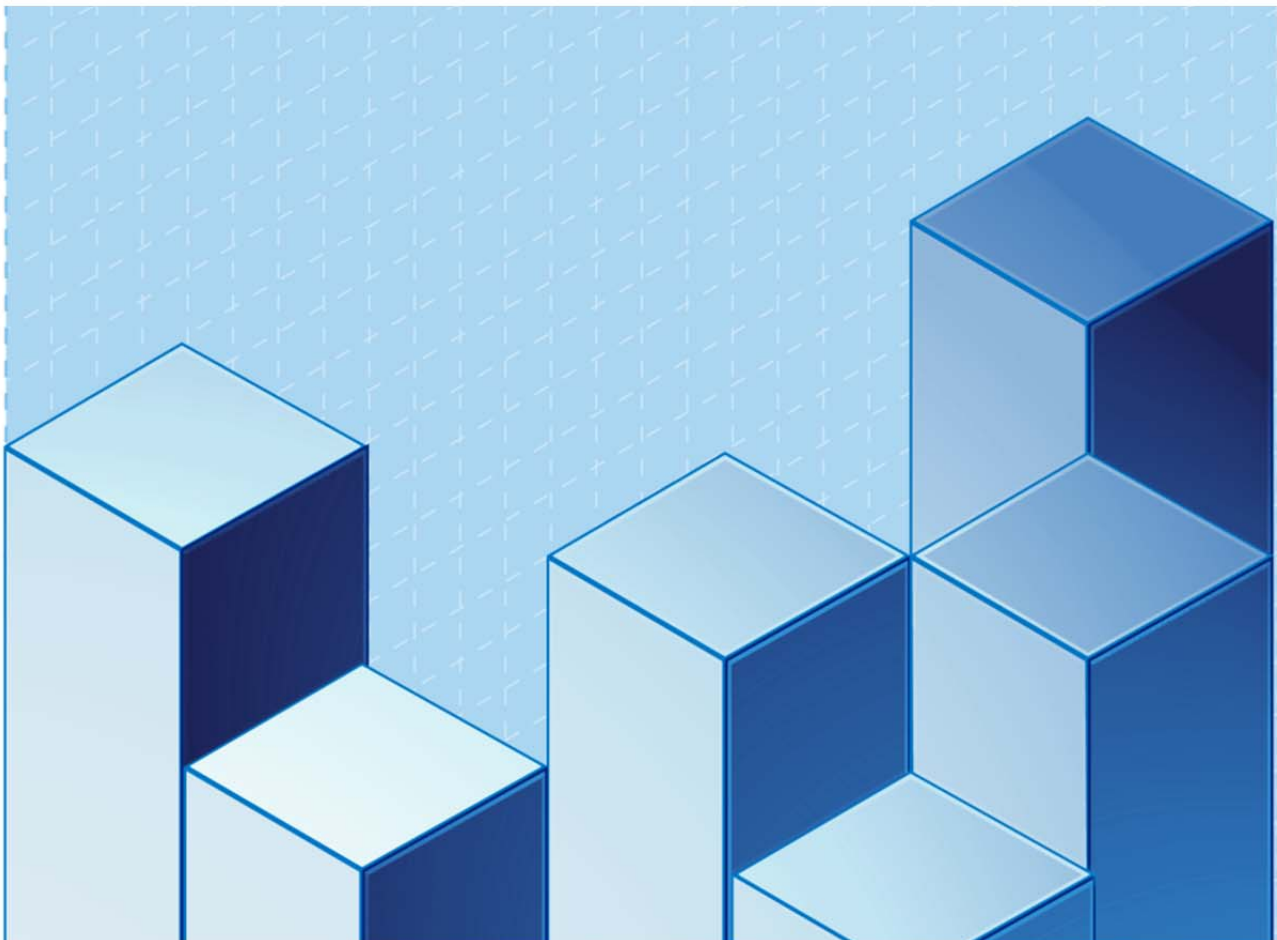


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A PROPOSAL FOR DISENTAGLING PUBLICLY FUNDED R&D (GBARD) BY INDUSTRY

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Abstract

In this paper we develop a methodology to disentangle public R&D expenditure (GBARD) by NACE industries and to identify the part devoted to ICT assets within each sector. We start from the methodology developed by Stančík (2012). Essentially, our methodology is based on the definition of a NACE-NABS correspondence and the construction of proper weights to assign GBARD by NABS into each NACE industry. The weights are based on the assumption that R&D intensity in each industry is related to the share of labour costs of employees with higher education over total labour costs. Finally, to compute the part of R&D expenditure devoted to ICT assets in each NACE industry, we assume that it is proportional to the share of labour costs of employees with higher education performing ICT occupations. The methodology is applied to the European Union and the Member States since 2006. The database comprises 37 NACE Rev. 2 industries.

Keywords: R&D, Public funding, NACE industries.

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1. INTRODUCTION

One of the SPINTAN project's aims is to build a database comprising investment and capital stock of intangible assets in the non-market sector. The project's measurement goal is to generate industry aggregates of intangible assets produced within the non-market sector. SPINTAN data complements other existing databases on intangibles, such as INTAN-Invest, COINVEST and INNODRIVE, which provide data on the market investment and capital stocks of the aggregated market sector and for eight industries. To achieve this goal, the SPINTAN project has developed a conceptual framework (Corrado, Haskel and Jona-Lasinio, 2015) that clarifies, among other factors, 1) the definition of the non-market sector; 2) the asset boundaries, i.e. what intangible investment and societal assets are produced by government and non-profit producers; 3) main implications that arise from the capitalisation of intangibles in the System of National Accounts; 4) the return on non-market capital; 5) the functions of the government related to SPINTAN goals; 6) which government expenditures have to be capitalised.

Regarding the last point, government expenditures to be capitalised, a key issue is to measure which part of public expenditures must be computed as gross fixed capital formation, particularly since public sector transfers (both of current costs and capital expenditures) and subsidies are not included as public sector investment, but are usually included as investment or expenditures of those sectors which receive the transfers. Hence, to properly measure the contribution of public funding to intangible assets, it is essential to have accurate information on public sector transfers used to acquire intangible assets. This issue is of special interest in the case of research and development (R&D), in which public sector funding is quite relevant.

According to the Frascati Manual (OECD, 2015), there are two alternative avenues to measure the resources governments allocate to R&D. On the one hand, the performer-based approach consists of the aggregation of the sums that an industry receives from the government for its intramural R&D. Performer-based indicators generally rely on surveys asking R&D performing units about their investment in this asset. The second alternative is the funder-based approach, based on government reports of the sums committed to fund other sectors' R&D. The Frascati Manual (OECD, 2015) explicitly recommends the performer-based approach, as it captures whether or not the funds were used for R&D and when the R&D effectively took place, among other issues. However, the manual also recognises that other procedures, such as the funder-based approach, may be useful to improve the quality and timeliness of R&D statistics.

