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Public ICT R&D funding in the European Union

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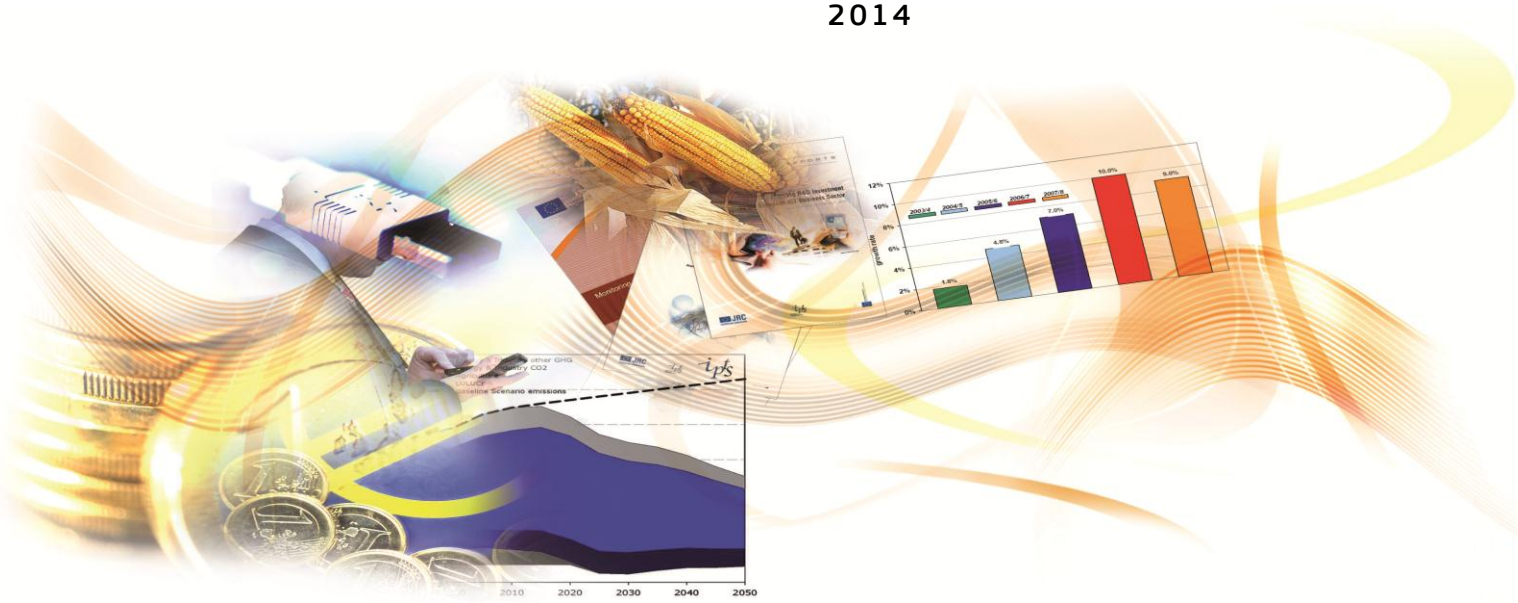

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Abstract
The report provides a detailed analysis of the state of public expenditure on Information and Communication Technologies (ICT) Research and Development (R&D) in the European Union (EU). We also provide an interim assessment of the extent to which the Digital Agenda target about doubling public ICT R&D expenditures has been achieved. Furthermore, besides focusing on the EU, we compare these expenditures with public expenditures on ICT R&D in the EU's main counterpart, the United States of America (US). Our analysis, covering the period 2006-2011, shows that EU ICT R&D public funding has been steadily growing. In 2011, it reached €6.1 billion which represented 6.6% of the whole public R&D funding. Regarding the comparison with the US, we conclude that the US government devotes more ICT R&D funds than all the EU Member States governments together but this gap has been shrinking and during the period 2006-2011 it decreased by 50%.

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Executive Summary

Introduction

This report provides a detailed analysis of the state of Research and Development (R&D) public expenditures on Information and Communication Technologies (ICT) in the European Union. We also provide an interim assessment of the extent to which the Digital Agenda Target to double public expenditures on ICT R&D has been achieved. In addition, we compare these EU expenditures with those of the EU's main counterpart, the United States of America (US).

There are two alternative sources of data to estimate ICT R&D public expenditures: the first is based on Government Budget Appropriations or Outlays on R&D (GBAORD), the second is based on Gross Domestic Expenditure on R&D (GERD). Currently available country-level public R&D expenditure data does not allow us to compute ICT-related R&D even though this data reflects real R&D spending, its availability is delayed and the coverage reduced (see Annex 3 for further discussion and details on the differences between these two indicators). Using the GBAORD data allows us to estimate ICT R&D expenditure based on the government budget plan, giving more timely results. Therefore in this report we employ the first data source (GBAORD), and apply the methodology described in Annex 1 to estimate public ICT-related R&D from the GBAORD data. Thus, under these circumstances and for readability purposes, we use the terms "GBAORD" and "public R&D expenditure" interchangeably in this report. Our analysis covers the periods 2006-2011 and employs official data from Eurostat.[1]

This analysis was produced by the Information Society Unit of the Institute for Prospective Technological Studies (JRC-IPTS) under the Prospective Insights on R&D in ICT (PREDICT)[2] project. PREDICT was carried out jointly by JRC-IPTS and the Directorate General for Communications Networks, Content and Technology (DG CONNECT) of the European Commission. It provides an analysis of private and public R&D investments in the EU ICT sector, and also benchmarks them against those of the EU's main global competitors.

R&D public funding at EU level

The total GBAORD in the EU Member States gradually increased from €81 billion in 2006, reaching a peak in 2010 (€93 billion). In 2011, it decreased to €92 billion.

GBAORD data is classified in 14 chapters defined in the Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets (NABS). These 14 chapters represent various socio-economic objectives. Our results show that the chapter which received by far the largest funding in 2011 was *General advancement of knowledge*. It received almost €47 billion, which represented 50.5% of the total EU GBAORD. The remaining NABS chapters received less than €10 billion each. Of these, the most important ones were *Industrial production and technology* (€9 billion or 9.7%), *Health* (€8 billion or 8.7%) and *Exploration and exploitation of space* (€5 billion or 5.7%). The chapters receiving the lowest public R&D funding were *Exploration and exploitation of the Earth* (€1.7 billion), *Culture, recreation, religion and mass media* and *Education* (€1 billion each).

[1] The GBAORD data was downloaded from Eurostat on 1 April 2014.
[2] The project's website can be accessed at http://is.jrc.ec.europa.eu/pages/ISG/PREDICT.html

In 2011, the largest contributor to total EU GBAORD was Germany, with €24 billion (26% of total EU GBAORD). France was the second largest contributor with €16.8 billion (18%). Other important countries were the UK €10.4 billion (11%), Italy €8.9 billion (10%) and Spain €7.3 billion (8%).

ICT R&D public funding at the EU level

Total EU ICT GBAORD in 2011, as estimated by means of the methodology described in Annex 1, amounted to €6.1 billion. Looking at the evolution of EU ICT GBAORD over the period 2006-2011, we can see that it grew steadily from only €5.2 billion in 2006. The main increase occurred during the first four years of the analysed period (2006 – 2009) when it grew 4.6% per annum on average. The importance of ICT-related research in public financing was also stable during the observed years. In 2011, the share of EU ICT GBAORD in the total EU GBAORD reached 6.6% which represented a very slight increase (0.1 percentage point) from 2010.

Our estimates and analysis further reveal that nearly 80% of the total EU ICT GBAORD in 2011 came from only two NABS chapters - *General advancement of knowledge* and *Industrial production and technology* which had expenditures of €2.9 billion (48%) and €1.9 billion (31%) respectively. The remaining eleven NABS chapters play only a small role. Altogether, they represented only 21% of the total EU ICT GBAORD. Of these, *Exploration and exploitation of space* received 4.5% (€277 million), followed by *Energy (*3.5% or 211 million), *Transport, telecommunication and other infrastructures (*2.9% or €177 million) and *Defence* (2.1% or €131 million). *Education* had the lowest share (0.2% or €12 million). In terms of ICT shares within each NABS chapter, ICT R&D funding represented almost 21% of GBAORD in *Industrial production*. It represented considerably less in *Culture recreation, religion and mass media* (11%), *Transport, telecommunication and other infrastructures* (6.5%), *General advancement of knowledge* (6.3%), *Energy* (5.6%) and *Exploration and exploitation of space* (5.2%). The ICT shares in the remaining NABS chapters was less than 5%.

From 2006 to 2011, ICT GBAORD increased the most in the *General advancement of knowledge* NABS chapter: i.e. by almost €75 million every year (from €2.6 billion in 2006 to € 2.9 billion in 2011). However, in terms of relative growth, the *Culture* NABS chapter came first with an annual growth rate of 45% (from €17 million in 2006 to € 112 million in 2011).

Shifting our attention to the distribution of ICT GBAORD among the Member States, six countries, five of which are the largest EU economies, accounted together for almost three quarters of EU ICT GBAORD: Germany (21.2%) led, followed by the UK (10.5%), France (10%), Spain (9.8%), Italy (8.2%), and Sweden (7.8%). Although these numbers present an important view of EU ICT GBAORD, they are predominantly driven by the corresponding country's economic size. Obviously, governments of larger countries can spend more on ICT-related research than those of smaller countries. Looking at ICT GBAORD intensities (i.e. the ratio of ICT GBAORD on total GBAORD) offers a comparison of the importance of ICT research in individual countries' public funding. In this regard, the most ICT GBAORD-intensive country in 2011 was Sweden. This country devoted almost 15% of its total GBAORD to ICT. Belgium followed with 11% and Czech Republic, Finland and Slovenia came next with around 10% each.

During the period 2006-2011, the biggest absolute growth in ICT GBAORD was seen in Germany where the average annual growth was €48 million (from €1.1 billion in 2006 to €1.3 billion in 2011). Another high-growth country (in absolute terms) was Spain. On average, its ICT GBAORD

increased by €41 million annually during this period. In terms of the relative growth, smaller EU countries like Estonia, Malta, and Lithuania led the region with growth rates of 37%, 35% and 32% respectively mainly due to low initial levels and the catching up process.

ICT GBAORD vs. DAE target

The "Digital Agenda for Europe"[3] (DAE) aims to help Europe's citizens and businesses get the most out of digital technologies. It is the one of seven flagship initiatives under Europe 2020, the EU's strategy to deliver smart sustainable and inclusive growth. Building on Europe's assets, one of the objectives of the initiative is to step up efforts in ICT research and development. The DAE, in its R&D-related pillar (Pilar V, Action 55 in particular), advises the Member States to double their annual public spending on ICT R&D by 2020, but has not imposed the rate of progress towards achieving this target.

If we assume, however, that progress will be uniform over time, the growth rate would be 5.48% per annum. Our analysis shows that the EU was behind this rate. This slowdown seems to have been affected more by the recent 0.4% year-to-year drop in overall GBAORD during 2010-2011.

The EU vs. the US comparison of ICT GBAORD

Over the period 2006-2011, US ICT GBAORD, as estimated using the same methodology explained in Appendix 1 based on the US Current Population Survey (CPS) oscillated between €8 billion and €10 billion with two (equal) peaks in 2006 and 2009 (€10 billion). As mentioned above, EU ICT GBAORD grew steadily during the period and reached a peak of €6 billion in the last two years (2010-2011).

Our estimates indicate that the EU-US ICT GBAORD gap had decreased by 50% over the six years analysed (2006-2011). In 2006, the EU-US ICT GBAORD gap was €4.8 billion. Since then, due to the fact that US ICT GBAORD did not increase significantly, while the EU one did, the gap shrank to €2.4 billion in 2011.

When looking at ICT GBAORD in the different NABS chapters in the EU and the US in 2011, we can see that there was one clearly dominant but different NABS chapter in each region. Whilst 68% of US ICT GBAORD went to *Defence*, 48% of EU ICT GBAORD went to *General advancement of knowledge*. Additionally, there was only one more important NABS chapter in the EU and three important NABS chapters in the US. In the EU, it was *Industrial production and technology* with a 31% share, whereas in the US, *Exploration and exploitation of space*, *Health* and *General advancement of knowledge* together accounted for 27% of the US ICT GBAORD.

[3] The Commission Communication and Annual Progress Reports are available at http://ec.europa.eu/information_society/digital-agenda/publications/index_en.htm

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Introduction

This report provides a detailed analysis of the state of public Research and Development (R&D) expenditures on Information and Communication Technologies (ICT) in the European Union. In addition, we compare these EU expenditures with those of the United States of America (US).

There are two alternative sources of data to estimate ICT R&D public expenditures: the first is based on Government Budget Appropriations or Outlays on R&D (GBAORD data), the second is based on Gross Domestic Expenditure on R&D (GERD). Currently available country-level public R&D expenditure data does not allow us to compute ICT-related R&D: even though this data reflects real R&D spending, its availability is delayed and coverage reduced (see Annex 3 for further discussion and details on the differences between these two indicators). Using the GBAORD data allows us to estimate ICT R&D expenditure based on the government budget plan, giving more timely results. Therefore in this report we employ the first data source (GBAORD), and apply the methodology described in Annex 1 to estimate public ICT-related R&D from the GBAORD data. Thus, under these circumstances and for readability purposes, we use the terms "GBAORD" and "public R&D expenditure" interchangeably in this report. Our analysis covers the periods 2006-2011 and employs official data from Eurostat.[4]

This analysis was produced by the Information Society Unit of the Institute for Prospective Technological Studies (JRC-IPTS) under the Prospective Insights on R&D in ICT (PREDICT)[5] project, a research project on R&D in ICT in Europe. PREDICT was carried out by JRC-IPTS and the Directorate General for Communications Networks, Content and Technology (DG CONNECT) of the European Commission. Data calculation was carried out jointly with the Valencian Institute of Economic Research (Ivie).

The report is structured as follows. We start with an overview of public R&D funding (GBAORD) in the EU. Then we shift our focus to public R&D funding specifically for ICT. We analyse ICT-related R&D in all the chapters of the Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets (NABS) and across all EU Member States. We also provide an interim assessment of progress towards the Digital Agenda Target of doubling public ICT R&D expenditures by 2020. Furthermore, we compare ICT GBAORD in the EU and the US. The last section offers some conclusions.

[4] The GBAORD data was downloaded from Eurostat on 1 April 2014.

