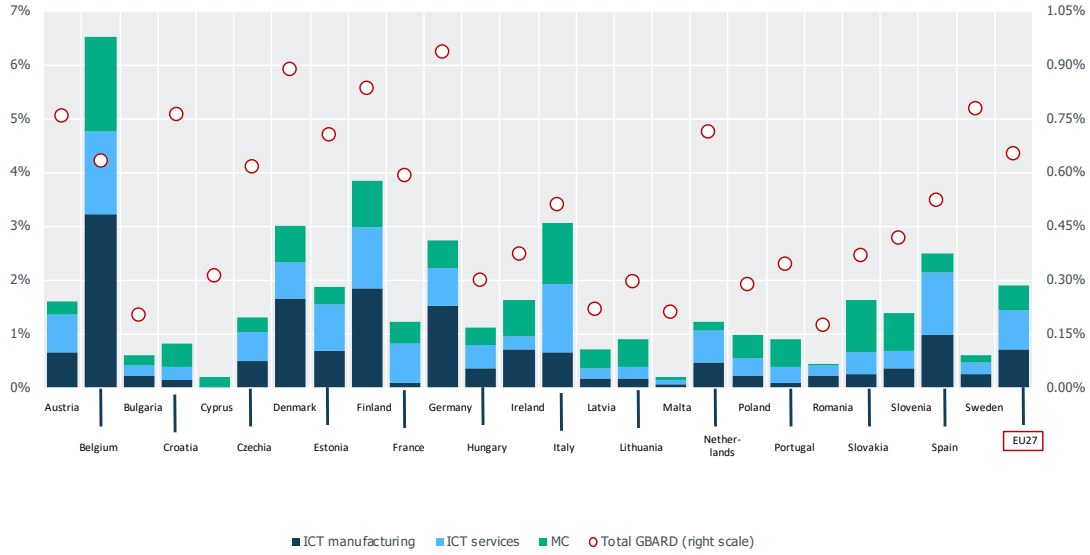


Note: 2014 for Ireland  
Source: 2021 PREDICT Dataset.

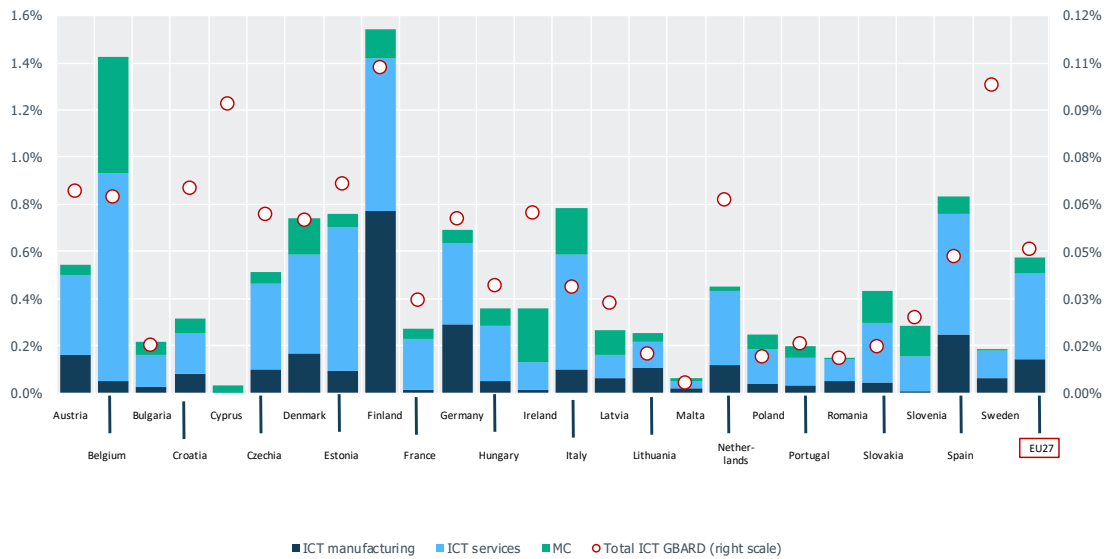
BERD intensity (BERD/GDP) was very different among EU countries. Sweden and Austria showed the highest ratio for the total economy in 2018. In the case of the ICT sector, Finland and Sweden stood out (Figure 17). For ICT sectors, BERD intensity (defined as ICT sector BERD/ICT sector VA) was higher than for the total economy, and higher in ICT manufactures than in ICT services. Finland and Sweden were the countries with the highest ratio for the ICT sector.

**Figure 18. ICT manufacturing, ICT services, MC and Total GBARD and ICT GBARD by EU27 Member State (2018)**

a) GBARD intensity (sub-sector GBARD/sub-sector VA)



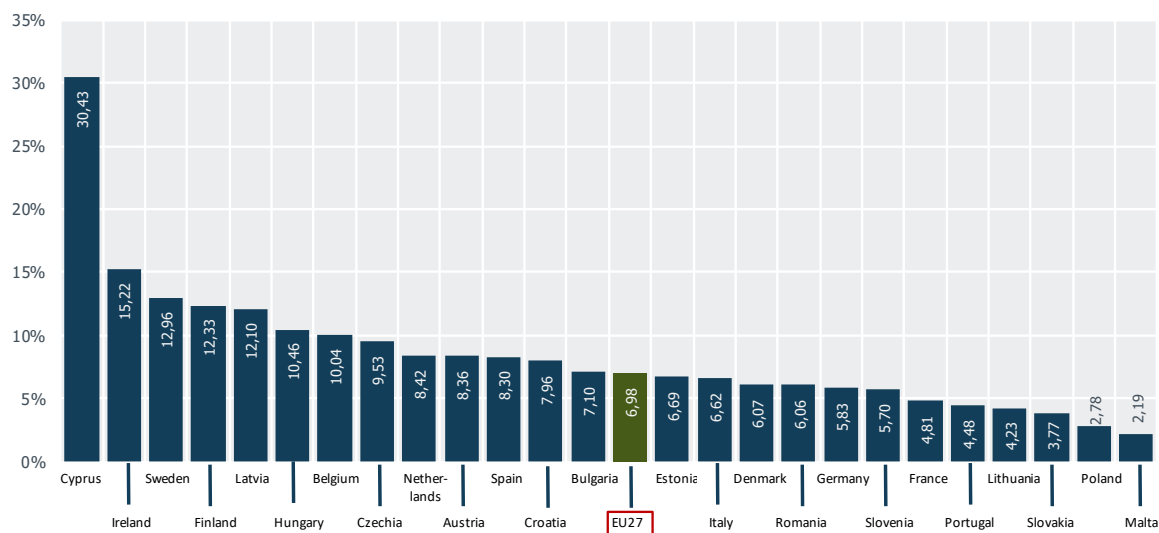
b) ICT GBARD intensity (sub-sector ICT GBARD/sub-sector VA)



Note: 2014 for Ireland. Data for Greece and Luxembourg no reliable.  
Source: 2021 PREDICT Dataset.

**Figure 18 (cont.) ICT manufacturing, ICT services, MC and Total GBARD and ICT GBARD by EU27 Member State (2018)**

c) ICT GBARD/GBARD



Note: 2019 for GBARD and ICT GBARD. Data for Greece and Luxembourg not reliable.  
Source: 2021 PREDICT Dataset.

In 2018, GBARD intensity (defined as sub-sector GBARD/sub-sector VA) was very different among EU countries for the total economy, and also for ICT manufacturing, ICT services and MC sector (Figure 18). In the case of the total economy, the highest values (above 0.8%) corresponded to Germany, Denmark and Finland. For ICT manufacturing, ICT services and MC, Belgium, Italy and Finland stood out. Similar results can be observed also for ICT GBARD where, again, Belgium and Finland stood out for the highest values of the sum of the three sub-sectors. However, in this case, Finland and Sweden were the two countries with the highest ICT GBARD intensity in the total economy. Finally, the ratio between ICT GBARD and total GBARD reached the highest values in Cyprus, Ireland, Sweden, Finland and Latvia.

## 4 The EU27 ICT sector in the international context

In the international context, the EU27 holds an intermediate position in value added, employment and BERD. Whereas the EU ICT sector accounted for 4.0% of total VA in the economy and 2.6% of employment in 2018, the ratios in Taiwan (16.7% in VA, 9.2% in employment), South Korea (10.8%, 4.1%), Japan (5.8%, 3.4%) or even in the US (5.9%, 2.8%) were notably higher (Table 3). Europe also lagged behind the leaders according to its BERD intensity (BERD/VA) in the ICT sector. In 2018, the EU ICT sector BERD intensity (5.4%) has been much lower than in South Korea (18.2%), Taiwan (11.9%) and the US (10.6%). China (6.2%) and Australia (6.3%) show BERD intensity levels similar to the EU (Table 3). In 2017, the annual growth of the EU ICT sector VA (5.5%) was modest, ranking sixth out of the 14 territories analysed, lagging far behind China (13.1%), India (12.1%), and South Korea (8.9%). In terms of employment growth in the ICT sector, the EU (3.1%) comes seventh among the countries included in PREDICT. The EU ICT BERD growth in 2018 (5.9%) was among the lowest of all the countries available, and the difference with the more dynamic countries is remarkable: Russia (26.3%), China (17.4%), South Korea (14.9%) and Australia (14.5). In 2018, ICT GBARD (ICT GBARD/GDP) in the EU (0.05%) was lower than in the US (0.06%) and Japan (0.07%). The EU ICT GBARD grew at a much lower rate (3.0%) than US (16.0%) and the United Kingdom (7.9%). It only surpasses that of Japan (2.7%).

**Table 3. Summary table of ICT indicators for the EU27 and other economies**

**a) 2018**

	<b>VA</b>	<b>Employment</b>	<b>BERD</b>	<b>GBARD</b>		<b>ICT GBARD</b>		<b>RERD</b>	<b>PERD</b>
	<b>ICT sector</b>	<b>ICT sector</b>	<b>ICT sector</b>	<b>ICT sector</b>	<b>Total Economy</b>	<b>ICT sector</b>	<b>Total Economy</b>	<b>ICT sector</b>	<b>ICT sector</b>
	(Millions of current EUR PPS)	(thousand persons employed)	(Millions of current EUR PPS)	(Millions of current EUR PPS)	(Millions of current EUR PPS)	(Millions of current EUR PPS)	(Millions of current EUR PPS)	(thousand full-time equivalent)	(thousand full-time equivalent)
Australia	28,096.8	396.7	1,777.7	-	-	-	-	11.3	20.2
Brazil	60,565.1	1,239.5	1,119.6	-	-	-	-	15.8	24.0
Canada	46,512.7	553.5	3,388.6	-	-	-	-	40.5	50.3
China	706,101.4	15,952.2	43,880.8	-	-	-	-	248.5	682.5
EU27	540,500.9	5,386.5	29,277.9	3,559.2	83,081.7	1,712.7	5,684.3	209.6	314.3
India	302,296.3	6,777.7	1,106.8	-	-	-	-	12.7	14.7
Japan	211,306.1	2,298.0	16,236.0	-	23,471.8	-	2,367.7	129.6	141.1
Korea	160,472.4	1,089.6	29,141.8	-	-	-	-	129.8	144.6
Norway	7,641.9	75.4	763.9	-	-	-	-	6.0	7.8
Russia	59,919.2	1,078.3	1,100.4	-	-	-	-	5.3	9.3
Switzerland	15,958.1	158.7	-	-	-	-	-	-	-
Taiwan	132,331.6	1,048.7	15,763.9	-	-	-	-	73.3	134.5
United Kingdom	99,039.3	1,122.5	3,579.7	300.1	10,332.9	164.4	699.3	27.6	48.8
United States	801,364.5	4,536.8	84,805.4	1,781.4	87,555.6	536.7	6,934.4	361.2	-

Note: 2017 for Canada (VA), India (EMP) and Brazil (BERD, RERD and PERD). ICT sector PERD for the United States not included because of lack of homogeneous data. ICT sector for the United States (GBARD and ICT GBARD) includes 268 NACE Rev.2 sector (Manufacture of magnetic and optical media).  
Source: 2021 PREDICT Dataset

**Table 3 (cont.) Summary table of ICT indicators for the EU27 and other economies**

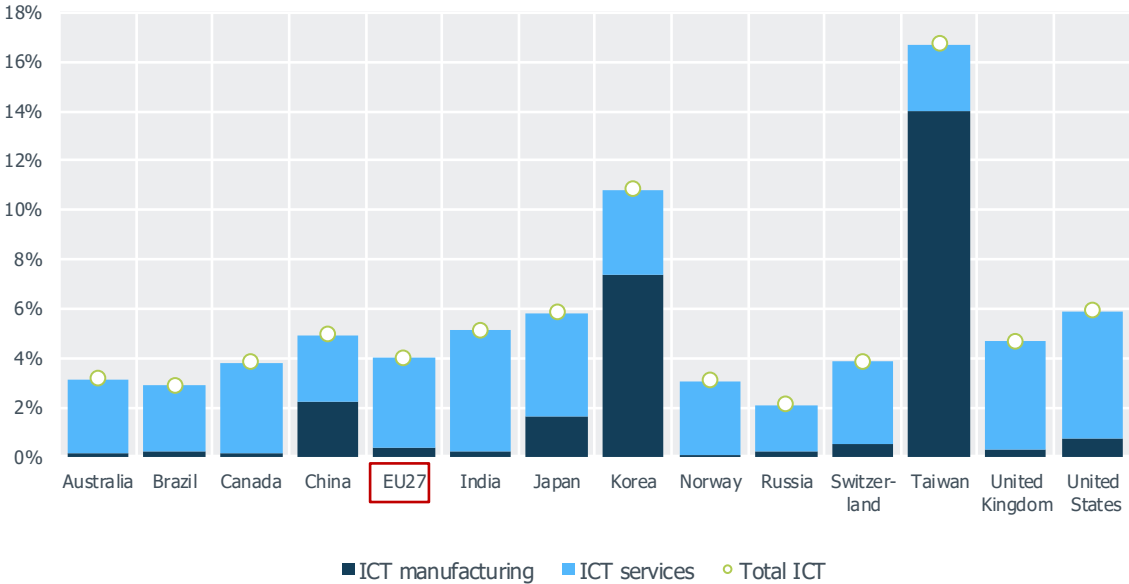
**b) Annual growth rates (%), 2017-2018**

	VA	Employment	BERD	GBARD		ICT GBARD		RERD	PERD
	ICT sector	ICT sector	ICT sector	ICT sector	Total Economy	ICT sector	Total Economy	ICT sector	ICT sector
Australia	4.1	5.2	14.5	-	-	-	-	11.5	8.5
Brazil	2.5	1.3	-	-	-	-	-	-	-
Canada	4.7	6.5	2.0	-	-	-	-	8.2	6.2
China	13.1	0.5	17.4	-	-	-	-	17.5	16.9
EU27	5.5	3.1	5.9	13.4	2.2	9.2	3.0	8.8	7.7
India	12.1	6.1	5.0	-	-	-	-	1.5	-7.0
Japan	5.1	3.2	-0.1	-	7.0	-	2.7	-1.7	-0.6
Korea	8.9	2.6	14.9	-	-	-	-	4.7	5.9
Norway	3.1	3.3	1.1	-	-	-	-	3.8	0.7
Russia	3.6	1.2	26.3	-	-	-	-	-6.2	-8.0
Switzerland	1.5	4.5	-	-	-	-	-	-	-
Taiwan	3.7	1.1	12.9	-	-	-	-	2.5	2.9
United Kingdom	6.3	1.2	7.5	11.3	5.6	12.2	7.9	2.5	6.4
United States	8.8	2.3	7.2	5.7	10.8	14.4	16.0	2.1	-



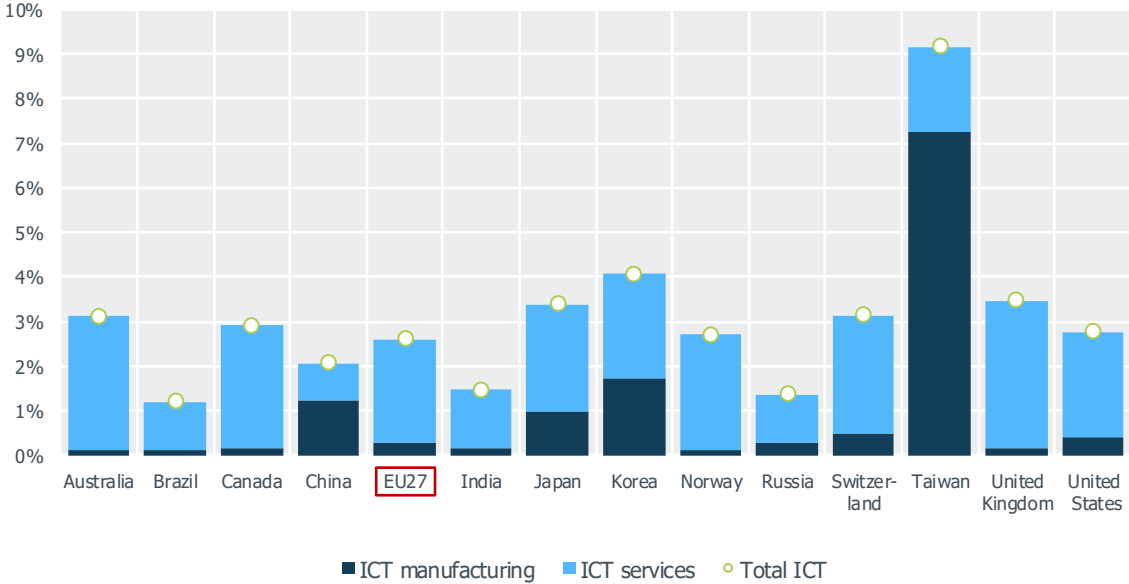
**Figure 19. ICT sector, ICT manufacturing and ICT services in the international context: VA, employment, BERD, RERD, PERD, GBARD and ICT GBARD (2018)**

a) ICT sector VA share of GDP



Note: 2017 for Canada.

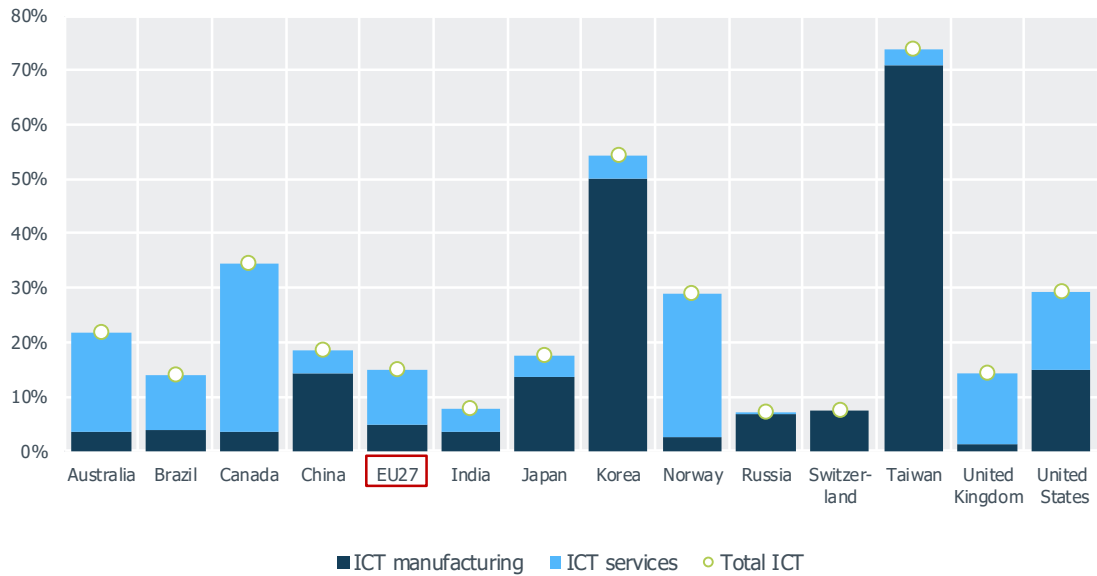
b) ICT sector employment share of total employment



Note: 2017 for India.  
Source: 2021 PREDICT Dataset.

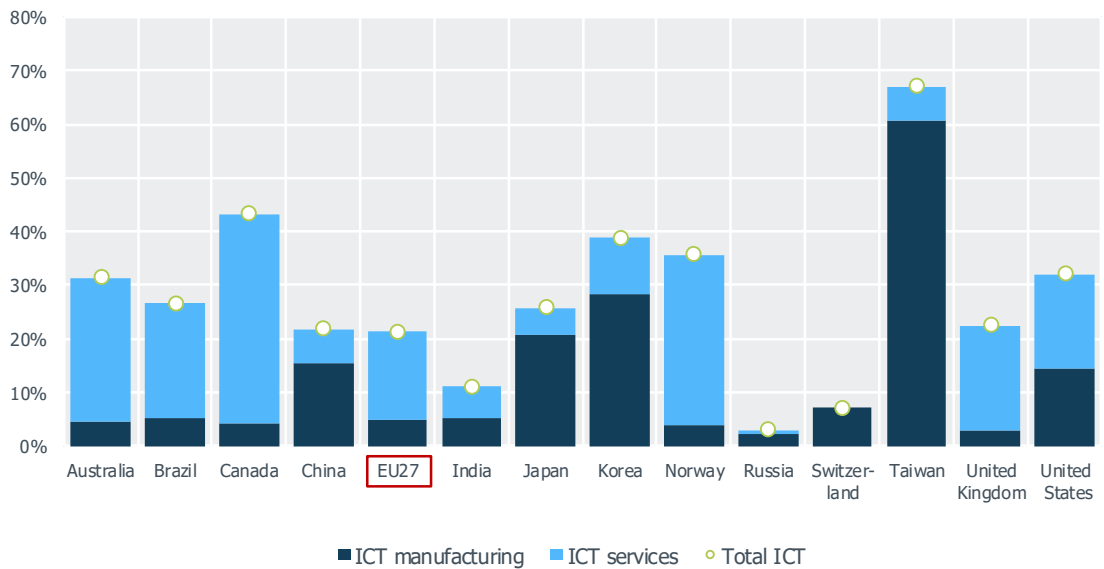
**Figure 19 (cont.) ICT sector, ICT manufacturing and ICT services in the international context: VA, employment, BERD, RERD, PERD, GBARD and ICT GBARD (2018)**

c) ICT sector BERD share of total BERD



Note: 2017 for Brazil and Switzerland. ICT sector for Switzerland includes only ICT manufacturing.

d) ICT sector RERD share of total RERD

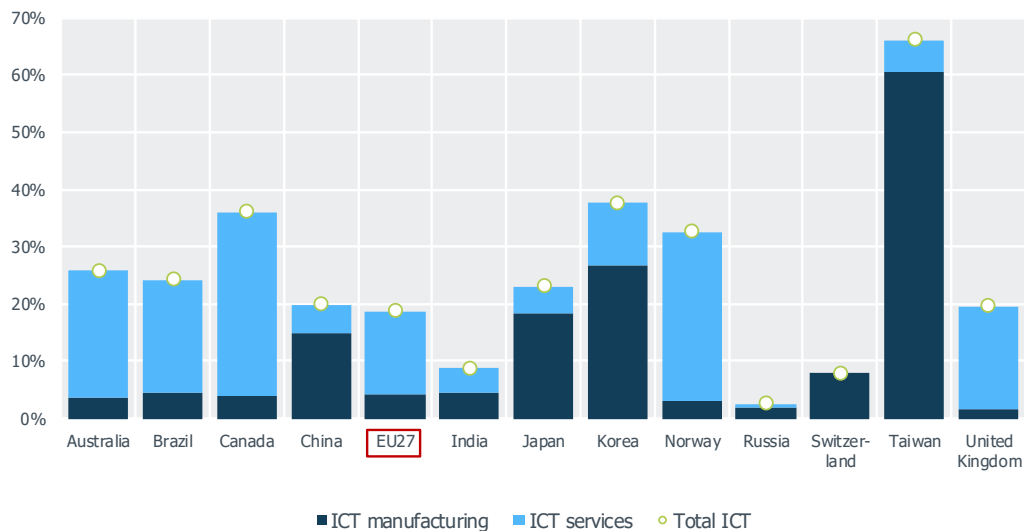


Note: 2017 for Brazil and Switzerland. ICT sector for Switzerland includes only ICT manufacturing.

Source: 2021 PREDICT Dataset.

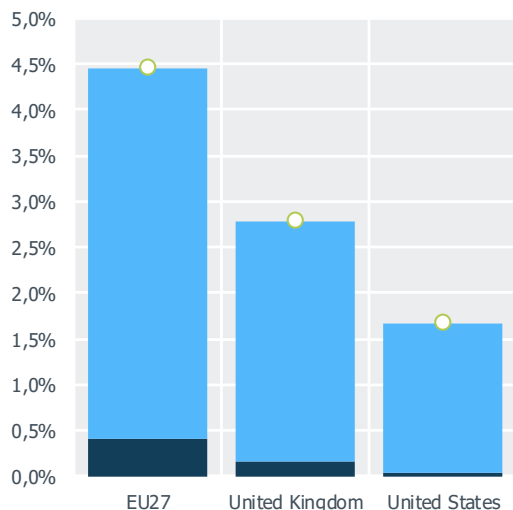
**Figure 19 (cont.) ICT sector, ICT manufacturing and ICT services in the international context: VA, employment, BERD, RERD, PERD, GBARD and ICT GBARD (2018)**

e) ICT sector PERD share of total PERD

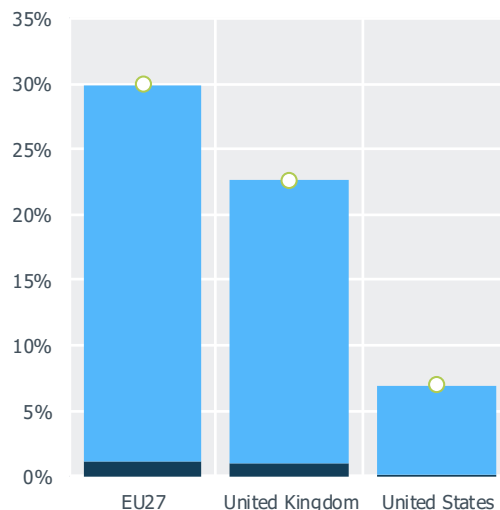


Note: 2017 for Brazil and Switzerland. ICT sector for Switzerland includes only ICT manufacturing. ICT sector for United States not included because of lack of homogeneous data.

f) ICT sector GBARD share of total GBARD



g) ICT sector ICT GBARD share of total ICT GBARD



Note: 2019 for GBARD and ICT GBARD. ICT manufacturing for United States includes 268 NACE Rev.2 sector (Manufacture of magnetic and optical media).

Source: 2021 PREDICT Dataset.

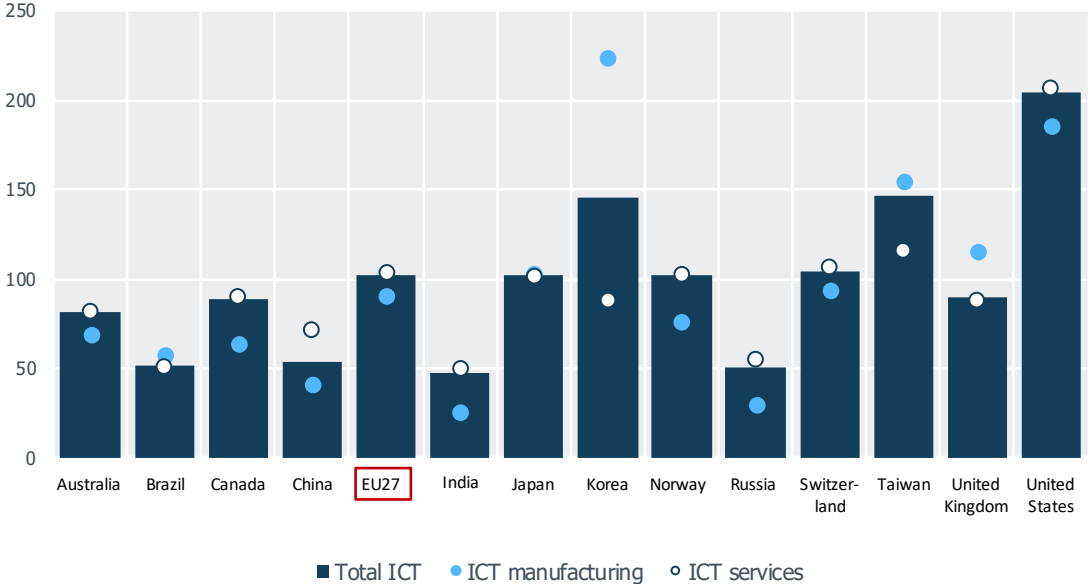
In 2018, three Asian countries: Taiwan (16.7%), South Korea (10.8%) and Japan (5.8%); and the US (5.9%) had the largest ICT sector measured as ICT VA share over total GDP, followed by India (5.1%) and China (4.9%) (Figure 19). All these countries had a larger share than the EU (4.0%). Taiwan (9.2%), South Korea (4.1%), the United Kingdom (3.5%) and Japan (3.4%) also took the lead in terms of employment, followed by Switzerland (3.1%) and Australia (3.1%), all of which had larger shares than the US (2.8%) and the EU (2.6%). China (2.1%), India (1.5%), Russia (1.4%) and Brazil (1.2%) lagged behind. Taiwan, South Korea and Canada, followed by the US and Norway, were the countries with the largest share of BERD, R&D researchers and R&D personnel<sup>12</sup> in the ICT sector over the total. The first two countries also stood out for the size of their ICT manufacturing sector. The EU was in an intermediate position among the countries included in the PREDICT dataset. It only surpassed the US in public funded R&D (GBARD) and ICT GBARD in the ICT sector.

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<sup>12</sup> No data on R&D personnel available for the US.

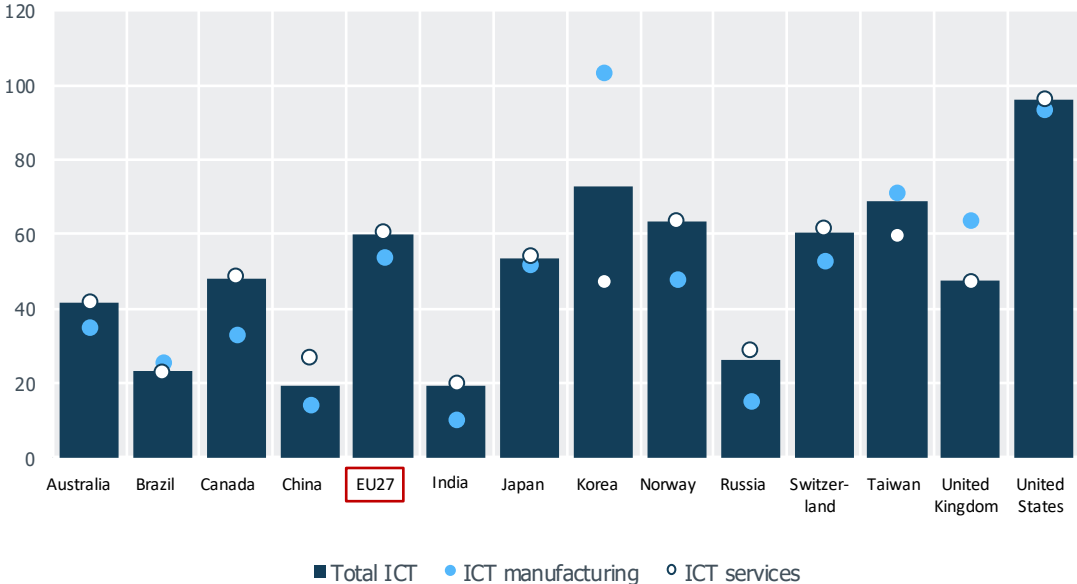
**Figure 20. ICT sector, ICT manufacturing and ICT services in the international context: labour productivities (2018)**

a) ICT sector productivity per person employed (thousand EUR PPS 2015 per person)



Note: 2017 for Canada and India.

b) ICT sector productivity per hour worked (EUR PPS 2015 per hour worked)

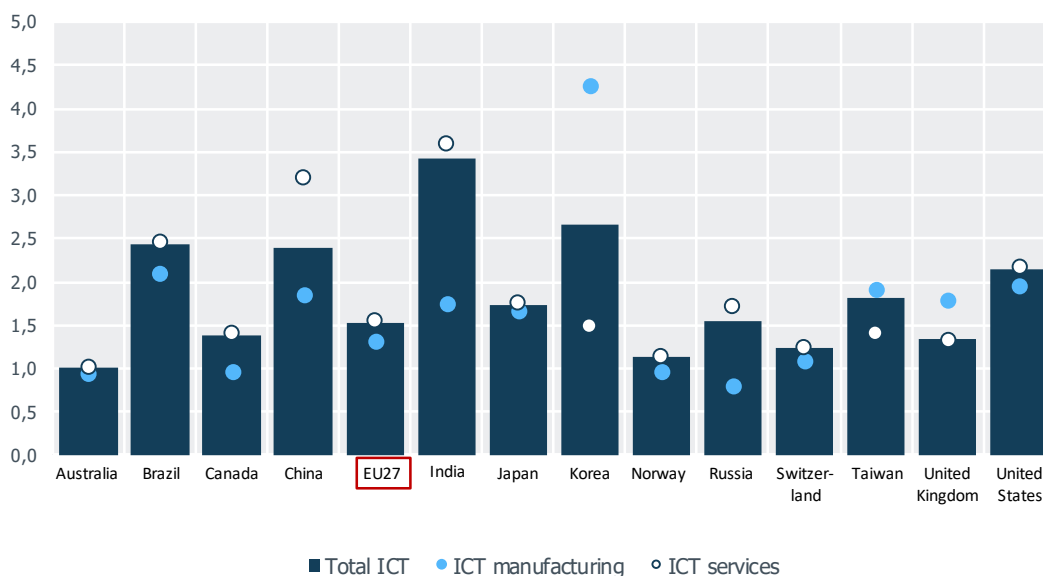


Note: 2017 for Canada and India.