The funder-based approach generally uses budgetary information GBARD (Government allocations for R&D),¹ identifying the budget items that may support R&D activities. This budgetary information has two main drawbacks. Firstly, it is not compatible with the performer-based approach. Secondly, GBARD measures the budget commitments and,

¹ Frascati Manual 2015 uses the term GBARD instead of the GBARD (Government budget appropriations or outlays for R&D) of previous editions.

therefore, not necessarily the amounts actually spent. On the other hand, it has the advantage of the timely availability of the information, which is not so lagged as the surveys used in the performer-based approaches, and it is also linked to socioeconomic objectives according to the Nomenclature for the Analysis and Comparison of Scientific Budgets and Programmes (NABS) chapters.

The relevance of knowing what contribution the public sector makes to R&D goes beyond the SPINTAN project. Target 2 of the European Commission's Europe 2020 strategy for smart, sustainable and inclusive growth,² approved in 2010, set a target of 3% of the EU's GDP to be invested in R&D. To achieve this objective, the first of the seven flagship initiatives under the Europe 2020 is the Digital Agenda for Europe, which aims to stimulate the EU economy by promoting smart growth through the fostering of digital technologies. Action 55 of the Digital Agenda established that Member States should double their annual public spending on research and development (R&D) in Information and Communication Technology (ICT). In 2015 the Digital Agenda was transformed into the Digital Single Market³ in which the role of ICTs and the public funding of ICT and R&D are closely monitored in the Digital Scoreboard.⁴

Although monitoring trends in public funding of R&D is an important task, it is not straightforward due to the lack of available data. Stančik (2012) and Stančik and Rohman (2014) have developed a methodology to disentangle the share of Government Budget Appropriations or Outlays on R&D (GBARD) that finances ICT R&D expenditure (ICT GBARD).

However, neither the ICT GBARD nor the GBARD statistics, which are available for NABS chapters, are sufficient to satisfy the SPINTAN objectives. The project's focus is to disentangle which part of the public sector subsidies helps each industry's R&D investments. What is needed here is to compute how public R&D funding is distributed by NACE industries and not by the NABS chapters. This is therefore, the main aim of the present document: to develop a methodology that allows us to disentangle which part of the Eurostat GBARD can be attributed to various different NACE industries. One further step is taken to estimate which part of the public funding invested in each NACE industry is allocated to increase the stock of ICT assets. The methodology developed starts from the approach of Stančik (2012) and Stančik and Rohman (2014), but is modified to achieve the objectives of this paper.

This document is organised as follows. Section 2 describes the methodological proposal to estimate GBARD (and ICT GBARD) in terms of NACE industries. Section 3 describes the main results of the implementation of this methodology for the EU countries. Section 4 concludes.

² European Commission (2010).

³ European Commission (2015).

⁴ <https://ec.europa.eu/digital-single-market/en/digital-scoreboard>

2. ESTIMATION OF GBARD (AND ICT GBARD) IN TERMS OF NACE SECTORS

Distribution of GBARD by NACE industries

The starting point of the methodology is the GBARD data published by Eurostat broken down by NABS chapters. GBARD, as mentioned above, is a measure of the government expenditure on R&D based on budgetary information following the Frascati Manual guidelines (OECD 2002 and 2015). It covers R&D performed directly by the government, but also R&D performed by other sectors –market sector, higher education sector, private non-profit and rest of the world– with government financing. GBARD differs from intramural R&D expenditures (GOVERD) because 1) it includes publicly-funded R&D of the other sectors in the economy, and 2) not all GOVERD is always government funded.

GBARD requires all the budget items involving R&D –current costs and capital expenditures– to be identified and their R&D content measured. ‘Government’ should cover central (or federal) and provincial (or state) government, when its contribution is significant. State-owned enterprises are excluded when they operate with funds raised within the market and they are not included in the public budget. In the case of government funding of R&D in the rest of the world, only the funding of international R&D programmes or organisations should be included. Although not offered separately, GBARD includes basic and applied research and experimental development. It also follows the same definitions, rules and conventions to measure R&D as the performer-based approach.

GBARD data are available on the Eurostat website for the most recent classification by NABS 2007 socio-economic objectives (see Table 1) for the period 2004-2015⁵ for all the EU Member States, Iceland, Norway, Switzerland, Serbia, Turkey, Russia, the United States, Japan and Korea. In the case of EU aggregates, data for the EU-28, EU-15 and EA-19 are available from 2007. Data are also available on the Eurostat website for the previous GBARD classification (NABS 1992 socio-economic objectives) for the period 1980-2007 (the EU-27 aggregate starts in 1999). The non-EU countries covered are Iceland (available for the years 1983-1986, 1991-2007), Norway (1981-2007), Switzerland (1981, 1983, 1986, 1988-1990, 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2006), Russia (1999-2007), the United States (1980-2007), Japan (1988-2007) and South Korea (2004-2007).

⁵ Data for Italy start in 2005, for Croatia in 2008, for Hungary in 2005, for Serbia in 2013; data for Korea are available for 2011 only. Data for Switzerland are available only for the years 2004, 2006, 2008, 2010 and 2012. The Czech Republic, Denmark, the Netherlands, Austria, Portugal, Romania, Finland, Sweden, Norway, Turkey and the United States have already published preliminary data for 2015.

Table 1. NABS 2007 chapters

NABS 2007 chapters	
1	Exploration and exploitation of the earth
2	Environment
3	Exploration and exploitation of space
4	Transport, telecommunication and other infrastructures
5	Energy
6	Industrial production and technology
7	Health
8	Agriculture
9	Education
10	Culture, recreation, religion and mass media
11	Political and social systems, structures and processes
12	General advancement of knowledge: R&D financed from General University Funds
13	General advancement of knowledge: R&D financed from other sources than GUF
14	Defence

Source: *Eurostat (2008)*

As mentioned above, our methodology draws heavily on Stančik (2012) and to some extent can be considered as an extension of his procedures. However, our aim is different. Whereas Stančik (2012) aims only to disentangle the part of total GBARD devoted to ICTs, we set out to estimate GBARD by NACE industries. Our industry disaggregation follows a homogeneous classification (NACE Rev.2) for the EU Member States, broken down by 37 industries, of which 7 are ICT sectors.⁶

To break down NABS GBARD by NACE industries, two elements are required: 1) a correspondence between NABS chapters and NACE industries, and 2) weights to distribute the GBARD of each NABS chapter into the different NACE industries, since each NABS chapter will generally be distributed across more than one industry (see Figure 1).

Regarding the first of these elements, Stančik (2012) provides a mapping to assign NACE industries to NABS chapters (Table 1 of his paper for the NACE Rev. 1.1 and Table 3 for the NACE Rev 2.). Here, we use these correspondences but in the reverse direction. Whereas Stančik (2012) aggregates the different NACE industries that make up a NABS chapter, we disentangle total GBARD NABS chapters into the different NACE industries. (See Figure 2).