[5] The project's website can be accessed through http://is.jrc.ec.europa.eu/pages/ISG/PREDICT.html

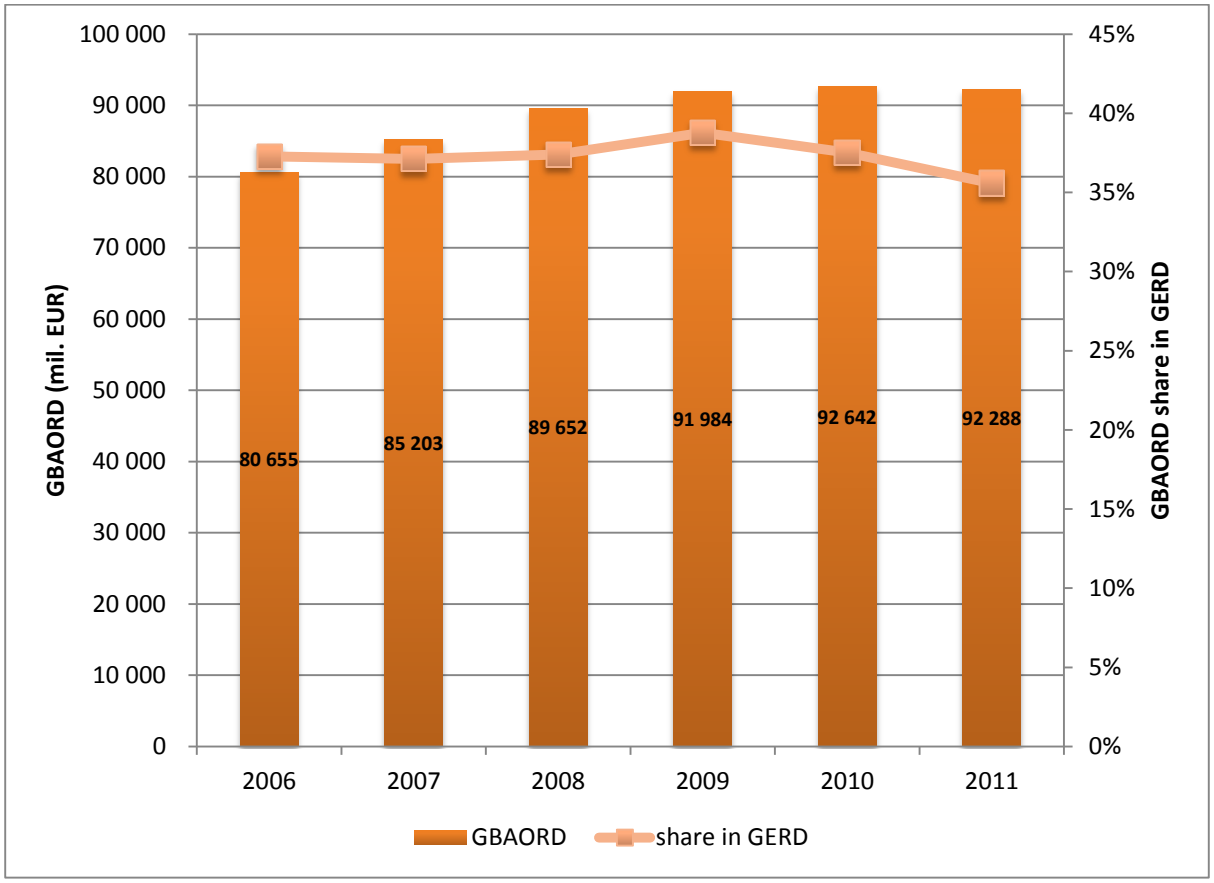
GBAORD at EU level

Evolution of GBAORD in 2006-2011

In 2011, the total government budget appropriations or outlays on R&D (GBAORD) in the EU Member States reached €92.3 billion, only slightly lower than the figure in 2010 (€92.6 billion). Figure 1 shows how EU GBAORD gradually increased from €80.7 billion in 2006 and reached its peak in 2010 (€92.6 billion). The biggest increase (percentage as well as nominal) occurred during the beginning of the analysed period up to 2009. From 2009 to 2011, EU GBAORD remained almost constant.

Figure 1 also provides information about the role of public support in overall R&D funding (i.e., gross expenditure on R&D (GERD)). This role, expressed as the ratio of GBAORD in GERD on the right axis of the figure, was fairly constant from 2006 to 2008 (36%). It reached a peak (39%) in 2009 and then fell in 2010 and 2011. The lowest ratio during the analysed period was in 2011 (35.6%).

Figure 1: EU GBAORD (2006 – 2011)



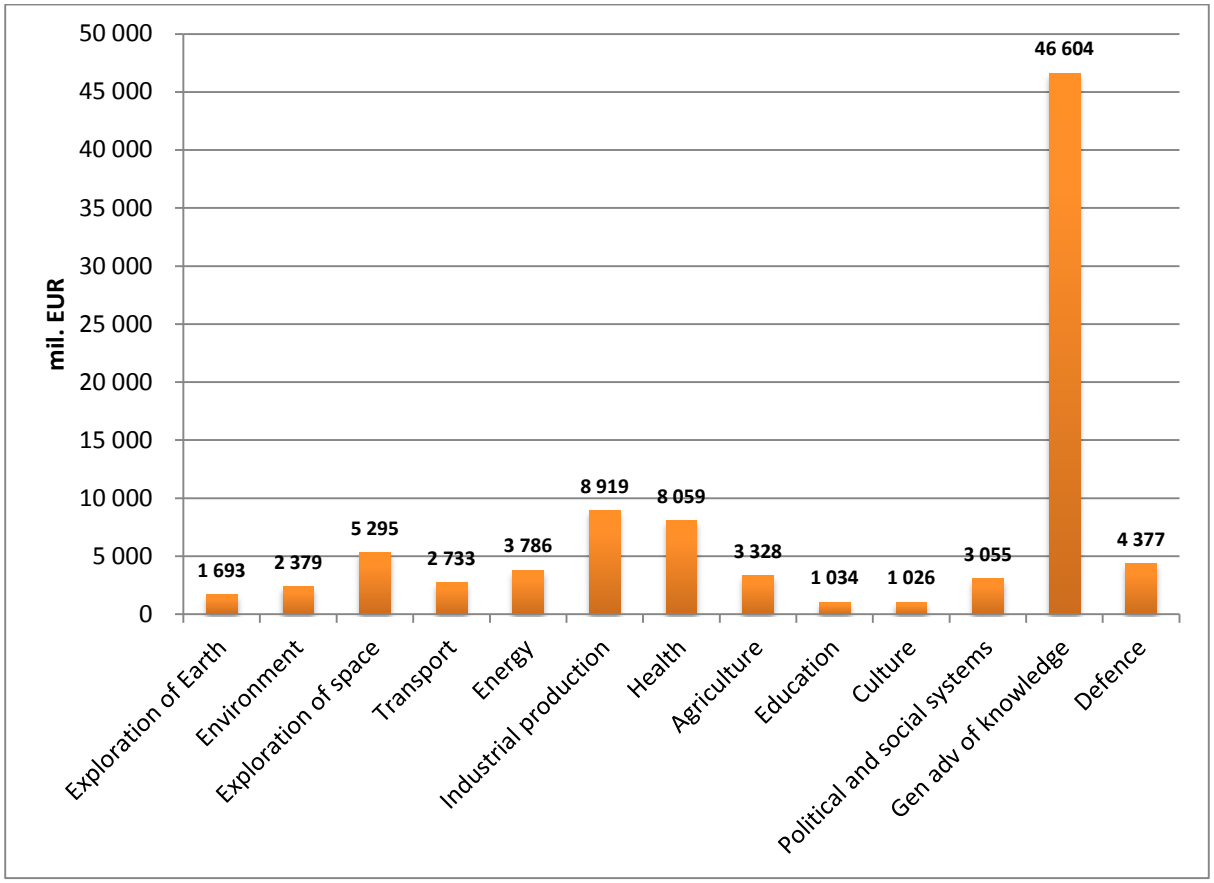
Source: Eurostat.

GBAORD by NABS chapters

GBAORD is reported for 14 different NABS chapters, which represent various socio-economic objectives. An overview of 2011 EU public R&D funding in these chapters is provided in Figure 2.

The NABS chapter that received by far the most funding was *General advancement of knowledge*.[6] It received €46.6 billion, which represented 50% of the total EU GBAORD. The remaining NABS chapters each got less than €10 billion. The most important ones were *Industrial production and technology* (€8.9 billion), Health (€8.1 billion), and *Exploration and exploitation of space* (€5.3 billion). The lowest R&D public funding was devoted to *Exploration and exploitation of the Earth* (€1.7billion), and *Education* and *Culture, recreation, religion and mass media* (€1 billion respectively). In terms of the relative growth during 2006-2011, sizable increases were reported only in *Political and social systems, structures and processes* (33%) and Culture, *recreation, religion and mass media* (22%).

Figure 2: EU GBAORD NABS Chapters (2011)



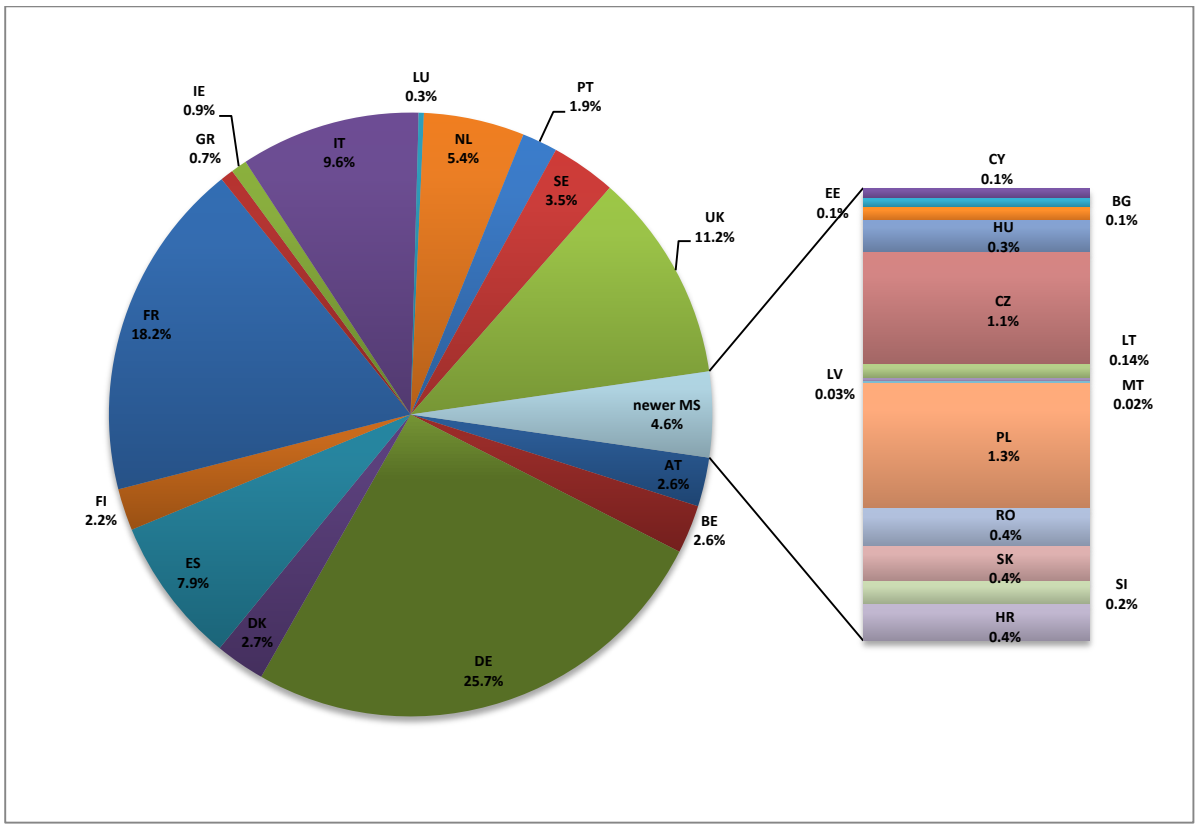
Source: Eurostat.

[6] For methodological reasons explained in Annex 1 we merged two NABS Chapters *General advancement of knowledge: R&D financed from General University Funds (GUF)* and *General advancement of knowledge: Research financed from other sources than GUF* into the one called *General advancement of knowledge*.

GBAORD by EU Member States

In 2011, Germany contributed the most to EU GBAORD (€24 billion or 26% of total EU GBAORD). France was the second largest contributor (€16.8 billion or 18%). Other important countries were the UK (€10.4 billion or 11%), Italy (€8.9 billion or 10%) and Spain (€7.3 billion or 8%). EU GBOARD data by Member State is shown in Figure 3.

Figure 3: EU GBAORD – country comparison (2011)



Source: Eurostat.

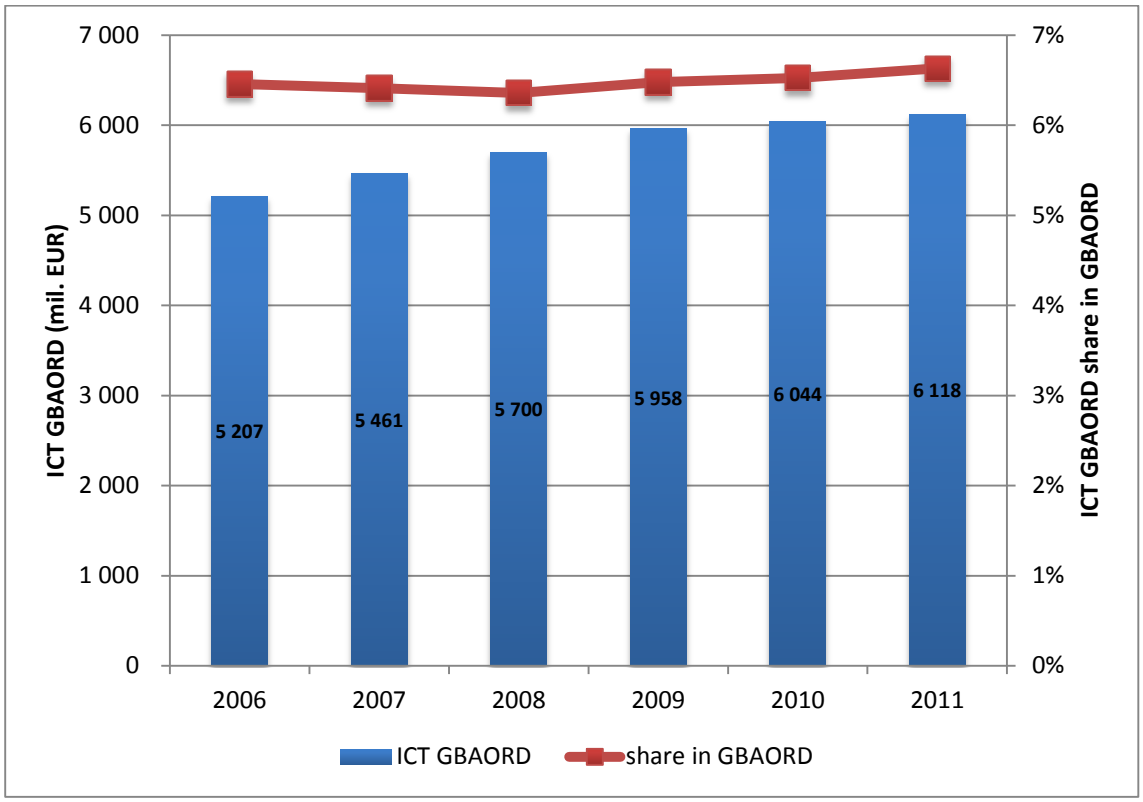
This picture slightly changed in recent years. In 2006, at the beginning of the analysed period, GBAORD in Germany was €17.6 billion, only €3 billion greater than the second largest R&D country in the region, France. In 2010 and 2011 the gaps became wider, amounting to €6.7 and €7 billion respectively. The biggest relative increase in GBOARD over the period 2006-2011 was found in Slovakia (21.9%), Luxembourg (18.9%), Estonia (13.3%) and Malta (12.4%). At the other end of the scale, countries where GBAORD decreased were Latvia (-7.1%), the UK (-4.3%), Hungary (-2.1%) and Greece (-1.1%).

ICT GBAORD at EU level

Evolution of ICT GBAORD in 2006-2011

The total EU ICT GBAORD in 2011, estimated using the methodology described in Annex 1, amounted to €6.1 billion.[7] The evolution of EU ICT GBAORD over the period between 2006 and 2011 is shown in Figure 4. We can see that EU ICT GBAORD grew steadily from 2006 to 2011, with an average growth rate of around 3.3% per annum. However, the growth rate decreased in 2011, when it fell to only 1.2%. Figure 4 also shows a recovery after 2008 in the importance of ICT-related research in public financing, measured by the share of EU ICT GBAORD in total EU GBAORD. This ratio reached 6.6% in 2011, slightly bigger than it was in 2010 (6.5%). The share in total EU GBAORD reached its lowest point in 2008 (6.4%).