Source: 2021 PREDICT Dataset.

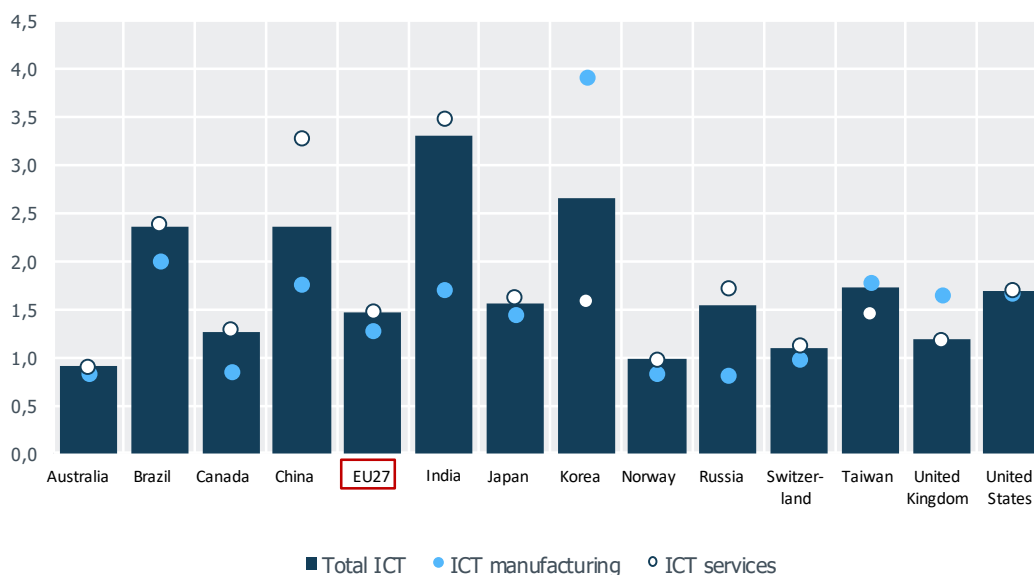
**Figure 20 (cont.) ICT sector, ICT manufacturing and ICT services in the international context: labour productivities (2018)**

c) ICT sector productivity per person employed ratio over total economy productivity



Note: 2017 for Canada and India.

d) ICT sector productivity per hour worked ratio over total economy productivity



Note: 2017 for Canada and India.

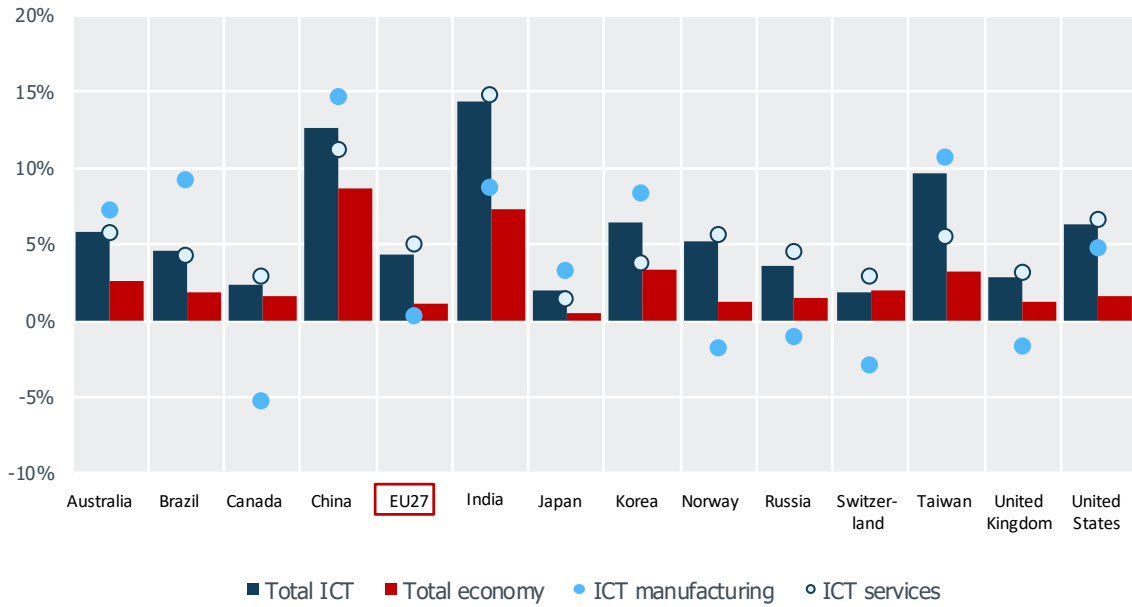
Source: 2021 PREDICT Dataset.

In 2018, the US was the country with the highest labour productivity in the ICT sector, both in terms of persons and per hour worked (Figure 20), followed by Taiwan (in term of persons) and South Korea (in terms of hours worked). Its leadership was especially noticeable in the ICT services sector, followed by Switzerland, Taiwan (in terms of persons) and Norway (in terms of hours worked). In the case of ICT manufacturing, South Korea took the lead followed by US and Taiwan. The EU occupies the seventh position when productivity is defined by person employed and the fifth per hour worked. In the EU, labour productivity was higher in the ICT services

sector than in ICT manufacturing. In all countries considered, labour productivity in the ICT sector was similar or exceeded the total economy, both in terms of persons and hours worked. In India it was around 3.5 times higher, and in South Korea, China and Brazil more than double. Productivity by hour worked in the ICT sector was about 1.5 higher than that of the whole economy in the EU and the US. In addition, in the two territories the gap was larger in ICT services than in ICT manufacturing.

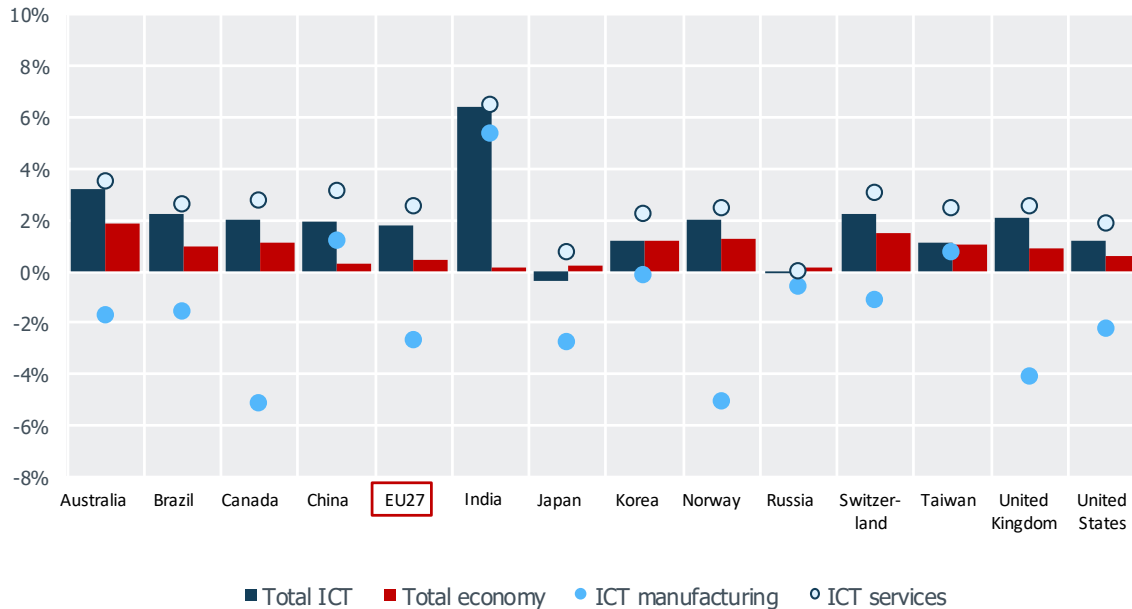
**Figure 21. Total economy, ICT sector, ICT manufacturing and ICT services in the international context. Mean annual growth rates (%) (2006-2018)**

a) Value added



Note: 2006-2017 for Canada.

b) Employment



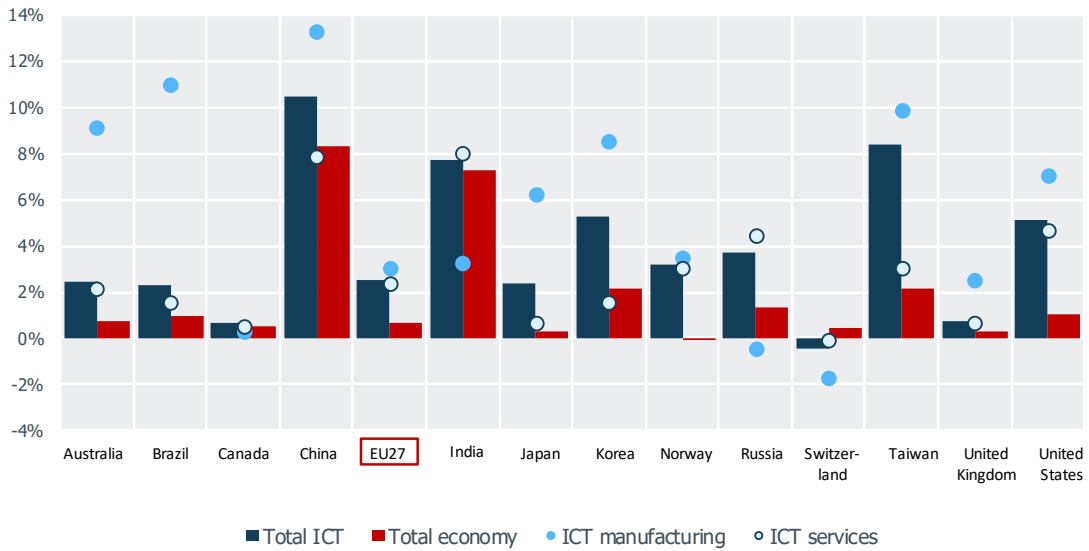
Note: Monetary variables are expressed in real terms. 2006-2017 for India.

Source: 2021 PREDICT Dataset.

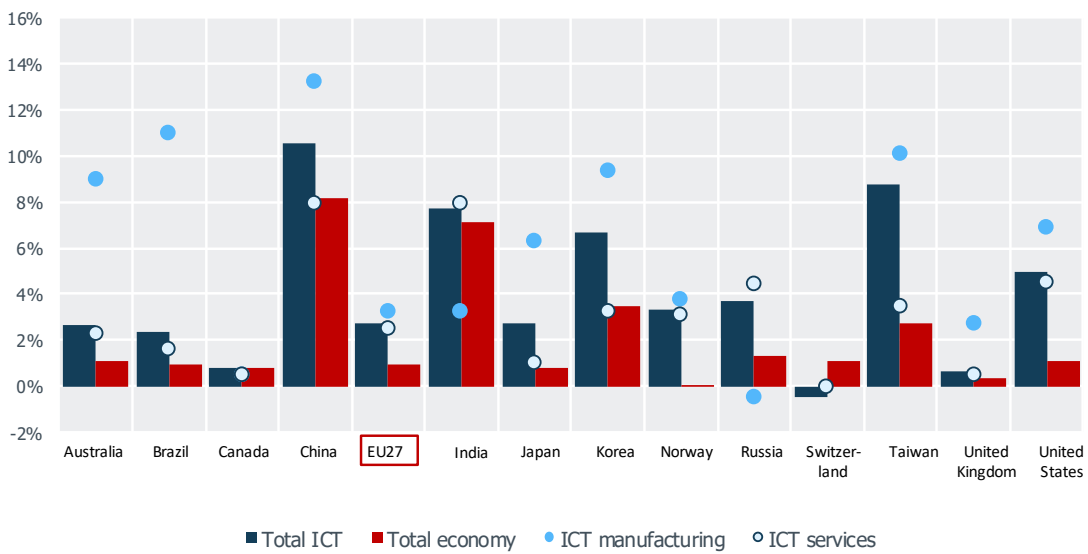


**Figure 21 (cont.) Total economy, ICT sector, ICT manufacturing and ICT services in the international context. Mean annual growth rates (%) (2006-2018)**

c) Productivity per person employed



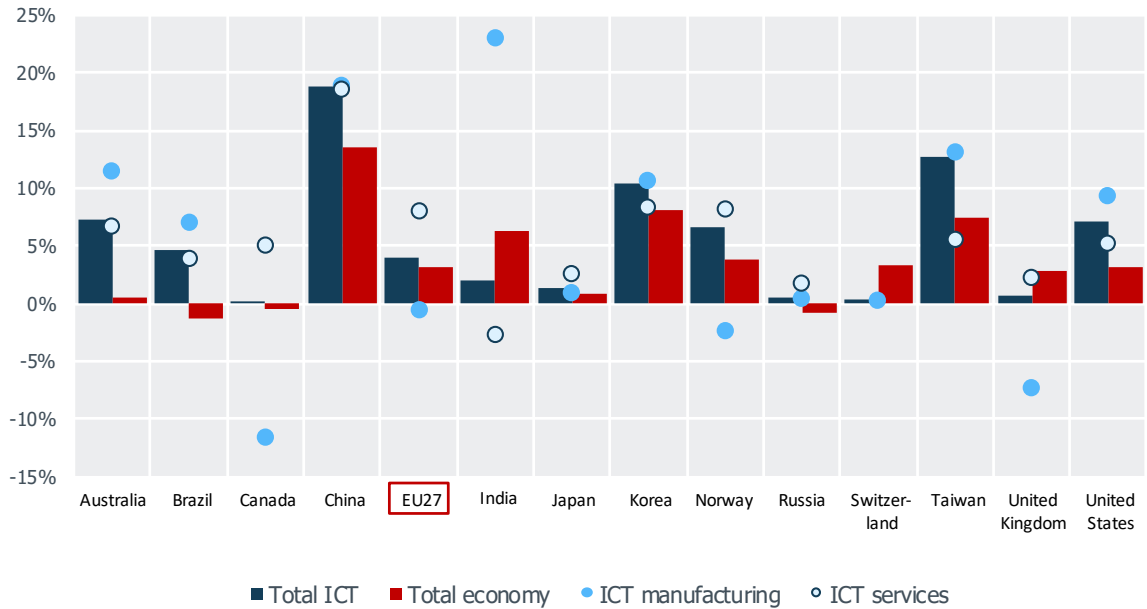
d) Productivity per hour worked



Note: Monetary variables are expressed in real terms. 2006-2017 for Canada and India.  
Source: 2021 PREDICT Dataset.

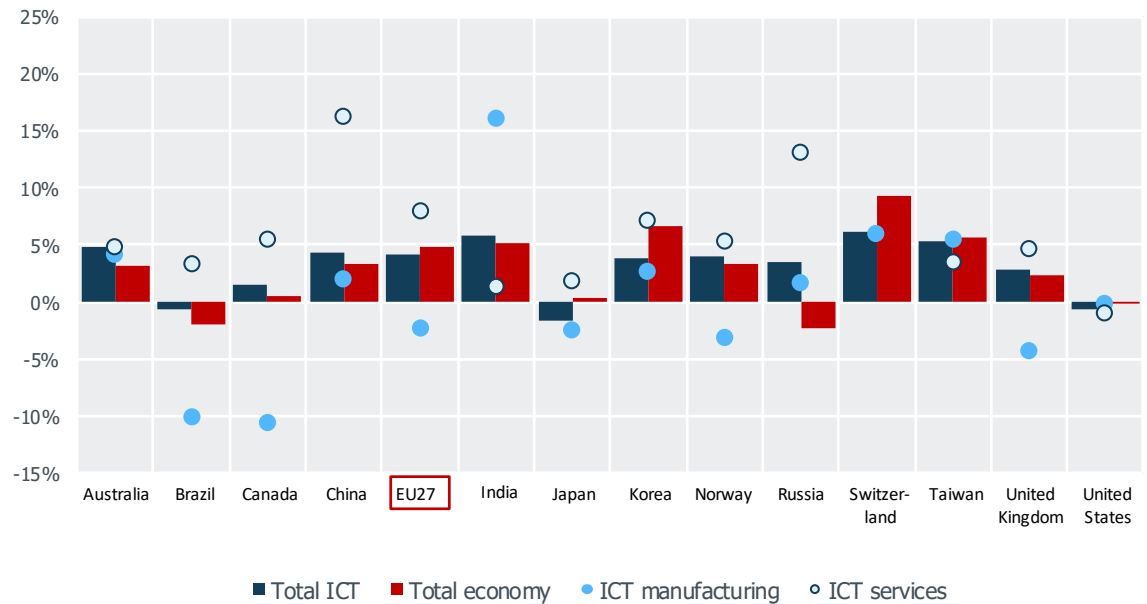
**Figure 21 (cont.): Total economy, ICT sector, ICT manufacturing and ICT services in the international context. Mean annual growth rates (%) (2006-2018)**

e) BERD



Note: 2008-2017 for Brazil and Switzerland and 2006-2017 for Canada. ICT sector for Switzerland includes only ICT manufacturing.

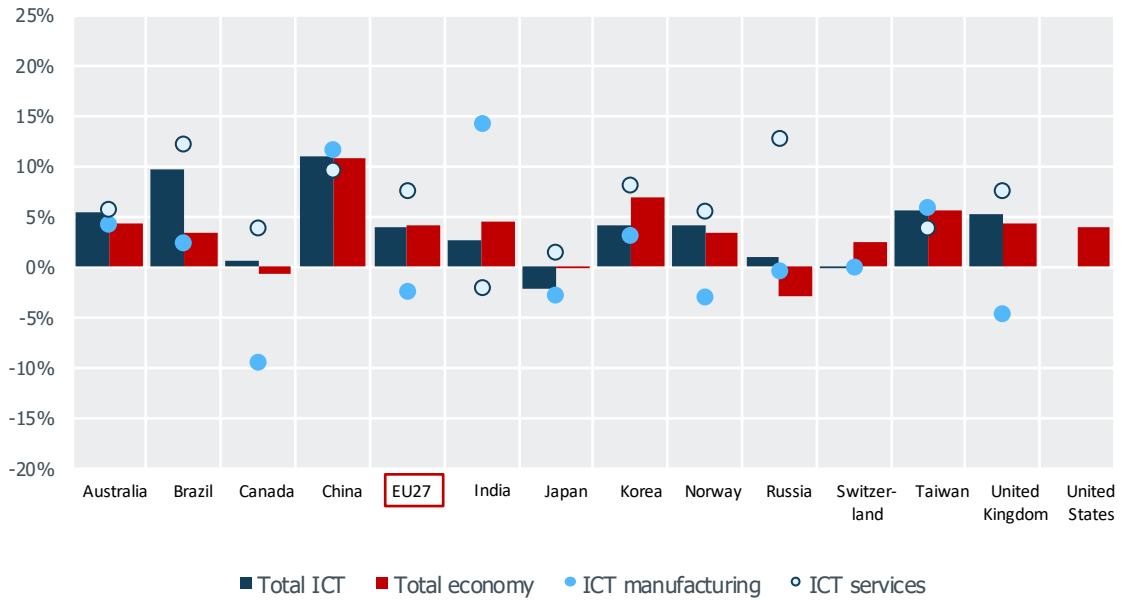
f) RERD



Note: Monetary variables are expressed in real terms. 2011-2017 for Brazil and 2008-2017 for Switzerland. ICT sector for Switzerland includes only ICT manufacturing.  
Source: 2021 PREDICT Dataset.

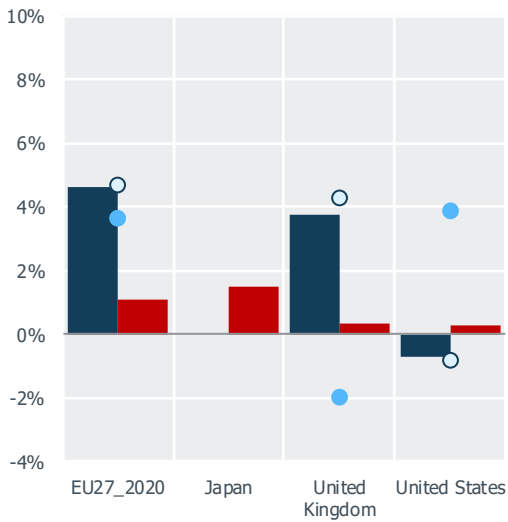
**Figure 21 (cont.) Total economy, ICT sector, ICT manufacturing and ICT services in the international context. Mean annual growth rates (%) (2006-2018)**

g) PERD

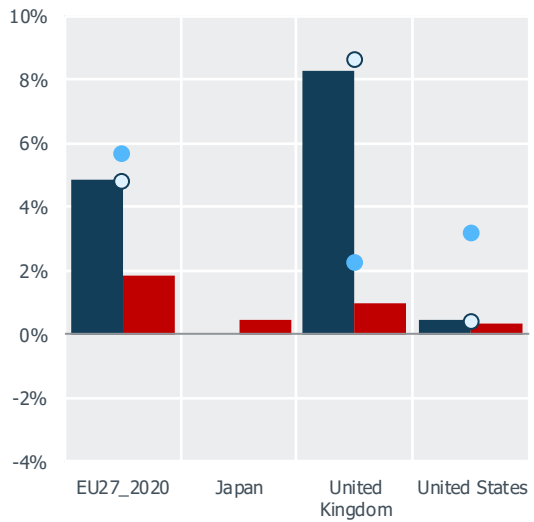


Note: 2008-2017 for Brazil and Switzerland. ICT sector for Switzerland includes only ICT manufacturing. ICT sector for United States not included because of lack of homogeneous data.

h) GBARD



i) ICT GBARD



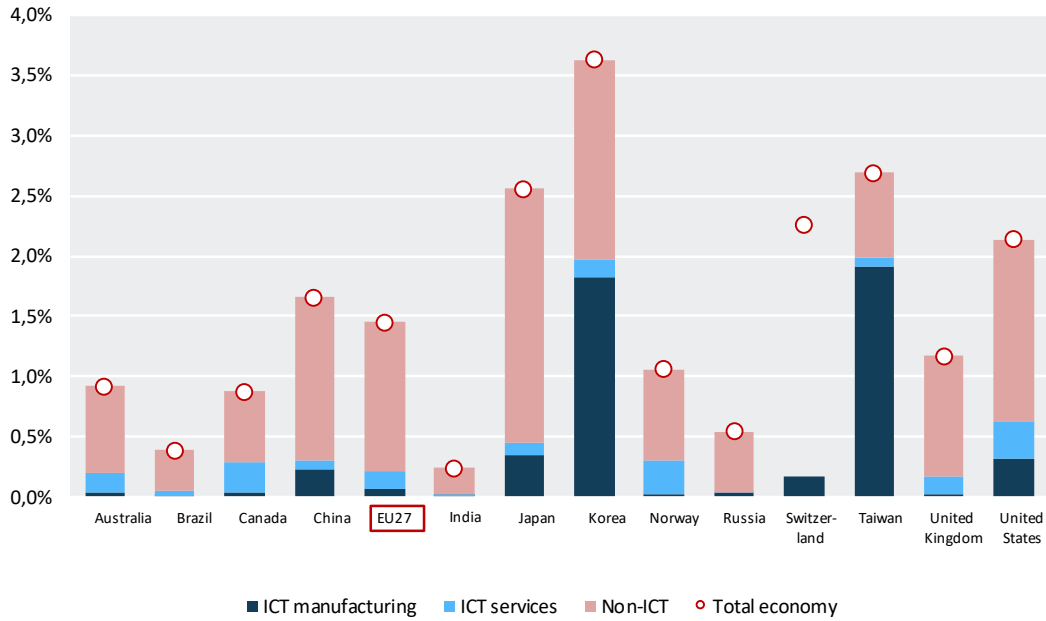
Legend: ■ Total ICT ■ Total economy ● ICT manufacturing ○ ICT services

Note: Monetary variables are expressed in real terms. 2006-2019 for GBARD and ICT GBARD for EU27, Japan and United States. ICT manufacturing for United States includes 268 NACE Rev.2 sector (Manufacture of magnetic and optical media).  
Source: Source: 2021 PREDICT Dataset

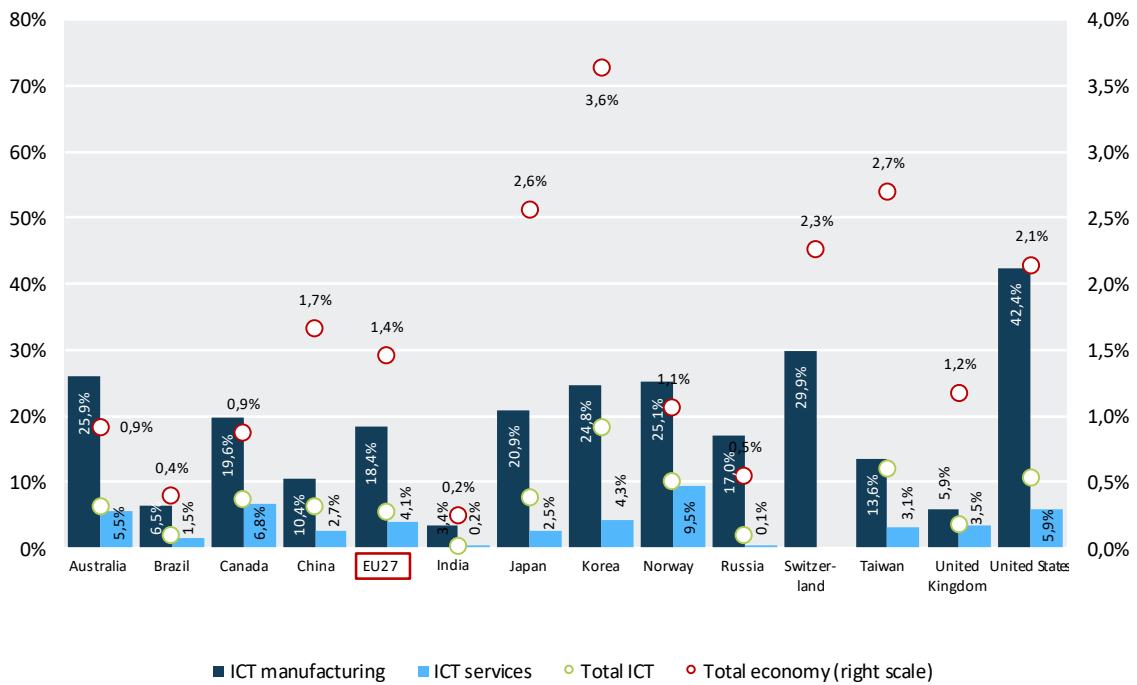
Between 2006 and 2018, India and China presented the highest growth rates for VA, both in the ICT sector and the total economy (Figure 21). In India the ICT services sector was more dynamic, while in China it was ICT manufacturing. In the case of employment, India and Australia showed the highest growth rates in the ICT sector, but only the latter led the growth of total economy. In the EU27 the annual growth rate of VA in the ICT sector (4.4%) was quite lower than that of the US (6.4%), while employment grew at a higher rate in the EU (1.8%) than in the US (1.2%). The annual growth in labour productivity per hour worked in the EU in the ICT sector was modest (2.7%), lagging far behind China (10.6%), Taiwan (8.7%), India (7.7%), South Korea (6.7%) and the US (5.0%). In terms of BERD, China showed the most dynamic behaviour (18.8%). Switzerland (6.1%) took the lead in R&D researchers and China (11.0%) in R&D personnel. Compared to those countries, the ICT sector in the EU, and also in the US, was much less dynamic. However, the EU presented a higher growth rate in GBARD and ICT GBARD in the ICT sector than the US.

**Figure 22. BERD intensity in the international context (2018)**

a) BERD/GDP



b) ICT sector BERD/ICT sector VA

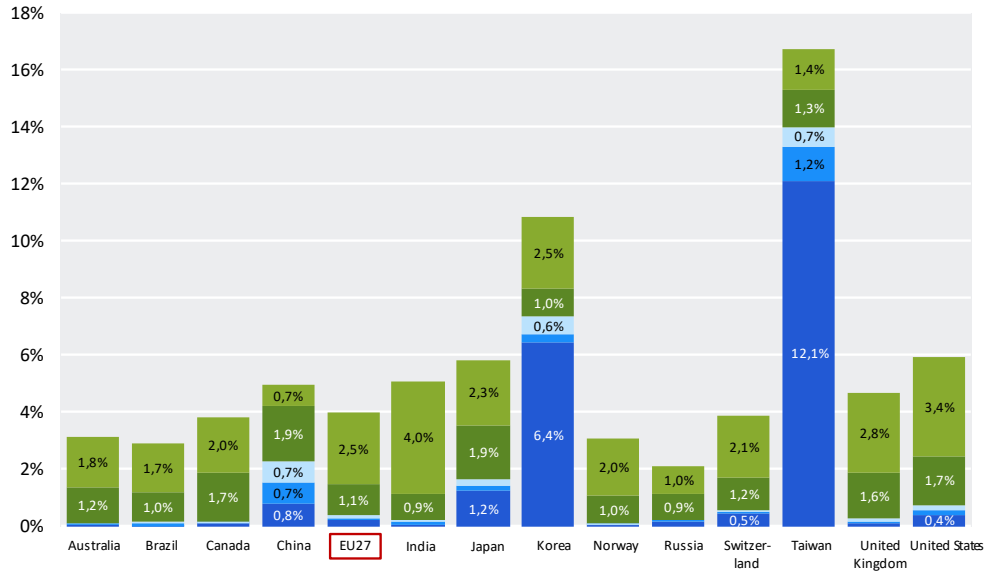


Note: 2017 for Brazil, Canada and Switzerland. ICT sector for Switzerland includes only ICT manufacturing.  
Source: 2021 PREDICT Dataset.

In 2018, South Korea (3.6%) had the highest BERD intensity (BERD/GDP) of all the countries considered (Figure 22), followed by Taiwan (2.7%), Japan (2.6%), Switzerland (2.3%) and the US (2.1%). In South Korea and Taiwan BERD intensity in the ICT manufacturing sectors was very high, while for the remaining countries, the non-ICT sectors presented the largest ratio. The BERD intensity level of the EU (1.4%) was lower than the one of China (1.7%). BERD intensity in the ICT sector (measured as sector BERD/sector VA) was very high in South Korea, both for the total economy (3.6%) and for the ICT sector (18.2%). For ICT manufacturing, the highest intensity corresponded to the US (42.4%) followed by Switzerland (29.9%) and Australia (25.9%). In the ICT service sector, Norway (9.5%) took the lead followed by Canada (6.8%). The EU occupied the seventh position for the total economy (1.4%), ninth for the ICT sector (5.4), eighth for ICT manufacturing (18.4%) and sixth for ICT services (4.1%).

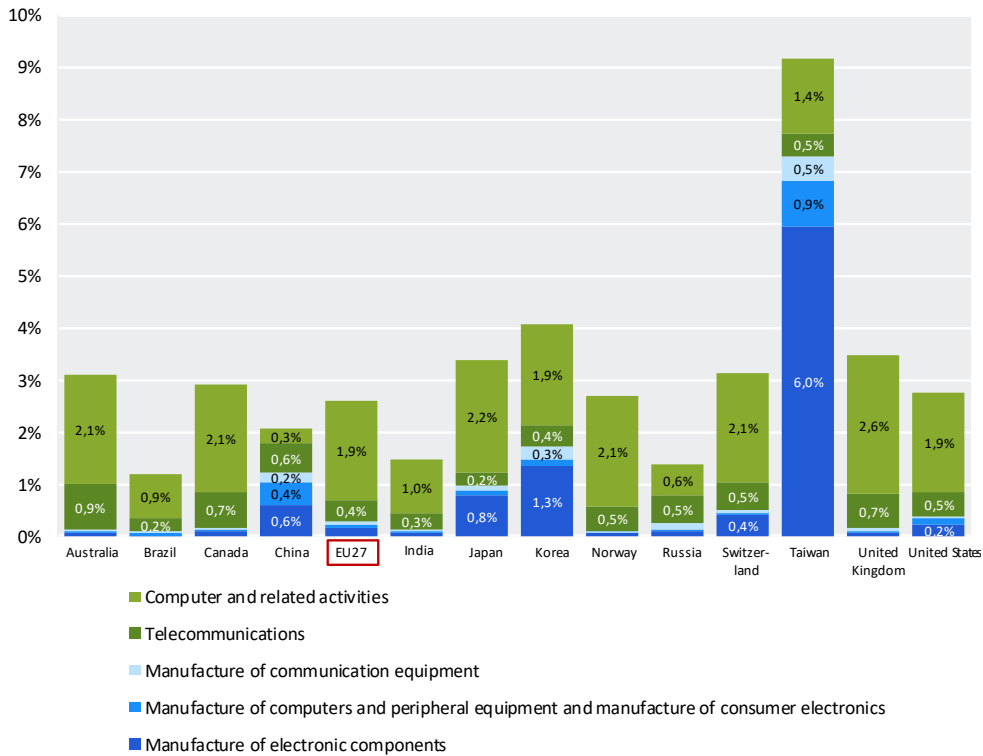
**Figure 23. ICT sector by subsectors in the international context: VA, employment, BERD, RERD, PERD, GBARD and ICT GBARD (2018)**

a) VA share of GDP



Note: 2017 for Canada.

b) ICT sector employment share of total employment

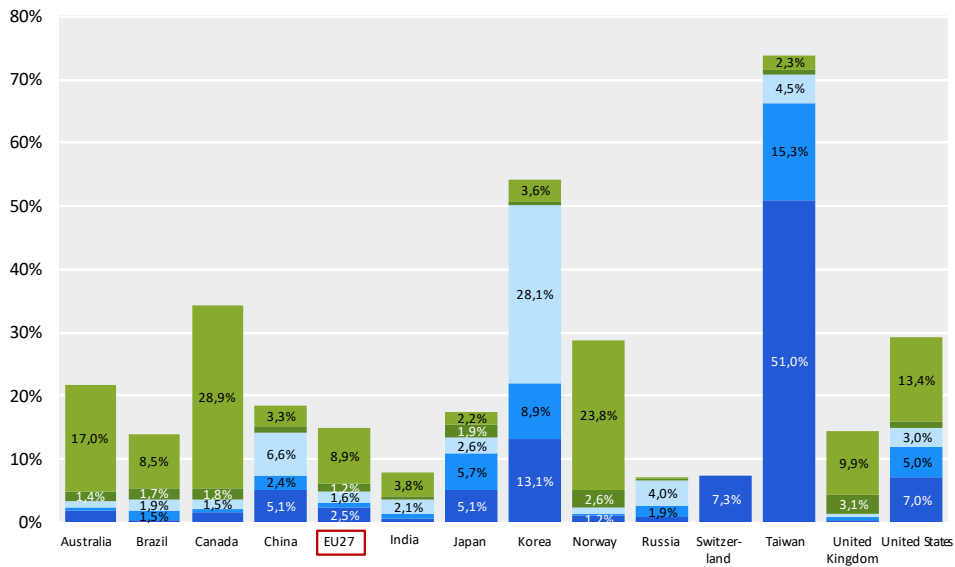


Note: 2017 for India.