⁶ Following the OECD 2007 ICT sector definition: OECD Information Economy–Sector definitions based on the International Standard Industry Classification (ISIC 4) available at <http://www.oecd.org/science/scienceandtechnologypolicy/38217340.pdf>, Annex 1, pg. 15. More details on methodology are provided in Mas, Robledo and Pérez (2012): *ICT sector definition transition from NACE Rev. 1.1 to NACE Rev. 2: A methodological note*, available at <http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=5919>.

Figure 1: Requirements of the methodology to break down GBARD by industry: equivalence between GBARD and industries (NACE) including weights

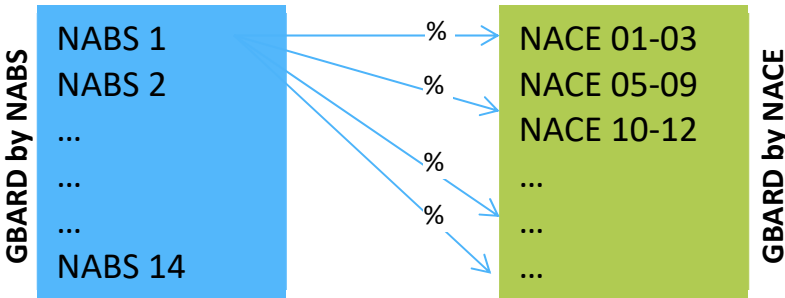
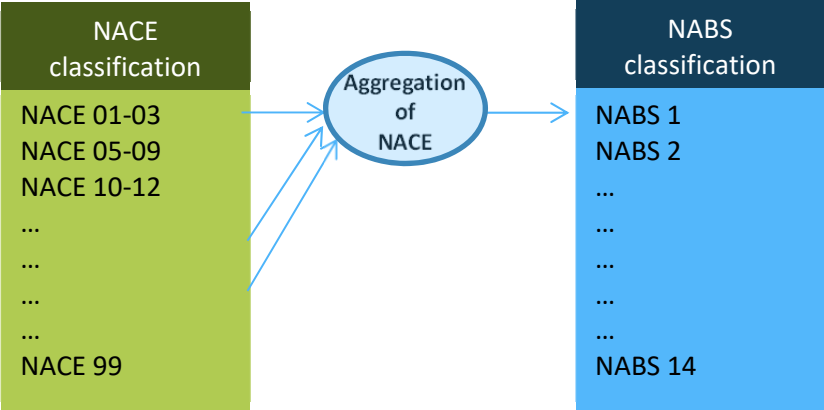
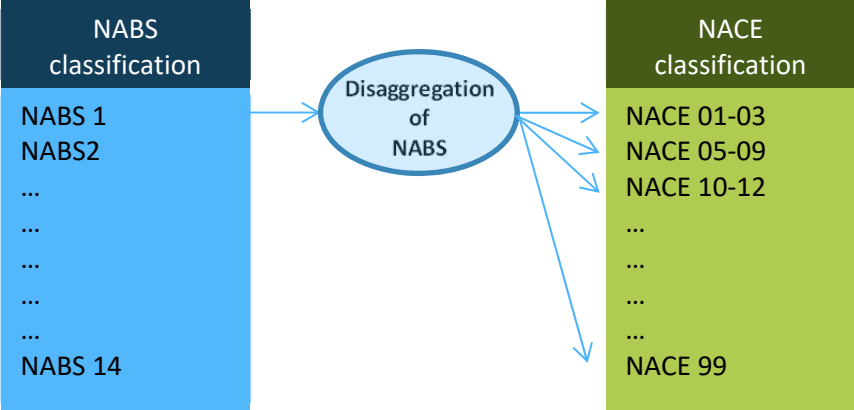


Figure 2: Differences between Stančik and Rohman (2014) NACE-NABS equivalence and the equivalence needed for the industry disaggregation of GBARD.

a) Stančik and Rohman (2014) NACE-NABS correspondence



b) What is needed: a NABS-NACE correspondence



In addition, the change in the NACE classification in 2008 has to be taken into account. Hence, Stančik’s (2012) two NACE-NABS correspondences of are required, one for NACE Rev. 1.1 for the period 2004-2007 and the other for NACE Rev. 2 for the period 2008-2013. The only difference in our procedure as compared to Stančik’s (2012) correspondence is that whereas he assign the NABS *General Advancement of knowledge: R&D financed from General University Funds (GUF)* to the R&D sector, we assign it to Education.

NABS 2007 → NACE Rev. 1.1 → NACE Rev. 2 (2004-2007)

NABS 2007 → NACE Rev. 2 (2008-2014)

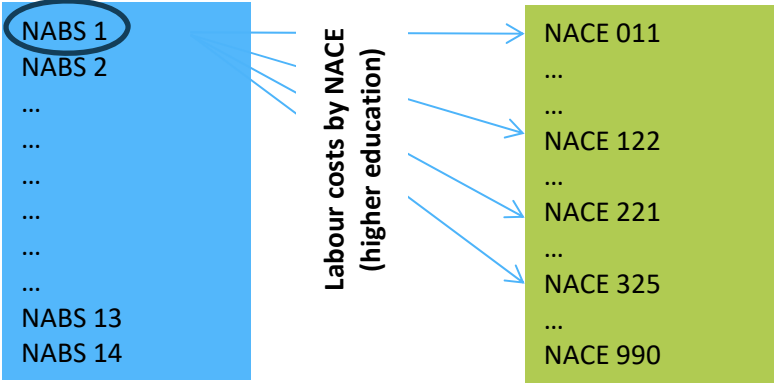
The second element needed is the distribution of the weights of each NABS chapter across the NACE (Rev. 1.1 and Rev. 2) industries, since each NABS chapter frequently corresponds to more than one NACE industry. We assume that the GBARD in each NABS is distributed across NABS chapters according to the weight of labour costs (salaries times hours worked) of employees with higher education (ISCED 5-6) of total labour costs. This choice assumes that the distribution of GBARD expenditure by industry is similar to the distribution of the labour costs of the highest qualified employees, who are assumed to be more likely to be performing R&D activities. Total labour costs are used instead of total employment because the former includes salaries, which in the case of perfect competition, may reflect differences in productivity.

The data needed to calculate the weights are hours worked by employees with higher education by 3-digit NACE Rev. 1.1. and Rev. 2 industries (Labour Force Survey, LFS) and hourly wages of employees with higher education by 3-digit NACE industries (Structure of Earnings Survey, SES). For the period to be estimated (2006-2013), data for wages were only available for the years 2006 and 2010 at the time the data was requested from Eurostat. Like Stančik (2012), we use 2006 SES data until 2007, and 2010 SES data are extrapolated from 2008 onwards. Tailor-made data for both LFS and SES data were requested from Eurostat. The data received were subject to confidentiality restrictions, limiting the data availability in some industries and occupations.

Figure 3 illustrates the procedure to break down GBARD NABS chapters by industry using the NACE-NABS correspondences and labour costs as weights. For example, according to the correspondence, NABS chapter 1 has to be broken down into four different NACE Rev. 2 industries (011, 122, 221, 325) (Figure 3A). To do this, the weights are calculated from the percentage distribution of total labour costs in these four industries (Figure 3B). These labour cost weights will be applied to NABS 1 GBARD to obtain an estimate of GBARD in NACE terms.