Figure 4: EU ICT GBAORD (2006-2011)



Source: JRC-IPTS calculation based on Eurostat data.

ICT GBAORD by NABS chapters

In this section, we provide an overview of the importance of particular NABS chapters for the EU ICT GBAORD. Figure 5 depicts the contribution of thirteen NABS chapters to the total EU ICT GBAORD in 2011. Then, in Figure 6, we present these chapters in absolute values (blue vertical

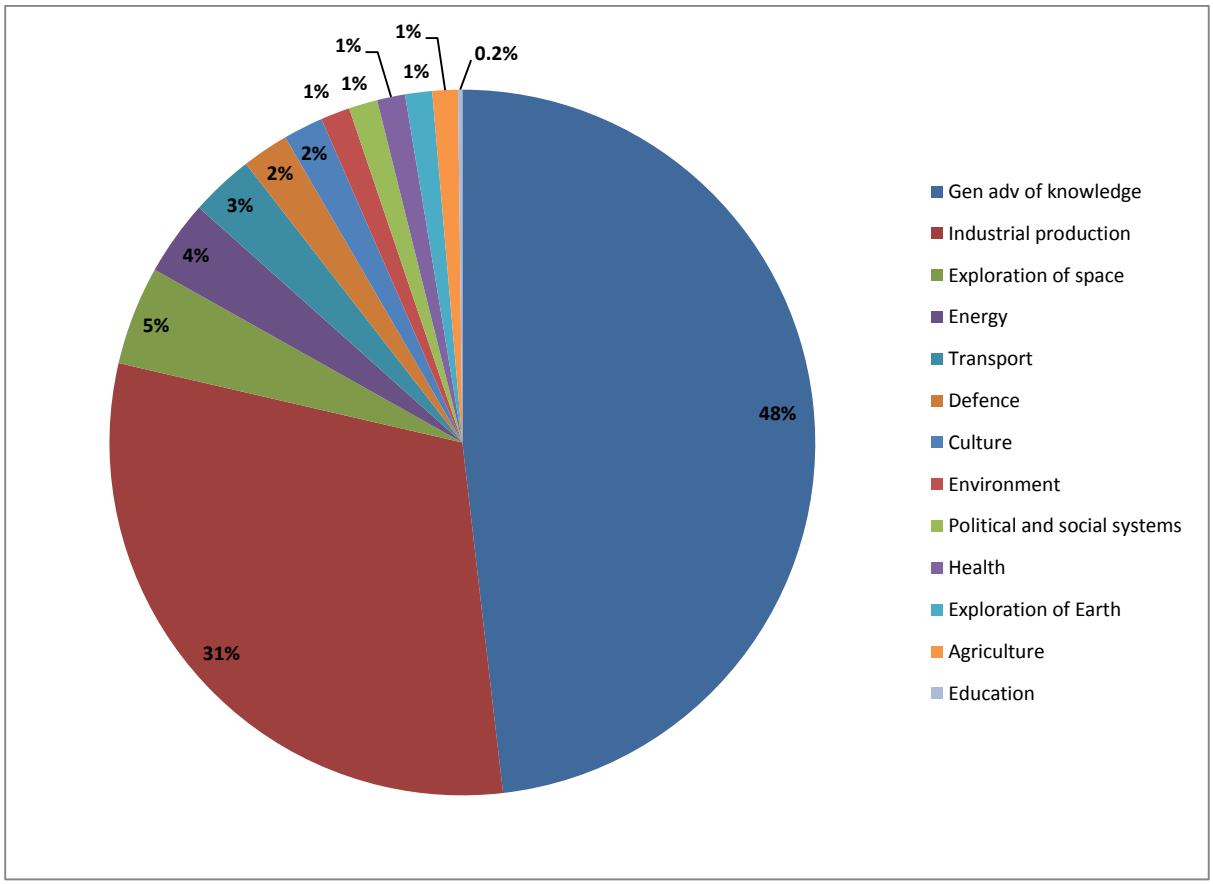
[7] The aggregate GBAORD value covering the whole EU countries is available, but at the country level, there is no data available for Poland GBOARD data by NABS chapter during 2009-2011. The GBAORD data was downloaded from Eurostat on **1 April 2014.** The updated SES data was based on Eurostat assistance on **7 April 2014** whereas the LFS data was extracted based on the data delivery by Eurostat on **17 February 2014**.

bars). The same graph also shows the share of ICT R&D funding in the total in each individual NABS chapter (red dots).

Our analysis reveals that around 78% of the total EU ICT GBAORD came from only two NABS chapters: *General advancement of knowledge* accounted for €2.9 billion (48%) and *Industrial production* accounted for €1.9 billion (31%). Compared to these two chapters, the remaining eleven NABS chapters play a much smaller role. Altogether, these remaining chapters represented only 21% of the total EU ICT GBAORD. Among them, *Exploration of space* had the largest share (€277 million or around 5%), followed by *Energy* (€211.1 million), *Transport, telecommunication and other infrastructures* (€177.3 million) and *Defence* (€130.8 million). *Education* had the lowest share (0.2% or €12.2 million).

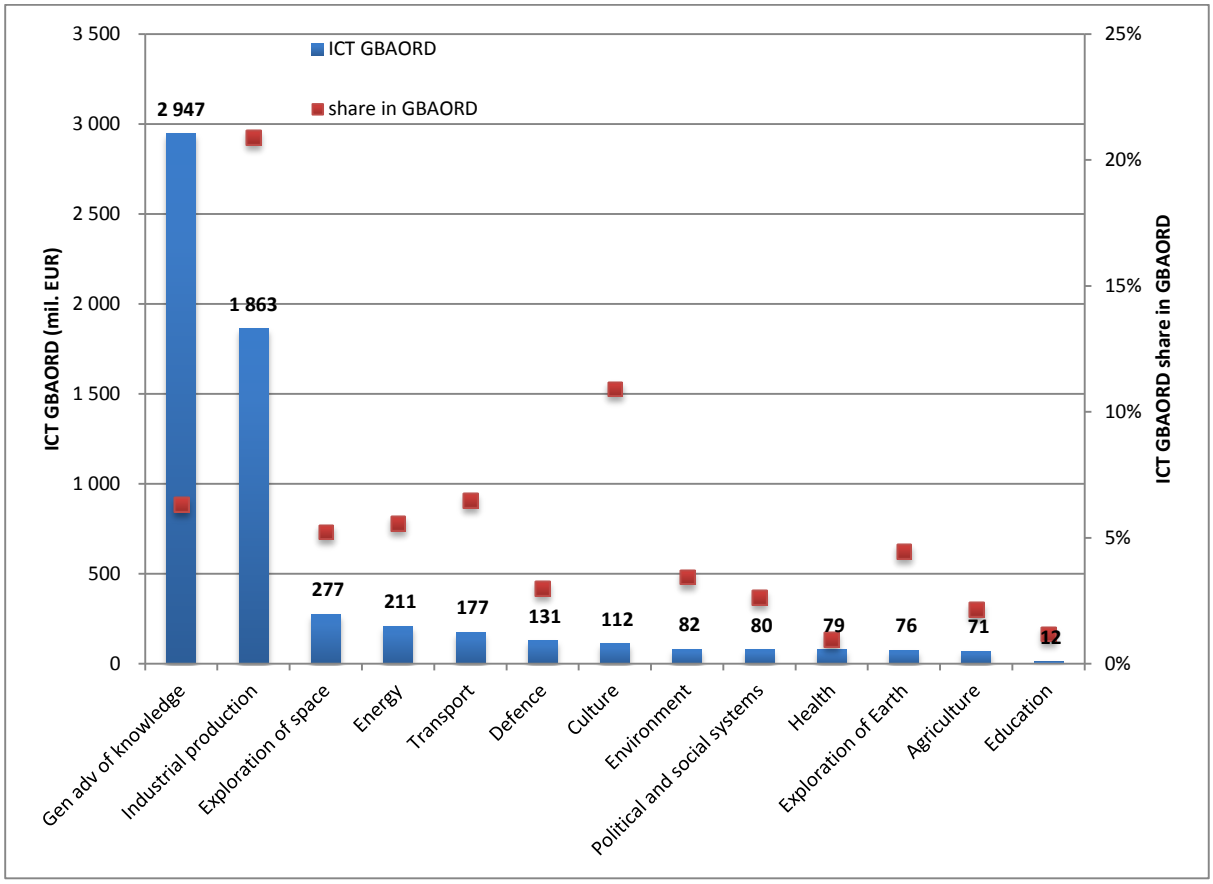
In terms of ICT shares within each NABS chapter (Figure 6), *Industrial production* again came first as it had ICT-related projects of almost 20.9% of the total GBAORD (right hand side vertical axis). In the remaining NABS chapters, maybe surprisingly our results show that ICT-related research projects contributed only a small amount to total R&D funding. Other than *Industrial production*, only five NABS chapters had more than a 5% ICT R&D funding share: *Culture recreation, religion and mass media* (10.9%), *Transport, telecommunication and other infrastructures* (6.5%), *General advancement of knowledge* (6.3%), *Energy* (5.6%) and *Exploration of space* (5.2%). The least ICT-oriented NABS chapters were *Health* (1%) and *Education* (1.2%).

Figure 5: Share of NABS chapters in EU ICT GBAORD (2011)



Source: JRC-IPTS calculation based on Eurostat data.

Figure 6: EU ICT GBAORD by NABS chapters (2011)



Source: JRC-IPTS calculation based on Eurostat data.

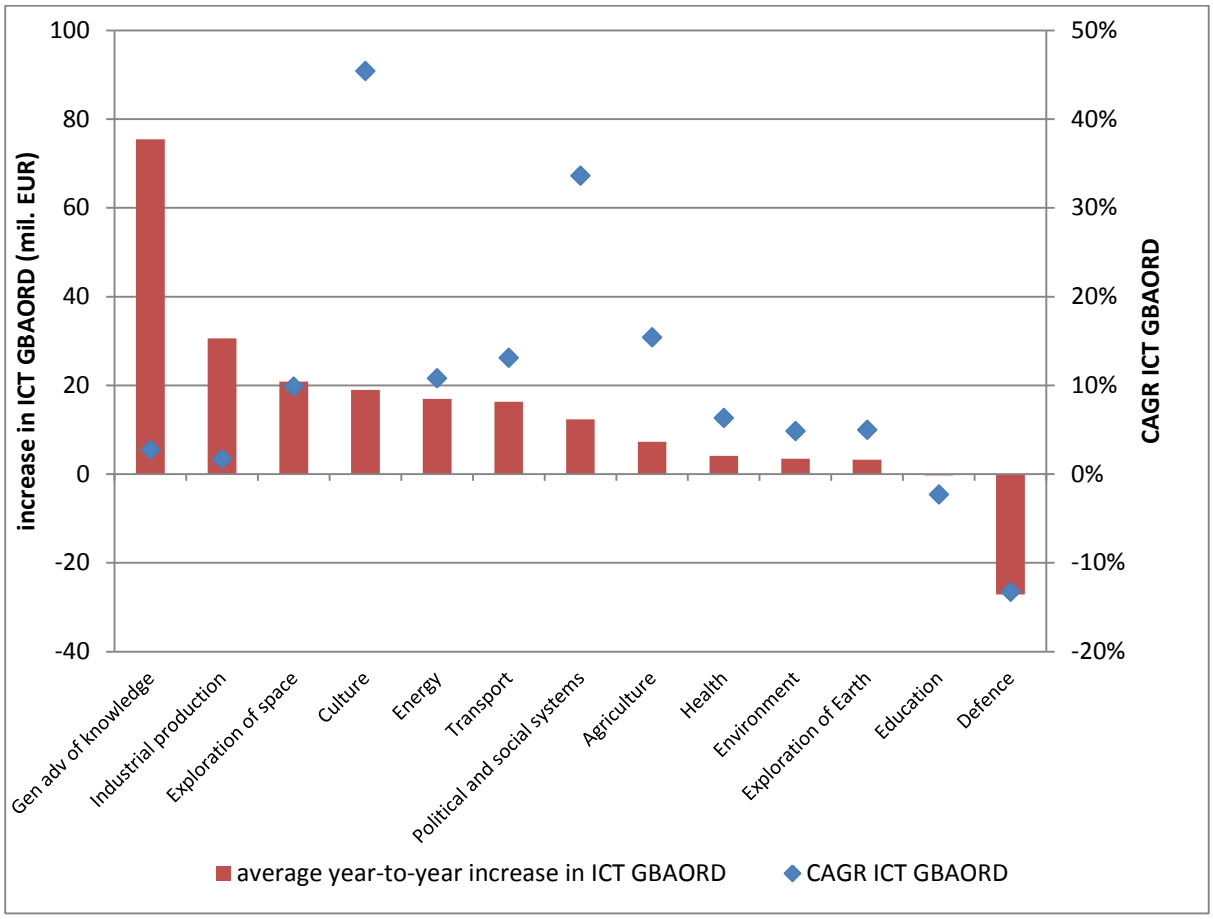
So far in this subsection, we have focused only on the last year for which data was available (i.e. 2011), without considering the development of particular NABS chapters over time. Nevertheless, some within-chapter changes are relatively important and help us understand the overall evolution of ICT GBAORD. Therefore, the following analysis (depicted in Figure 7) looks more closely at the relative, as well as the absolute growth[8] of EU ICT GBAORD in the different NABS chapters. Each of these measures has a different interpretation. On the one hand, high absolute growth is an important message, showing the nominal amount of the change in ICT GBAORD, although the corresponding relative growth may be only small. And on the other hand, high relative growth of ICT GBAORD signals an increasing importance of ICT in public R&D for that socio-economic objective, even if the contribution is still only marginal.

The greatest absolute increase of ICT GBAORD occurred in the *General advancement of knowledge* NABS chapter. There, ICT GBAORD increased by €75 million every year, which resulted in 2.7% relative growth (from €2.6 billion in 2006 to €2.9 billion in 2011). This chapter's absolute growth was greater than that of other NABS chapters, particularly due to the greater size of the *General advancement of knowledge* NABS chapter. On the other hand, this chapter's 3% relative growth rate was among the smallest reported.

[8] Relative growth is calculated as the compound annual growth rate (CAGR) from 2006-2011. Absolute growth is calculated as the average change from 2007 until 2011.

We observed the highest relative increase in importance of ICT over the total in *Culture*; where relative year-to-year growth was 45%. The corresponding absolute year-to-year growth of €19 million was also among the biggest. Specifically, ICT GBAORD in *Culture* grew from €17 million in 2006 to €112 million in 2011. At the other end of the scale, two NABS chapters recorded a negative growth rate in ICT GBAORD. In *Defence*, it was -13% (or a €27 million yearly average decrease from €266 million in 2006 to €131 million in 2011). *Education* also had a negative growth of about -2%, from €13.7 million in 2006 to €12.2 million in 2011.

Figure 7: Relative and absolute growth of EU ICT GBAORD by NABS chapters (2007-2011)



Source: JRC-IPTS calculation based on Eurostat data.
Note: Relative growth is calculated as the compound annual growth rate (CAGR) 2006-2011. Absolute growth is calculated as the average change from 2007 till 2011.

