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The 2019 PREDICT Key Facts Report

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

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Title: The 2019 PREDICT Key Facts Report. An Analysis of ICT R&D in the EU and Beyond

Abstract

The 2019 PREDICT Key Facts Report provides a detailed analysis of the state of ICT R&D activities in the EU. This is the twelfth edition of a series that is published annually. As the previous editions, an online version is available at: <https://ec.europa.eu/jrc/en/predict>. The report covers the period between 1995 and 2016, providing a long-term analysis of the European Union (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 2016. Whenever possible, the report includes nowcasted data for 2017 and 2018. 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 MC and RS sectors; EU countries; the EU and the international context (including the most relevant countries in the world economy). The report is focused especially on the ICT R&D macroeconomic dynamics.

Keywords

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

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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 (ICT) industries and their R&D in Europe since 2006. The project covers major world competitors including 40 advanced and emerging countries – the EU28 plus Norway, Russia and Switzerland 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

ICT 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 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 the Digital Agenda for Europe in 2010 was identified as one of the seven pillars of the Europe 2020 Strategy for growth in the Union. In addition, the achievement of a Digital Single Market (DSM) has been one of the 10 political priorities of the Commission since 2015.

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 2017 and 2018, and time series go back to 1995.

Team

PREDICT is a collaboration between the 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 JRC and the Valencian Institute of Economic Research (Instituto Valenciano de Investigaciones Económicas - Ivie).

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Abstract

The 2019 PREDICT Key Facts Report provides a detailed analysis of the state of ICT R&D activities in the EU. This is the twelfth edition of a series that is published annually. As the previous editions, an online version is available at: <https://ec.europa.eu/jrc/en/predict>. The report covers the period between 1995 and 2016, providing a long-term analysis of the European Union (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 2016. Whenever possible, the report includes nowcasted data for 2017 and 2018. 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 MC and RS sectors; EU countries; the EU and the international context (including the most relevant countries in the world economy). The report is focused especially on the ICT R&D macroeconomic dynamics.

Keywords

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

Introduction

The 2019 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)¹. The 2019 PREDICT Report covers the period between 1995 and 2016. 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 2016. Whenever possible, the Report includes nowcasted data for 2017 and 2018. The EU aggregate (EU28) in the PREDICT Dataset and Report refers, for the whole period, to the aggregate of the 28 countries of the current configuration, regardless of the legal status of the 28 countries as Member State of the EU in the corresponding year. This is implemented in order to allow a comparison of the same aggregate over time.

The report is organized as follows. The *Executive Summary* offers, in a very synthetic way, the diagnosis of the EU ICT sector and its R&D. Then, the main body of the report presents a selection of figures and tables followed by short comments summarizing the main findings. The report is structured in three sections. Section 1 focuses on the analysis of the EU ICT sector and presents the evolution of the EU ICT sector, including its R&D expenditure since 1995. In Section 2, the ICT sector and sub-sectors of EU Member States are compared, starting from 2006. In Section 3, the analysis is extended to non-EU countries, therefore considering the position of 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 per person and per hour 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 expenditure in any industry of the economy (see Box 1). Throughout the report the term *billion* refers to one thousand million.

PREDICT analyses follow the OECD definition of the ICT sector (OECD, 2007), which is based on the Statistical Classification of Economic Activities in the European Community (NACE) Rev. 2². This definition of the ICT sector was adopted in 2006, and since 2008 all EU Member States have been required to refer to it when reporting ICT sector data. Regarding the *Media and Content* sector³ (MC), which has been included in the report because of its relevance and its increasing inter-relation with the ICT sector, PREDICT also follows the OECD definition (OECD, 2011). The 2019 edition of the PREDICT Key Facts Report is based on the Operational definition, shown in Box 2. The latter 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 allows the comparison of data over a long-term period and also with non-EU countries. This 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). In the 2019 PREDICT Dataset, information according to the more comprehensive OECD definition is also available for the EU and its Member States.

¹ This Key Facts Report mainly uses the information included in the PREDICT 2019 Dataset. However, some additional information is needed, i.e. Value added, Employment, BERD, RERD and PERD for the European Union aggregate, in the years not covered by the routine data collection and not nowcasted for the whole EU. This additional information is taken from Eurostat and AMECO (European Commission).

² The period covered in the PREDICT Dataset 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 J., Turlea G. and Desruelle (2012).

³ The Media and content industries are those "engaged in the production, publishing and/or the electronic distribution of content products", OECD (2011).

Box 1. Definition of GBARD and ICT GBARD

GBARD and ICT GBARD
<p>GBARD (Government budget allocations for R&D) is -according to the 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.</p> <p>ICT sector GBARD is the part of total GBARD assigned to ICT producing industries.</p> <p>ICT GBARD is the part of GBARD devoted to fund ICT-related expenditure in any industry of the economy, not only those belonging to the ICT producing sector.</p> <p>ICT sector ICT GBARD is the part of ICT GBARD assigned to ICT producing industries.</p>

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

Nace Rev. 2	Description
261-264, 582, 61, 62, 631, 951	ICT total (operational)
261-264	ICT manufacturing industries ((operational)
261	Manufacture of electronic components and boards
262	Manufacture of computers and peripheral equipment
263	Manufacture of communication equipment
264	Manufacture of consumer electronics
582, 61, 62, 631, 951	ICT services industries
61	Telecommunications
582, 62, 631, 951	Computer and related activities

This report considers data for different levels of sectoral disaggregation. The total economy and the following sectors are considered: *ICT, Media and content, and Retail sale via mail order houses or via Internet (RS)*. 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 service 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 economic landscape).

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? Which is its role in the creation of employment? Is ICT manufacturing still the key sector for R&D expenditure? 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?*

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. The Annex is organized in four Sub-Sections. Sub-Section 4.1 refers to the ICT

sector and its R&D in the EU. Sub-Section 4.2 provides an analysis of the EU ICT sub-sectors. Sub-Section 4.3 offers the information by EU Member State. Sub-Section 4.4 addresses the comparison with other non-EU economies. Details regarding the development of the 2019 PREDICT Dataset are contained in the 2019 PREDICT Dataset Methodology.

Executive Summary

New ICTs have transformed the production process of many existing economic sectors, in particular by facilitating the diffusion of robotisation and automation. These technologies, which underpin the digital transformation of the economy and society, have led to the development of entire new processes of production and retail, hence determining new competitive power in the knowledge economy. New sectors have been born and many have adapted. Moreover, their role in the phenomenon of globalization and in the fragmentation of production processes in different stages (the so called global value chains) is crucial.

ICT is a key sector in changing businesses organizations and in enabling innovations in many techno-economic domains. In addition, its impact on people's everyday life is pervasive. The relevance of this sector has been recognized at the EU policy intervention level. The Digital Agenda for Europe in 2010, in the perspective of maximising its social and economic potential, identified the development of ICT as one of the seven pillars of the Europe 2020 Strategy for growth in the Union. In addition, the achievement of a Digital Single Market (DSM) has been one of the 10 political priorities of the Commission since 2015. Moreover, in the Commission 2017 reflection paper on "Harnessing globalisation", digitalisation is considered as one of the main drivers.

In order to provide a 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 closely related sectors: *Media and content* and *Retail sale via mail order houses or via Internet*. The results presented below are set out according to the three sections in which the main body of the report is structured.

Analysis of the EU ICT Sector

In 2016 the EU ICT sector had a VA of 591 billion euros, employed 6 million people and spent 31 billion euros on Business expenditure on R&D. In percentage terms, the **ICT sector represented 4.0% of the EU value added, 2.6% of total employment, 15.6% of total BERD, and 18.2% and 20.4% of the R&D personnel and researchers** in the EU, respectively.

The ICT producing sector is one of the most dynamic sectors in the economy, standing out for its high R&D intensity and for a Productivity that is higher than that of the whole economy. From 1995 until 2016, the EU ICT sector multiplied its VA in real terms by a factor of 3.6, while the one of the total economy increased by 1.4. The growth of employment was much more moderate: the number of persons employed in ICT in 2016 is 1.5 times the number of persons employed in the same sector in 1995. According to PREDICT estimates, both variables continued to grow in 2017 and 2018. The labour productivity in the ICT sector (both in terms of per person and per hour worked) grew much faster than labour productivity in the total economy. The value reached in 2016 is 2.5 times the value of 1995 and, according to the estimations elaborated in this project, the same trend is maintained also in 2017 and 2018. Business expenditure in R&D in the ICT sector presents a behaviour that is more dynamic than the one of the total economy. From 1995 to 2016, its value is multiplied by a factor of 3.7, and estimated values indicate this trend has continued in 2017 and in 2018. In the same period, the BERD of the total economy only grew 1.8 times. On the other hand, BERD intensity (measured as the BERD/GDP ratio in nominal terms) presents a decrease in the period 1995-2016 and the PREDICT estimations reveal the same trend also for the two following years. 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 almost 2 since 1995, but not the number of R&D personnel which increased, 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, ICT GBARD, in the ICT sector grew by 4.0% annually in nominal terms between 2006 and 2017, whereas ICT GBARD in the total economy only grew at an annual rate of 2.6% (in nominal terms).

The more dynamic behaviour of the ICT sector in the EU is **mostly due to the ICT services sector**. ICT manufactures experienced a sharp contraction from the beginning of the economic crisis, in 2007, in VA and BERD. In the ICT manufacturing sector, employment almost halved in the period 1995-2018. Number of R&D researchers and R&D personnel also experienced a reduction albeit not as strong. On the opposite, RERD and PERD showed a fast growth in the ICT services sector. The current value of RERD in the ICT service equals 4.7 times the value of 1995, and the value of PERD in 2016 is almost 5 times its value in 1995. In general, ICT sector employment increased along the 1995-2018 period thanks to the positive contribution of the ICT service sector. The combined trends of VA and employment produced a higher growth rate of ICT manufactures labour productivity than what observed in ICT service sectors.

As introduced before, the PREDICT Key Facts Report provides information for the period 2006 onwards for two additional sectors which are not included within the OECD definition of the ICT sector, but which are closely related to it. These are: *Media and content sector* and *Retail sale via mail order houses or via Internet*.

In 2016, the ICT service sector represented the 3.6% of GDP, and ICT manufacturing represented 0.3% of GDP. In the same year, the MC sector has a share of almost 1% of GDP, therefore higher than what observed for ICT manufacturing. However, the MC sector has been showing a declining trend since 2006. The share of the RS sector is much lower, i.e. 0.15%, but with a slightly increasing trend. According to PREDICT's nowcast for 2017 and 2018, the ICT services sub-sector confirms its weight in the economic landscape, while ICT manufacturing and MC decrease, and RS stagnates. Similar trends are observable also in relation to the employment. Labour productivity is higher than the total economy average in all ICT sectors, apart from RS, and all of them show a declining trend. The BERD presents an interesting evolution in the ICT sub-sectors. In the two years preceding the economic crisis, 2006 and 2007, the ICT manufacturing sector had a share (10%) of total BERD higher than the one of ICT services (8.6%). Since the beginning of the crisis, ICT manufacturing has followed a continuous declining path, while ICT service sector has shown an increase. Regarding the two additional sectors, MC's share of total BERD is practically negligible (0.6% in 2016) while RS has a higher share (2.3% in 2016). These considerations can also be extended for what observed about RERD and PERD.

GBARD over GDP in the ICT sector remained almost constant (between 0.025% and 0.030%) along the period 2006-2016, while GBARD over GDP of the total economy showed a trend more influenced by the crisis, decreasing from 0.74% in 2009, to 0.63% in 2016. **Regarding ICT GBARD over GDP, it increased slightly in both the ICT sector and the total economy along the same period**. However, in the case of the total economy, after reaching a peak in 2009, both GBARD and ICT GBARD ratios over GDP showed a declining trend up to 2017. When considering ICT sub-sectors, it is observed that GBARD/VA is a bit higher for ICT manufacturing than for ICT services (0.71% and 0.64% respectively in 2017), but only in recent years. Both present a value larger than the one of the MC sector. However, ICT GBARD/VA is much higher in the ICT service sector than in ICT manufacturing and MC for all studied years. The RS sector does not receive a significant amount of public funding for its R&D.

In 2016, in terms of **VA, employment, GBARD and ICT GBARD**, the sub-sectors presenting the highest shares over the total economy are two ICT services sub-sectors (**Computer and related activities** and **Telecommunications**) and the **MC sector**. In terms of **BERD, RERD and PERD**, the services sub-sector **Computer and related activities** is always the one showing, by far, the highest share. Regarding **labour productivity** in 2016, the **Telecommunications** services sub-sector presents the highest ratio with respect to total economy productivity, around 2.5 times higher. On the

other hand, the RS sector presents the lowest ratio (around 0.7 times the one in the total economy). In 2016, **Manufacture of communications equipment** has the highest **BERD intensity**, and **Manufacture of computers**, the highest **GBARD** and **ICT GBARD intensities** (despite corresponding values in 2006 were much lower). Finally, **Computer and related activities** in 2016 presents the highest **ratio of ICT GBARD over GBARD**.

The ICT sector in the EU Member States

In 2016, the **EU countries** presenting the **largest ICT sectors in relative size** (ICT sector VA / GDP) were **Ireland, Malta, Sweden, Finland, Hungary and Romania**, all above 5.0%. Regarding employment, the EU countries presenting the largest values in relative terms were Malta, Estonia, Hungary, Ireland, Finland and Luxembourg, with a share over total employment higher than 3.6%. On the other hand, Finland was the country with the highest ICT sector BERD intensity in 2016 (12.8% of total value added), followed by Austria, Denmark, Sweden, France and Belgium (all above 7%).

In the **2006-2016** period, the **ICT sector** had a **positive VA growth in all countries of the EU** (with the only exceptions of Greece and Finland), with the highest growth rates showed by Bulgaria, Poland and Denmark (all above 7%). Regarding the growth of employment, Finland, Greece, Italy and Ireland are the countries presenting negative values, meaning that employment in ICT has decreased. On the opposite, the countries presenting the most positive growth are three eastern countries (Estonia, Bulgaria and Latvia) and Luxembourg.

In the same period, **Denmark, Ireland and Poland** were the EU countries with the **highest growth rate in labour productivity**. **Poland and Slovakia** presented the **highest growth rates of BERD**. Regarding RERD and PERD, Lithuania, Poland and Bulgaria stand out. The countries with largest increases in GBARD and ICT GBARD were Malta (only in GBARD), Estonia, Croatia (only in ICT GBARD) and Luxembourg.

BERD intensity (BERD/GDP) in the ICT sector is **very high in Finland** (especially in the ICT manufacturing sector) and **Sweden**, and comparatively low in Croatia, Latvia, Luxembourg, Lithuania, and Slovakia. ICT sector BERD intensity (measured as ICT sector BERD/ICT sector VA) is very high in Finland (the only country with more than 10%), followed by Austria, Denmark and Sweden. The countries with the **highest values of public funding of R&D (GBARD) in the ICT sector over VA** are **Belgium, Italy, Germany and Finland**. Finally, the weight of ICT GBARD over total GBARD is especially high in Cyprus (almost 27%), followed by Ireland, Latvia, Finland and Sweden (all above 12.5%).

The EU ICT sector in the international context

In the considered international landscape, namely the EU as a whole together with 12 non-EU countries⁴, **Taiwan** is the country in which the **ICT sector has the highest share over the total economy (16%)**. In addition, also in the other variables considered, Taiwan always presents the largest shares, especially for ICT manufacturing. In the **second position**, in all variables, it is possible to observe **South Korea**. The third position is claimed by **Japan** in VA and employment, **United States** and **Norway** in BERD, and by **Norway** and **Canada** in RERD and PERD. The position of the EU depends on the selected variable. **In VA, the EU occupies the 8th position**, behind India, China and Switzerland; and **in BERD it is 9th**, behind China (7th) but not India (10th). In terms of RERD and PERD, the shares of the ICT sector in the EU are only slightly higher than in these two countries. For most variables (VA, employment, BERD and RERD), the US presents higher ICT sector shares than those of the EU. Nevertheless, both the shares of ICT sector GBARD over total GBARD and of ICT sector ICT GBARD over total ICT GBARD are higher in the EU than in the US.

⁴ Australia, Brazil, Canada, China, India, Japan, Norway, Russia, South Korea, Switzerland, Taiwan and United States.

The country with the largest labour productivity per hour worked in the ICT sector, ICT manufacturing and ICT services is the US, followed by Norway, Taiwan, and the EU. The lowest per hour productivity level is observable in China 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 (4 times higher). China, Brazil and South Korea follow. For the EU, the same ratio is slightly lower than the one of the US (1.43 for the EU and 1.57 for the US), meaning that in the EU the gap between ICT sector productivity and total productivity is lower.

India and China are the countries showing in almost all variables **the most dynamic behaviour during the 2006-2016 period**. In particular, they present the largest growth rates in VA. In terms of employment, India shows the largest growth, followed by Australia, China and Brazil. In labour productivity (per hour worked) Taiwan stands out, followed by China, India, South Korea and Russia. China had also the most dynamic behaviour in BERD, while India in RERD. In PERD, Brazil is the country showing the largest increase. Compared with those of Asian countries, the ICT sector of the EU and the US have shown modest growth rates in all dimensions. Only in the two variables related to GBARD (GBARD and ICT GBARD) in ICT, the EU has been more dynamic than the US. Despite the EU has been more dynamic in comparison with the US, it has not been enough high enough to achieve the objective established in the Digital Agenda strategy.

BERD intensity (BERD/GDP) for the whole economy is higher in the Asian countries and in the US than in the EU. South Korea, Japan and Taiwan present the highest ratios. In South Korea and Taiwan, the ICT manufacturing sub-sector is the one with highest BERD intensity, when compared to ICT services or the rest of the economy (non-ICT), while in Japan and in the US it is the non-ICT sector the one with the highest BERD intensity. Total BERD intensity is higher in China than in the EU. When BERD intensity is defined at sector level, as ICT sector BERD/ ICT sector VA, South Korea has the highest ratio for the ICT sector, followed by the US, Taiwan, Norway and Japan. The EU occupies the eighth position, with a BERD intensity lower than in China.

The distinction by ICT sub-sectors makes possible to confirm that the **strength of Taiwan and South Korea** relies on **Manufactures of electronic components**. Additionally, **the ICT sectors in Japan, China and Russia are concentrated in manufactures in the majority of variables**. For the rest of countries, including the **EU and the US**, the sub-sector with **the highest share in almost all variables** is the services sub-sector **Computer and related activities**. GBARD and ICT GBARD in the EU ICT sector are concentrated in the ICT service sector, especially in *Computer and related activities*. In the US, public funding in the ICT sector is concentrated exclusively in *Telecommunications*. Labour productivity per employed person in the US is higher than in the EU for all sub-sectors considered. Additionally, the gap has increased in all sub-sectors between 2006 and 2016.

The evidence presented here confirms that the centre of gravity of ICT is moving towards East. China and India have been showing a very dynamic behaviour in all variables in the 2006-2016 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 all R&D related variables indicate that China wants to play a prominent role in the world economy. Up to now the US still is the leading country in the world. **The EU is not improving its overall position in the international context, while showing a clearly less dynamic behaviour than most of the Asian countries**, among which China (due to the size of its economy) is already threatening a leading position in the international context. The results presented here call for a reflection on the current and future relative position of the EU ICT sector in the international landscape.

1 The EU ICT sector

In 2016 the EU ICT sector had a VA of 591 billion euros, employed 6.0 million people and spent 31 billion euros on R&D business expenditures. The ICT sector represented 4.0% of the EU value added in 2016, 2.6% of the employment, 15.6% of total BERD, 18.2% of the R&D personnel and 20.4% of the researchers (see Table 1). In general, the ICT sector in 2016 was more dynamic than the whole EU economy, growing at a higher rate: value added increased in the ICT sector by 4.7%, employment by 1.8% and BERD by 4.0%. The ICT GBARD in the EU was 6.5 billion euros, which represented 6.9% of total public funding in R&D (total GBARD) and 0.04% of total GDP.

Table 1: Summary table of ICT indicators by sub-sector. Operational definition. EU

a) 2016

NACE Rev. 2	Description	VA	Employment	BERD	GBARD	ICT GBARD	RERD	PERD
		(Millions of current EUR)	(thousand persons employed)	(Millions of current EUR)	(Millions of current EUR)	(Millions of current EUR)	(thousand full-time equivalent)	(thousand full-time equivalent)
261-264	ICT manufacturing industries	51,213.6	623.5	10,883.6	335.6	72.3	56.7	77.9
261	Manufacture of electronic components and boards	27,141.8	319.6	4,870.2	153.1	16.6	22.8	32.5
262	Manufacture of computers and peripheral equipment	5,756.7	82.7	1,159.7	62.3	26.1	6.6	9.5
263	Manufacture of communication equipment	14,010.1	156.5	4,429.0	99.1	26.4	24.7	32.0
264	Manufacture of consumer electronics	4,305.0	64.6	424.8	20.9	3.3	2.6	3.8
582, 61, 62, 631, 951	ICT services industries	540,185.4	5,385.7	20,124.6	3,438.5	1,770.2	137.7	224.2
61	Telecommunications	176,057.0	1,103.8	3,735.0	1,566.9	489.5	20.0	30.9
582, 62, 631, 951	Computer and related activities	364,128.4	4,281.9	16,389.6	1,871.6	1,280.7	117.8	193.3
261-264, 582, 61, 62, 631, 951	ICT total	591,398.9	6,009.2	31,008.2	3,774.1	1,842.6	194.4	302.1
	Total economy	14,953,489.7	232,143.1	198,838.5	94,796.0	6,544.6	951.9	1,655.6

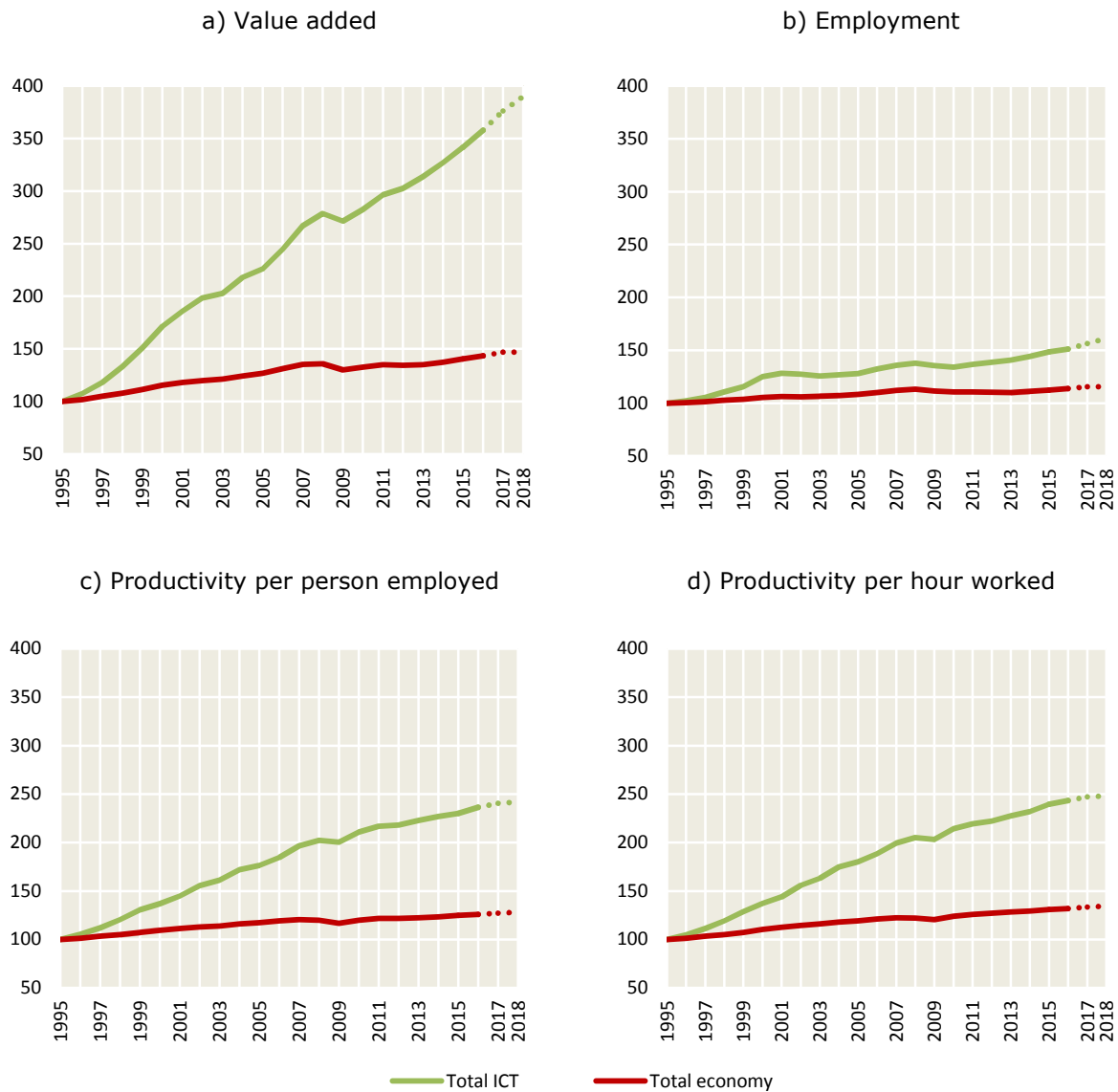
b) Annual growth rates (%), 2015-2016

NACE Rev. 2	Description	VA	Employment	BERD	GBARD	ICT GBARD	RERD	PERD
261-264	ICT manufacturing industries	6.6	2.8	-5.4	5.0	5.0	-7.7	-7.8
261	Manufacture of electronic components and boards	9.0	5.0	6.4	5.0	5.0	1.3	0.7
262	Manufacture of computers and peripheral equipment	-7.1	-1.0	0.5	5.0	5.0	-9.9	-5.9
263	Manufacture of communication equipment	8.7	2.5	-17.6	5.0	5.0	-15.8	-16.8
264	Manufacture of consumer electronics	5.8	-2.0	5.2	5.0	5.0	14.2	6.3
582, 61, 62, 631, 951	ICT services industries	4.5	1.7	10.1	1.0	2.0	9.6	7.8
61	Telecommunications	4.8	2.4	20.3	-1.5	-1.5	7.4	12.2
582, 62, 631, 951	Computer and related activities	4.4	1.5	7.4	3.9	3.9	10.0	7.2
261-264, 582, 61, 62, 631, 951	ICT total	4.7	1.8	4.0	1.3	2.1	3.9	3.3
	Total economy	2.0	1.2	3.5	0.9	2.0	4.9	5.0

Note: Monetary variables are expressed in real terms. GBARD and ICT GBARD growth rates for ICT sectors are practically the same because the 2015 LFS weights are used for calculations in the last two years. For further details see the methodological report.

Source: 2019 PREDICT Dataset.

Figure 1: Total economy and ICT sector: VA, employment, labour productivity, BERD, BERD intensity, RERD and PERD in the EU (1995-2018, Index 1995=100)



Note: Monetary variables are expressed in real terms. Dashed lines indicate nowcasted data.
Source: 2019 PREDICT Dataset, AMECO and Eurostat.

The ICT sector in the European Union (EU) has shown a more dynamic behaviour than the total economy since 1995. The gap is especially noticeable for Value Added (VA) (Figure 1a) and business expenditures in R&D (BERD) (Figure 1e). Between 1995 and 2016, both have been multiplied by a factor of 3.6 in real terms. The differences in terms of employment are much less intense (Figure 1b). From 1995 to 2016 employment increased only 1.5 times, and the number of researchers and R&D personnel 1.9 times (Figure 1 g-h). As a consequence, labour productivity per hour worked in the ICT sector multiplied its level by 2.4 in 1995, 1.6 times higher than the growth for the aggregated economy (Figure 1 c-d). All the aforementioned variables were expected to increase according to the PREDICT estimates in 2017 and 2018. The only exception to this general profile is BERD intensity (expressed as BERD/GDP in nominal terms) which presented a negative trend throughout the period in the ICT sector, while it increased slightly in the total economy (Figure 1f).

Figure 1 (cont.): Total economy and ICT sector: VA, employment, labour productivity, BERD, BERD intensity, RERD and PERD in the European Union (1995-2018, Index 1995=100)

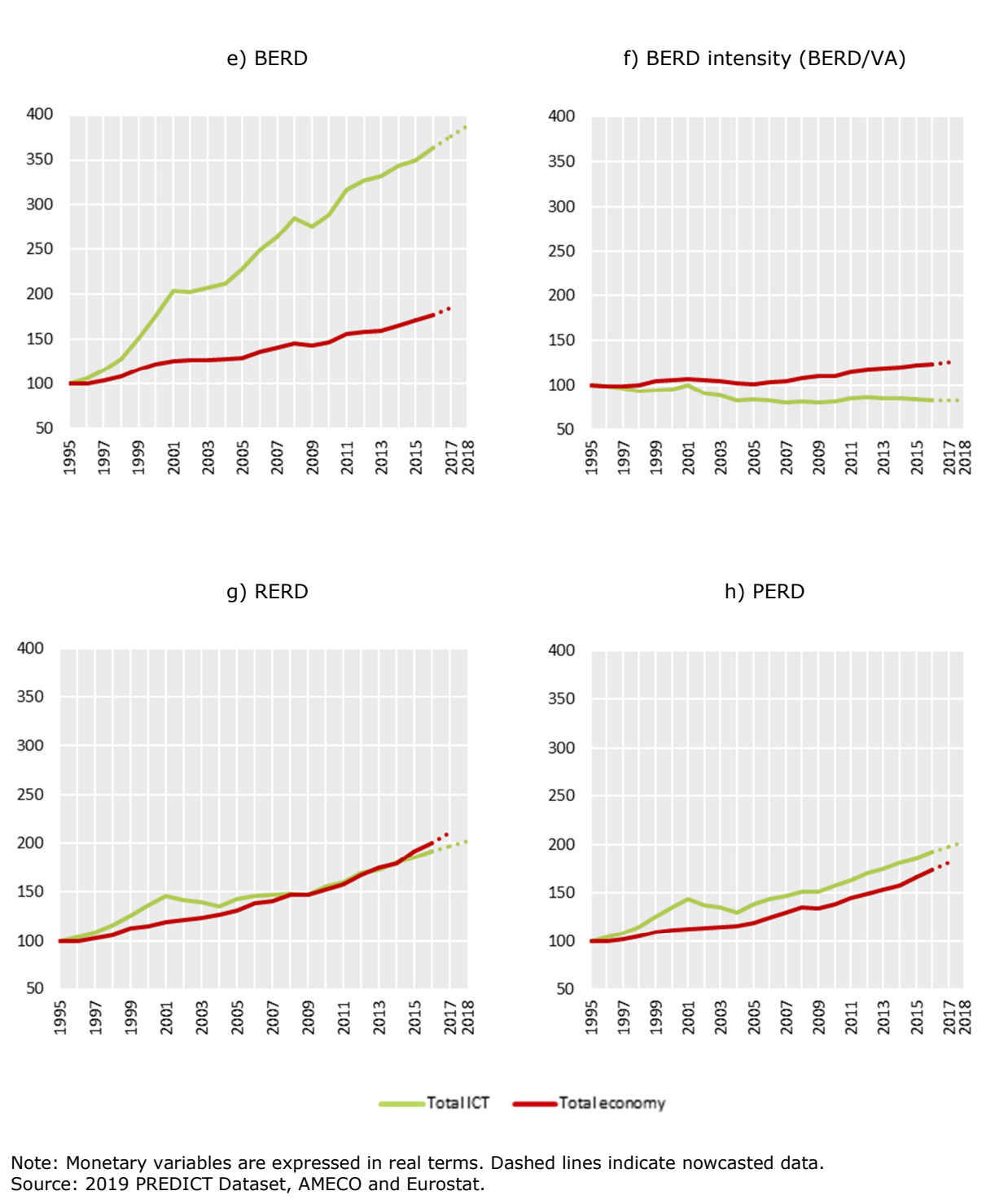
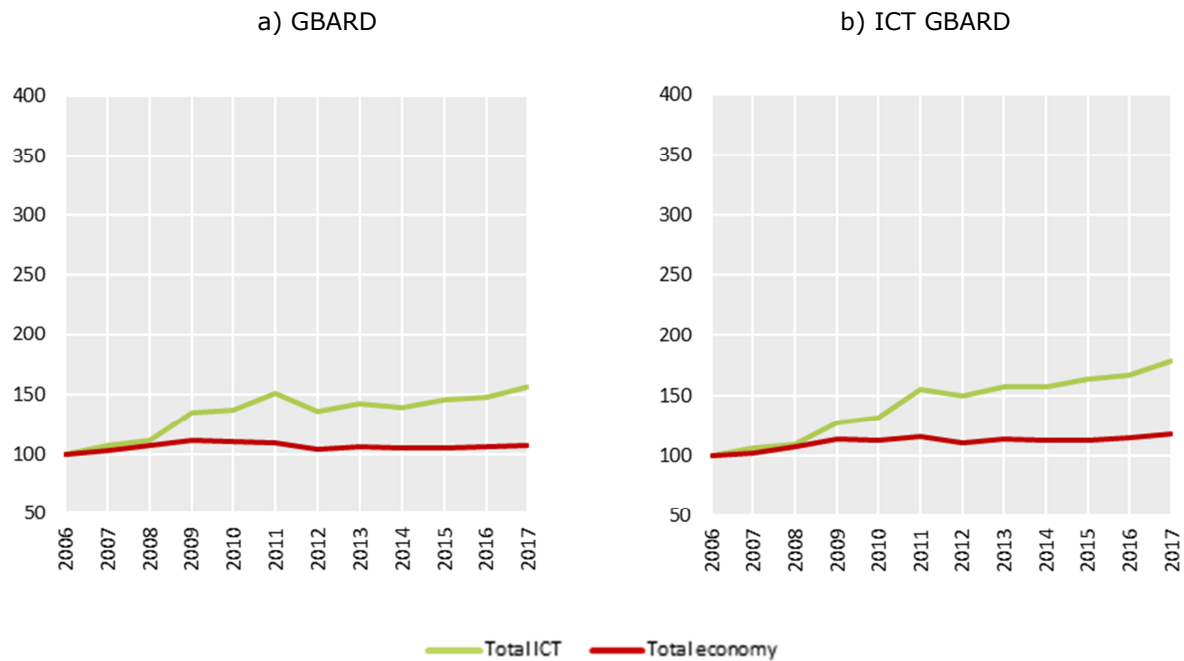


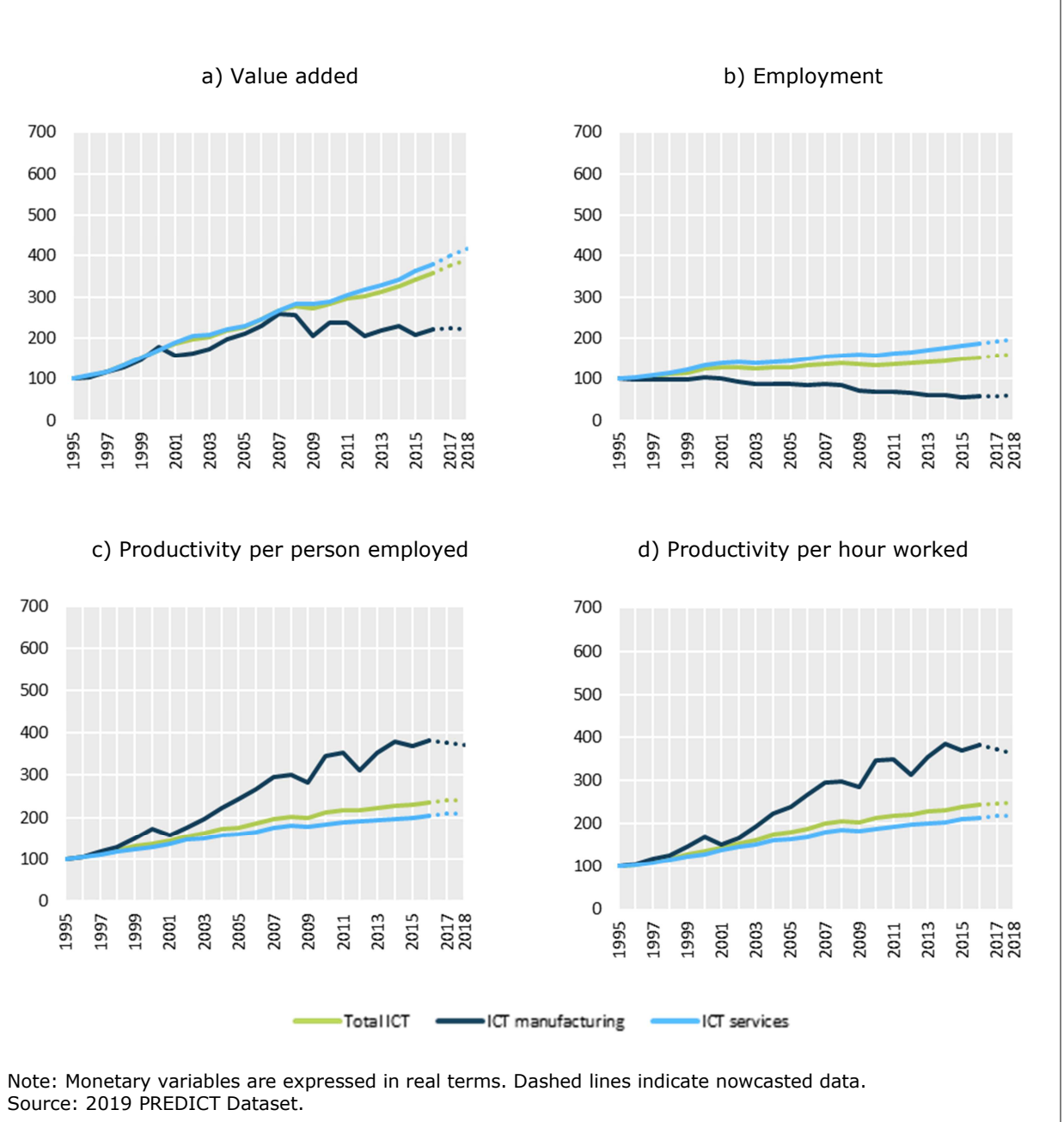
Figure 2: Total economy and ICT sector: GBARD and ICT GBARD in the European Union (2006-2017, Index 2006=100)



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: 2019 PREDICT Dataset.

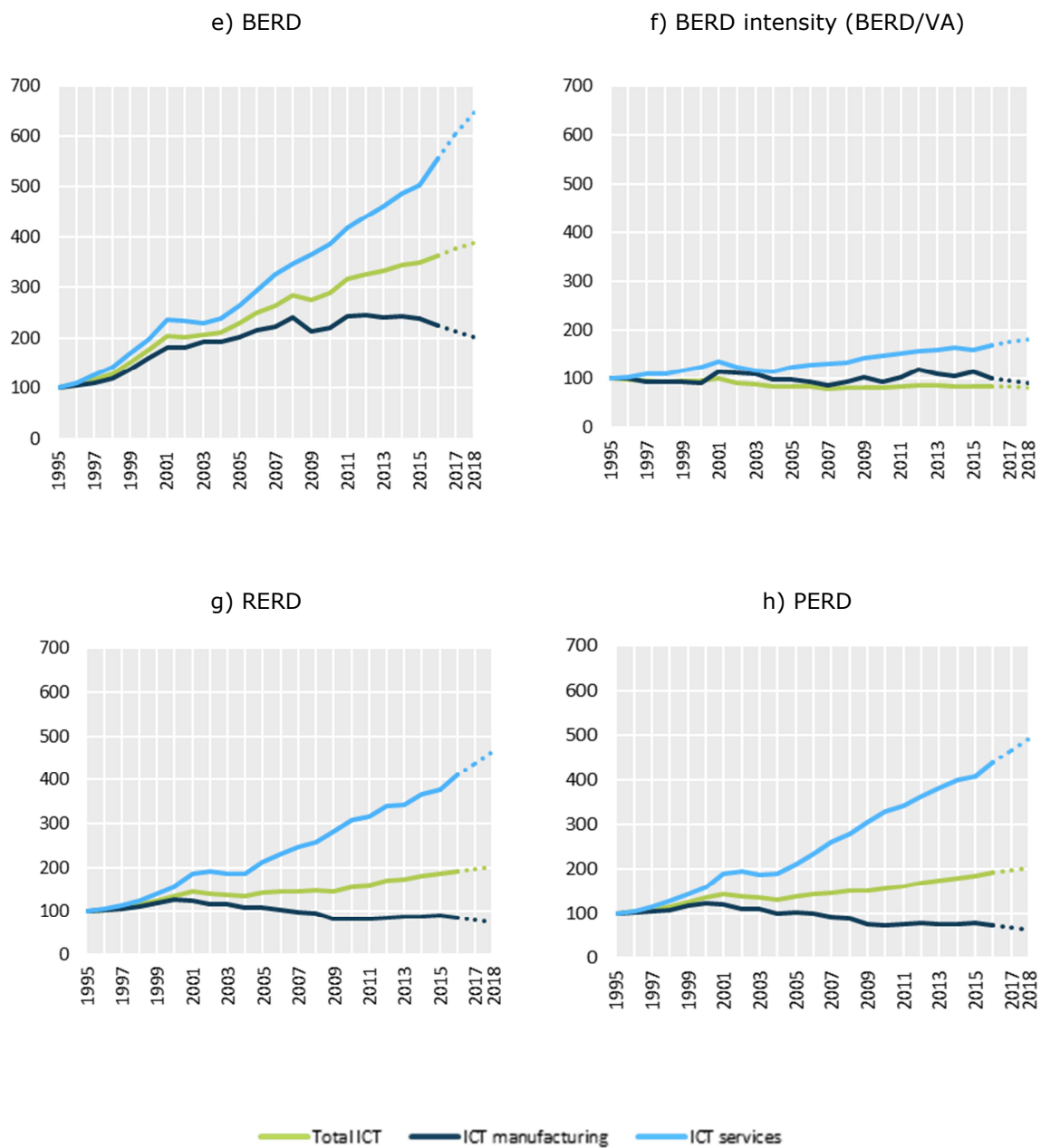
Public funding in R&D also had a more dynamic behaviour in the ICT sector than in the total economy. This result applies to both total GBARD assigned to the ICT producing industries as well as to ICT GBARD (Figure 2) which considers ICT related expenditures (see Box 1 in the Introduction). In the first case, it multiplied its level between 2006 and 2017 by a factor of 1.6, while for total economy it did so 1.1 times. In the case of ICT GBARD, the corresponding values are 1.8 and 1.2.

Figure 3: ICT sector, ICT manufacturing and ICT services: VA, employment, labour productivity, BERD, BERD intensity, RERD and PERD in the EU (1995-2018, Index 1995=100)



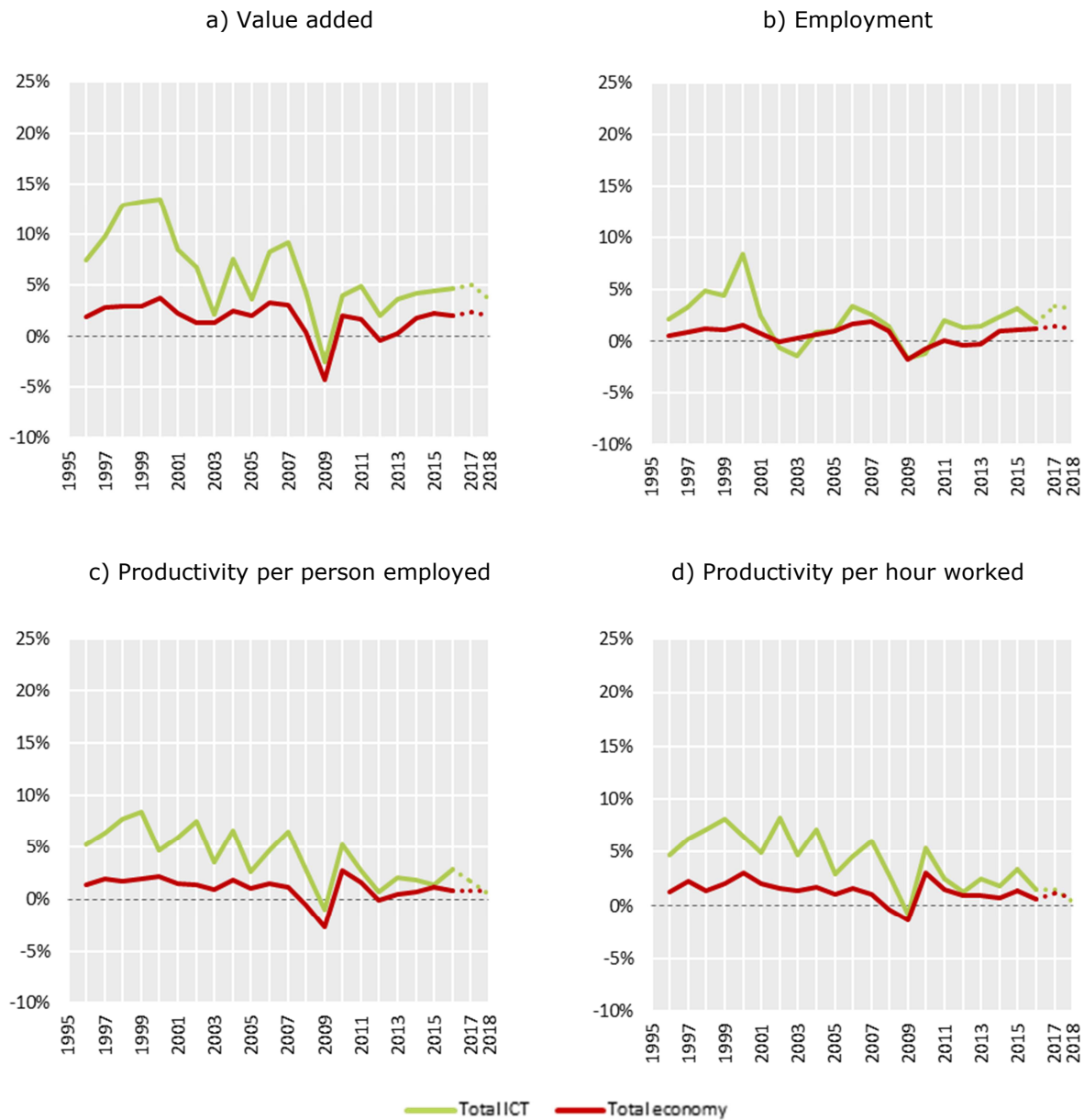
The more dynamic behaviour shown by the ICT sector has its origin in the ICT services sector (Figure 3). From 1995 to the aftermath of the crisis, value added in ICT manufacturing and ICT services sectors grew at similar rate (Figure 3a). Since then, ICT manufacturing has slowed down, while ICT services VA has continued growing. In the case of BERD (Figure 3e), the increase in ICT services also surpasses that of ICT manufacturing. In terms of labour, while employment growth in the ICT services sectors was higher than for the total economy (Figure 3b), ICT manufacturing employment suffered an almost continuous decline, at least since 1999. As a result, labour productivity in ICT manufactures presented a much higher rate of growth than in ICT services (Figure 3 c-d). The pattern is similar, but more pronounced for R&D researchers and personnel (Figure 3 g-h).

Figure 3 (cont.): ICT sector, ICT manufacturing and ICT services: VA, employment, labour productivity, BERD, BERD intensity, RERD and PERD in the EU (1995-2018, Index 1995=100)



Note: Monetary variables are expressed in real terms. Dashed lines indicate nowcasted data.
Source: 2019 PREDICT Dataset.

Figure 4: Total economy and ICT sector: VA, employment, labour productivity, BERD, BERD intensity, RERD and PERD in the EU. Annual growth rates (1995-2018)



Note: Monetary variables are expressed in real terms. Dashed lines indicate nowcasted data.
Source: 2019 PREDICT Dataset.

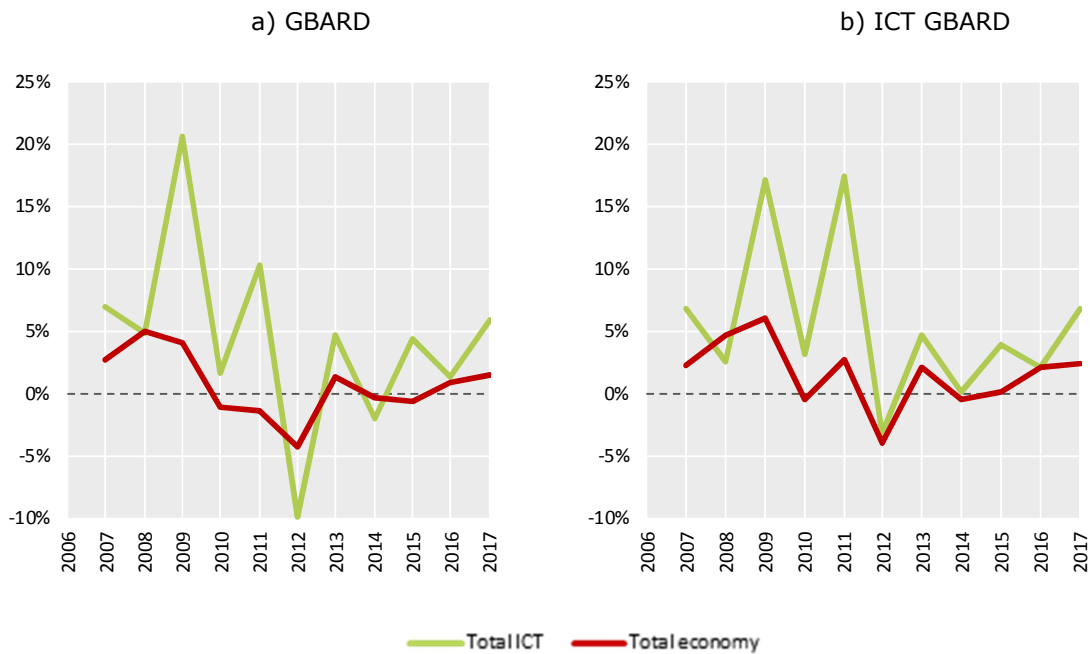
In terms of annual rates of change, all variables grew at a faster rate in the ICT sector than in the total economy, especially between 1995 and 2008 (Figure 4). The only exceptions were R&D researchers (Figure 4g) and R&D personnel (Figure 4h), which presented lower rates during the first years of the century. Since the crisis started, the dynamics of the ICT sector has been similar to the total economy. In 2016, ICT sector VA, labour productivity per person employed, BERD, R&D researchers, and R&D personnel showed an accelerated growth. However, ICT sector employment and productivity per hour worked slowed down (Figure 4d). The ICT sector estimated figures in 2017-2018 show a deceleration in the growth for all variables except employment.