Figure 3: Example of NABS 1- NACE correspondences and estimation of weights based on labour costs

A) NABS 1- NACE Rev. 2 correspondence



Source: The authors based on Stančík (2012) NACE – NABS correspondence.

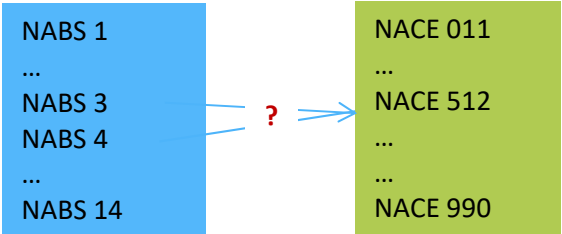
B) Example: NABS 1 – NACE Rev. 2 correspondence and estimation of weights based on labour costs

NABS codes	NACE codes	Labour costs	Weights
NABS 1	NACE 011	100	15%
	NACE 122	200	31%
	NACE 221	250	38%
	NACE 325	100	15%
	Total NACEs assigned to	650	100%

The method described above is followed as a general rule for each NABS chapter to obtain estimates of GBARD by NACE industries. However, there are some cases in which the procedure is not so straightforward, particularly when several NACE industries are assigned to more than one NABS chapter. In these cases, a prior step is needed. For example, NACE Rev. 2 code 512 (Freight air transport and space transport) is assigned to NABS 3 (Exploration and exploitation of space) and NABS 4 (Transport, telecommunication and other infrastructures), but we do not have information about how much of the labour costs of employees with higher education in industry 512 should be assigned to each NABS 3 and 4 (Figure 4). As far as in NABS 3 or in NABS 4 there are more than one NACE industries involved, total labour costs of NACE 512 cannot be used twice to calculate the weights within each NABS chapter, otherwise they will be counted twice. Hence, it is necessary to split NACE 512 labour costs among those NABS affected (NABS 3 and 4 in the example). The GBARD weight in the NABS involved is therefore used to assign the labour costs of each NACE industry to the corresponding NABS chapters for each country and year. This procedure to assign NACE industries in several NABS chapters deviates from the baseline

methodology proposed in Stančik (2012), which does not explicitly explain how to distribute NACE industries across several NABS chapters.

Figure 4: Example of distribution of NACE Rev. 2 512 code (Freight air transport and space transport) into NABS 3 (Exploration and exploitation of space) and NABS 4 (Transport, telecommunication and other infrastructures)



NACE codes	Labour costs	NABS codes	GBARD	Weights	Labour costs by NABS
NACE 512	1000	NABS 3	100	80%	800
		NABS 4	25	20%	200

As mentioned previously, all the procedures described above rely on the calculation of the appropriate weights to disentangle GBARD (NABS) by industries. To do this, the labour costs of employees with higher education in 3-digit NACE Rev. 1.1. and Rev. 2 industries need to be assigned correctly to each NABS chapter. Then, the weight of these costs is calculated for each NACE industry within the given NABS chapter. This weight will be used to estimate GBARD figures by industries for each country and year according to equation [1].

$$GBAORD_k = \sum_{j=1}^{14} GBAORD_j * \left[\frac{Labour\ costs_{j,k}}{\sum_{k \in j} Labour\ costs_{j,k}} \right] \quad (1)$$

where j stands for the NABS chapters, k for each NACE industry, and labour costs are hours worked by employees with higher education obtained from the LFS multiplied by their SES hourly wages in each NABS chapter and NACE industry.

Because LFS and SES data are classified according to NACE Rev. 1.1 for the period 2004-2007 and NACE Rev. 2 for the period 2008 onwards, applying the methodology produces GBARD data based on two different NACE classifications. In order to harmonise the data over the whole period covered by the database, Eurostat’s official correspondence between NACE Rev. 1.1 and Rev. 2⁷ is used to give the final NACE classification of 37 2-digit NACE Rev. 2 industries, comprising 7 ICT sectors (according to the OECD, 2006, classification),

⁷ http://ec.europa.eu/eurostat/ramon/relations/index.cfm?TargetUrl=LST_REL&StrLanguageCode=EN&IntCurrentPage=8.

described in Table 2. The transition from NACE Rev. 1 to Rev. 2 is not smooth in terms of the industries analysed. To take into account the effects on the dataset of the NACE revision in 2008, data on GBARD by NACE is smoothed by estimating a linear regression for the whole period with a trend and a step dummy for 2006-2013, the period affected by the change to the new NACE classification (Rev. 2).

Table 2: Final NACE classification: 37 2-digit NACE Rev. 2 industries, differentiating ICT sectors

Industry description	NACE Rev. 2 code
1 Agriculture, forestry and fishing	01-03
2 Mining and quarrying	05-09
3 Manufacture of food products, beverages and tobacco products	10-12
4 Manufacture of textiles, apparel, leather and related products	13-15
5 Manufacture of wood and paper products, and printing	16-18
6 Manufacture of coke, and refined petroleum products	19
7 Manufacture of chemicals and chemical products	20
8 Manufacture of pharmaceuticals, medicinal chemical and botanical products	21
9 Manufacture of rubber and plastics products, and other non-metallic mineral products	22-23
10 Manufacture of basic metals and fabricated metal products, except mach. & eq.	24-25
11 Manufacture of computer, electronic and optical products (except ICT industries)	26(nonICT)
12 Manufacture of electronic components and boards	ICT261
13 Manufacture of computers and peripheral equipment	ICT262
14 Manufacture of communication equipment	ICT263
15 Manufacture of consumer electronics	ICT264
16 Manufacture of magnetic and optical media	ICT268
17 Manufacture of electrical equipment	27
18 Manufacture of machinery and equipment n.e.c.	28
19 Manufacture of transport equipment	29-30
20 Other manufacturing, and repair and installation of machinery and equipment	31-33
21 Electricity, gas, steam and air-conditioning supply	35
22 Water supply, sewerage, waste management and remediation	36-39
23 Construction	41-43
24 Transportation and storage	49-53
25 Publishing, audiovisual and broadcasting activities (except ICT industries)	58-60(nonICT)
26 ICT Computer and related activities	ICT5820+62+631+951
27 Telecommunications	ICT61
28 Computer programming, consultancy and related activ.; Information service activ. (exc. ICT)	62-63(nonICT)
29 Legal and accounting, head offices, management consultancy, architectural and engineering activ; technical testing and analysis	69-71
30 Scientific research and development	72
31 Advertising and market research; other professional, scientific and technical activities; veterinary activities	73-75
32 Administrative and support service activities	77-82
33 Public administration and defence; compulsory social security	84
34 Education	85
35 Human health and social work	86-88
36 Arts, entertainment and recreation	90-93
37 Activities of membership organisations	94

*ICT sectors shaded in blue. Source: the authors
From GBARD by NACE industries to ICT GBARD*

Once GBARD has been distributed across the 37 NACE Rev. 2 industries, the next step is to split the GBARD within each industry, year and country into ICT and non-ICT assets. In this case, we make the same assumption as Stančik (2012) that the ICT intensity in R&D is proportional to the intensity of labour costs of employees with higher education in ICT occupations (in proportion to total labour costs of employees with higher education. More precisely we split total GBARD of industry k using its ICT share:

$$ICT\ GBARD_k = GBARD_k * ICT\ share_k \tag{2}$$

The ICT shares are calculated as:

$$ICT\ share_k = \frac{Labour\ costs\ for\ employees\ with\ higher\ education\ in\ ICT\ occupations_k}{Labour\ costs\ for\ employees\ with\ higher\ education_k} \tag{3}$$

For a definition of ICT occupations (Table 3 and Table 4), we follow Stančik (2012). Note that the weights to disentangle GBARD by industries are based on the ratio of labour costs of employees with tertiary education to total labour costs. Here, this ratio is expressed as the percentage of labour costs of employees with tertiary education working in ICT occupations to total labour costs of employees with tertiary education.