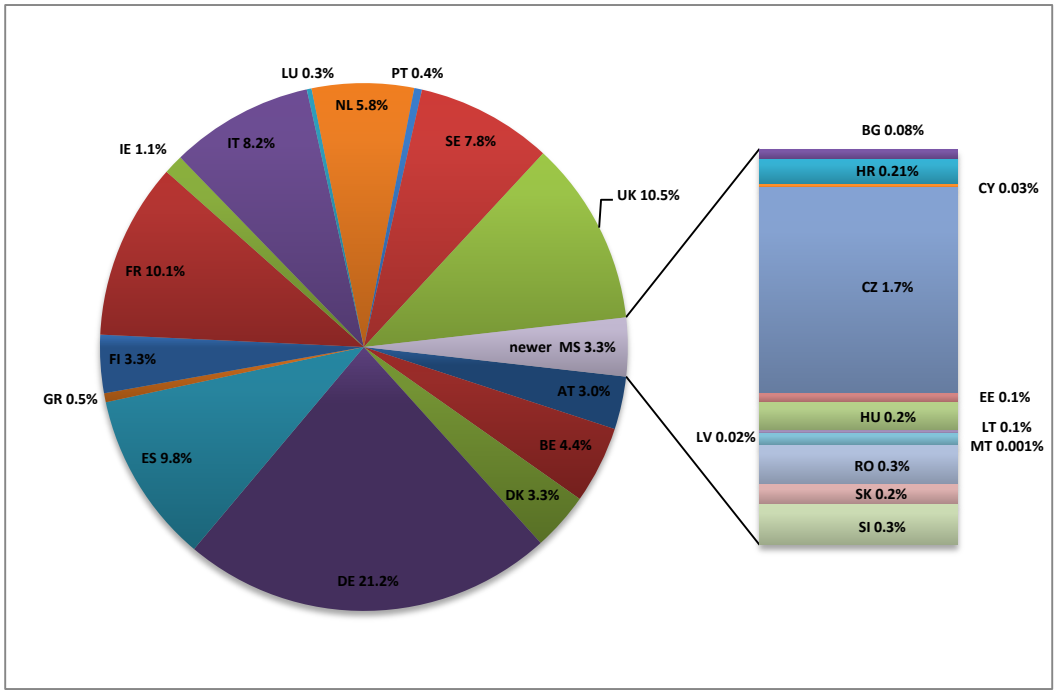
ICT GBAORD in the EU Member States

In this section, we shift our attention to the distribution of estimated ICT GBAORD in 2011 among Member States as shown in Figure 8. Six countries, five of which are the largest EU economies, accounted together for more than two-thirds of EU ICT GBAORD: Germany (21.2%), the UK (10.5%), France (10%), Spain (9.8%), Italy (8.2%), and Sweden (7.8%). Next were the Netherlands (5.8%), Belgium (4.4%) and Finland and Denmark (3.3%). The twelve newer Member States accounted

together for 3.3% of the total EU ICT GBAORD, which was lower than their economic weight (5.2% of the total EU GDP).[9]

Table 1 shows the estimates of ICT GBAORD in the EU Member States in 2011. For the full set of ICT GBAORD estimates in the EU Member States over the whole analysed period (2006-2011), see Table A7 in Annex 2.

Figure 8: EU ICT GBAORD – country comparison (2011)



Source: JRC-IPTS calculation based on Eurostat data.
Note: data for Poland in 2009-2011 is not available.

Table 1: ICT GBAORD in the EU Member States (mil. EUR, 2011)

Germany	1 298	Denmark	202	Hungary	14
United Kingdom	644	Austria	184	Croatia	13
France	615	Czech Republic	106	Slovakia	10
Spain	598	Ireland	68	Lithuania	6
Italy	499	Greece	31	Bulgaria	5
Sweden	475	Portugal	27	Estonia	5
Netherlands	355	Slovenia	21	Cyprus	2
Belgium	269	Romania	20	Latvia	1
Finland	202	Luxembourg	17	Malta	0.1

Source: JRC-IPTS calculation based on Eurostat data.

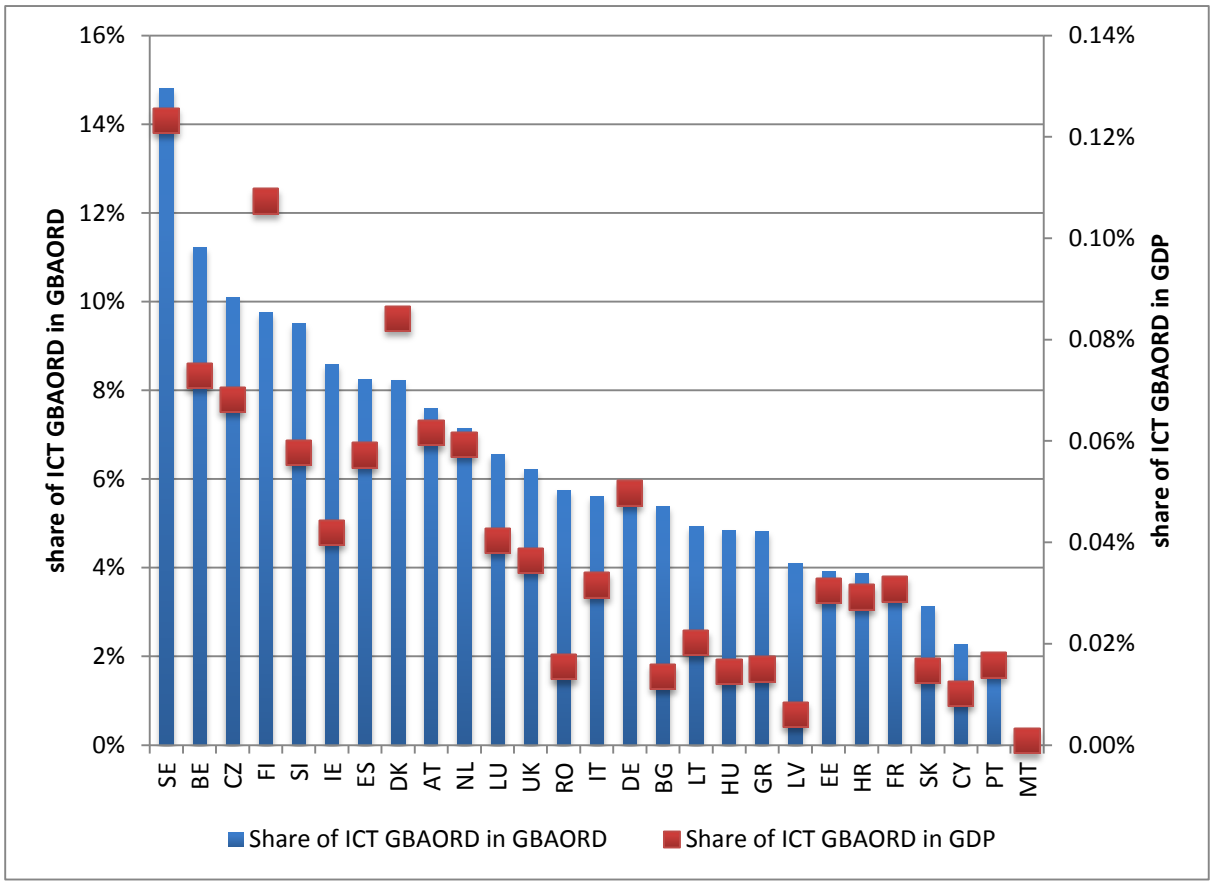
Note: Data for Poland in 2011 is not available.
France data excluded two NABS chapters (Education and Culture)
Due to missing data in several NABS at country level, the estimated ICT GBAORD value obtained by summing-up all 28 Member States does not correspond to the total ICT GBAORD of all NABS at EU level (27 and 28). In the present report the value of ICT GBAORD at EU level (27 and 28) is estimated separately, rather than by summing up the value of ICT GBAORD from each Member State.

[9] Poland is excluded from the ratio of GDP due to missing ICT GBAORD data. The GDP ratio of a total 13 newer MS (including Poland) is 8.2% in 2011 over total EU GDP.

In the above overview, the ICT GBAORD of the different EU countries appears to be related to economic size. Obviously, bigger countries can spend more, in terms of absolute value, on ICT-related research than smaller countries. Looking at ICT GBAORD intensities offers a comparison of the importance of ICT research in individual countries' public funding. This comparison is provided in Figure 9. There, ICT GBAORD intensity is expressed in two different ways – first as the share of ICT GBAORD in total GBAORD, and then as the share of ICT GBAORD in GDP.

First of all, Figure 9 suggests that countries with high ICT GBAORD shares in total GBAORD also have high ICT GBAORD shares in GDP. According to this figure, Sweden tops the measurements in both ICT GBAORD intensity with respect to total GBAORD and GDP. Sweden devoted 14.8% of its total GBAORD to ICT. In this indicator, there were only two other countries with values equal to or more than 10% of ICT GBAORD intensity (Belgium: 11.2% and the Czech Republic: 10.1%). At the EU level, the ICT GBAORD intensity in 2011 was 6.6%. In terms of ICT GBAORD intensity with respect to GDP, the list of countries is again led by Sweden (0.12%). Other highly ICT-intensive countries were Finland (0.11%), Denmark (0.08%), and Belgium (0.07%). By contrast, the least ICT GBAORD-intensive countries in 2011 were predominantly newer Member States, particularly Cyprus, Latvia, and Malta. It is perhaps surprising that France also belonged to the least ICT GBAORD-intensive countries. Its government devoted only 3.7% of the country's total R&D public funding or 0.03% of its GDP to ICT-related research.

Figure 9: ICT GBAORD intensity – country comparison (2011)



Source: JRC-IPTS calculation based on Eurostat data.
Note: data for Poland in 2011 is not available.

In Figure 10, we look more closely at within-country changes in ICT GBAORD over the periods investigated. We focus on relative as well as absolute growth rates.[10]

From this perspective, the most relevant progress (i.e. the biggest absolute growth) could be seen in Germany, which had an average annual growth of €48 million (from €1.06 billion in 2006 to €1.3 billion in 2011). Another high-growth country (in absolute terms) was Spain. Its ICT GBAORD increased by €41 million on average (from €392 million in 2006 to €598 million in 2011). Note that for Spain, this impressive progress was mainly driven by a massive growth of ICT GBAORD from 2006 to 2009 before slowing down and recording negative growth rates during 2009-2011.

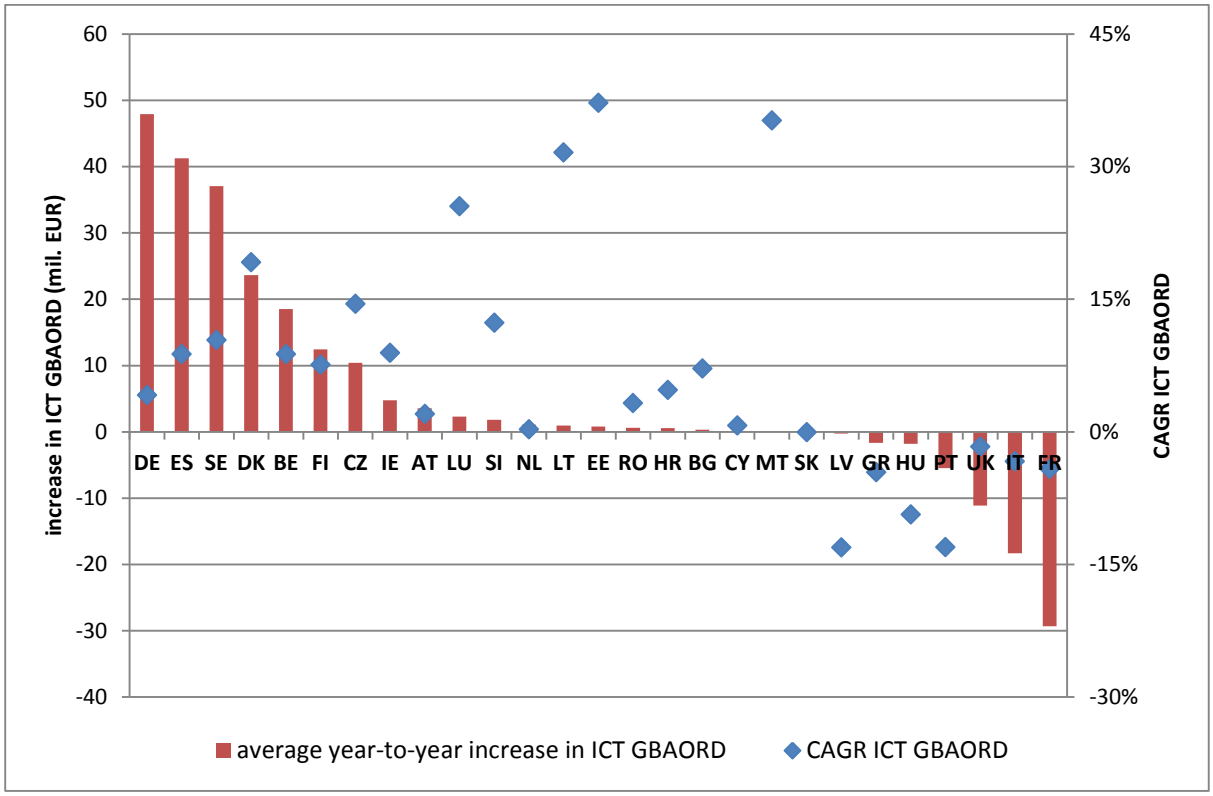
In terms of relative ICT GBAORD growth (right vertical axis), interestingly, among the best performing countries we found new Member States with relatively small economies, led by Estonia (37%) and followed by Malta (35%) and Lithuania (32%). However, the corresponding absolute growth rates were rather small – all below €3 million. Nevertheless, although the economic significance of these growth rates is small, it is still worth mentioning them because they indicate the increasing importance of ICT-related research in public funding in these countries. Germany had the biggest absolute growth but somewhat small relative growth (4%).

At the other end of the scale, there were seven countries with negative relative growth in ICT GBAORD during the period 2006 to 2011: Portugal and Latvia (-13%), Hungary (-9%), Greece (-4.5%), France (-4%), Italy (-3%), and the United Kingdom (-2%). Here, we highlight France, Italy and the UK, which are among the largest economies in the region. On average, ICT GBAORD in France dropped yearly by €29 million (the largest reduction per annum in the EU)[11]. Italy and the UK came next with average annual decreases of €18 million and €11 million respectively.

[10] Relative growth is calculated as the compound annual growth rate (CAGR) from 2006-2011. Absolute growth is calculated as the average changes from 2007 until 2011.

[11] Due to data availability, the ICT GBAORD for France was estimated excluding two NABS chapters (Education and Culture) which may be the reason of smaller estimated ICT GBAORD.