Figure 4 (cont.): Total economy and ICT sector: VA, employment, labour productivity, BERD, BERD intensity, RERD and PERD in the EU. Annual growth rates (1995-2018)



Note: Monetary variables are expressed in real terms. Dashed lines indicate nowcasted data.
Source: 2019 PREDICT Dataset.

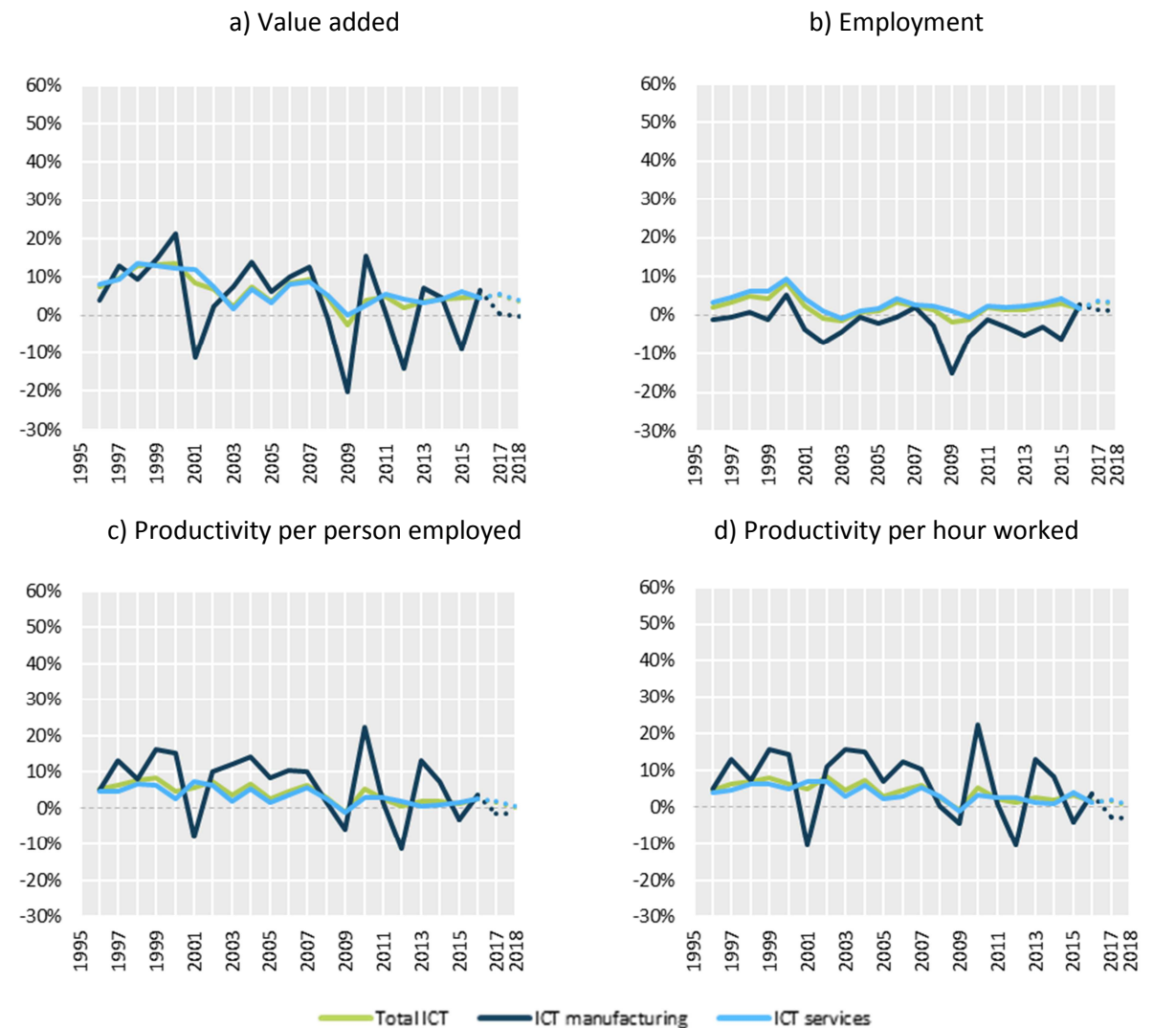
Figure 5: Total economy and ICT sector: GBARD and ICT GBARD in the EU. Annual real growth rates (2006-2017)



Source: 2019 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 2012 and 2014. A similar result can be observed for ICT GBARD. In 2017 GBARD and ICT GBARD for the ICT sector showed an upturn after the decrease in 2016, while it slightly increased for the total economy.

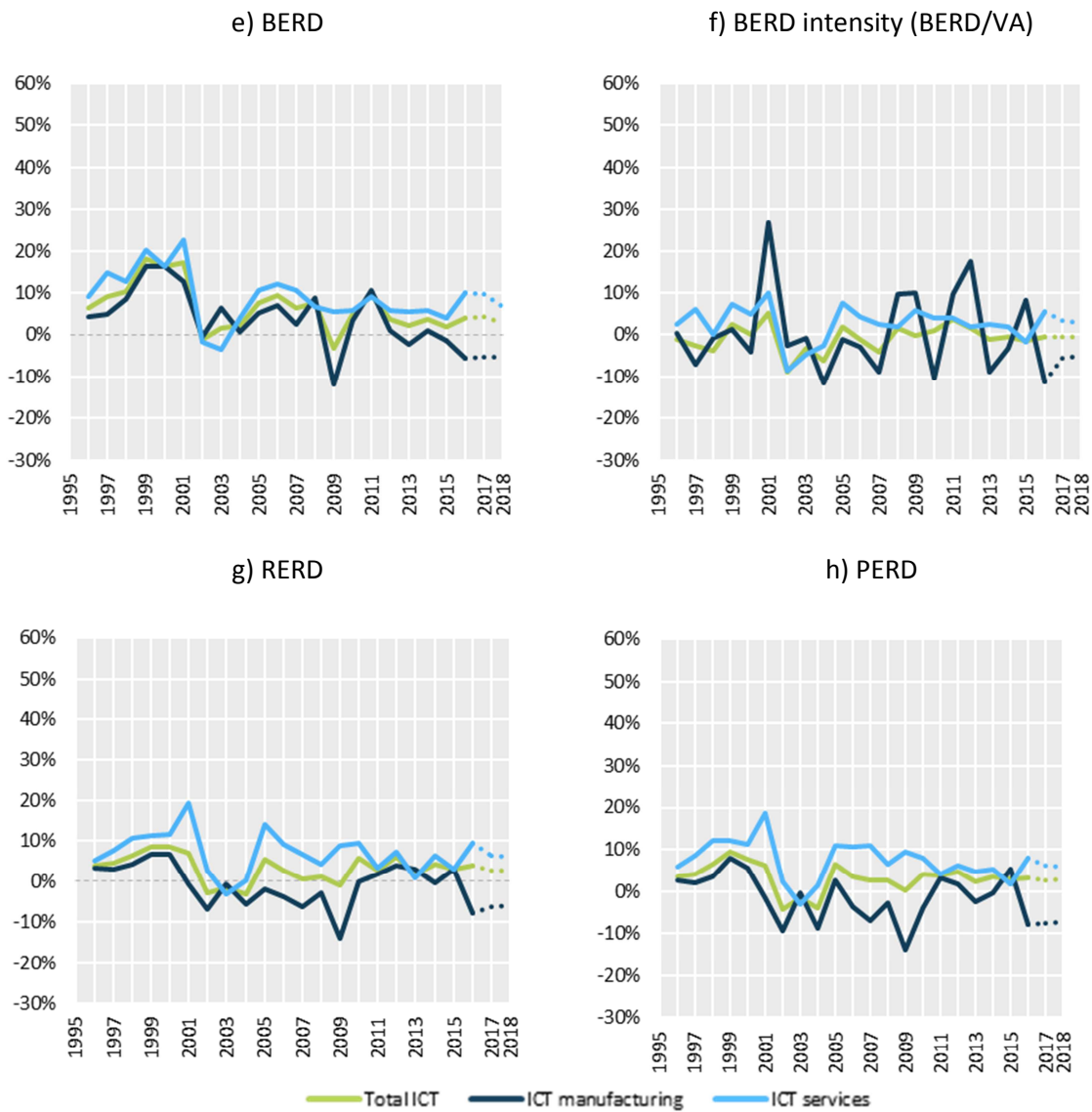
Figure 6: ICT sector, ICT manufacturing and ICT services: VA, employment, labour productivity, BERD, BERD intensity, RERD and PERD in the EU. Annual growth rates (1995-2018)



Note: Monetary variables are expressed in real terms. Dashed lines indicate nowcasted data.
Source: 2019 PREDICT Dataset, AMECO and Eurostat.

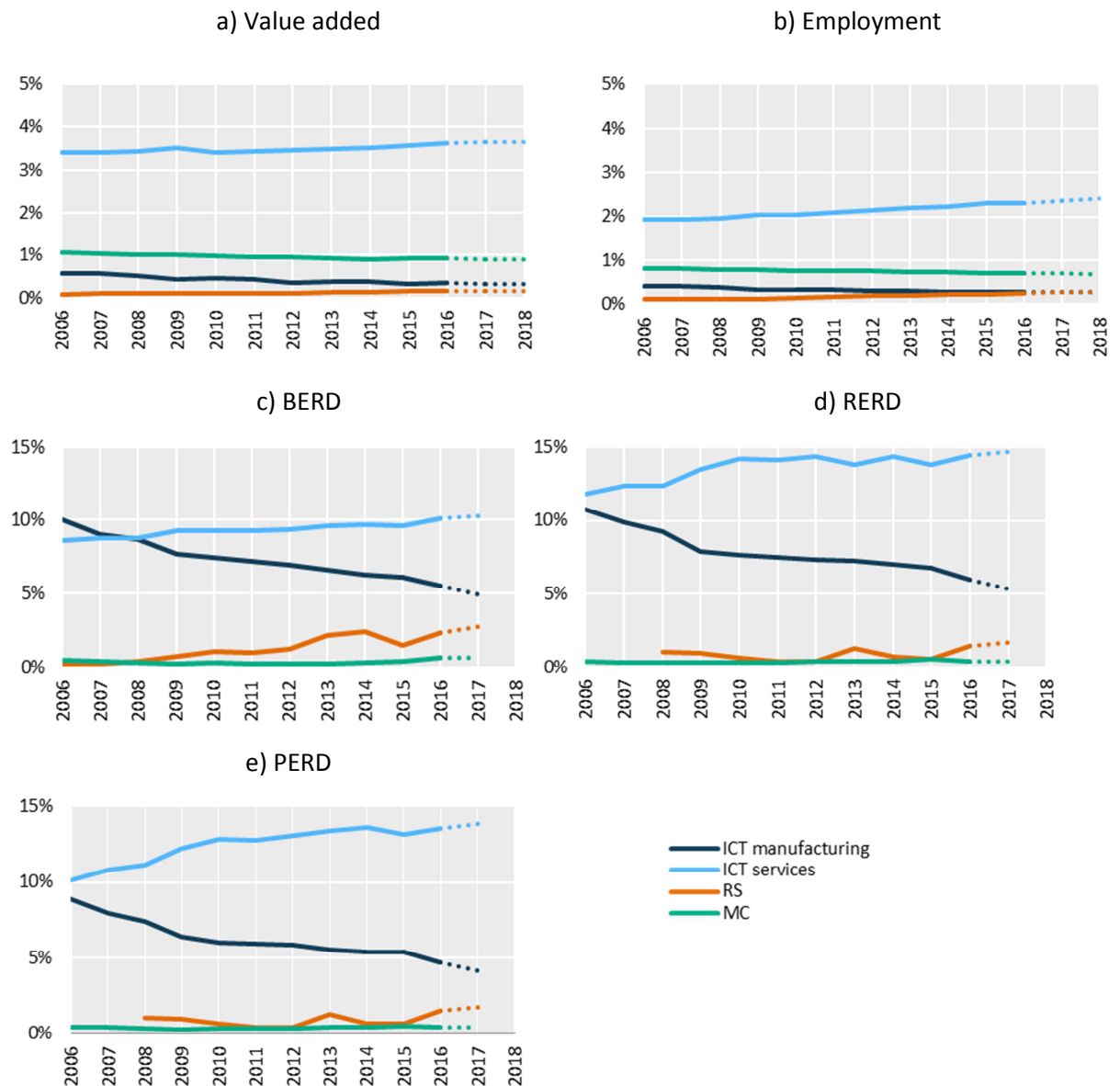
The cyclical profile (as measured by the annual growth rates) for total ICT sector follows that of ICT services sector due to its higher weight (in comparison with the ICT manufacturing sector). ICT services sector shows a much more stable growth rate than the ICT manufacturing sector. This is evident in the cases of VA (Figure 6a), employment (Figure 6b), labour productivity (Figure 6c), BERD (Figure 6e) and BERD intensity (Figure 6f), but is less apparent for R&D researchers (Figure 6g) and personnel (Figure 6h). In the case of the last two variables, both ICT services and ICT manufacturing show volatility. However, the growth rate is always higher for ICT services. In 2016 VA and productivity showed a positive growth both in ICT manufacturing and ICT services. In the case of BERD, R&D researchers and R&D personnel, the growth rates were positive for ICT services and negative for ICT manufactures.

Figure 6 (cont.): ICT sector, ICT manufacturing and ICT services: VA, employment, labour productivity, BERD, BERD intensity, RERD and PERD in the EU. Annual growth rates (1995-2018)



Note: Monetary variables are expressed in real terms. Dashed lines indicate nowcasted data.
 Source: 2019 PREDICT Dataset, AMECO and Eurostat.

Figure 7: ICT manufacturing, ICT services, MC and RS sectors share of the total economy in the EU (percentages, 2006-2018)

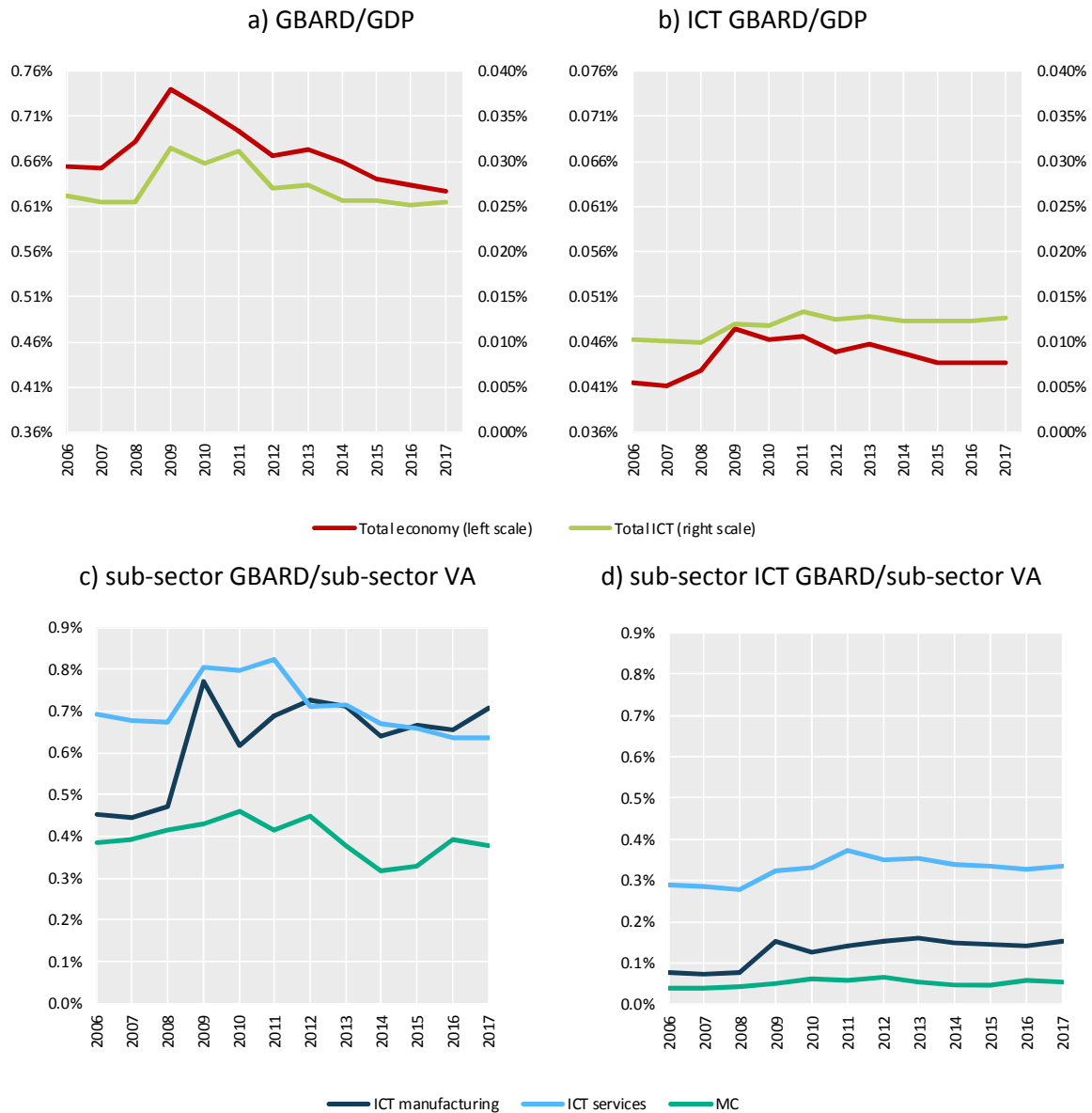


Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.

Source: 2019 PREDICT Dataset, AMECO and Eurostat.

In 2016 the VA generated by the ICT service sector represents 3.6% of GDP, following a slightly positive trend, while the ICT manufacturing only reaches 0.3%, showing a declining evolution (Figure 7a). The ICT producing sectors altogether approximately amounted to 4.0% of GDP. The weight of the media content sector in GDP is twice that of ICT manufacturing and also shows a declining trend. The share of the retail sector via mail order houses or via Internet is almost negligible in the EU but shows a positive trend in the most recent years. In terms of employment, the weight of all ICT-related sectors is low (adding 2.6%). In line with other variables already analysed, ICT manufacturing has suffered a severe decline in terms of R&D researchers (Figure 7d), R&D personnel (Figure 7e) and also BERD (Figure 7c). It is interesting to observe how the retail share (RS) is relatively higher in BERD than in other variables.

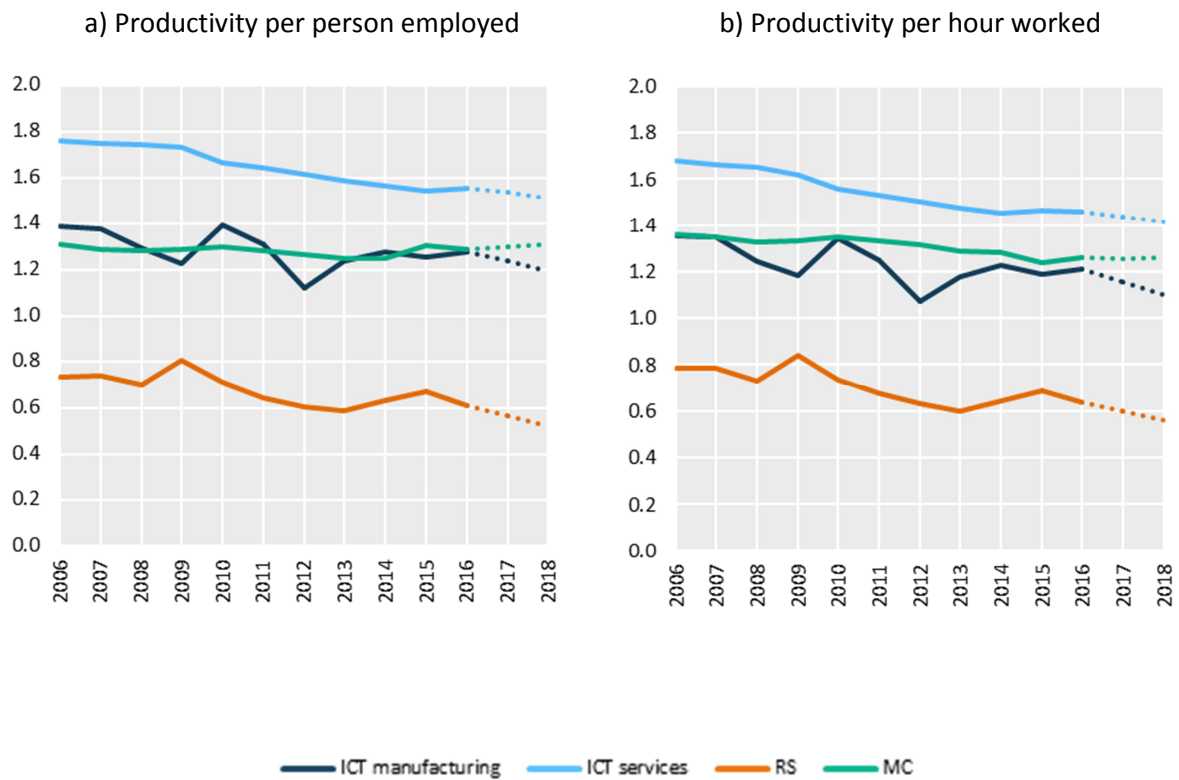
Figure 8: Total economy, ICT sector, ICT manufacturing, ICT services and MC sector. GBARD and ICT GBARD intensities in the EU (percentages, 2006-2017)



Note: MC: Media and Content. GDP nowcasted for 2017.
 Source: 2019 PREDICT Dataset, AMECO and Eurostat.

Total GBARD represented 0.63% of GDP in 2017 and 0.026% in the ICT sector. The first one has suffered a severe downturn since 2009, year in which it was equal to 0.74% (Figure 8a). This decline is not observed (at least not as strongly) for the ICT sector. The evolution of ICT GBARD presents similar profiles (Figure 8b). In 2017, GBARD in the ICT manufacturing sector amounted to 0.71% of its value added (Figure 8c), a percentage slightly higher than in the ICT services, and almost doubling 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 EU (2006-2018)

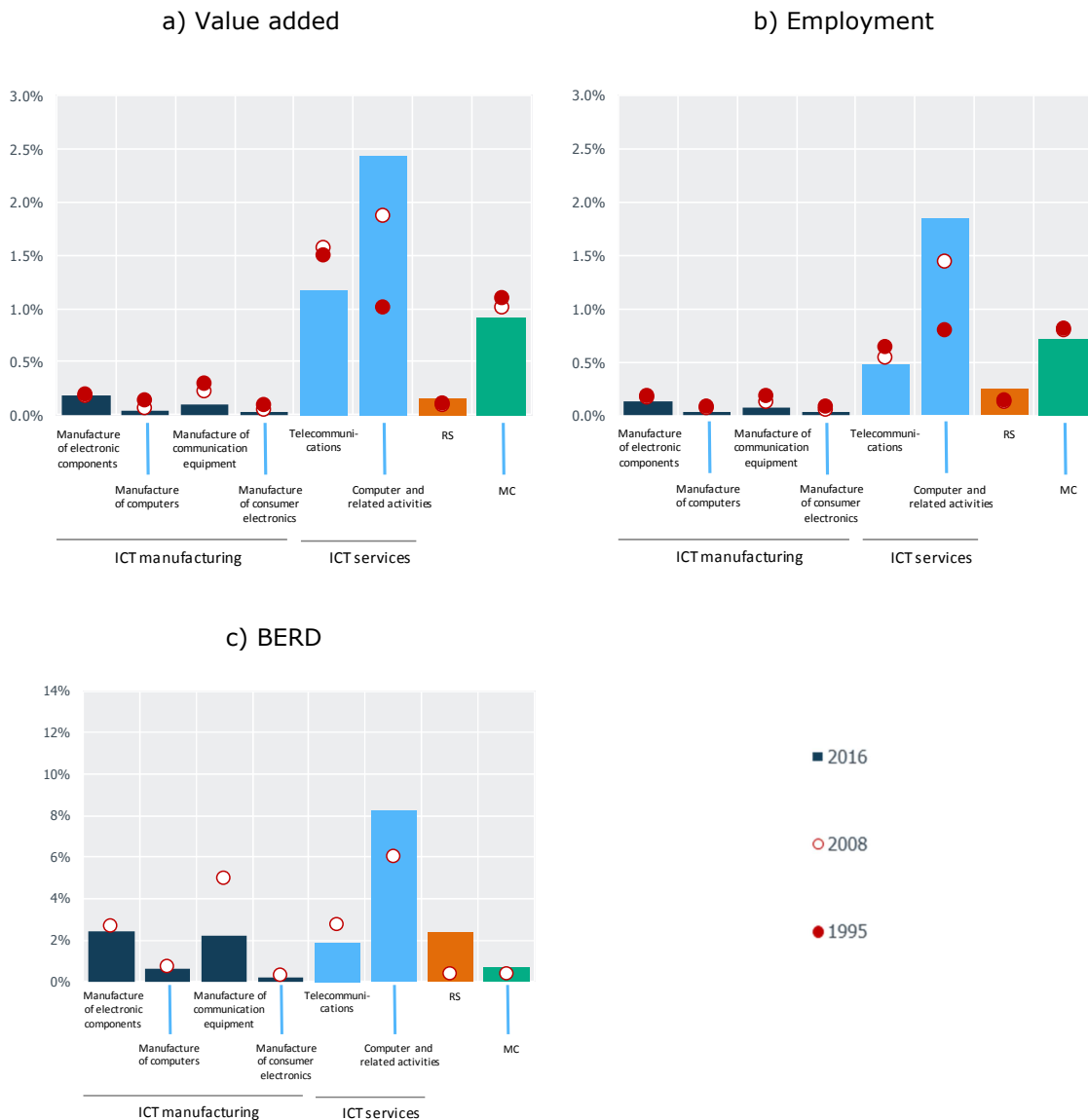


Note: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.

Source: 2019 PREDICT Dataset, AMECO and Eurostat.

Labour productivity is higher in the ICT service sector, and similar in ICT manufacturing and MC sectors. In all three cases, it is higher than the one of the RS sector. This result applies to both productivity in terms of persons and in terms of hours worked (Figure 9). It is interesting to notice that all the sectors have followed a declining path since 2006. The estimations for 2017 and 2018 show a downward trend for all sectors, with the only exception of the slight recovery of productivity per hour worked for the MC sector.

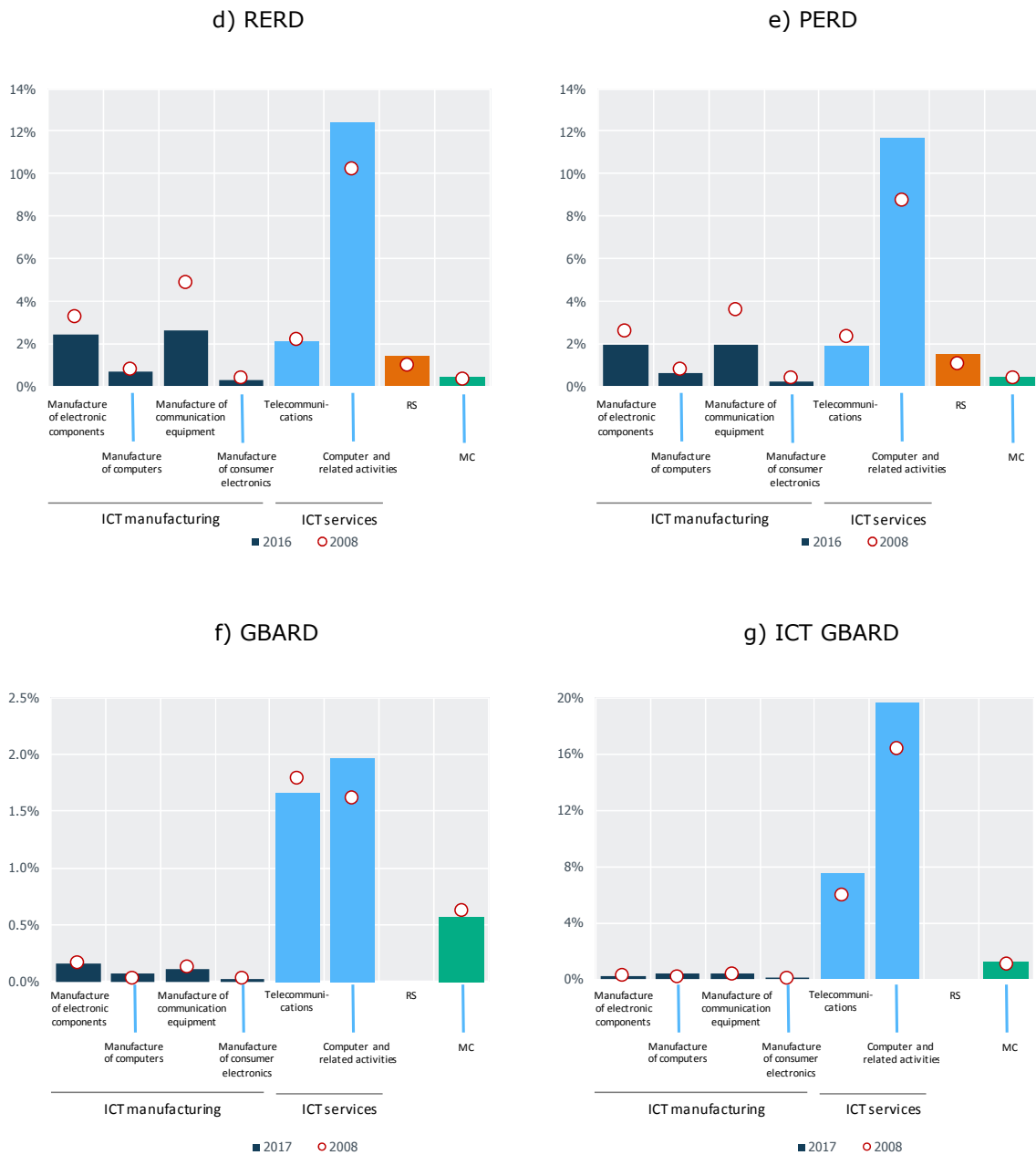
Figure 10: ICT sector, MC and RS sector share of total economy by sub-sector in the EU (percentages, 1995, 2008, 2016)



Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet.
Source: 2019 PREDICT Dataset.

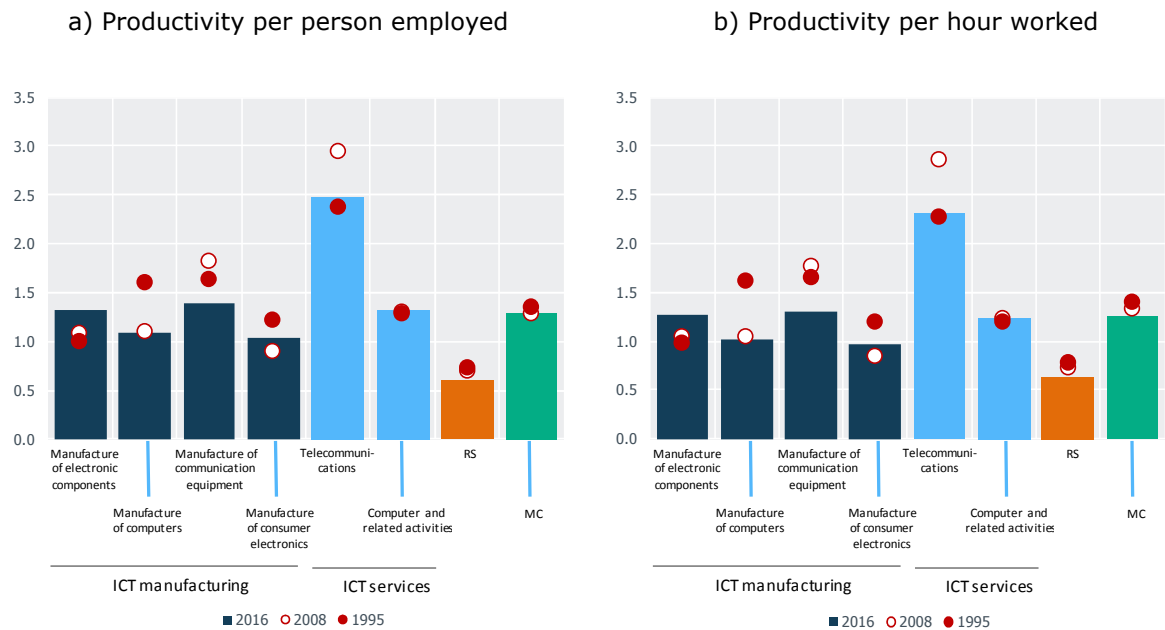
Computer and related activities is the ICT services sector with the highest weight over the total economy in all PREDICT variables in 2016 (2017 for GBARD and ICT GBARD) (Figure 10): VA (2.4%), employment (1.8%), Public funding (GBARD) (2.0%), BERD (8.2%), and especially ICT GBARD (19.6%), R&D researchers (12.4%) and R&D personnel (11.7%). *Telecommunications* is the second in importance in the case of VA, employment, public funding, and ICT GBARD. *Manufacture of electronic components* is the second in importance in R&D researchers and R&D personnel. In the case of BERD, the second in order of importance is *Manufacture of communications equipment*. The *Media and content* sector has important shares in terms of VA and employment (0.91% and 0.71% respectively) in 2016, but in 1995 they were higher. Its weight in terms of R&D variables is almost negligible.

Figure 10 (cont.): ICT sector, MC and RS sector share of total economy by sub-sector in the EU (percentages, 1995, 2008, 2016)



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: 2019 PREDICT Dataset.

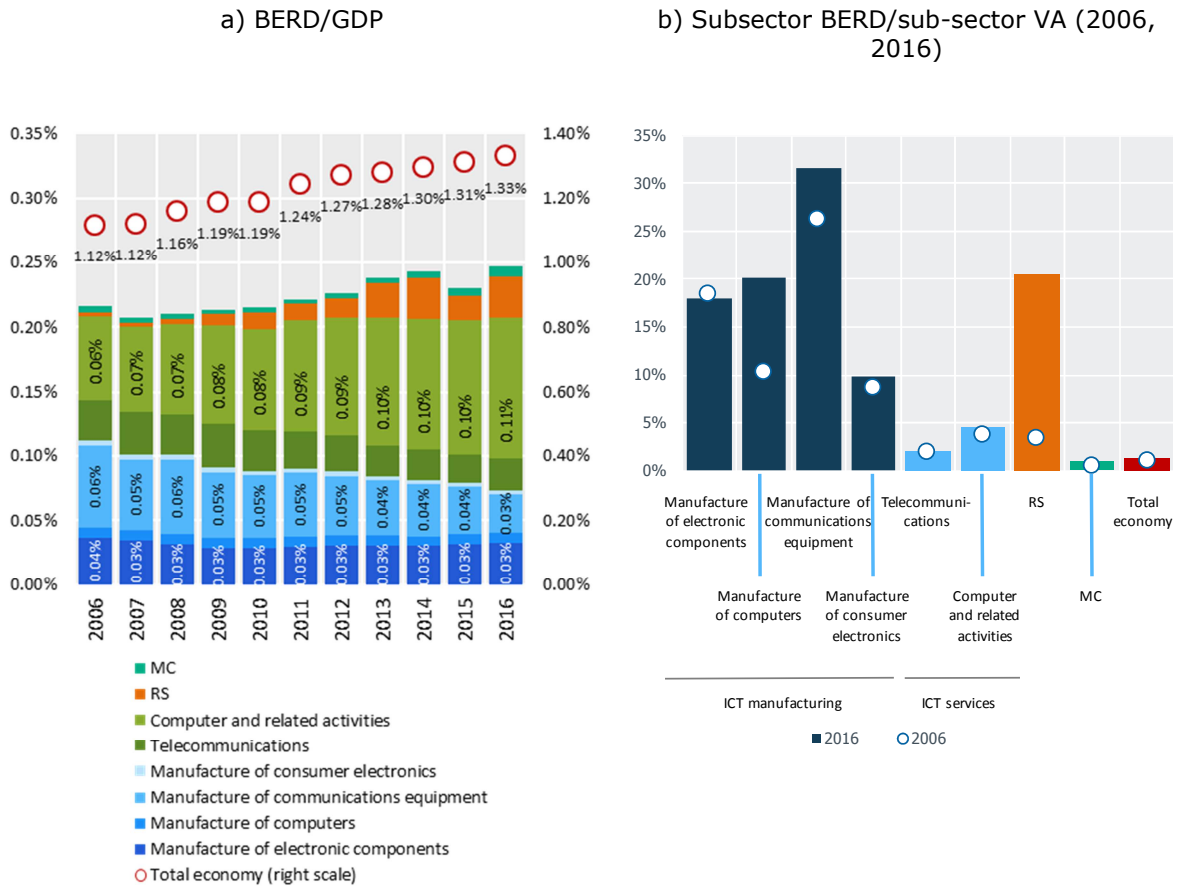
Figure 11: ICT sub-sectors, MC and RS sector productivity as a ratio over productivity in total economy in the EU (1995, 2008, 2016)



Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet.
Source: 2019 PREDICT Dataset.

All sub-sectors belonging to the ICT sector present a labour productivity higher than the one of total economy, both in terms of persons and of hours worked, with the only exception of *Manufacture of consumer electronic* (in terms of hours worked) and RS. *Telecommunications* has the highest ratio, followed by *Computer and related activities*, *Manufacture of communication equipment* and *Media and content* (Figure 11). However, only the sectors of *Manufacturing of electronic components*, *Computer and related activities* and *Telecommunications* have increased the gap since 1995, although the third one fell with respect to 2008. For the rest it has narrowed.

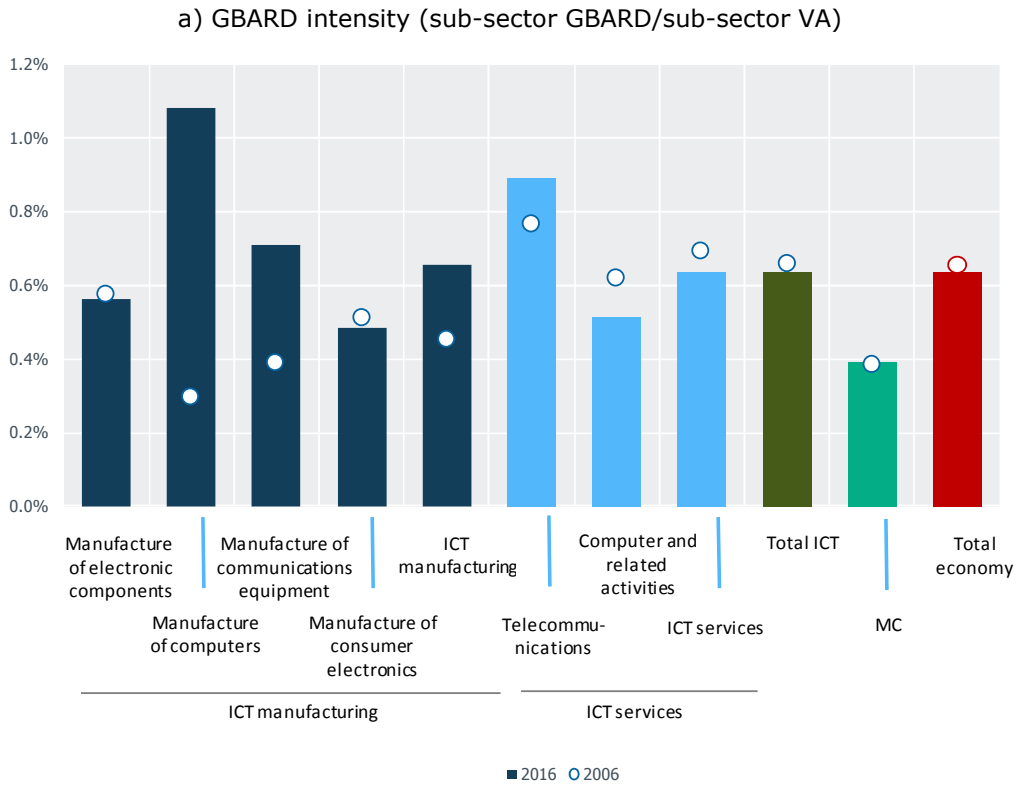
Figure 12: Total economy, ICT manufacturing, ICT services, RS and MC sectors BERD intensity in the EU (percentages, 2006-2016)



Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet.
Source: 2019 PREDICT Dataset.

In 2016 the share of BERD over GDP amounted to 1.3% for the total economy and 0.21% in ICT, 0.01% in MC and 0.03% in RS sector. The highest share is the one of *Computer and related activities* (0.11%) (Figure 12a). BERD intensity for each sub-sector (sub-sector BERD/sub-sector VA) is higher in *Manufacture of communications equipment* (31.6%), followed by RS sector (20.5%) and *Manufacture of computers* (20.1%) and *Manufacture of electronic components* (17.9%). For almost all sub-sectors, BERD intensity was higher in 2016 than in 2006, with the only exception of *Manufacture of electronic components* (Figure 12b).

Figure 13: ICT manufacturing and ICT services, GBARD and ICT GBARD in the EU (percentages, 2006, 2016)

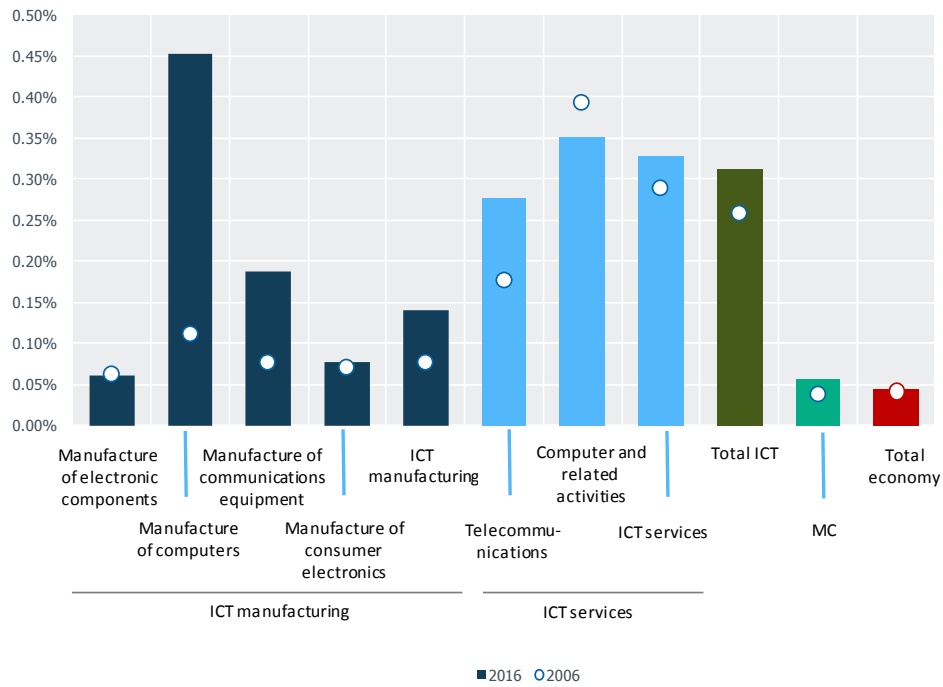


Note: MC: Media and Content.
 Source: 2019 PREDICT Dataset.

In 2016, GBARD intensity (defined as sub-sector GBARD/sub-sector VA) was of a similar magnitude for ICT manufacturing and ICT services (Figure 13a). However, while in the former it had increased since 2006, in the latter it had decreased. For the MC sector, this ratio is much lower and remained stable. *Manufacture of computers* and *Telecommunications* are the sub-sectors with the highest ratio. ICT GBARD intensity (Figure 13b) is higher in ICT services, more than twice the one of ICT manufacturing, about six times higher than that of the MC sector, and seven times that of the total economy. The highest value for this variable is reached by *Manufacture of computers*, followed by *Computer and related activities* and *Telecommunications*. Finally, ICT GBARD over GBARD in the ICT sector (Figure 13c) amounted to 49.5% in 2017, a percentage seven times higher than for the total economy. *Computer and related activities* was, again, the sub-sector with the highest ratio.

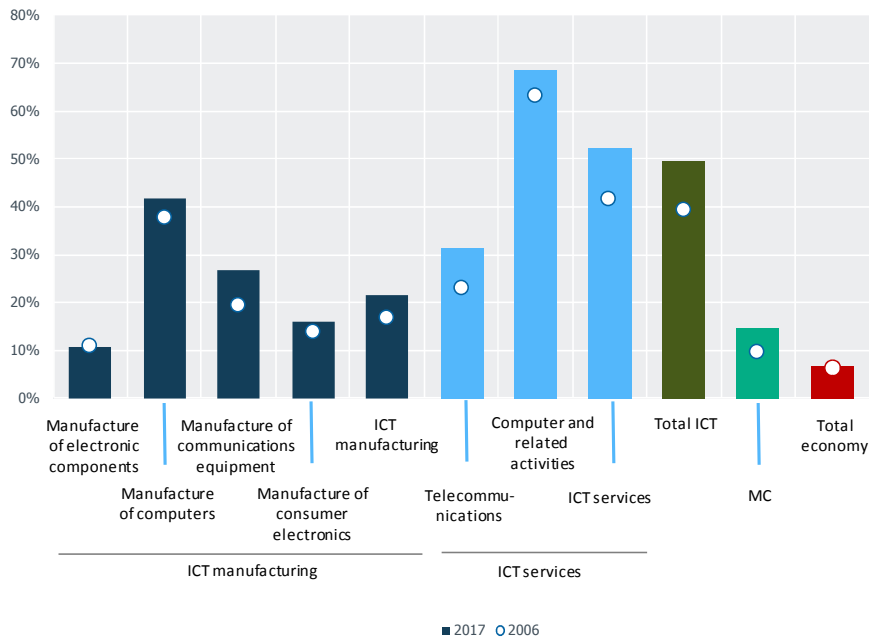
Figure 13 (cont.): ICT manufacturing and ICT services, GBARD and ICT GBARD in the EU (percentages, 2006, 2017)

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



Note: MC: Media and Content.
Source: 2019 PREDICT Dataset

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



Note: 2017 for GBARD and ICT GBARD.
Source: 2019 PREDICT Dataset.

2 The ICT sector in the EU Member States

Table 2: Summary table of total ICT sector by EU Member States

a) 2016

	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
	(Millions of current EUR PPS)	(1000 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)	(1000 Full Time Equivalent)	(1000 Full Time Equivalent)
Austria	10,146.4	102.2	963.8	88.4	2,644.2	39.2	226.2	5.2	8.4
Belgium	12,302.8	98.2	885.6	204.4	2,460.3	110.9	244.0	6.0	8.4
Bulgaria	4,734.9	82.4	198.9	10.1	201.0	7.3	15.1	1.8	3.0
Croatia	2,623.6	41.6	38.8	2.6	539.4	1.7	43.7	0.3	0.5
Cyprus	816.2	8.2	25.3	0.1	67.6	0.0	18.0	0.1	0.1
Czechia	12,908.3	154.3	527.7	62.2	1,584.3	39.3	144.2	5.2	8.2
Denmark	6,468.5	75.4	540.8	29.7	1,908.5	17.2	106.6	4.3	6.2
Estonia	1,385.8	27.4	86.8	14.0	198.2	9.2	17.4	0.5	0.6
Finland	9,296.2	91.9	1,189.6	89.5	1,493.1	52.9	184.5	8.1	10.6
France	85,792.5	750.6	6,470.4	441.2	12,828.6	144.9	565.9	44.3	52.2
Germany	111,029.2	1,057.0	6,448.7	859.9	25,917.0	365.4	1,546.5	32.7	54.1
Greece	6,272.7	50.4	138.5	37.1	1,153.0	12.9	79.6	1.2	2.0
Hungary	9,736.3	170.8	147.5	35.6	762.2	16.9	77.2	2.5	2.9
Ireland	18,257.9	78.8	799.7	53.9	652.2	19.3	102.1	4.0	7.1
Italy	54,884.7	591.7	2,275.6	674.2	8,898.2	264.2	611.3	11.6	29.0
Latvia	1,595.0	27.6	6.3	3.3	77.9	1.8	8.7	0.1	0.1
Lithuania	1,916.7	25.4	15.4	5.4	199.2	2.8	8.9	0.3	0.4
Luxembourg	1,837.3	15.1	16.7	21.0	268.3	8.2	25.5	0.1	0.2
Malta	743.7	9.4	22.6	0.3	24.9	0.1	0.2	0.3	0.5
Netherlands	25,366.1	235.7	1,186.5	126.9	4,440.9	63.2	365.8	10.8	16.8
Poland	25,594.4	368.0	1,344.5	105.2	2,516.2	46.1	106.0	12.0	14.0
Portugal	6,388.3	81.9	306.8	19.7	890.1	8.1	39.7	3.9	5.0
Romania	16,896.8	199.6	198.1	52.1	937.1	23.9	60.8	1.2	2.2
Slovakia	4,939.8	65.3	67.8	15.0	453.4	9.1	14.4	0.5	0.8
Slovenia	1,693.2	25.9	65.9	4.6	200.3	2.0	12.5	0.6	1.4
Spain	42,093.6	419.8	1,020.5	364.7	6,723.9	161.5	531.3	7.8	16.1
Sweden	19,247.0	164.6	1,463.1	50.4	2,788.4	26.6	359.7	8.2	14.0
United Kingdom	90,395.5	1,064.6	3,121.3	327.9	10,834.8	172.8	750.0	20.7	36.9
European Union	591,398.9	6,009.2	31,008.2	3,774.1	94,796.0	1,842.6	6,544.6	194.4	302.1

Note: 2014 for Ireland ICT sector VA.

Source: 2019 PREDICT Dataset.