Table 3: 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

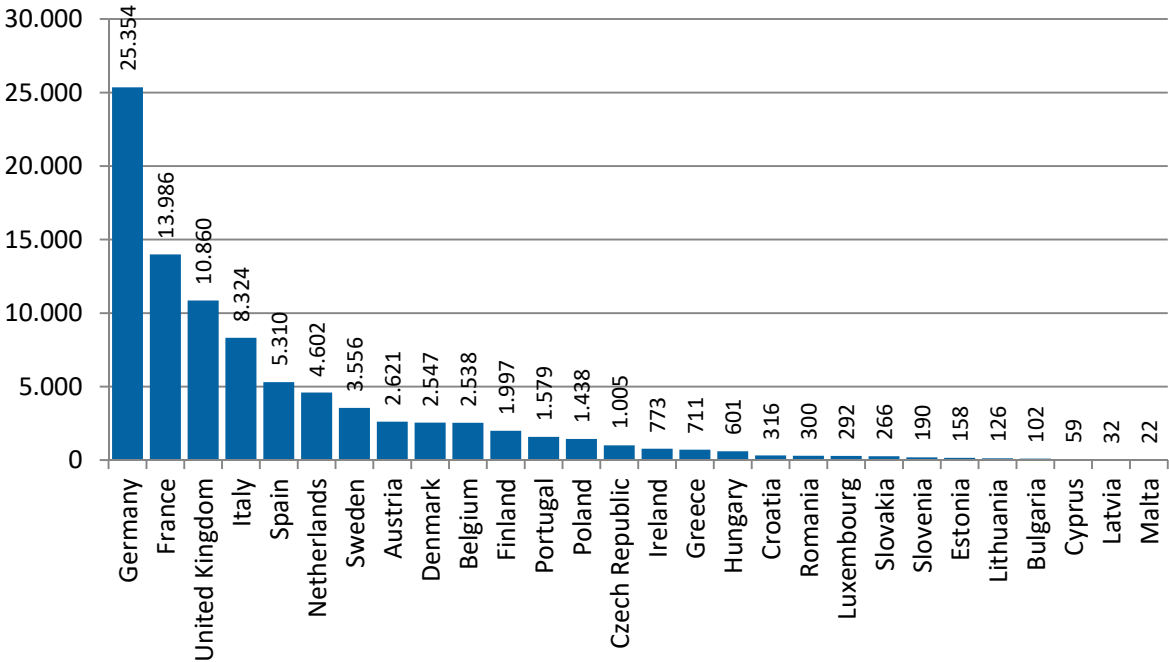
Table 4: ICT occupations in ISCO-08 classification

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
352	Telecommunications and broadcasting technicians
742	Electronics and telecommunications installers and repairers

3. DATA ON GBARD AND ICT GBARD BY NACE INDUSTRIES

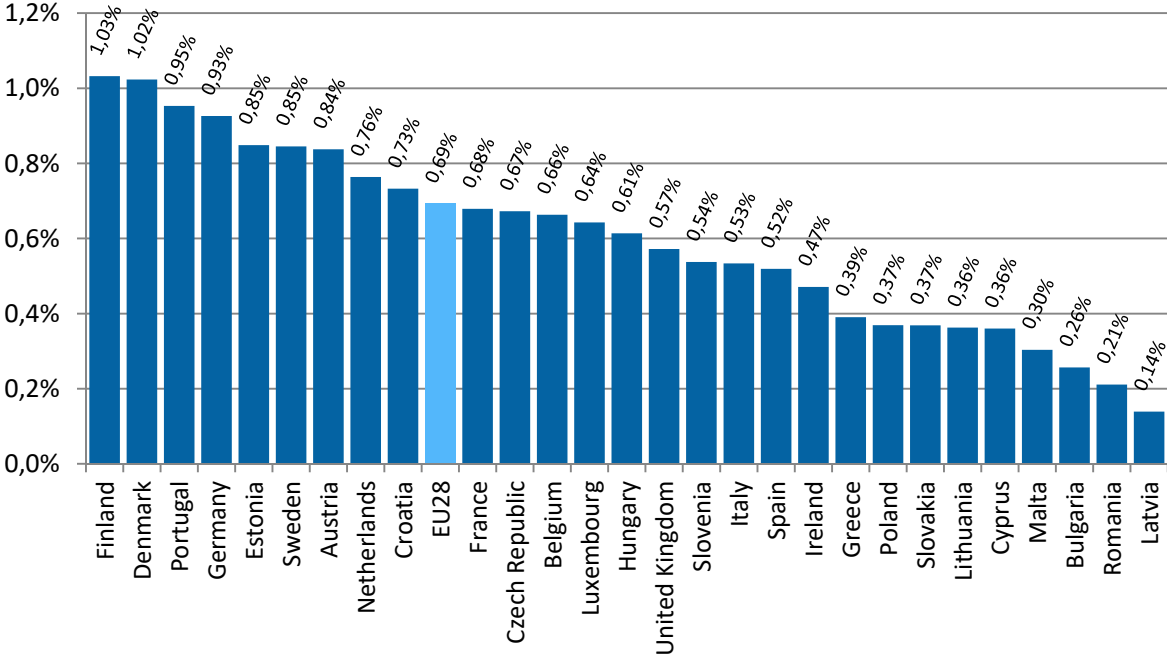
This section shows the results of the estimation of GBARD and ICT GBARD by NACE industries using the methodology described in the previous section for the EU countries from 2006 to 2013. As mentioned above, the starting point of the methodology is the GBARD data published by Eurostat. Figure 5 shows that in 2013 GBARD in the EU was 91 billion euros and that it was concentrated in the large countries: Germany (28%), France (16%), UK (12%), Italy (9%) and Spain (6%). The country ranking changes if we compute the GBARD intensity (GBARD/GDP). Figure 6 shows the distribution of countries according to the ratio of GBARD to GDP in 2013. Finland and Denmark show ratios above 1%. Portugal, Germany, Estonia and Sweden are also outstanding with values above 0.8%. The distribution of GBARD by NABS chapters is highly concentrated (Figure 6) in the EU. In 2013 more than one third of all GBARD is concentrated in the *General advancement of knowledge: R&D financed from General University Funds* (35%), and 18% is in the *General advancement of knowledge: R&D financed from other sources than GUF*. Industrial production and technology, and Health follow in relevance with values around 9%.