Figure 10: Relative and absolute growth of EU ICT GBAORD by EU Member States



Source: JRC-IPTS calculation based on Eurostat data.
Note: Relative growth is calculated as the compound annual growth rate (CAGR) 2006-2007. Absolute growth is calculated as the average change from 2007 till 2011.
Poland data is missing from 2007-2011

ICT GBAORD vs. DAE target

The "Digital Agenda for Europe"[12] (DAE) aims to help Europe's citizens and businesses get the most out of digital technologies. It is one of seven flagship initiatives under Europe 2020 of the EU's strategy to deliver smart sustainable and inclusive growth. Building on Europe's assets, one of the objectives of the strategy is to step up efforts in ICT R&D. The DAE, in its R&D-related pillar, expects Member States to double their annual public spending on ICT research and development: in Action 55, the DAE states that "*Member States should, by 2020, double annual total public spending on ICT R&D from €5.5 billion to €11 billion (which includes EU programmes), in ways that leverage an equivalent increase in private spending from €35 billion to €70 billion.*"

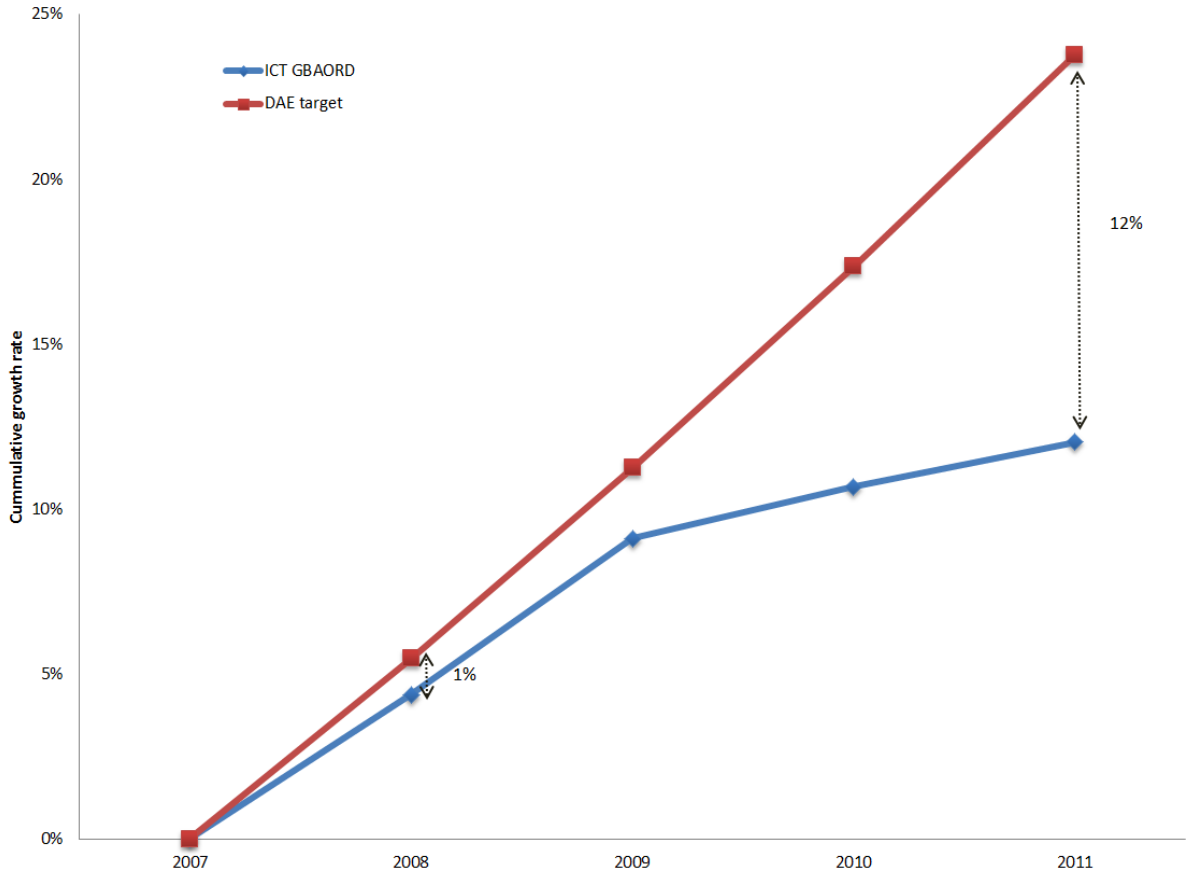
Figure 11 shows the estimated EU ICT GBAORD, together with an "anticipated DAE target progress" over the period 2007-2011. A short explanation about what we mean with "anticipated DAE target progress" is necessary: the DAE specifies that public ICT R&D expenditures should double over the period 2007-2020. It does not, however, specify a rate of progress over time. Therefore, we use in this analysis a uniform progress rate: a 5.48% annual growth rate of €5.5 billion is set as the reference point in 2007.

On this basis, and in spite of the positive overall growth in estimated ICT GBAORD in the EU, the annual rate of growth from 2007 to 2011 has been lower than the average annual rate required to

[12] The Commission Communication and Annual Progress Reports are available at http://ec.europa.eu/information_society/digital-agenda/publications/index_en.htm

achieve the target of doubling public ICT R&D expenditures by 2020. The compound annual growth rate of the estimated ICT GBAORD in the EU was about 3.4% from 2007-2010, lower than the 5.48% target. Between 2010 and 2011, the growth rate fell further. The gap of cumulative growth rates (that should reach 100% by 2020) between the estimated ICT GBAORD and the DAE targets increased from only 1% in 2008 to 12% in 2011, as can be seen in Figure 11. Based on the DAE target, the EU should have achieved €5.8 billion in 2008 with the actual spending of €5.7 billion and €6.8 billion in 2011 with the actual spending of €6.1 billion.

Figure 11: EU ICT GBAORD and DAE target evolution (2007-2011)



Source: JRC-IPTS calculation based on Eurostat data.

EU vs. US comparison of ICT GBAORD

After the detailed analysis of EU GBAORD and ICT GBAORD, this section offers a more global perspective, by comparing the EU with its closest economic counterpart, the United States of America (US). We start this comparison by looking at the overall GBAORD, then we continue with ICT GBAORD and finish with a closer look at individual NABS chapters. The comparison covers the period 2006 – 2011.

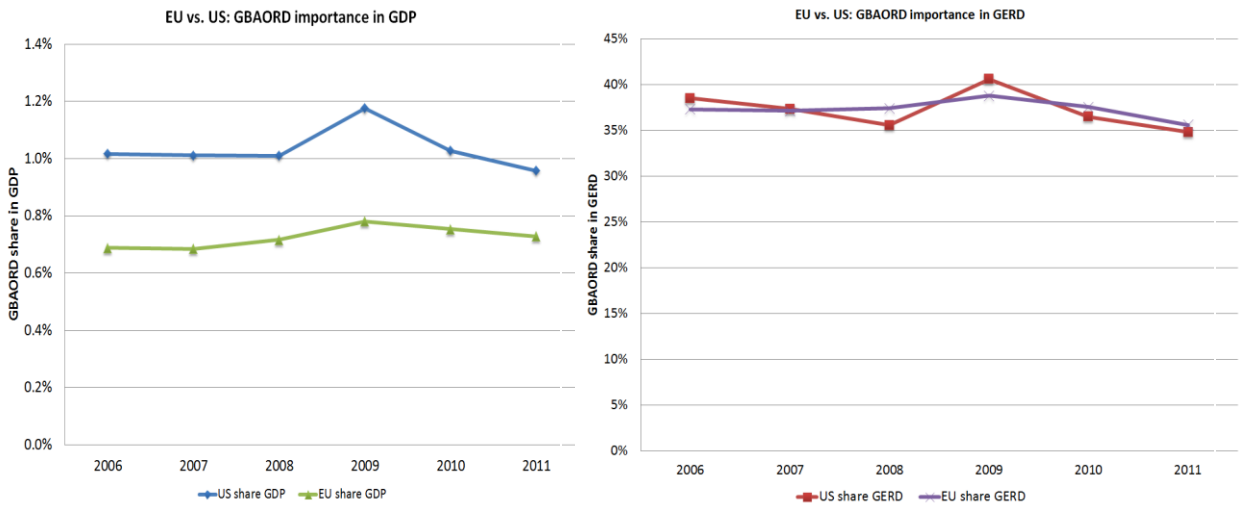
Share of GBAORD in GDP and GERD

On average during the period 2006 to 2011, the US spent 22.9% more on total R&D public funding than the EU. In 2011, US GBAORD was €103.7 billion, which was €11.4 billion more than the EU GBAORD. During the whole analysed period, the US GBAORD was also higher with respect to the ratio on GDP and Government Expenditure on R&D (GERD). While the share of EU GBAORD in GDP

was around 0.7% – 0.8%, the corresponding share for the US was bigger, around 1% - 1.2%, reaching its peak in 2009 (see the left panel in Figure 12). It is quite interesting that the two regions followed similar patterns as they both reached their highest points in 2009 and declined during the two subsequent years.

However, the situation is different when we look at the share of GBAORD in total GERD (see the right panel in Figure 12). The share of EU GBAORD to GERD steadily increased until 2009, starting at 37.3% in 2006 and reaching almost 38.8% in 2009. The corresponding share for the US also increased over these periods but fluctuated more. During the last two years (i.e. 2010 and 2011), the GBAORD to GERD ratio in EU was even higher than that of the US.

Figure 12: EU vs. US – share of GBAORD in GDP and GERD (2006-2011)



Source: JRC-IPTS calculation based on Eurostat data.

To sum up, the comparisons between the share of R&D public funding in the EU and the US with respect to GDP and GERD offer different results. In terms of the ratio to GDP, the EU GBAORD is still lower than that of the US, but the ratio to GERD is more stable in the EU than in the US.

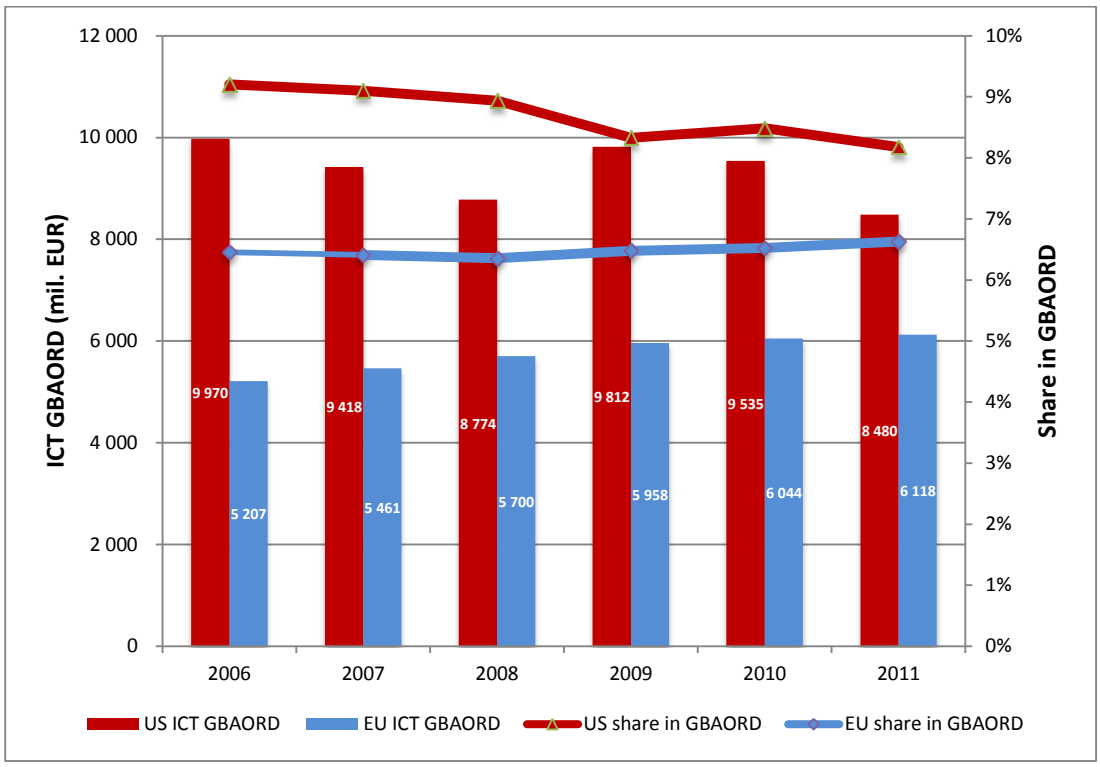
ICT GBAORD evolution

In Figure 13 we present the evolution of EU and US ICT GBAORD over the period 2006-2011 (blue bars for the EU and red bars for the US). Figure 13 shows that US ICT GBAORD oscillated between €8-10 billion, whereas in the EU it was between €5-6 million. While EU ICT GBAORD was fairly stable over the last three years of the analysed period (2009-2011), the US had two peaks (2006 and 2009) and, after reaching the second peak in 2009, it declined quite sharply in 2010 and 2011. In 2006, the EU-US ICT GBAORD gap was estimated to be €4.8 billion. Since then, due to the fact that US ICT GBAORD did not increase, whereas EU ICT GBAORD did, the gap shrank to €2.4 billion in 2011. The EU-US ICT GBAORD gap therefore shrank by 50% over those six years.

The increasing importance of ICT in EU public R&D funding is further emphasized by comparing the shares of EU and US ICT GBAORD in total GBAORD. In Figure 13, the share of EU ICT GBAORD was fairly stationary during the whole analysed period, oscillating between 6.4% – 6.6% of total GBAORD. The corresponding US share decreased - from 9.2% in 2006 to 8.2% in 2011. The figure

shows that the difference in shares in two regions was of 3 percentage points in 2006, which then shrank to 1.6 percentage points in 2011.

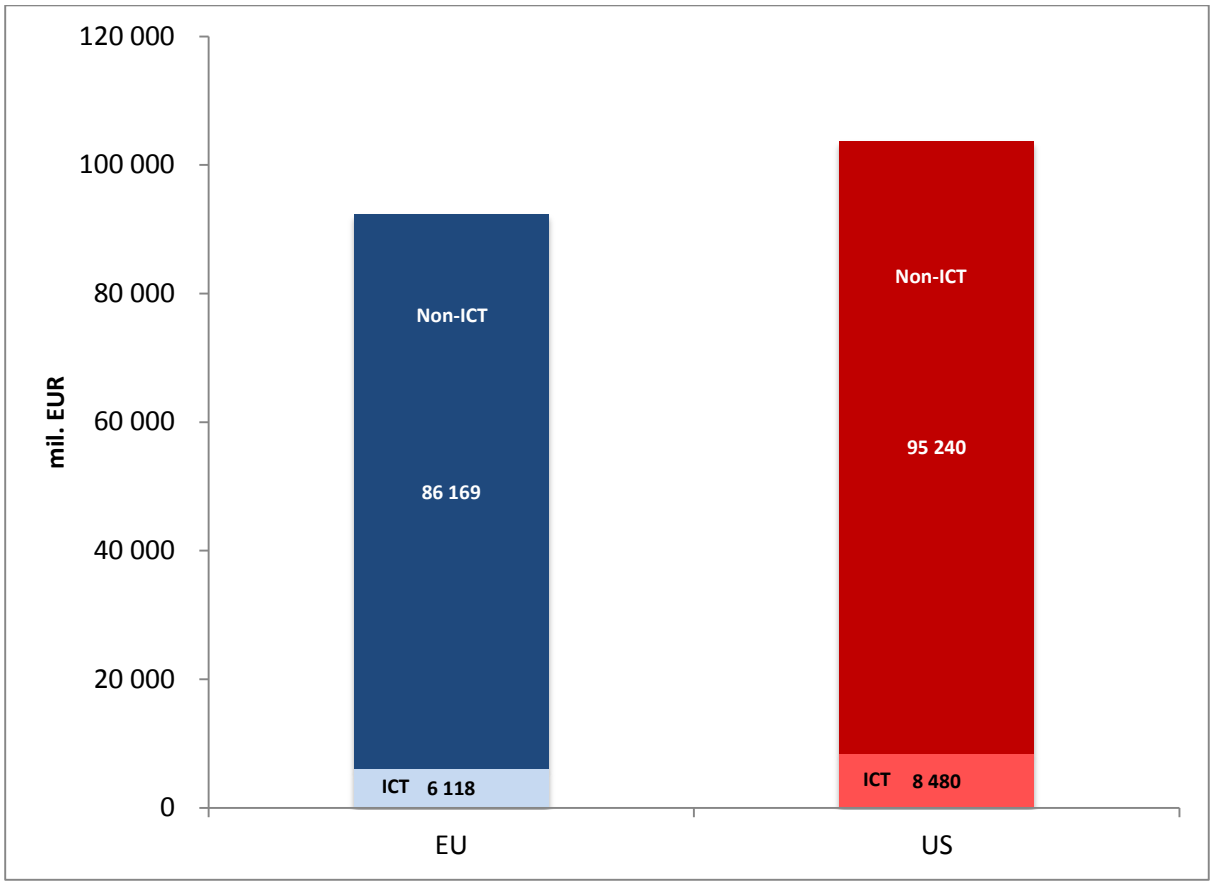
Figure 13: EU vs. US – ICT GBAORD evolution (2006-2011)



Source: JRC-IPTS calculation based on Eurostat data.