Table 2 (cont.): Summary table of total ICT sector by EU Member States

b) Annual growth rates (%), 2015-2016

	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	5.0	4.5	2.6	5.9	3.3	5.2	4.3	2.0	2.8
Belgium	2.9	3.2	3.4	7.1	4.0	6.2	4.0	3.7	6.6
Bulgaria	14.2	8.1	111.1	-10.8	-13.7	-12.0	-9.0	88.1	83.5
Croatia	4.9	28.2	-26.7	47.2	-4.9	38.3	-6.4	62.5	-38.5
Cyprus	3.9	8.1	129.4	-21.1	0.8	-21.1	0.9	16.4	27.2
Czechia	4.5	6.5	6.9	-13.6	-0.7	-16.2	-1.7	10.3	4.8
Denmark	14.8	2.1	24.1	-6.8	-6.5	-9.4	-6.8	19.2	10.7
Estonia	-2.7	10.5	4.9	88.8	1.9	110.4	51.2	22.7	9.9
Finland	14.2	0.5	-10.9	-14.2	-8.8	-14.1	-8.0	-9.9	-12.6
France	3.8	2.5	6.3	-30.6	-1.1	-28.8	-11.1	1.4	0.0
Germany	2.8	3.3	1.2	8.5	2.1	8.7	3.5	0.0	0.3
Greece	1.4	0.3	33.4	40.4	2.8	76.6	1.7	8.6	11.9
Hungary	8.3	8.5	-9.8	70.9	44.3	78.8	39.7	9.8	2.6
Ireland	12.6	4.3	5.6	-6.1	-1.5	-7.2	-4.4	-0.9	-1.0
Italy	4.9	4.6	13.0	10.8	3.2	10.1	6.1	19.2	22.8
Latvia	5.5	6.9	-39.5	-3.0	11.9	-2.5	21.8	-8.0	-33.3
Lithuania	4.5	7.3	-36.7	19.4	-1.3	17.9	5.6	-42.8	-31.1
Luxembourg	-4.3	5.1	24.9	-11.1	-1.3	-23.3	-4.4	-9.8	-8.2
Malta	7.9	11.0	-1.6	-62.5	-17.9	-62.6	-63.6	12.3	10.0
Netherlands	6.0	3.4	17.3	-7.3	0.5	-10.6	-1.7	12.0	3.2
Poland	11.7	-0.7	70.5	-48.2	-17.0	-58.8	-48.3	26.7	13.4
Portugal	1.1	4.2	17.5	-0.2	1.4	0.6	1.4	32.2	13.5
Romania	5.4	0.7	112.4	6.0	13.6	12.0	17.0	72.0	47.1
Slovakia	4.0	4.5	7.9	-28.3	-8.2	-30.9	-30.7	2.1	3.8
Slovenia	-1.3	3.5	-26.1	-6.6	1.1	-7.6	-2.1	2.8	-10.3
Spain	6.3	5.5	4.9	15.5	-0.1	14.5	2.6	4.3	2.6
Sweden	-3.5	0.3	-17.7	9.8	2.1	9.6	1.9	-7.3	41.9
United Kingdom	5.3	0.6	0.3	23.0	0.0	27.5	5.0	-8.1	-12.2
European Union	4.7	1.8	4.0	1.3	0.9	2.1	2.0	3.9	3.3

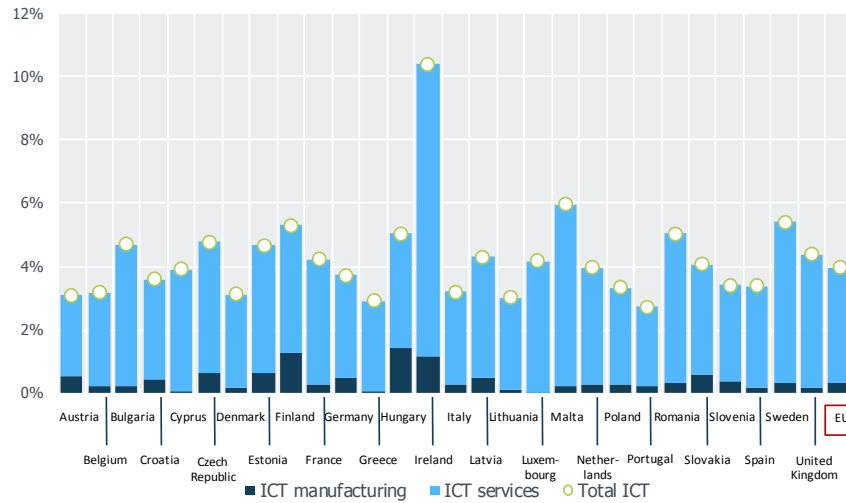
Note: Monetary variables are expressed in real terms. 2013-2014 for Ireland, ICT sector (VA and BERD).
Source: 2019 PREDICT Dataset.

In 2016 the largest ICT sectors in the EU in relative size (ICT sector VA / GDP) were Malta, Sweden, Finland, Hungary and Romania, all above 5.0% (Table 2a)⁵. In terms of employment, the largest EU ICT sectors in relative size were Malta, Estonia, Hungary, Ireland and Finland, with a share over total employment higher than 3.6%. On the other hand, Finland was the country with the highest ICT sector BERD intensity in 2016 (12.8% of total value added), followed by Austria, Denmark, Sweden, France and Belgium. The most dynamic countries (Table 2b) in Europe in 2016 were: Denmark, Bulgaria and Finland in VA; Croatia, Malta and Estonia in employment; and Cyprus, Romania and Bulgaria in BERD. The countries with the highest ICT GBARD in relation to GDP were Finland and Sweden, where it represented more than 0.1%. ICT GBARD increased at a higher rate in Malta, Slovakia, Estonia and Bulgaria in 2016.

⁵ Ireland has not published official data for VA since 2014.

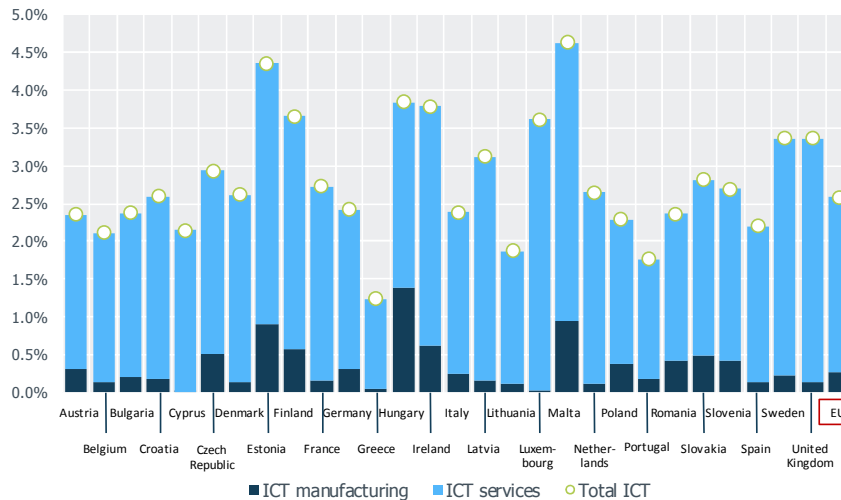
Figure 14: ICT sector, ICT manufacturing and ICT services: VA, employment, labour productivity, BERD, BERD intensity, RERD, PERD, GBARD and ICT GBARD by EU Member State (2016)

a) ICT sector VA share of GDP



Note: 2014 for Ireland.

b) ICT sector employment share of total employment

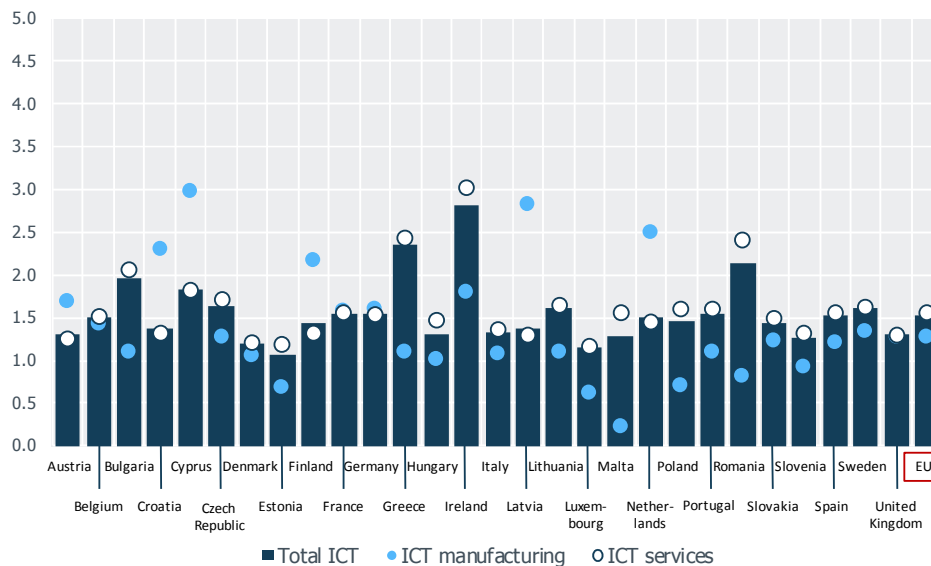


Source: 2019 PREDICT Dataset.

In terms of employment in the ICT sector (Figure 14b), Estonia and Malta, followed by Hungary and Finland show the highest share over the total. The productivity of EU countries in the ICT services (Figure 14c-d) sector is higher than in ICT manufacturing, which is a consequence of the higher proportion of ICT services in total ICT in VA (Figure 14a) in comparison to its proportion in employment. Hungary presents the highest share of ICT manufacturing in VA over GDP. The share of BERD in the ICT sector over total BERD (Figure 14e) is very uneven among EU countries. Besides Malta and Cyprus, three countries stand out in this variable: Estonia, Ireland and Finland. The share of the ICT sector GBARD over total GBARD (Figure 14i) is also very uneven among EU countries; Ireland, Belgium, Italy and Luxembourg show the highest shares.

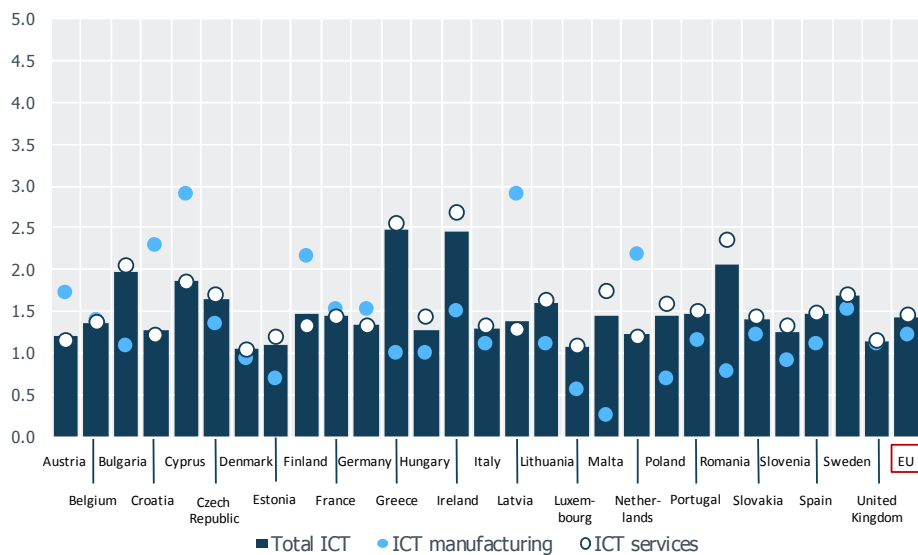
Figure 14 (cont.): ICT sector, ICT manufacturing and ICT services: VA, employment, labour productivity, BERD, BERD intensity, RERD, PERD, GBARD and ICT GBARD by EU Member State (2016)

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



Note: 2014 for Ireland.

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

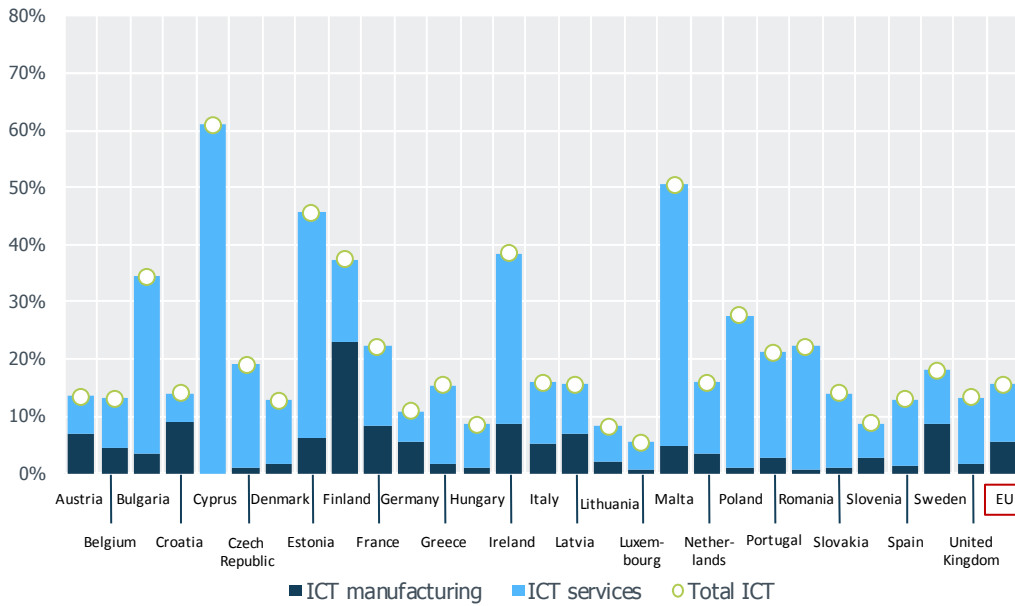


Note: 2014 for Ireland.

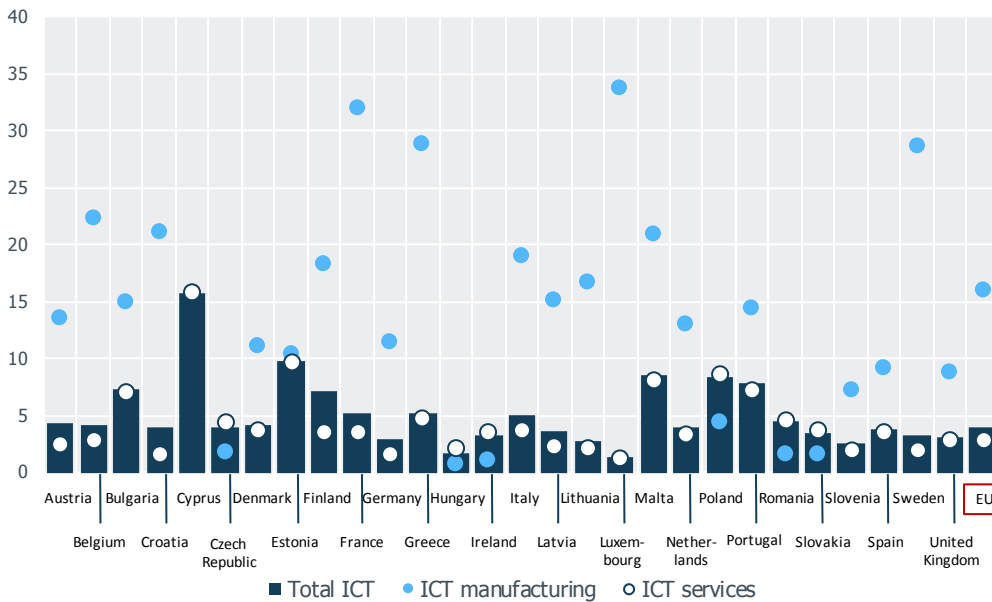
Source: 2019 PREDICT Dataset.

Figure 14 (cont.): ICT sector, ICT manufacturing and ICT services: VA, employment, labour productivity, BERD, BERD intensity, RERD, PERD, GBARD and ICT GBARD by EU Member State (2016)

e) Share of ICT sector BERD on total BERD



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

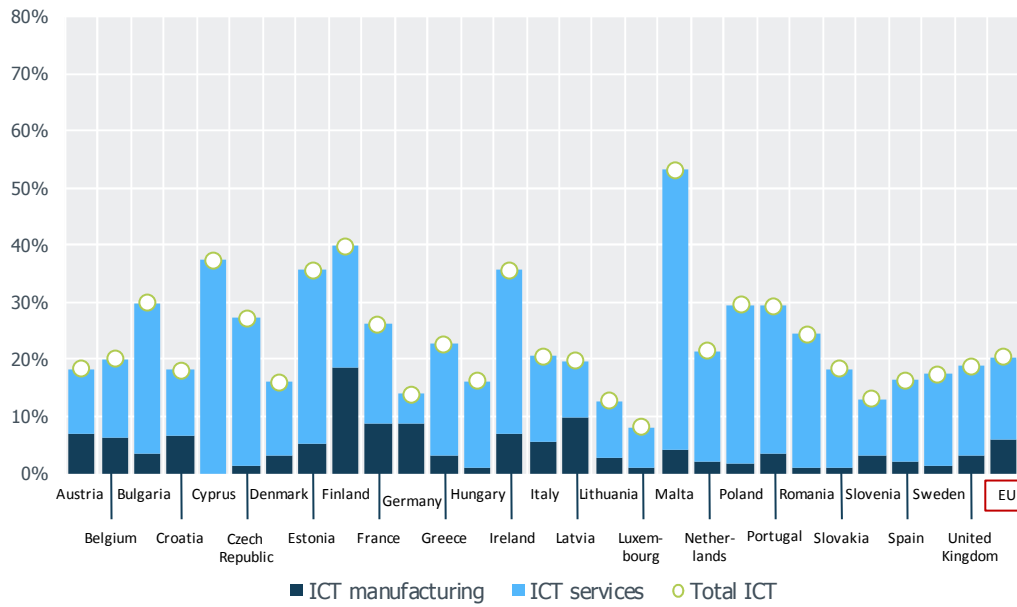


Note: 2014 for Ireland.

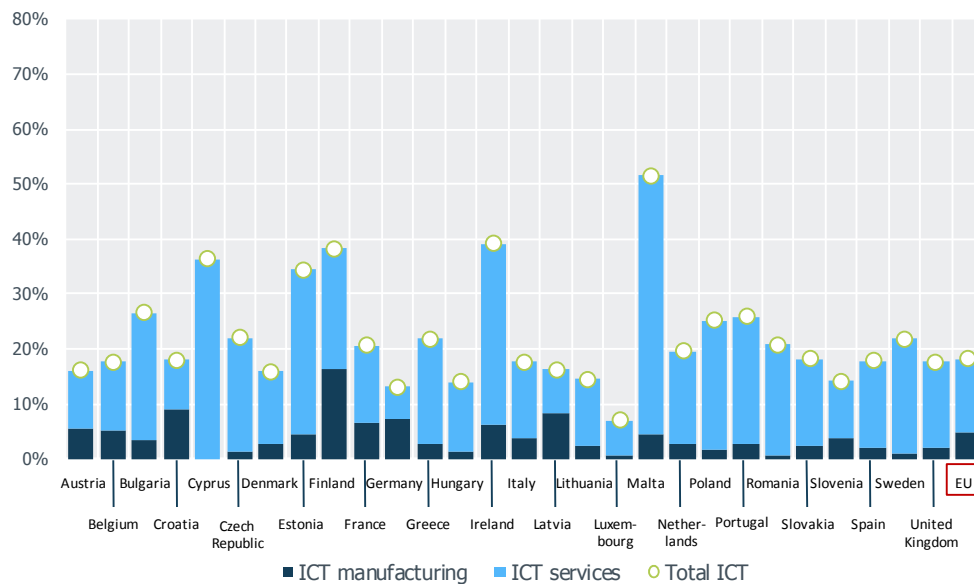
Source: 2019 PREDICT Dataset.

Figure 14 (cont.): ICT sector, ICT manufacturing and ICT services: VA, employment, labour productivity, BERD, BERD intensity, RERD, PERD, GBARD and ICT GBARD by EU Member State (2016)

g) ICT sector RERD share of total RERD



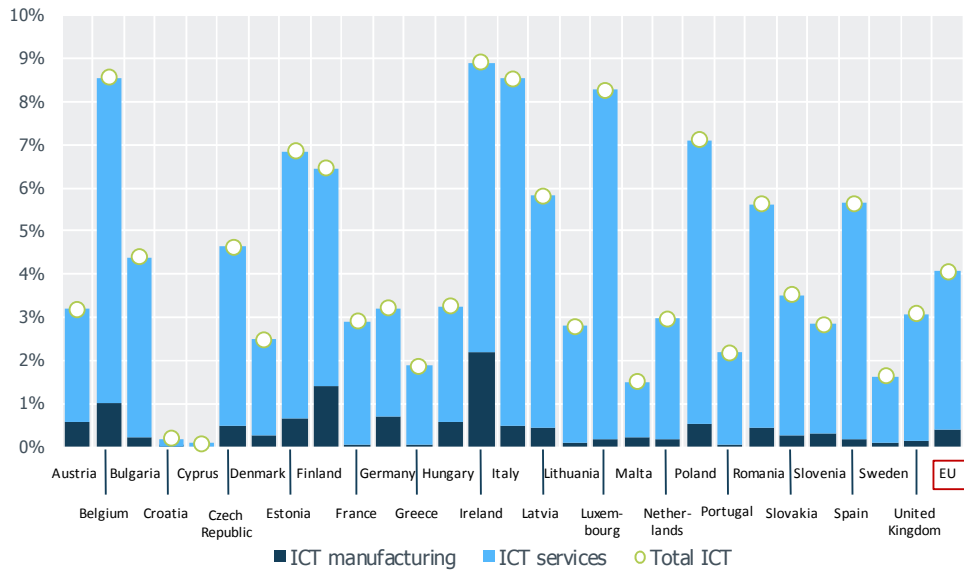
h) ICT sector PERD share of total PERD



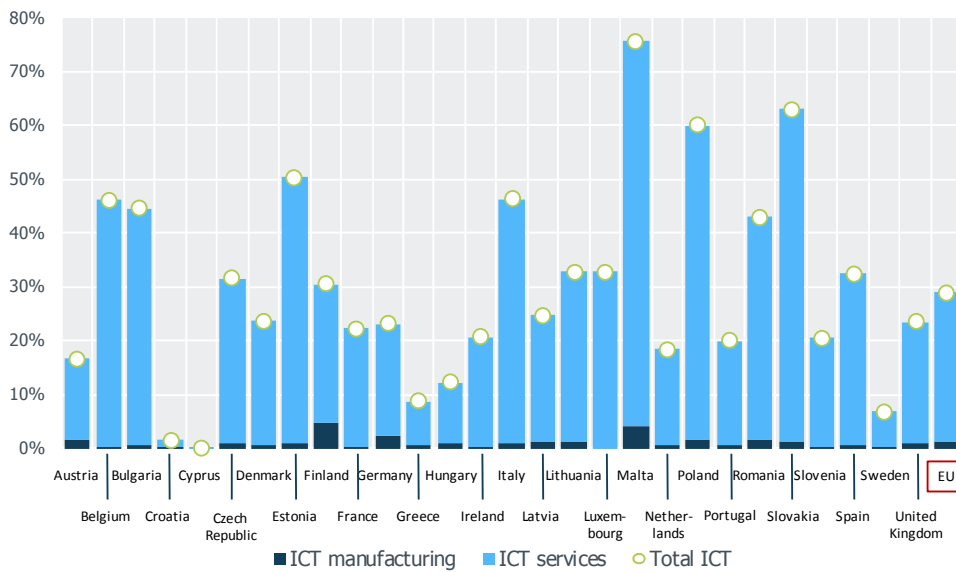
Source: 2019 PREDICT Dataset.

Figure 14 (cont.): ICT sector, ICT manufacturing and ICT services: VA, employment, labour productivity, BERD, BERD intensity, RERD, PERD, GBARD and ICT GBARD by EU Member State (2016)

i) ICT sector GBARD share of total GBARD



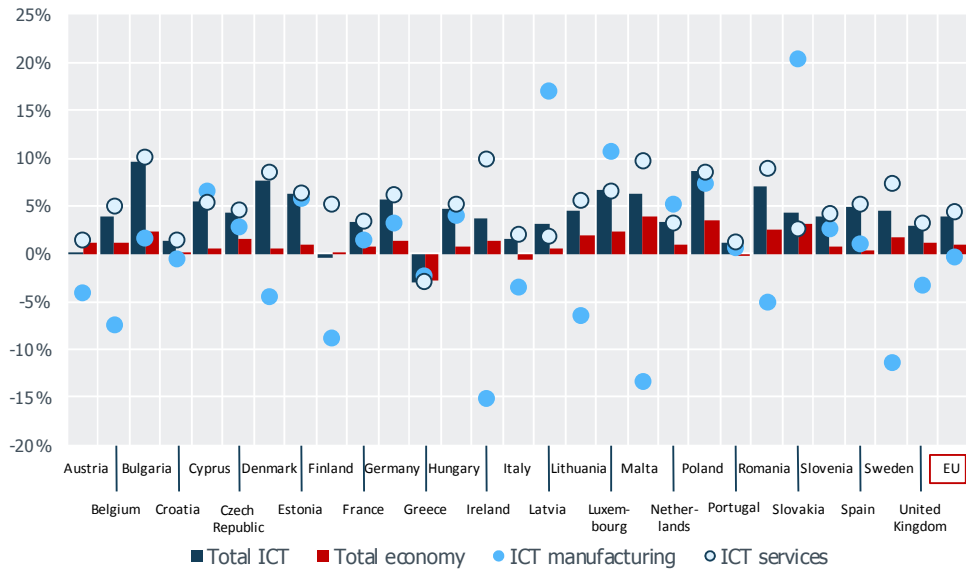
j) ICT sector ICT GBARD share of total ICT GBARD



Note: 2017 for GBARD and ICT GBARD.
Source: 2019 PREDICT Dataset.

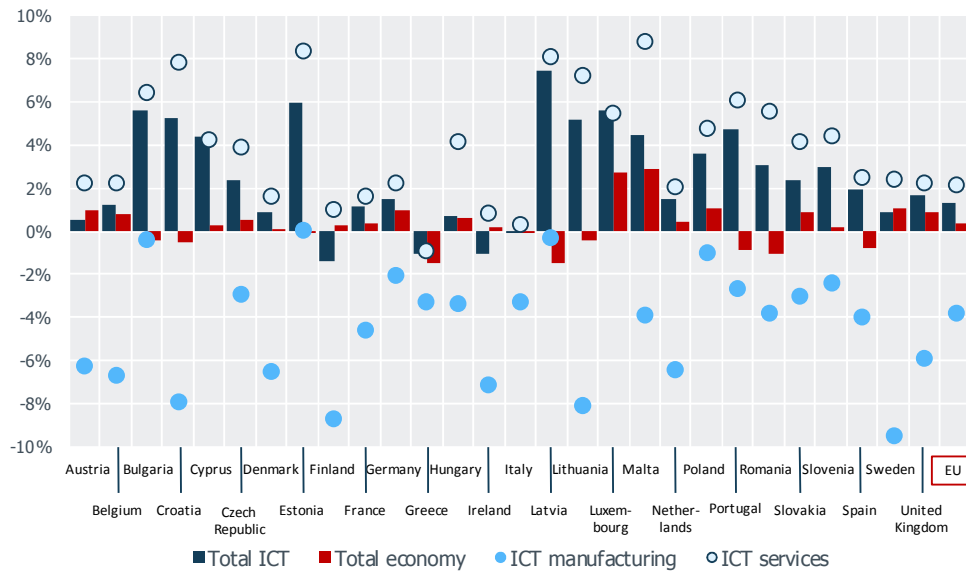
Figure 15: Total economy, ICT sector, ICT manufacturing and ICT services: VA, employment, productivity, BERD, RERD, PERD, GBARD and ICT GBARD by EU Member State. Mean annual growth rates (%) (2006-2016)

a) VA



Note: 2006-2014 for Ireland.

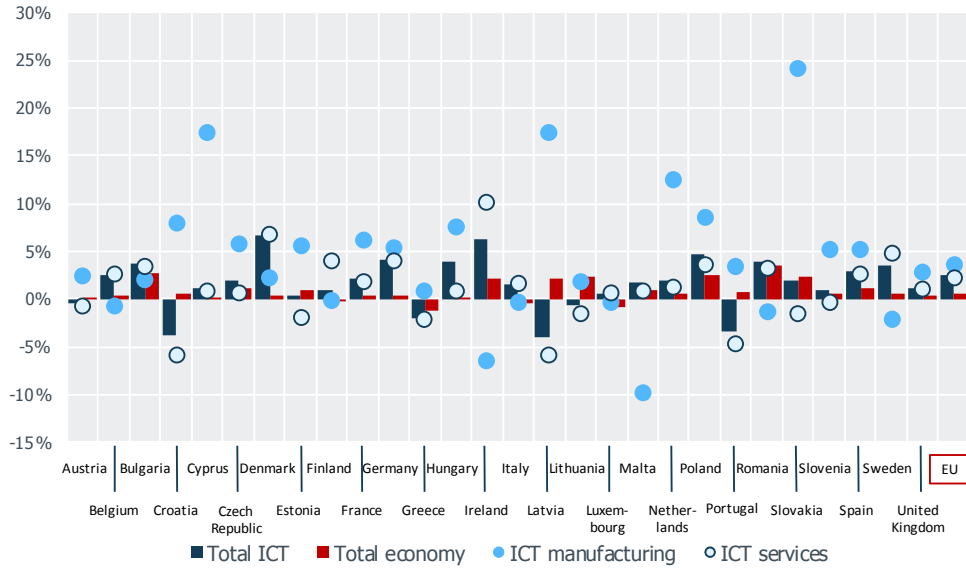
b) Employment



Note: Monetary variables are expressed in real terms.
Source: 2019 PREDICT Dataset.

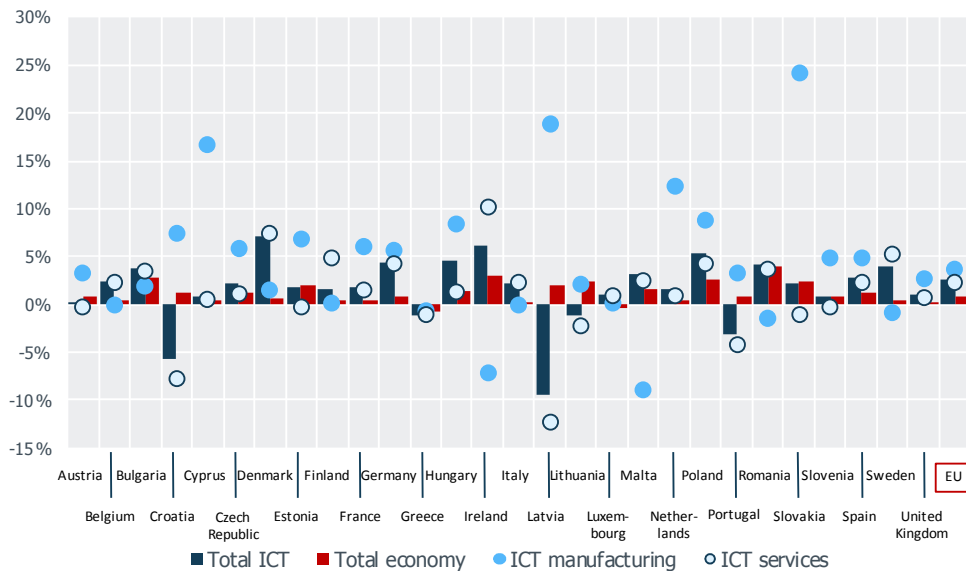
Figure 15 (cont.): Total economy, ICT sector, ICT manufacturing and ICT services: VA, employment, productivity, BERD, RERD, PERD, GBARD and ICT GBARD by EU Member State. Mean annual growth rates (%) (2006-2016)

c) Productivity per person employed



Note: 2006-2014 for Ireland.

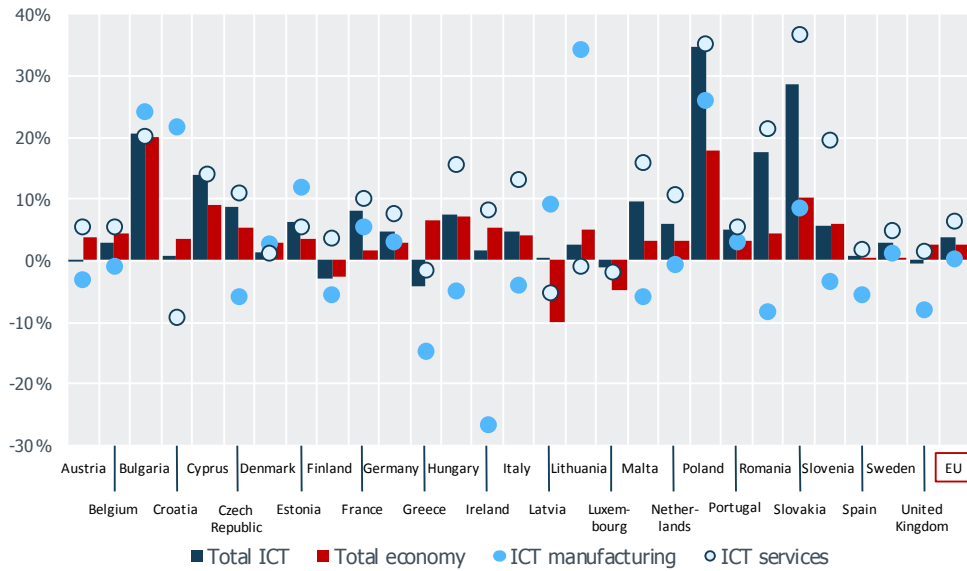
d) Productivity per hour worked



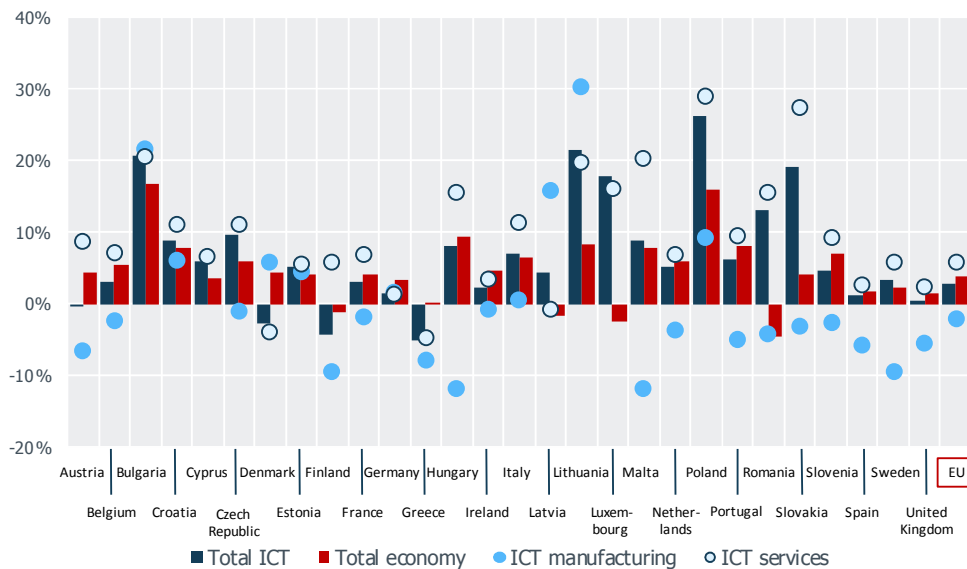
Note: Monetary variables are expressed in real terms. 2006-2014 for Ireland.
Source: 2019 PREDICT Dataset.

Figure 15 (cont.): Total economy, ICT sector, ICT manufacturing and ICT services: VA, employment, productivity, BERD, RERD, PERD, GBARD and ICT GBARD by EU Member State. Mean annual growth rates (%) (2006-2016)

e) BERD



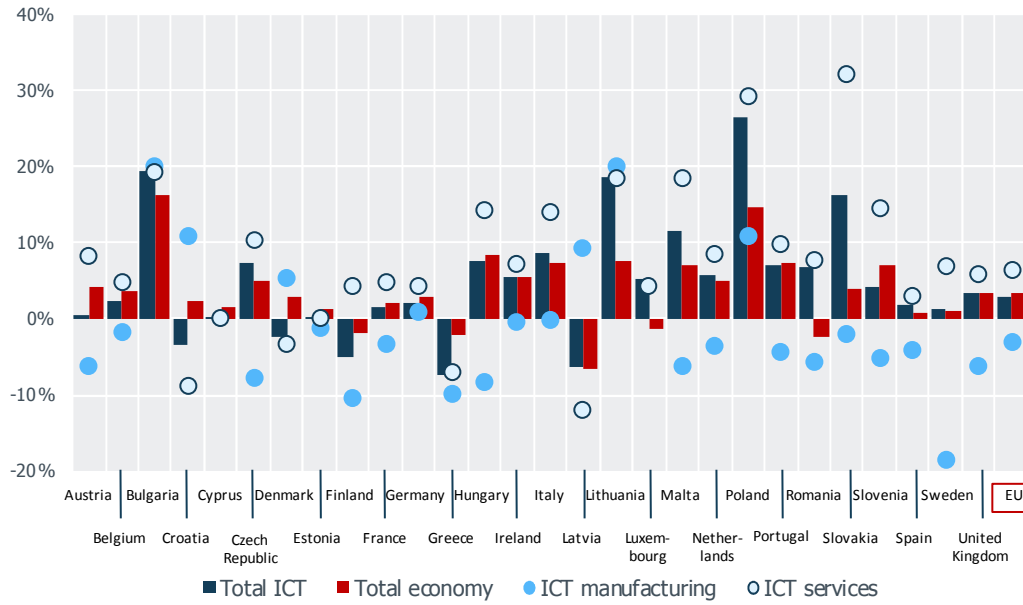
f) RERD



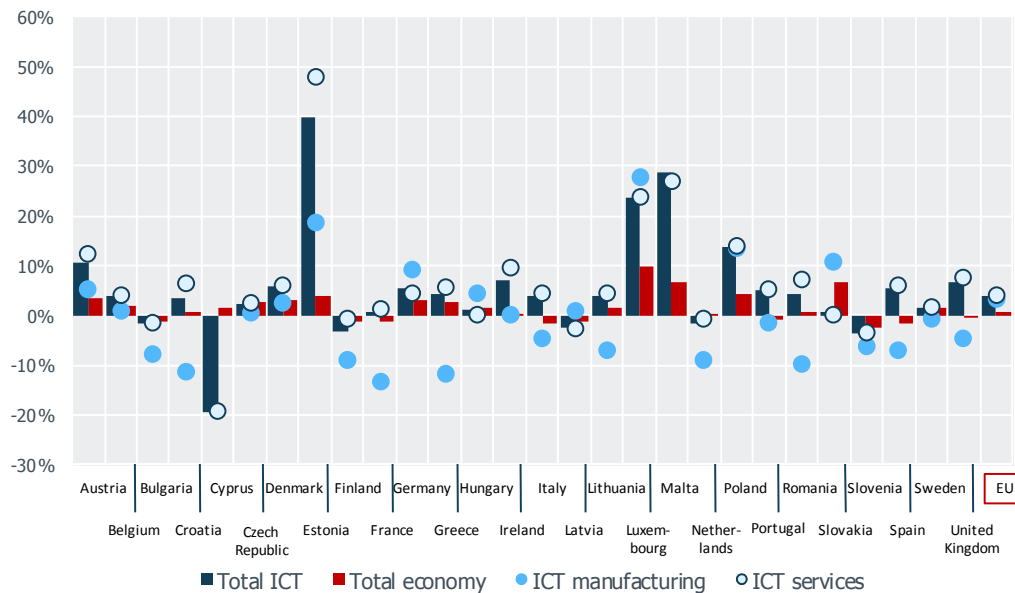
Note: Monetary variables are expressed in real terms.
Source: 2019 PREDICT Dataset.

Figure 15 (cont.): Total economy, ICT sector, ICT manufacturing and ICT services: VA, employment, productivity, BERD, RERD, PERD, GBARD and ICT GBARD by EU Member State. Mean annual growth rates (%) (2006-2016)

g) PERD

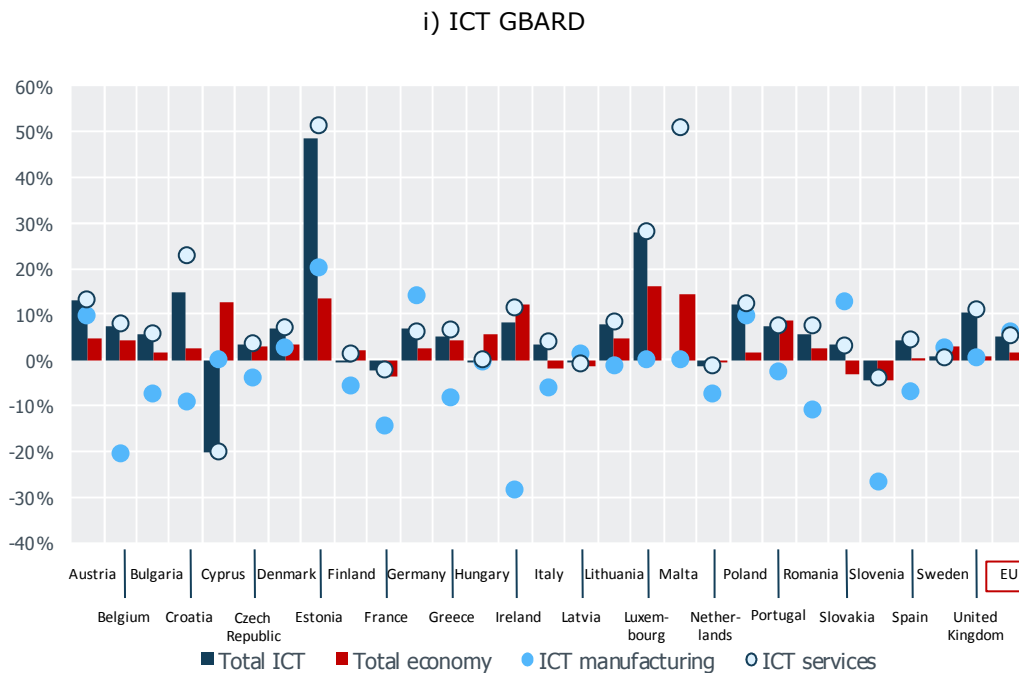


h) GBARD



Note: Monetary variables are expressed in real terms. 2008-2015 for Croatia and 2006-2014 for Ireland.
Source: 2019 PREDICT Dataset.

Figure 15 (cont.): Total economy, ICT sector, ICT manufacturing and ICT services: VA, employment, productivity, BERD, RERD, PERD, GBARD and ICT GBARD by EU Member State. Mean annual growth rates (%) (2006-2016)

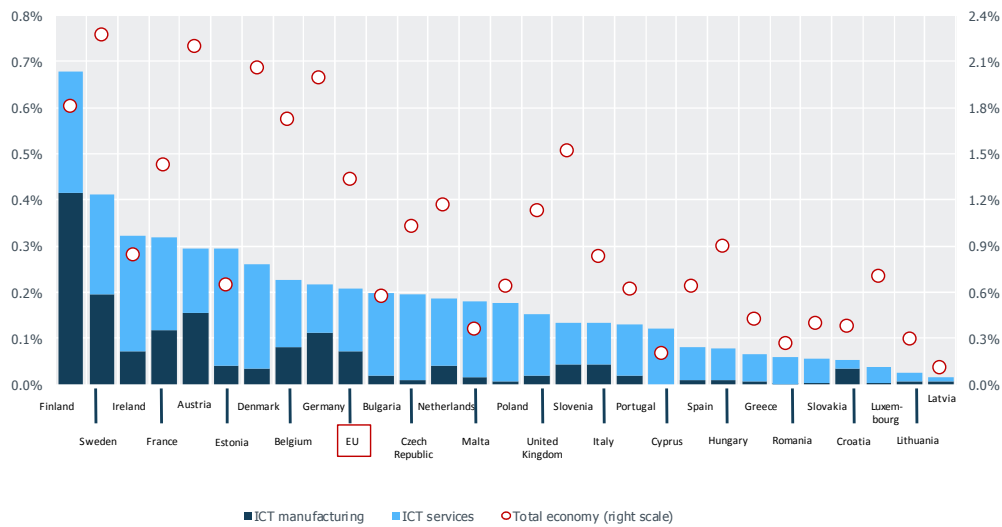


Note: Monetary variables are expressed in real terms. 2008-2015 for Croatia and 2006-2014 for Ireland.
Source: 2019 PREDICT Dataset.

In all EU countries (with the only exceptions of Greece, Finland and Austria), ICT sector VA growth was higher than GDP growth during the 2006-2016 period (Figure 15a). Thirteen, out of 28 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, which was higher than in total employment (Figure 15b). 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 (Figure 15 c-d). For almost all countries, 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 (Figure 15e), and also faster in ICT services than ICT manufactures. However, this pattern cannot be considered a general one. The countries with the highest growth rate of BERD in the ICT sector were Poland and Slovakia, while Finland, Greece, Luxembourg, Austria and United Kingdom showed a negative change. Growth rates in R&D researchers and R&D personnel in the ICT sector were especially high in Lithuania, Poland, Bulgaria and Slovakia (Figure 15 f-g). GBARD in the ICT sector grew at the fastest rate in Luxembourg, Malta, Poland and Estonia (Figure 15h).

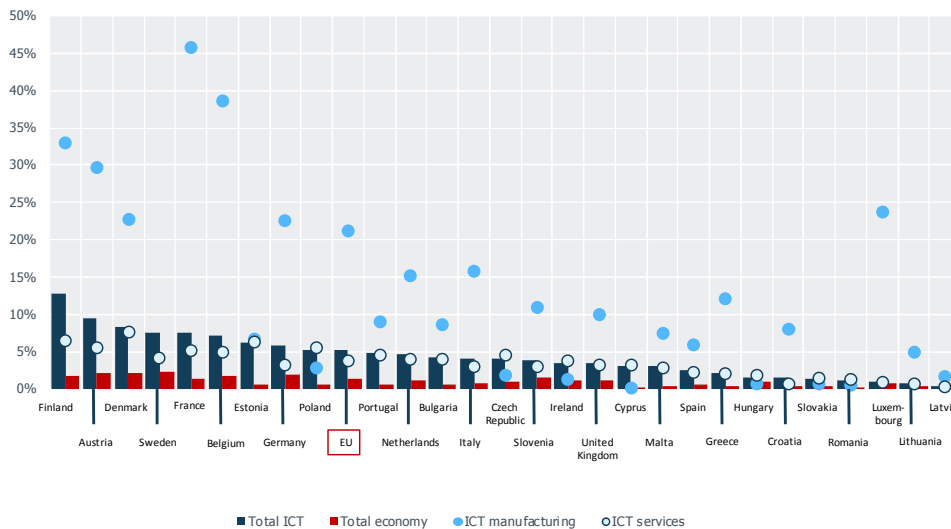
Figure 16: BERD intensity by EU Member State (2016)

a) BERD/GDP



Source: 2018 PREDICT Dataset, elaborated by JRC-Dir. B and Ivie

b) ICT sector BERD/ICT sector VA



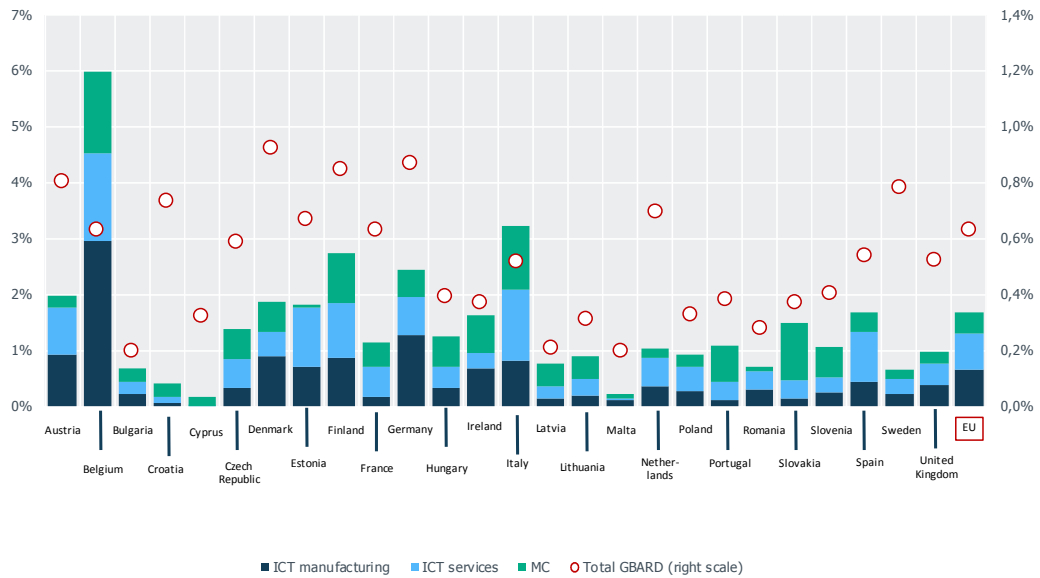
Note: 2014 for Ireland. ICT manufacturing for Sweden is available but has been excluded due to high value (65.2%)

Source: 2019 PREDICT Dataset.