Figure 5. GBARD by Member State (2013). Millions of euros



Source: Eurostat

Figure 6. GBARD intensity (GBARD / GDP) by Member State (2013). Percentage.



Source: Eurostat.

Table 5 shows the distribution of GBARD by industries in 2013 calculated using the methodology developed in the paper, and Table 6 presents the percentage distribution across industries. In the same vein as the distribution by NABS, GBARD is also highly concentrated by NACE industries. Education accounts for the highest part of public funding of R&D as it includes the NABS that corresponds with the General University Funds. As already described, this NABS included the largest chunk of the GBARD. Other services also stand out among the industries which receive a large share of public funding. For example, Scientific research and development represents 17% of the total, whereas Human health and social work; Legal and Accounting, management consultancy, technical testing and analysis and architectural and engineering activities; and Public administration and defence represent around 8-9% each.

The ICT sector (NACE codes 261-264, 268, 5820, 61, 62, 631, 951) is of particular relevance in terms of the European Commission policy. This sector received 3,100 million euros in 2013 as public funding for their R&D activities, a 20% increase on the amount received in 2006 (2,587 M€). This implies that the ICT sector received 3.4% of all public R&D funding in the EU. This percentage has remained fairly stable over the period analysed at around 3.3%. The ICT computer and related activities (NACE codes 5820, 62, 631, 951) is the ICT subsector that concentrated by far the greatest portion of the GBARD within the ICT sector, accounting for 2.6% of total GBARD.

Table 5. GBARD by NACE Rev. 2 industries in the EU, 2006-2013. Millions of euros

NACE Rev. 2 industries	2006	2007	2008	2009	2010	2011	2012	2013
1. Agriculture, forestry and fishing (01-03)	1,459	1,452	1,451	1,424	1,381	1,331	1,264	1,224
2. Mining and quarrying (05-09)	551	648	737	803	848	879	888	907
3. Manufacture of food products, beverages and tobacco products (10-12)	641	664	687	695	693	684	664	655
4. Manufacture of textiles, apparel, leather and related products (13-15)	128	142	154	162	167	170	169	170
5. Manufacture of wood and paper products, and printing (16-18)	309	329	349	360	364	365	358	357
6. Manufacture of coke, and refined petroleum products (19)	0	32	66	94	117	136	149	162
7. Manufacture of chemicals and chemical products (20)	1,206	1,173	1,147	1,104	1,052	997	932	890
8. Manufacture of pharmaceuticals, medicinal chemical and botanical products (21)	501	525	549	560	562	558	545	540
9. Manufacture of rubber and plastics products, and other non-metallic mineral products (22-23)	454	478	500	511	514	511	498	495
10. Manufacture of basic metals and fabricated metal products, except machinery and equipment (24-25)	1,071	1,034	1,004	960	909	856	796	756
11. Manufacture of computer, electronic and optical products (except ICT industries) (26, exc. 261-264 and 268)	342	350	359	360	356	349	337	331
12. Manufacture of electronic components and boards (261)	150	170	188	201	209	214	214	217
13. Manufacture of computers and peripheral equipment (262)	0	15	41	64	82	97	107	118
14. Manufacture of communication equipment (263)	158	163	168	169	168	166	160	158
15. Manufacture of consumer electronics (264)	30	34	37	39	40	41	40	41
16. Manufacture of magnetic and optical media (268)	0	0	0	1	3	5	6	7
17. Manufacture of electrical equipment (27)	335	364	392	410	419	423	418	420
18. Manufacture of machinery and equipment n.e.c. (28)	1,444	1,523	1,599	1,637	1,648	1,641	1,604	1,594
19. Manufacture of transport equipment (29-30)	1,381	1,277	1,188	1,088	987	892	795	724
20. Other manufacturing, and repair and installation of machinery and equipment (31-33)	657	643	633	612	586	559	525	503
21. Electricity, gas, steam and air-conditioning supply (35)	2,435	2,569	2,699	2,764	2,783	2,772	2,710	2,693
22. Water supply, sewerage, waste management and remediation (36-39)	1,447	1,422	1,405	1,364	1,310	1,252	1,179	1,134
23. Construction (41-43)	1,487	1,374	1,278	1,171	1,062	959	855	778
24. Transportation and storage (49-53)	1,827	1,738	1,666	1,572	1,469	1,368	1,257	1,180
25. Publishing, audiovisual and broadcasting activities (except ICT industries) (58-60, exc. 582)	360	374	388	393	393	388	377	373
26. ICT computer and related activities (5820, 62, 631 and 951)	1,712	1,900	2,075	2,191	2,262	2,300	2,288	2,309
27. Telecommunications (61)	537	489	448	404	361	320	280	250
28. Information service activities (except ICT industries) (63, exc. 631)	105	99	94	89	82	76	70	65
29. Legal and accounting; management consultancy; ; technical testing and analysis and architectural and engineering activities (69-71)	8,185	8,275	8,387	8,332	8,173	7,958	7,624	7,446
30. Scientific research and development (72)	14,537	15,204	15,855	16,141	16,172	16,040	15,619	15,476
31. Advertising and market research; other professional, scientific and technical activities and Veterinary activities (73-75)	101	164	220	266	301	329	346	364
32. Administrative and support service activities (77-82)	0	0	0	0	2	247	448	624
33. Public administration and defence; compulsory social security (84)	9,328	9,109	8,947	8,641	8,261	7,857	7,367	7,054
34. Education (85)	22,329	25,186	27,826	29,650	30,827	31,527	31,504	31,910
35. Human health and social work (86-88)	5,167	5,965	6,699	7,225	7,582	7,812	7,854	7,995
36. Arts, entertainment and recreation (90-93)	237	264	288	304	314	320	318	321
37. Activities of membership organisations (94)	271	279	287	289	286	282	272	268
TOTAL	80,881	85,428	89,813	92,048	92,748	92,682	90,835	90,506

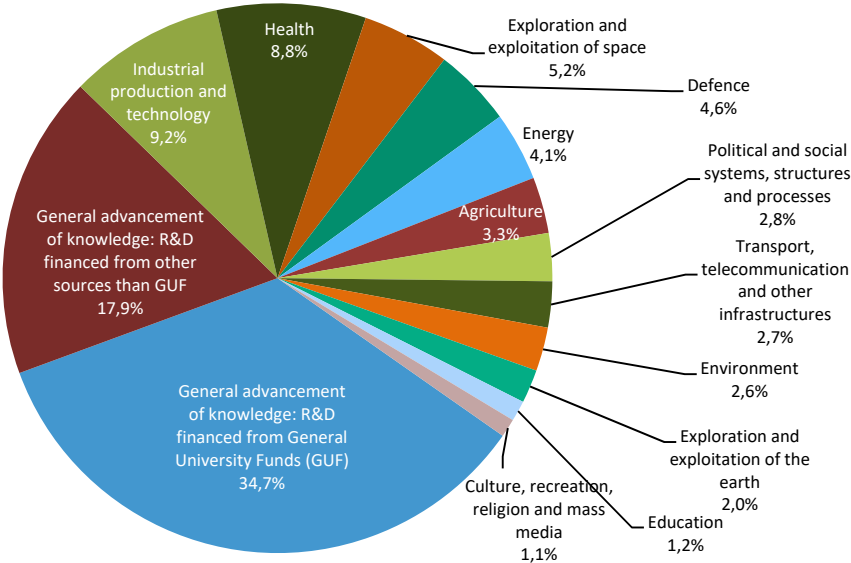
Source: Eurostat and the authors.