However, though public funding for ICT R&D was growing, it remained quite small in both the US and the EU (see Figure 14).

Figure 14: EU vs. US – ICT and non-ICT GBAORD shares comparison (2011)



Source: JRC-IPTS calculation based on data from Eurostat and US Bureau of Labour Statistics.

ICT GBAORD NABS comparison

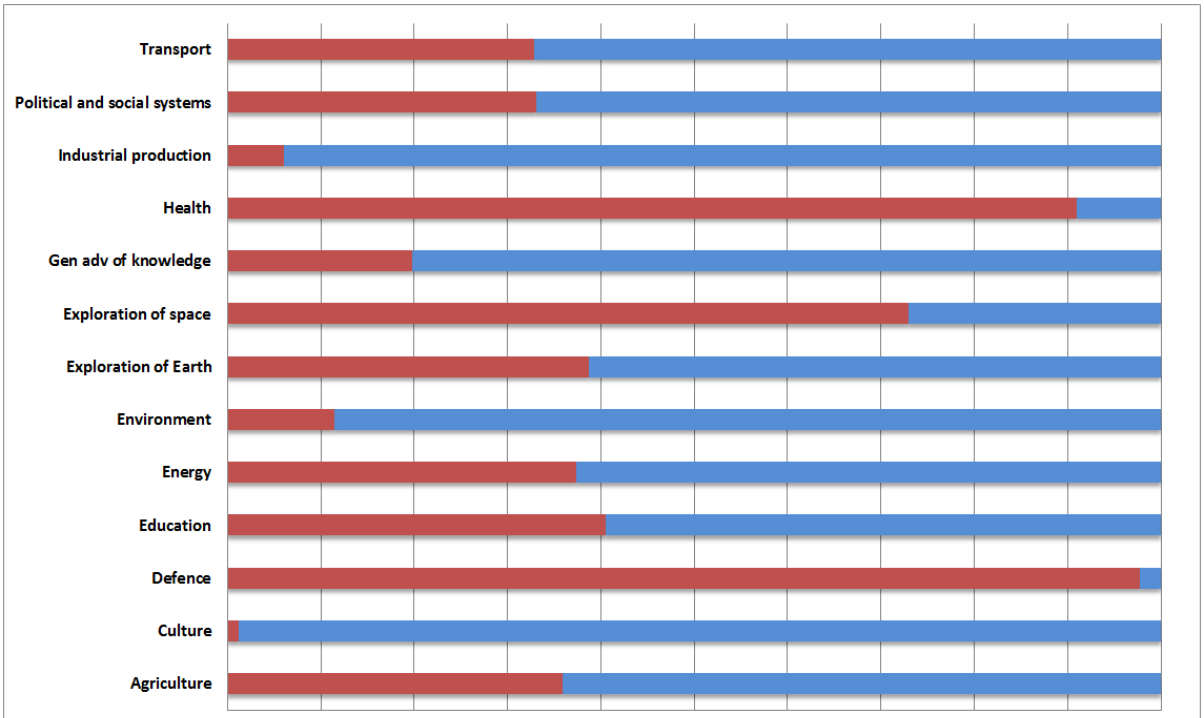
In the last part of our comparative analysis, we describe EU and US ICT GBAORD by individual NABS chapters. The point is to see whether there are any regional variances in the importance of ICT for different socio-economic objectives (i.e., NABS chapters). The results of this comparison are depicted in Figure 15, which shows the relative (EU vs. US) importance of particular NABS chapters for ICT GBAORD. Blue horizontal bars represent the EU and the red ones represent the US. A balanced situation would be represented by both regions scoring 50%. Going chapter by chapter, if either of these two regions scores more than 50%, it means that this region attracts relatively more public funds for specific ICT-related research.[13]

The first observation that results from this graph is that in 2011, the EU dominated most of these NABS chapters. In fact, in ten out of thirteen NABS chapters; the value of EU ICT GBAORD was higher than that of the US. However, in terms of the absolute values, the differences are often quite small. For this reason, the table below the graph shows the values of ICT GBAORD for each region and NABS chapter. In 2011, the true EU dominance in terms of percentage of total happened primarily in four NABS chapters – *Culture* (*with a €111 million difference*), *Industrial*

[13] We stress here that one has to look at the NABS chapters individually because they are in no way mutually comparable within this graph. For instance, the fact that the EU (blue) horizontal bar for *Culture* is longer than the one for *General advancement of knowledge*, does not mean that EU ICT GBAORD is bigger in *Culture* than in *General advancement of knowledge*. In fact, in this example, it is the other way around; the level of EU ICT GBAORD in *General advancement of knowledge* is much higher than in *Culture*.

production (€1.7 billion difference), Environment (with a €71 million difference), and *General advancement of knowledge* (with a €2.2 billion difference). In terms of the absolute difference, *General advancement and knowledge* and *Industrial production and technology* were the strongest NABS chapters in the EU, having €2.2 billion and €1.7 billion more than those in the US. The opposite is true for the remaining three NABS chapters which were relatively more important in the US. Specifically, in 2011, the US spent €5.6 billion more on ICT-related research in *Defence*, €715 million more on ICT in *Health* and €472 million more on ICT in *Exploration and exploitation of space*.

Figure 15: EU vs. US – Relative importance of ICT GBAORD NABS chapters across regions (2011)

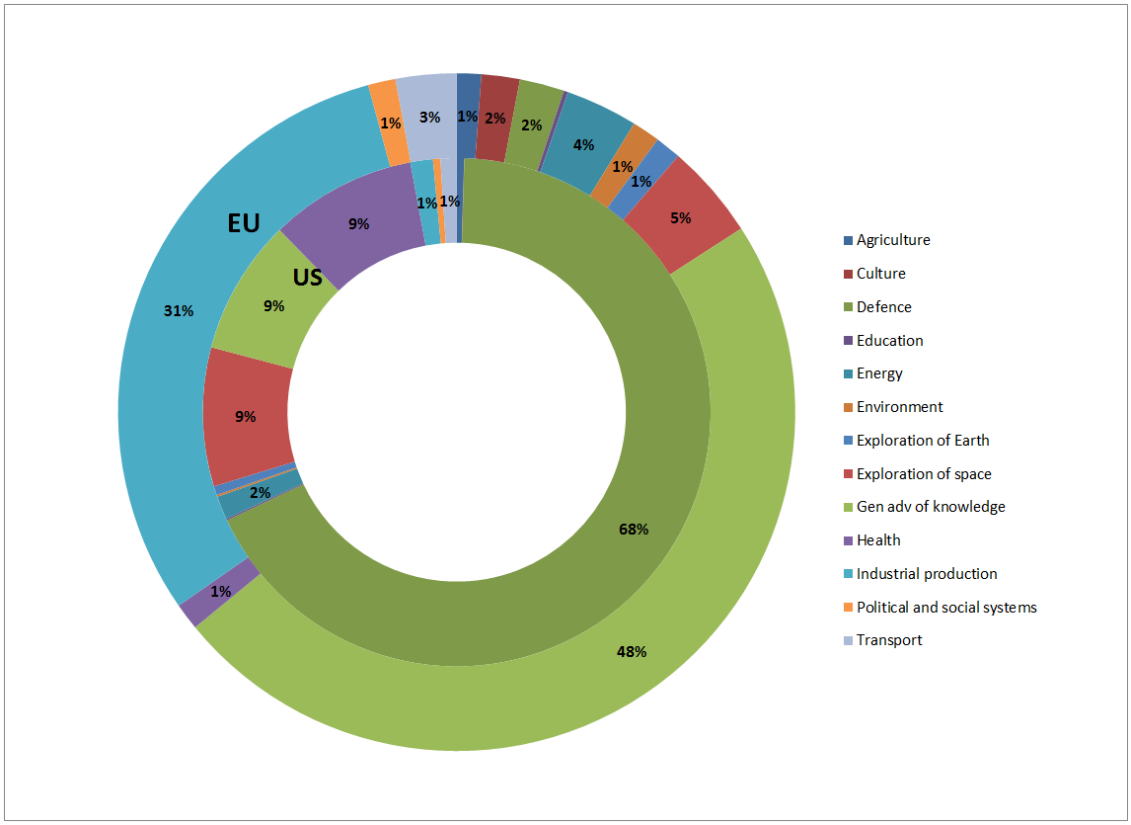


	Agriculture	Culture	Defence	Education	Energy	Environment	Exploration of Earth	Exploration of space	Gen adv of knowledge	Health	Industrial production	Political and social systems	Transport
US ICT GBAORD (mil. EUR)	40.0	1.4	5726.0	8.3	126.0	10.6	47.8	748.7	729.8	793.3	121.6	39.8	87.0
EU ICT GBAORD (mil. EUR)	71.4	112.0	130.8	12.2	211.1	81.9	75.6	277.0	2946.6	78.5	1863.4	80.5	177.3

Source: JRC-IPTS calculation based on data from Eurostat and US Bureau of Labour Statistics.

We complete this analysis by converting the above mentioned table into a pie chart (Figure 16). This offers a clearer view of the role of individual NABS chapters within each region. In this figure, the outer pie represents the distribution of ICT GBAORD among NABS chapters in the EU in 2011 and the inner one represents the US. When looking at ICT GBAORD in the different NABS chapters in the EU and the US in 2011, we can see that there was one clearly dominant but different NABS chapter in each region. Whilst 68% of the US ICT GBAORD went to *Defence*, 48% of the EU ICT GBAORD went to *General advancement of knowledge*. Additionally, there was only one important NABS chapter in the EU and three important NABS chapters in the US. In the EU, it was *Industrial production* with a 31% share, whereas in the US they were *Exploration and exploitation of space*, *Health* and *General advancement of knowledge*, which together accounted for 27% of the US ICT GBAORD (9% each).

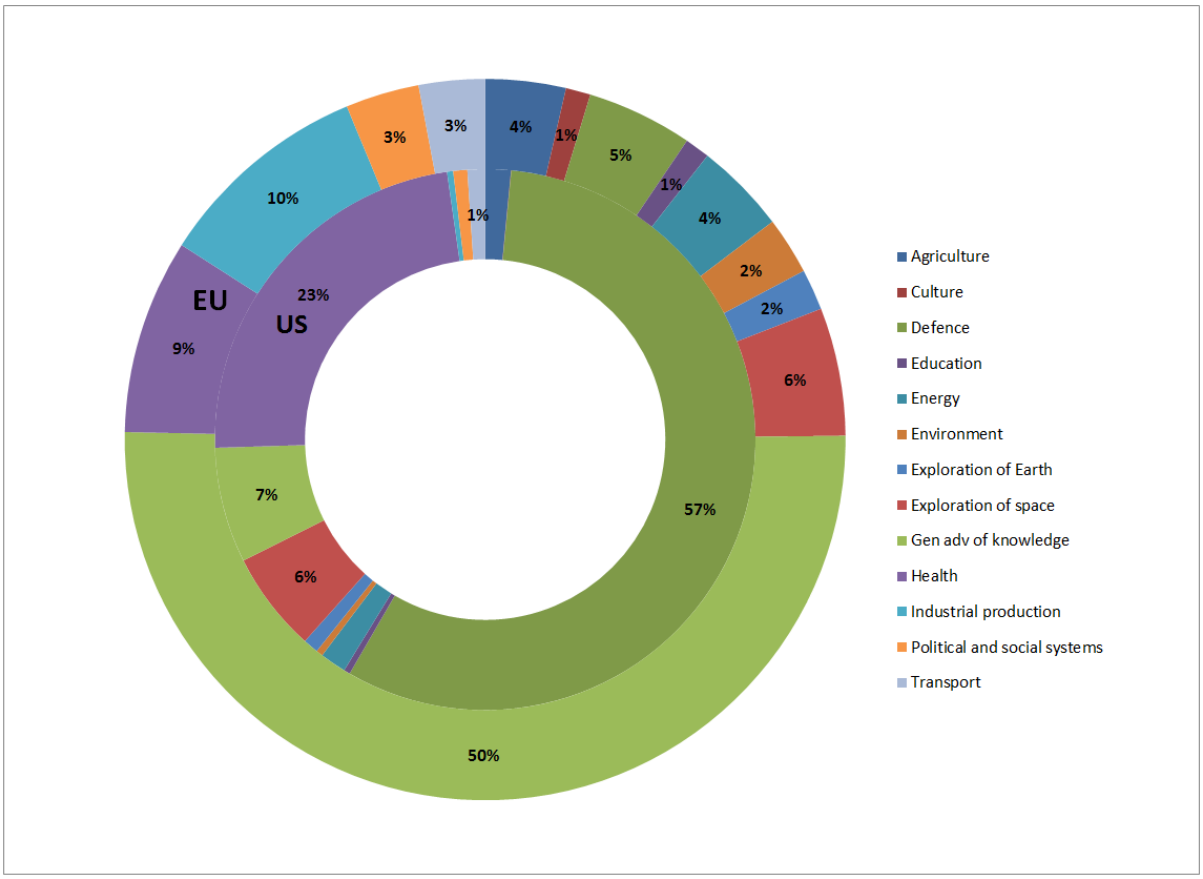
Figure 16: EU vs. US – Regional importance of ICT GBAORD NABS chapters (2011)



Source: JRC-IPTS calculation based on data from Eurostat and US Bureau of Labour Statistics.

Seeing these results in the context of overall GBAORD reveals an interesting comparison of the relative importance of ICT research within individual NABS chapters. Figure 17 shows the distribution of GBAORD among various socio-economic objectives in the EU and the US. From Figure 17, it can be seen that, on the one hand, EU GBAORD was dominated by *General advancement of knowledge* (50%) in 2011. In the US, on the other hand, it was dominated by *Defence* (57%). What is, however, more interesting is a comparison of these shares with corresponding shares in ICT GBAORD (Figure 16). In this perspective, a 50% share of *General advancement of knowledge* in EU GBAORD decreased to 48% in EU ICT GBAORD, showing a slight decrease of the importance of ICT in this NABS chapter compared to others. Moreover, the importance of ICT increased significantly in *Industrial production* (a shift from only 10% in GBAORD to 31% in ICT GBAORD). In the US, we can observe a similar increase in the importance of ICT in *Defence* (from 57% in total GBAORD to 68% in ICT GBAORD). In *Health*, on the other hand, this shift was negative (from 23% to 9%). This may imply that, in the US, ICT-related research in *Health* plays only a marginal role compared to other NABS chapters.

Figure 17: EU vs. US – Regional importance of total GBAORD NABS chapters (2011)



Source: JRC-IPTS calculation based on data from Eurostat and US Bureau of Labour Statistics.