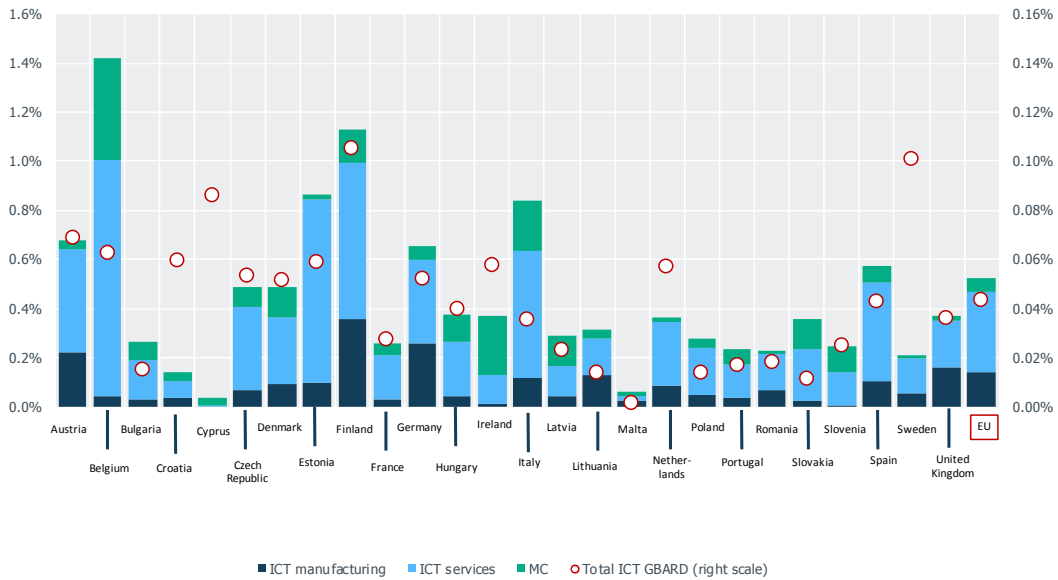
BERD intensity (BERD/GDP) is very different among EU countries. Sweden and Austria showed the highest ratio for the total economy in 2016. In the case of the ICT sector, Finland and Sweden stand out (Figure 16a). For ICT sectors, BERD intensity at industry level (defined as ICT sector BERD/ICT sector VA) is higher than the one of the total economy, and higher in ICT manufacturing than in ICT services. Finland and Austria are the countries with the highest ratio for the ICT sector (Figure 16b).

Figure 17: ICT manufacturing, ICT services, MC and Total GBARD and ICT GBARD by EU Member State (2016)

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



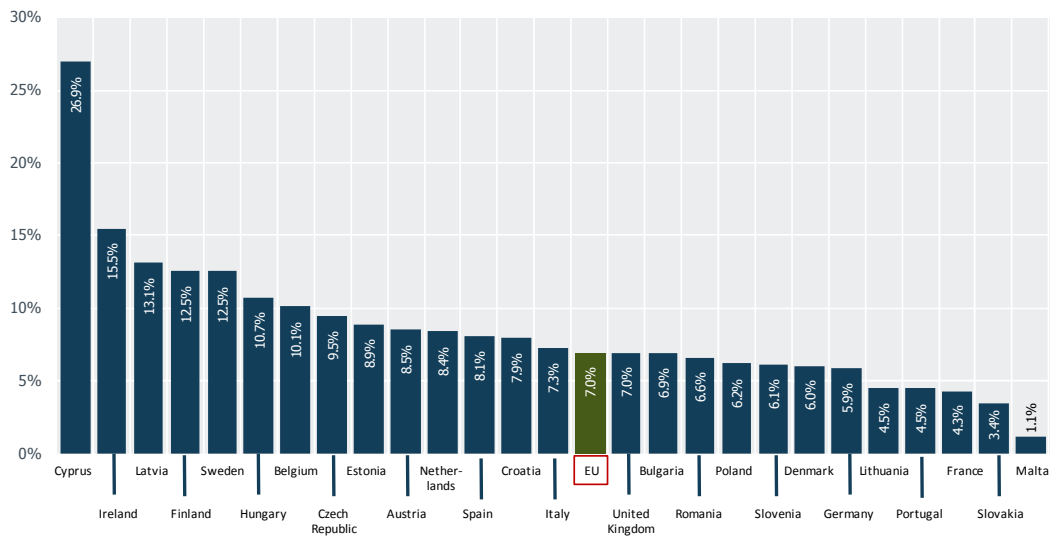
b) ICT GBARD intensity (sub-sector ICT GBARD/sub-sector VA)



Note: 2014 for Ireland. Data for Greece and Luxembourg no reliable.
Source: 2019 PREDICT Dataset.

Figure 17 (cont.): ICT manufacturing, ICT services, MC and Total GBARD and ICT GBARD by EU Member State (2016)

c) ICT GBARD/GBARD



Note: 2017 for GBARD and ICT GBARD. Data for Greece and Luxembourg not reliable.
Source: 2019 PREDICT Dataset.

GBARD intensity (defined as sub-sector GBARD/sub-sector VA) is very different among EU countries for the total economy, and also for ICT manufactures, ICT services and MC sector (Figure 17a). In the case of the total economy, the highest values (above 0.8%) correspond to Denmark, Germany, Finland and Austria. For ICT manufacturing, ICT services and MC, Belgium, Italy and Finland stand out. Similar results are observable also for ICT GBARD (Figure 17b) where, again, Belgium and Finland stand out for the highest values of the sum of the three sub-sectors. However, in this case, Finland and Sweden are the two countries with the highest ICT GBARD intensity in the total economy. Finally, the ratio between ICT GBARD and total GBARD (Figure 17c) reaches the highest values in Ireland, Latvia, Finland and Sweden, as well as Cyprus.

3 The EU ICT sector in the international context

In the international context, the EU holds an intermediate position in value added, employment and BERD. Whereas the EU ICT sector represented 4.0% of total VA in the economy and 2.6% of the employment in 2016, the ratios in Taiwan (16.0% in VA, 8.8% in employment), South Korea (8.2%, 4.4%), Japan (5.8%, 3.1%) or even in the US (5.4%, 2.7%) are notably higher. Europe also lagged behind the leaders for its BERD intensity (BERD/VA) in the ICT sector. In 2016, the EU ICT sector BERD intensity (5.2%) has been much lower than the one of South Korea (20.9%), the US (11.9%) and Taiwan (11.3%). With levels of BERD intensity similar to the one of EU, it is possible to observe China (5.7%) and Australia (5.2%) (Table 3). In 2016, the annual growth of the EU ICT sector VA (4.7%) was modest, as it is slightly more than half of that of the most performing countries (Australia 9.0%, China 8.8% and India 8.5%). In terms of employment growth in the ICT sector, the EU (1.8%) comes fifth among the countries included in PREDICT. The EU ICT BERD growth in 2016 (4.0%) was among the lowest of all the countries available, and the difference with the more dynamic countries is remarkable: Russia (20.1%), Australia (18.7%), China (15.6%) and Norway (11.3%). In 2016, the ICT GBARD intensity (ICT GBARD/GDP) in the EU (0.04%) was lower than in the US (0.07%) and Japan (0.06%). The EU ICT GBARD grew at a rate of 2.0%, while in Japan it decreased by 2.0% and in the US it raised by 6.9%.

Table 3: Summary table of ICT indicators for the European Union and other economies

a) 2016

	VA	Employment	BERD		GBARD	ICT GBARD		RERD	PERD
	ICT sector (Millions of current EUR PPS)	ICT sector (thousand 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 (thousand full-time equivalent)	ICT sector (thousand full-time equivalent)
Australia	28,840.2	367.0	1,493.6	-	-	-	-	9.3	17.3
Brazil	62,597.6	1,200.5	1,521.1	-	-	-	-	16.6	23.6
Canada	44,272.2	500.5	2,707.9	-	-	-	-	34.2	40.5
China	764,065.3	15,994.7	43,932.3	-	-	-	-	194.7	510.2
EU	591,398.9	6,009.2	31,008.2	3,774.1	94,796.0	1,842.6	6,544.6	194.4	302.1
India	337,517.1	5,718.2	2,062.3	-	-	-	-	13.0	24.5
Japan	230,717.1	2,097.3	18,501.9	-	25,358.2	-	2,559.2	126.1	134.4
South Korea	113,887.3	1,147.0	23,833.7	-	-	-	-	119.6	132.0
Norway	7,225.6	71.7	689.0	-	-	-	-	5.4	7.1
Russia	58,148.5	1,002.4	1,141.8	-	-	-	-	5.7	10.1
Switzerland	16,424.8	147.3	-	-	-	-	-	-	-
Taiwan	133,258.3	991.8	15,123.2	-	-	-	-	71.3	129.9
United States	743,244.0	4,362.1	88,364.7	2,448.8	110,684.0	705.6	9,187.1	369.0	-

b) Annual growth rates (%), 2015-2016

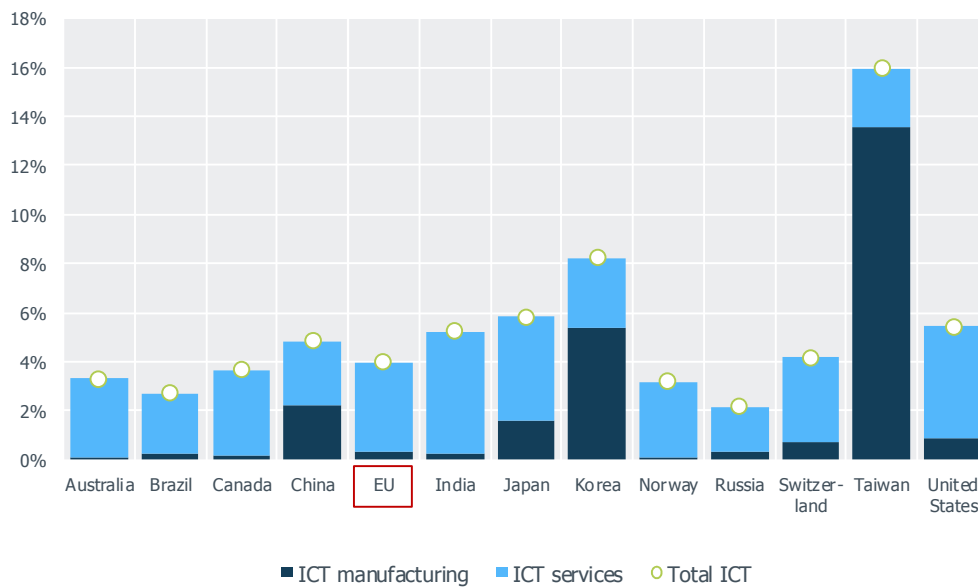
	VA	Employment	BERD		GBARD	ICT GBARD		RERD	PERD
	ICT sector	ICT sector	ICT sector	ICT sector	Total Economy	ICT sector	Total Economy	ICT sector	ICT sector
Australia	9.0	6.4	18.7	-	-	-	-	13.2	11.4
Brazil	-1.5	-4.7	-	-	-	-	-	-	-
Canada	3.6	3.1	-3.4	-	-	-	-	-2.0	-11.3
China	8.8	0.1	15.6	-	-	-	-	2.8	3.3
EU	4.7	1.8	4.0	1.3	0.9	2.1	2.0	3.9	3.3
India	8.5	-0.9	9.7	-	-	-	-	9.3	17.1
Japan	-0.1	-1.1	-7.2	-	-0.9	-	-2.0	-1.8	-4.9
South Korea	4.3	0.2	8.3	-	-	-	-	-1.6	-1.5
Norway	3.1	2.6	11.3	-	-	-	-	7.4	8.0
Russia	-4.1	-0.7	20.1	-	-	-	-	3.1	-5.1
Switzerland	1.6	0.1	-	-	-	-	-	-	-
Taiwan	5.4	-1.2	7.6	-	-	-	-	2.8	2.7
United States	6.1	2.7	7.1	6.7	7.2	7.0	6.9	-1.1	-

Note: 2015 for Canada (VA), 2014 for Brazil (BERD, RERD and PERD) and 2013 for India (BERD, RERD and PERD). ICT sector PERD for United States not included because of lack of homogeneous data. ICT sector for United States (GBARD and ICTGBARD) includes 268 NACE Rev.2 sector (Manufacture of magnetic and optical media).

Source: 2019 PREDICT Dataset.

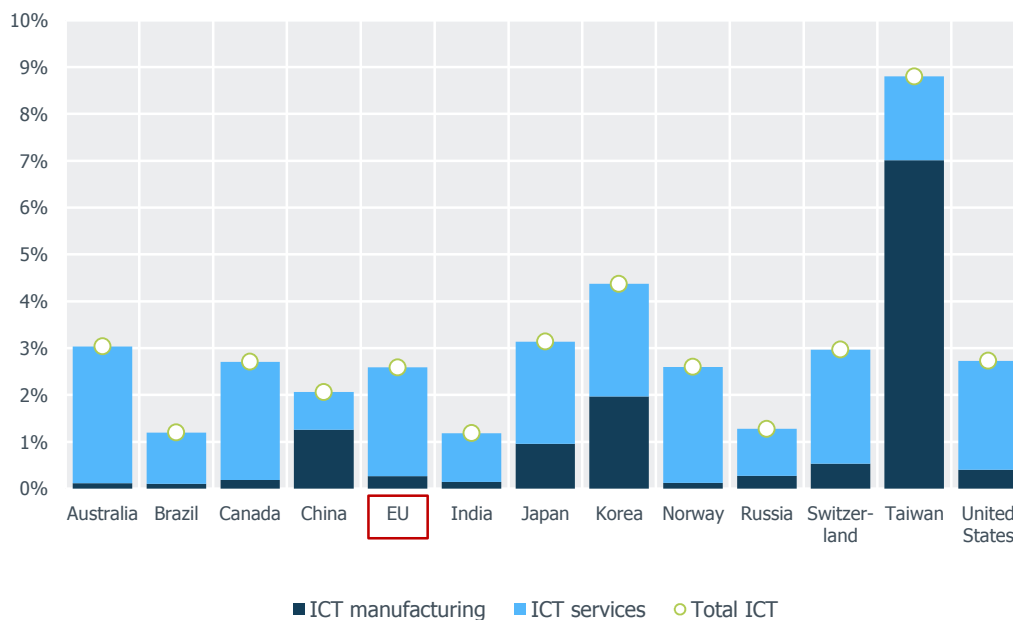
Figure 18: ICT sector, ICT manufacturing and ICT services in the international context: VA, employment, BERD, RERD, PERD, GBARD and ICT GBARD (2016)

a) ICT sector VA share of GDP



Note: 2015 for Canada.

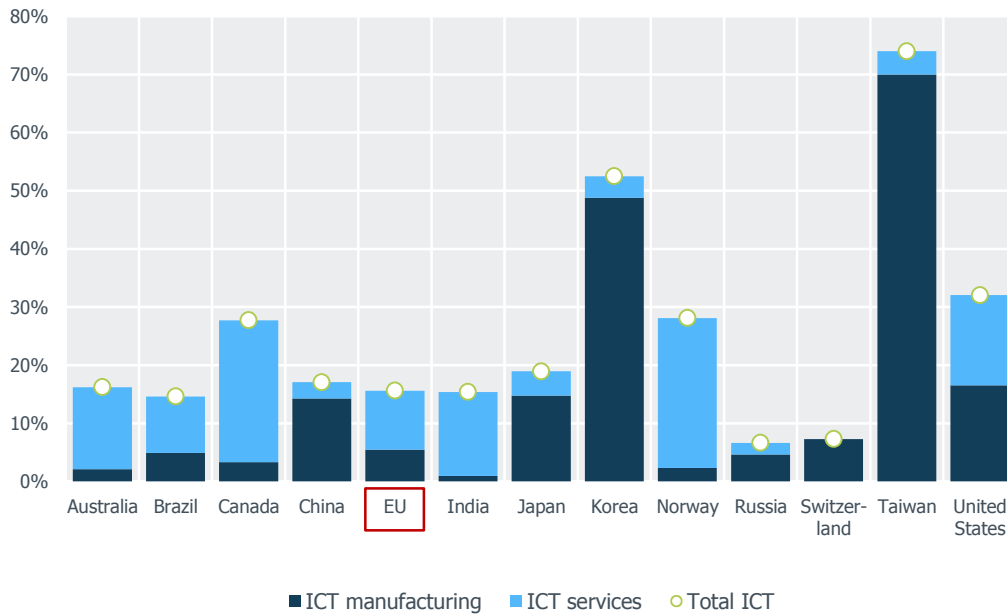
b) ICT sector employment share of total employment



Source: 2019 PREDICT Dataset.

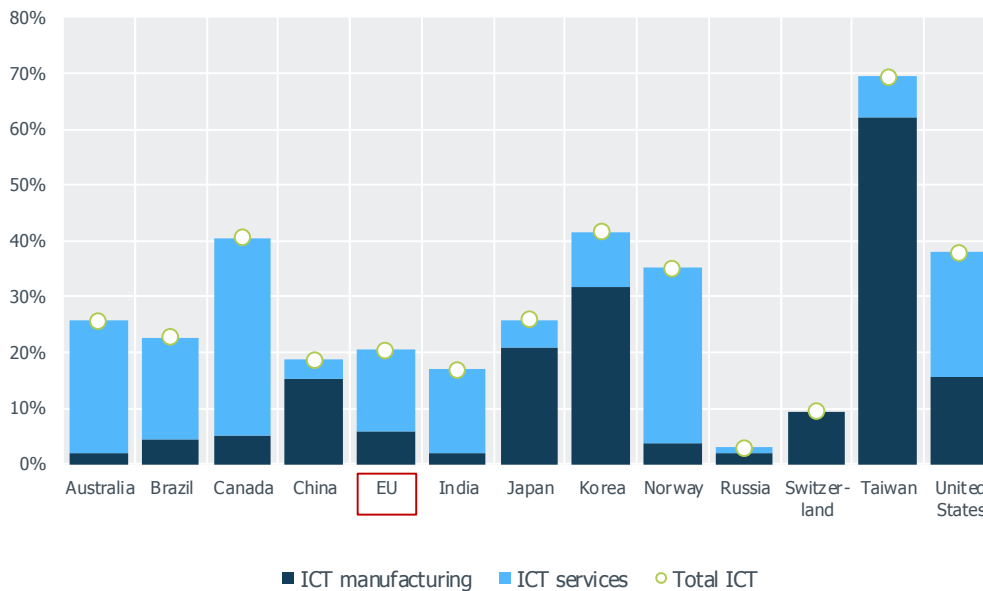
Figure 18 (cont.): ICT sector, ICT manufacturing and ICT services in the international context: VA, employment, BERD, RERD, PERD, GBARD and ICT GBARD (2016)

c) ICT sector BERD share of total BERD



Note: 2013 for India, 2014 for Brazil and 2015 for Switzerland. ICT sector for Switzerland includes only ICT manufacturing.

d) ICT sector RERD share of total RERD

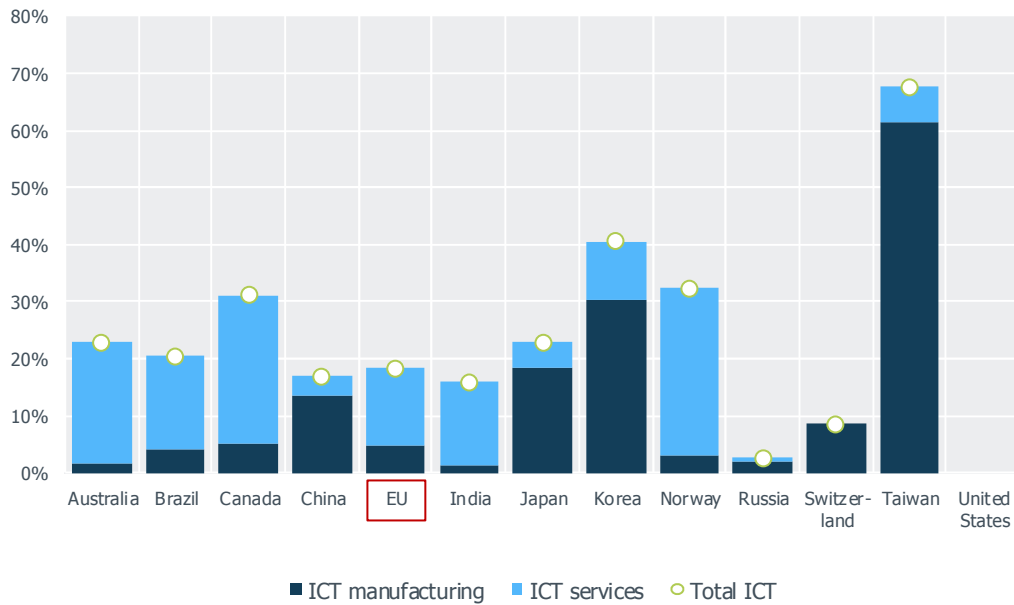


Note: 2013 for India, 2014 for Brazil and 2015 for Switzerland. ICT sector for Switzerland includes only ICT manufacturing.

Source: 2019 PREDICT Dataset.

Figure 18 (cont.): ICT sector, ICT manufacturing and ICT services in the international context: VA, employment, BERD, RERD, PERD, GBARD and ICT GBARD (2016)

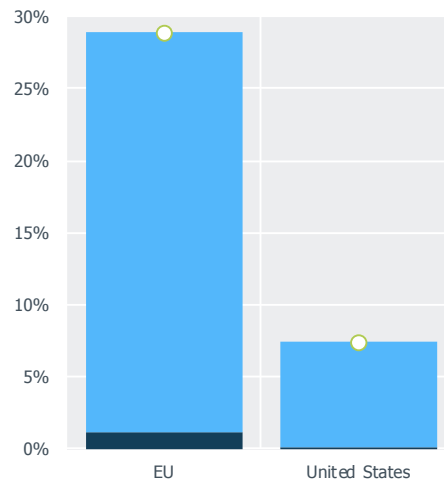
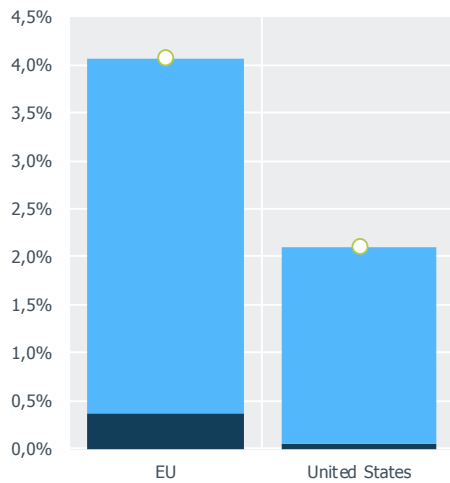
e) ICT sector PERD share of total PERD



Note: 2013 for India, 2014 for Brazil and 2015 for 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



■ ICT manufacturing ■ ICT services ○ Total ICT

Note: 2017 for GBARD and ICT GBARD. ICT manufacturing for United States includes 268 NACE Rev.2 sector (Manufacture of magnetic and optical media).

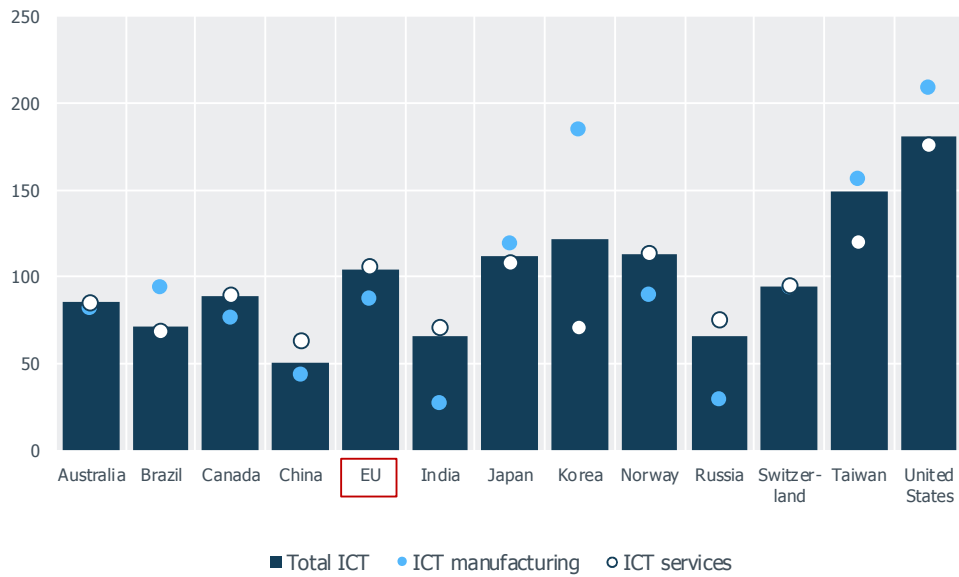
Source: 2019 PREDICT Dataset.

The Asian countries, Taiwan (16.0%), South Korea (8.2%) and Japan (5.8%), have the largest ICT sector measured as ICT VA share over total GDP (Figure 18a). In 2016, India (5.2%) had a similar share to the US (5.4%), with China (4.9%) approaching it. All the countries aforementioned had a larger share than the EU (4.0%). Taiwan (8.8%), South Korea (4.4%) and Japan (3.1%) also take the lead in terms of employment (Figure 18b), followed by Australia (3.0%), Switzerland (3.0%) and US (2.7%), all of which had larger shares than the EU (2.6%). China (2.1%), Russia (1.3%), Brazil (1.2%) and India (1.2%) lagged behind. Taiwan, South Korea, followed by US, Canada and Norway are the countries with the largest share of BERD (Figure 18c), R&D researchers (Figure 18d) and R&D personnel⁶ (Figure 18e) in the ICT sector over the total. The first two countries also stand out for the size of their ICT manufacturing sector. The EU occupies an intermediate position among the countries included in the PREDICT Dataset. It only surpasses the US in public funded R&D (GBARD) and ICT GBARD in the ICT sector (Figure 18 f-g).

⁶ No data on R&D personnel available for the US.

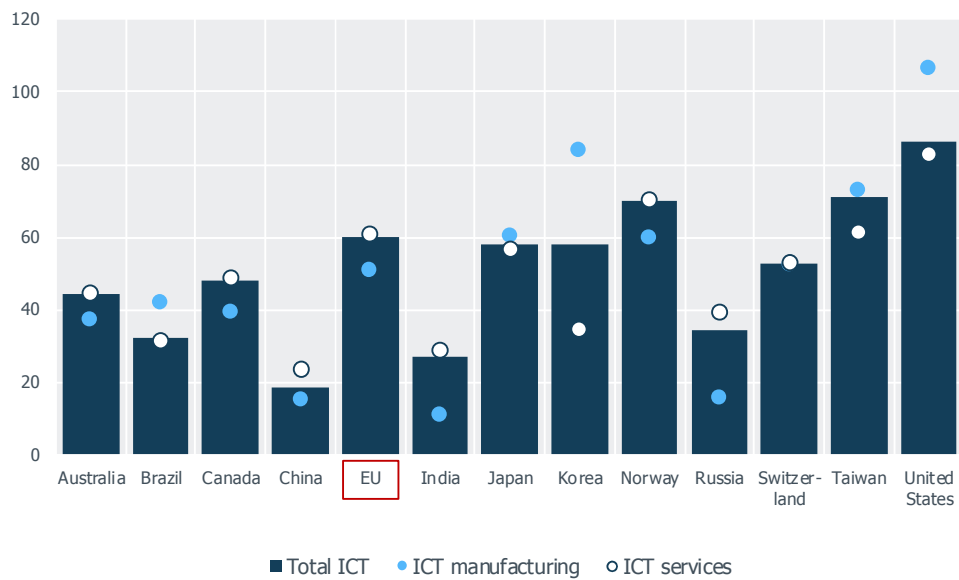
Figure 19: ICT sector, ICT manufacturing and ICT services in the international context: labour productivity (2016)

a) ICT sector productivity per person employed (Thousands of euros PPS 2010 per person)



Note: 2015 for Canada.

b) ICT sector productivity per hour worked (Euros PPS 2010 per hour worked)

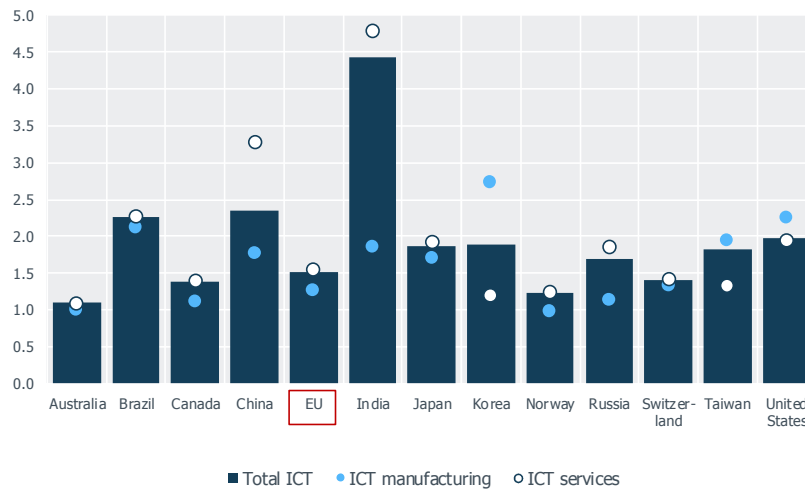


Note: 2015 for Canada.

Source: 2019 PREDICT Dataset.

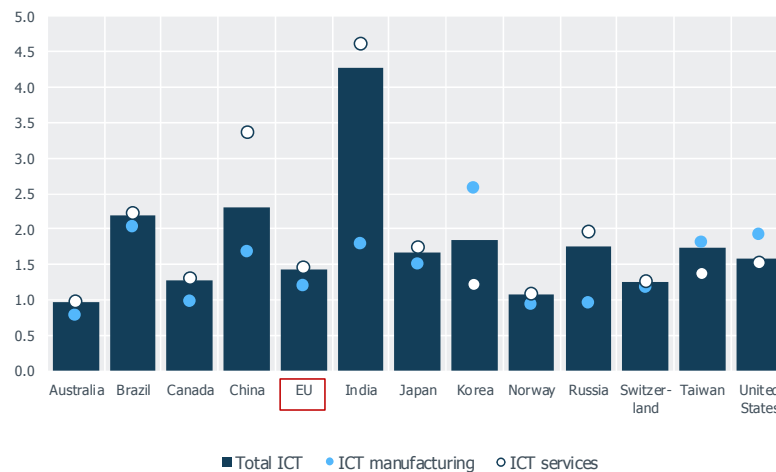
Figure 19 (cont.): ICT sector, ICT manufacturing and ICT services in the international context: labour productivity (2016)

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



Note: 2015 for Canada.

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

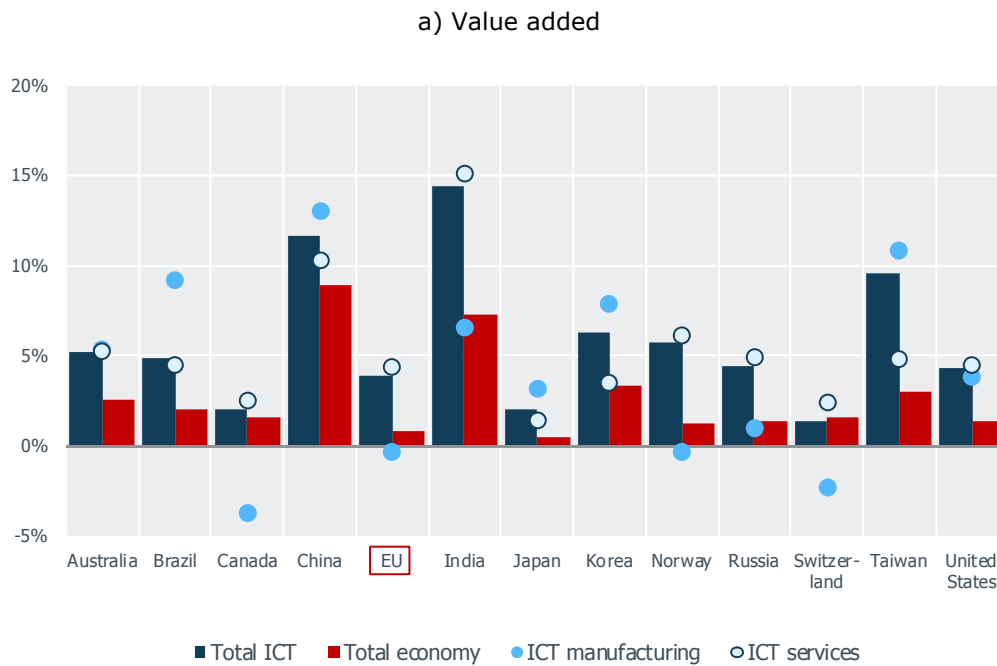


Note: 2015 for Canada.

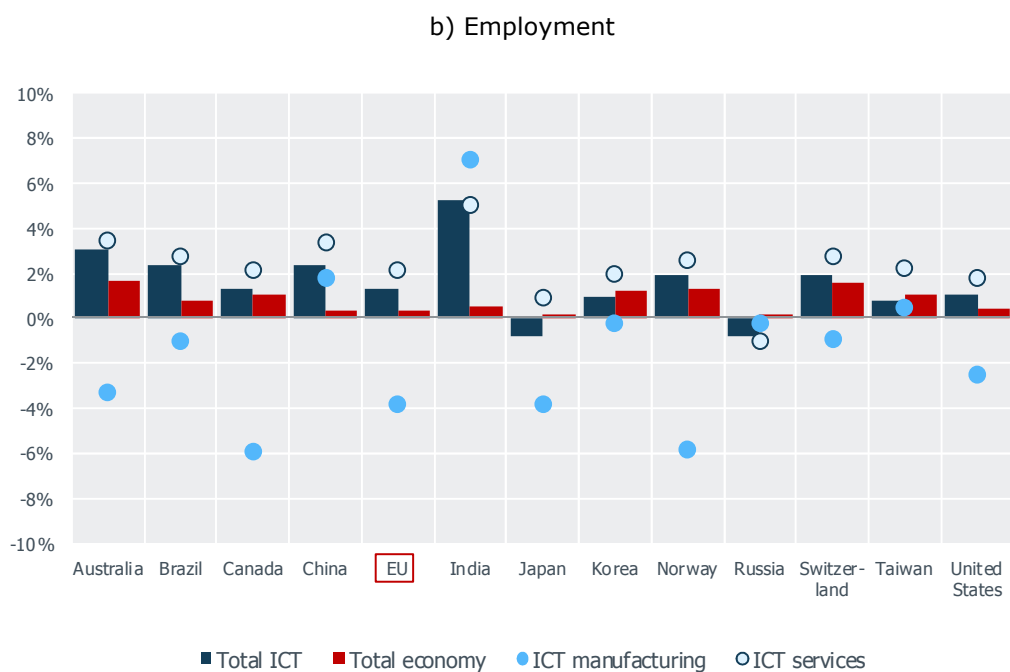
Source: 2019 PREDICT Dataset.

The US is the country with the highest labour productivity in the ICT sector, in terms of persons and also per hour worked (Figure 19 a-b). Its leadership is especially noticeable in the ICT manufacturing sector, followed by Taiwan, South Korea (in terms of persons) and Norway (in terms of hours worked). The EU occupies the sixth position when productivity is defined by person employed (Figure 19c) and the fourth per hour worked (Figure 19d). In the EU, labour productivity is higher in the ICT service than in ICT manufacturing. In all countries considered, labour productivity in the ICT sector is similar or exceeds the total economy, both in terms of persons and hours worked. In India it is almost 4 times higher and in China and Brazil more than double. Productivity by hour worked in the ICT sector (Figure 19d) is about 1.5 higher than that of total economy in the EU and the US. However, while in the US the gap is larger in ICT manufacturing, in the EU it is larger in ICT services.

Figure 20: Total economy, ICT sector, ICT manufacturing and ICT services in the international context. Mean annual growth rates (%) (2006-2016)



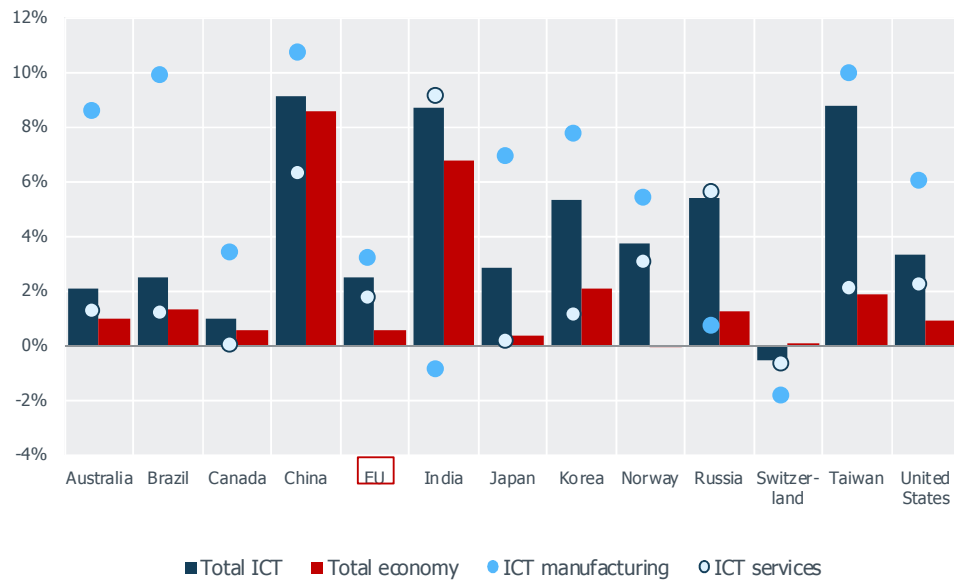
Note: 2006-2015 for Canada.



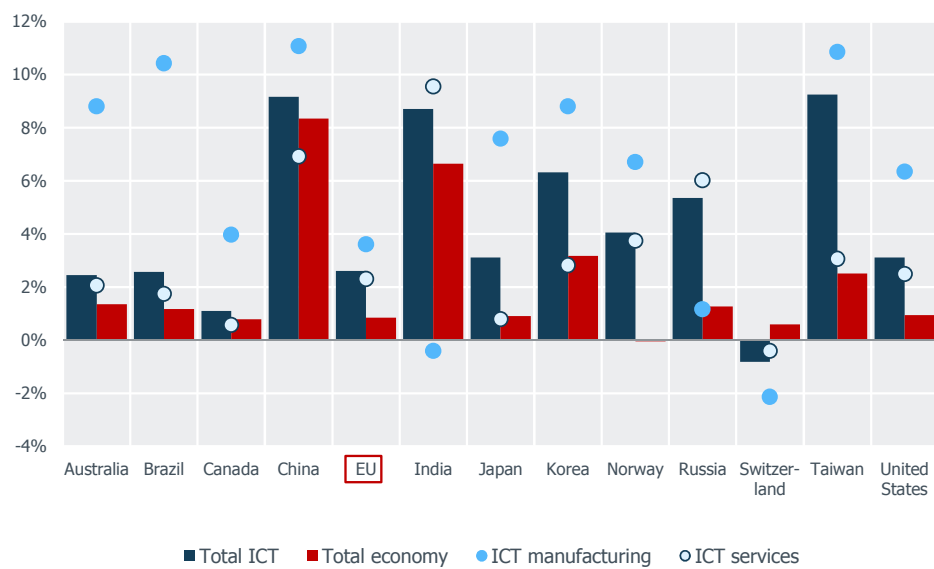
Note: Monetary variables are expressed in real terms.
Source: 2019 PREDICT Dataset.

Figure 20 (cont.): Total economy, ICT sector, ICT manufacturing and ICT services in the international context. Mean annual growth rates (%) (2006-2016)

c) Productivity per person employed

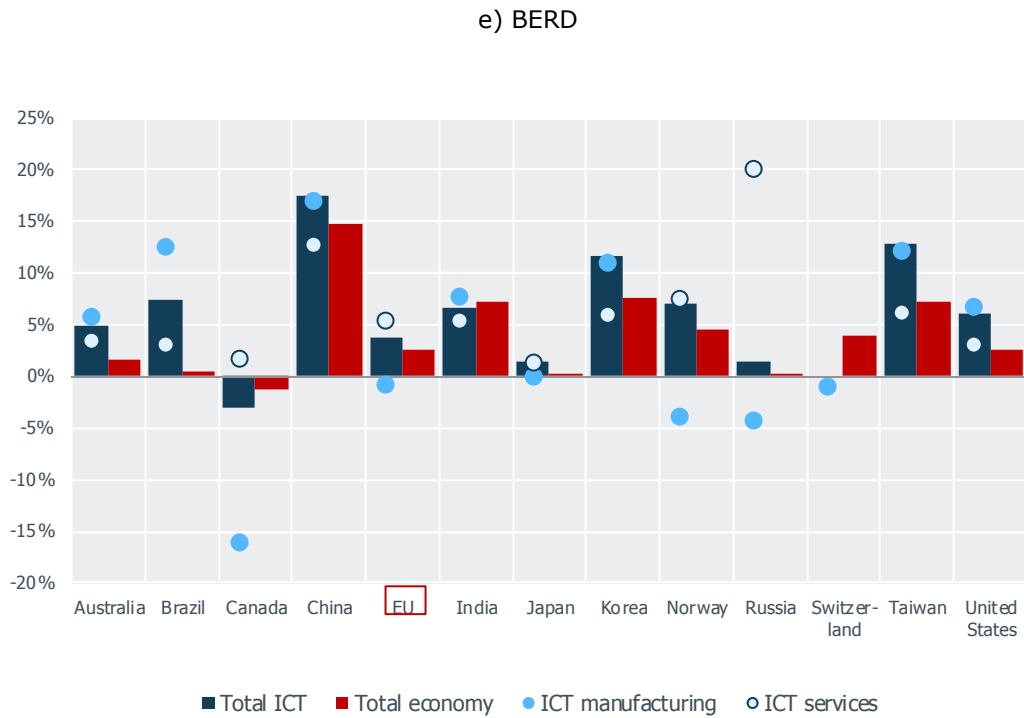


d) Productivity per hour worked

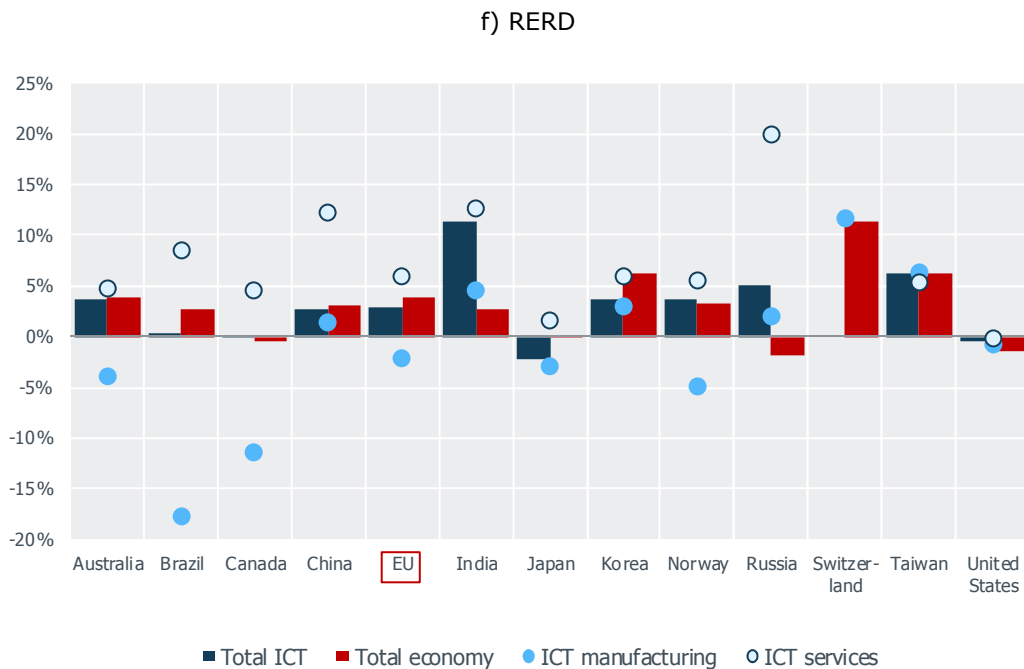


Note: Monetary variables are expressed in real terms. 2006-2015 for Canada.
Source: 2019 PREDICT Dataset.

Figure 20 (cont.): Total economy, ICT sector, ICT manufacturing and ICT services in the international context. Mean annual growth rates (%) (2006-2016)

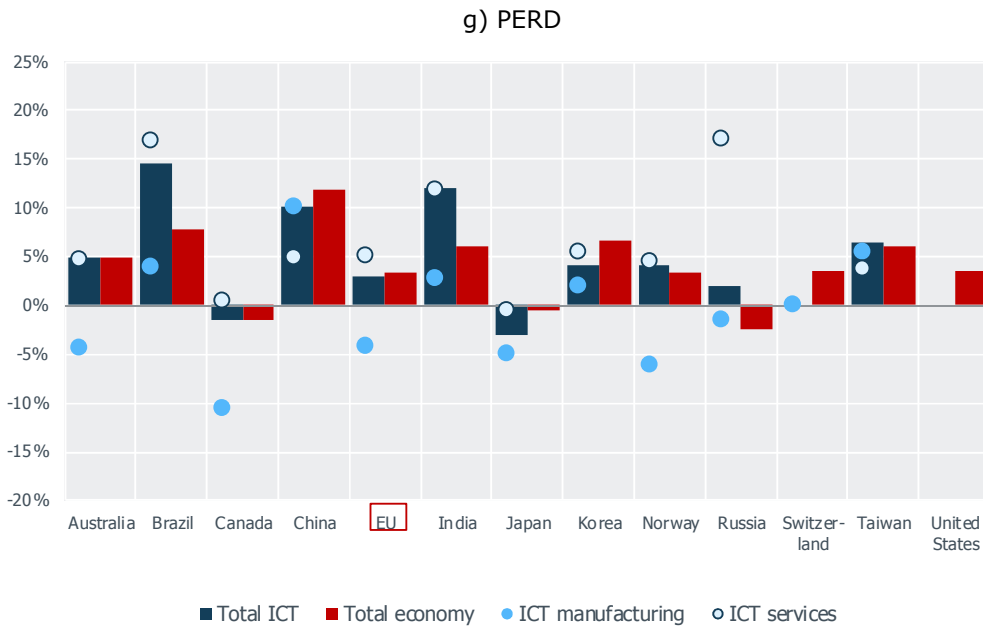


Note: 2008-2014 for Brazil, 2006-2013 for India, 2008-2015 for Switzerland and 2006-2015 for Canada. ICT sector for Switzerland includes only ICT manufacturing.

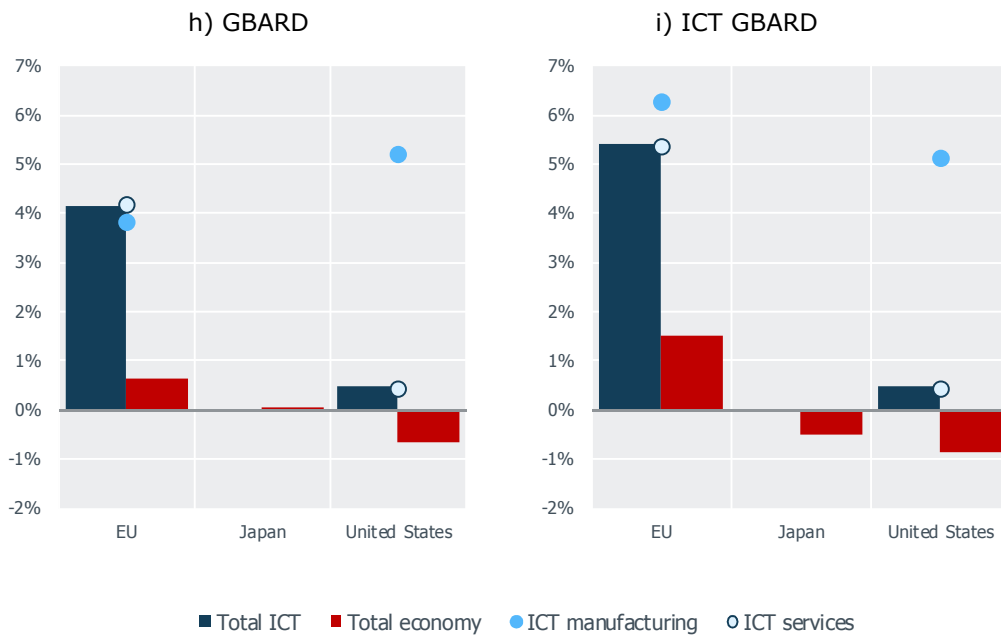


Note: Monetary variables are expressed in real terms. 2011-2014 for Brazil, 2006-2013 for India and 2008-2015 for Switzerland. ICT sector for Switzerland includes only ICT manufacturing. Source: 2019 PREDICT Dataset.

Figure 20 (cont.): Total economy, ICT sector, ICT manufacturing and ICT services in the international context. Mean annual growth rates (%) (2006-2016)



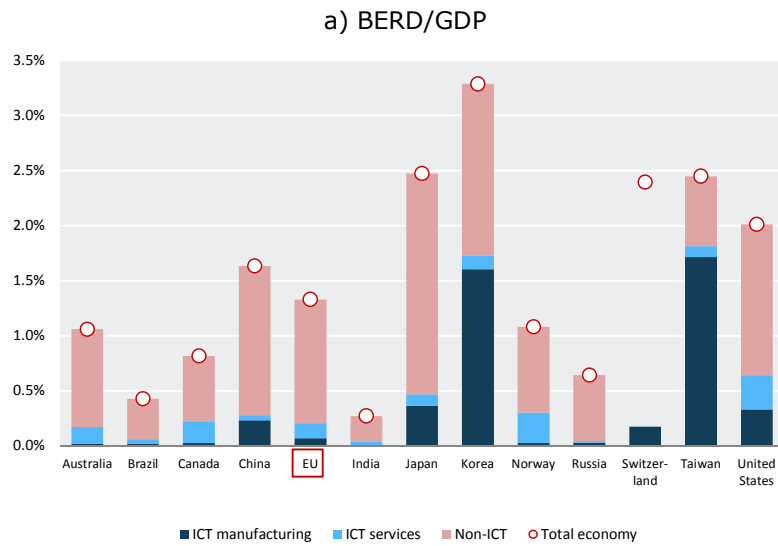
Note: Monetary variables are expressed in real terms. 2008-2014 for Brazil, 2006-2013 for India and 2008-2015 for Switzerland. ICT sector for Switzerland includes only ICT manufacturing.