Table 6. Percentage structure of GBARD by NACE Rev. 2 industries in the EU. 2006-2013. Percentage

NACE Rev. 2 industries	2006	2007	2008	2009	2010	2011	2012	2013
1. Agriculture, forestry and fishing (01-03)	1.80	1.70	1.62	1.55	1.49	1.44	1.39	1.35
2. Mining and quarrying (05-09)	0.68	0.76	0.82	0.87	0.91	0.95	0.98	1.00
3. Manufacture of food products, beverages and tobacco products (10-12)	0.79	0.78	0.77	0.76	0.75	0.74	0.73	0.72
4. Manufacture of textiles, apparel, leather and related products (13-15)	0.16	0.17	0.17	0.18	0.18	0.18	0.19	0.19
5. Manufacture of wood and paper products, and printing (16-18)	0.38	0.39	0.39	0.39	0.39	0.39	0.39	0.39
6. Manufacture of coke, and refined petroleum products (19)	0.00	0.04	0.07	0.10	0.13	0.15	0.16	0.18
7. Manufacture of chemicals and chemical products (20)	1.49	1.37	1.28	1.20	1.13	1.08	1.03	0.98
8. Manufacture of pharmaceuticals, medicinal chemical and botanical products (21)	0.62	0.62	0.61	0.61	0.61	0.60	0.60	0.60
9. Manufacture of rubber and plastics products, and other non-metallic mineral products (22-23)	0.56	0.56	0.56	0.56	0.55	0.55	0.55	0.55
10. Manufacture of basic metals and fabricated metal products, except machinery and equipment (24-25)	1.32	1.21	1.12	1.04	0.98	0.92	0.88	0.84
11. Manufacture of computer, electronic and optical products (except ICT industries) (26, exc. 261-264 and 268)	0.42	0.41	0.40	0.39	0.38	0.38	0.37	0.37
12. Manufacture of electronic components and boards (261)	0.19	0.20	0.21	0.22	0.23	0.23	0.24	0.24
13. Manufacture of computers and peripheral equipment (262)	0.00	0.02	0.05	0.07	0.09	0.10	0.12	0.13
14. Manufacture of communication equipment (263)	0.20	0.19	0.19	0.18	0.18	0.18	0.18	0.17
15. Manufacture of consumer electronics (264)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
16. Manufacture of magnetic and optical media (268)	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
17. Manufacture of electrical equipment (27)	0.41	0.43	0.44	0.44	0.45	0.46	0.46	0.46
18. Manufacture of machinery and equipment n.e.c. (28)	1.79	1.78	1.78	1.78	1.78	1.77	1.77	1.76
19. Manufacture of transport equipment (29-30)	1.71	1.49	1.32	1.18	1.06	0.96	0.88	0.80
20. Other manufacturing, and repair and installation of machinery and equipment (31-33)	0.81	0.75	0.70	0.67	0.63	0.60	0.58	0.56
21. Electricity, gas, steam and air-conditioning supply (35)	3.01	3.01	3.00	3.00	3.00	2.99	2.98	2.98
22. Water supply, sewerage, waste management and remediation (36-39)	1.79	1.66	1.56	1.48	1.41	1.35	1.30	1.25
23. Construction (41-43)	1.84	1.61	1.42	1.27	1.15	1.04	0.94	0.86
24. Transportation and storage (49-53)	2.26	2.03	1.86	1.71	1.58	1.48	1.38	1.30
25. Publishing, audiovisual and broadcasting activities (except ICT industries) (58-60, exc. 582)	0.44	0.44	0.43	0.43	0.42	0.42	0.42	0.41
26. ICT computer and related activities (5820, 62, 631 and 951)	2.12	2.22	2.31	2.38	2.44	2.48	2.52	2.55
27. Telecommunications (61)	0.66	0.57	0.50	0.44	0.39	0.35	0.31	0.28
28. Information service activities (except ICT industries) (63, exc. 631)	0.13	0.12	0.11	0.10	0.09	0.08	0.08	0.07
29. Legal and accounting; management consultancy; ; technical testing and analysis and architectural and engineering activities (69-71)	10.12	9.69	9.34	9.05	8.81	8.59	8.39	8.23
30. Scientific research and development (72)	17.97	17.80	17.65	17.54	17.44	17.31	17.19	17.10
31. Advertising and market research; other professional, scientific and technical activities and Veterinary activities (73-75)	0.13	0.19	0.24	0.29	0.33	0.35	0.38	0.40
32. Administrative and support service activities (77-82)	0.00	0.00	0.00	0.00	0.00	0.27	0.49	0.69
33. Public administration and defence; compulsory social security (84)	11.53	10.66	9.96	9.39	8.91	8.48	8.11	7.79
34. Education (85)	27.61	29.48	30.98	32.21	33.24	34.02	34.68	35.26
35. Human health and social work (86-88)	6.39	6.98	7.46	7.85	8.18	8.43	8.65	8.83
36. Arts, entertainment and recreation (90-93)	0.29	0.31	0.32	0.33	0.34	0.34	0.35	0.35
37. Activities of membership organisations (94)	0.33	0.33	0.32	0.31	0.31	0.30	0.30	0.30
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: Eurostat and the authors.

Figure 7. Distribution of GBARD by NABS chapters in the EU. 2013. Percentage



Source: Eurostat

Table 7 shows the percentage distribution of GBARD across industries for the largest countries in the EU (France, Germany, Italy, Spain and the United Kingdom) and for three other relevant R&D players in the EU, namely Finland, Netherlands and Sweden. Figure 8 shows the ranking of all EU countries in Education (NACE 85) in terms of the share of this industry in total GBARD. Figures 9-12 report the same information but for Scientific research and development (NACE 72); Health and social services (NACE 86-87); Legal, accounting, management consulting, architectural and engineering activities (NACE 69-71) and for Public Administration. Overall the picture is similar in all industries. There is large variation across countries; for example, apart from Malta which showed a disproportionate percentage (93.3%), the share of Education in total GBARD ranges from values higher than 50% in Austria (59.0%), Croatia (54.9%), Lithuania (54.7%), Netherlands (51.5%) and Sweden (50.2%); while others were well below 10%, such as Poland (6.9%), Romania (6.5%), Estonia (3.4%), Latvia (2.6%) and Slovenia (1.4%). In terms of the percentage devoted to the public support of R&D, the large countries were not homogeneous in their share of the NACE education in total GBARD. Netherlands (51.5%), Sweden (50.2%), Italy (40.6%) and Germany (39.7%) showed high values in comparison with Finland (27.8%), France (27.8%) and Spain (30.7%), which were closer to the EU average.