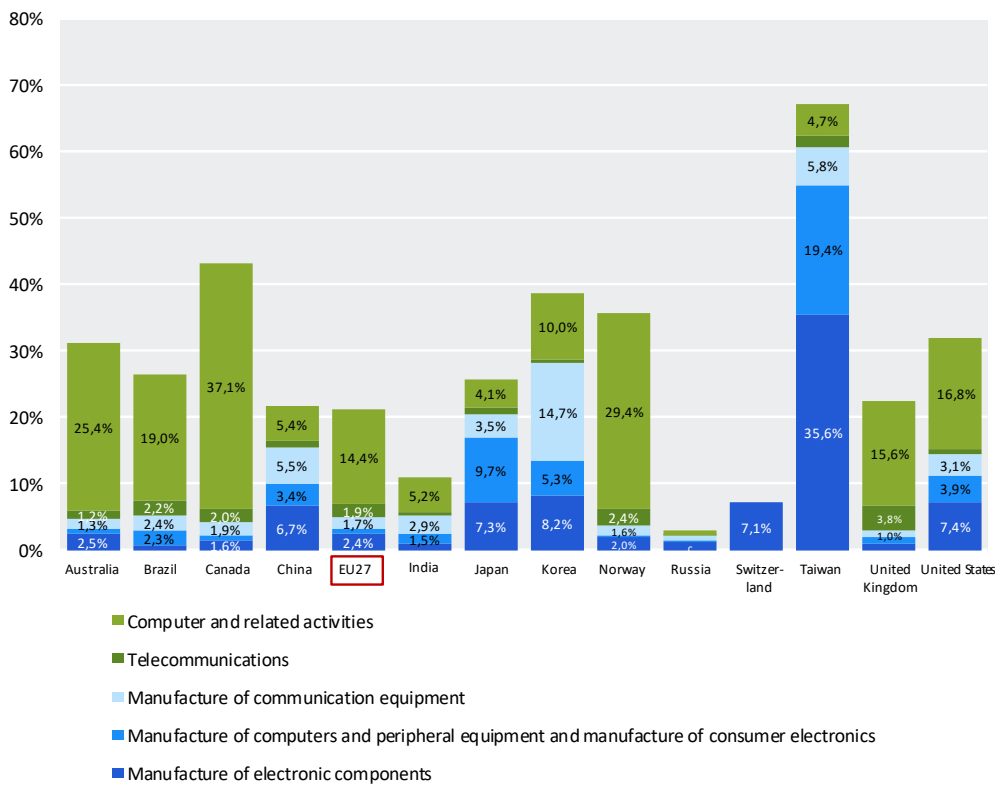
Source: 2021 PREDICT Dataset

**Figure 23 (cont.) ICT sector by subsectors in the international context: VA, employment, BERD, RERD, PERD, GBARD and ICT GBARD (2018)**

c) ICT sector BERD share of total BERD



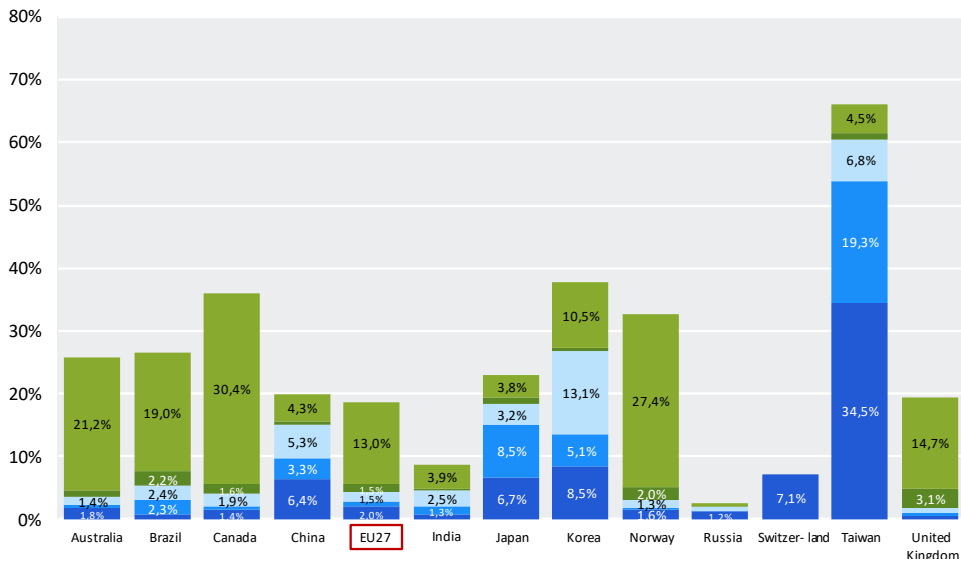
d) ICT sector RERD share of total RERD



Note: 2017 for Brazil and Switzerland.  
Source: 2021 PREDICT Dataset

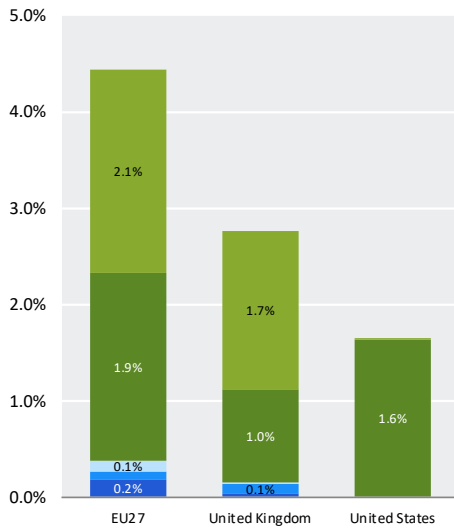


**Figure 23 (cont.) ICT sector by subsectors in the international context: VA, employment, BERD, RERD, PERD, GBARD and ICT GBARD (2018)e) ICT sector PERD share of total PERD**

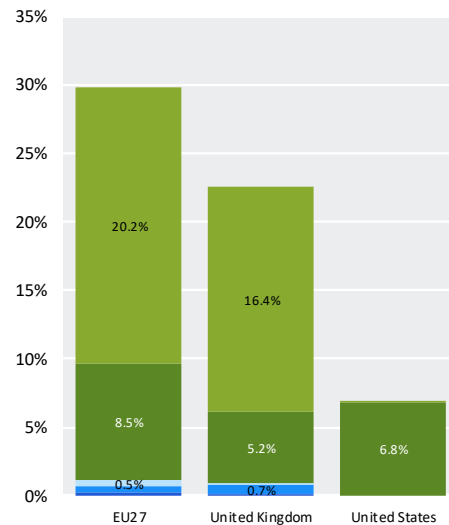


Note: 2017 for Brazil and Switzerland. ICT sector for United States not included because of lack of homogeneous data.

f) ICT sector GBARD share of total GBARD



g) ICT sector ICT GBARD share of total ICT GBARD

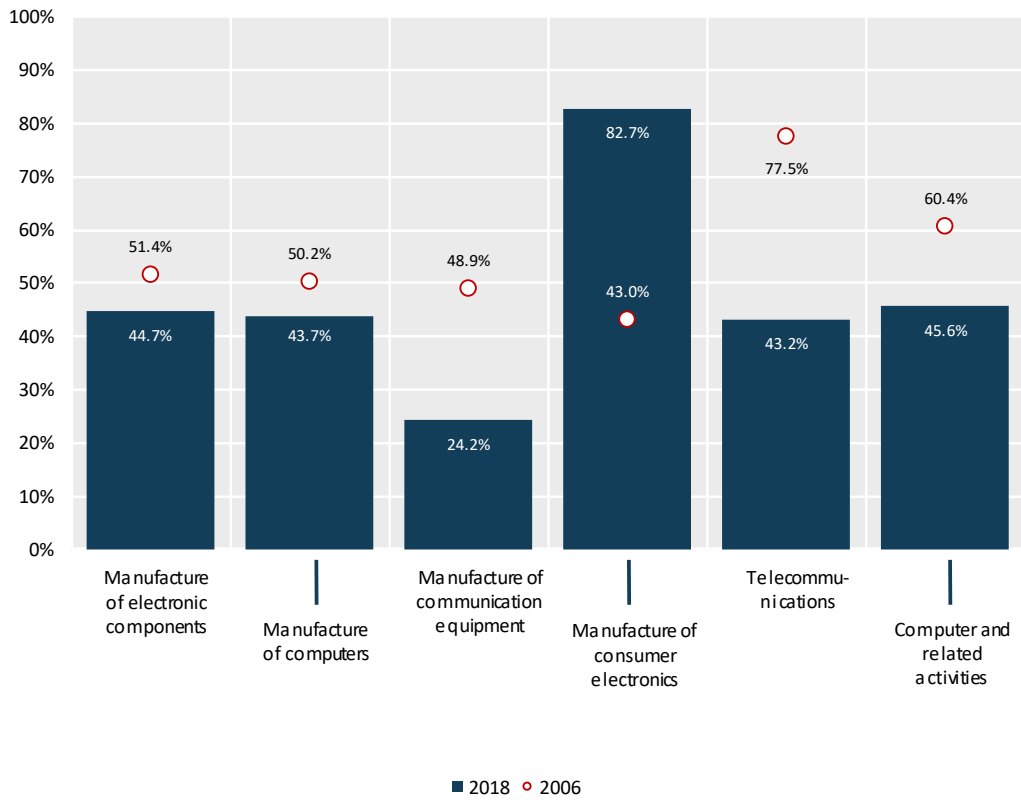


Note: 2019 for GBARD and ICT GBARD.

Source: 2021 PREDICT Dataset.

In 2018, ICT manufacturing sectors had a high share in the majority of the Asian countries in all the variables. In Taiwan (the country with the largest ICT sector in relative terms), the VA of the *Manufacturing of electronic components* sector amounted to 12.1% of total GDP (Figure 23), 6.0% of total employment, 51.0% of BERD, 35.6% of R&D researchers and 34.5% of R&D personnel. In China, the sector with the highest share in terms of VA was *Telecommunications* (1.9%), while in India it was *Computer and related activities* (4.0%). In the EU and the US, ICT services sectors (*Telecommunications* and *Computer and related activities*) had the largest shares in terms of all variables, especially in GBARD.

**Figure 24. ICT subsector productivity per employed EU27 over United States (2006, 2018)**

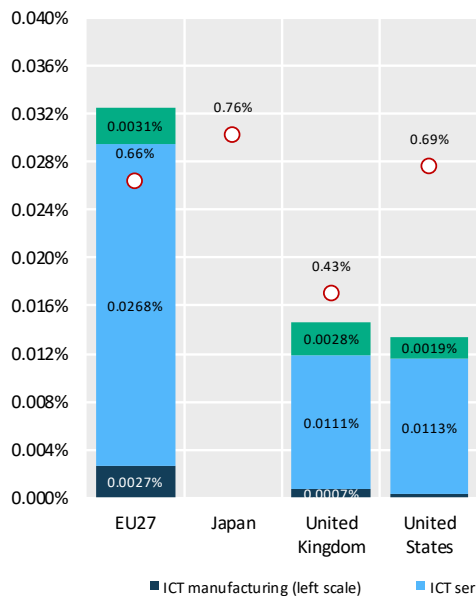


Source: 2021 PREDICT Dataset.

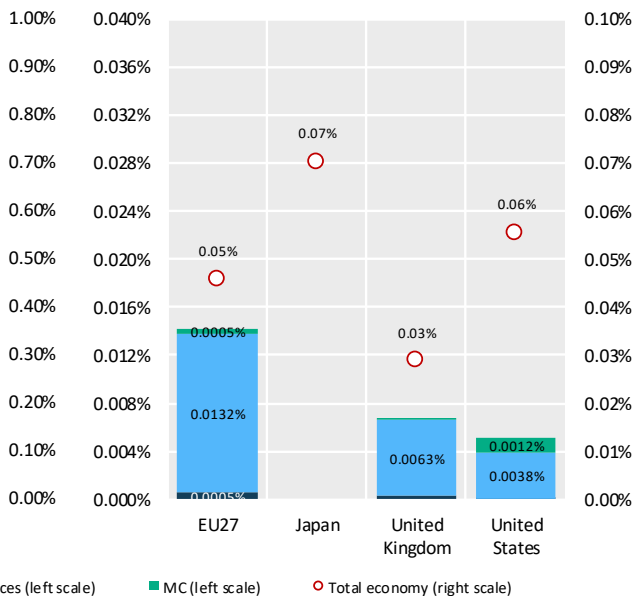
When comparing the EU and the US in the years analysed, the latter was the leader in many aspects, but especially in labour productivity (Figure 24). The US had a higher labour productivity per person employed than the EU in all ICT sub-sectors. *Manufacture of communication equipment* was the ICT sub-sector in which the gap was wider (EU only represents 24.2% of the total of the US), followed by *Telecommunications* (43.2%) and *Manufacture of computers* (43.7%). In addition, the gap widened since 2006 in five of the six sub-sectors considered, while only narrowing for *Manufacture of consumer electronics* (82.7%).

**Figure 25. GBARD and ICT GBARD by non-EU economies (2019)**

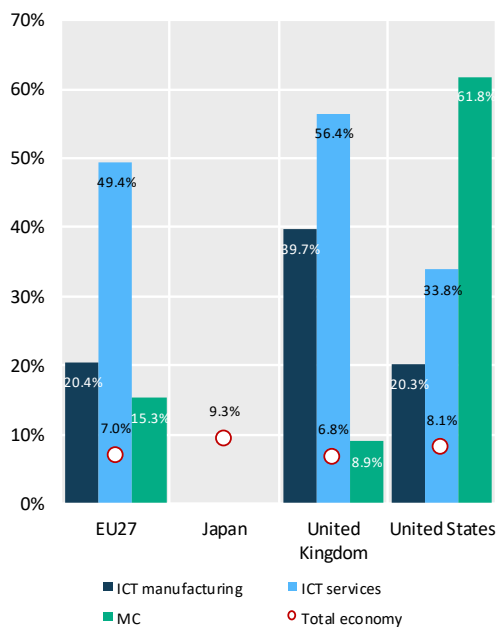
a) GBARD intensity (GBARD/GDP)



b) ICT GBARD intensity (ICT GBARD/GDP)



c) ICT GBARD/GBARD



Note: Figures for Japan not fully homogeneous with EU and the United States (see methodology). ICT sector ICT GBARD for United States includes 268 NACE Rev.2 sector (Manufacture of magnetic and optical media). GDP nowcasted for 2019. Source: 2021 PREDICT Dataset, Eurostat, US Bureau of Economic Analysis (BEA) and Economic and Social Research Institute (ESRI) of Japan.

In 2019, public funding of R&D (GBARD) intensity (defined as GBARD/GDP) for the total economy was larger in Japan (0.76%) than in the US (0.69%), the EU27 (0.66%) and the United Kingdom (0.43%). However, the EU presented higher values for the ICT sector, ICT manufacturing, ICT services and MC sectors (Figure 25). The same results applied to the ICT GBARD intensity. The only difference is that it was higher in the US than in the EU in the MC sector. The weight of ICT GBARD over total GBARD was especially high for the MC sector in the US (61.8%) as compared with the EU (15.3%) and the United Kingdom (8.9%). On the contrary, for the ICT services it was higher in the United Kingdom (56.4%) and the EU (49.4%) than in the US (33.8%). In the case of the ICT manufacturing sector, the United Kingdom presented higher values (39.7%), almost twice that of the US and EU, accounting for around 20%.

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## List of abbreviations

BERD	Business Expenditure on Research and Development
BRDIS	Business R&D and Innovation Survey
DG CONNECT	Directorate General for Communications Networks, Content and Technology
EU28	European Union 28 countries (2013-2020)
EU27	European Union 27 countries (since 2020, without the United Kingdom)
EUR	Euros
Eurostat	Statistical Office of the European Communities
FTE	Full-time equivalent
GBARD	Government budget allocations for 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
MC	Media and Content sector
MS	Member State
NACE	Statistical classification of economic activities in the European Community
NMS	New Member States
OECD	Organisation for Economic Co-operation and Development
PERD	Business R&D personnel
PPS	Purchase Power Standard
PREDICT	Prospective Insights on R&D in ICT
RERD	Business R&D researchers
R&D	Research and Development
RS	Retail sale via mail order houses or via Internet
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.

Billions: Thousands of millions.

Business R&D personnel (PERD): All persons employed directly in 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 (RERD): 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 this 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.

EU13: Member States of the European Union acceding since 2004, they include the 2004 and 2007 European Union enlargements consisting of Bulgaria, Cyprus, Czechia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia; and Croatia, which acceded in July 2013.

EU15: Member States of the European Union acceding before 2004: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, the United Kingdom.

EU28: The former EU-28 aggregate covers the composition of the EU between 2013 and 2020, with 28 Member States (including the United Kingdom).

EU27: European aggregate covering the EU with 27 Member States (without the United Kingdom) from 2020.

GBARD: Government budget allocations for R&D are a way of measuring government support for research and development activities. GBARD 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 GBARD: Government budget allocations for ICT R&D public funding of ICT assets in all industries of the economy. ICT GBARD is allocated to all sectors in the economy, not only the ICT sector.

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 since 2008. 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/scienceandtechnologypolicy/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, 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 (582, 62, 631,951).

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.

MC sector: includes Publishing of books, periodicals and other publishing activities (581), Audiovisual and broadcasting activities (59-60) and Other information service activities (639). It corresponds to the definition given by OECD in 2007. See OECD definition: <http://www.oecd.org/sti/ieconomy/oecdguidetomeasuringtheinformationsociety2011.html>

RS sector: includes data for Retail sale via mail order houses or via Internet (NACE Rev. 2 Code 4791).

Member States: Member States of the European Union composition from 2020: Austria, Belgium, Bulgaria, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden.

Other economies: countries included for the non-EU comparison consisting of: Australia, Canada, China, Brazil, India, Japan, South Korea, Norway, Russia, Switzerland, Taiwan, the United Kingdom and the United States.

Productivity per person employed: Is defined as value added per person employed.

Productivity per hour worked: Is defined as value added per hour worked.

Purchasing Power Standard (PPS): National currencies are converted into Purchasing Power Standards (PPS), an accounting unit based on current euros, to net for the effect of differences in price levels across countries and of movements in exchange rates. Using PPS it is possible to produce meaningful indicators (based on either price or volume) required for cross-country comparisons.

Value added: In the SNA it 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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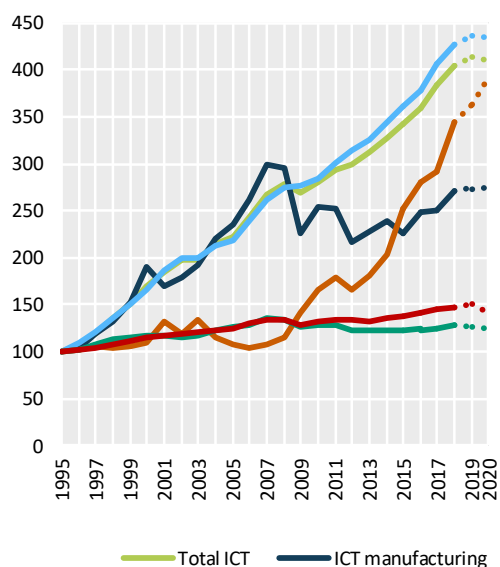
## **Annex**



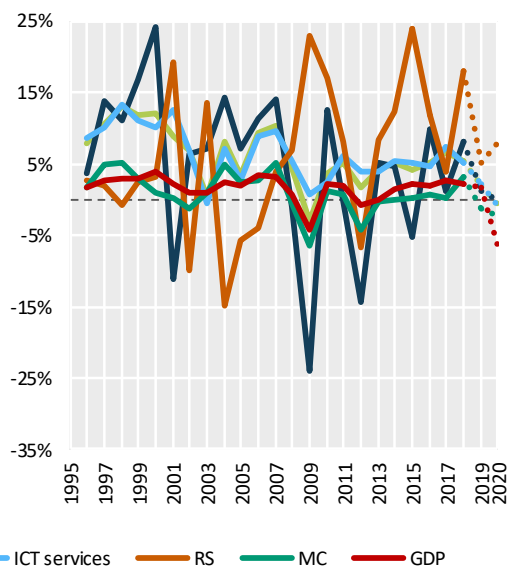
## A.1. ICT sector and its R&D in the EU27

**Figure A. 1. ICT sector VA in the EU27 (1995-2020)**

a) Index 1995=100



b) Annual real growth rates

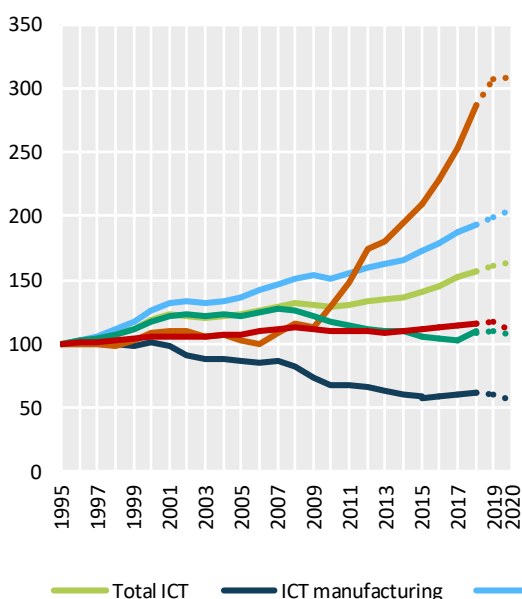


— Total ICT — ICT manufacturing — ICT services — RS — MC — GDP

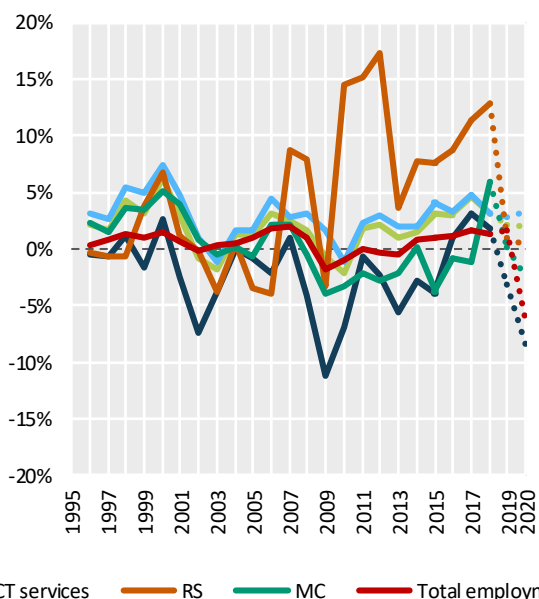
Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.  
Source: 2021 PREDICT Dataset and Eurostat

**Figure A. 2. ICT sector employment in the EU27 (1995-2020)**

a) Index 1995=100



b) Annual growth rates

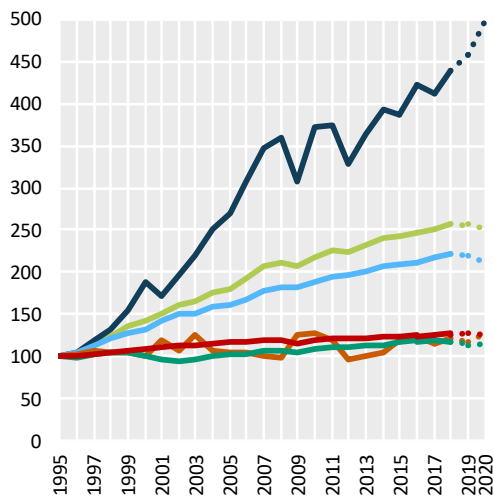


— Total ICT — ICT manufacturing — ICT services — RS — MC — Total employment

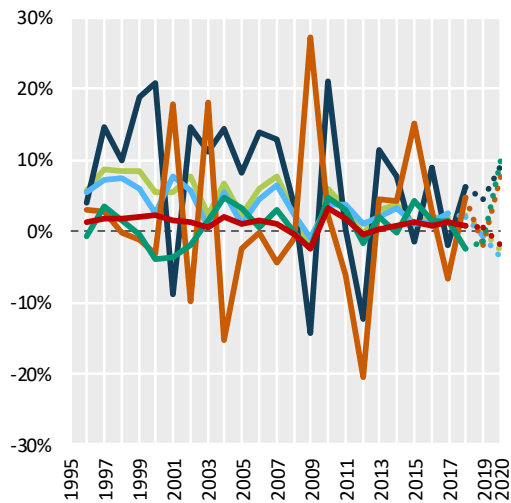
Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.  
Source: 2021 PREDICT Dataset and Eurostat

**Figure A. 3. ICT sector productivity per person employed in the EU27 (1995-2020)**

a) Index 1995=100



b) Annual real growth rates

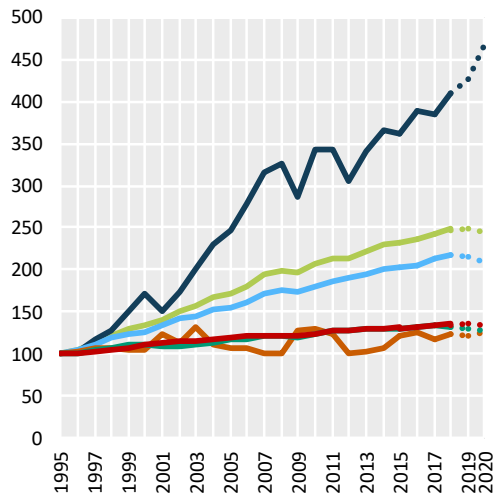


— Total ICT — ICT manufacturing — ICT services — RS — MC — Total economy

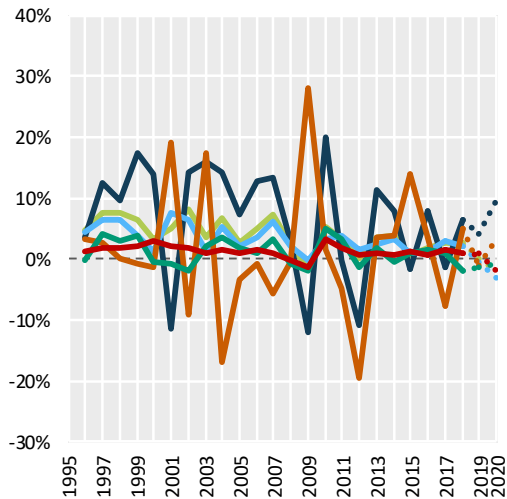
Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.  
Source: 2021 PREDICT Dataset and Eurostat

**Figure A. 4. ICT sector productivity per hour worked in the EU27 (1995-2020)**

a) Index 1995=100



b) Annual real growth rates

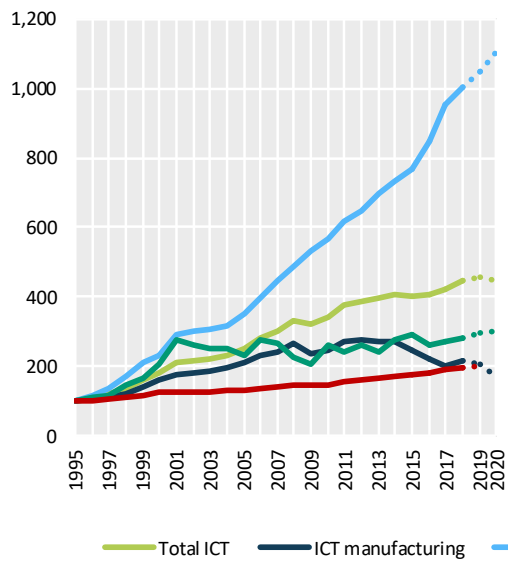


— Total ICT — ICT manufacturing — ICT services — RS — MC — Total economy

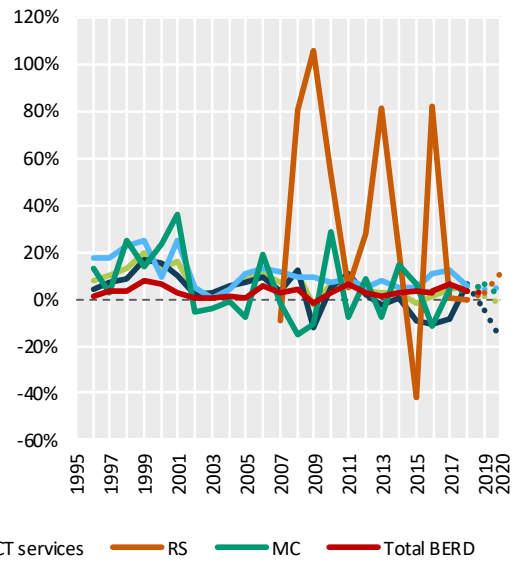
Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.  
Source: 2021 PREDICT Dataset and Eurostat

**Figure A. 5. ICT sector BERD in the EU27 (1995-2020)**

a) Index 1995=100



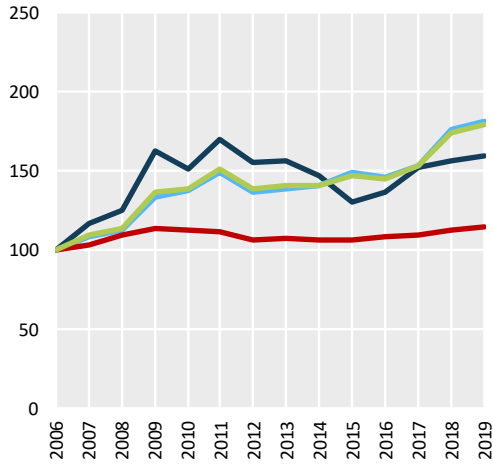
b) Annual real growth rates



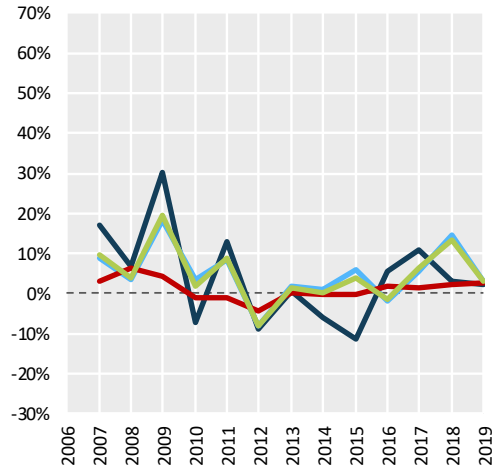
Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data  
 Source: 2021 PREDICT Dataset and Eurostat