Conclusions

The main objective of this report is to present an analysis of the state of public expenditure on Research and Development (R&D) on Information and Communication Technologies (ICT) in the European Union and its evolution over time, based on estimates of ICT GBAORD in the EU Member States. In addition, we attempt to position EU ICT R&D public funding in a global perspective by comparing it with the US. Keeping this in mind, we would like to convey two main conclusions.

First and foremost, our estimates show that EU ICT GBAORD grew steadily over the whole analysed period (2006-2011). In 2011, it reached €6.1 billion which represented 6.6% of all R&D public funding. However, this growth is somewhat lower than the DAE target, which was to double public ICT R&D expenditures by 2020. By comparing EU ICT GBAORD growth with progress towards the DAE target over the period 2007-2011, we see that extra efforts are needed to achieve this target since the gap of cumulative growth rate between estimated ICT GBAORD and the DAE targets increased from only 1% in 2008 to 12% in 2011

Second, when we compare the EU with the US, we conclude that the US devoted more R&D funds to ICT than the EU. In fact, the ICT GBAORD gap between the EU and US consisted of €2.4 billion in 2011. Nevertheless, it is worth highlighting that the EU-US ICT GBAORD gap shrank by 50% from 2006 to 2011.

Annex 1 – Methodology for estimating ICT GBAORD

This methodology builds upon and improves the methodology designed by Stančík (2012). In order to estimate ICT GBAORD, we employ existing GBAORD data, which is reported for 14 different NABS-2007 chapters and is available for every EU Member State in Eurostat databases.[14] A dedicated ICT NABS chapter, however, does not exist in these databases and ICT-related R&D is likely to be included in several NABS chapters. Due to the very broad definition of NABS chapters, a straightforward extraction of ICT from GBAORD is not possible either.

For this reason, there is a need to create a proxy variable that enables us to estimate ICT shares within different GBAORD NABS chapters. The values of this proxy would have to differ across countries, time and NABS chapters. If we assume that the share of ICT R&D expenditures in GBAORD is similar to the share of ICT R&D labour costs (from total R&D labour costs), a possible solution comes from the Labour Force Survey[15] (LFS). A direct link between GBAORD and the LFS has not been defined yet but the LFS provides information about workers' sectors of activity categorized by NACE[16] codes. The link can, therefore, be created by defining a correspondence between NABS chapters and NACE codes. In the absence of a ready-made correspondence table, we have created one which shows how NABS chapters can be linked to NACE codes (see Table A1 for NACE Rev. 1.1 and Table A2 for NACE Rev. 2).[17]

Once the link between NABS and NACE is created, we are able to determine the total R&D employment as well as ICT R&D employment for each NABS chapter. For this, we follow the International Labour Organization's (ILO) methodology and define ICT occupations as described in Table A3 (ISCO-88) and A4 (ISCO-08).[18] Furthermore, we define R&D employees as those with tertiary education.[19] R&D employment is measured in hours worked, which allows the inclusion of partial employment or partial involvement in ICT-related activities that prevents the method from overestimating ICT R&D employment shares. Additionally, since wages play an important part of R&D expenditures and they can differ substantially across occupations, applying an indicator of wages should better reflect expenditures. This information comes from the Structure of Earnings Survey[20] (SES). This database allows us to see average hourly wages for different occupations, education groups or countries.

Once we have all the necessary information, we calculate ICT R&D labour shares separately for each NABS category *i*, country *j* and year *t* using the following formula:

$$ICT\_R\&D\_emp\_share_{ijt} = \frac{\sum_{k:\, ISCO\text{–}88 \in ICT\ \&\ tertiaryedu} hours\_worked_{kijt} * wages_{kijt}}{\sum_{k:\, tertiaryedu} hours\_worked_{kijt} * wages_{kijt}} \quad , \qquad (1)$$

where index *k* denotes individual employee-groups,[21] variable *hours_worked* represents the total number of hours worked by all employees within each group and variable *wages* represents

[14] Total GBAORD by NABS 2007 socio-economic objectives (gba_nabsfin07) (Based on the data on 01-04-2014)

[15] http://epp.eurostat.ec.europa.eu/portal/page/portal/microdata/lfs

[16] "Nomenclature générale des Activités économiques dans les Communautés Européennes" (Statistical classification of economic activities in the European Communities).

[17] NACE Rev. 1.1 classification is available till 2007. Since 2008, NACE Rev. 2 has been employed.

[18] For further discussion about ICT occupations see Sabadash (2012).

[19] ISCED codes 5a, 5b and 6.

[20] http://epp.eurostat.ec.europa.eu/portal/page/portal/microdata/ses. Tailor-made extractions from the Structure of Earnings Survey (SES) microdata from Eurostat was received on 07-04-2014

[21] For each country and year, LFS data provides information about the aggregated number of employees across several groups. Therefore, these individual employee groups are combinations of regions, occupations, sectors, fields of education and degrees of education. Tailor-made extractions from the Labour Force Survey (LFS) microdata from Eurostat were received on 17-02-2014.

average hourly wages within these groups. The sum in numerator represents the total costs for R&D employees working in a country *j*, year *t*, NABS category *i* and in occupations that are considered to be ICT occupations. The sum in denominator represents the total costs for R&D employees in a country *j*, year *t*, NABS category *i*, irrespective of their occupation.

The aim of calculating these ICT R&D labour shares is to estimate the weight of ICT within each particular NABS chapter. It is unlikely that these shares will change much from year to year. For some countries, however, LFS data estimates show some data gaps across the years (disappearances/appearances of ICT occupations). Since we do not want our results to depend on this volatile and, in reality, highly improbable behaviour, we use ICT R&D labour share trends in further calculations rather than actual shares. These ICT R&D labour share trend values are calculated separately for each country and NABS chapter. Here, labour shares from equation (1) are regressed on time (years). Consequent linear prediction provides us the trend values.

Finally, the resulting ICT GBAORD for country *j* in year *t* is estimated by the following formula:

$$ICT\_GBAORD_{jt} = \sum_{i=1}^{14} GBAORD_{ijt} * ICT\_R\&D\_emp\_share\_trends_{ijt},$$

where index *i* denotes a NABS category.[22]

A graphical presentation of this method is shown in Figure A1. The method relies mainly on two datasets, GBAORD and LFS, which are linked through NABS-NACE correspondence. GBAORD here represents public R&D expenditures; LFS (together with SES) serves for calculating ICT R&D labour shares. These shares are estimated according to desired occupation (ISCO) and education (ISCED) codes. Finally, when these ICT R&D labour shares are applied on GBAORD data, we get ICT GBAORD.

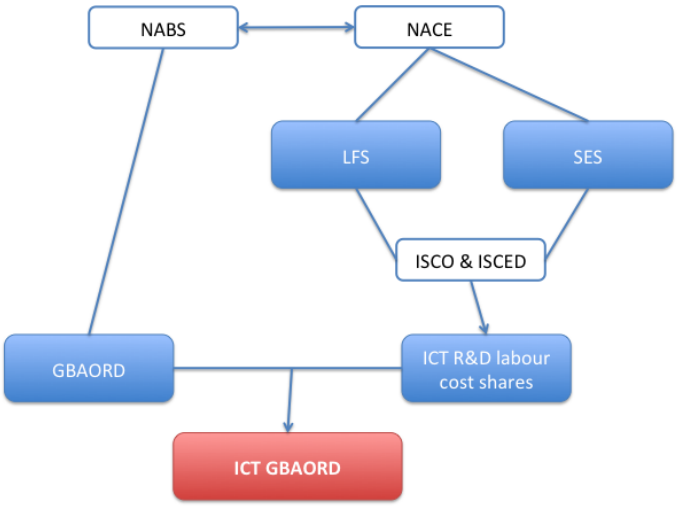


Figure A1: Schematic diagram of the estimation method

This methodology describes the estimation of EU ICT GBAORD. Regarding the estimation of US ICT GBAORD, though, it has to be slightly modified. Namely, we use the US Census Industrial Classification (CIC)[23] (see Table A5). ICT occupations are identified based on the MPICT definition[24]

[22] Although according to this formula index *i* goes from 1 to 14, in fact it covers only 13 distinct NABS chapters, since chapters #12 and #13 have been merged. However, in order to avoid a misinterpretation, index *i* corresponds to NABS chapters' numbering and therefore it goes up to number 14.

[23] http://www.bls.gov/cps/cenind.pdf. Current Population Survey (CPS) was downloaded from the Bureau of Labor Statistics (BLS) and the US Census Bureau (http://dataferrett.census.gov/) on 24-02-2014.

[24] Mid-Pacific Information and Communication Technologies Center (MPICT).

(see Table A6) following the Standard Occupational Classification (SOC).[25] All US employment data comes from the Current Population Survey.[26]

NABS – NACE correspondence

When creating NABS-NACE correspondence tables, we have followed and compared detailed descriptions and definitions of both NABS[27] and NACE[28] categories. To illustrate this process, we provide below several examples (NACE codes are from Rev. 2 here):

- NABS chapter #6 (*Industrial production and technology*) includes R&D related to the improvement of industrial production and technology, as well as all manufacturing activities, and it excludes any R&D that forms an integral part of other objectives. Therefore, we include here NACE codes 10 to 33 *Manufacturing*, plus NACE 62 *Computer programming, consultancy and related activities* and 63 *Information service activities* but we exclude any manufacturing NACE codes that are included in other NABS chapters (see Table A2 for details).
- NABS chapter #7 (*Health*) includes R&D related to protecting, promoting and restoring human health – broadly interpreted to include health aspects of nutrition and food hygiene. It ranges from preventative medicine, including all aspects of medical and surgical treatment, both for individuals and groups, and the provision of hospital and home care, to social medicine and paediatric and geriatric research. Therefore, we include NACE 86 *Human health activities* and 87 *Residential care activities* here.
- NABS chapter #14 (*Defence*) includes R&D related to all military purposes. Looking at NACE classification, we can include military activities in 25.4 *Manufacture of weapons and ammunition*, 30.4 *Manufacture of military fighting vehicles* and in 84.22 *Defence activities*. As explained above, although NABS chapter #6 (*Industrial production and technology*) is supposed to include all manufacturing activities, it excludes any R&D that forms an integral part of other objectives, which is *Defence* in this case.

There are also several other cases that require a special approach and attention:

- NACE sectors 71.12 *Engineering activities and related technical consultancy* and 71.2 *Technical testing and analysis* cover several NABS categories, with none of them necessarily dominating the others. Therefore, ICT employment in these two NACE sub-categories is distributed among seven (technology-related) NABS chapters according to their corresponding shares in a country's total GBAORD. These seven NABS chapters are: *Exploration and exploitation of the earth; Environment; Exploration and exploitation of space; Transport, telecommunication and other infrastructures; Energy; Industrial production and technology;* and *Agriculture.*
- NABS chapters #12 (*General advancement of knowledge: R&D financed from General University Funds (GUF)*) and #13 (*General advancement of knowledge: R&D financed from other sources than GUF*) differ in their sources of financing. The NACE classification, however, does not allow for this division, so we treat these two NABS chapters jointly (i.e.,

[25] http://www.bls.gov/soc/.

[26] The Current Population Survey (CPS), sponsored jointly by the U.S. Census Bureau and the U.S. Bureau of Labor Statistics, is the primary source of labour force statistics for the population of the United States.

[27] Eurostat (2008) – Comparison between NABS 2007 and NABS 1992 http://www.oecd.org/dataoecd/62/38/43299905.pdf

[28] Eurostat (2008) – NACE Rev. 2: http://goo.gl/Fxfpy. For NACE Rev. 1.1 follow http://goo.gl/BfVOz.

we sum up GBAORD from these two chapters) and link it with NACE 72 (*Scientific research and development*).

Table A1: NABS – NACE Rev. 1.1 correspondence table

NABS 2007		NACE Rev. 1.1	
code	name	code	name
1	Exploration and exploitation of the Earth	10	Mining of coal and lignite; extraction of peat
		11	Extraction of crude petroleum and natural gas
		12	Mining of uranium and thorium ores
		13	Mining of metal ores
		14	Other mining and quarrying
		29.51	Manufacture of machinery for metallurgy
		29.52	Manufacture of machinery for mining, quarrying and construction
2	Environment	23.3	Processing of nuclear fuel
		37	Recycling
		90.02	Collection and treatment of other waste
3	Exploration and exploitation of space	62.3	Space transport
4	Transport, telecommunication and other infrastructures	34	Manufacture of motor vehicles, trailers and semi-trailers
		35.11	Building and repairing of ships
		35.2	Manufacture of railway and tramway locomotives and rolling stock
		35.3	Manufacture of aircraft and spacecraft
		41	Collection, purification and distribution of water
		45	Construction
		60	Land transport; transport via pipelines
		61	Water transport
		62	Air transport
		63	Supporting and auxiliary transport activities; activities of travel agencies
		64	Post and telecommunications
		74.2	Architectural and engineering activities and related technical consultancy
		90.01	Collection and treatment of sewage
		90.03	Repair and maintenance of aircraft and spacecraft
		excluded here: 60.3, 62.3	
5	Energy	40	Electricity, gas, steam and hot water supply
		60.3	Transport via pipelines
6	Industrial production and technology	15-37	Manufacturing
		72	Computer and related activities
		excluded here: 22.1, 23.3, 24.15, 24.2, 24.4, 29.3, 29.51, 29.52, 29.6, 33.1, 34, 35.11, 35.2, 35.3, 37	
7	Health	24.4	Manufacture of pharmaceuticals, medicinal chemicals and botanical products
		33.1	Manufacture of medical and surgical equipment and orthopaedic appliances
		85.1	Human health activities
		85.31	Social work activities with accommodation

Source: JRC-IPTS.
Note: some NACE sub-categories are referred as *excluded* – it is because they are part of a different NABS chapter.

(this table continues on the next page)

Table A1 (cont.): NABS – NACE Rev. 1.1 correspondence table

(this table begins on previous page)

NABS 2007		NACE Rev. 1.1	
code	name	code	name
8	Agriculture	1	Agriculture, hunting and related service activities
		2	Forestry, logging and related service activities
		5	Fishing, fish farming and related service activities
		24.15	Manufacture of fertilisers and nitrogen compounds
		24.2	Manufacture of pesticides and other agrochemical products
		29.3	Manufacture of agricultural and forestry machinery
		85.2	Veterinary activities
9	Education	80	Education
10	Culture, recreation, religion and mass media	22.1	Publishing
		91.3	Activities of other membership organizations
		92	Recreational, cultural and sporting activities
11	Political and social systems, structures and processes	74.5	Labour recruitment and provision of personnel
		75	Public administration and defence; compulsory social security
		85.32	Social work activities without accommodation
		excluded here: 75.22	
12 - 13	General advancement of knowledge (joint category for NABS 12 and 13)	73	Research and development
14	Defence	29.6	Manufacture of weapons and ammunition
		75.22	Defence activities
1 - 6, 8	ICT employment in this NACE sub-category is distributed among seven NABS chapters according to corresponding shares in the overall economy by NACE	74.3	Technical testing and analysis

Source: JRC-IPTS.
Note: some NACE sub-categories are referred as *excluded* – it is because they are part of a different NABS chapter.