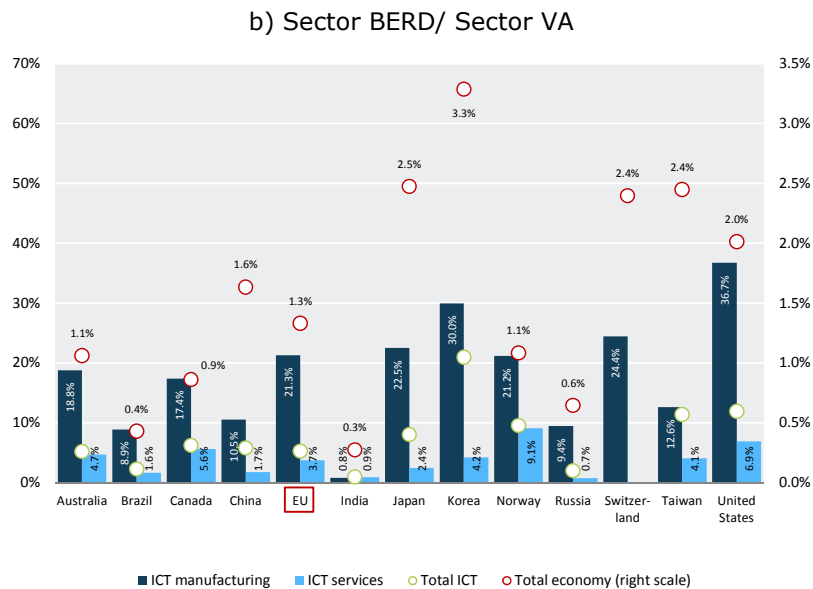
Note: 2006-2017 for GBARD and ICT GBARD. ICT manufacturing for United States includes 268 NACE Rev.2 sector (Manufacture of magnetic and optical media).
 Source: Source: 2019 PREDICT Dataset

India and China presented the highest growth rates between 2006 and 2016 for VA and employment, both in the ICT sector and the total economy (Figure 20 a-b). In India the ICT service sector was more dynamic, while for China it was ICT manufacturing. In the EU the annual growth rate of VA in the ICT sector (3.9%) was somewhat lower than in the US (4.4%), while employment grew at a slightly higher rate in the EU (1.3%) than in the US (1.0%). The highest annual growth in labour productivity per hour worked in the ICT sector is shown by Taiwan (9.2%), China (9.2%), India (8.7%), Russia (6.4%) and South Korea (6.3%) (Figure 20d), more than twice those of the EU (2.6%) and the US (3.1%). In terms of BERD (Figure 20e), China showed the most dynamic behaviour (17.5%). India (11.3%) leads in R&D researchers (Figure 20f), and Brazil (14.5%) in R&D personnel (Figure 20g). 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 and Japan (Figure 20 h-g).

Figure 21: BERD intensity in the international context (2016)



Note: 2014 for Brazil, 2013 for India and 2015 for Switzerland.



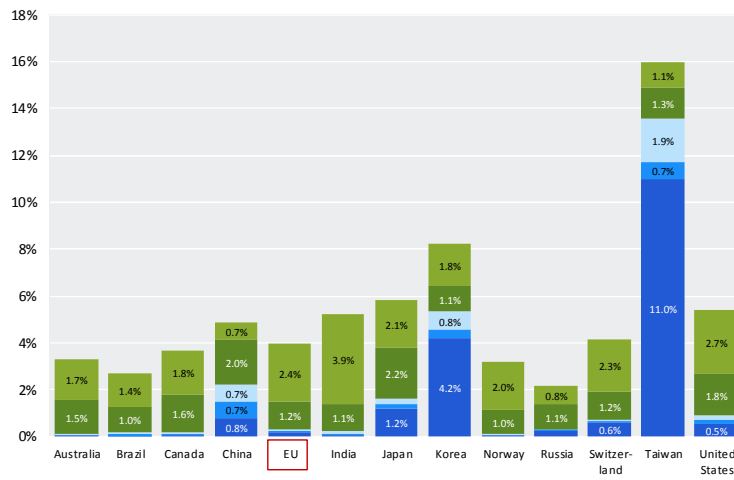
Note: 2014 for Brazil, 2013 for India and 2015 for Switzerland and Canada.
Source: 2019 PREDICT Dataset.

South Korea (3.3%) has the highest BERD intensity (BERD/GDP) of all the countries considered (Figure 21a), followed by Japan (2.5%), Taiwan (2.4%), Switzerland (2.3%) and the US (2.0%). In South Korea and Taiwan, BERD intensity in the ICT manufacturing sectors is very high, while for the remaining countries the non-ICT sectors present the largest ratio. The BERD intensity showed by EU (1.3%) is lower than the one of China (1.6%).

BERD intensity by sector (measured as sector BERD/ sector VA, Figure 21b) is very high in South Korea, both for the total economy (3.3%) and also for the ICT sector (20.9%). For ICT manufacturing, the highest intensity corresponds to US (36.7%) followed by South Korea (30.0%). In the ICT service sector, Norway (9.1%) takes the lead followed by the US (6.9%). The EU occupies the seventh position for the total economy (1.3%), the eighth for the ICT sector (5.2%), the seventh for ICT services (3.7%) and the fifth for ICT manufacturing (21.3%).

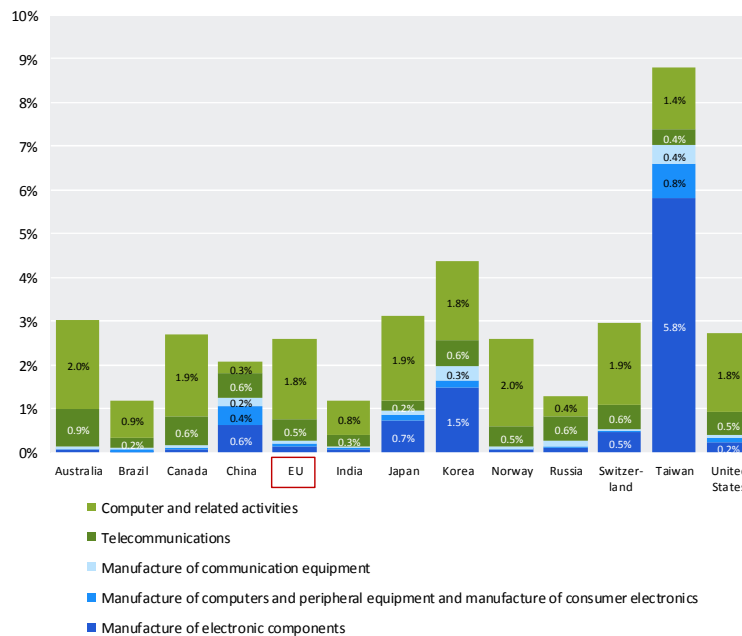
Figure 22: ICT sector by sub-sectors in the international context: VA, employment, BERD, RERD, PERD, GBARD and ICT GBARD (2016)

a) VA share of GDP



Note: 2015 for Canada.

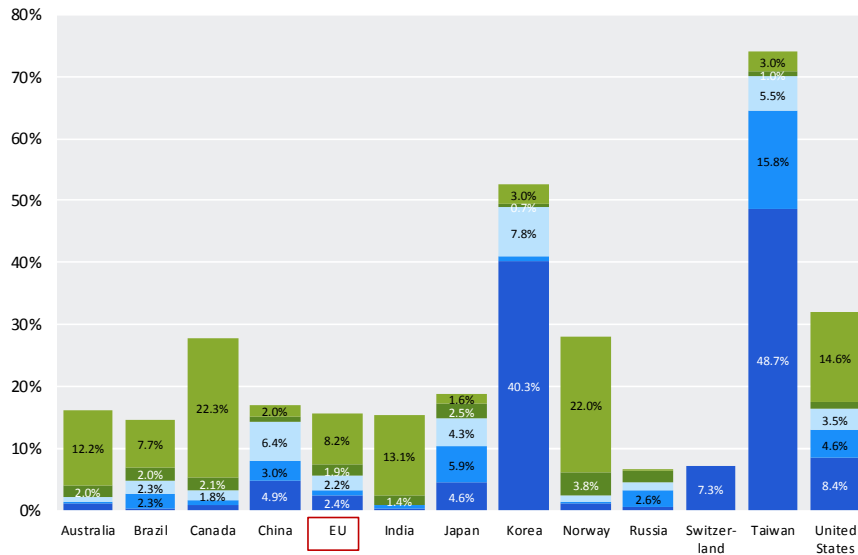
b) ICT sector employment share of total employment



Source: 2019 PREDICT Dataset

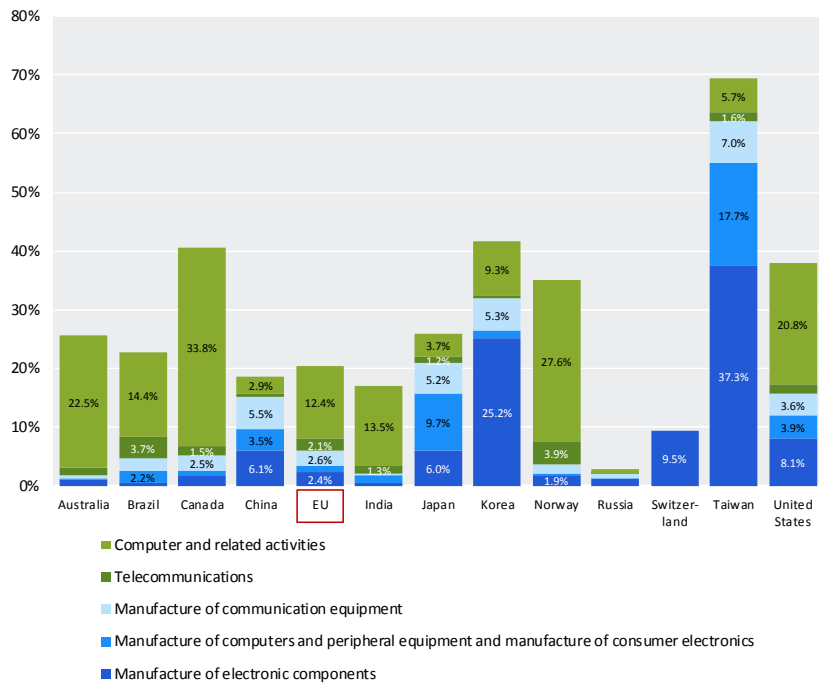
Figure 22 (cont.): ICT sector by sub-sectors in the international context: VA, employment, BERD, RERD, PERD, GBARD and ICT GBARD (2016)

c) ICT sector BERD share of total BERD



Note: 2013 for India, 2014 for Brazil and 2015 for Switzerland.

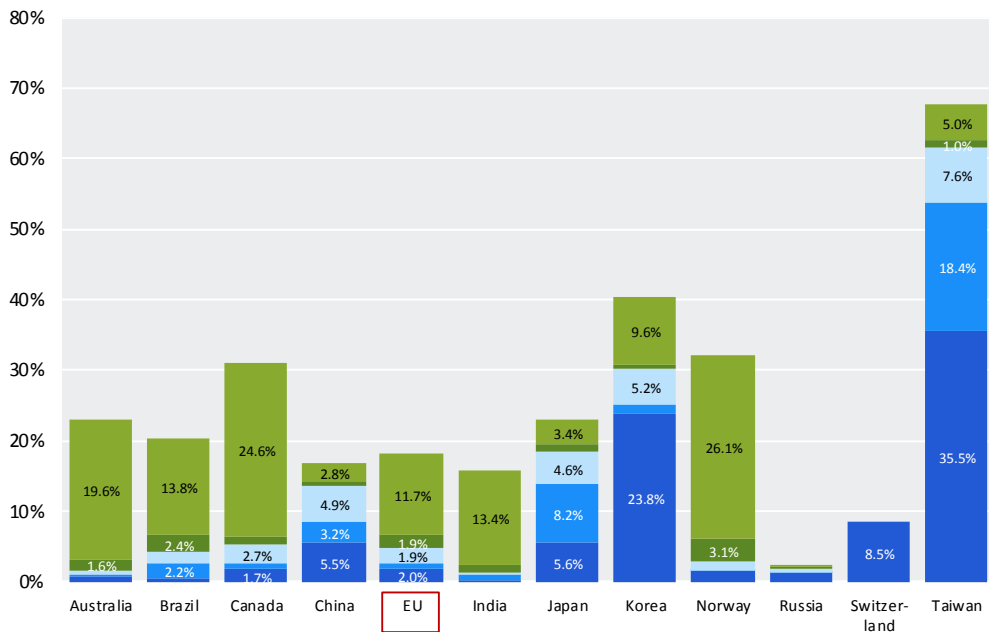
d) ICT sector RERD share of total RERD



Note: 2013 for India, 2014 for Brazil and 2015 for Switzerland.

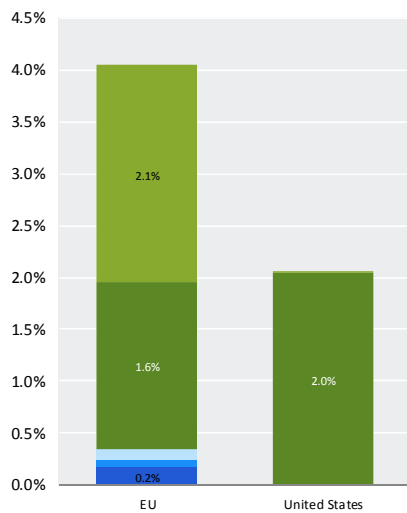
Figure 22 (cont.): ICT sector by sub-sectors in the international context: VA, employment, BERD, RERD, PERD, GBARD and ICT GBARD (2016)

e) ICT sector PERD share of total PERD

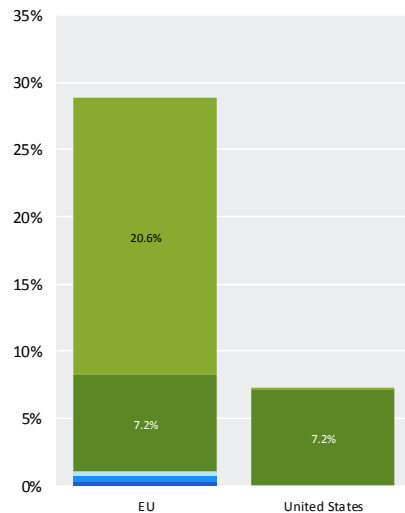


Note: 2013 for India, 2014 for Brazil and 2015 for Switzerland. ICT sector for United States not included because of lack of homogeneous data.

f) ICT sector GBARD share of total GBARD



g) ICT sector ICT GBARD share of total ICT GBARD

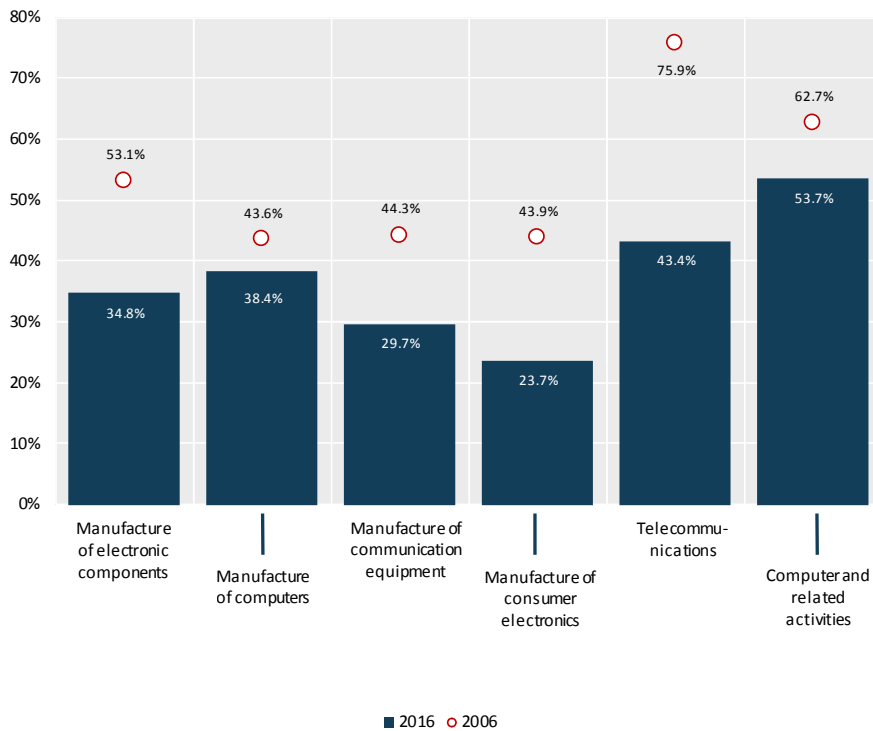


- Computer and related activities
- Telecommunications
- Manufacture of communication equipment
- Manufacture of computers and peripheral equipment and manufacture of consumer electronics
- Manufacture of electronic components

Note: 2017 for GBARD and ICT GBARD.
Source: 2019 PREDICT Dataset.

ICT manufacturing sectors have 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 amounts to 11.0% of total GDP (Figure 22a), 5.8% of total employment (Figure 22b), 48.7% of BERD (Figure 22c), 37.3% of R&D researchers (Figure 22d) and 35.50% of R&D personnel (Figure 22e). In China, the sector with the highest share in terms of VA is *Telecommunications* (2.0%), while in India it is *Computer and related activities* (3.9%). In the EU and the US, ICT services sectors (*Telecommunications* and *Computer and related activities*) have the largest shares in terms of all variables, especially in GBARD (Figure 22 f-g).

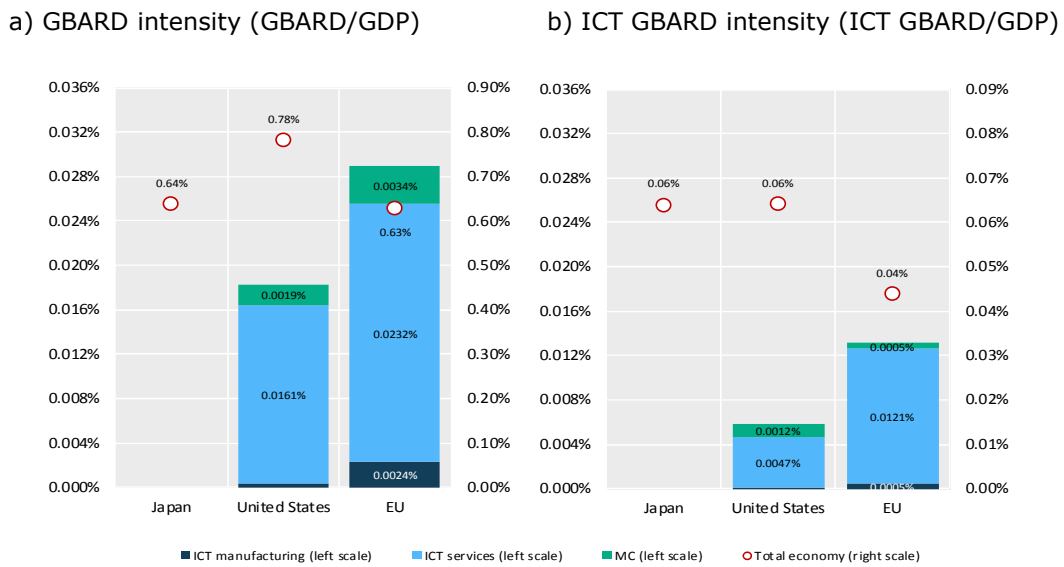
Figure 23: ICT sub-sector productivity per employed EU over United States (2006, 2016)



Source: 2019 PREDICT Dataset.

In the comparison between EU and US, the latter is the leader in many aspects and especially in labour productivity (Figure 23). It has a higher labour productivity per person employed than the EU in all ICT sub-sectors, especially in ICT manufacturing sub-sectors. *Manufacture of consumer electronics* is the ICT sub-sector which shows the widest gap (EU only represents 23.7% of the total of the US), followed by *Manufacture of communication equipment* (29.7%), *Manufacture of electronic components* (34.8%) and *Manufacture of computers* (38.4%). In the case of ICT services sub-sectors, the US advantage is below 50% only in *Computer and related activities*. In addition, the gap has widened since 2006 in all the sub-sectors considered.

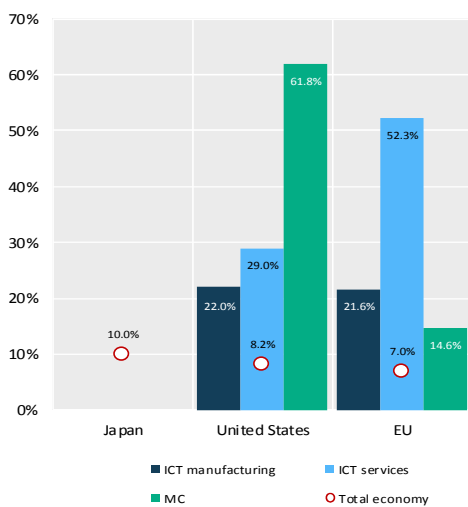
Figure 24: GBARD and ICT GBARD by non-EU economies (2017)



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 2017.

Source: 2019 PREDICT Dataset, AMECO and Eurostat.

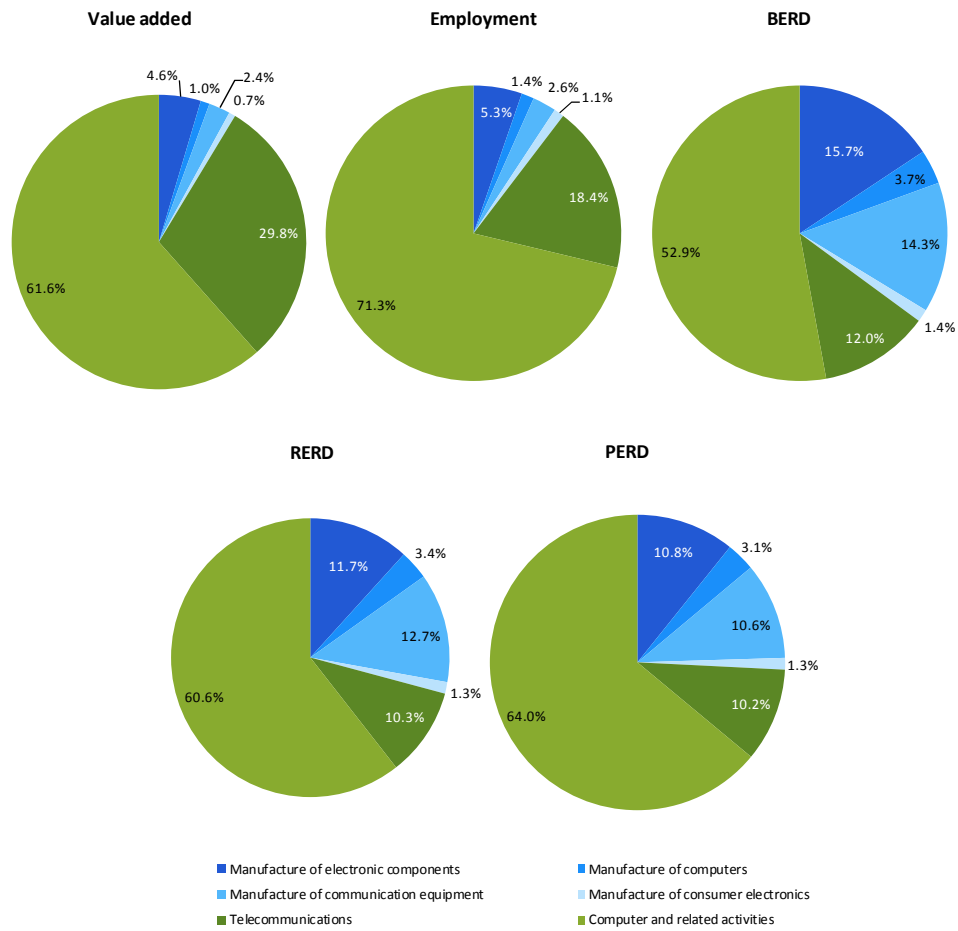
c) ICT GBARD/GBARD



Source: 2019 PREDICT Dataset

Public funding of R&D (GBARD) intensity (defined as GBARD/GDP) for the total economy is larger in the US (0.78%) than in Japan (0.64%) and in the EU (0.63%). However, the EU presents larger values for the ICT sector, ICT manufacturing, ICT services and MC sectors (Figure 24a). The same results apply to ICT GBARD intensity. The only difference is that it is higher in the US than in the EU in the MC sector. The weight of ICT GBARD over total GBARD (Figure 24c) is especially high for the MC sector in the US (61.8%) as compared with the one of EU (14.6%). On the contrary, for the ICT services it is higher in the EU (52.3%) than in the US (29.0%), while the shares for the ICT manufacturing sector are similar.

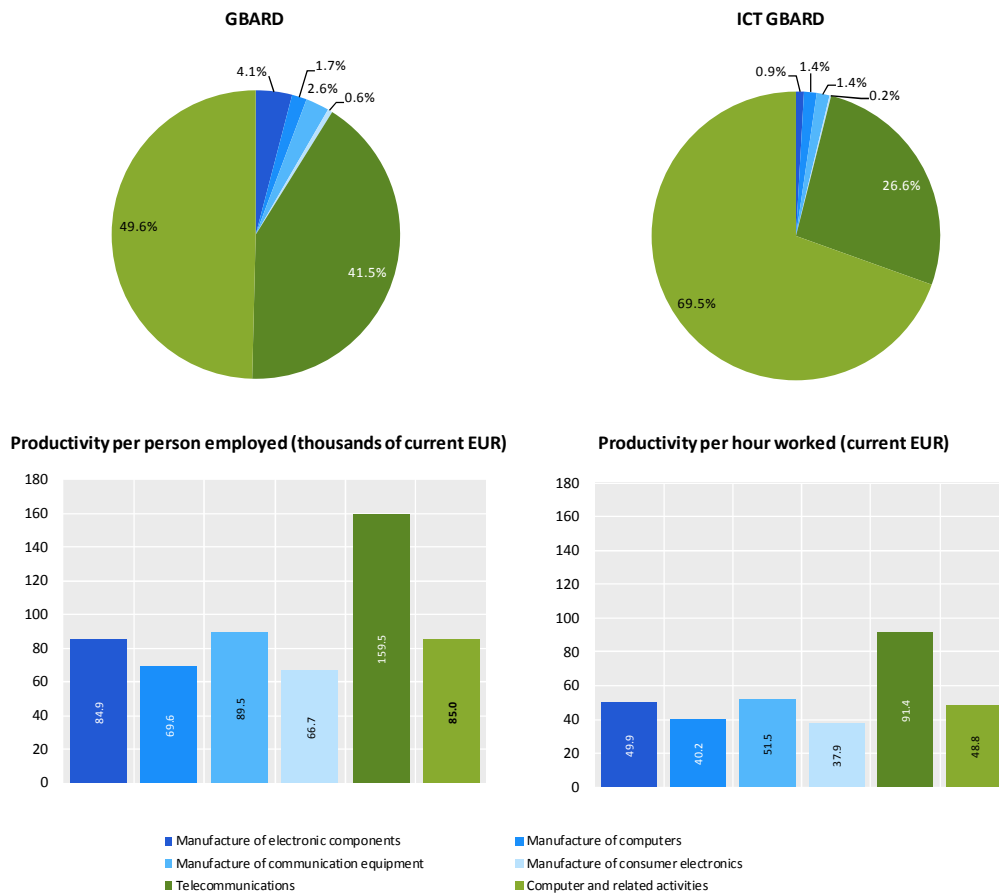
Figure 25: Overview of PREDICT variables: value added, employment, BERD, RERD, PERD, GBARD, ICT GBARD and labour productivity by ICT sub-sector in the European Union (2016)



Source: 2019 PREDICT Dataset.

The *Computer and related activities* sub-sector presents the largest share in the seven indicators, with values between 49.6% (GBARD) and 71.3% (employment) in 2016 (Figure 25). The *Telecommunications* sub-sector led labour productivity, both productivity per person employed and productivity per hour worked.

Figure 25 (cont.): Overview of PREDICT variables: value added, employment, BERD, RERD, PERD, GBARD, ICT GBARD and labour productivity by ICT sub-sector in the European Union (2016)



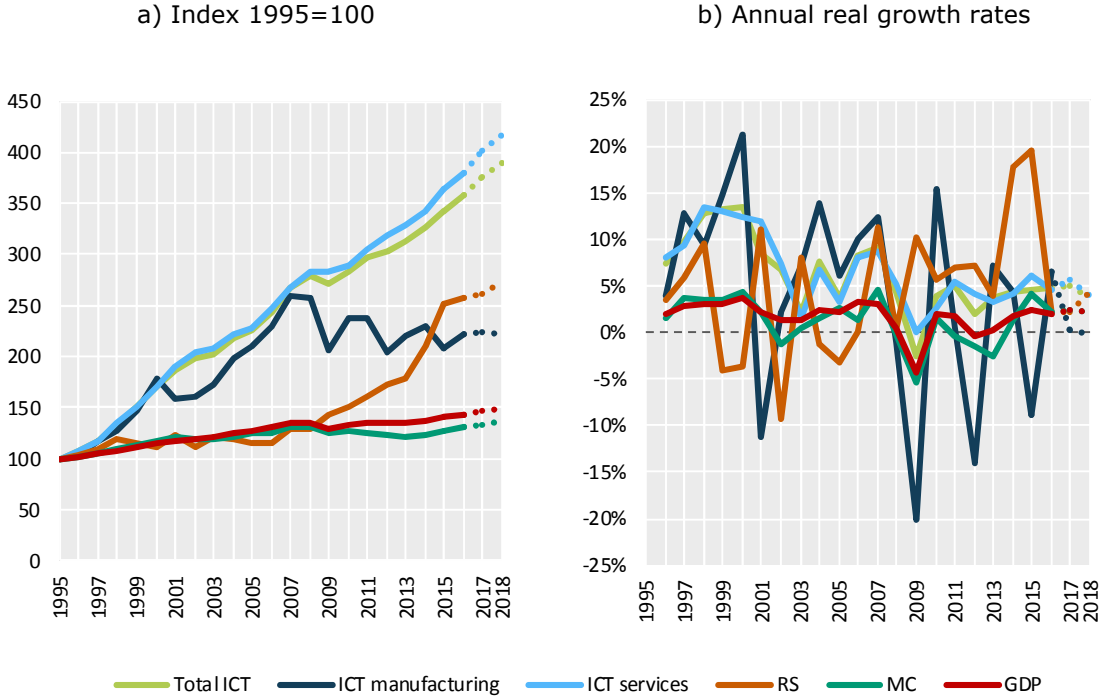
Note: ICT GBARD is the part of GBARD devoted to fund ICT assets in all industries of the economy. ICT GBARD is allocated to all sectors in the economy, not only the ICT sector (see Box 1 in the introduction).

Source: 2019 PREDICT Dataset.

4 ANNEX

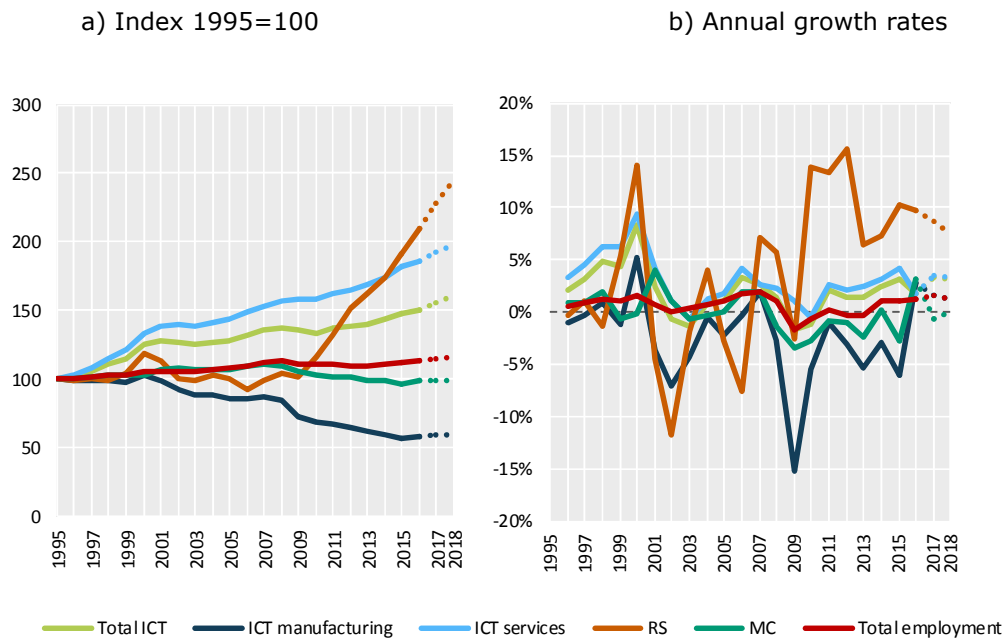
4.1 ICT sector and its R&D in the EU

Figure A 1: ICT sector VA in the EU (1995-2018)



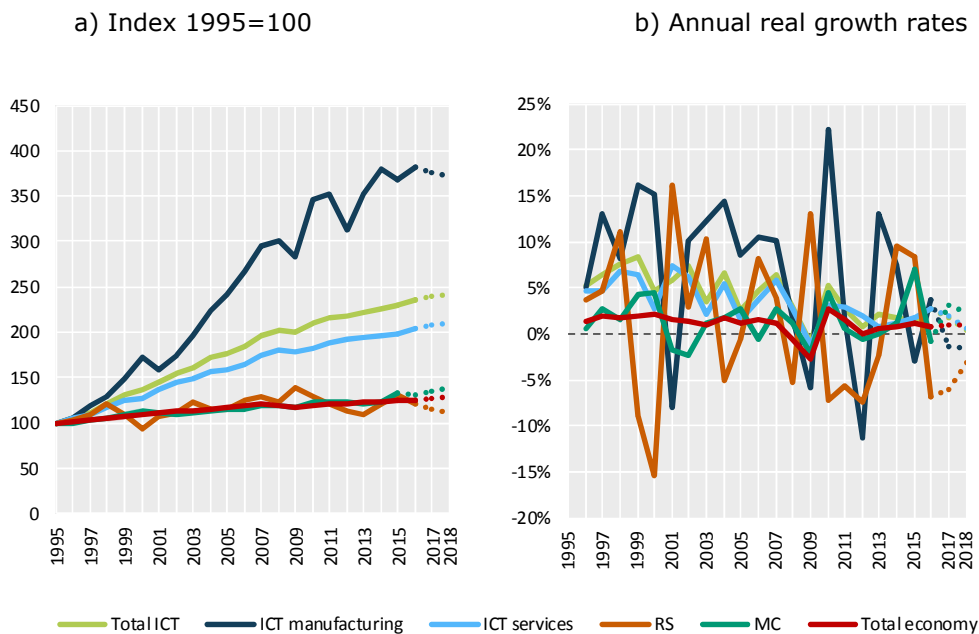
Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.
 Source: 2019 PREDICT Dataset, AMECO and Eurostat.

Figure A 2: ICT sector employment in the EU (1995-2018)



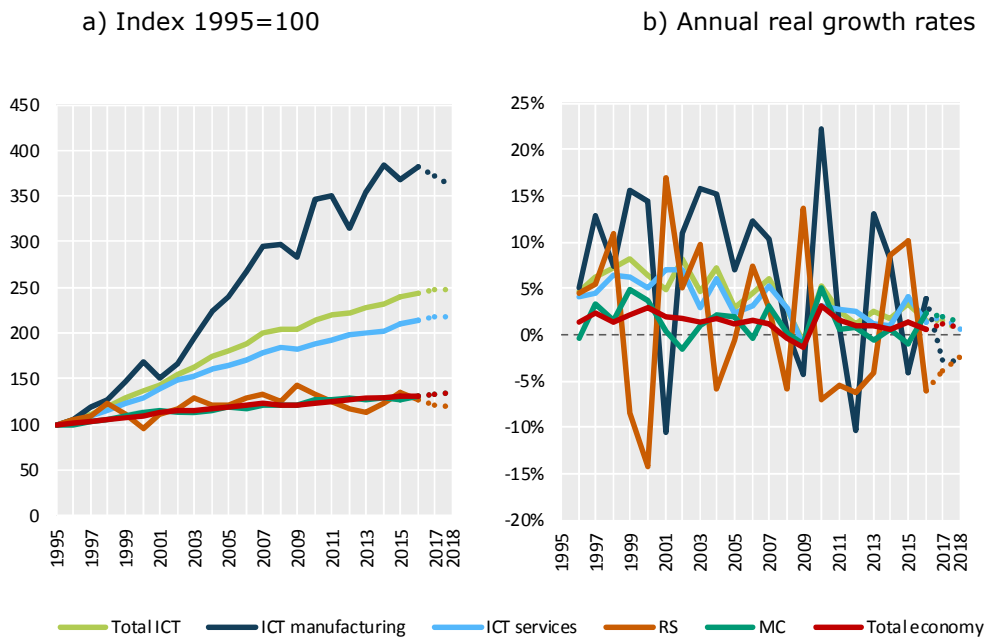
Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.
Source: 2019 PREDICT Dataset, AMECO and Eurostat.

Figure A 3: ICT sector productivity per person employed in the EU (1995-2018)



Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.
Source: 2019 PREDICT Dataset, AMECO and Eurostat.

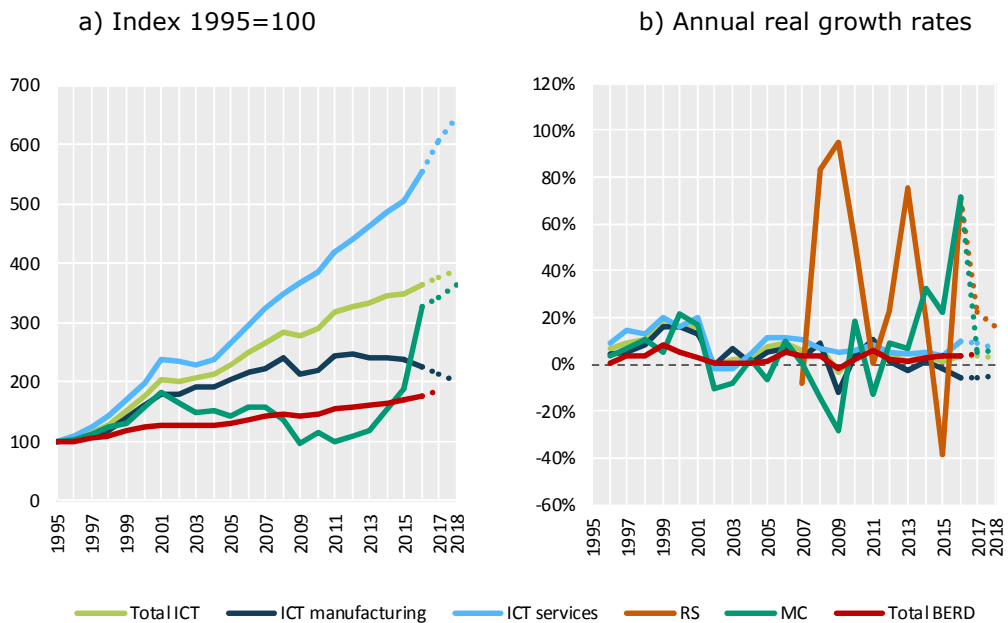
Figure A 4: ICT sector productivity per hour worked in the EU (1995-2018)



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

Source: 2019 PREDICT Dataset, AMECO and Eurostat.

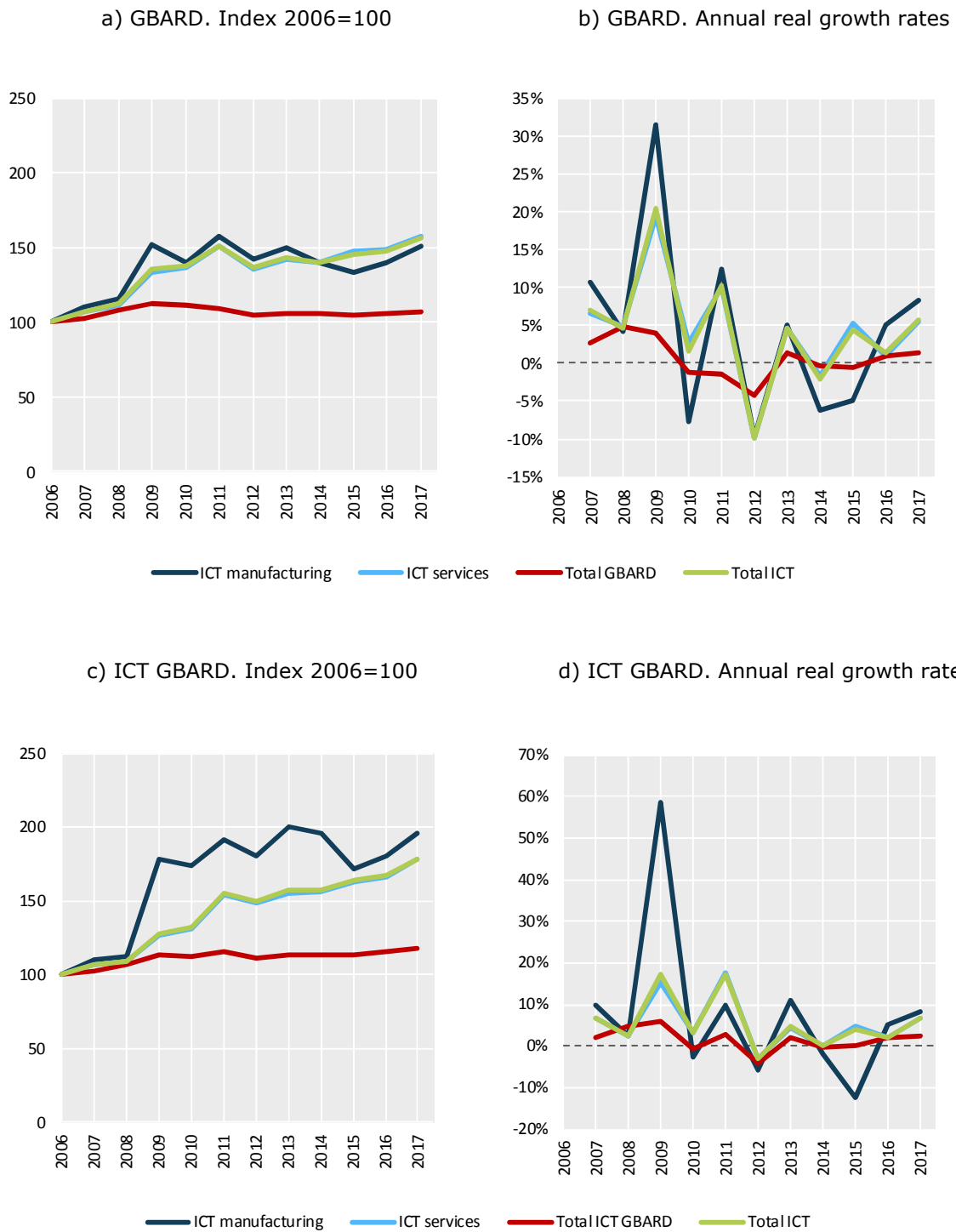
Figure A 5: ICT sector BERD in the EU (1995-2018)



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

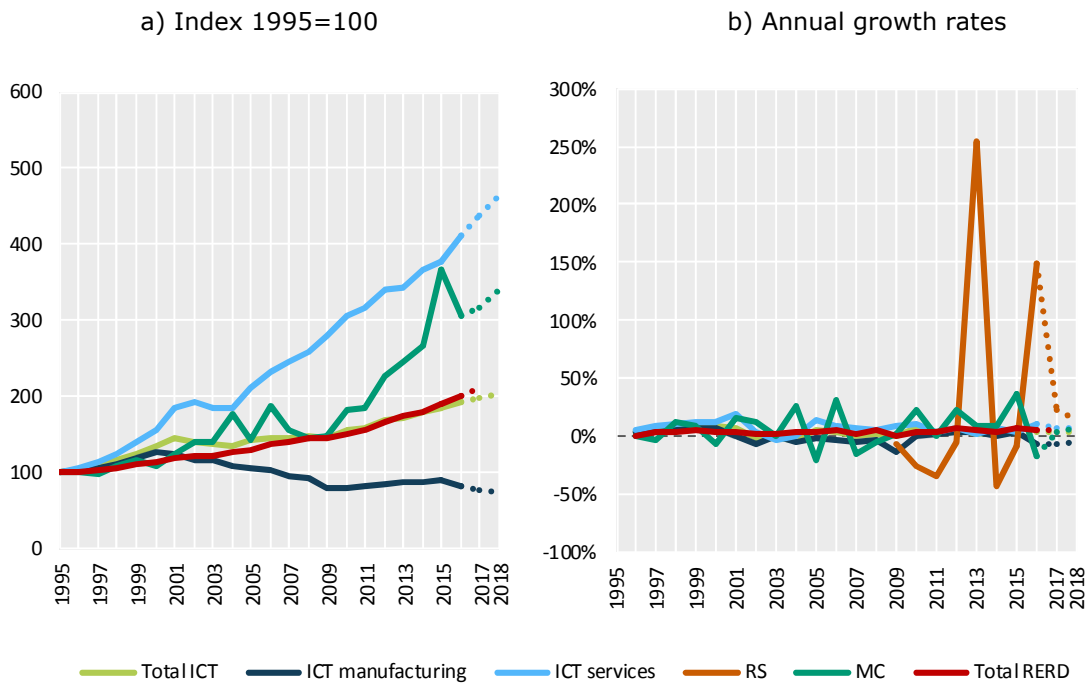
Source: 2019 PREDICT Dataset, AMECO and Eurostat.

Figure A 6: GBARD and ICT GBARD in the EU (2006-2017)



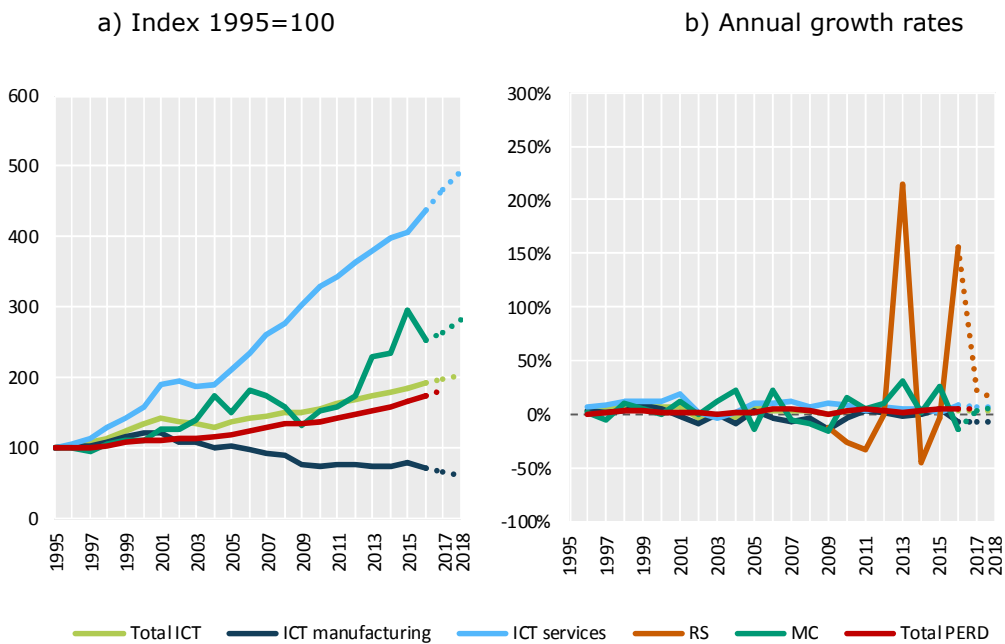
Source: 2019 PREDICT Dataset.

Figure A 7: ICT sector RERD in the EU (1995-2018)



Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.
Source: 2019 PREDICT Dataset.

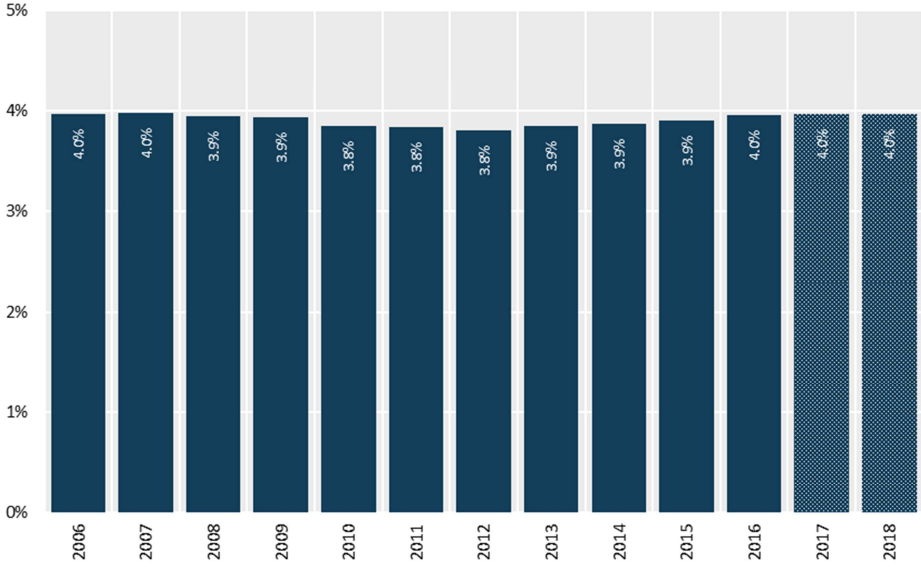
Figure A 8: ICT sector PERD in the EU (1995-2018)



Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.
Source: 2019 PREDICT Dataset.