**Figure A. 6. GBARD and ICT GBARD in the EU27 (2006-2019)**

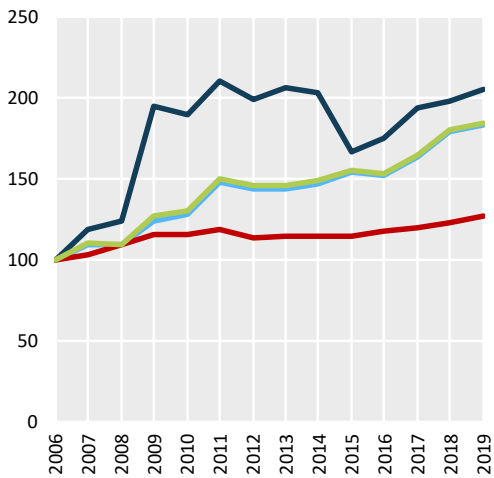
a) GBARD. Index 2006=100



b) GBARD. Annual real growth rates



c) ICT GBARD. Index 2006=100



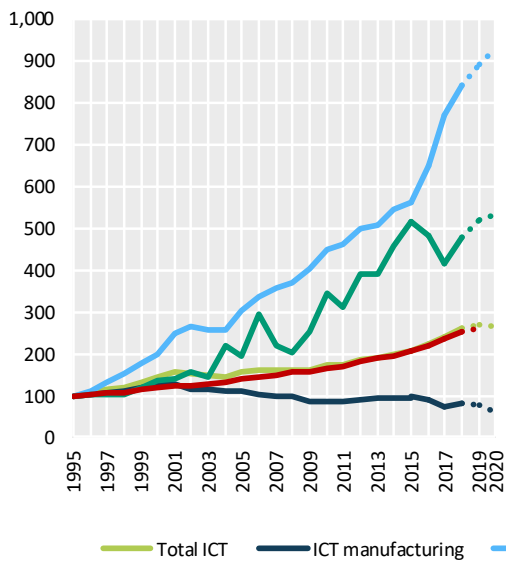
d) ICT GBARD. Annual real growth rates



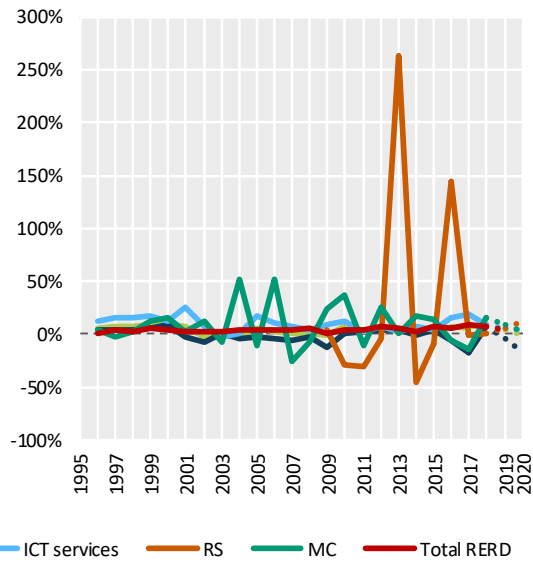
Source: 2021 PREDICT Dataset

**Figure A. 7. ICT sector RERD in the EU27 (1995-2020)**

a) Index 1995=100



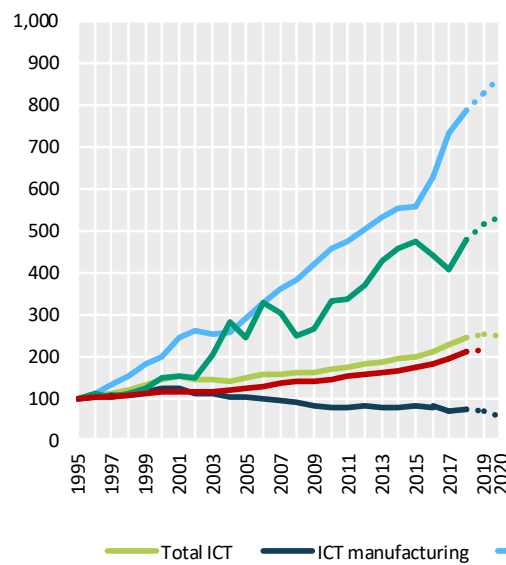
b) Annual growth rates



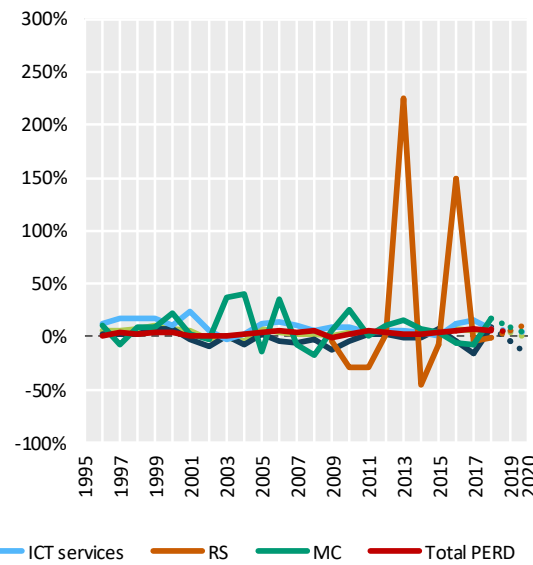
Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.  
Source: 2021 PREDICT Dataset

**Figure A. 8. ICT sector PERD in the EU27 (1995-2020)**

a) Index 1995=100

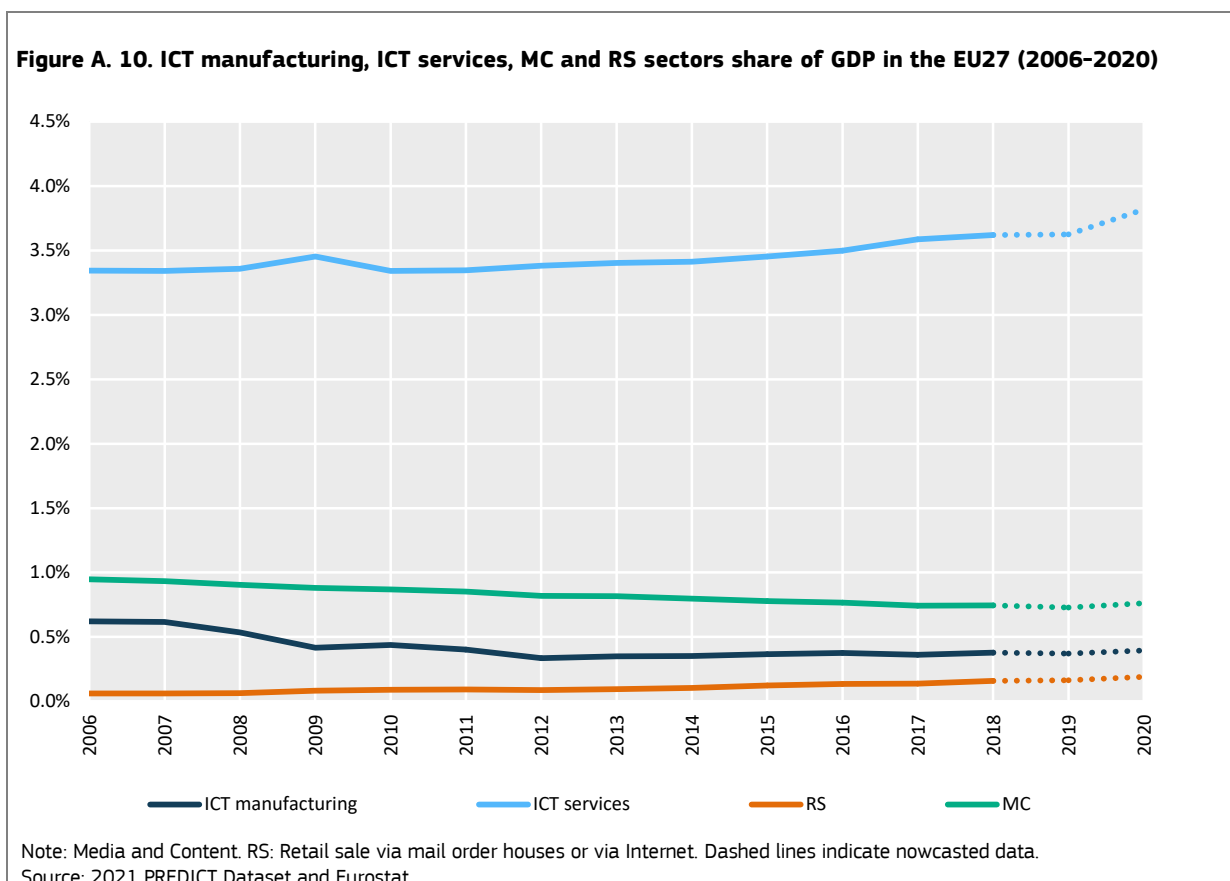
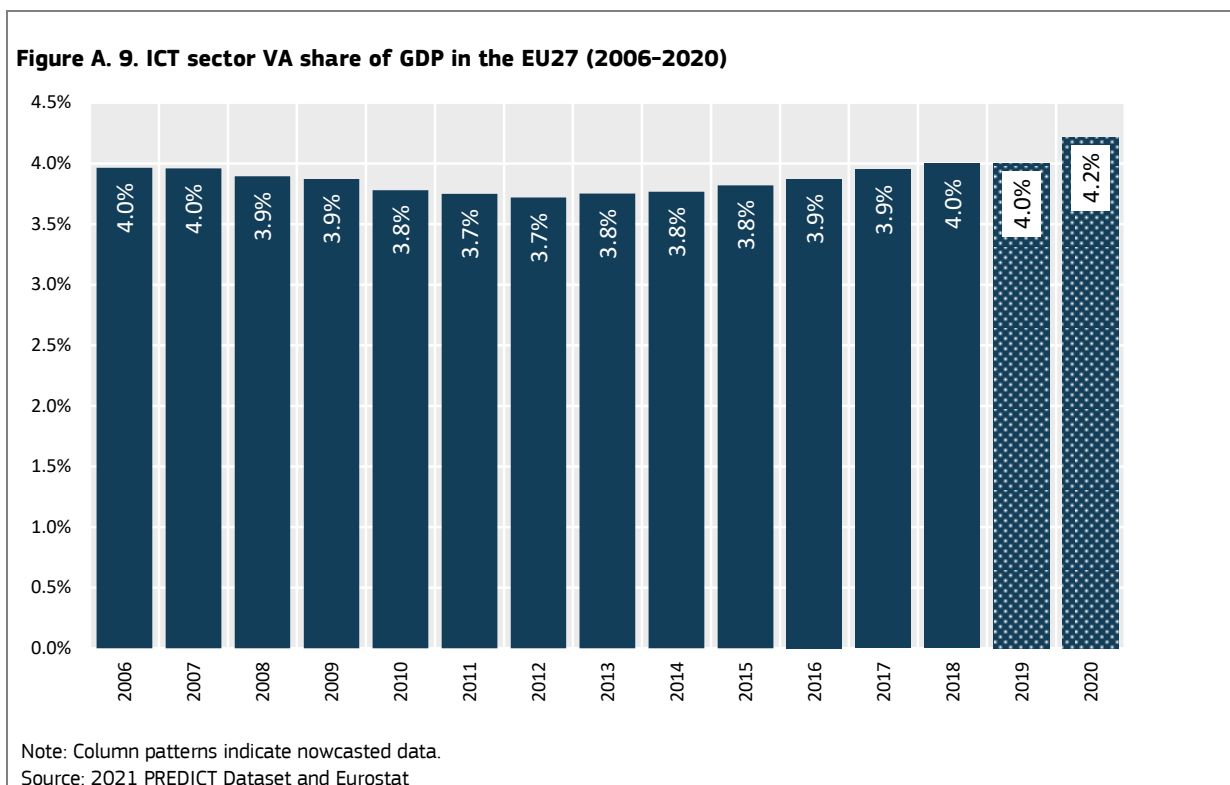


b) Annual growth rates

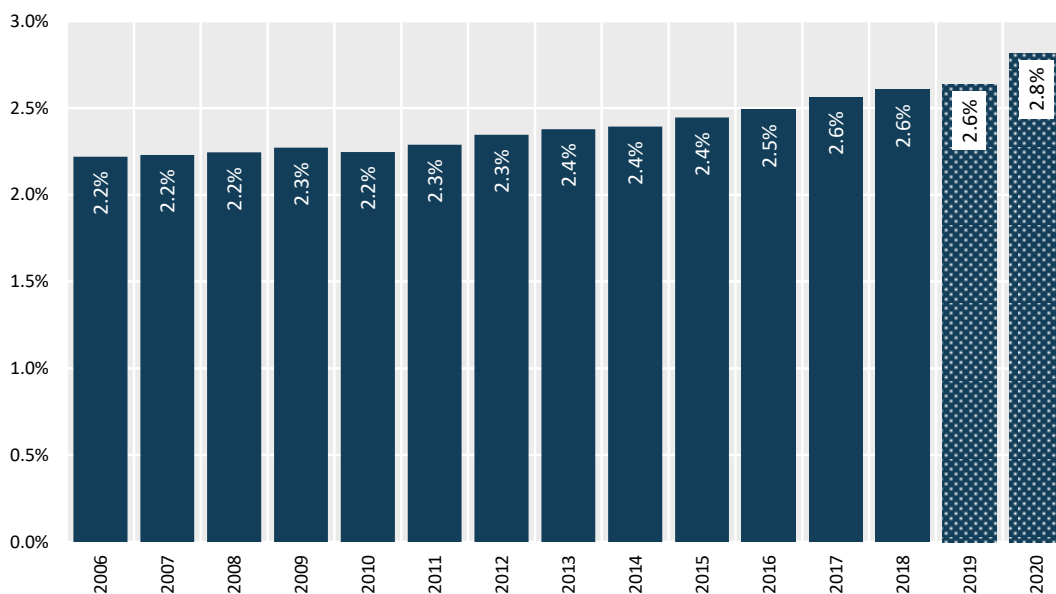


Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.  
Source: 2021 PREDICT Dataset.

## A.2. Analysis by sub-sectors in the EU27



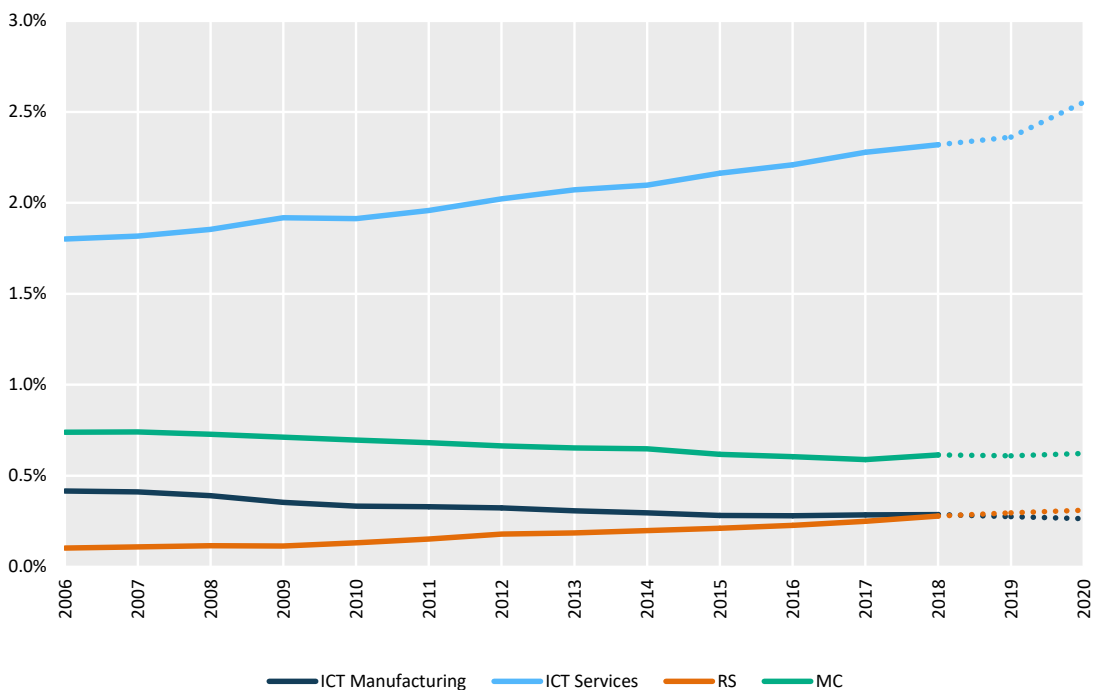
**Figure A. 11. ICT sector employment share of total employment in the EU27 (2006-2020)**



Note: Column patterns indicate nowcasted data.

Source: 2021 PREDICT Dataset and Eurostat.

**Figure A. 12. ICT manufacturing, ICT services, MC and RS sectors share of the total employment in the EU27 (2006-2019)**

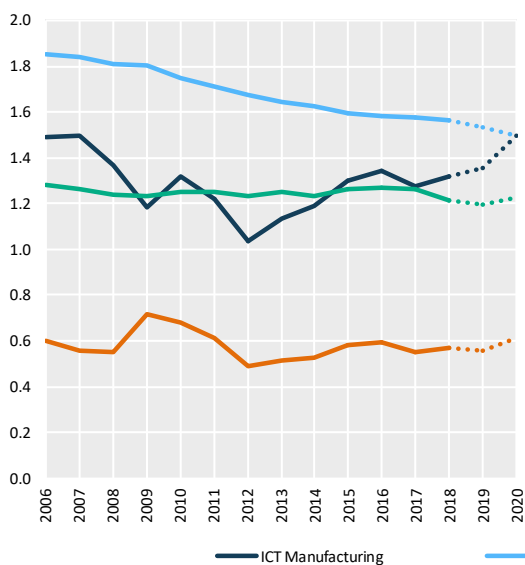


Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.

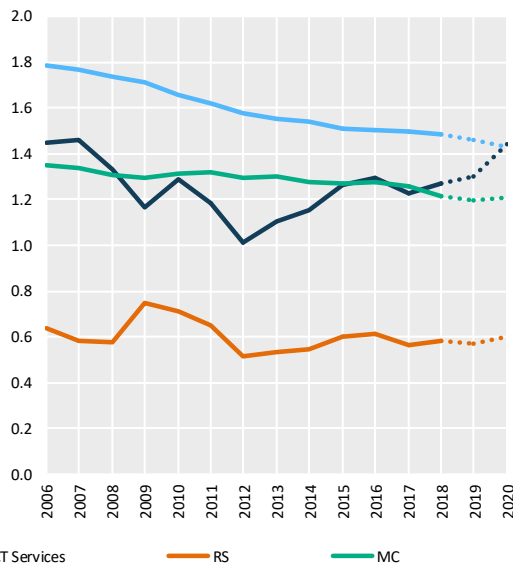
Source: 2021 PREDICT Dataset and Eurostat

**Figure A. 13. Productivity in ICT manufacturing, ICT services, MC and RS sectors as a ratio of total economy productivity in the EU27 (2006-2020)**

a) Productivity per person employed

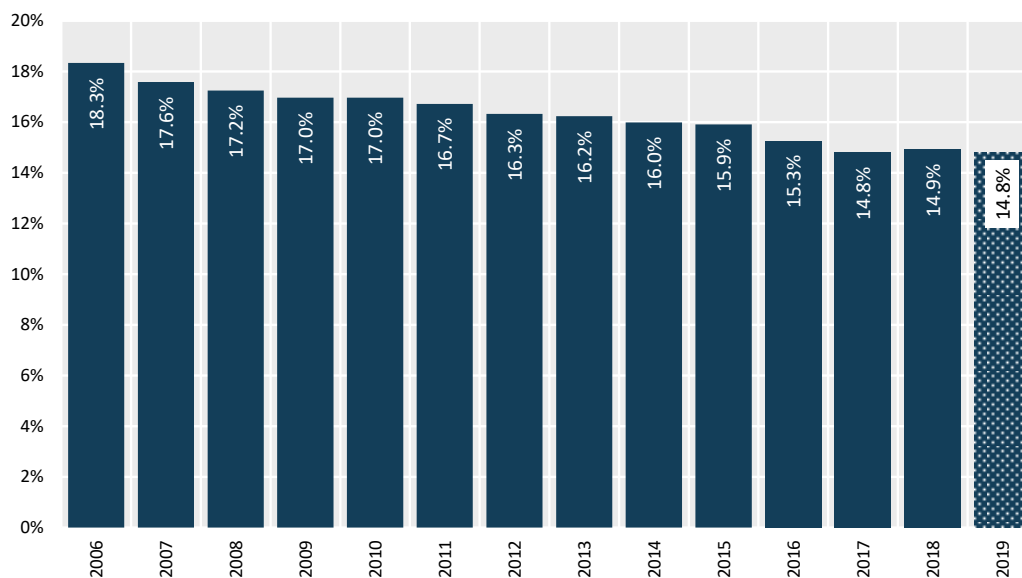


b) Productivity per hour worked



Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.  
Source: 2021 PREDICT Dataset and Eurostat.

**Figure A. 14. ICT sector BERD share of total BERD in the EU27 (2006-2019)**

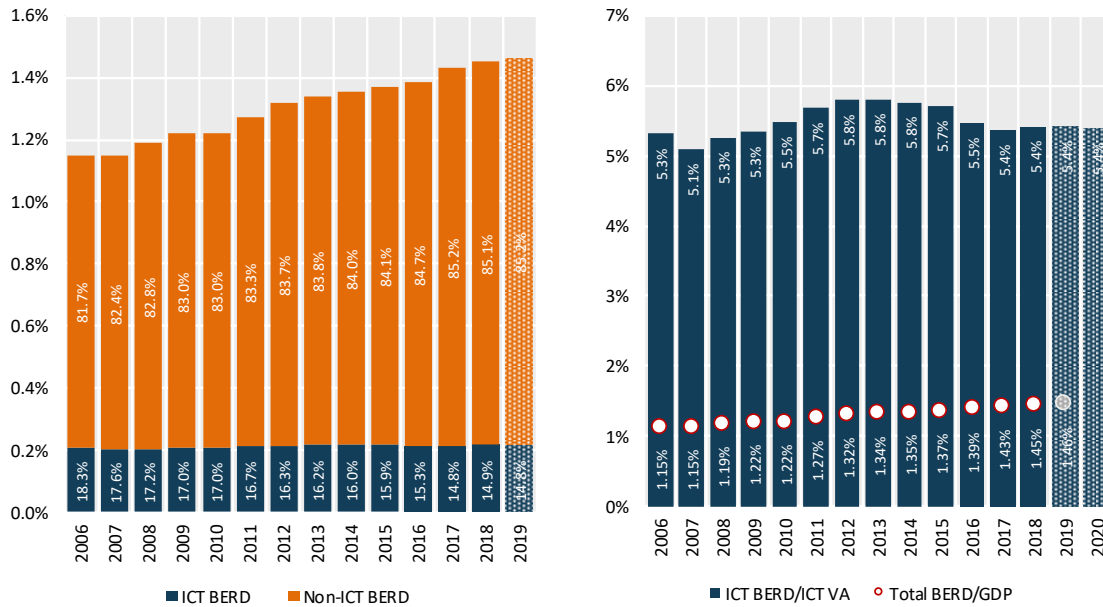


Note: Column patterns indicate nowcasted data.  
Source: 2021 PREDICT Dataset.



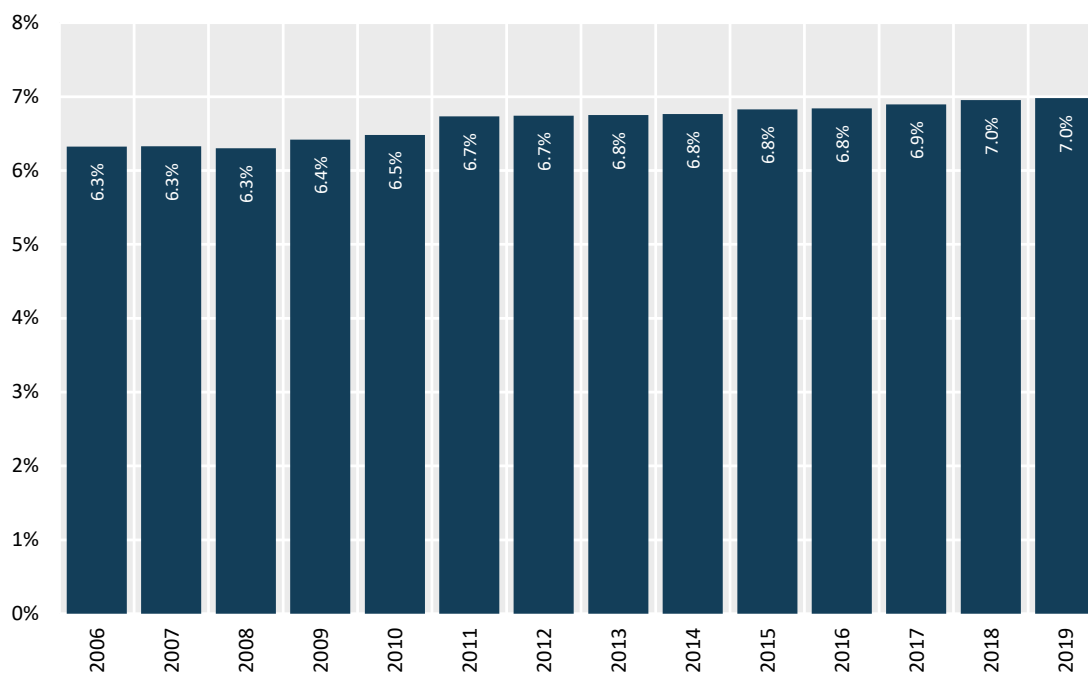
**Figure A. 15. ICT BERD intensity and total BERD intensity in the EU27 (2006-2020)**

a) Contribution of ICT and non-ICT BERD to total BERD    b) ICT BERD intensity and total BERD intensity (BERD/GDP)



Note: Column and circle patterns indicate nowcasted data.  
Source: 2021 PREDICT Dataset and Eurostat.

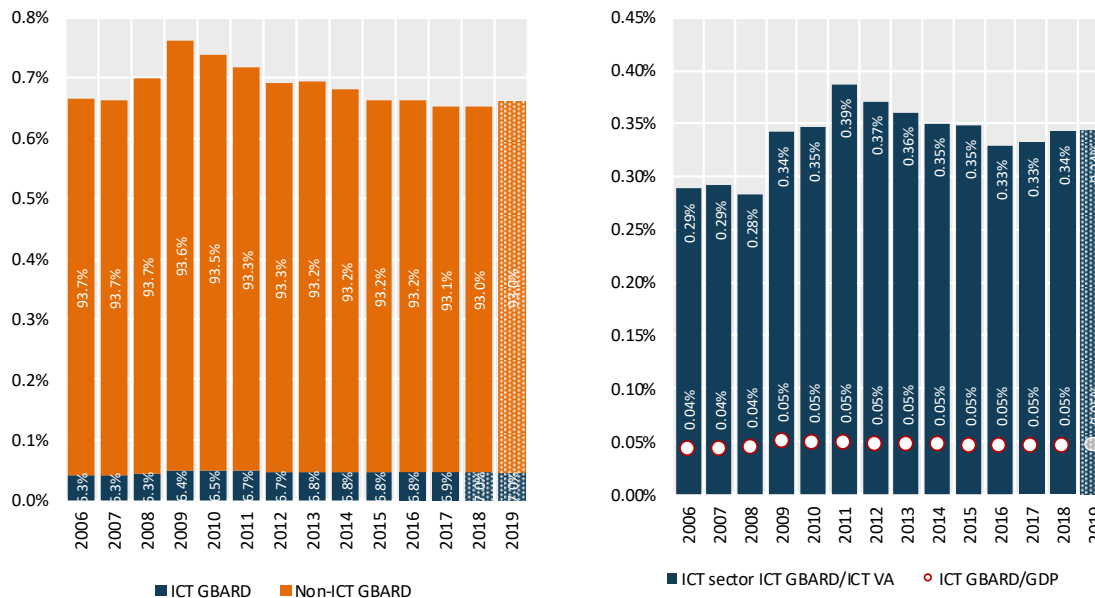
**Figure A. 16. ICT GBARD share of total GBARD in the EU27 (2006-2019)**



Source: 2021 PREDICT Dataset.

**Figure A. 17. ICT GBARD intensity in ICT sector and total economy in the EU27 (2006-2019)**

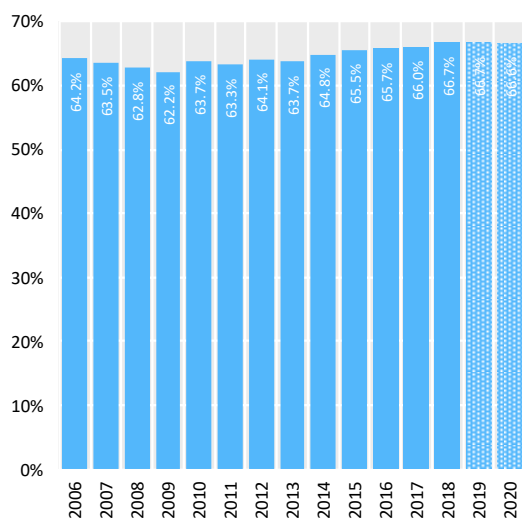
a) Contribution of ICT and non-ICT GBARD to total GBARD    b) ICT GBARD intensity



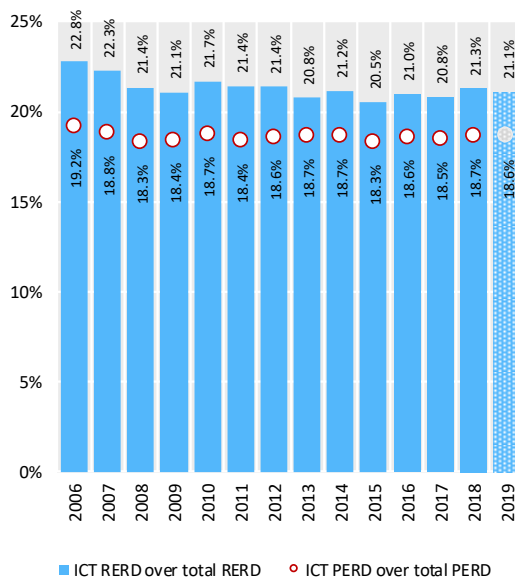
Note: Column and circle patterns indicate nowcasted data.  
Source: 2021 PREDICT Dataset and Eurostat.

**Figure A. 18. ICT sector RERD and ICT sector PERD in the EU27 (2006-2020)**

a) ICT RERD over ICT PERD

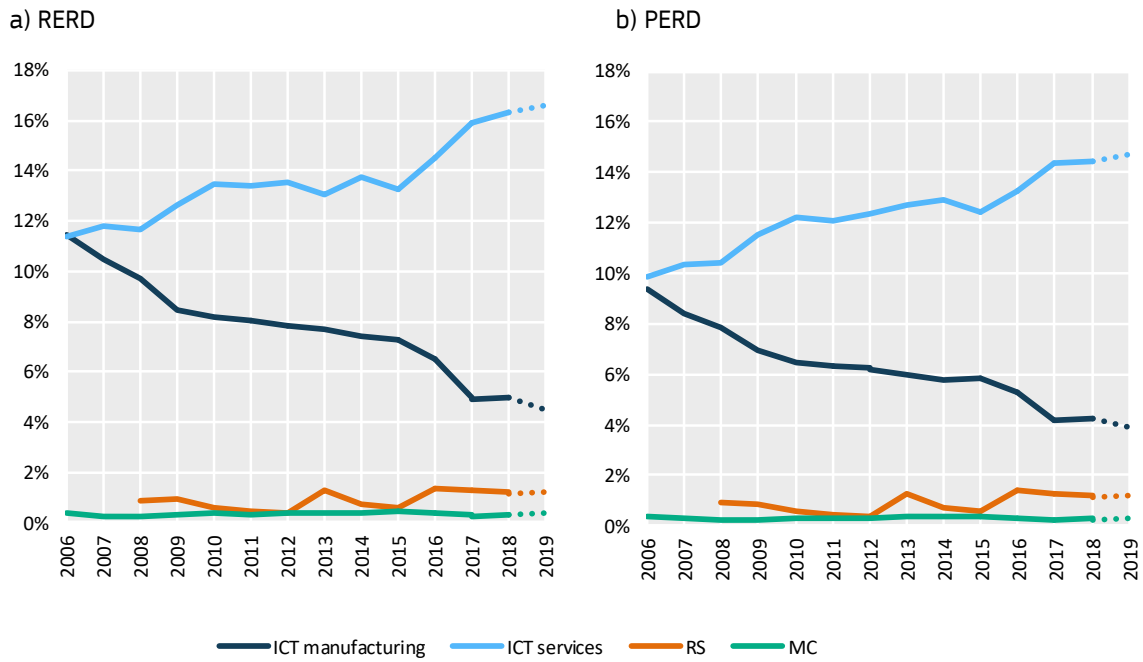


b) ICT RERD over total RERD, and ICT PERD over total PERD



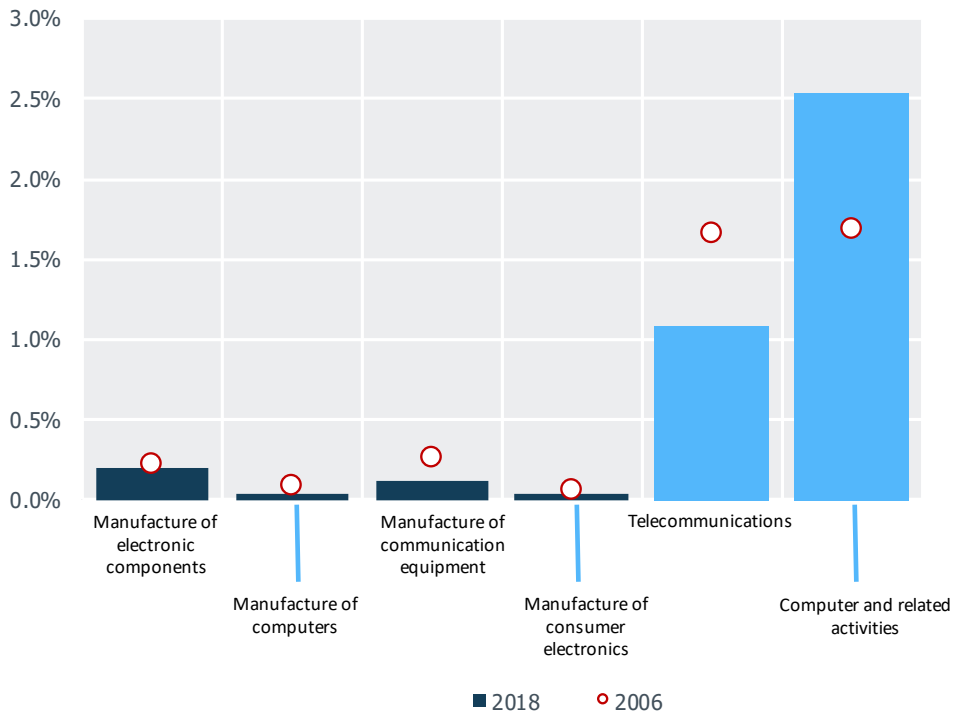
Note: Column and circle patterns indicate nowcasted data.  
Source: 2021 PREDICT Dataset and Eurostat.