Table A2: NABS – NACE Rev. 2 correspondence table

NABS 2007		NACE Rev. 2	
code	name	code	name
1	Exploration and exploitation of the Earth	5	Mining of coal and lignite
		6	Extraction of crude petroleum and natural gas
		7	Mining of metal ores
		8	Other mining and quarrying
		9	Mining support service activities
		28.91	Manufacture of machinery for metallurgy
		28.92	Manufacture of machinery for mining, quarrying and construction
2	Environment	38	Waste collection, treatment and disposal activities; materials recovery
		39	Remediation activities and other waste management services
3	Exploration and exploitation of space	51.22	Space transport
4	Transport, telecommunication and other infrastructures	29	Manufacture of motor vehicles, trailers and semi-trailers
		30.11	Building of ships and floating structures
		30.2	Manufacture of railway locomotives and rolling stock
		30.3	Manufacture of air and spacecraft and related machinery
		33.15	Repair and maintenance of ships and boats
		33.16	Repair and maintenance of aircraft and spacecraft
		33.17	Repair and maintenance of other transport equipment
		36	Water collection, treatment and supply
		37	Sewerage
		41	Construction of buildings
		42	Civil engineering
		43	Specialised construction activities
		49	Land transport and transport via pipelines
		50	Water transport
		51	Air transport
		52	Warehousing and support activities for transportation
		53	Postal and courier activities
		61	Telecommunications
		71.11	Architectural activities
		excluded here: 49.5, 51.22	
5	Energy	35	Electricity, gas, steam and air conditioning supply
		49.5	Transport via pipeline
6	Industrial production and technology	10 - 33	(all) Manufacturing
		62	Computer programming, consultancy and related activities
		63	Information service activities
		excluded here: 20.15, 20.2, 21, 25.4, 28.3, 28.91, 28.92, 29, 30.11, 30.2, 30.3, 30.4, 32.5, 33.15, 33.16, 33.17	

Source: JRC-IPTS.
Note: some NACE sub-categories are referred as *excluded* – it is because they are part of a different NABS chapter.

(this table continues on next page)

Table A2 (cont.): NABS – NACE Rev. 2 correspondence table

(this table begins on previous page)

NABS 2007		NACE Rev. 2	
code	name	code	name
7	Health	21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
		32.5	Manufacture of medical and dental instruments and supplies
		86	Human health activities
		87	Residential care activities
8	Agriculture	1	Crop and animal production, hunting and related service activities
		2	Forestry and logging
		3	Fishing and aquaculture
		20.15	Manufacture of fertilisers and nitrogen compounds
		20.2	Manufacture of pesticides and other agrochemical products
		28.3	Manufacture of agricultural and forestry machinery
		75	Veterinary activities
9	Education	85	Education
10	Culture, recreation, religion and mass media	58	Publishing activities
		59	Motion picture, video and television programme production, sound recording and music publishing activities
		60	Programming and broadcasting activities
		90	Creative, arts and entertainment activities
		91	Libraries, archives, museums and other cultural activities
		93	Sports activities and amusement and recreation activities
		94.9	Activities of other membership organisations
11	Political and social systems, structures and processes	78	Employment activities
		84	Public administration and defence; compulsory social security
		88	Social work activities without accommodation
		excluded here: 84.22	
12 - 13	General advancement of knowledge (joint category for NABS 12 and 13)	72	Scientific research and development
14	Defence	25.4	Manufacture of weapons and ammunition
		30.4	Manufacture of military fighting vehicles
		84.22	Defence activities
1 – 6, 8	ICT employment in these two NACE sub-categories is distributed among seven NABS chapters according to their corresponding shares in total GBAORD	71.12	Engineering activities and related technical consultancy
		71.2	Technical testing and analysis

Source: JRC-IPTS.
Note: some NACE sub-categories are referred as *excluded* – it is because they are part of a different NABS chapter.

Table A3: ICT occupations in ISCO-88 classification

ISCO-88	
123	Computing services managers only persons with 'Computer science' or 'Computer use' field of education
213	Computing professionals
214	Architects, engineers and related professionals only persons with 'Computer science' or 'Computer use' field of education
231	College, university and higher education teaching professionals only persons with 'Computer science' or 'Computer use' field of education
311	Physical and engineering science technicians only persons with 'Computer science' or 'Computer use' field of education
312	Computer associate professionals
313	Optical and electronic equipment operators only persons with 'Computer science' or 'Computer use' field of education

Table A4: ICT occupations in ISCO-08 classification

ISCO-08	
133	Information and communications technology services managers
215	Electrotechnology engineers only persons with 'Computer science' or 'Computer use' field of education
216	Architects, planners, surveyors and designers only persons with 'Computer science' or 'Computer use' field of education
235	Other teaching professionals only persons with 'Computer science' or 'Computer use' field of education
243	Sales, marketing and public relations professionals only persons with 'Computer science' or 'Computer use' field of education
251	Software and applications developers and analysts
252	Database and network professionals
351	Information and communications technology operations and user support technicians
352	Telecommunications and broadcasting technicians
742	Electronics and telecommunications installers and repairers

Table A5: NABS – CIC correspondence table

NABS 2007		CIC 2007	
code	name	code	name
1	Exploration and exploitation of the Earth	0370-0490	Mining, quarrying, and oil and gas extraction
		3080	Construction, and mining and oil and gas field machinery manufacturing
2	Environment	0680	Sewage treatment facilities
		7790	Waste management and remediation services
3	Exploration and exploitation of space	3590	Aerospace product and parts manufacturing
		9570	Administration of economic programs and space research
4	Transport, telecommunication and other infrastructures	0770	Construction
		3570	Motor vehicles and motor vehicle equipment manufacturing*
		3580	Aircraft and parts manufacturing*
		3670	Railroad rolling stock manufacturing
		3680	Ship and boat building*
		3690	Other transportation equipment manufacturing
		6070-6390	Transportation and warehousing
		6680-6690	Telecommunications
		7290	Architectural, engineering, and related services
		excluded here: 6270	
5	Energy	0570-0690	Utilities
		6270	Pipeline transportation
		excluded here: 0680	
6	Industrial production and technology	1070-2390	Nondurable goods manufacturing
		2470-2990	Durable goods manufacturing
		3090	Commercial and service industry machinery manufacturing
		3170	Metalworking machinery manufacturing
		3180	Engines, turbines, and power transmission equipment manufacturing
		3190	Machinery manufacturing, n.e.c.
		3290	Not specified machinery manufacturing
		3360	Computer and peripheral equipment manufacturing
		3370	Communications, and audio and video equipment manufacturing
		3380	Navigational, measuring, electromedical, and control instruments manufacturing*
		3390	Electronic component and product manufacturing, n.e.c.
		3470-3490	Electrical equipment and appliances manufacturing
		3770-3870	Wood products manufacturing
		3970	Sporting and athletic goods, and doll, toy and game manufacturing
		3980	Miscellaneous manufacturing, n.e.c.
		3990	Not specified manufacturing industries
		7380	Computer systems design and related services
		excluded here: 2180, 2190, 2970	

Source: JRC-IPTS.
Note: some CIC sub-categories are referred as *excluded* – it is because they are part of a different NABS chapter.
* only 50% of this sub-category is included here.

Table A5 (cont.): NABS – CIC correspondence table

(this table begins on previous page)

NABS 2007		CIC 2007	
code	name	code	name
7	Health	2190	Pharmaceutical and medicine manufacturing
		3960	Medical equipment and supplies manufacturing
		7970-8180	Health services, except hospitals
		8270-8290	Health services, except hospitals
8	Agriculture	0170-0290	Agriculture, forestry, fishing, and hunting
		2180	Agricultural chemical manufacturing
		3070	Agricultural implement manufacturing
		7480	Veterinary services
9	Education	7860-7890	Educational services
10	Culture, recreation, religion and mass media	6470-6490	Publishing, except Internet
		6570-6590	Motion picture and sound recording industries
		6770-6780	Other information services
		8560-8590	Arts, entertainment, and recreation
		9160-9190	Membership associations and organizations
		9290	Private households
11	Political and social systems, structures and processes	7580	Employment services
		8370-8470	Social assistance
		9370-9590	Public administration
		excluded here: 9570, 9590	
12 - 13	General advancement of knowledge (joint category for NABS 12 and 13)	7460	Scientific research and development services
14	Defence	2970	Ordnance
		3380	Navigational, measuring, electromedical, and control instruments manufacturing*
		3570	Motor vehicles and motor vehicle equipment manufacturing*
		3580	Aircraft and parts manufacturing*
		3680	Ship and boat building*
		9590	National security and international affairs

Source: JRC-IPTS.
Note: some CIC sub-categories are referred as *excluded* – it is because they are part of a different NABS chapter.
* only 50% of this sub-category is included here.

Table A6: ICT occupations in COC and SOC classifications

2010 COC	2010 SOC	
0110	11-3021	Computer and Information Systems Managers
1000 1010 1020 1040 1050 1060 1100 1110	15-1100	Computer Occupations
1400	17-2061	Computer Hardware Engineers
5010 5020 5030	43-2000	Communications Equipment Operators
5800	43-9011	Computer Operators
5830	43-9031	Desktop Publishers
7020	49-2020	Radio and Telecommunications Equipment Installers and Repairers
7420	49-9052	Telecommunications Line Installers and Repairers

Annex 2 – Additional results

Table A7: ICT GBAORD estimates (mil. EUR)

Country	2006	2007	2008	2009	2010	2011
Austria	166.52	167.13	179.64	183.39	183.16	184.25
Belgium	176.47	190.88	233.87	244.04	262.89	269.11
Bulgaria	-	3.93	4.54	3.61	4.76	5.18
Croatia	-	-	11.28	11.31	12.20	12.96
Cyprus	1.76	2.44	2.38	2.49	2.08	1.82
Czech Republic	53.87	63.21	72.09	79.53	85.35	105.91
Denmark	84.11	104.74	138.82	161.22	184.21	202.39
Estonia	1.02	1.52	2.48	2.77	3.63	4.94
Finland	140.17	144.03	154.91	177.12	199.57	202.42
France	761.47	741.51	663.79	700.30	646.07	614.93
Germany	1,058.11	1,087.62	1,108.42	1,202.40	1,276.46	1,297.59
Greece	39.36	39.30	50.81	42.77	34.88	31.19
Hungary	23.36	19.74	23.50	27.10	20.50	14.32
Ireland	44.43	59.97	63.37	68.66	70.57	68.23
Italy	590.44	601.45	583.12	612.34	545.52	498.83
Latvia	2.44	3.01	3.04	1.65	1.23	1.21
Lithuania	1.58	3.29	4.30	4.90	5.00	6.24
Luxembourg	5.40	7.73	9.55	10.93	14.42	16.83
Malta	0.01	0.06	0.07	0.03	0.02	0.06
Netherlands	349.67	347.03	345.70	362.90	352.27	355.20
Poland	46.02	55.75	64.61	-	-	-
Portugal	54.31	48.82	29.86	34.08	30.53	27.01
Romania	17.24	25.37	32.96	21.45	19.07	20.26
Slovakia	10.18	8.15	10.87	11.21	9.76	10.15
Slovenia	11.65	12.40	14.32	21.38	19.22	20.86
Spain	392.09	556.30	630.39	688.78	671.54	598.34
Sweden	289.56	321.14	354.04	364.41	435.83	474.82
United Kingdom	699.72	739.28	648.22	634.96	651.26	644.23
European Union 27	5,191.26	5,445.80	5,684.64	5,943.73	6,029.37	6,103.68
European Union	5,207.49	5,461.29	5,700.46	5,958.48	6,044.32	6,118.39
United States	9,969.69	9,417.86	8,773.75	9,812.03	9,535.32	8,480.24

Source: JRC-IPTS calculation based on Eurostat data.

Annex 3 - GBAORD by OECD Frascati Manual (2002)

GBAORD and government-financed GERD

There are two ways of measuring how much governments spend on R&D. The first and most accurate is to carry out surveys of the units that carry out R&D (firms, institutes, universities, etc.) in order to identify the amount effectively spent on R&D over the previous year and the share financed by government. The sum of the R&D spending in a national territory is known as "government-financed gross domestic expenditure on R&D" (government-financed GERD).

A second way of measuring government support for R&D has been developed using data from budgets. This essentially involves identifying all the budget items involving R&D and measuring or estimating their R&D content in terms of funding. These estimates are less accurate than performance-based data but as they are derived from the budget, they can be linked to policy through classification by "objectives" or "goals". Budget-based data are now officially referred to as GBAORD.

Sources of budgetary data for GBAORD

Although details of the budgetary procedure vary from country to country, seven broad stages can be identified:

i) Forecasts (estimates of funding before beginning of budget discussion).

ii) Budget forecasts (preliminary figures as requested by ministries, especially for inter-ministerial discussions).

iii) Budget proposal (figures presented to the parliament for the coming year).

iv) Initial budget appropriations (figures as voted by the parliament for the coming year, including changes introduced in the parliamentary debate).

v) Final budget appropriations (figures as voted by the parliament for the coming year, including additional votes during the year).

vi) Obligations (money actually committed during the year).

vii) Actual outlays (money paid out during the year).

Stages i)-iv) describe the government's intentions. The data for budgetary year *y* should be available as soon as possible after the end of year *y – 1*. It is suggested that the preliminary GBAORD data should be based on the first budget agreed between the government and the parliament, or stage iv). Some countries might even base their preliminary figures on stage iii). During the budgetary year, supplementary budgets may be voted, including increases, cuts and reallocations of R&D funding. These are reflected in stage v). Data should be available as soon as possible after the end of the budgetary year. It is suggested that the final GBAORD data should be based on final budget appropriations. Some countries may have to base their final figures on stages vi) or vii).

Main differences between GBAORD and GERD data

Users of the GBAORD often discover differences between the sums reported as *Total GBAORD* and *government-financed GERD* and have difficulty in understanding them.

General differences

In principle, both series should be established on the basis of the same definition of R&D, they should cover R&D in both *natural sciences and engineering* and *social sciences and humanities* and both current and capital expenditures.

- They differ in two main respects. First, government-financed GERD and GERD objectives data are based on reports by R&D performers, whereas GBAORD is based on reports by funders. Second, the GERD-based series cover only R&D performed on national territory, whereas GBAORD also includes payments to foreign performers, including international organisations.
- Differences may also occur because the periods covered are different (calendar or fiscal years), because the money is finally spent by the performer in a later year than the one in which it was committed by the funder, and because the performer may have a different and more accurate idea of the R&D content of the project concerned.

GBAORD and government-financed GERD

- In addition to the general differences, government-financed GERD should include R&D financed by central (or federal), provincial (or state) and local government, whereas GBAORD excludes local government and sometimes also provincial government.

GBAORD and GERD by socio-economic objectives

- GBAORD covers only R&D financed by government (including abroad), whereas GERD covers all sources of funds on national territory.
- The performer's appreciation of the objectives of the project concerned may differ significantly from that of the funder, notably for R&D funded from block grants such as GUF, which should be distributed by objective in the GERD approach.

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Glossary

CAGR – Compound Annual Growth Rate

CIC – Census Industrial Classification

COC – Census Occupation Code

CPS – Current Population Survey

DAE – Digital Agenda for Europe

EU – European Union

GBAORD – Government Budget Appropriations or Outlays on R&D

GDP – Gross Domestic Product

GERD – Gross Expenditure on R&D

GUF – *General University Funds*

ICT – Information and Communication Technology

ILO – International Labour Organization

IPTS – Institute for Prospective Technological Studies, part of the European Commission's Joint Research Centre

ISCED – International Standard Classification of Education

ISCO – International Standard Classification of Occupations

ISIC – International Standard Industrial Classification

JRC – Joint Research Centre, European Commission

LFS – Labour Force Survey

MPICT – Mid-Pacific Information and Communication Technologies Center

NABS – Nomenclature for the analysis and comparison of scientific programmes and budgets

NACE – Nomenclature générale des Activités économiques dans les Communautés Européennes

OECD – Organisation for Economic Cooperation and Development

PREDICT – Prospective Insights on R&D in ICT project

R&D – Research and Development

SES – Structure of Earnings Survey

SOC – Standard Occupational Classification

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