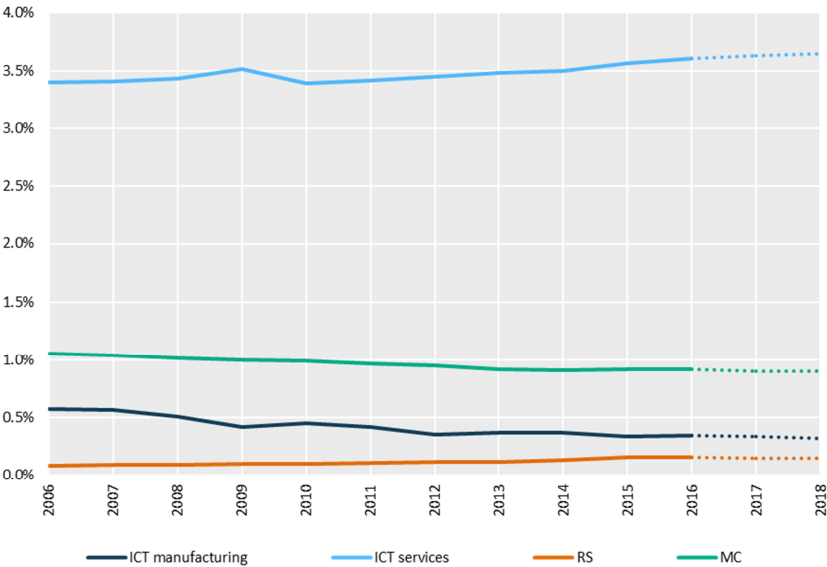
4.2 Analysis by sub-sectors in the EU

Figure A 9: ICT sector VA share of GDP in the EU (2006-2018)



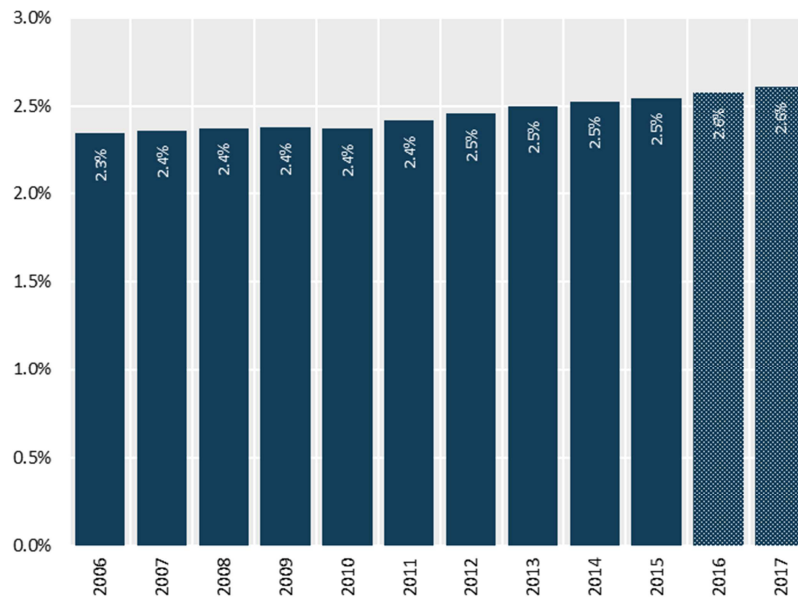
Note: Column patterns indicate nowcasted data.
 Source: 2019 PREDICT Dataset, AMECO and Eurostat

Figure A 10: ICT manufacturing, ICT services, MC and RS sectors share of GDP in the EU (2006-2018)



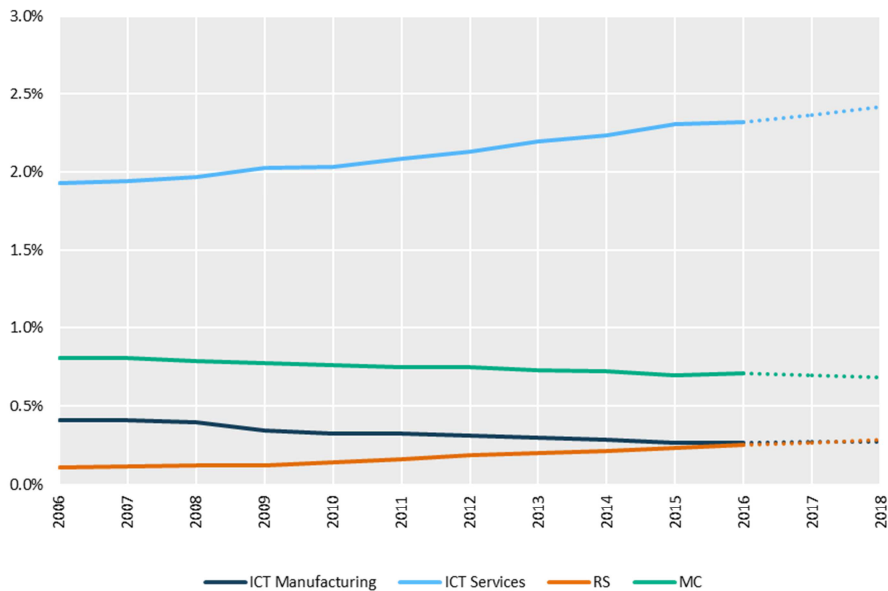
Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.
 Source: 2019 PREDICT Dataset, AMECO and Eurostat.

Figure A 11: ICT sector employment share of total employment in the EU (2006-2018)



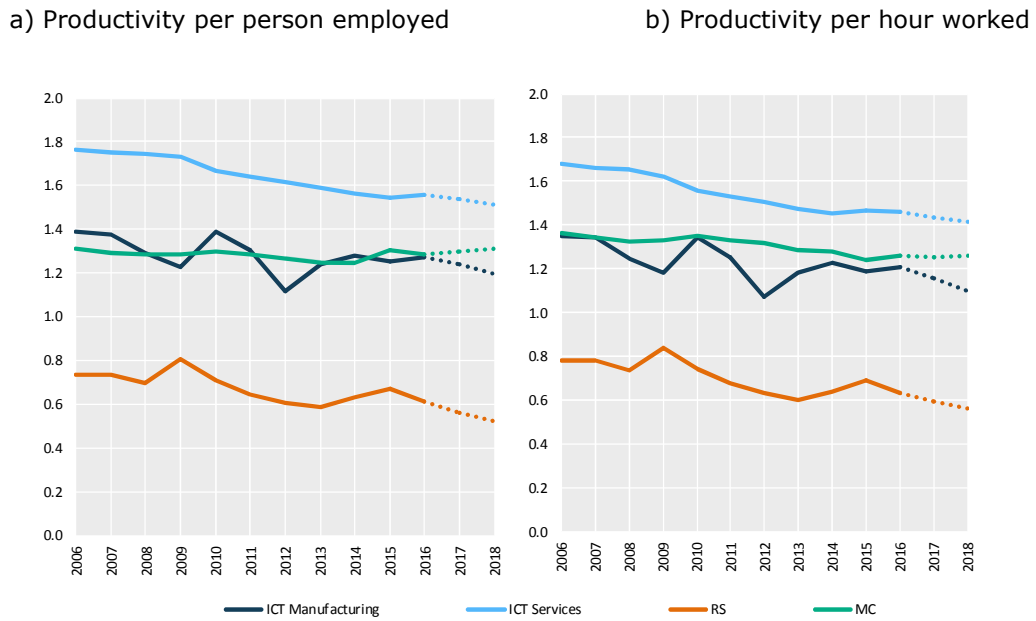
Note: Column patterns indicate nowcasted data.
Source: 2019 PREDICT Dataset, AMECO and Eurostat.

Figure A 12: ICT manufacturing, ICT services, MC and RS sectors share of the total employment in the EU (2006-2018)



Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.
Source: 2019 PREDICT Dataset, AMECO and Eurostat.

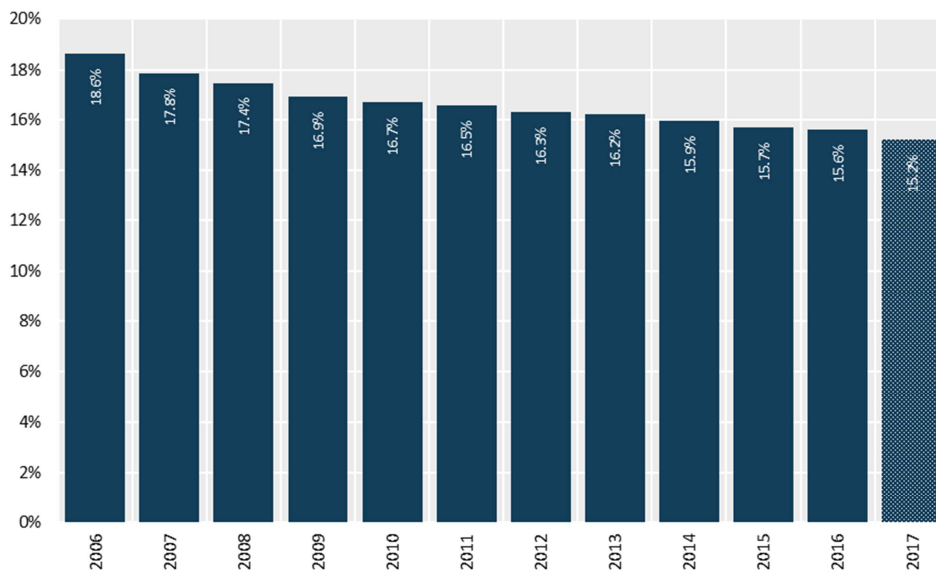
Figure A 13: Productivity in ICT manufacturing, ICT services, MC and RS sectors as a ratio of total economy productivity in the EU (2006-2018)



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

Source: 2019 PREDICT Dataset, AMECO and Eurostat.

Figure A 14: ICT sector BERD share of total BERD in the EU (2006-2017)

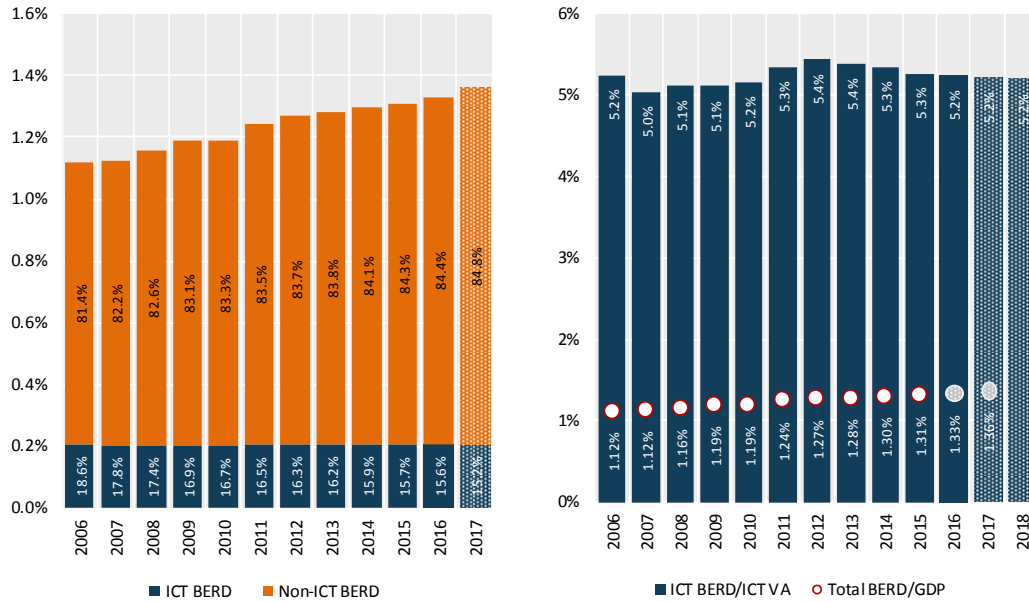


Note: Column patterns indicate nowcasted data.

Source: 2019 PREDICT Dataset.

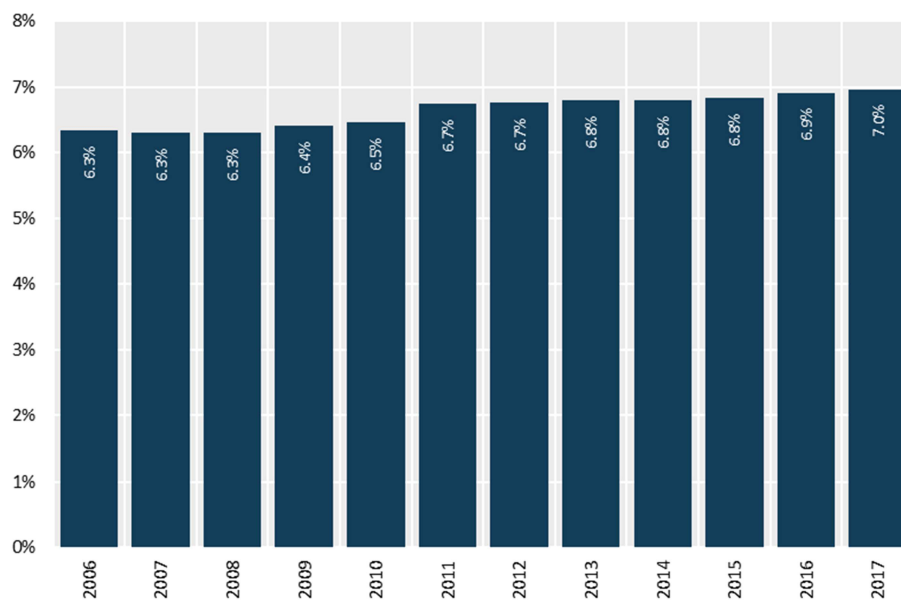
Figure A 15: ICT BERD intensity and total BERD intensity in the EU (2006-2018)

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



Note: Column and circle patterns indicate nowcasted data.
Source: 2019 PREDICT Dataset, AMECO and Eurostat.

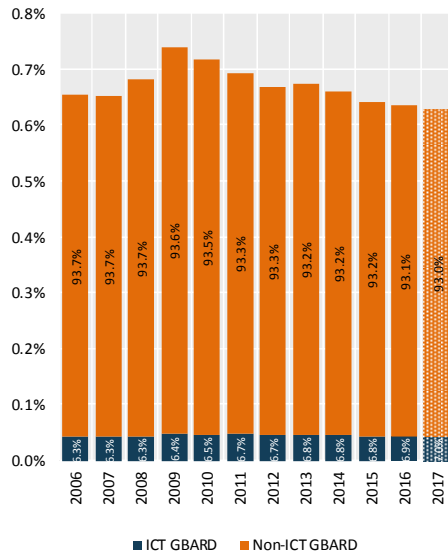
Figure A 16: ICT GBARD share of total GBARD in the EU (2006-2017)



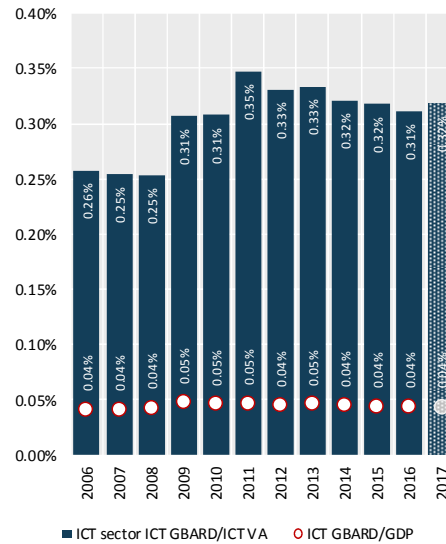
Source: 2019 PREDICT Dataset.

Figure A 17: ICT GBARD intensity in ICT sector and total economy in the EU (2006-2017)

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



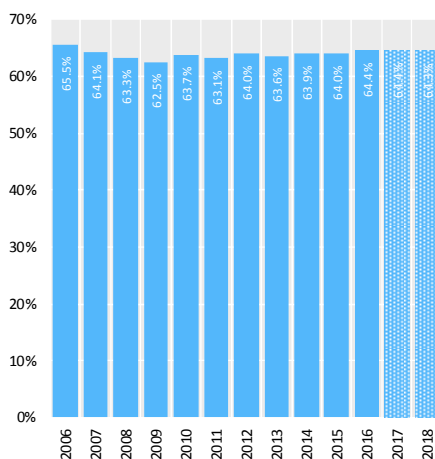
b) ICT GBARD intensity



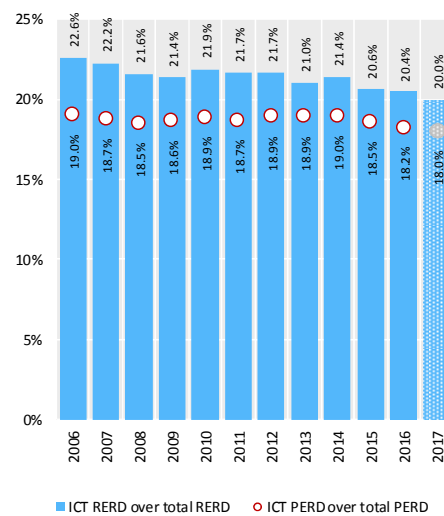
Note: Column and circle patterns indicate nowcasted data.
Source: 2019 PREDICT Dataset, AMECO and Eurostat.

Figure A 18: ICT sector RERD and ICT sector PERD in the EU (2006-2018)

a) ICT RERD over ICT PERD

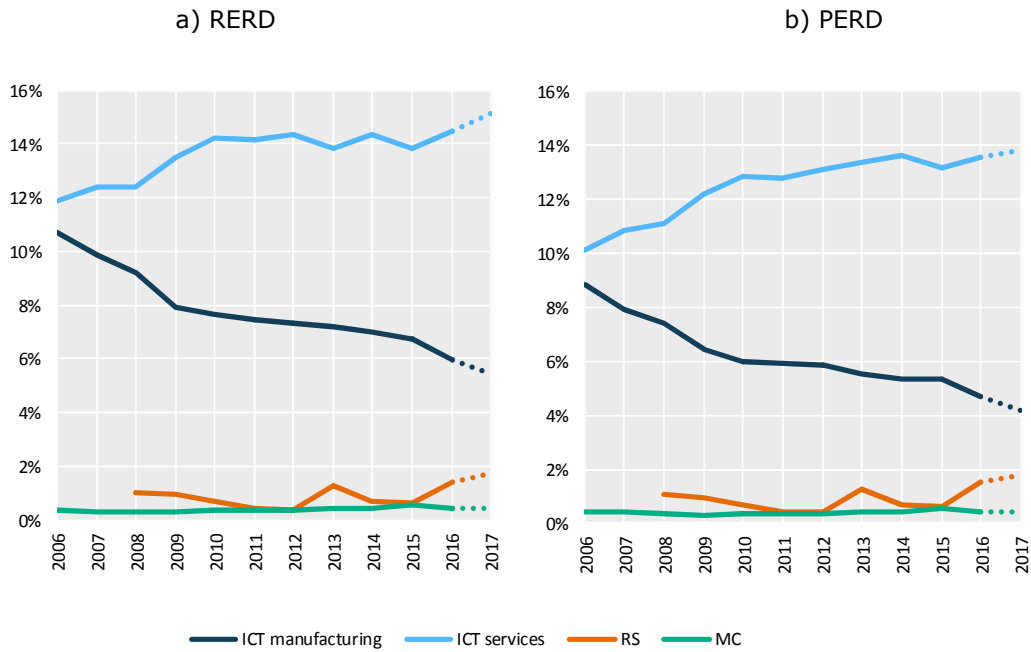


b) ICT RERD over total RERD, and ICT PERD over total PERD



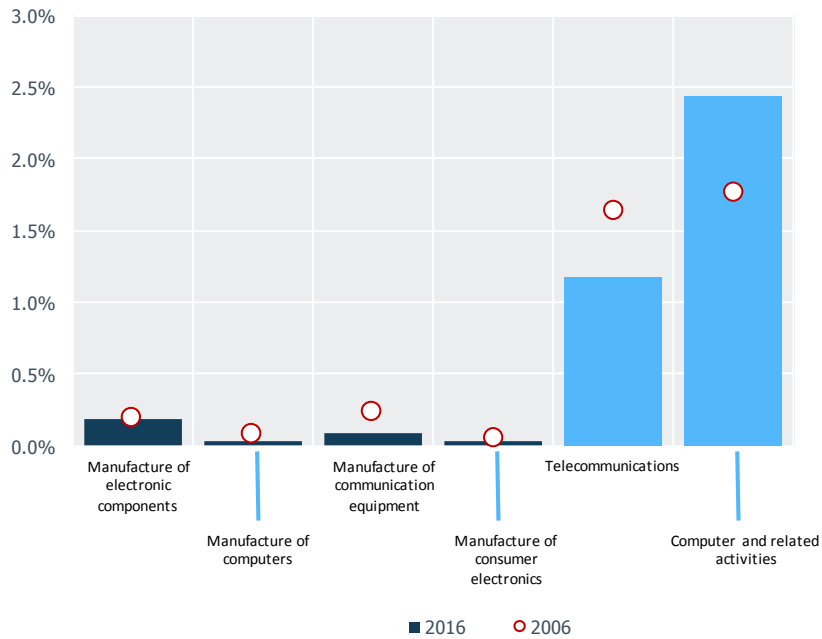
Note: Column and circle patterns indicate nowcasted data.
Source: 2019 PREDICT Dataset.

Figure A 19: ICT manufacturing, ICT services, MC and RS sector share of total in the EU (2006-2017)



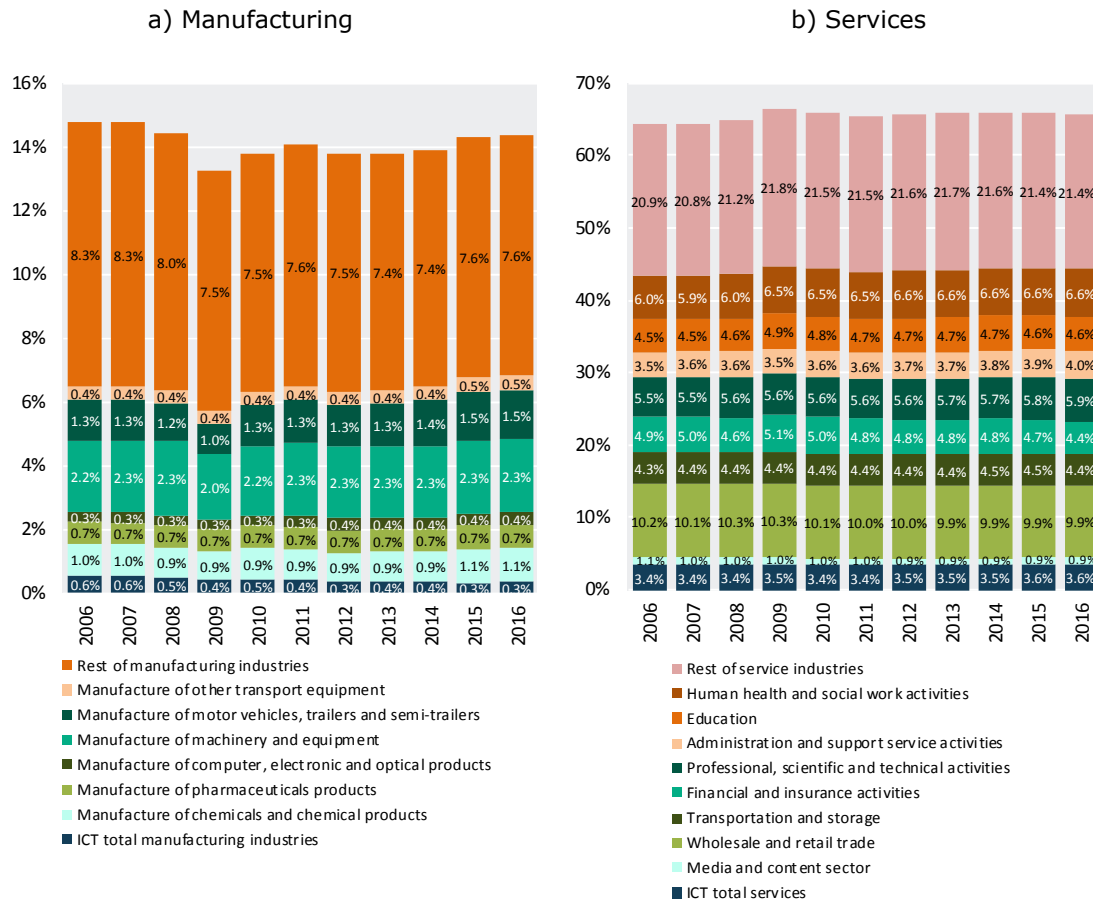
Note: MC: Media and Content. RS: Retail sale via mail order houses or via Internet. Dashed lines indicate nowcasted data.
Source: 2019 PREDICT Dataset.

Figure A 20: ICT sector VA share of GDP by sub-sector in the EU (2006, 2016)



Source: 2019 PREDICT Dataset

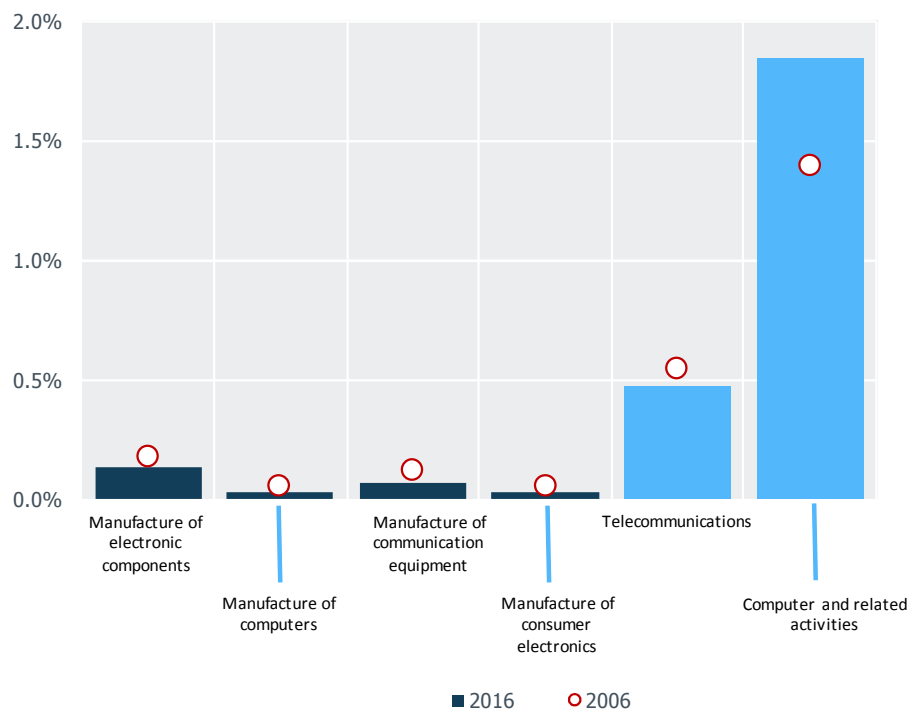
Figure A 21: ICT sector VA share of GDP and comparison with non-ICT economic activities in the EU (2006-2016)



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.

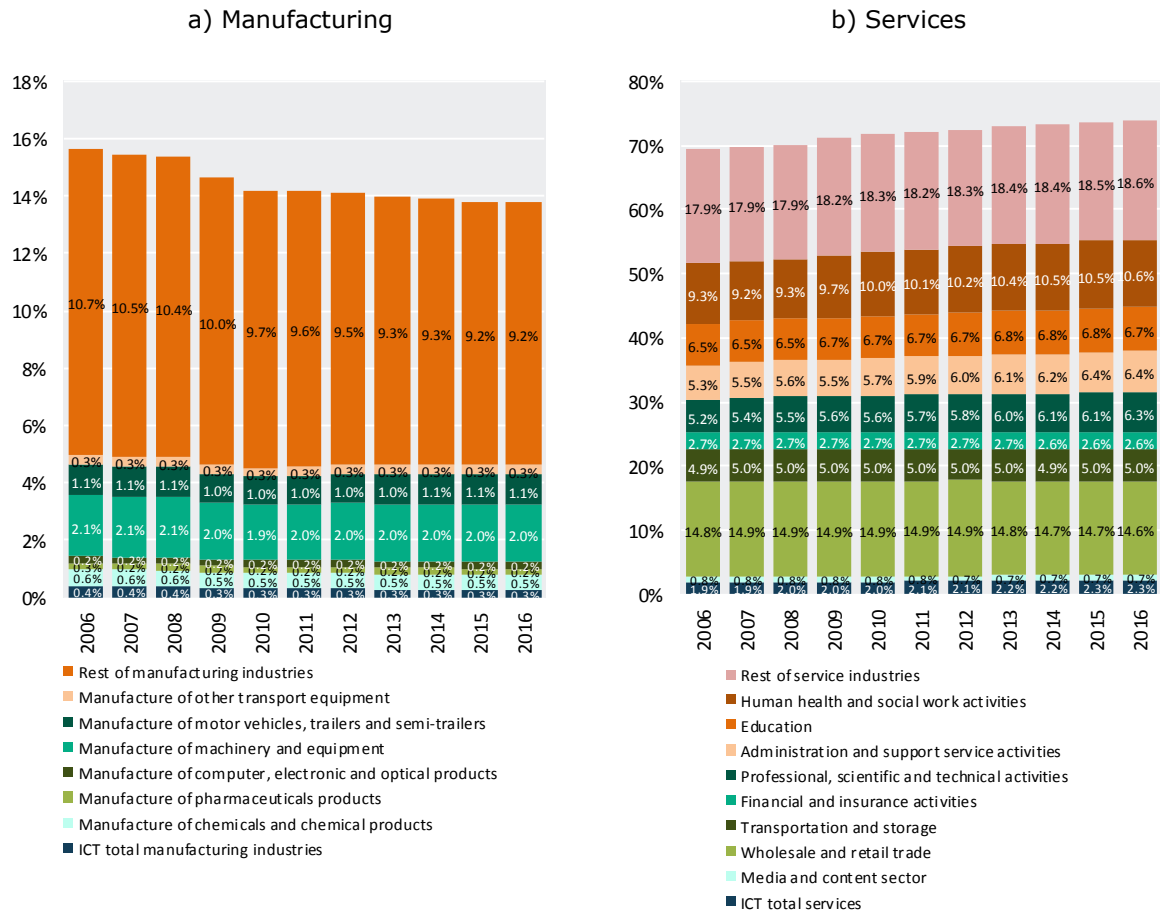
Source: 2019 PREDICT Dataset

Figure A 22: ICT sector employment share of total employment by sub-sector in the EU (2006, 2016)



Source: 2019 PREDICT Dataset.

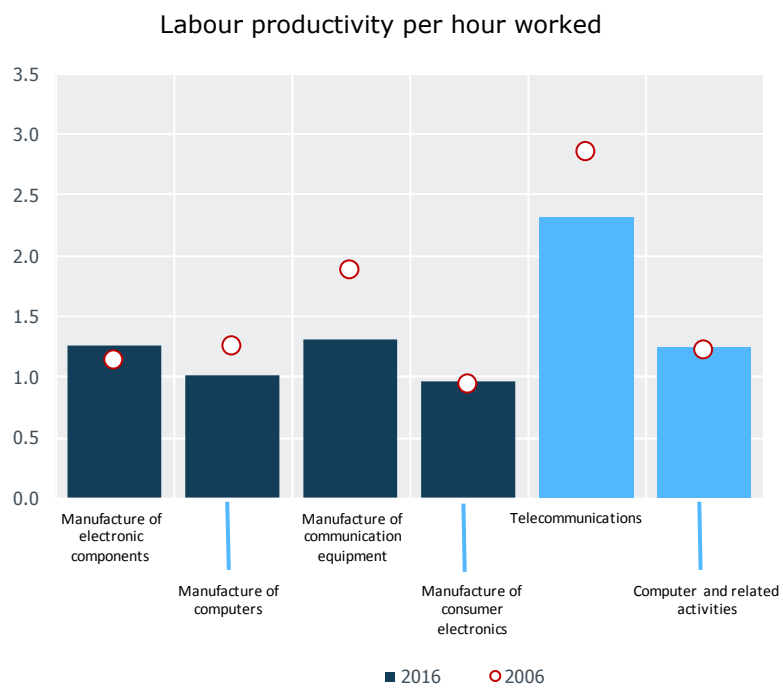
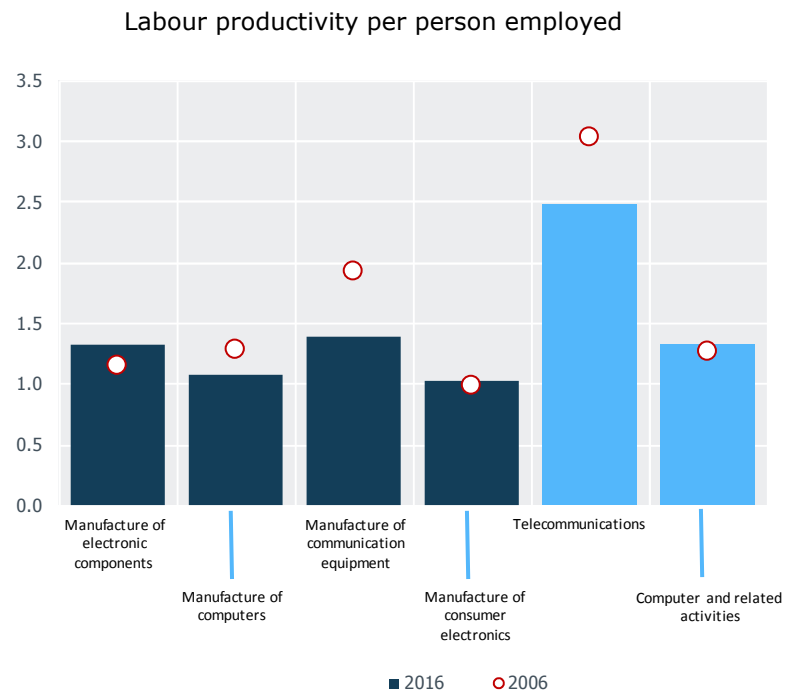
Figure A 23: ICT sector employment share on total employment and comparison with non-ICT economic activities in the EU (2006-2016)



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.

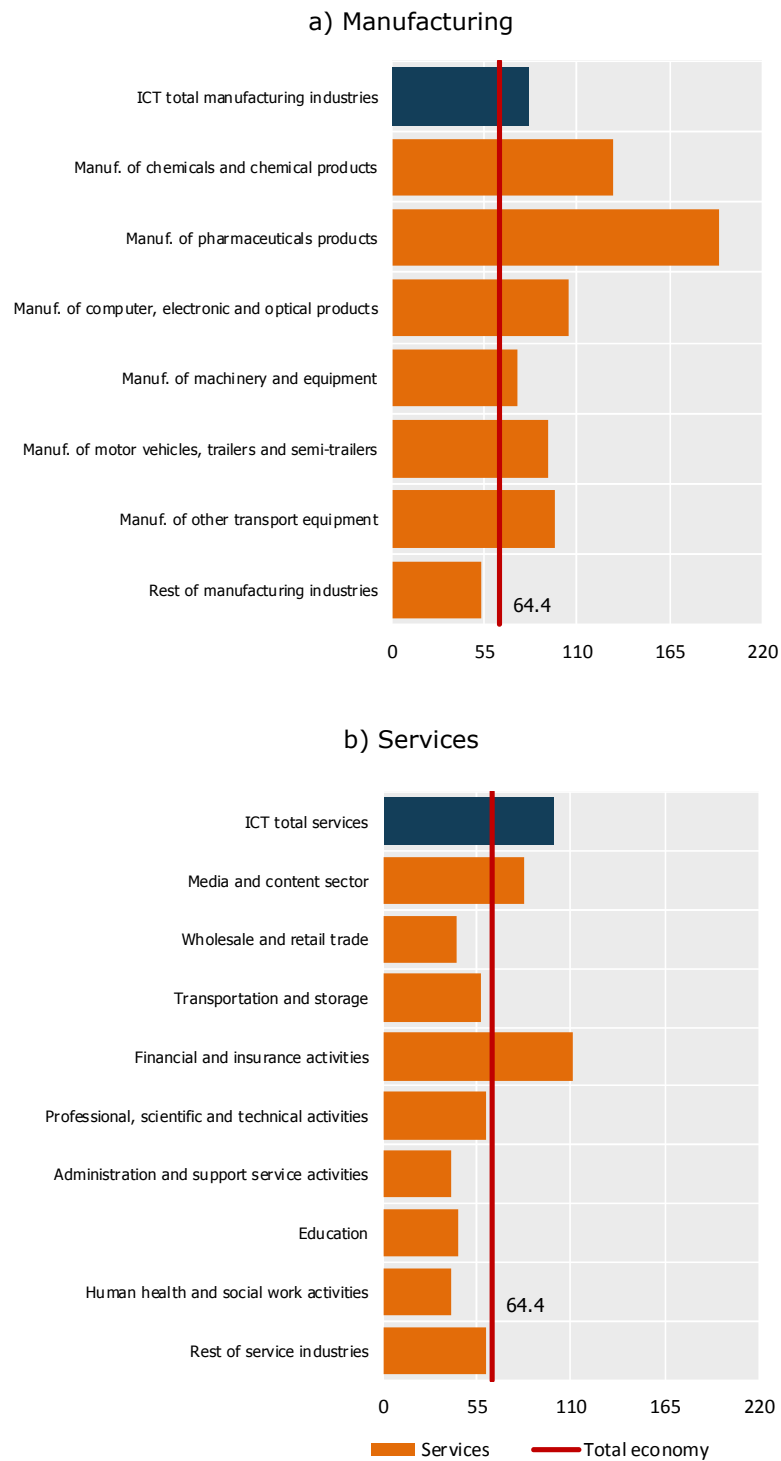
Source: 2019 PREDICT Dataset

Figure A 24: ICT sector productivity ratio over productivity in total economy by sub-sector in the EU (2006, 2016)



Source: 2019 PREDICT Dataset.

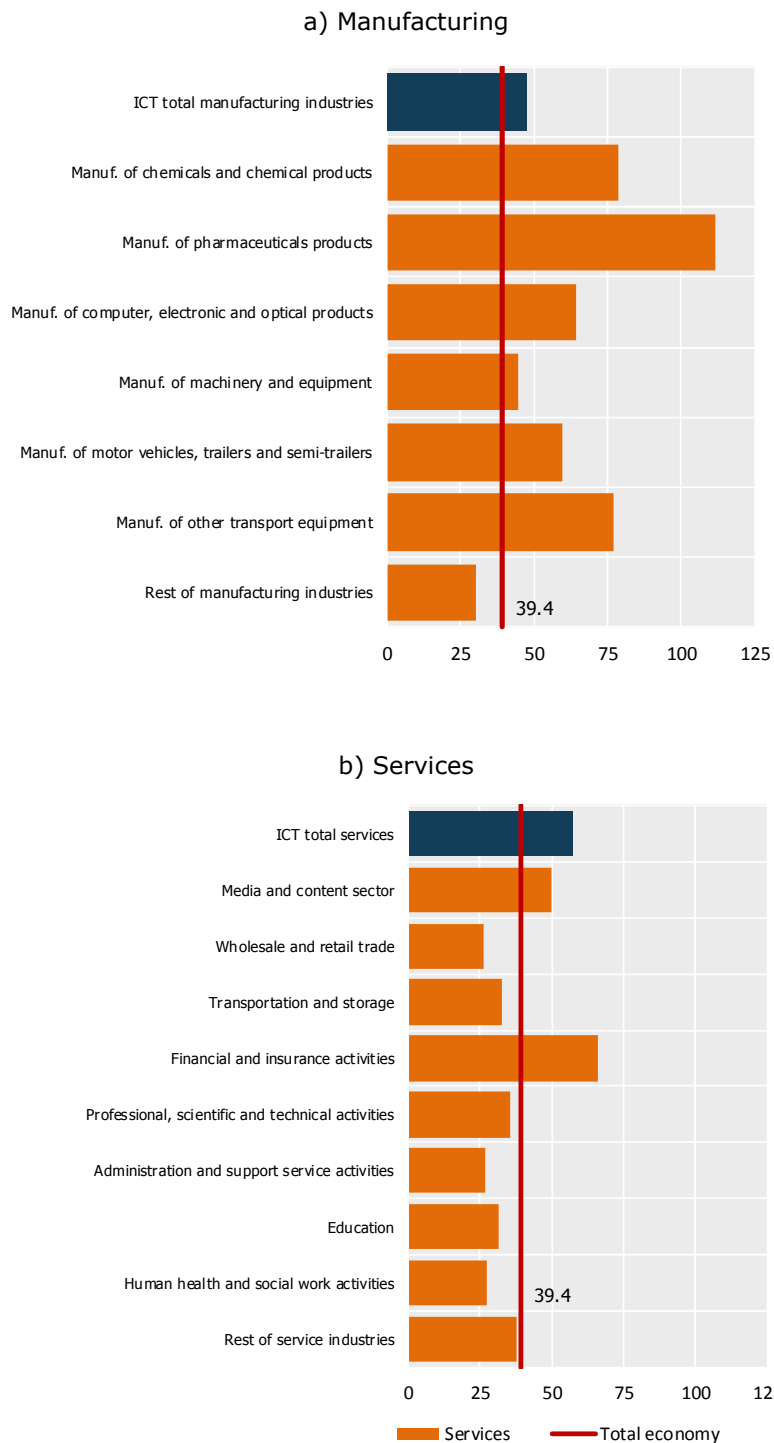
Figure A 25: ICT sector productivity per person employed and comparison with non-ICT economic activities in the EU (thousand current EUR per person; 2016)



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: 2019 PREDICT Dataset.

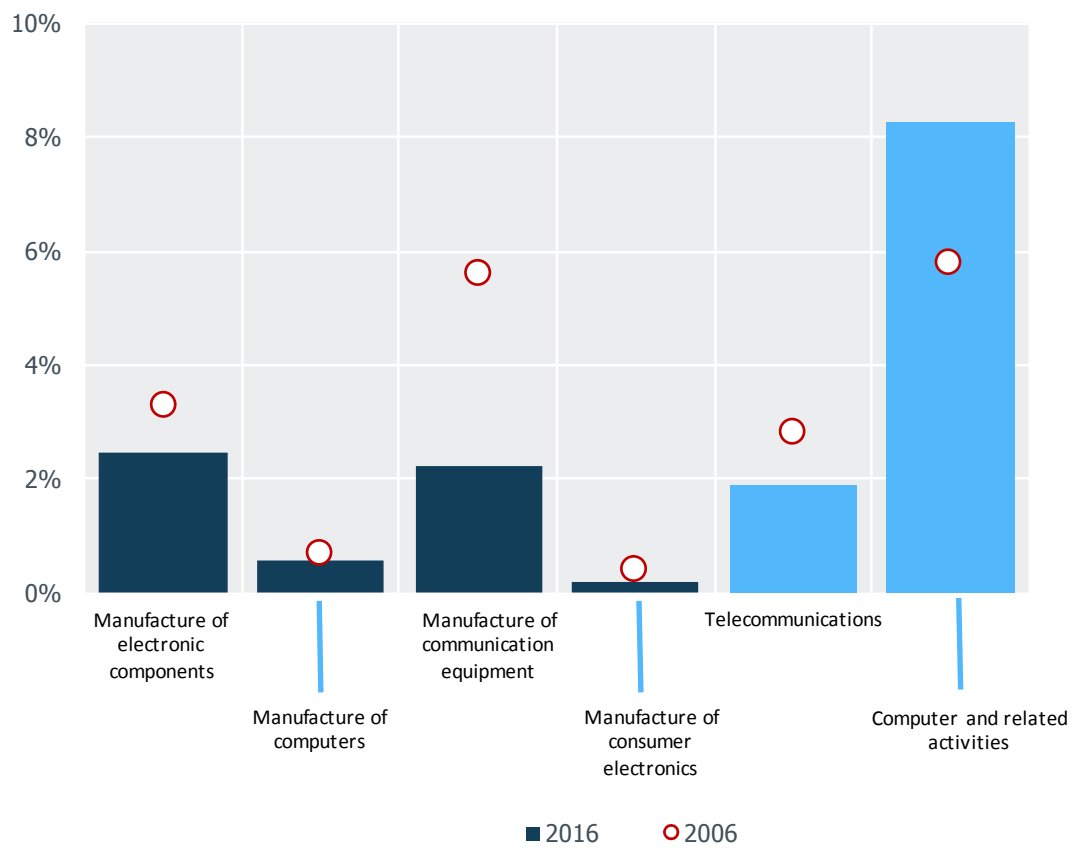
Figure A 26: ICT sector productivity per hour worked and comparison with non-ICT economic activities in the EU (current EUR per hour worked; 2016)



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.

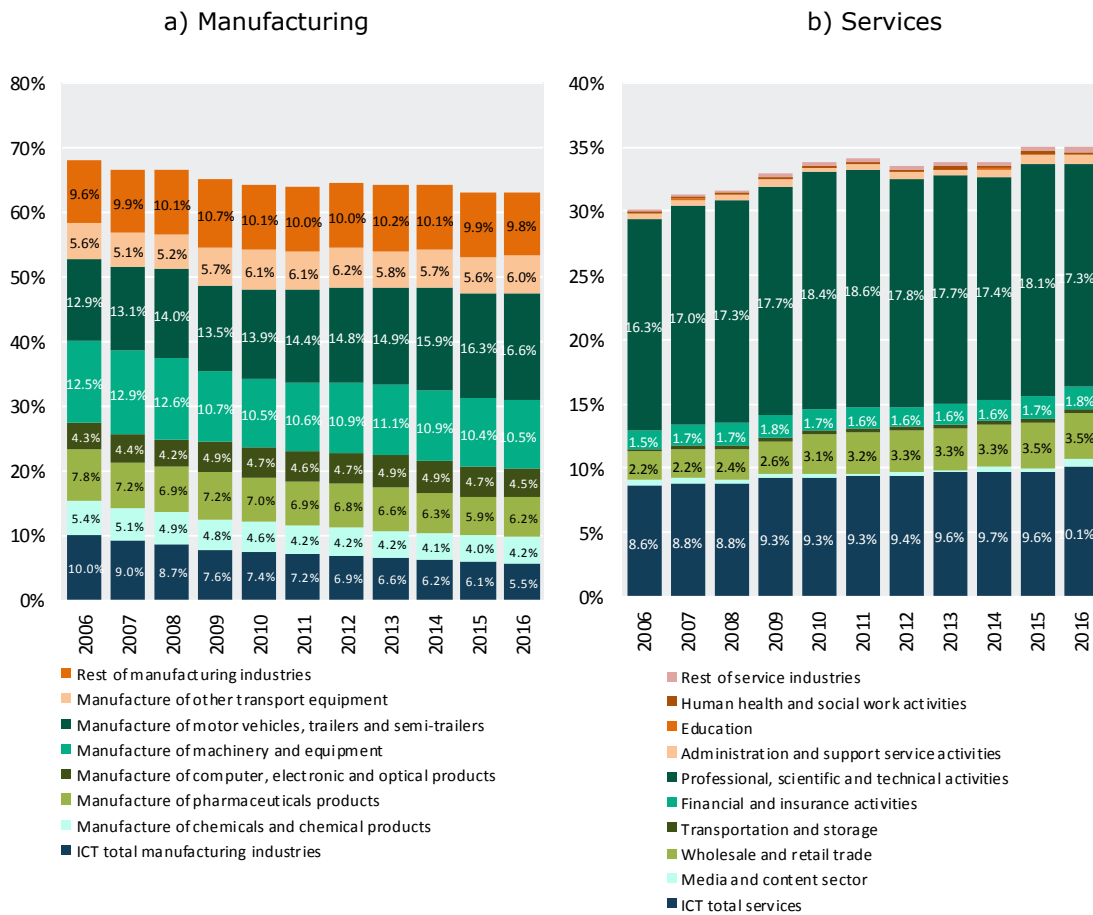
Source: 2019 PREDICT Dataset

Figure A 27: ICT sector BERD share of total BERD by sub-sector in the EU (2006, 2016)



Source: 2019 PREDICT Dataset

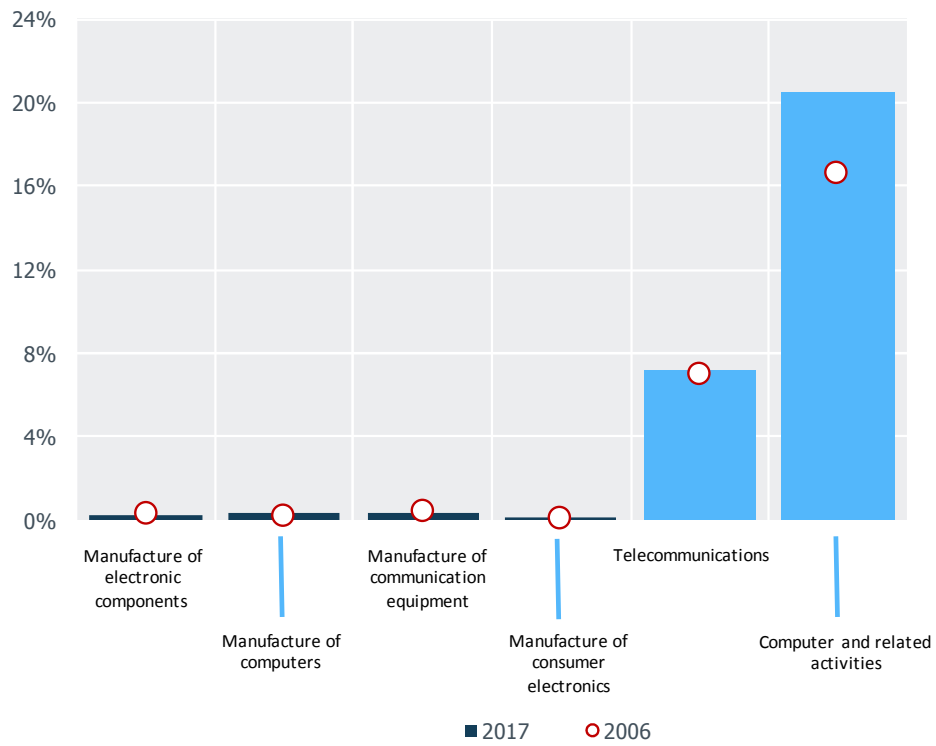
Figure A 28: ICT sector BERD share of total BERD and comparison with non-ICT economic activities in the EU (2006-2016)



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.