**Figure A. 19. ICT manufacturing, ICT services, MC and RS sector share of total in the EU27 (2006-2019)**



Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.  
Source: 2021 PREDICT Dataset and Eurostat

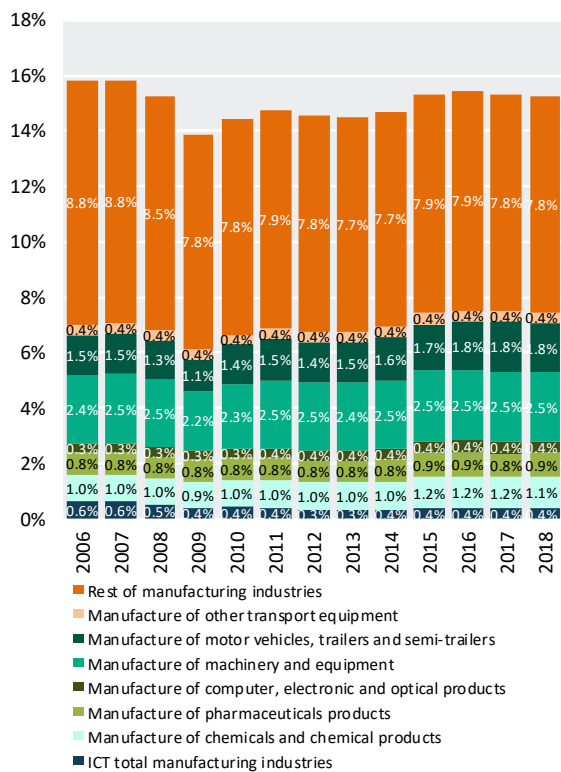
**Figure A. 20. ICT sector VA share of GDP by sub-sector in the EU27 (2006, 2018)**



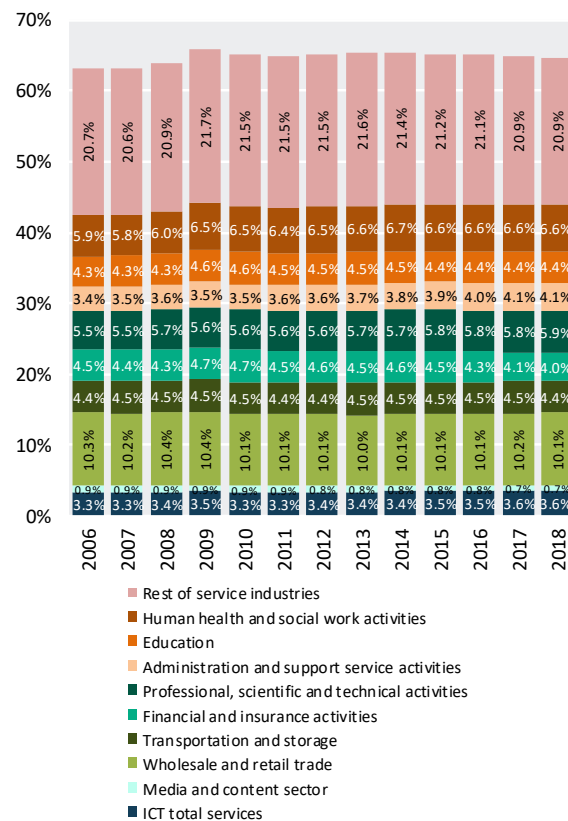
Source: 2021 PREDICT Dataset

**Figure A. 21. ICT sector VA share of GDP and comparison with non-ICT economic activities in the EU27 (2006-2018)**

a) Manufacturing



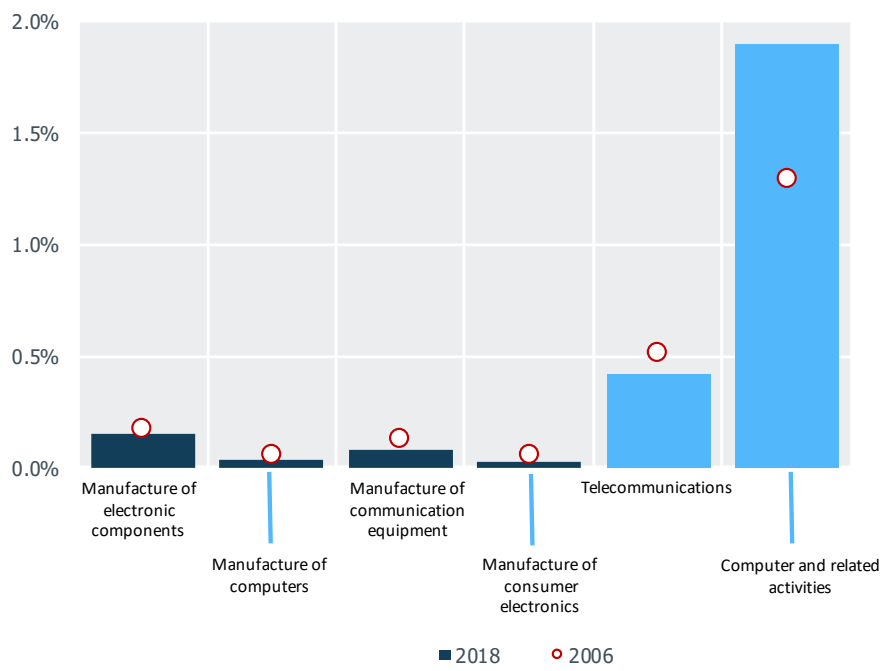
b) Services



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 not included neither in manufacturing nor in services industries.

Source: 2021 PREDICT Dataset.

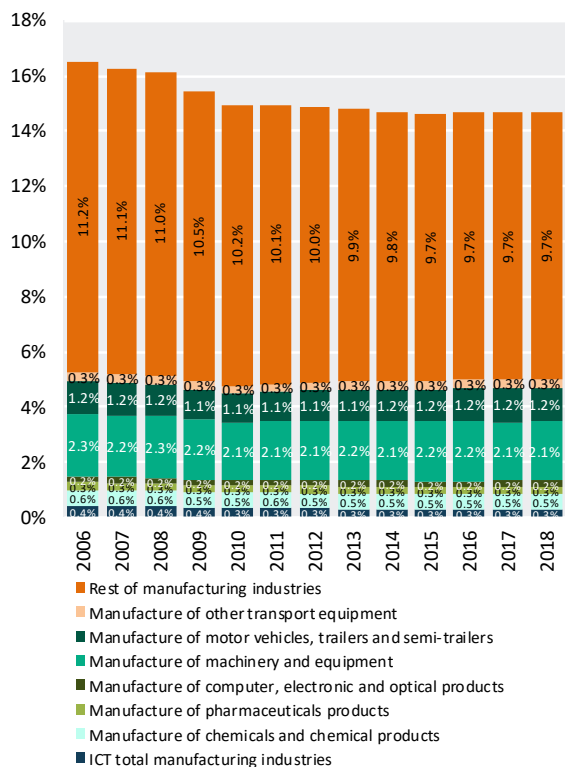
**Figure A. 22. ICT sector employment share of total employment by sub-sector in the EU27 (2006, 2018)**



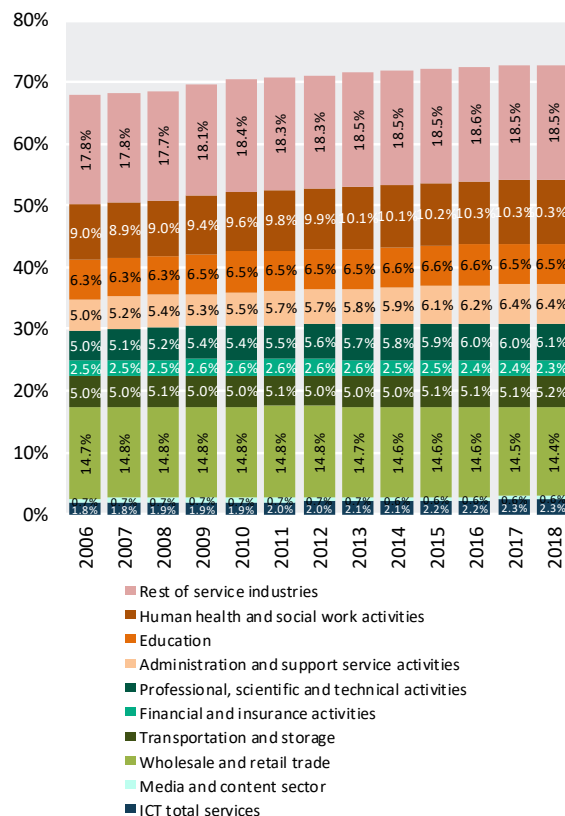
Source: 2021 PREDICT Dataset.

**Figure A. 23. ICT sector employment share on total employment and comparison with non-ICT economic activities in the EU27 (2006-2018)**

**a) Manufacturing**



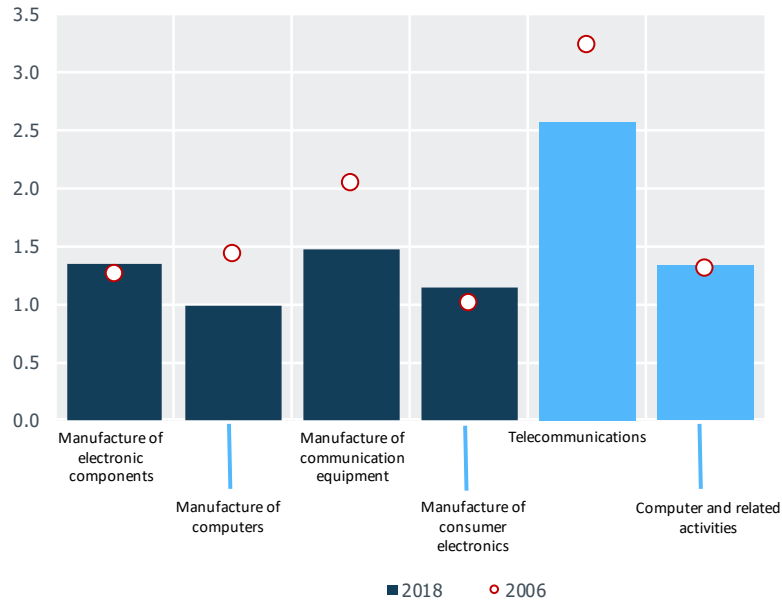
**b) Services**



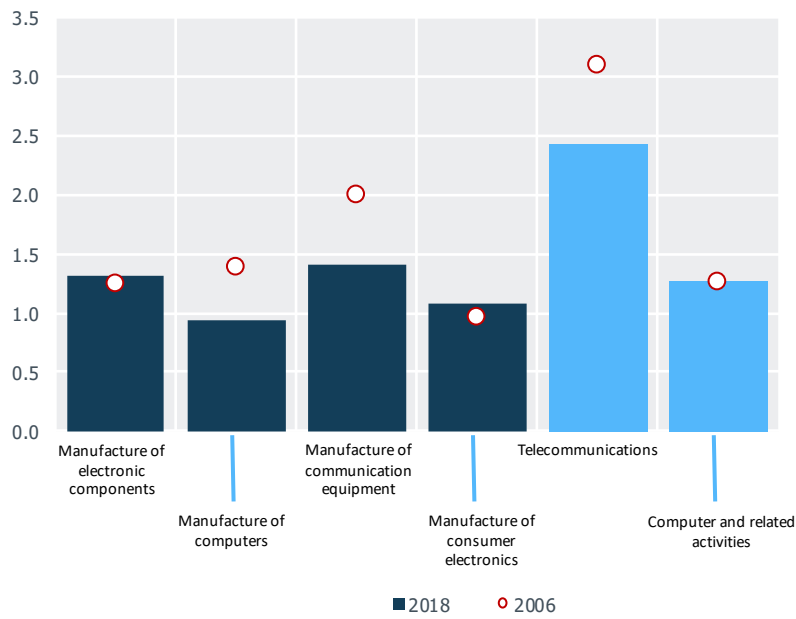
Note: Agriculture, forestry and fishing; mining and quarrying; electricity, gas, steam and air conditioning supply; water supply, sewerage, waste management and remediation activities; and construction not included neither in manufacturing nor in services industries.  
Source: 2021 PREDICT Dataset.

**Figure A. 24. ICT sector productivity ratio over productivity in total economy by sub-sector in the EU27 (2006, 2018)**

a) Labour productivity per person employed



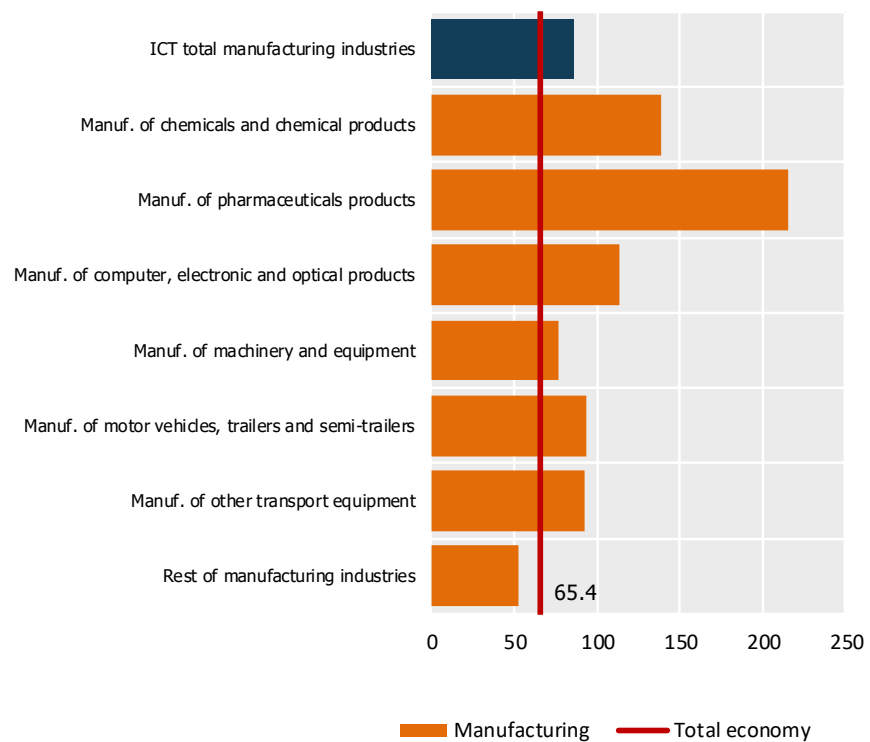
b) Labour productivity per hour worked



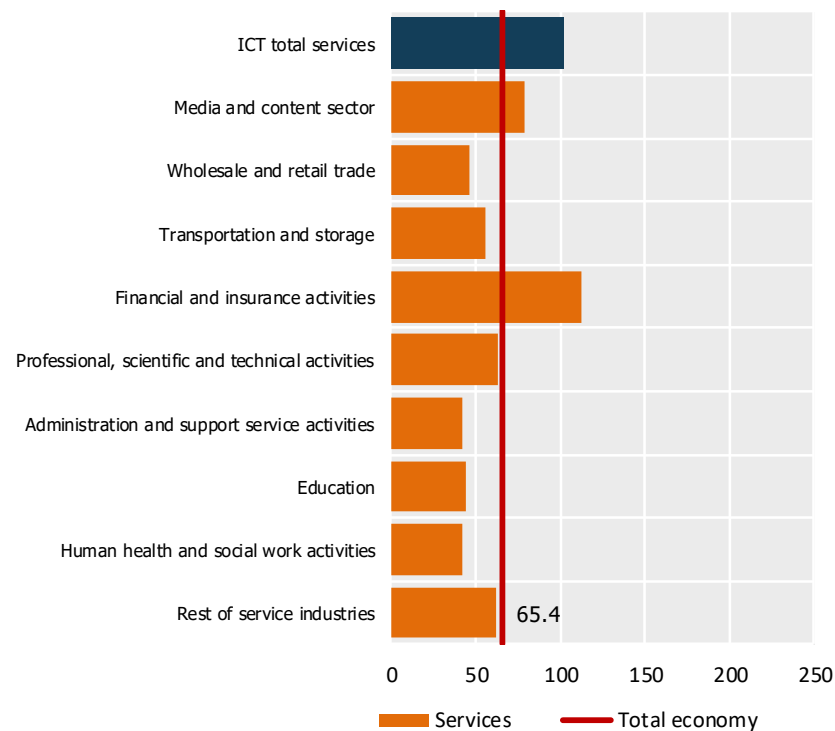
Source: 2021 PREDICT Dataset.

**Figure A. 25. ICT sector productivity per person employed and comparison with non-ICT economic activities in the EU27 (thousand current EUR per person; 2018)**

a) Manufacturing



b) Services

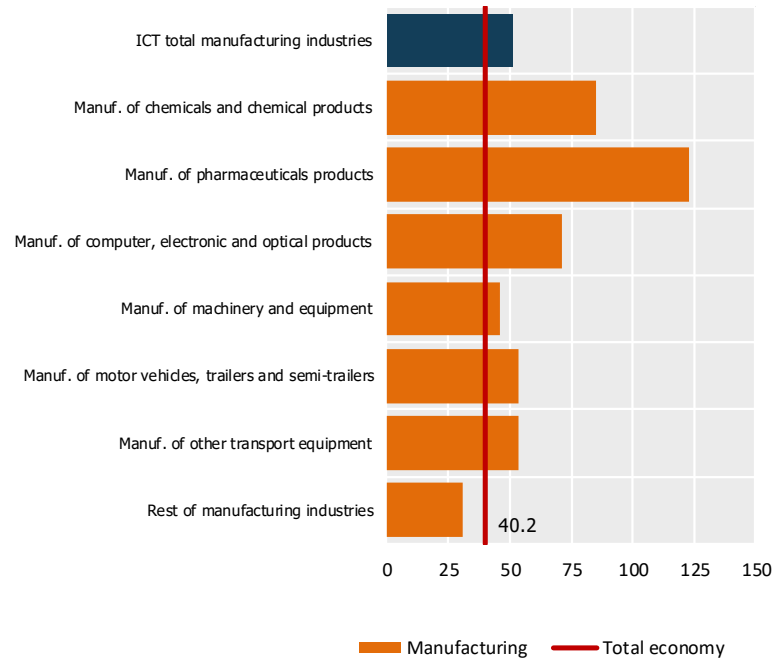


Note: Agriculture, forestry and fishing; mining and quarrying; electricity, gas, steam and air conditioning supply; water supply, sewerage, waste management and remediation activities; and construction not included neither in manufacturing nor in services industries  
 Source: 2021 PREDICT Dataset.

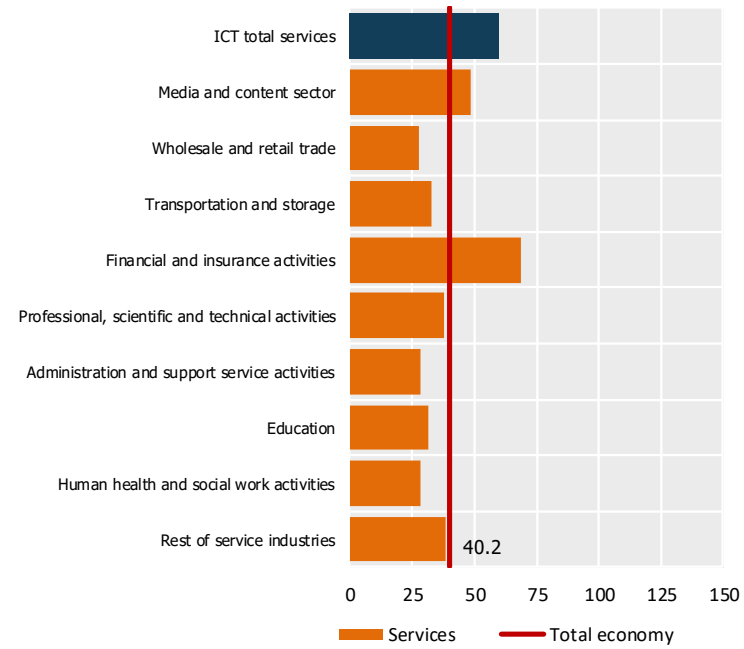


**Figure A. 26. ICT sector productivity per hour worked and comparison with non-ICT economic activities in the EU27 (current EUR per hour worked; 2018)**

a) Manufacturing



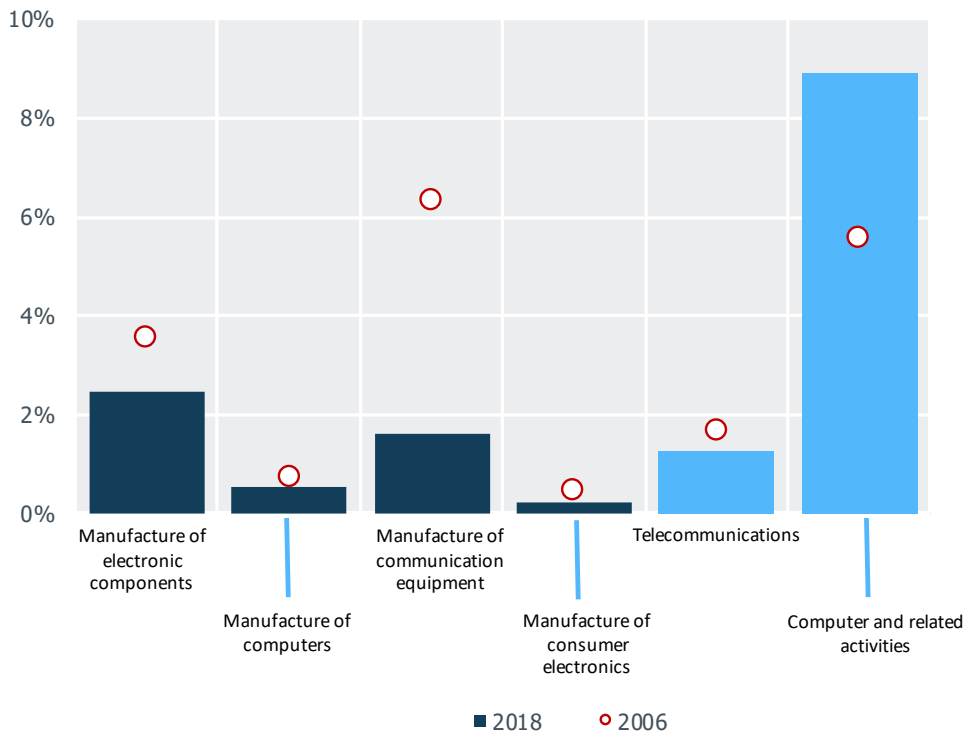
b) Services



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 not included neither in manufacturing nor in services industries.

Source: 2021 PREDICT Dataset.

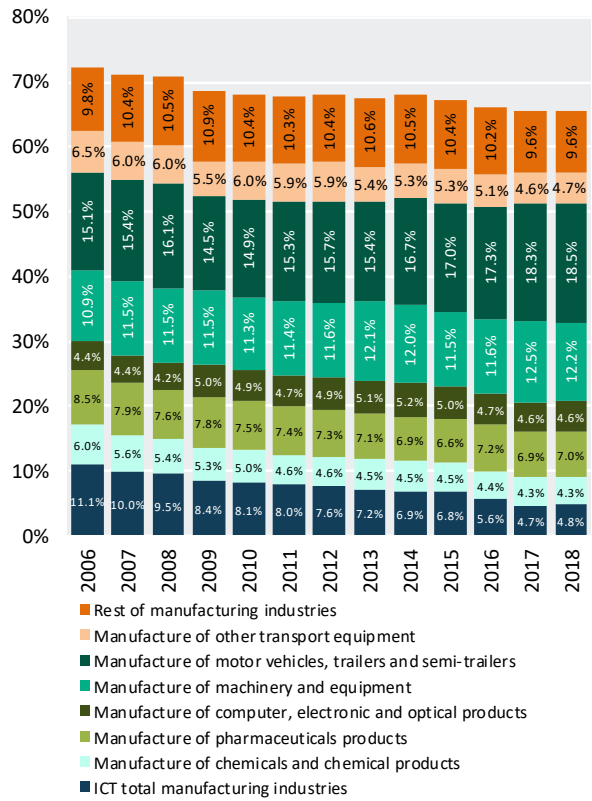
**Figure A. 27. ICT sector BERD share of total BERD by sub-sector in the EU27 (2006, 2018)**



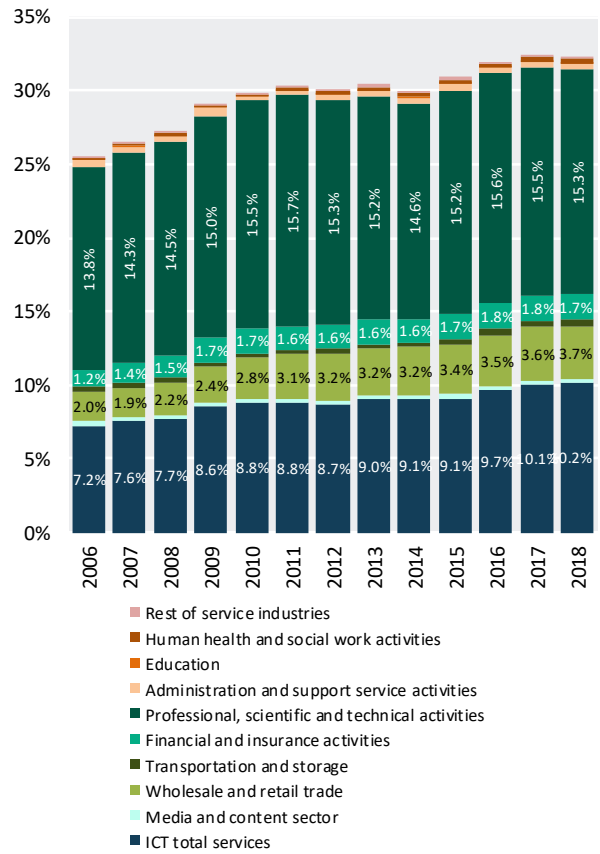
Source: 2021 PREDICT Dataset.

**Figure A. 28. ICT sector BERD share of total BERD and comparison with non-ICT economic activities in the EU27 (2006-2018)**

a) Manufacturing



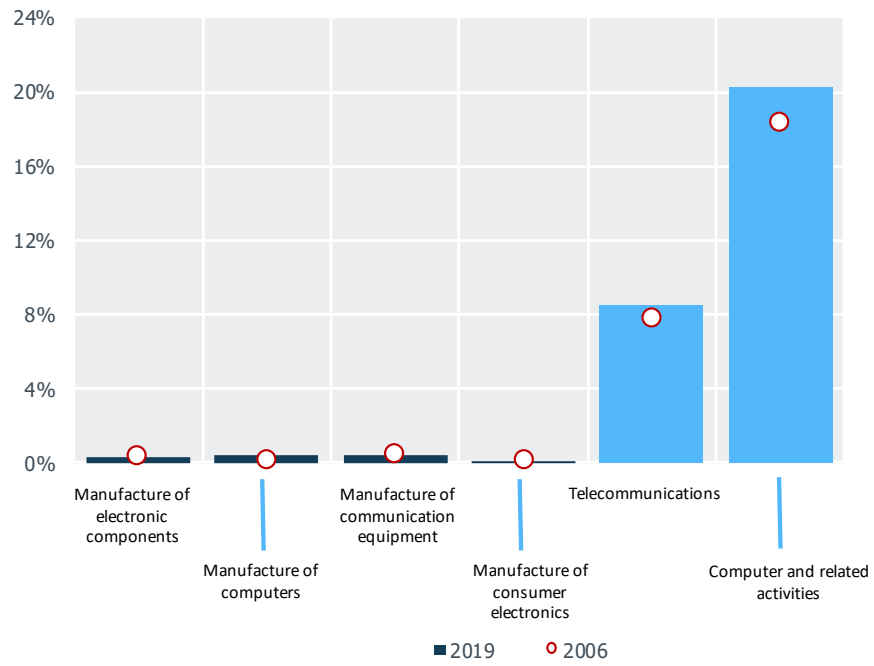
b) Services



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 not included neither in manufacturing nor in services industries.

Source: 2021 PREDICT Dataset.

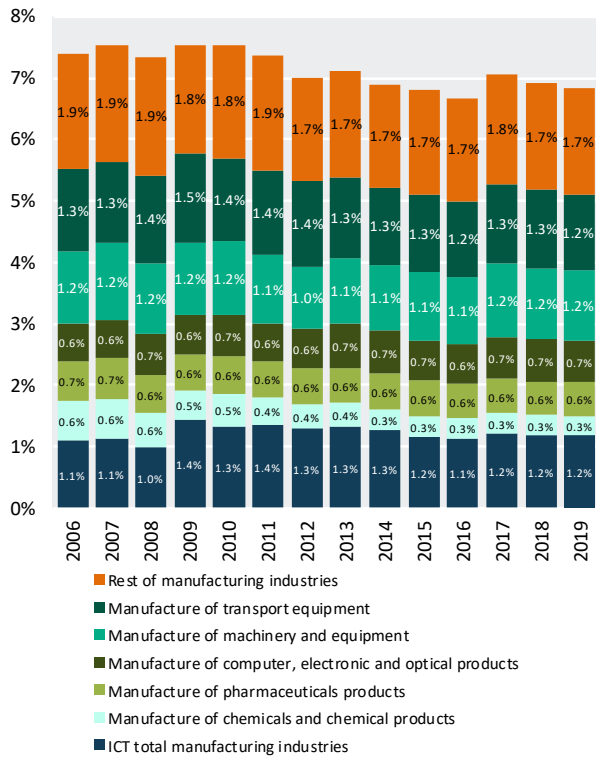
**Figure A. 29. ICT GBARD share of total ICT GBARD by sub-sector in the EU27 (2006, 2019)**



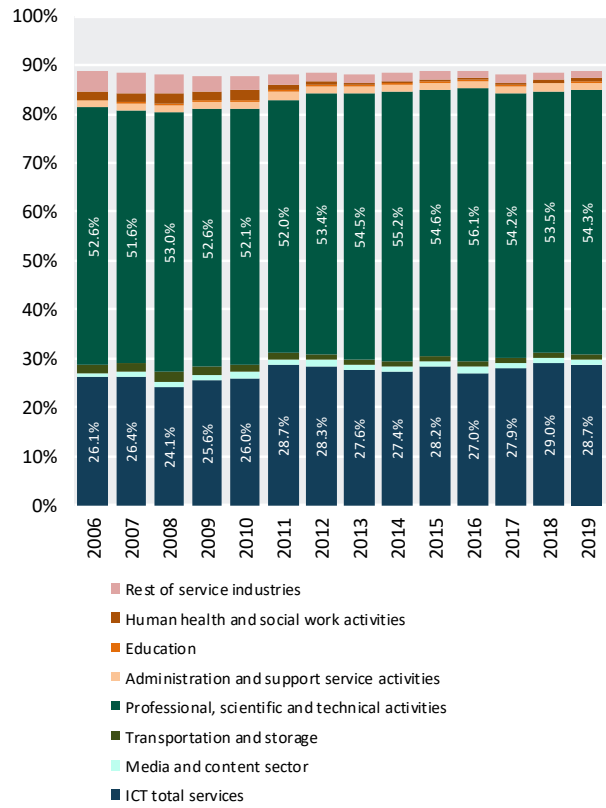
Source: 2021 PREDICT Dataset.

**Figure A. 30. ICT sector ICT GBARD share on total ICT GBARD and comparison with non-ICT economic activities in the EU27 (2006-2019)**

a) Manufacturing



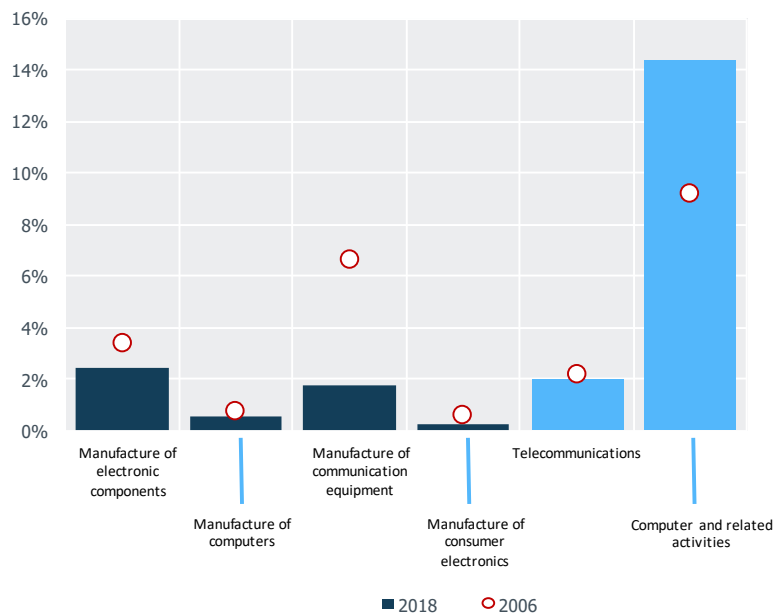
b) Services



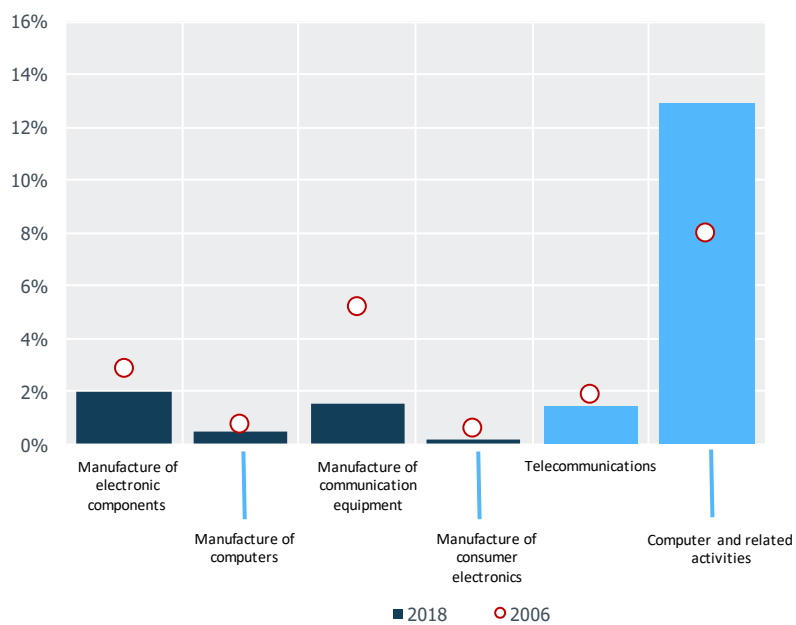
Note: Agriculture, forestry and fishing; mining and quarrying; electricity, gas, steam and air conditioning supply; water supply, sewerage, waste management and remediation activities; and construction not included neither in manufacturing nor in services industries  
 Source: 2021 PREDICT Dataset.

**Figure A. 31. ICT sector share of total by sub-sector, RERD and PERD in the EU27 (2006, 2018)**

a) RERD



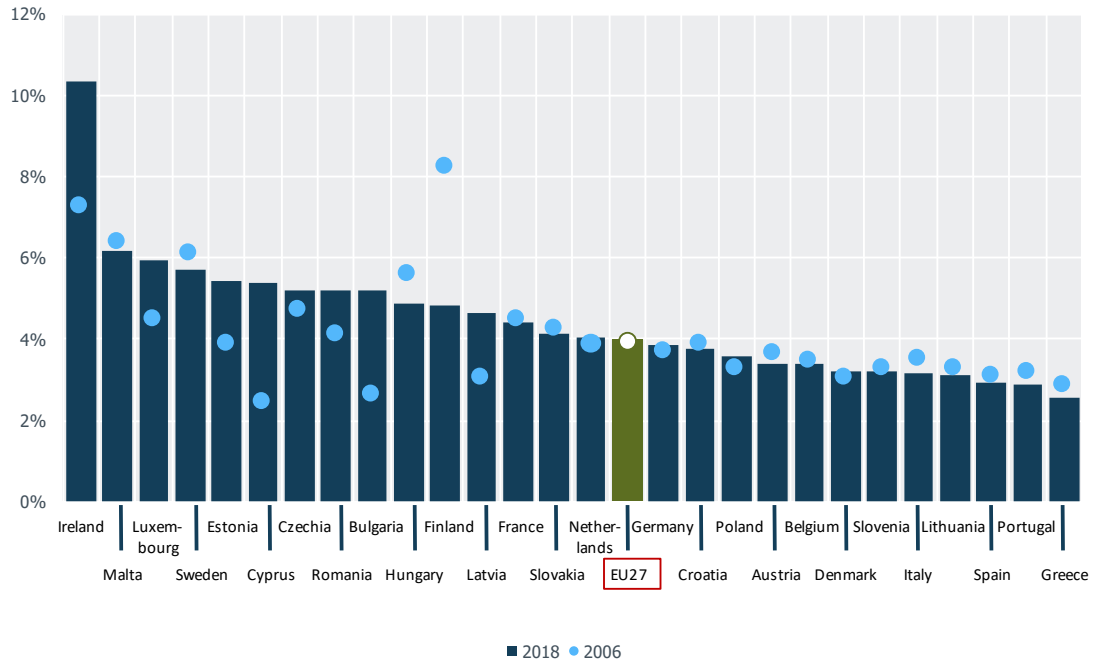
b) PERD



Source: 2021 PREDICT Dataset.

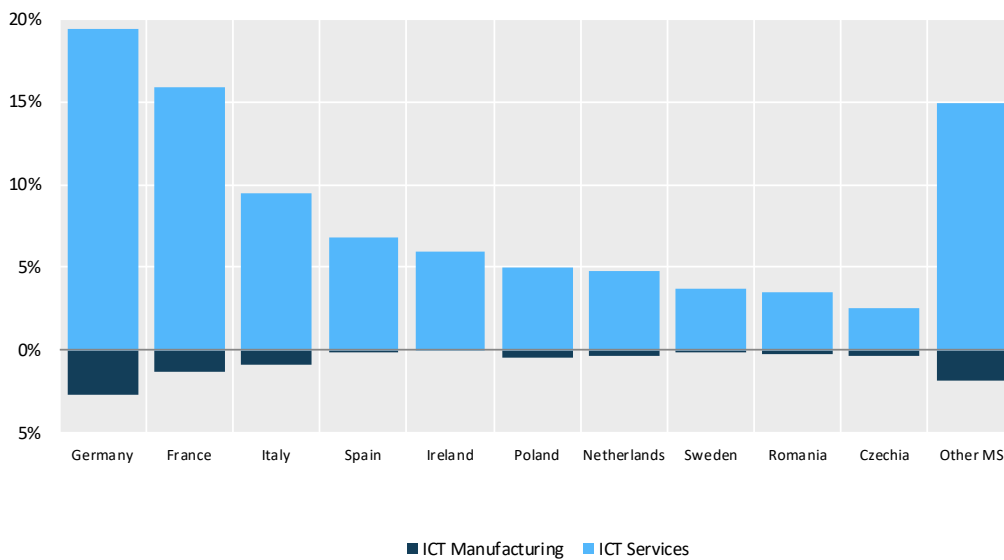
### A.3. Analysis by Member State

**Figure A. 32. ICT sector VA share of GDP. EU27 Member States (2006, 2018)**



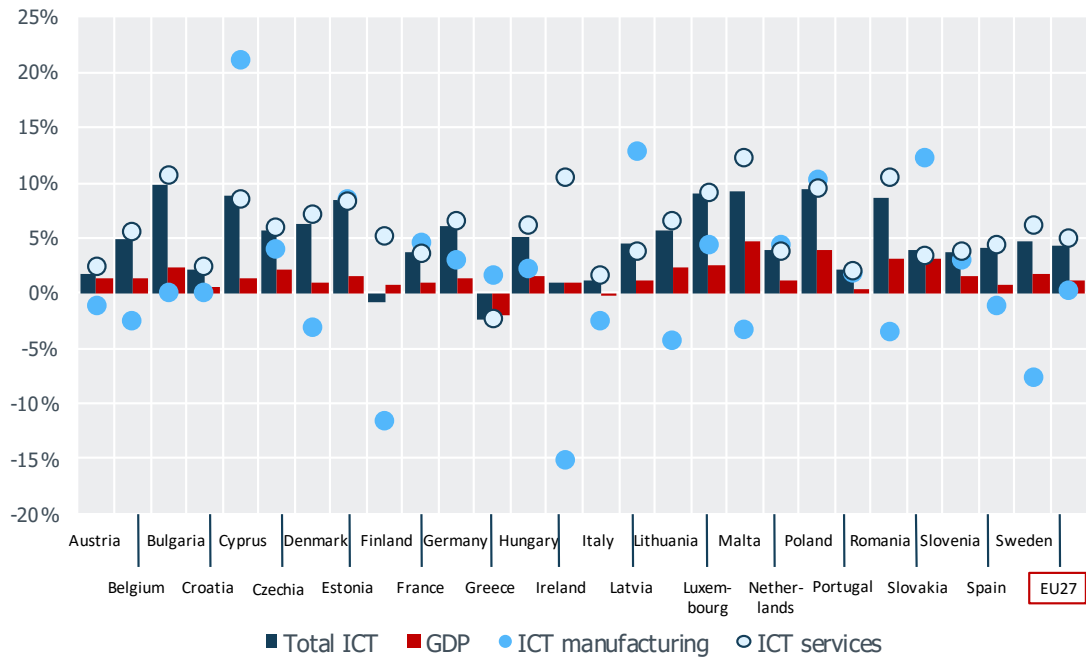
Note: 2014 for Ireland.  
Source: 2021 PREDICT Dataset.

**Figure A. 33. ICT manufacturing and ICT services VA in the ten largest EU27 Member States' contributors (percentages, 2018)**



Note: ICT manufacturing is not available for Ireland in 2018 due to confidentiality reasons. In 2014, this sector accounts for around 0.4% of total ICT sector VA  
Source: 2021 PREDICT Dataset.

**Figure A. 34. Mean annual real growth rate of VA in ICT sector, ICT manufacturing, ICT services and GDP by EU27 Member State (2006-2018)**



Note: 2006-2014 for Ireland.  
Source: 2021 PREDICT Dataset.

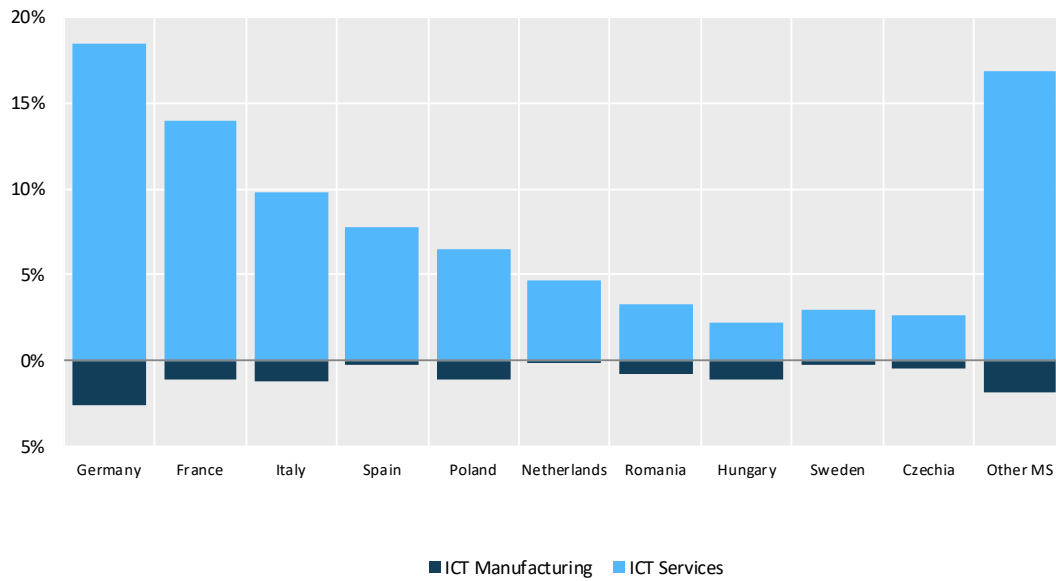
**Figure A. 35. ICT sector employment share of total employment by EU27 Member State (2006, 2018)**



Source: 2021 PREDICT Dataset.

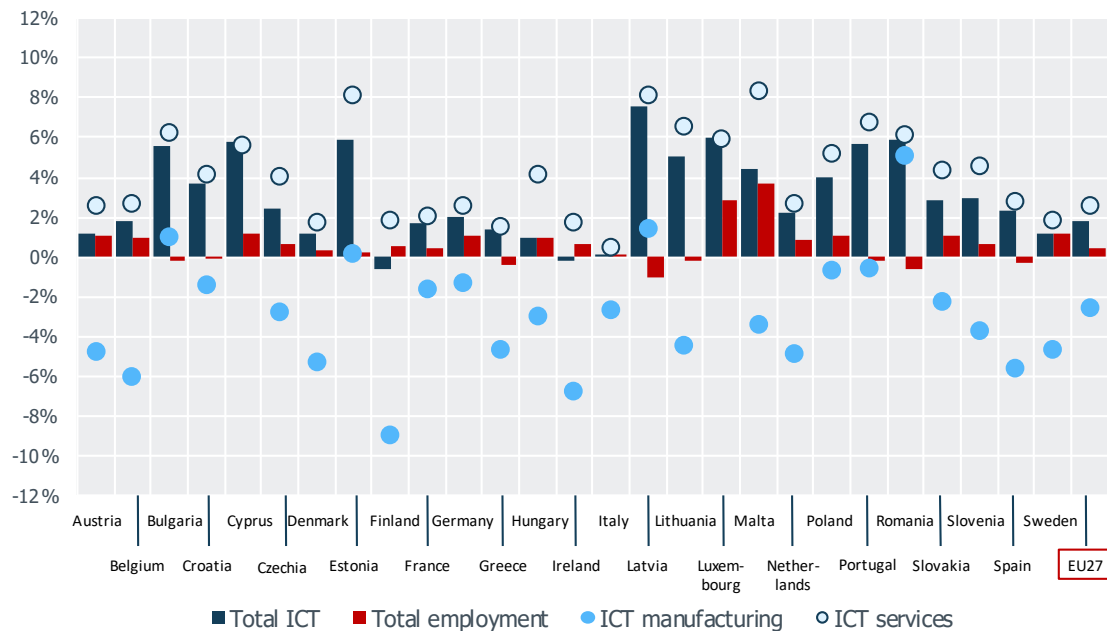


**Figure A. 36. ICT manufacturing and ICT services employment in the ten largest EU27 Member States' contributors (percentages, 2018)**



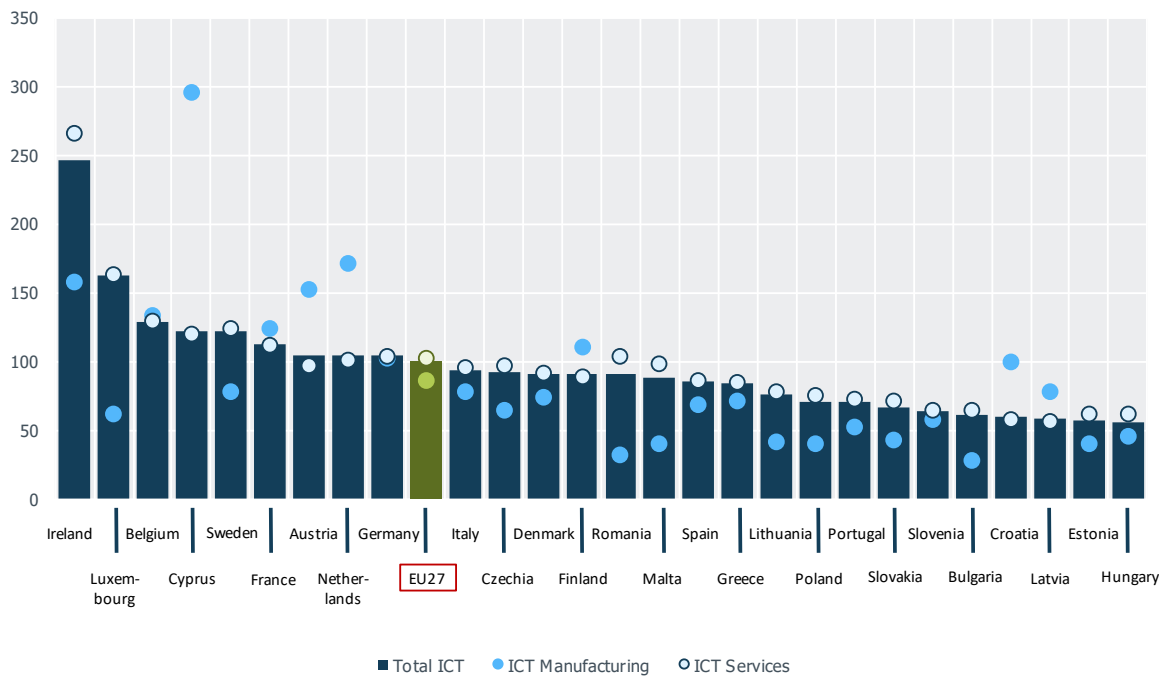
Source: 2021 PREDICT Dataset.

**Figure A. 37. Mean annual growth rate of employment in ICT sector, ICT manufacturing, ICT services and total employment by EU27 Member State (2006-2018)**



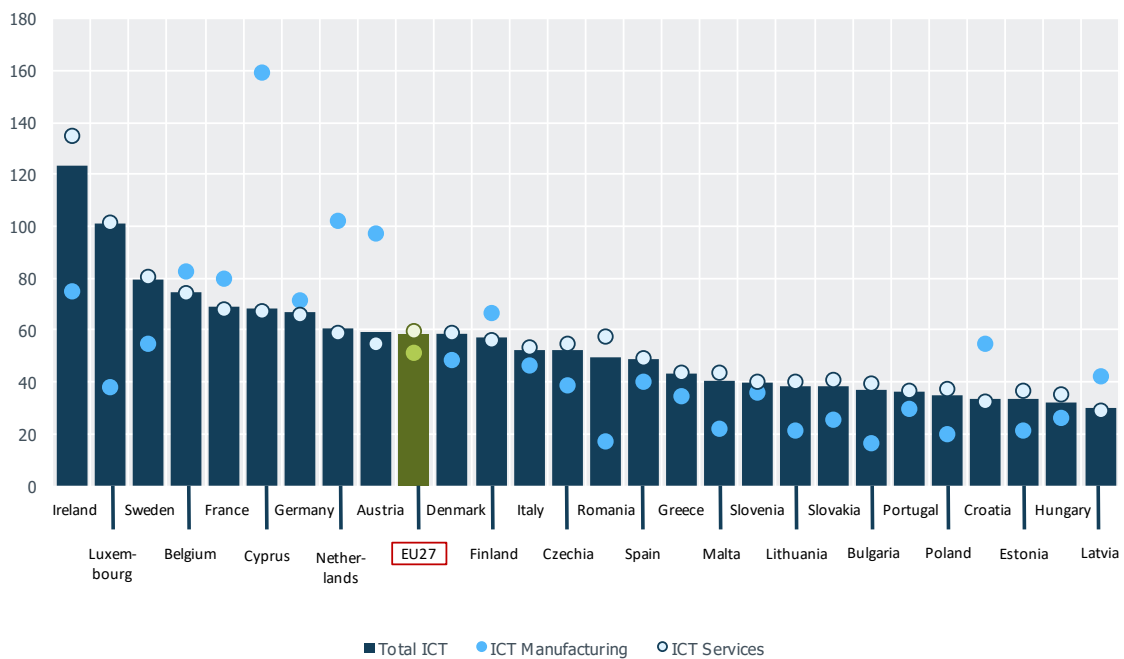
Source: 2021 PREDICT Dataset.

**Figure A. 38. ICT sector productivity per person employed by EU27 Member State (thousands of EUR PPS per person, 2018)**



Note: 2014 for Ireland.  
Source: 2021 PREDICT Dataset.

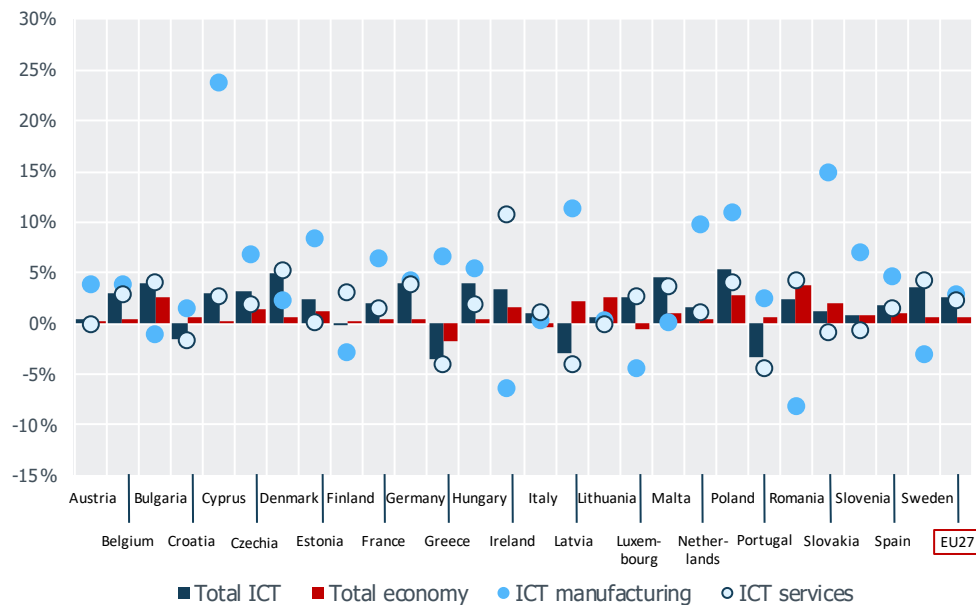
**Figure A. 39. ICT sector productivity per person employed by EU27 Member State (current EUR PPS per hour, 2018)**



Note: 2014 for Ireland.  
Source: 2021 PREDICT Dataset.

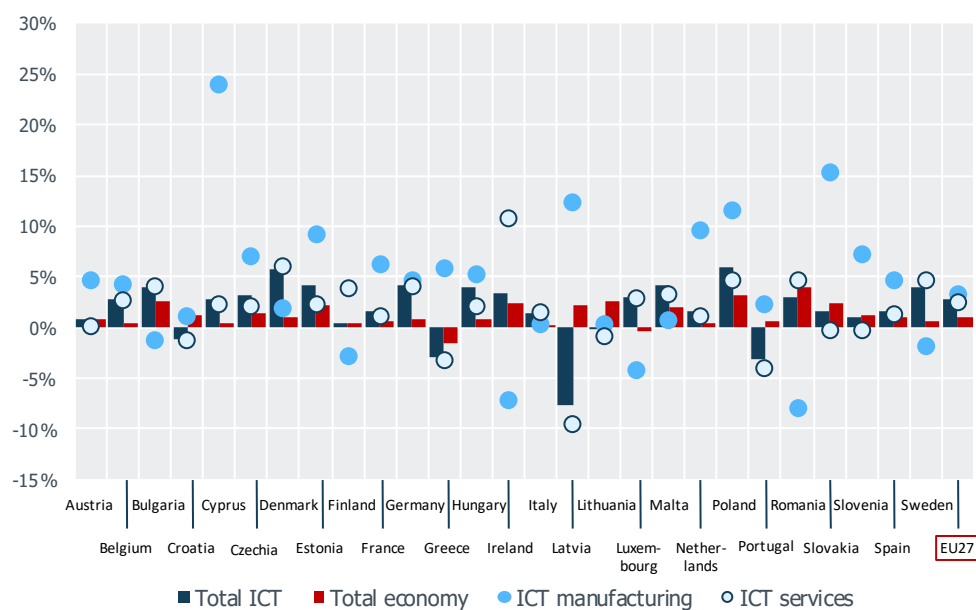
**Figure A. 40. Mean annual real growth rate of labour productivity in ICT sector, ICT manufacturing, ICT services and total economy by EU27 Member State (2006-2018)**

a) Productivity per person employed



Note: 2006-2014 for Ireland.

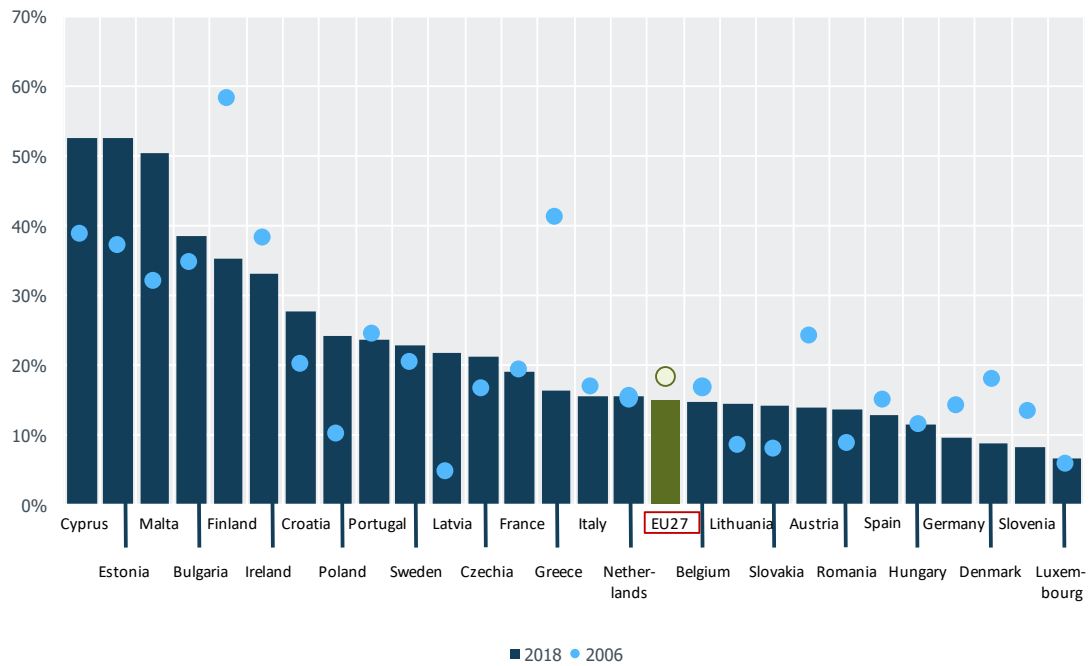
b) Productivity per hour worked



Note: 2006-2014 for Ireland.

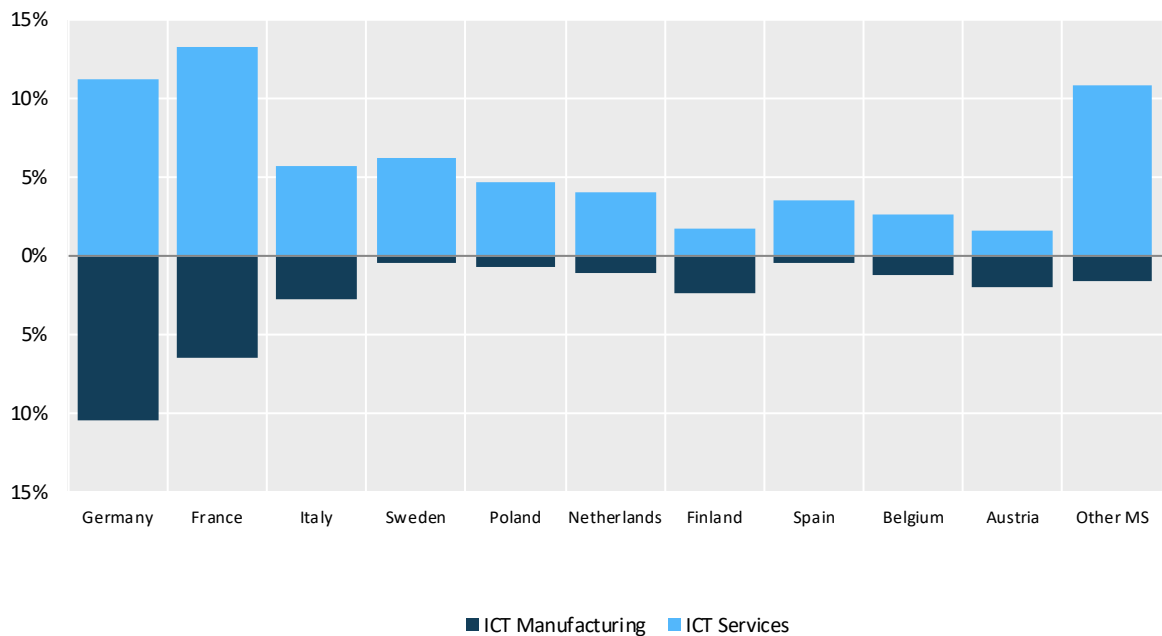
Source: 2021 PREDICT Dataset.

**Figure A. 41. ICT sector BERD share of total BERD by EU27 Member State (2006, 2018)**



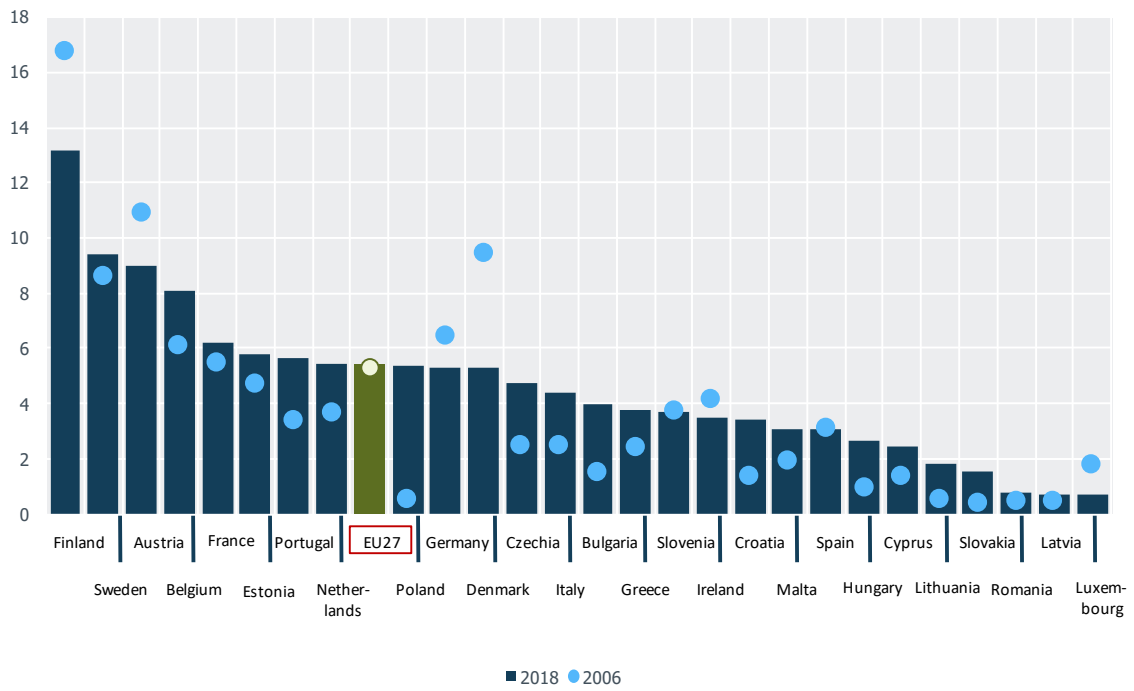
Source: 2021 PREDICT Dataset.

**Figure A. 42. ICT manufacturing and ICT services BERD in the ten largest EU27 Member States' contributors (percentages, 2018)**



Source: 2021 PREDICT Dataset.

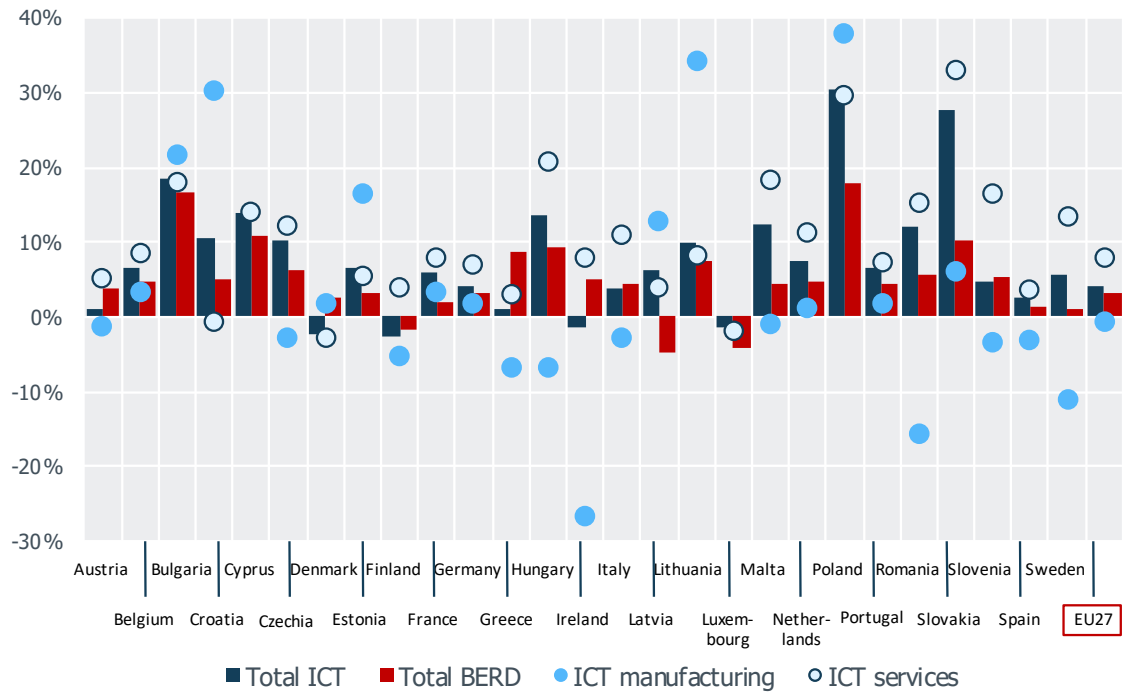
**Figure A. 43. ICT sector BERD intensity (ICT sector BERD/ICT sector VA) by EU27 Member State (2006, 2018)**



Note: 2014 for Ireland.

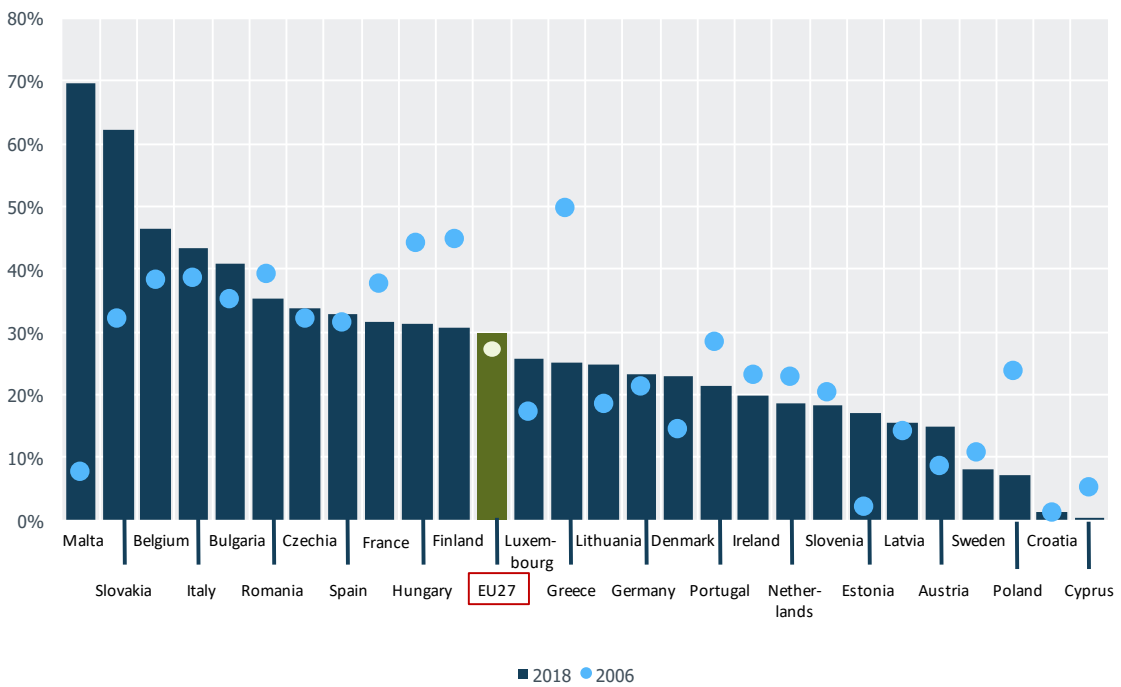
Source: 2021 PREDICT Dataset.