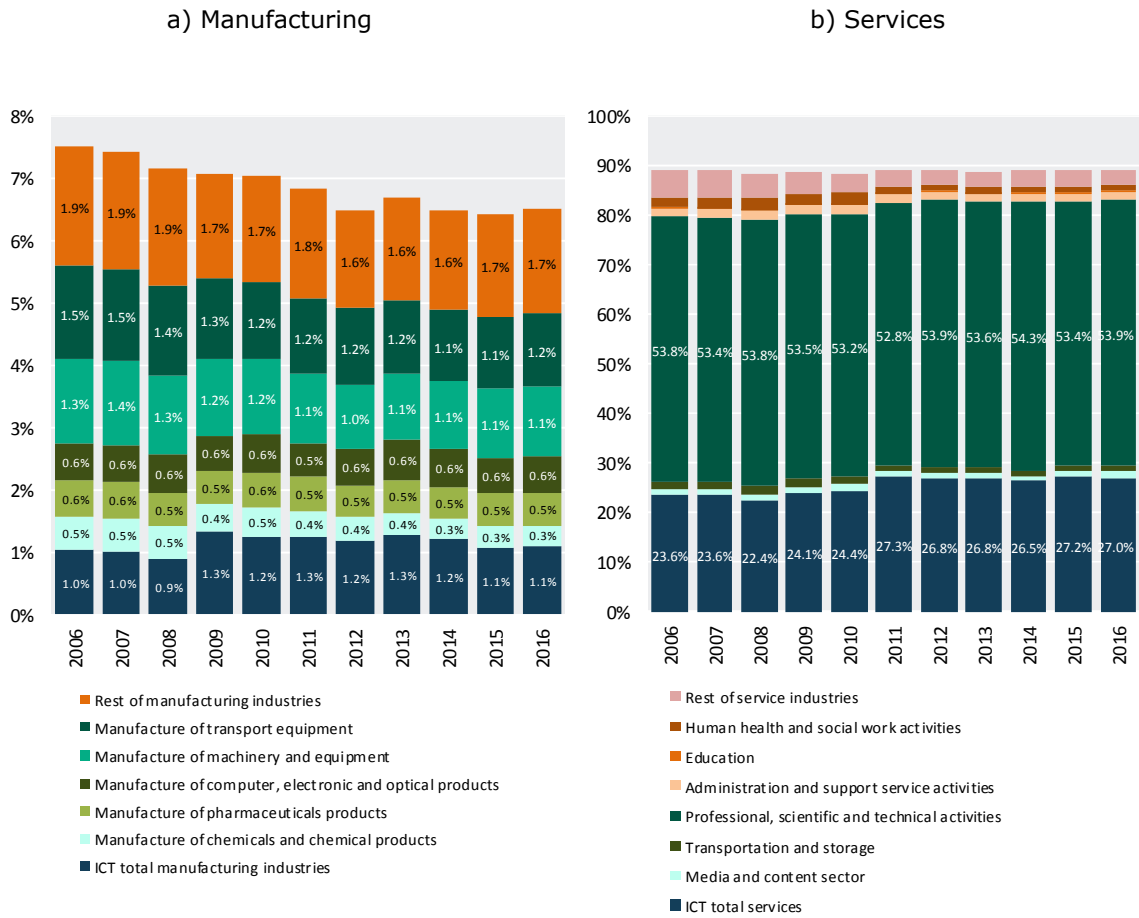
Source: 2019 PREDICT Dataset.

Figure A 29: ICT GBARD share of total ICT GBARD by sub-sector in the EU (2006, 2017)



Source: 2019 PREDICT Dataset.

Figure A 30: ICT sector ICT GBARD share on total ICT GBARD and comparison with non-ICT economic activities in the EU (2006-2016)



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: 2019 PREDICT Dataset.

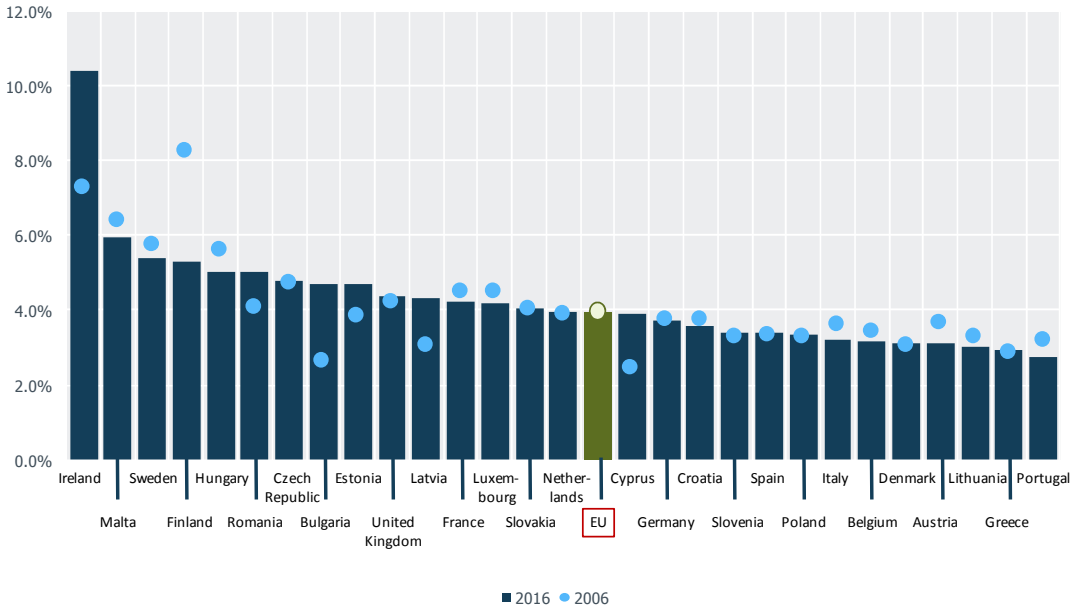
Figure A 31: ICT sector share of total by sub-sector, RERD and PERD in the EU (2006, 2016)



Source: 2019 PREDICT Dataset.

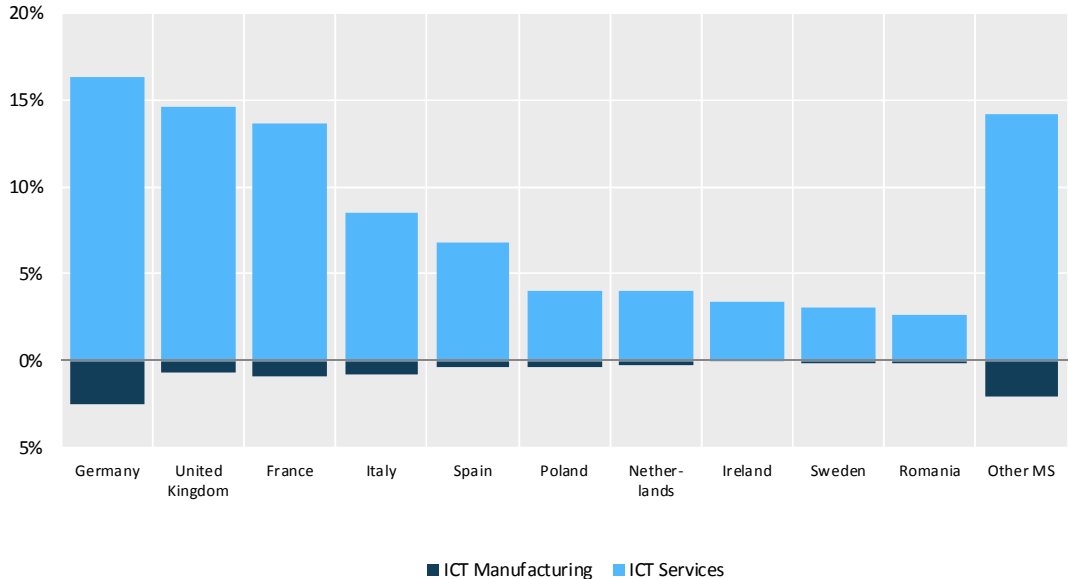
4.3 Analysis by Member State

Figure A 32: ICT sector VA share of GDP. EU Member States (2006, 2016)



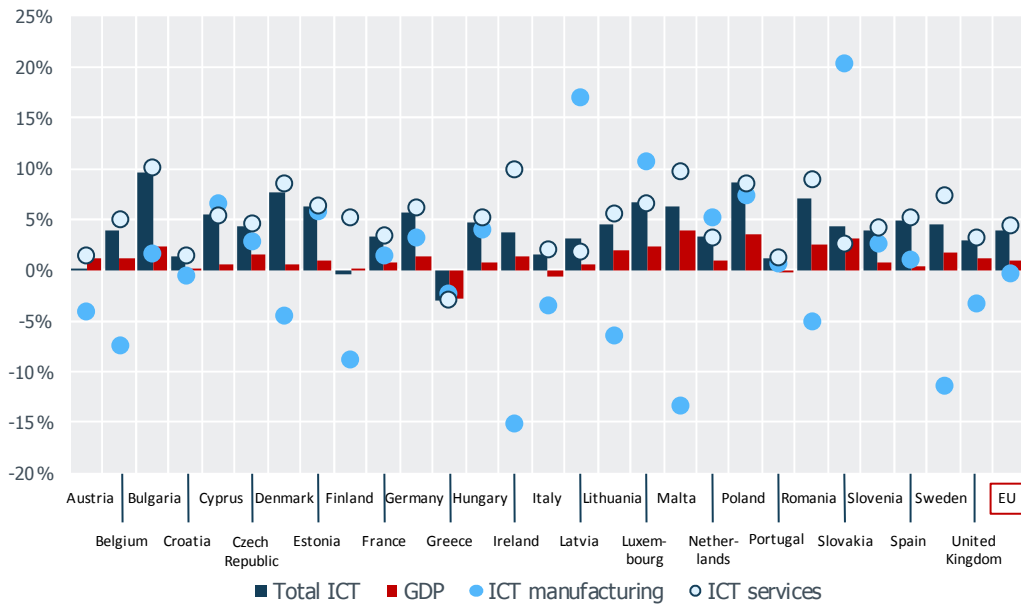
Note: 2014 for Ireland.
Source: 2019 PREDICT Dataset

Figure A 33: ICT manufacturing and ICT services VA in the ten largest EU Member States' contributors (percentages, 2016)



Note: ICT manufacturing is not available for Ireland in 2016 due to confidentiality reasons. In 2014, this sector accounts for around 0.4% of total ICT sector VA.
Source: 2019 PREDICT Dataset.

Figure A 34: Mean annual real growth rate of VA in ICT sector, ICT manufacturing, ICT services and GDP by EU Member State (2006-2016)



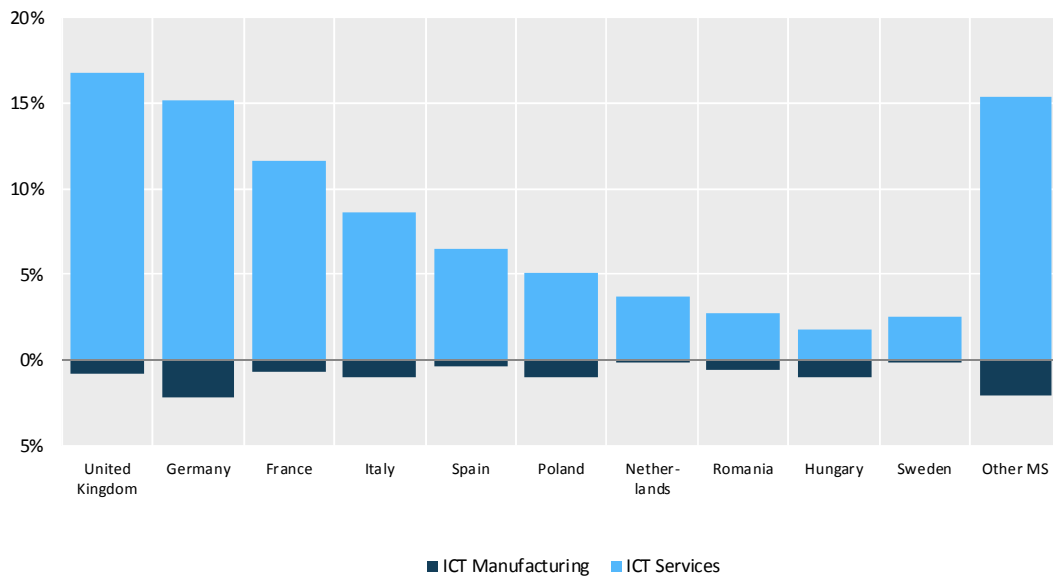
Note: 2006-2014 for Ireland.
Source: 2019 PREDICT Dataset.

Figure A 35: ICT sector employment share of total employment by EU Member State (2006, 2016)



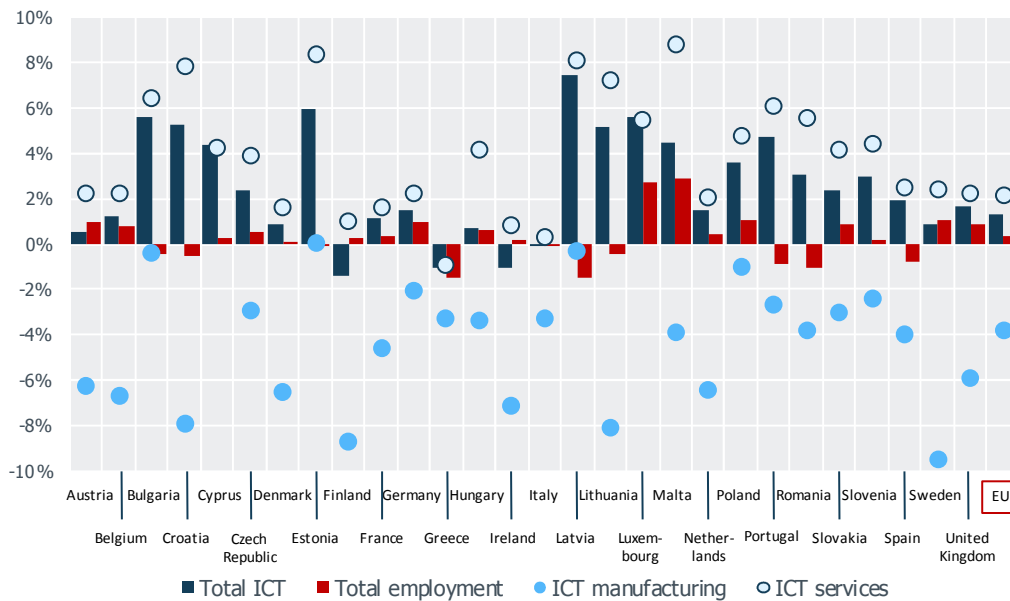
Source: 2019 PREDICT Dataset.

Figure A 36: ICT manufacturing and ICT services employment in the ten largest EU Member States' contributors (percentages, 2016)



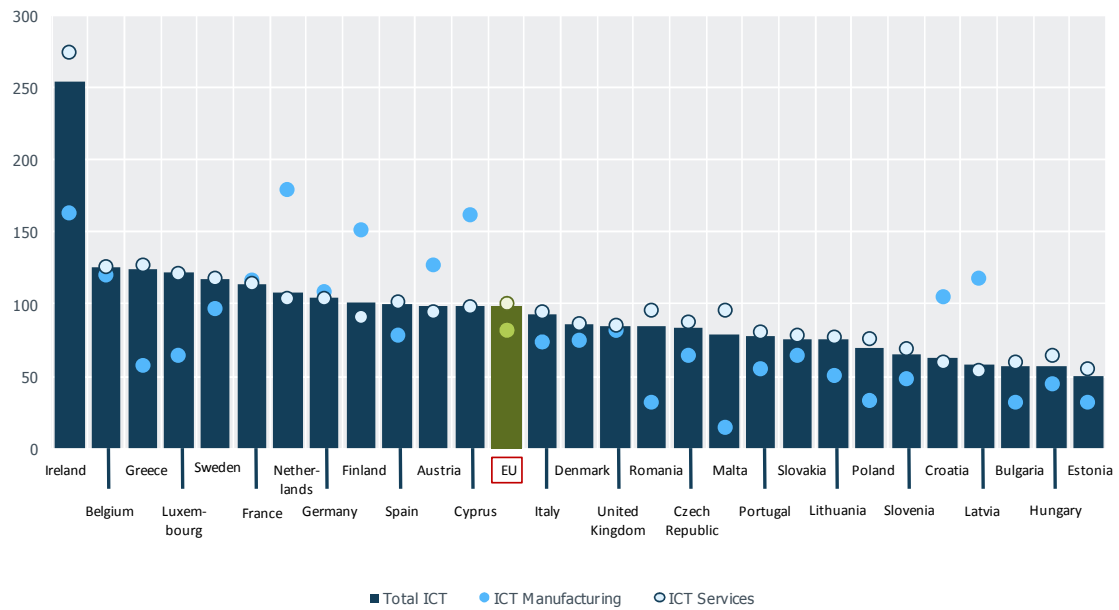
Source: 2019 PREDICT Dataset.

Figure A 37: Mean annual growth rate of employment in ICT sector, ICT manufacturing, ICT services and total employment by EU Member State (2006-2016)



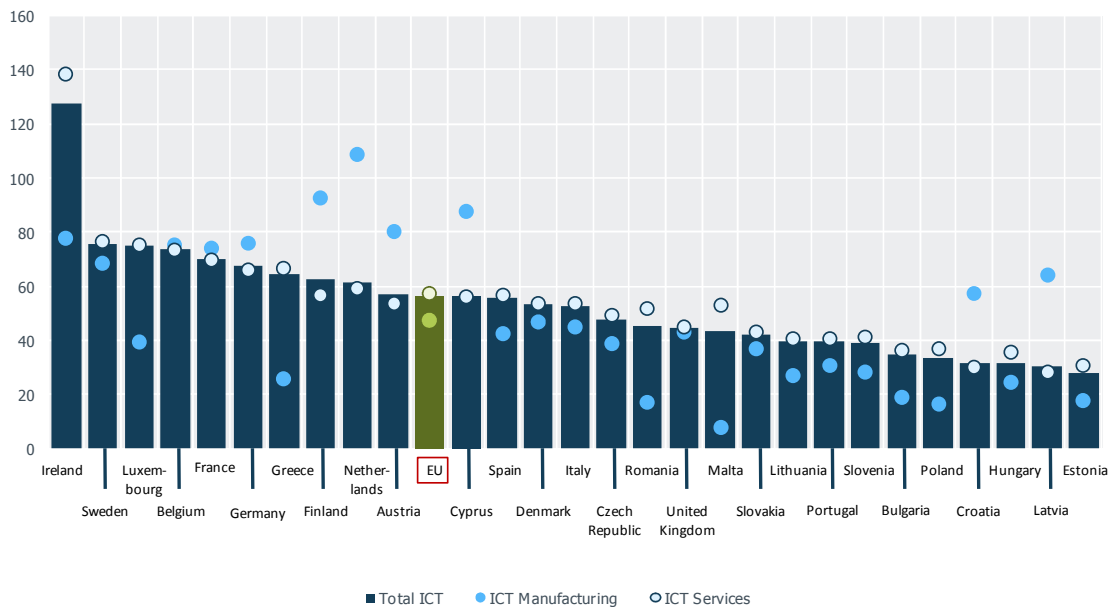
Source: 2019 PREDICT Dataset.

Figure A 38: ICT sector productivity per person employed by EU Member State (thousands of EUR PPS per person, 2016)



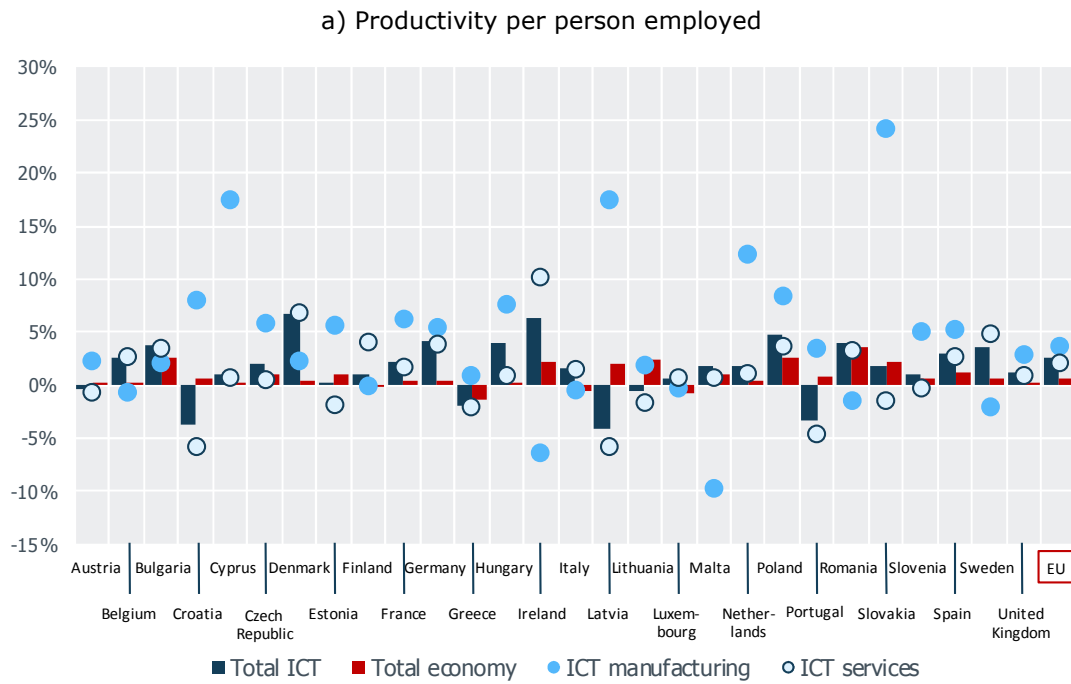
Note: 2014 for Ireland.
Source: 2019 PREDICT Dataset.

Figure A 39: ICT sector productivity per person employed by EU Member State (current EUR PPS per hour, 2016)

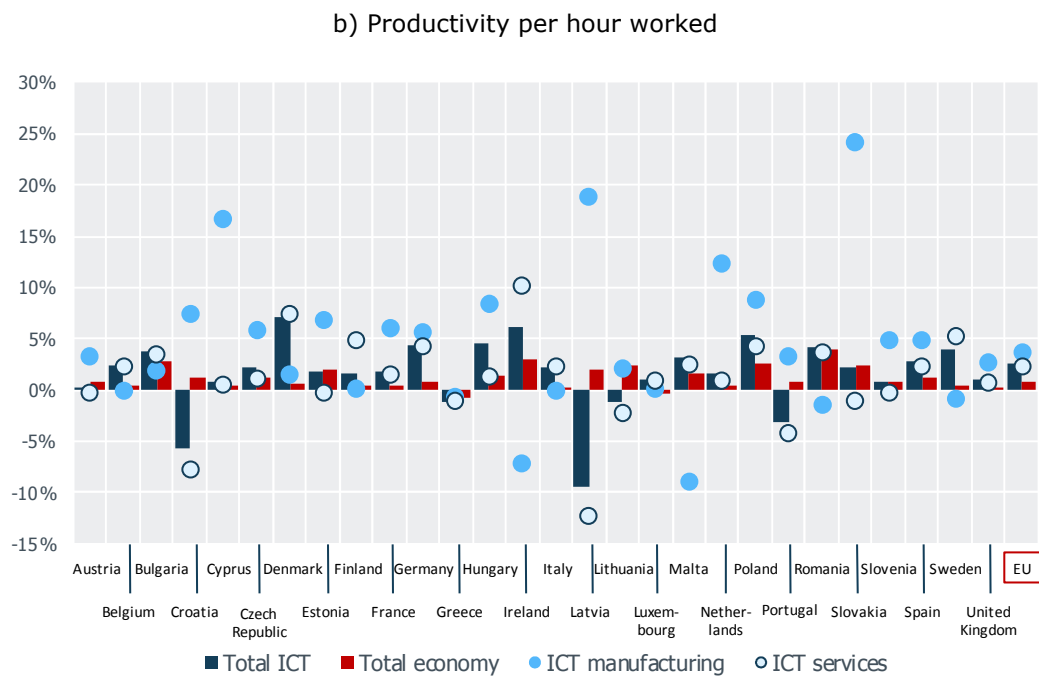


Note: 2014 for Ireland.
Source: 2019 PREDICT Dataset.

Figure A 40: Mean annual real growth rate of labour productivity in ICT sector, ICT manufacturing, ICT services and total economy by EU Member State (2006-2016)

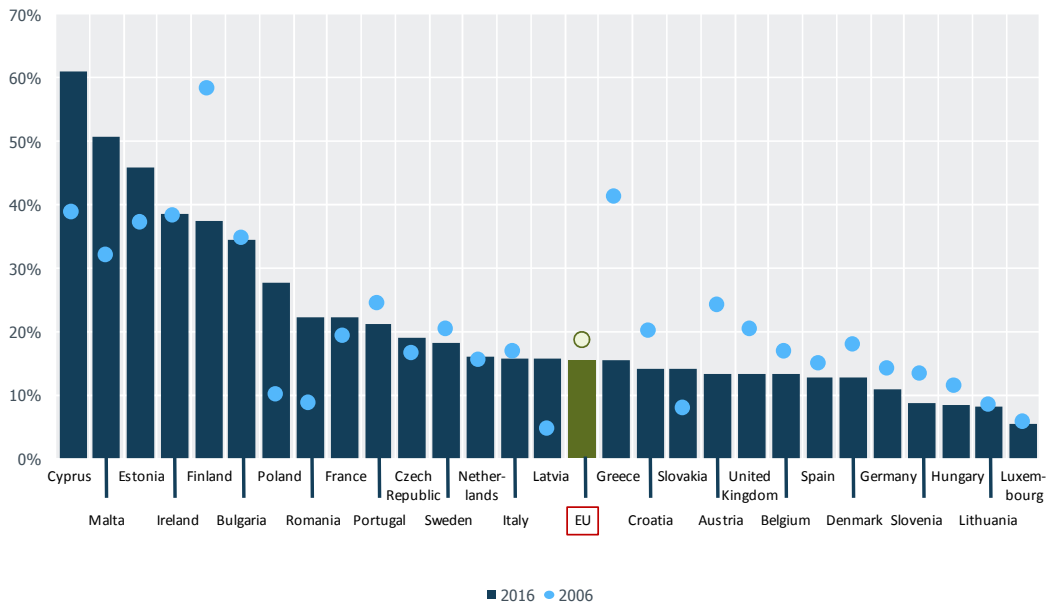


Note: 2006-2014 for Ireland



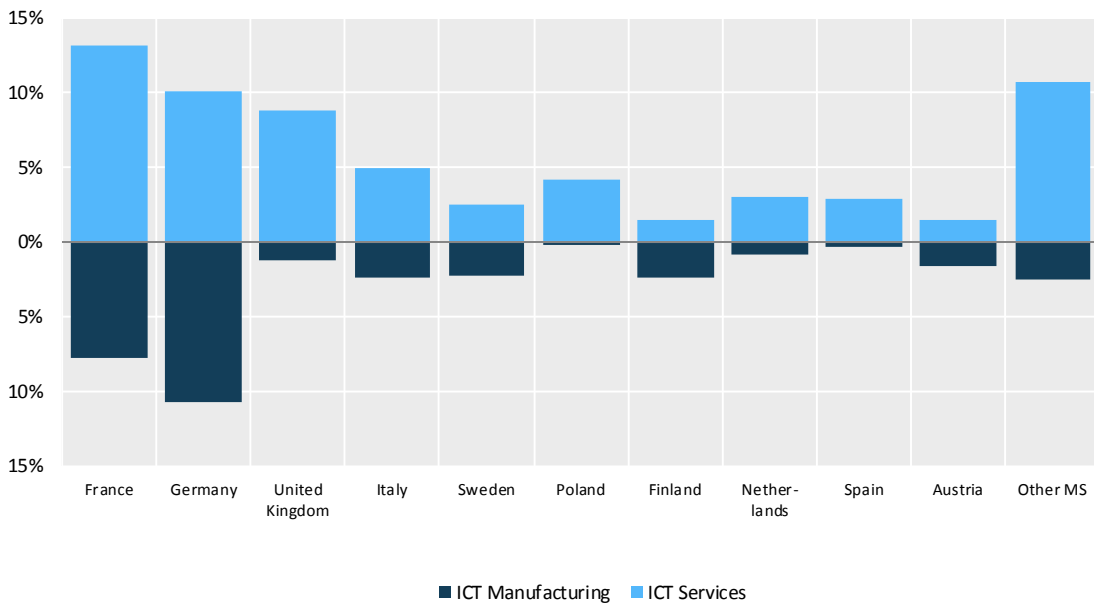
Note: 2006-2014 for Ireland
Source: 2019 PREDICT Dataset.

Figure A 41: ICT sector BERD share of total BERD by EU Member State (2006, 2016)



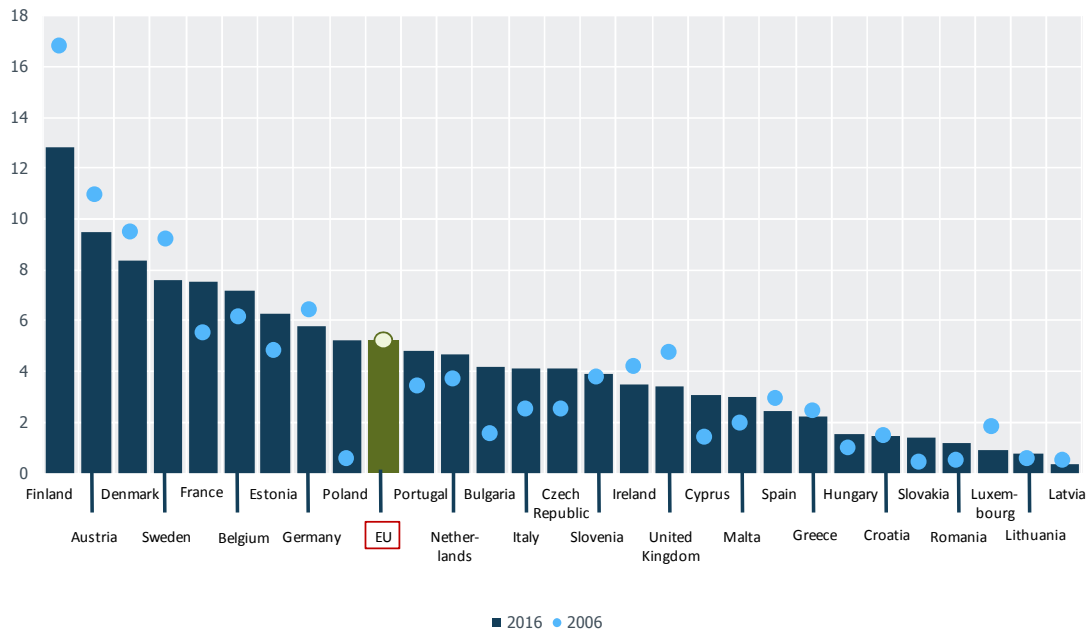
Source: 2019 PREDICT Dataset.

Figure A 42: ICT manufacturing and ICT services BERD in the ten largest EU Member States' contributors (percentages, 2016)



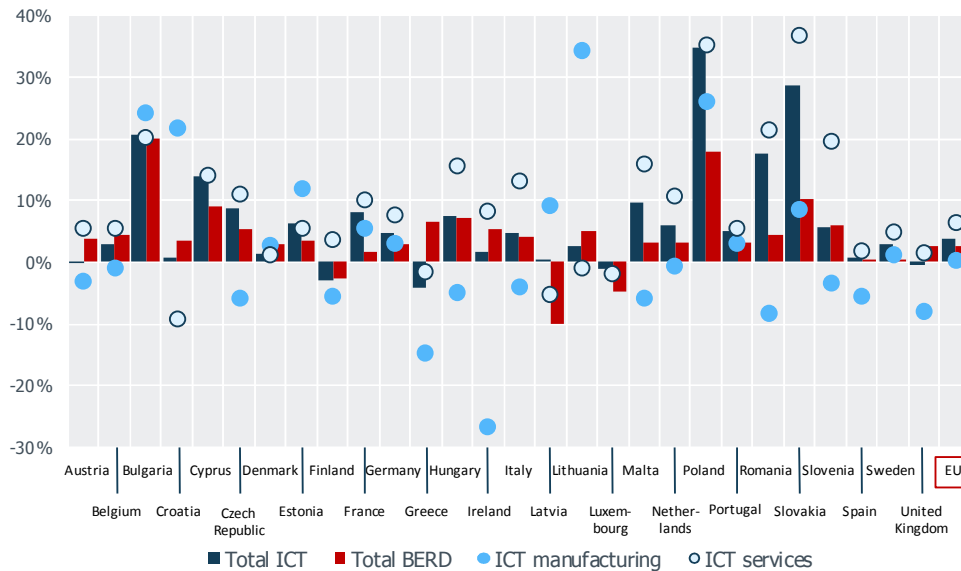
Source: 2019 PREDICT Dataset.

Figure A 43: ICT sector BERD intensity (ICT sector BERD/ICT sector VA) by EU Member State (2006, 2016)



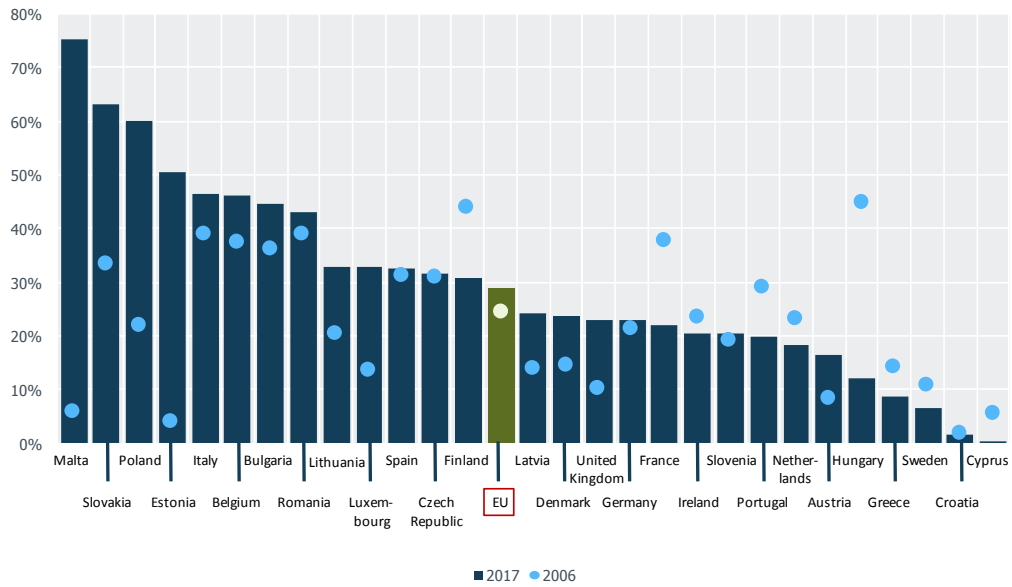
Note: 2014 for Ireland.
Source: 2019 PREDICT Dataset.

Figure A 44: Mean annual real growth rate of BERD in ICT sector, ICT manufacturing, ICT services and total BERD by EU Member State (2006-2016)



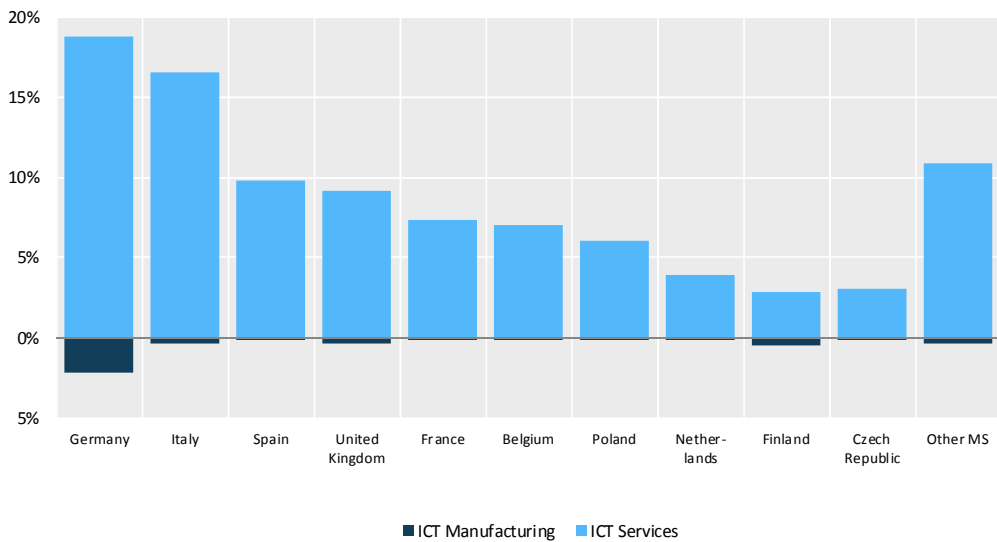
Note: 2006-2014 for Ireland.
Source: 2019 PREDICT Dataset.

Figure A 45: ICT sector ICT GBARD share of total ICT GBARD by EU Member State (2006, 2017)



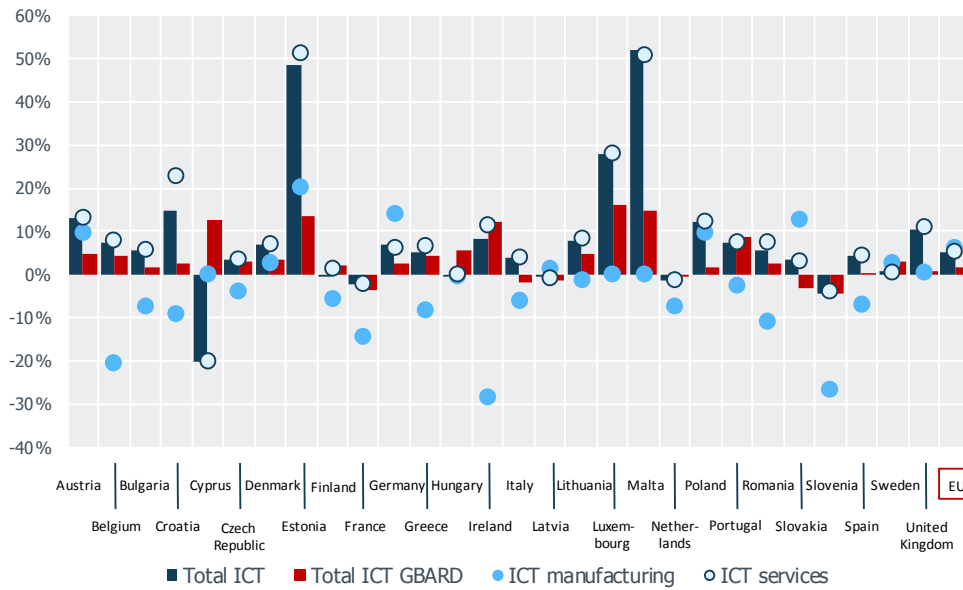
Note: 2008 is the first year available for Croatia.
Source: 2019 PREDICT Dataset.

Figure A 46: ICT manufacturing and ICT services ICT GBARD in the ten largest Member States' contributors (percentages, 2017)



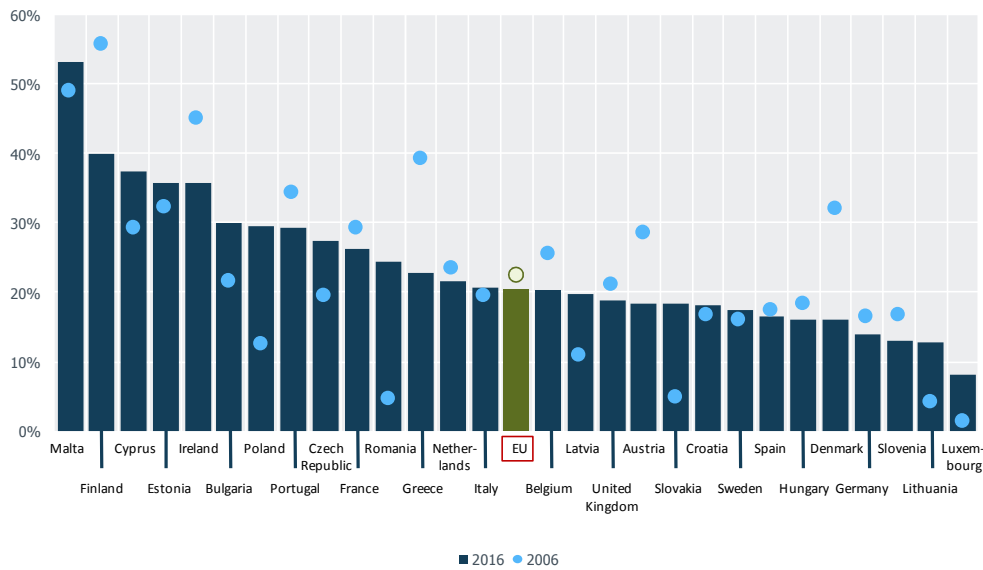
Source: 2019 PREDICT Dataset.

Figure A 47: Mean annual real growth rate of ICT GBARD in ICT sector, ICT manufacturing, ICT services and total economy by EU Member State (2006-2016)



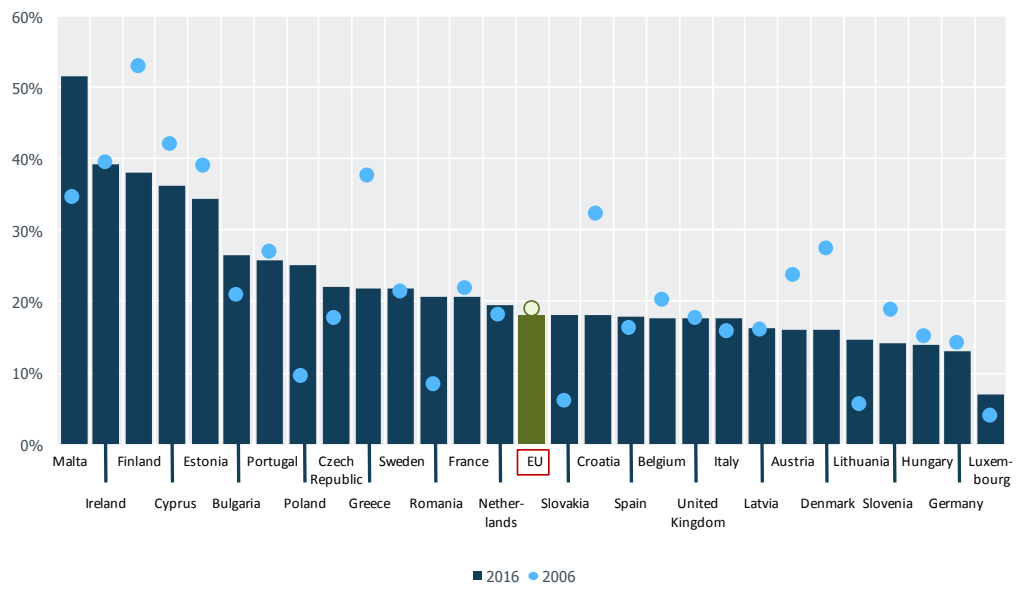
Note: 2006-2014 for Ireland and 2008-2016 for Croatia.
Source: 2019 PREDICT Dataset.

Figure A 48: ICT sector RERD share of total RERD by EU Member State (2006, 2016)



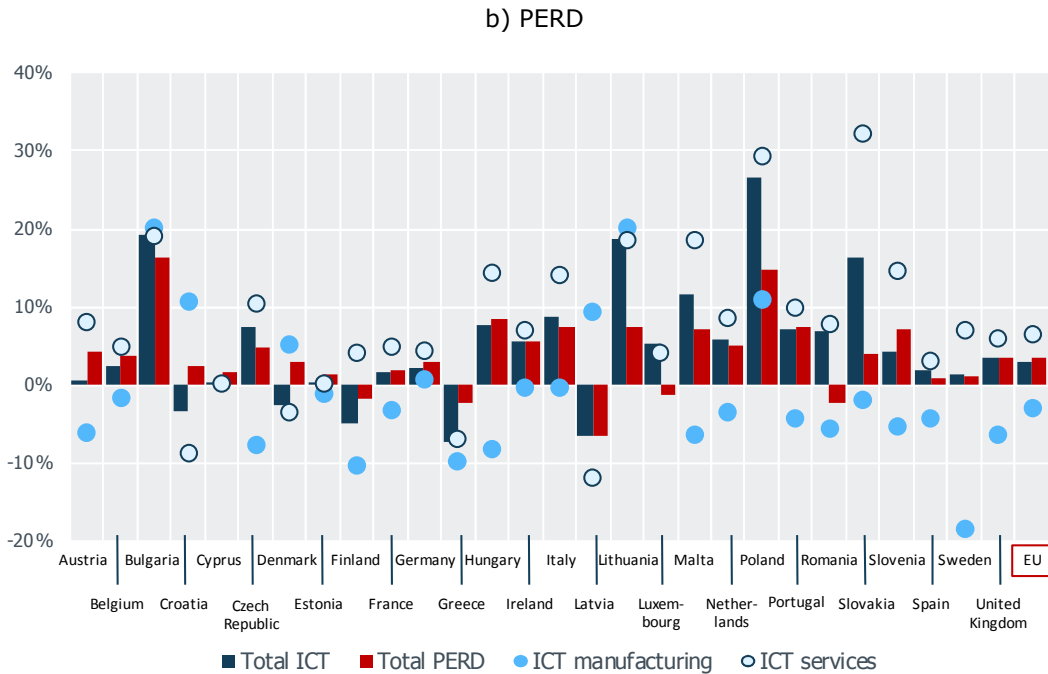
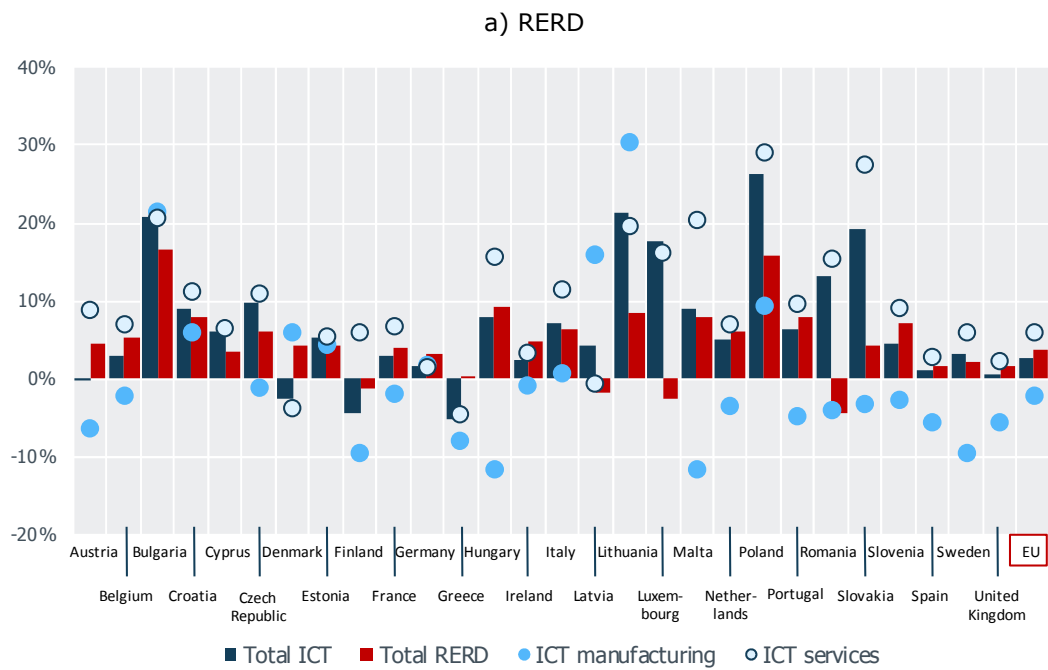
Source: 2019 PREDICT Dataset.

Figure A 49: ICT sector PERD share of total PERD by EU Member State (2006, 2016)



Source: 2019 PREDICT Dataset.

Figure A 50: Mean annual growth rate of RERD and PERD in ICT sector, ICT manufacturing, ICT services and total economy by EU Member State (2006-2016)



Source: 2019 PREDICT Dataset.

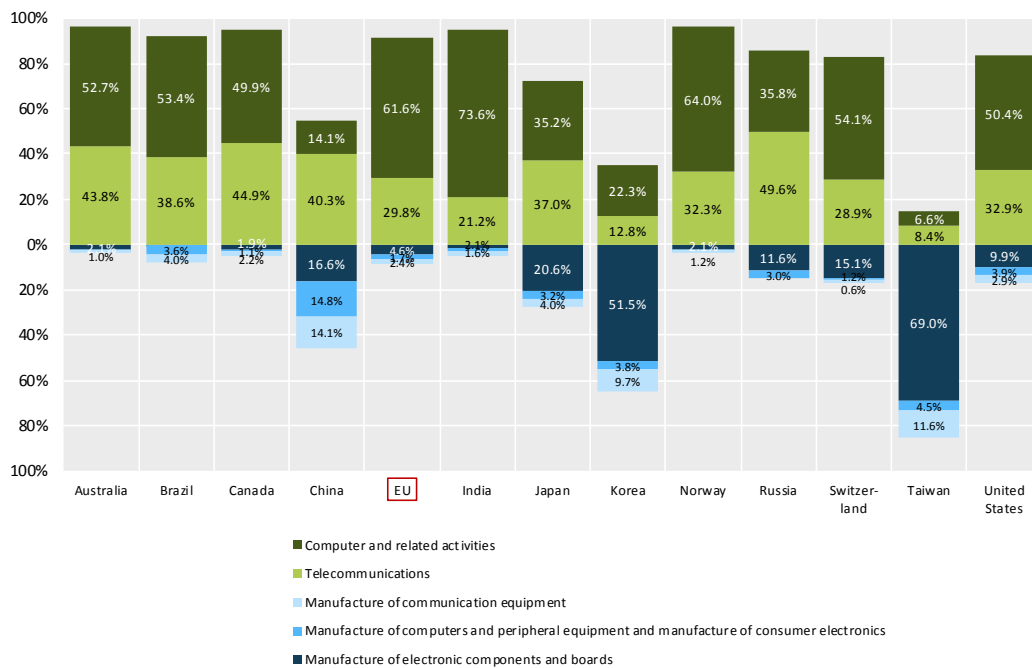
4.4 Comparison with other economies

Figure A 51: ICT sector VA share of GDP in the EU and other non-EU economies (2006, 2016)



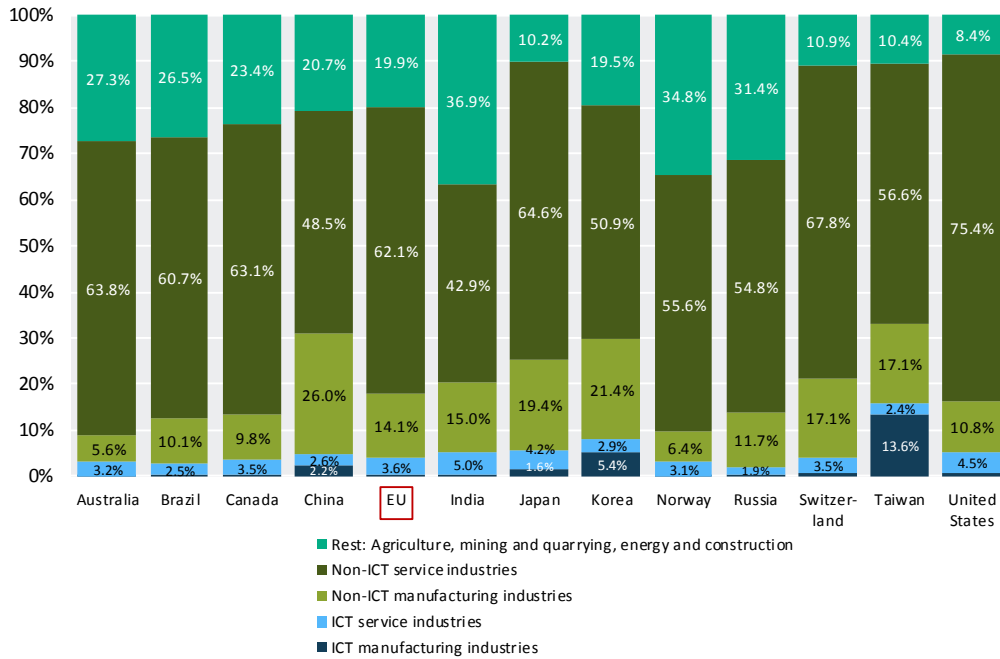
Note: 2015 for Canada.
Source: 2019 PREDICT Dataset

Figure A 52: ICT sector VA by sub-sectors in the EU and other non-EU economies (2016)



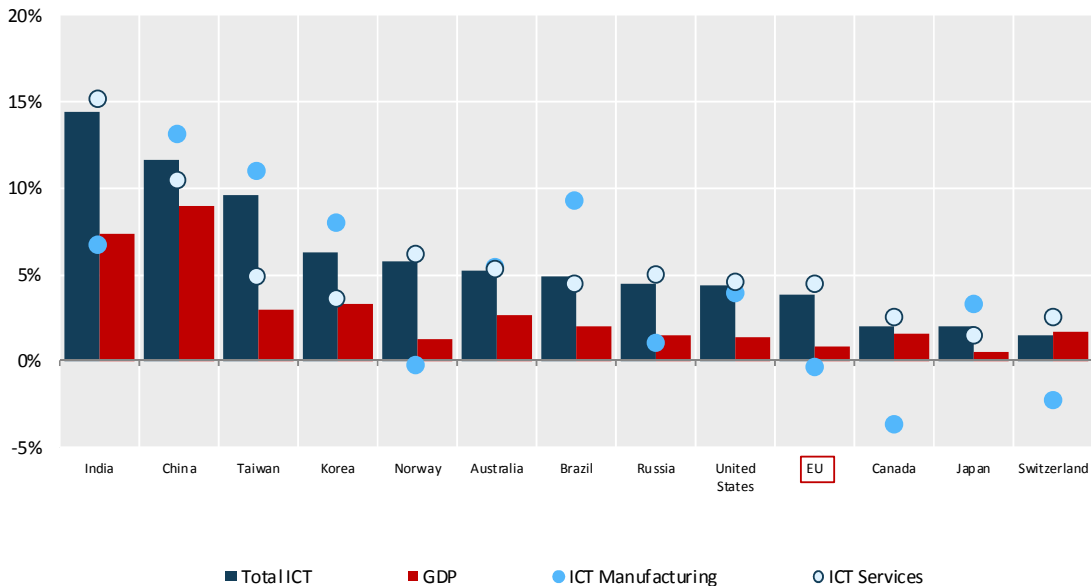
Note: 2015 for Canada.
Source: 2019 PREDICT Dataset.

Figure A 53: ICT sector VA share of GDP and comparison with non-ICT economic activities. EU and other non-EU economies (2016)



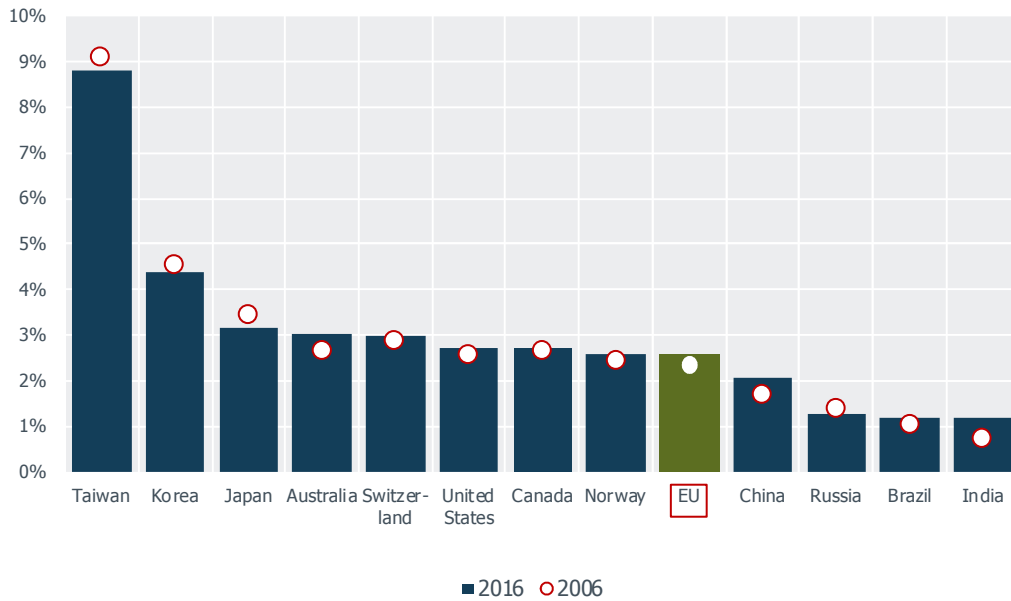
Note: 2015 for Canada. Non-ICT service industries include total Trade.
Source: 2019 PREDICT Dataset.

Figure A 54: Mean annual real growth rate of ICT sector VA in the EU and other non-EU economies (2006-2016)



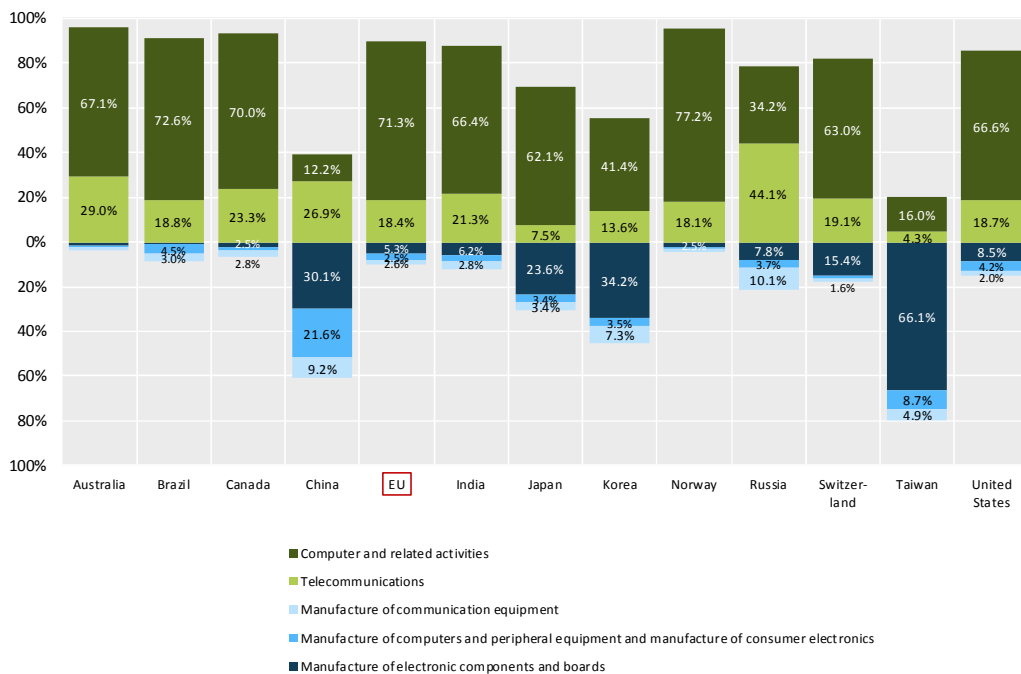
Source: 2019 PREDICT Dataset

Figure A 55: ICT sector employment share of total employment in the EU and other non-EU economies (2006, 2016)



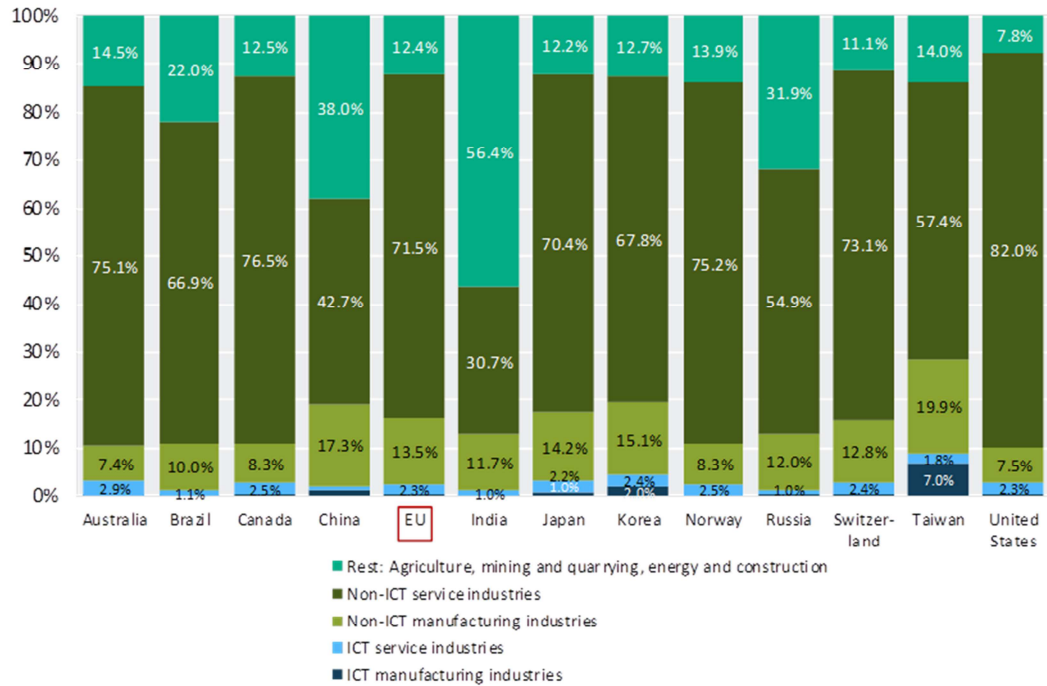
Source: 2019 PREDICT Dataset

Figure A 56: ICT sector employment by sub-sectors in the EU and other non-EU economies (2016)



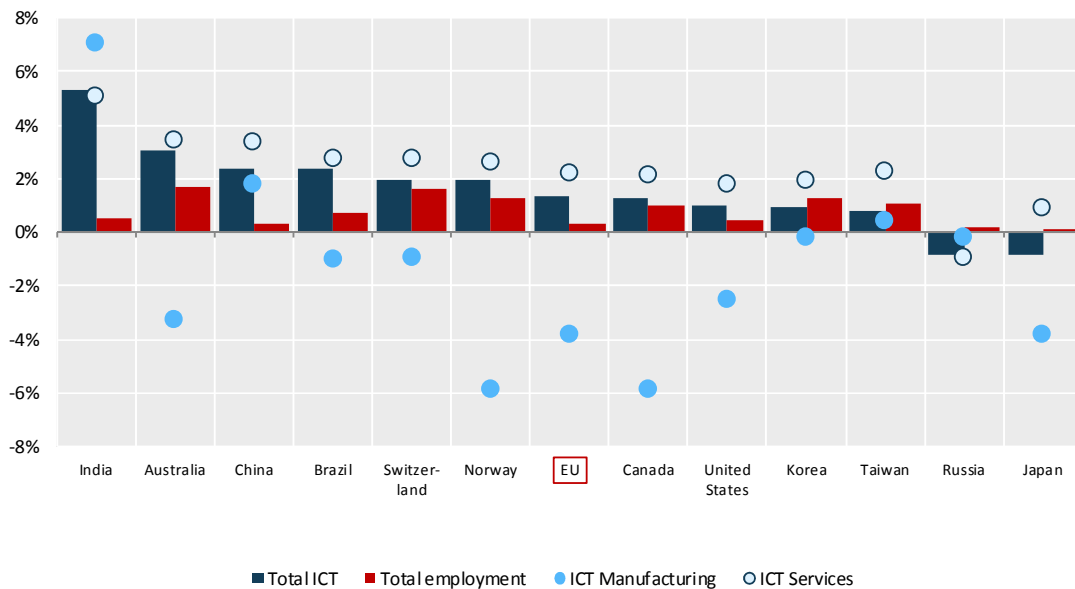
Source: 2019 PREDICT Dataset

Figure A 57: ICT sector employment share of total employment and comparison with non-ICT economic activities. EU and other non-EU economies (2016)



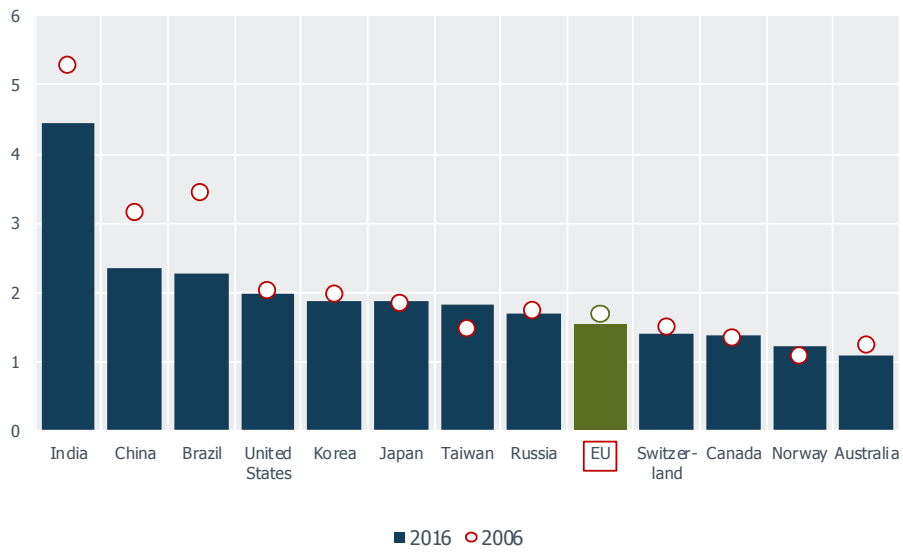
Note: Non-ICT service industries include total Trade.
Source: 2019 PREDICT Dataset

Figure A 58: Mean annual growth rate of ICT sector employment in the EU and other non-EU economies (2006-2016)



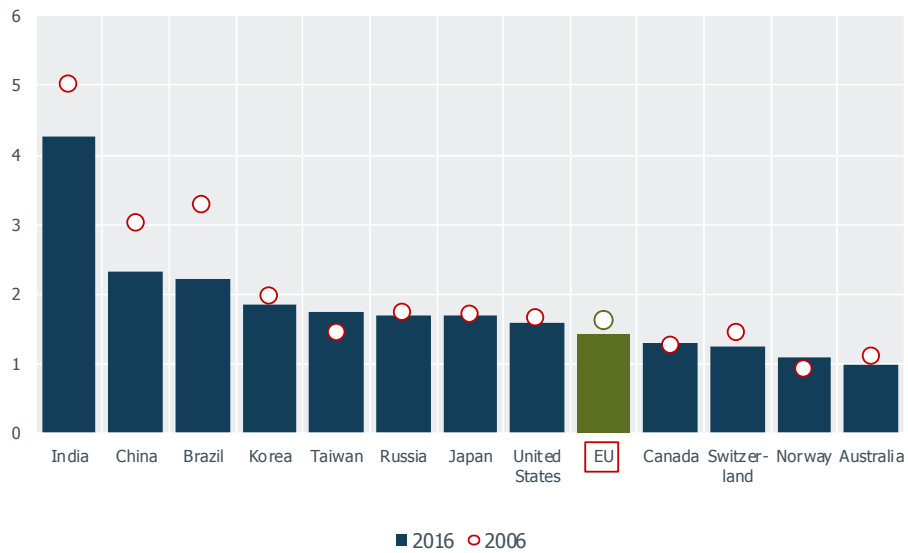
Source: 2019 PREDICT Dataset

Figure A 59: ICT sector productivity per person employed ratio over total economy productivity in EU and other non-EU economies (2006, 2016)



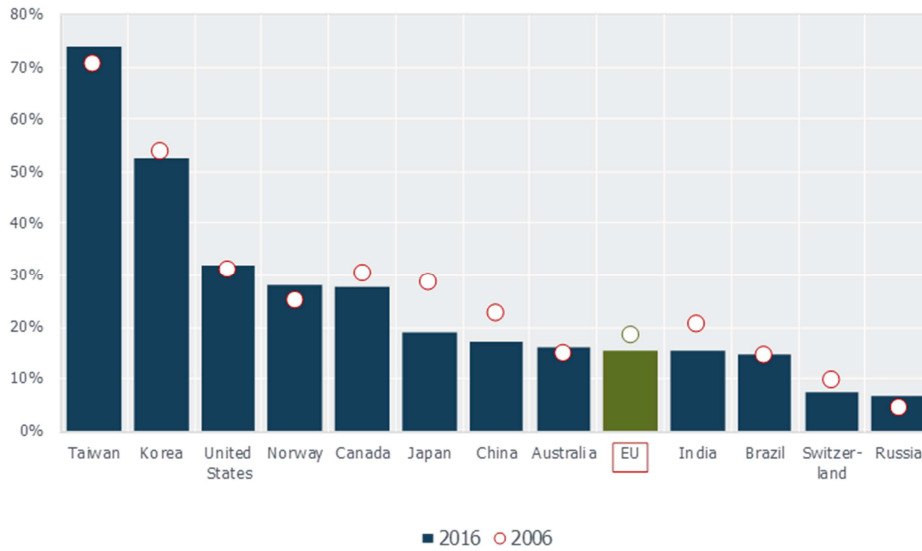
Note: 2015 for Canada.
Source: 2019 PREDICT Dataset

Figure A 60: ICT sector productivity per hour worked ratio over total economy productivity in EU and other non-EU economies (2006, 2016)



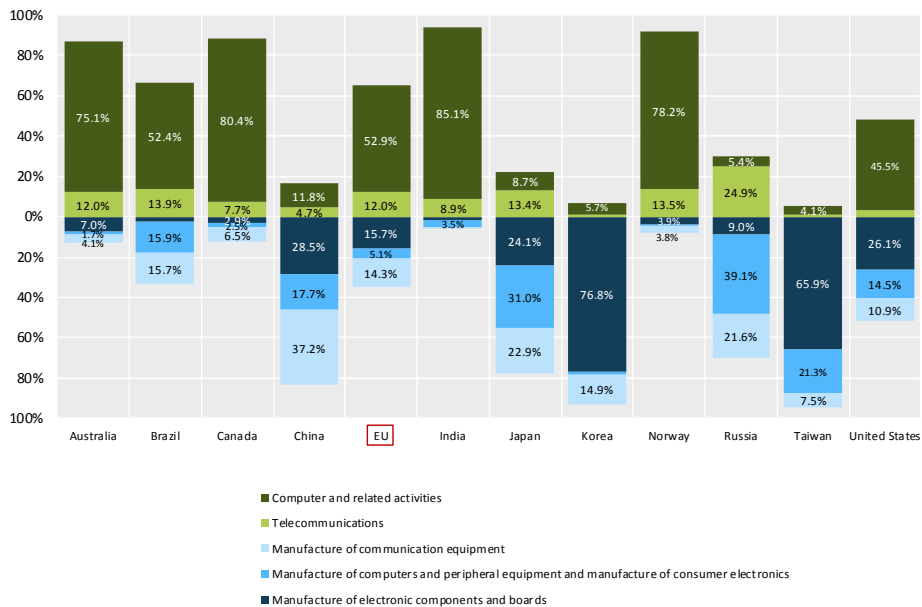
Note: 2015 for Canada.
Source: 2019 PREDICT Dataset

Figure A 61: ICT sector BERD share of total BERD in the EU and other non-EU economies (2006, 2016)



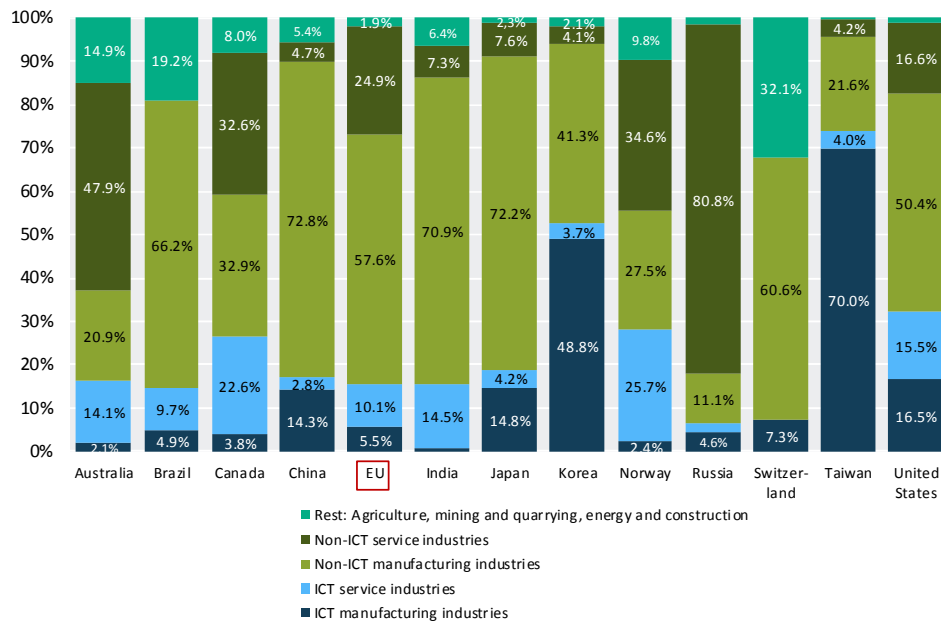
Note: 2008 is the first year available for Brazil and Switzerland. 2013 is the last year available for India, 2014 for Brazil and 2015 for Switzerland. ICT sector for Switzerland includes only ICT manufacturing.
Source: 2019 PREDICT Dataset

Figure A 62: ICT sector BERD by sub-sectors in the EU and other non-EU economies (2016)



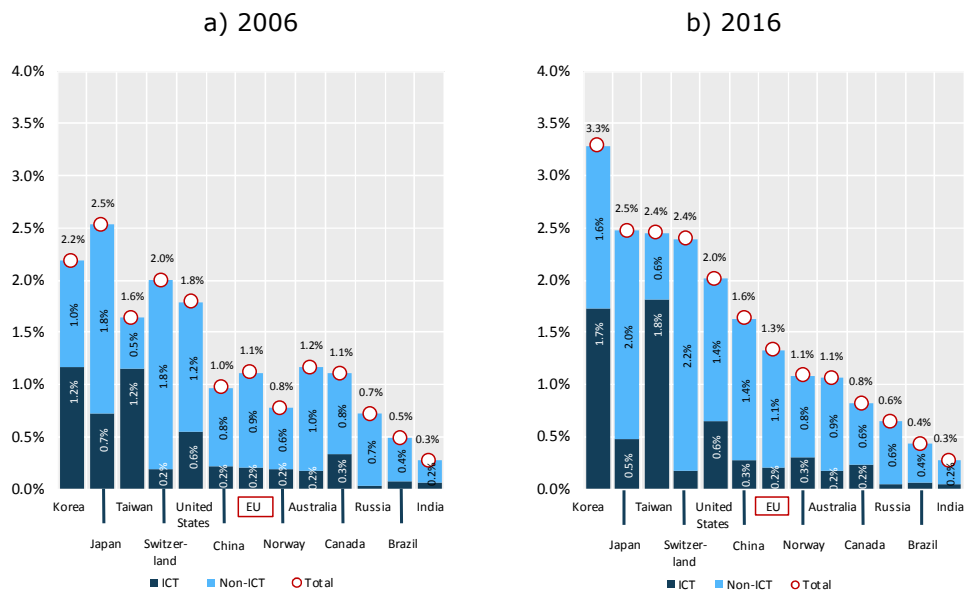
Note: 2013 for India and 2014 for Brazil. ICT BERD for Switzerland not included because of lack of sub-sector data.
Source: 2019 PREDICT Dataset

Figure A 63: ICT sector BERD share of total BERD and comparison with non-ICT economic activities. EU and other non-EU economies (2016)



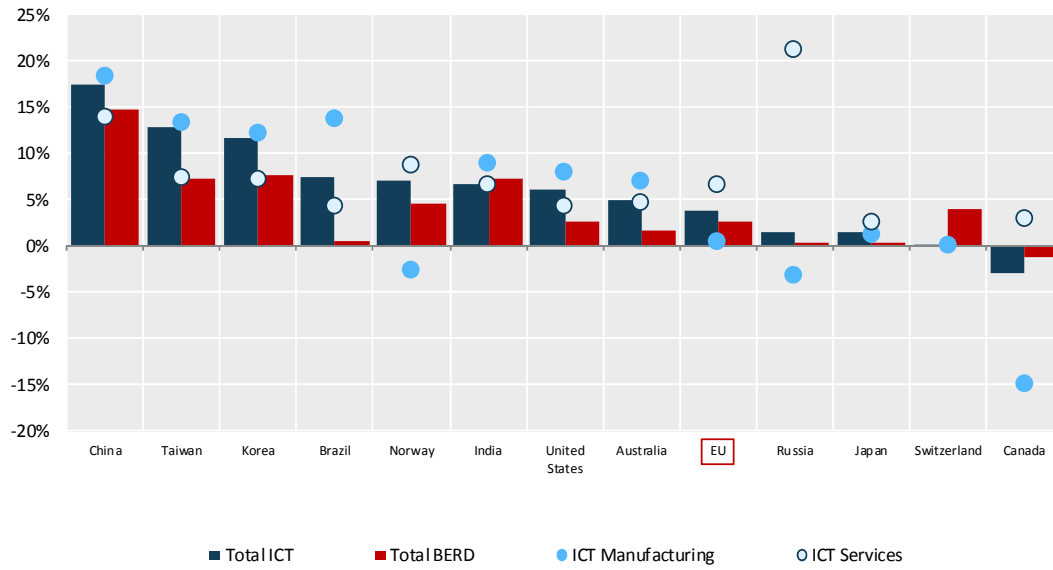
Note: 2013 for India, 2014 for Brazil and 2015 for Switzerland. Rest include non-ICT service industries for Brazil and service industries (ICT and non-ICT services) for Switzerland.
Source: 2019 PREDICT Dataset

Figure A 64: Contribution of ICT and non-ICT BERD to total BERD intensity (BERD/GDP) in the EU and other non-EU economies (2006, 2016)



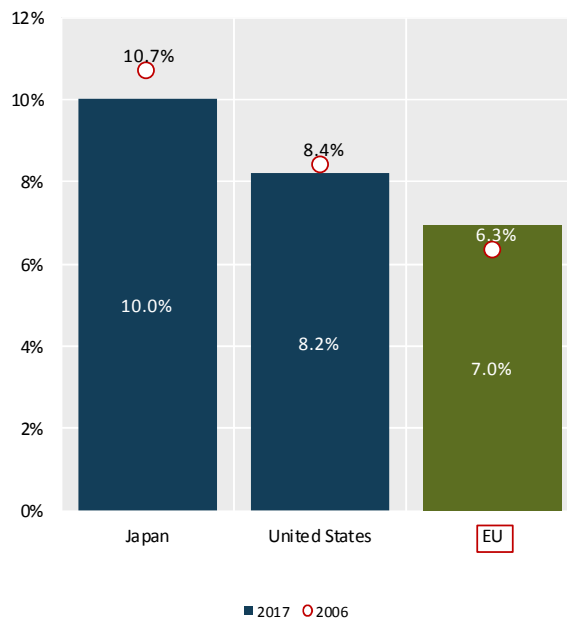
Note: 2008 is the first year available for Brazil and Switzerland. 2013 is the last year available for India, 2014 for Brazil and 2015 for Switzerland. ICT sector for Switzerland includes only ICT manufacturing.
Source: 2019 PREDICT Dataset

Figure A 65: Mean annual real growth rate of ICT sector BERD in the EU and other non-EU economies (2006-2016)



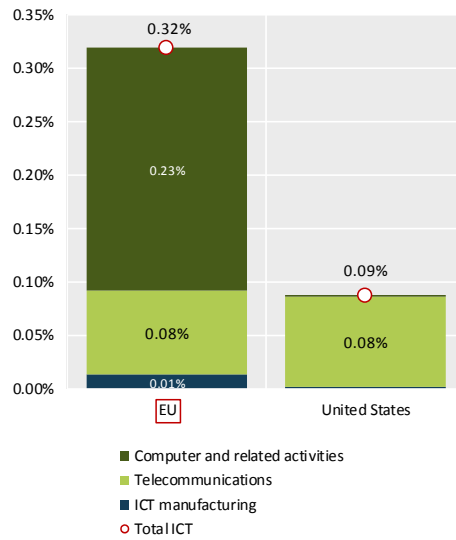
Note: 2008-2014 for Brazil, 2006-2013 for India, 2006-2015 for Canada and 2008-2015 for Switzerland. ICT sector for Switzerland includes only ICT manufacturing.
Source: 2019 PREDICT Dataset

Figure A 66: ICT GBARD share of total GBARD in the EU and other non-EU economies (2006, 2017)



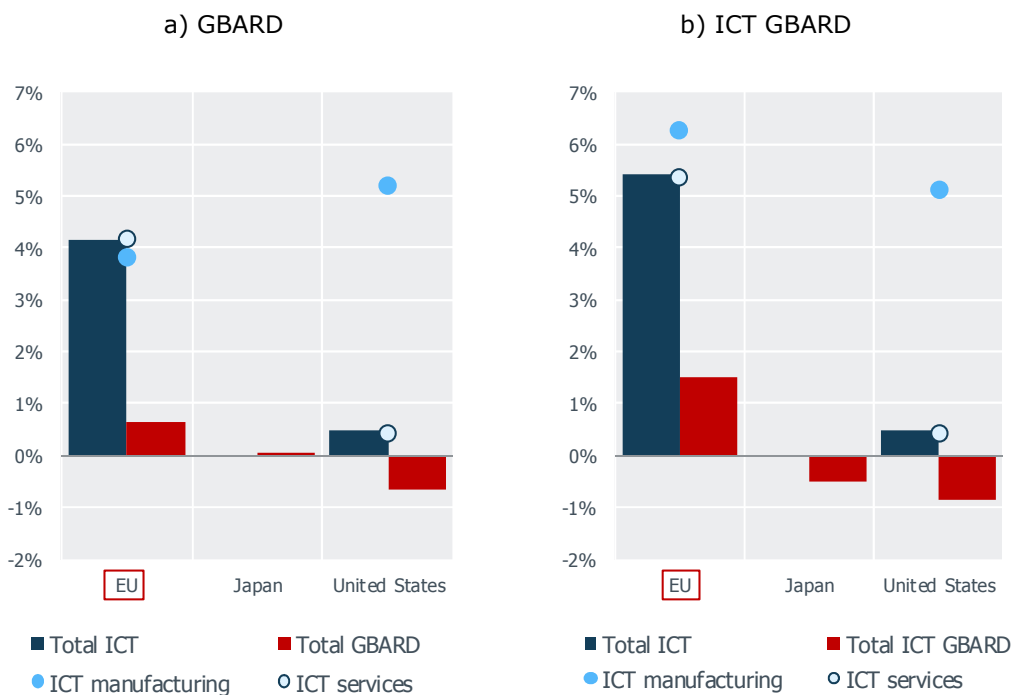
Note: Figures for Japan not fully homogeneous with EU and the United States (see methodology).
Source: 2019 PREDICT Dataset

Figure A 67: Contribution of ICT sub-sectors to ICT sector ICT GBARD intensity in the EU and United States (2017)



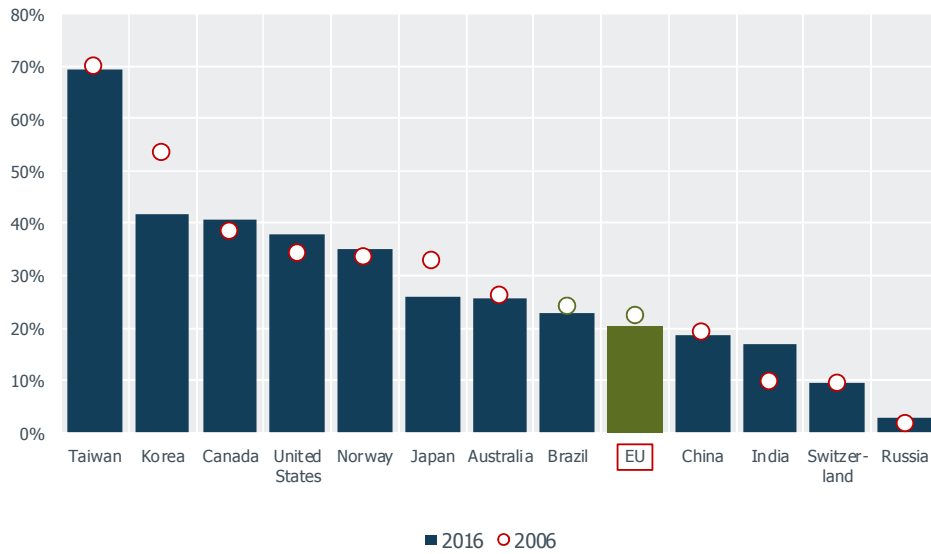
Note: ICT sector ICT GBARD for United States includes 268 NACE Rev.2 sector (Manufacture of magnetic and optical media).
Source: 2019 PREDICT Dataset

Figure A 68: Mean annual real growth rate of ICT sector GBARD and ICT GBARD in the EU and other non-EU economies (2006-2017)



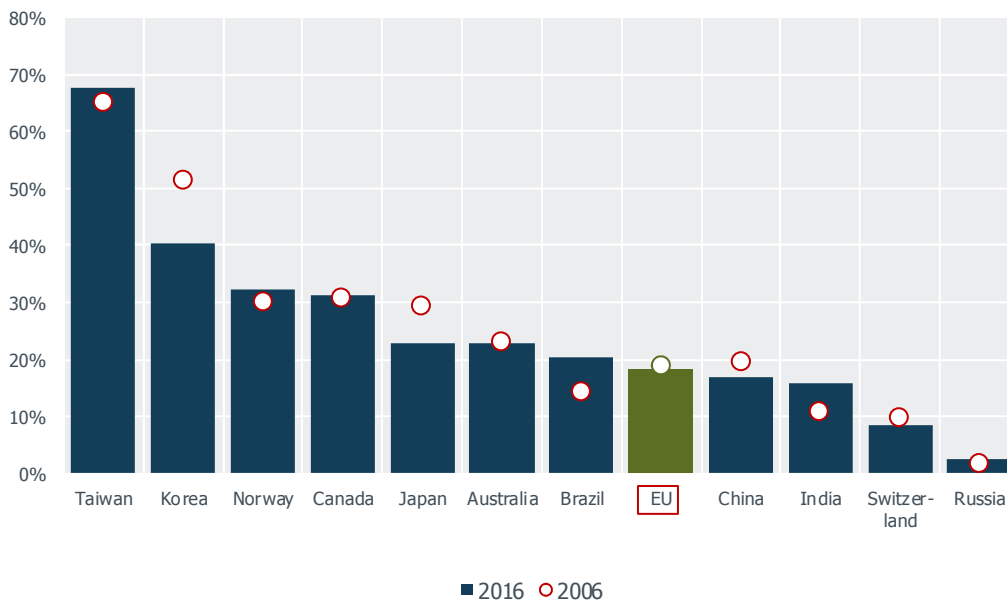
Note: ICT manufacturing for United States includes 268 NACE Rev.2 sector (Manufacture of magnetic and optical media).
Source: Source: 2019 PREDICT Dataset.

Figure A 69: ICT sector RERD share of total RERD in the EU and other non-EU economies (2006, 2016)



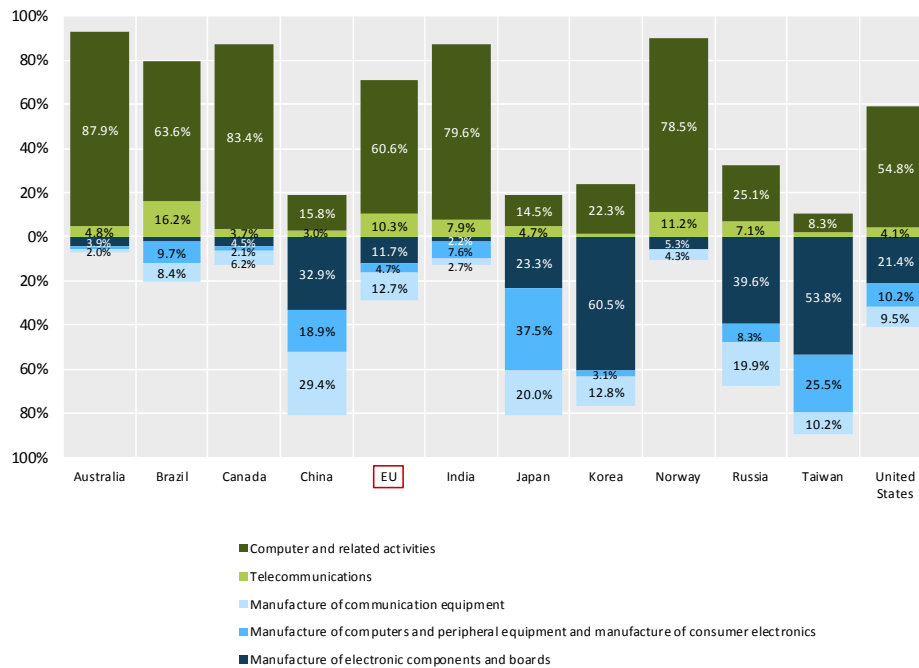
Note: 2008 is the first year available for Switzerland and 2011 for Brazil. 2013 is the last year available for India, 2014 for Brazil and 2015 for Switzerland. ICT sector for Switzerland includes only ICT manufacturing.
Source: 2019 PREDICT Dataset

Figure A 70: ICT sector PERD share of total PERD in the EU and other non-EU economies (2006, 2016)



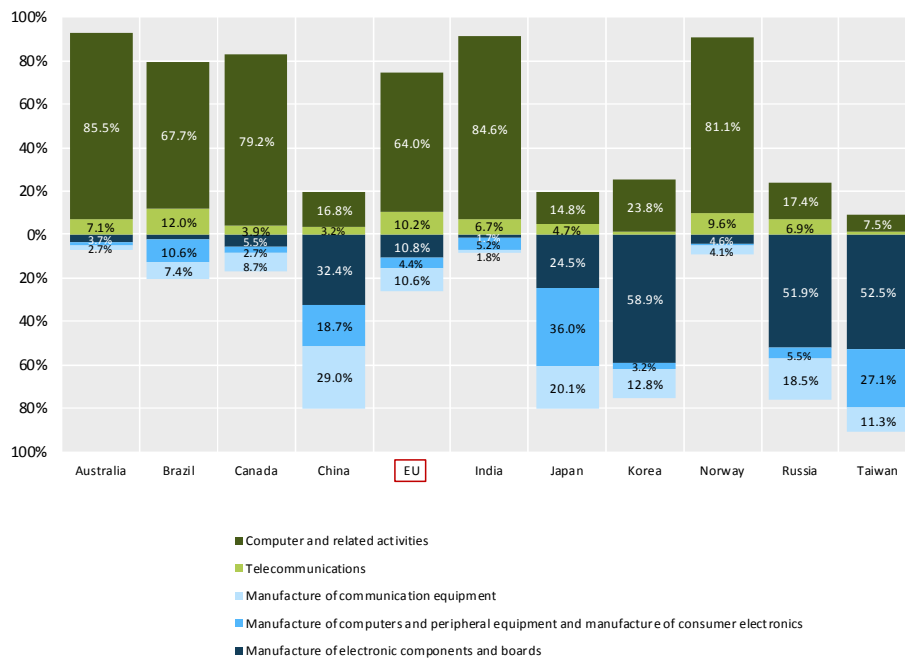
Note: 2008 is the first year available for Brazil and Switzerland. 2013 is the last year available for India, 2014 for Brazil and 2015 for Switzerland. ICT sector for United States not included because of lack of homogeneous data. ICT sector for Switzerland includes only ICT manufacturing.
Source: 2019 PREDICT Dataset.

Figure A 71: ICT sector RERD by sub-sectors in the EU and other non-EU economies (2016)



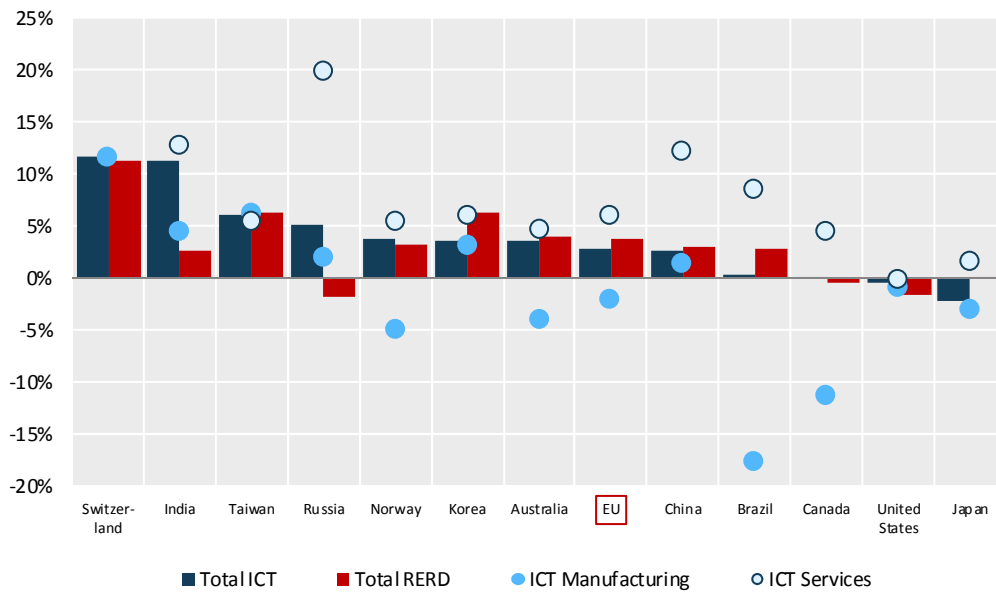
Note: 2013 for India, 2014 for Brazil and 2015 for Switzerland. ICT sector for Switzerland not included because of lack of sub-sector data.
Source: 2019 PREDICT Dataset.

Figure A 72: ICT sector PERD by sub-sectors in the EU and other non-EU economies (2016)



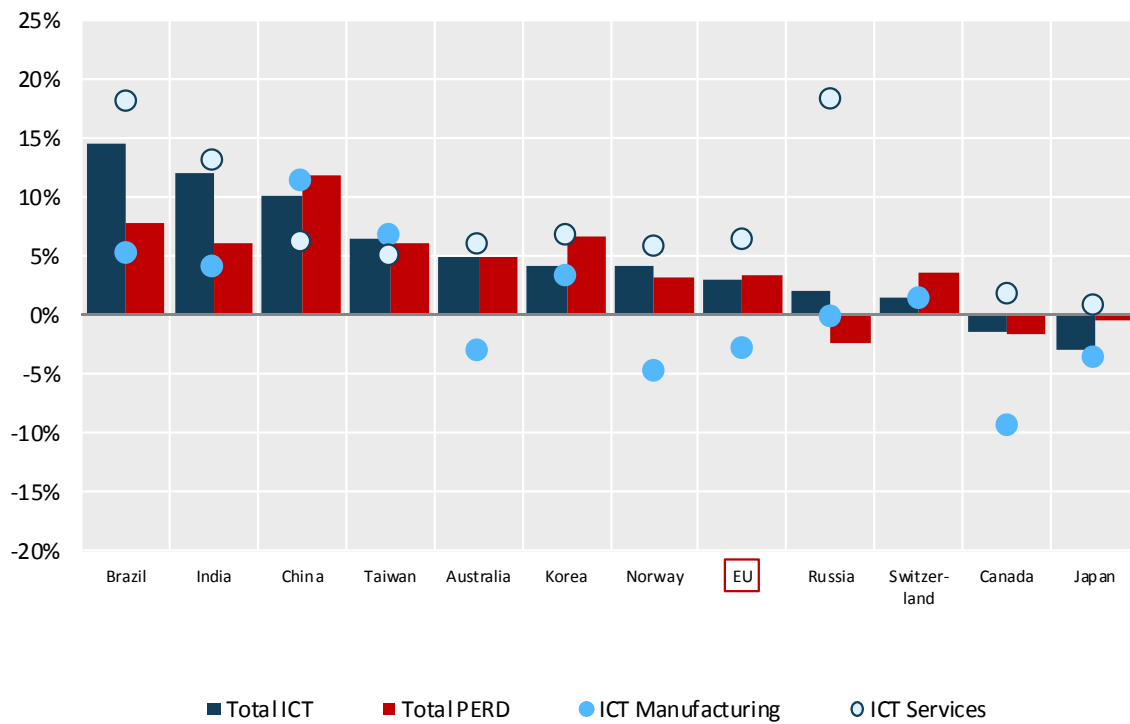
Note: 2013 for India, 2014 for Brazil and 2015 for Switzerland. ICT sector for Switzerland not included because of lack of sub-sector data. ICT sector for United States not included because of lack of homogeneous data.
Source: 2019 PREDICT Dataset.

Figure A 73: Mean annual growth rate of ICT sector RERD in the EU and other non-EU economies (2006-2016)



Note: 2011-2014 for Brazil, 2006-2013 for India and 2008-2015 for Switzerland. ICT sector for Switzerland includes only ICT manufacturing.

Figure A 74: Mean annual growth rate of ICT sector PERD in the EU and other non-EU economies (2006-2016)



Note: 2008-2014 for Brazil, 2006-2013 for India and 2008-2015 for Switzerland. ICT sector for Switzerland includes only ICT manufacturing. ICT for United States not included because of lack of homogeneous data.

Source: 2019 PREDICT Dataset.

References

Benages E., Hernández L., Mínguez C., Pérez J., Robledo J.C., Salamanca J., Solaz M., Cardona M., López-Cobo M., Righi R., Samoili S., De Prato G., Mas M., Fernández de Guevara J (2019) The 2019 PREDICT Dataset Methodology. European Commission, Joint Research Centre (JRC).

López-Cobo M., Cardona M., De Prato G., Samoili S., Righi R., Mas M., Fernández de Guevara J., Benages E., Hernández L., Mínguez C., Pérez J.; Robledo J.C., Salamanca J., Solaz M (2019). 2019 PREDICT Dataset. European Commission, Joint Research Centre (JRC) [Dataset] PID: <http://data.europa.eu/89h/jrc-predict-predict2018-core>.

Mas M., Benages E., Fernández de Guevara J. and Hernández L. (2016). "A proposal for disentangling publicly funded R&D (GBARD) by industry". SPINTAN Working Paper Series 23.

Mas M., Robledo J.C., Pérez J., Stančík J., Turlea G. and Desruelle P. (2012). *ICT sector definition transition from NACE Rev. 1.1 to NACE Rev. 2. A methodological note*, EUR 25690 EN. Publications Office of the European Union, Luxembourg, 2012, ISBN 978-92-79-28089-4 (pdf), ISSN 1831-9424 (online), doi:10.2791/40232, JRC77364

OECD (2007), Information Economy – Sector definitions based on the International Standard Industry Classification (ISIC 4). Working Party on Indicators for the Information Society. DSTI/ICCP/11S(2006)2/FINAL. OECD, Paris.

OECD (2011), Guide to measuring the Information Society. ISBN 978-92-64-09598-4. www.oecd.org/sti/measuring-infoeconomy/guide

OECD (2015), Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris, <https://doi.org/10.1787/9789264239012-en>.

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
EU:	European Union
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:	Research and Development personnel
PPS:	Purchase Power Standard
PREDICT:	Prospective Insights on R&D in ICT
R&D:	Research and Development
RERD:	Research and Development researchers
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

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: 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: 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, Czech Republic, 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, United Kingdom.

EU28: The EU aggregate in the PREDICT dataset always refers to the aggregate of the 28 countries of the current configuration regardless of the legal status of all 28 countries as Member state of the EU in the respective year. This is to allow for a comparison to the same aggregate.

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 (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.

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), OECD (2007).

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 in 2018: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

New Member States (NMS): 2004 and 2007 European Union Eastern enlargements consisting of Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia. Finally Croatia acceded to the EU in July 2013.

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

Productivity per person employed: Is defined as value added per person employed. It measures how efficiently labour input is combined with other factors of production and how it is used in the production process. Labour input is defined as total persons engaged in production. Labour productivity only partially reflects the productivity of labour in

terms of the personal capacities of workers or the intensity of their effort, as it depends on the use of other production factors, e.g. physical capital.

Productivity per hour worked: It is a measure of labour productivity and is defined as value added per hour worked. It measures how efficiently labour input is combined with other factors of production and how it is used in the production process. Labour input is defined as total hours worked of all persons engaged in production. Labour productivity only partially reflects the productivity of labour in terms of the personal capacities of workers or the intensity of their effort.

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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