**Figure A. 44. Mean annual real growth rate of BERD in ICT sector, ICT manufacturing, ICT services and total BERD by EU27 Member State (2006-2018)**



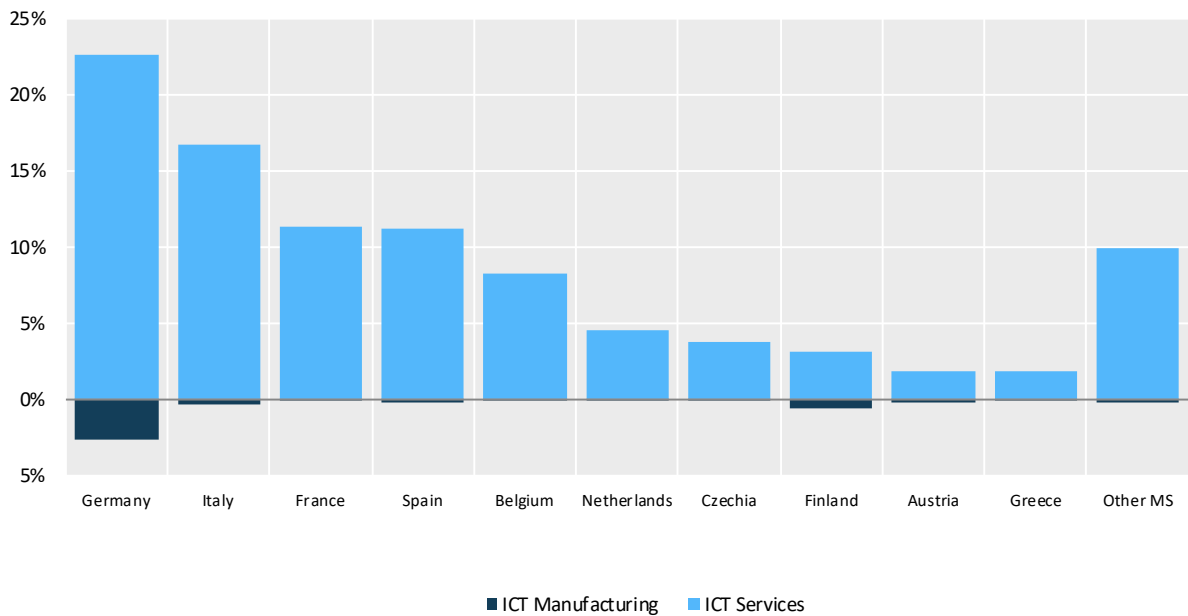
Note: 2006-2014 for Ireland.  
Source: 2021 PREDICT Dataset.

**Figure A. 45. ICT sector ICT GBARD share of total ICT GBARD by EU27 Member State (2006, 2019)**



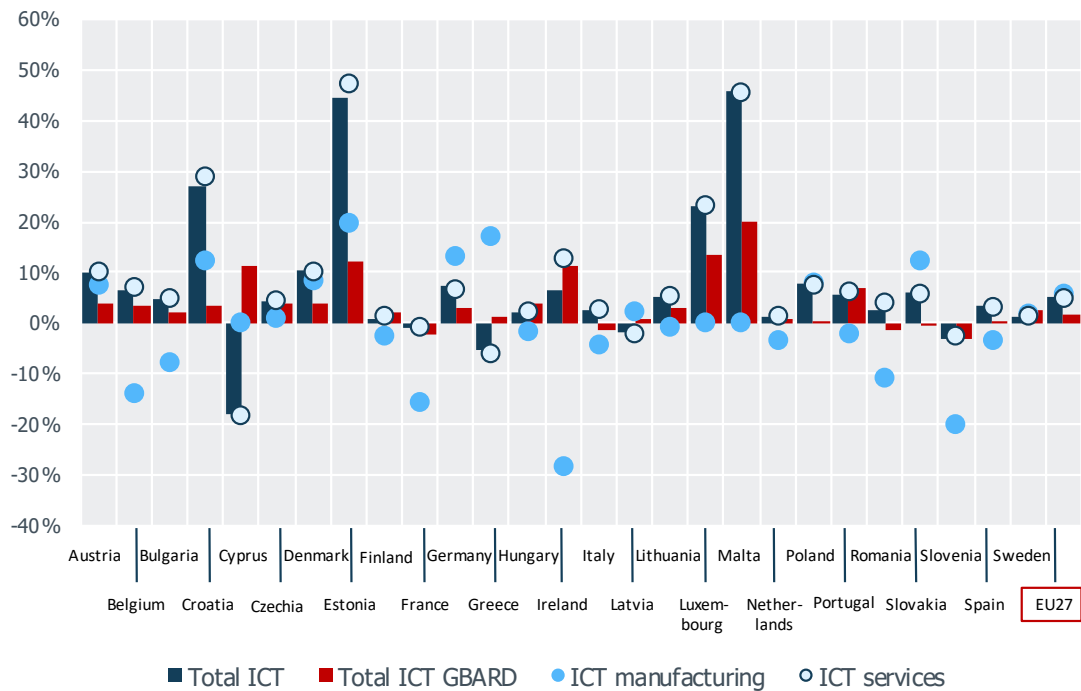
Note: 2008 is the first year available for Croatia.  
Source: 2021 PREDICT Dataset.

**Figure A. 46. ICT manufacturing and ICT services ICT GBARD in the ten largest Member States' contributors (percentages, 2019)**



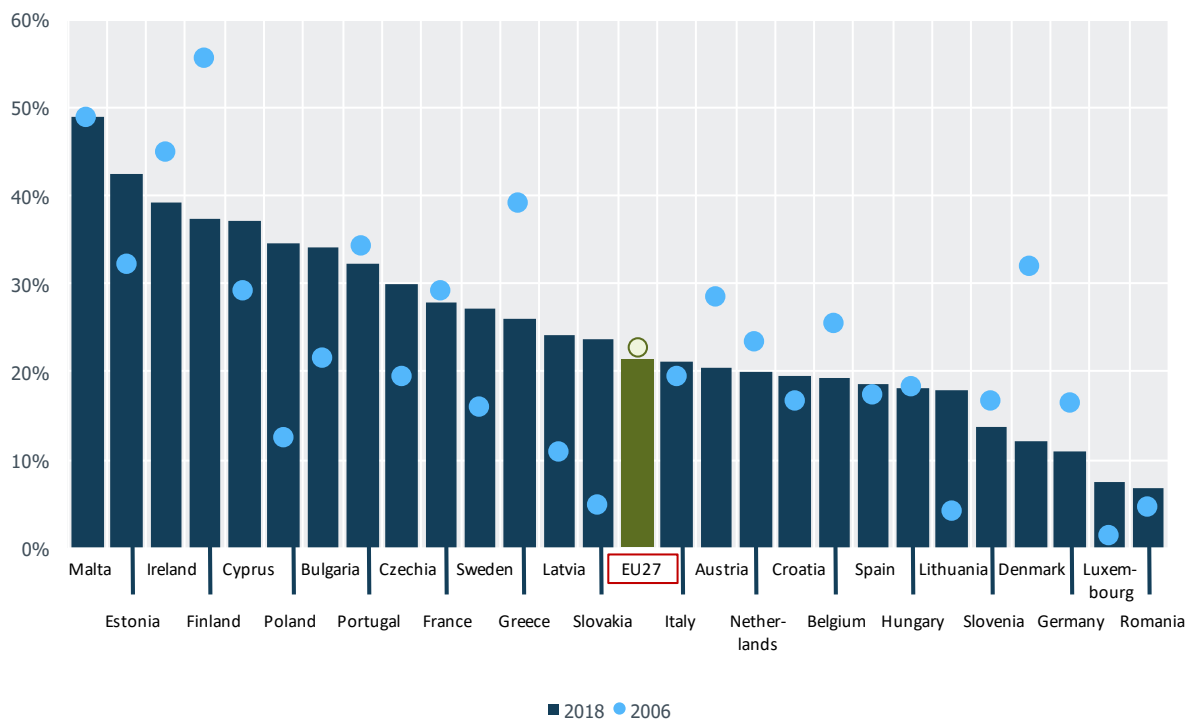
Source: 2021 PREDICT Dataset.

**Figure A. 47. Mean annual real growth rate of ICT GBARD in ICT sector, ICT manufacturing, ICT services and total economy by EU27 Member State (2006-2018)**



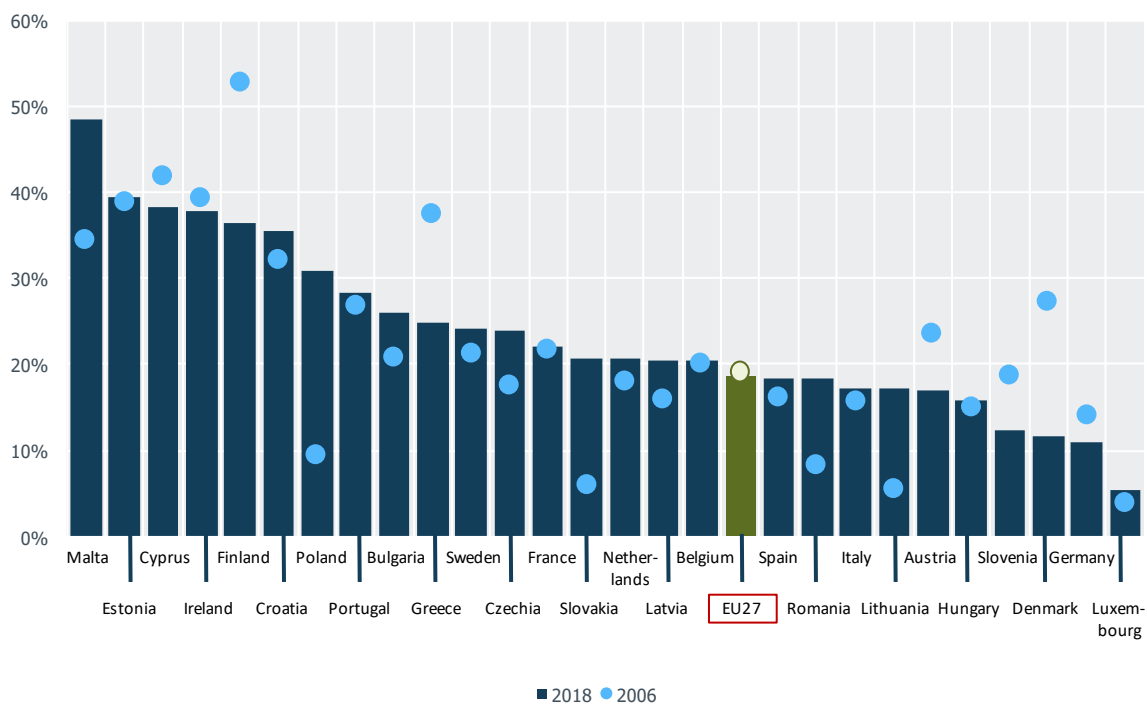
Note: 2006-2014 for Ireland and 2008-2018 for Croatia.  
Source: 2021 PREDICT Dataset.

**Figure A. 48. ICT sector RERD share of total RERD by EU27 Member State (2006, 2018)**



Source: 2021 PREDICT Dataset.

**Figure A. 49. ICT sector PERD share of total PERD by EU27 Member State (2006, 2018)**

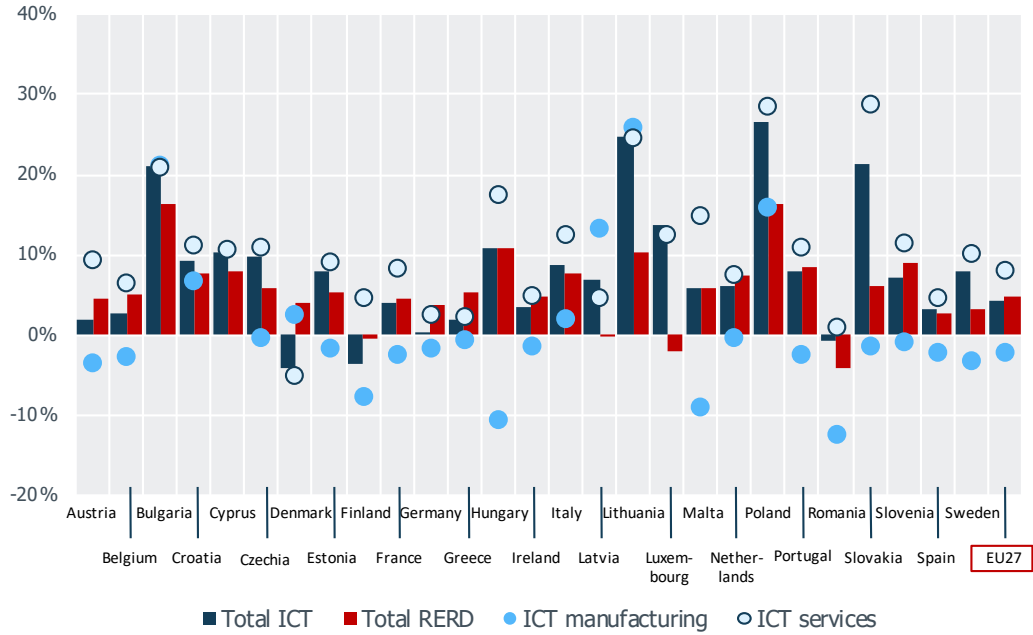


Source: 2021 PREDICT Dataset.

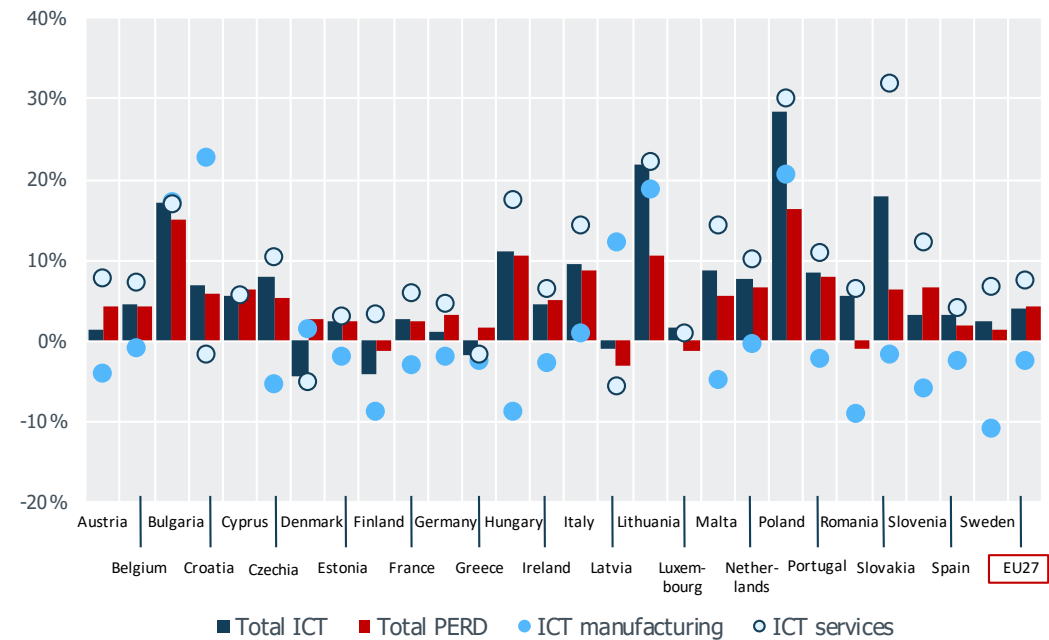


**Figure A. 50. Mean annual growth rate of RERD and PERD in ICT sector, ICT manufacturing, ICT services and total economy by EU27 Member State (2006-2018)**

a) RERD



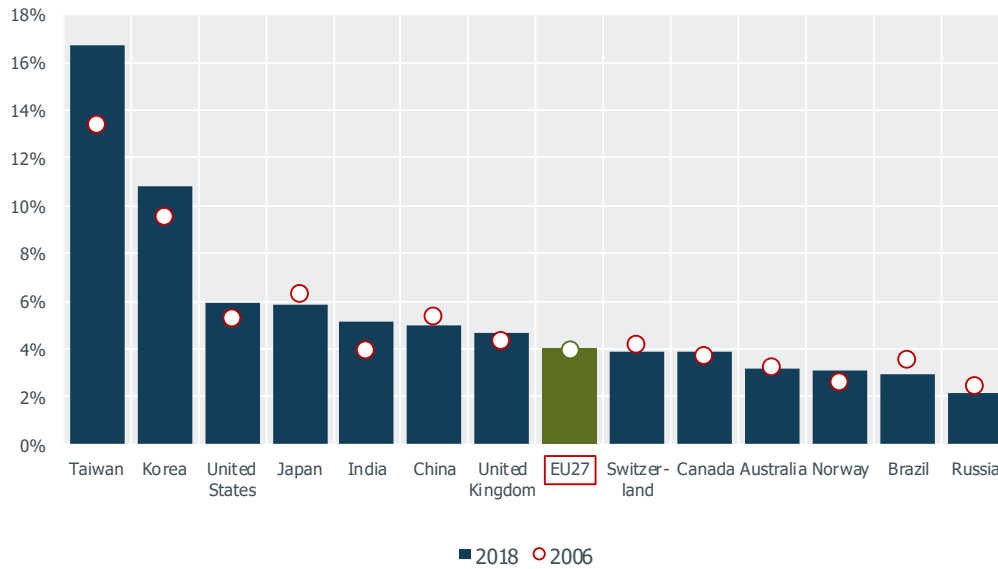
b) PERD



Source: 2021 PREDICT Dataset.

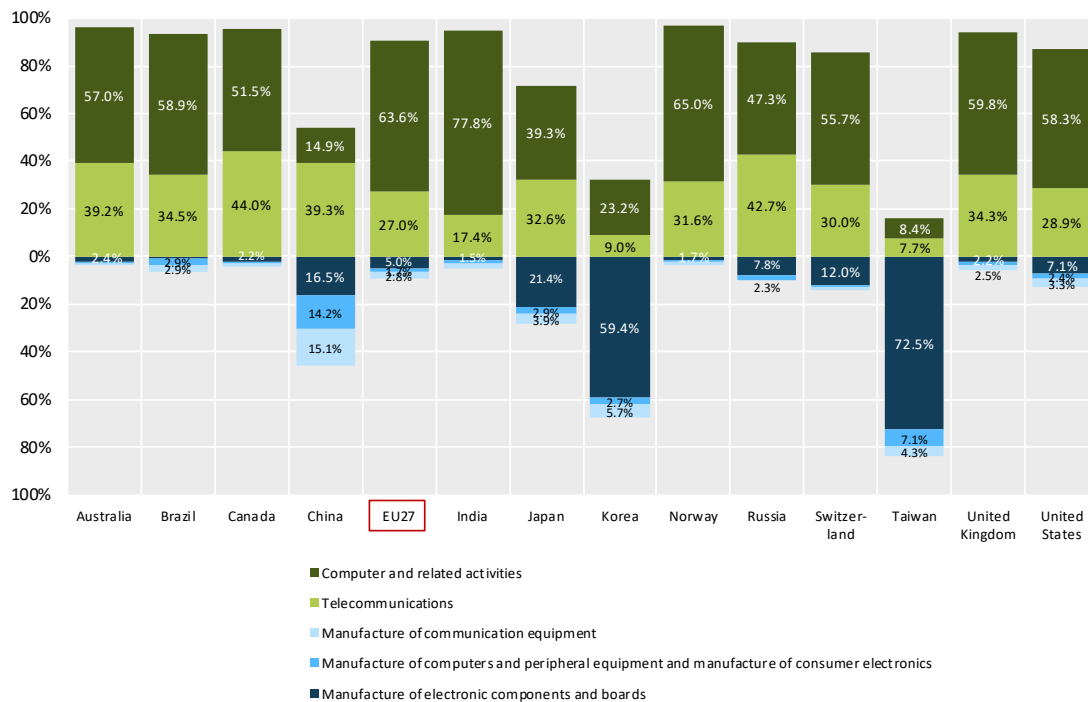
#### A.4. Comparison with other economies

**Figure A. 51. ICT sector VA share of GDP in the EU27 and other non-EU27 economies (2006, 2018)**



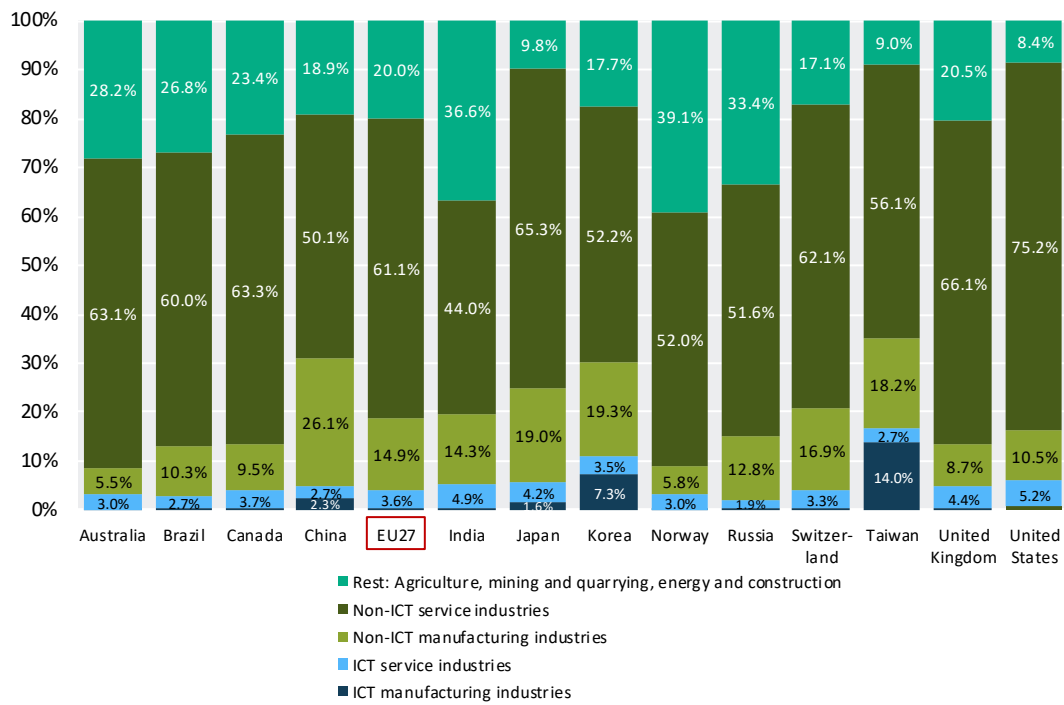
Note: 2017 for Canada.  
Source: 2021 PREDICT Dataset.

**Figure A. 52. ICT sector VA by sub-sectors in the EU27 and other non-EU27 economies (2018)**



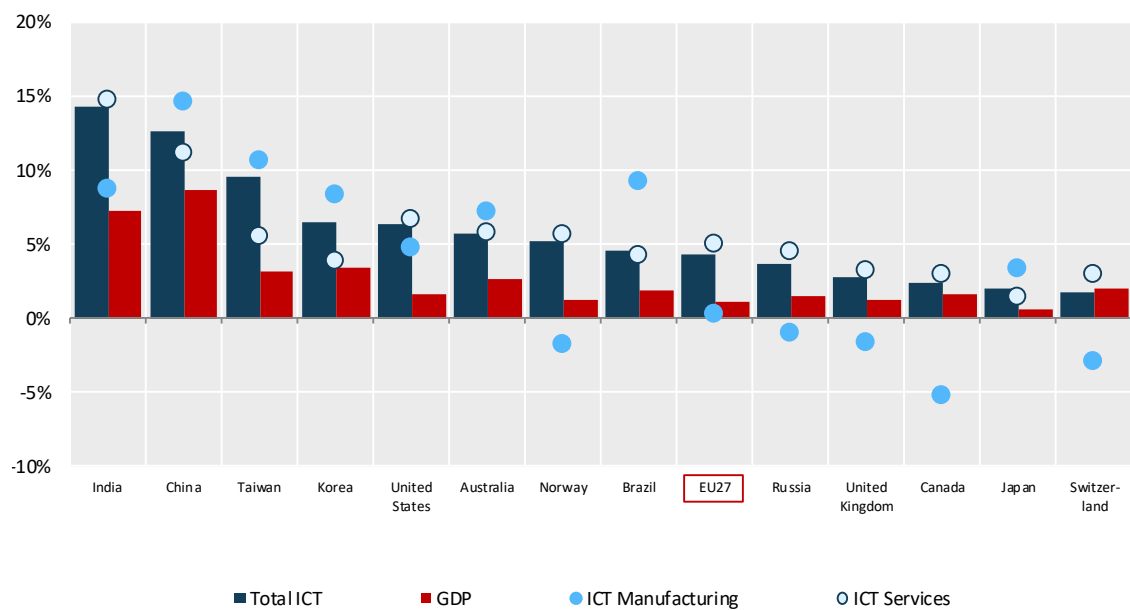
Note: 2017 for Canada.  
Source: 2021 PREDICT Dataset.

**Figure A. 53. ICT sector VA share of GDP and comparison with non-ICT economic activities. EU27 and other non-EU27 economies (2018)**



Note: 2017 for Canada. Non-ICT service industries include total Trade.  
Source: 2021 PREDICT Dataset.

**Figure A. 54. Mean annual real growth rate of ICT sector VA in the EU27 and other non-EU27 economies (2006-2018)**



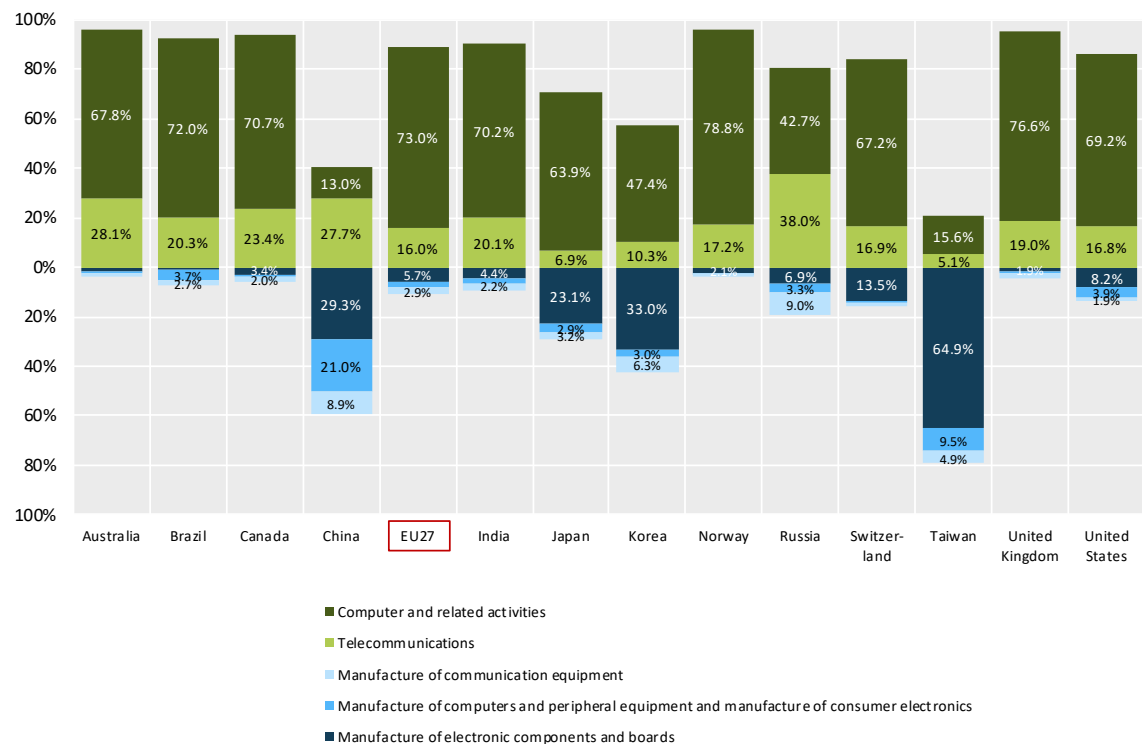
Note: 2006-2017 for Canada.  
Source: 2021 PREDICT Dataset.

**Figure A. 55. ICT sector employment share of total employment in the EU27 and other non-EU27 economies (2006, 2018)**



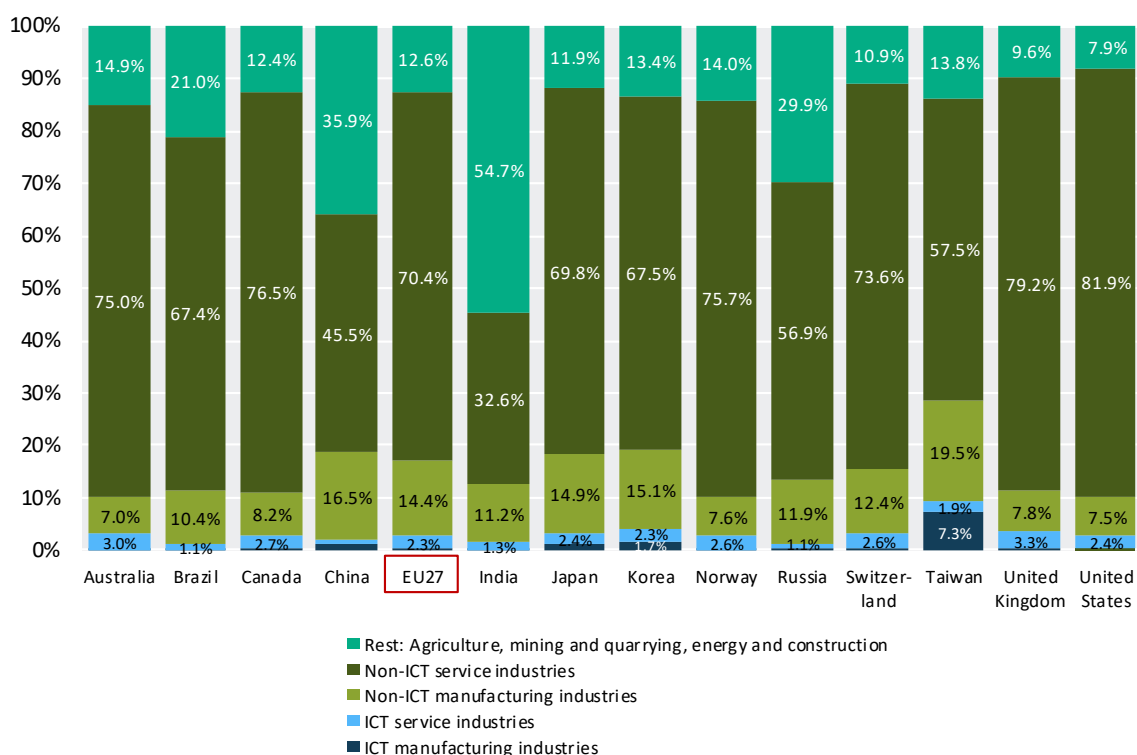
Note: 2006-2017 for India.  
Source: 2021 PREDICT Dataset.

**Figure A. 56. ICT sector employment by sub-sectors in the EU27 and other non-EU27 economies (2018)**



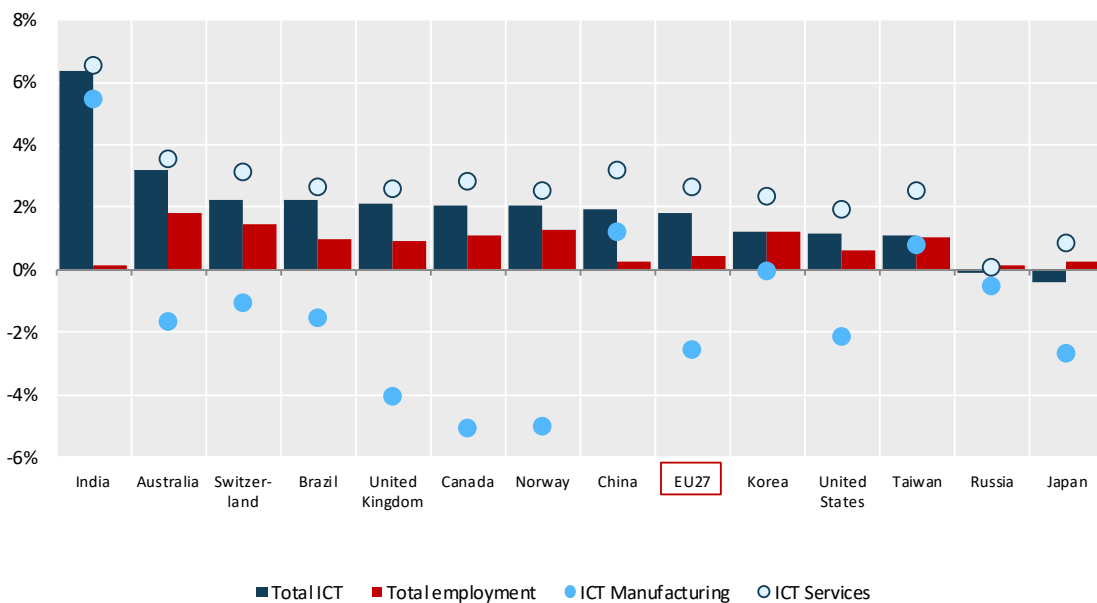
Note: 2017 for India.  
Source: 2021 PREDICT Dataset.

**Figure A. 57. ICT sector employment share of total employment and comparison with non-ICT economic activities. EU27 and other non-EU27 economies (2018)**



Note: Non-ICT service industries include total Trade. 2017 for India.  
Source: 2021 PREDICT Dataset

**Figure A. 58. Mean annual growth rate of ICT sector employment in the EU27 and other non-EU27 economies (2006-2018)**



Note: 2006-2017 for India.  
Source: 2021 PREDICT Dataset.

**Figure A. 59. ICT sector productivity per person employed ratio over total economy productivity in EU27 and other non-EU27 economies (2006, 2018)**



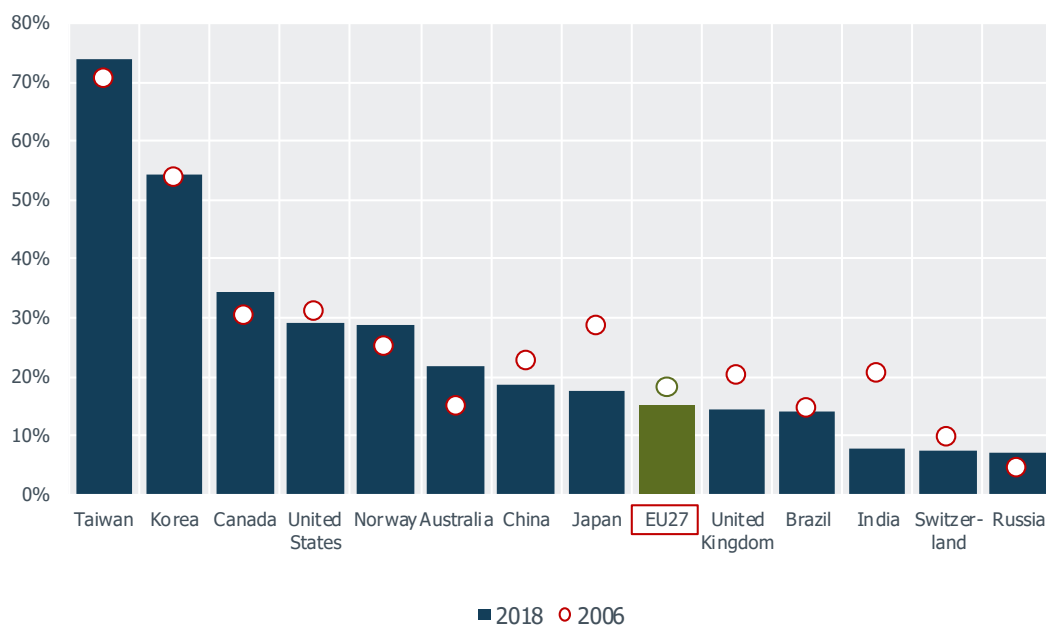
Note: 2017 for India and Canada.  
Source: 2021 PREDICT Dataset.

**Figure A. 60. ICT sector productivity per hour worked ratio over total economy productivity in EU27 and other non-EU27 economies (2006, 2018)**



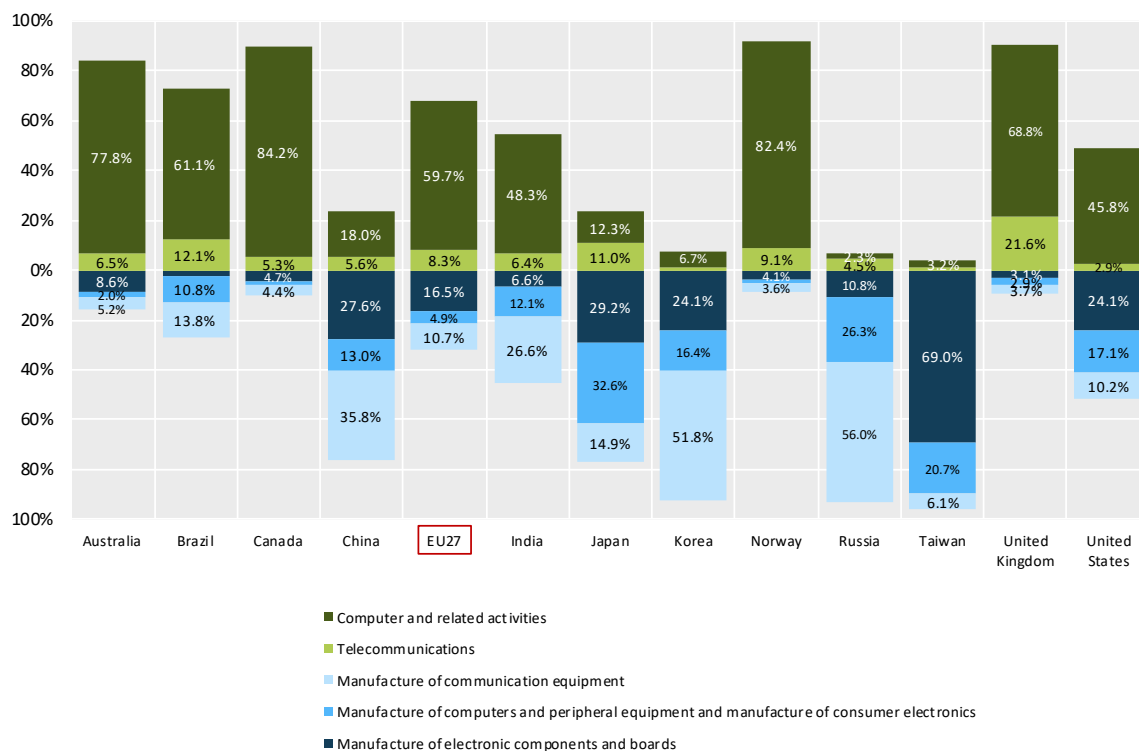
Note: 2017 for India and Canada.  
Source: 2021 PREDICT Dataset.

**Figure A. 61. ICT sector BERD share of total BERD in the EU27 and other non-EU27 economies (2006, 2018)**



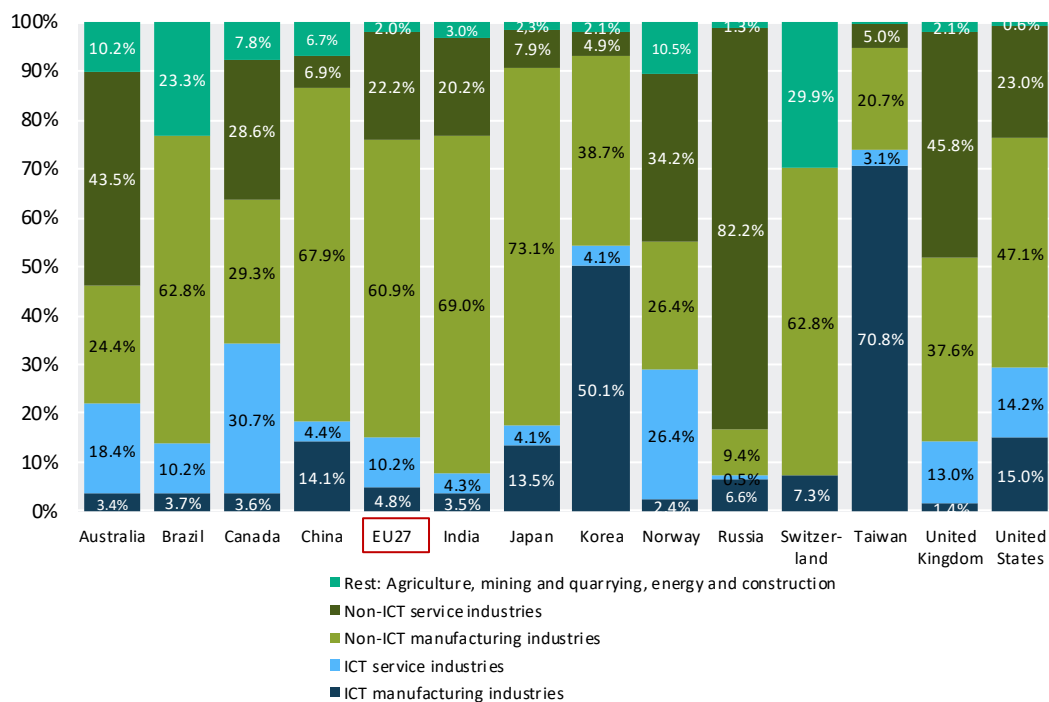
Note: 2008 is the first year available for Brazil and Switzerland. 2017 is the last year available for Brazil and Switzerland. ICT sector for Switzerland includes only ICT manufacturing.  
Source: 2021 PREDICT Dataset.

**Figure A. 62. ICT sector BERD by sub-sectors in the EU27 and other non-EU27 economies (2018)**



Note: 2017 for Brazil. ICT BERD for Switzerland not included because of lack of sub-sector data.  
Source: 2021 PREDICT Dataset.

**Figure A. 63. ICT sector BERD share of total BERD and comparison with non-ICT economic activities. EU27 and other non-EU27 economies (2018)**

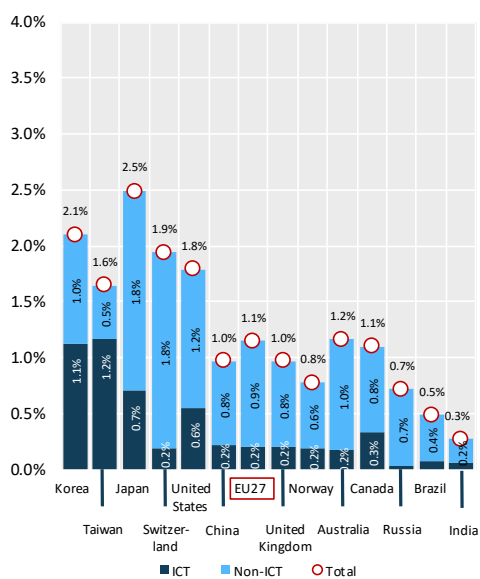


Note: 2017 for Brazil and Switzerland. Rest include non-ICT service industries for Brazil and service industries (ICT and non-ICT services) for Switzerland.

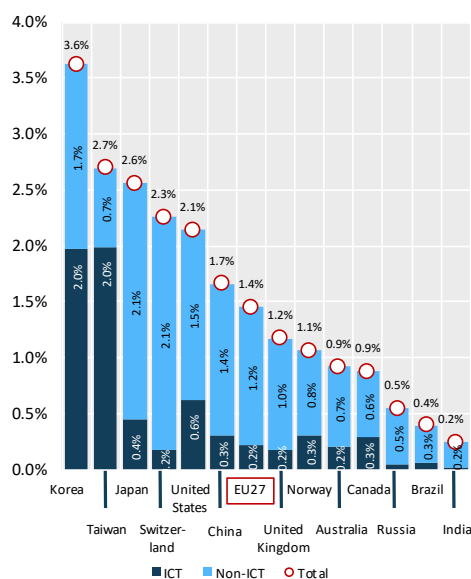
Source: 2021 PREDICT Dataset.

**Figure A. 64. Contribution of ICT and non-ICT BERD to total BERD intensity (BERD/GDP) in the EU27 and other non-EU27 economies (2006, 2018)**

a) 2006



b) 2018

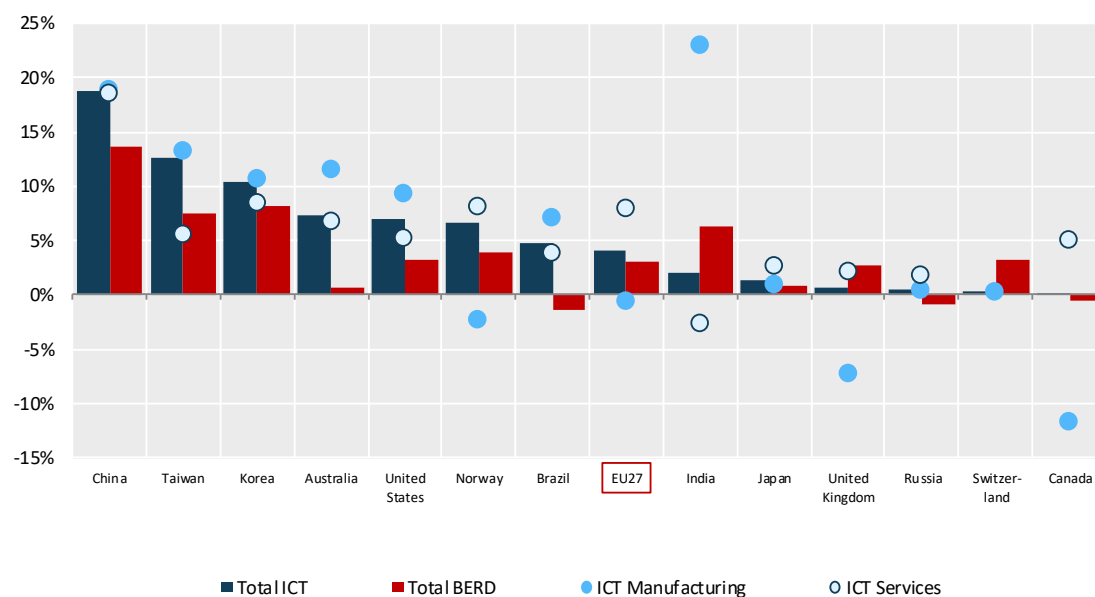


Note: 2008 is the first year available for Brazil and Switzerland. 2017 is the last year available for Brazil, Canada and Switzerland. ICT sector for Switzerland includes only ICT manufacturing.

Source: 2021 PREDICT Dataset.

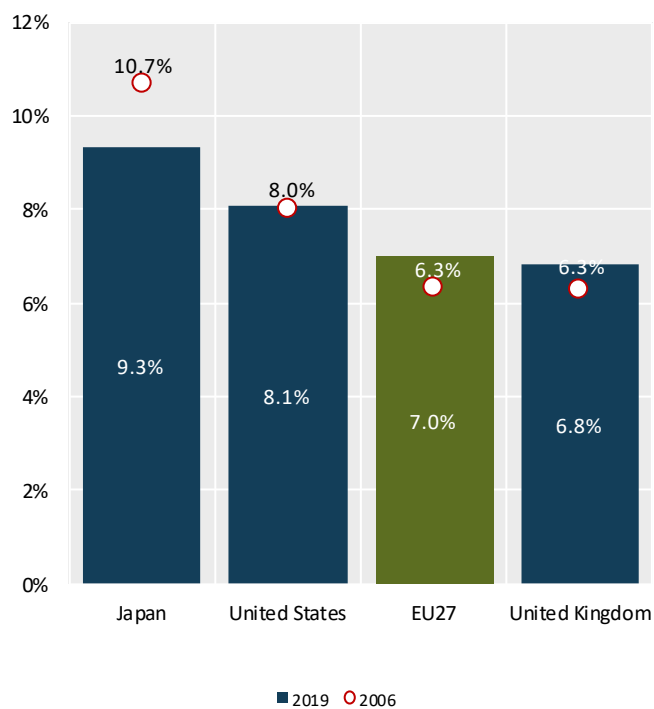


**Figure A. 65. Mean annual real growth rate of ICT sector BERD in the EU27 and other non-EU27 economies (2006-2018)**



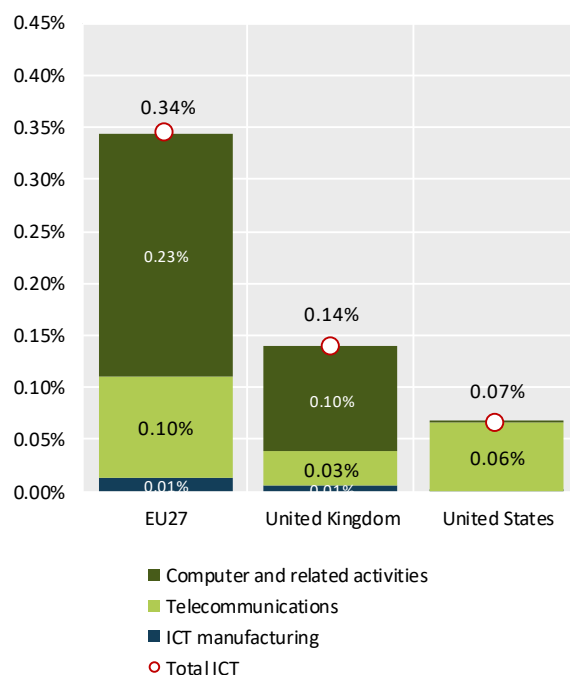
Note: 2008-2017 for Brazil and Switzerland, 2006-2017 for Canada. ICT sector for Switzerland includes only ICT manufacturing. Source: 2021 PREDICT Dataset.

**Figure A. 66. ICT GBARD share of total GBARD in the EU27 and other non-EU27 economies (2006, 2019)**



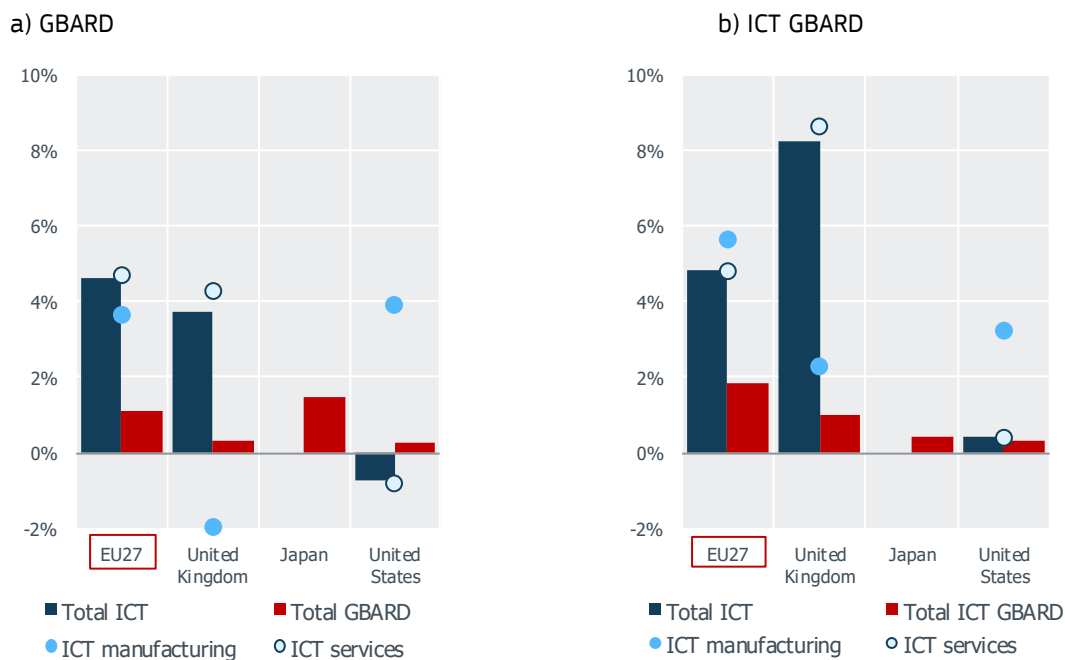
Note: Figures for Japan not fully homogeneous with EU27, the United Kingdom and the United States (see methodology). Source: 2021 PREDICT Dataset.

**Figure A. 67. Contribution of ICT sub-sectors to ICT sector ICT GBARD intensity in the EU27, the United Kingdom and the United States (2019)**



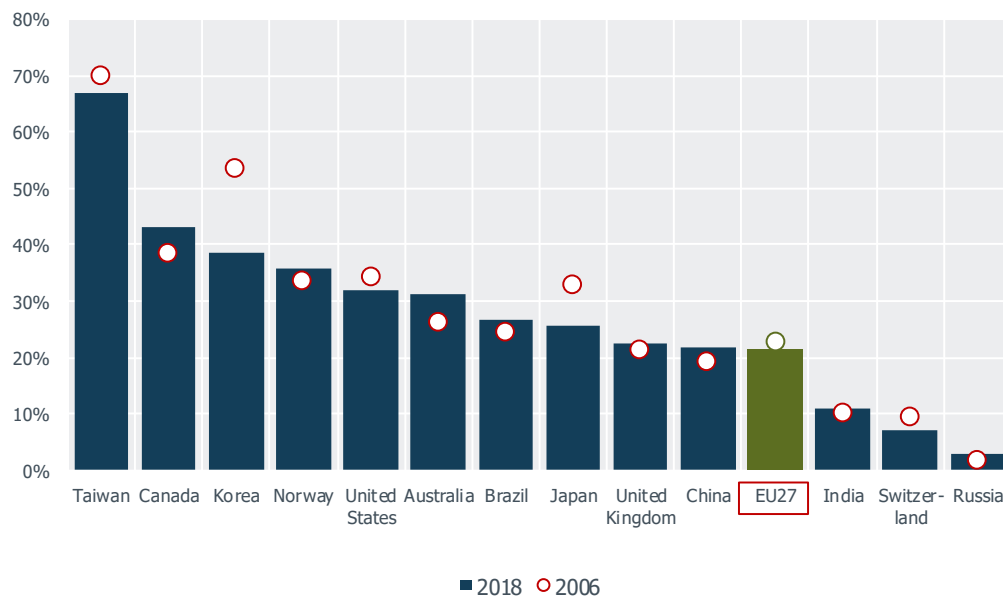
Note: ICT sector ICT GBARD for United States includes 268 NACE Rev.2 sector (Manufacture of magnetic and optical media). Source: 2021 PREDICT Dataset.

**Figure A. 68. Mean annual real growth rate of ICT sector GBARD and ICT GBARD in the EU27 and other non-EU27 economies (2006-2019)**



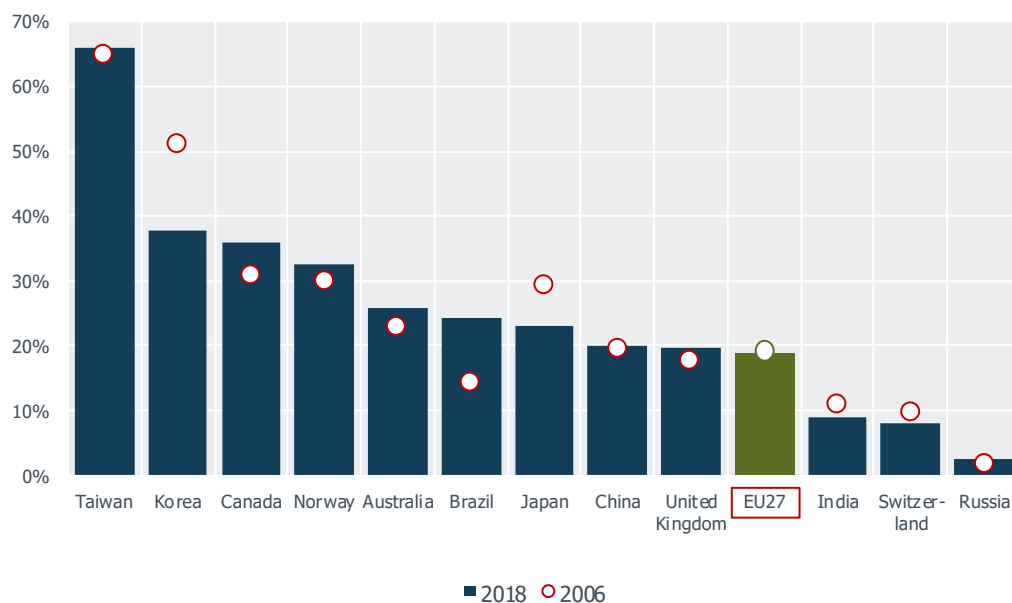
Note: ICT manufacturing for United States includes 268 NACE Rev.2 sector (Manufacture of magnetic and optical media). 2018 for the United Kingdom. Source: 2021 PREDICT Dataset.

**Figure A. 69. ICT sector RERD share of total RERD in the EU27 and other non-EU27 economies (2006, 2018)**



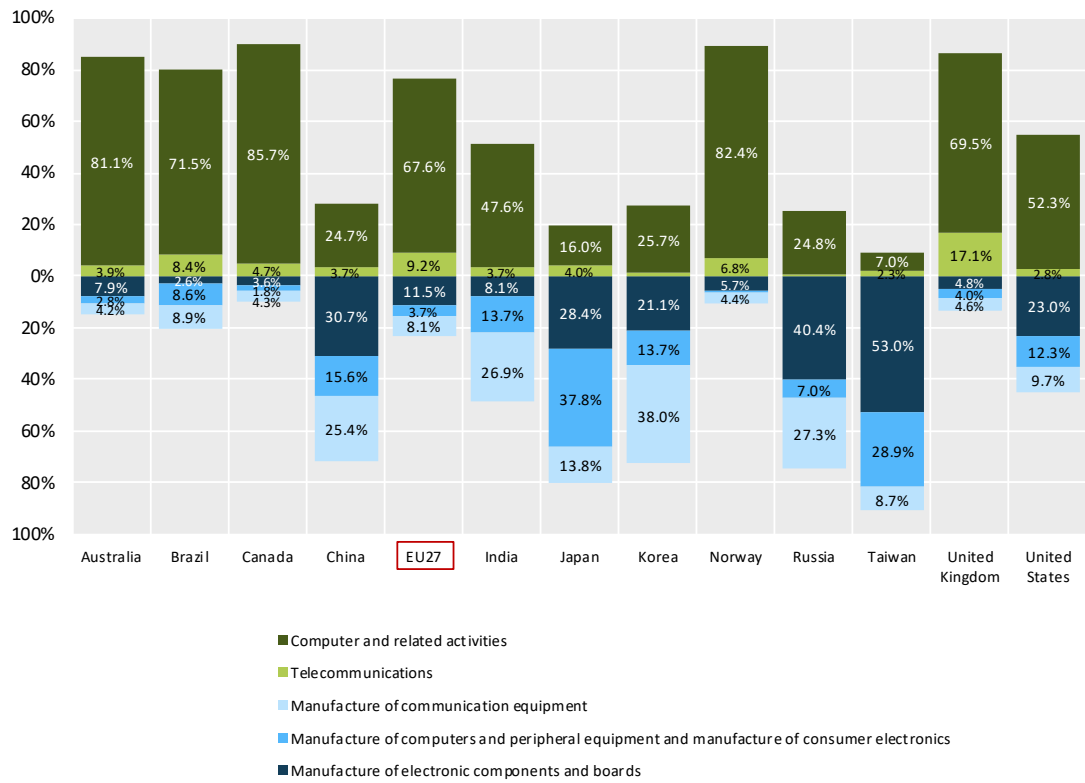
Note: 2008 is the first year available for Switzerland and 2011 for Brazil. 2017 is the last year available for Brazil and Switzerland. ICT sector for Switzerland includes only ICT manufacturing.  
Source: 2021 PREDICT Dataset.

**Figure A. 70. ICT sector PERD share of total PERD in the EU27 and other non-EU27 economies (2006, 2018)**



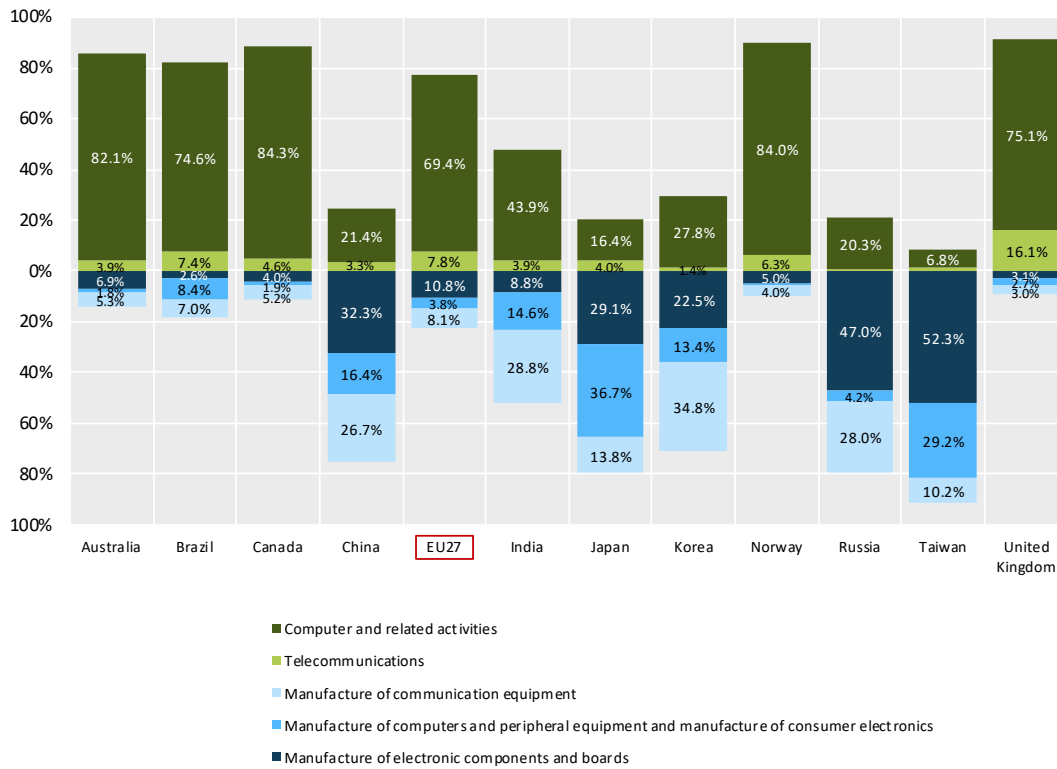
Note: 2008 is the first year available for Brazil and Switzerland. 2017 is the last year available for Brazil and Switzerland. ICT sector for United States not included because of lack of homogeneous data. ICT sector for Switzerland includes only ICT manufacturing.  
Source: 2021 PREDICT Dataset.

**Figure A. 71. ICT sector RERD by sub-sectors in the EU27 and other non-EU27 economies (2018)**



Note: 2017 for Brazil. ICT sector for Switzerland not included because of lack of sub-sector data.  
 Source: 2021 PREDICT Dataset.

**Figure A. 72. ICT sector PERD by sub-sectors in the EU27 and other non-EU27 economies (2018)**



Note: 2017 for Brazil. ICT sector for Switzerland not included because of lack of sub-sector data. ICT sector for United States not included because of lack of homogeneous data.

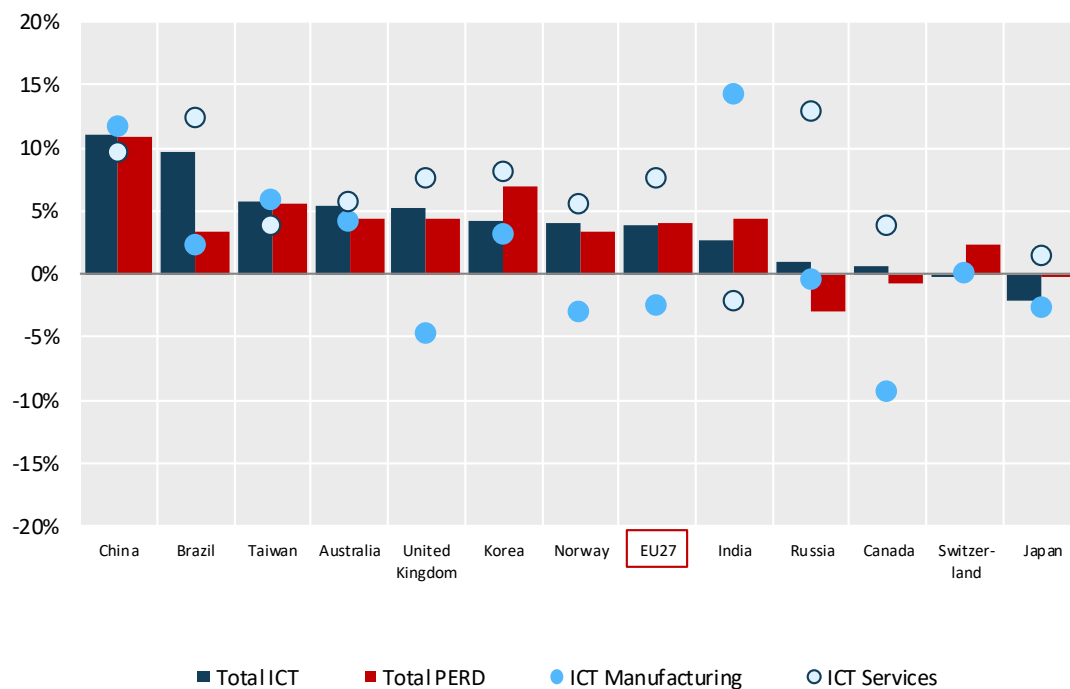
Source: 2021 PREDICT Dataset.

**Figure A. 73. Mean annual growth rate of ICT sector RERD in the EU27 and other non-EU27 economies (2006-2018)**



Note: 2011-2017 for Brazil and 2008-2017 for Switzerland. ICT sector for Switzerland includes only ICT manufacturing. Source: 2021 PREDICT Dataset.

**Figure A. 74. Mean annual growth rate of ICT sector PERD in the EU27 and other non-EU27 economies (2006-2018)**



Note: 2008-2017 for Brazil and Switzerland. ICT sector for Switzerland includes only ICT manufacturing. ICT sector for United States not included because of lack of homogeneous data. Source: 2021 PREDICT Dataset.



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