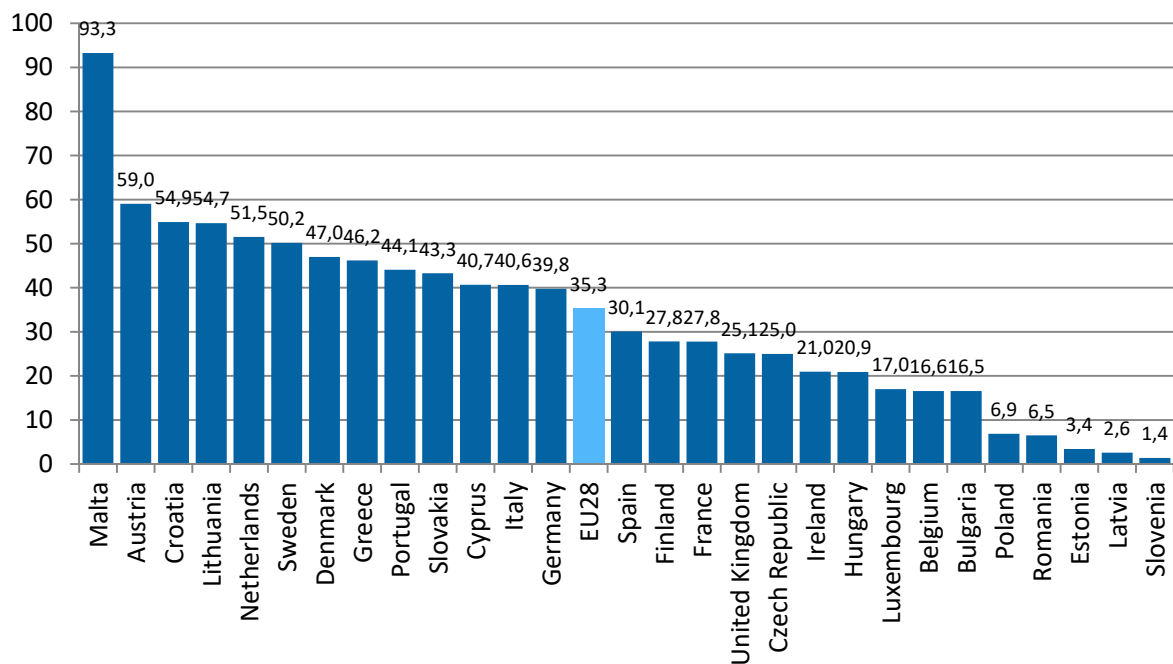
The same picture of dispersion arises in the case of the other large industries in terms of the aggregated GBARD (health scientific research; legal, accounting, consulting, etc; and public administration). For example, in all these industries the country placed in percentile 75 (7th country with the highest value) has an industry share in total GBARD that is more than twice of that of percentile 25 (country in position 22 out of 28). Therefore, the dispersion of the distribution across countries of the public R&D funding is high, showing great differences among countries.

Table 7. Percentage structure of GBARD by NACE Rev. 2 industries in the EU and the largest R&D players. 2006-2013. Percentage

NACE Rev. 2 industries	EU28	Finland	France	Germany	Italy	Netherlands	Spain	Sweden
1. Agriculture, forestry and fishing (01-03)	1.35	2.65	0.97	1.58	1.63	0.96	3.74	0.67
2. Mining and quarrying (05-09)	1.00	0.50	0.28	0.73	1.97	0.25	0.40	0.26
3. Manufacture of food products, beverages and tobacco products (10-12)	0.72	0.91	0.21	0.67	1.06	0.93	1.04	0.08
4. Manufacture of textiles, apparel, leather and related products (13-15)	0.19	0.12	0.07	0.19	0.67	0.04	0.20	0.01
5. Manufacture of wood and paper products, and printing (16-18)	0.39	1.49	0.10	0.44	0.43	0.25	0.38	0.13
6. Manufacture of coke, and refined petroleum products (19)	0.18	0.19	0.03	0.06	0.15	0.18	0.26	0.00
7. Manufacture of chemicals and chemical products (20)	0.98	0.83	0.65	1.46	0.89	1.13	1.20	0.22
8. Manufacture of pharmaceuticals, medicinal chemical and botanical products (21)	0.60	0.11	0.64	0.34	0.56	0.15	0.73	0.01
9. Manufacture of rubber and plastics products, and other non-metallic mineral products (22-23)	0.55	0.75	0.16	0.76	0.80	0.27	0.68	0.06
10. Manufacture of basic metals and fabricated metal products, except machinery and equipment (24-25)	0.84	1.45	0.30	1.30	1.04	0.58	0.82	0.42
11. Manufacture of computer, electronic and optical products (except ICT industries) (26, exc. 261-264 and 268)	0.37	0.65	0.13	0.43	0.31	0.28	0.08	0.08
12. Manufacture of electronic components and boards (261)	0.24	0.07	0.04	0.51	0.45	0.15	0.10	0.02
13. Manufacture of computers and peripheral equipment (262)	0.13	0.14	0.04	0.14	0.15	0.00	0.04	0.01
14. Manufacture of communication equipment (263)	0.17	1.98	0.01	0.37	0.15	0.05	0.03	0.00
15. Manufacture of consumer electronics (264)	0.04	0.06	0.00	0.06	0.06	0.36	0.05	0.00
16. Manufacture of magnetic and optical media (268)	0.01	0.00	0.00	0.04	0.04	0.00	0.00	0.00
17. Manufacture of electrical equipment (27)	0.46	0.78	0.12	0.89	0.79	0.22	0.34	0.08
18. Manufacture of machinery and equipment n.e.c. (28)	1.76	3.65	0.64	3.76	3.05	1.28	1.18	0.48
19. Manufacture of transport equipment (29-30)	0.80	0.26	1.70	0.83	0.63	0.25	0.80	1.07
20. Other manufacturing, and repair and installation of machinery and equipment (31-33)	0.56	0.59	0.43	0.67	0.64	0.65	0.53	0.14
21. Electricity, gas, steam and air-conditioning supply (35)	2.98	4.94	5.56	4.00	2.99	1.40	2.37	2.34
22. Water supply, sewerage, waste management and remediation (36-39)	1.25	0.39	1.13	1.53	2.36	0.40	2.31	0.60
23. Construction (41-43)	0.86	0.76	2.04	0.42	0.35	0.87	1.16	1.33
24. Transportation and storage (49-53)	1.30	0.34	2.62	0.41	0.70	1.59	1.06	1.43
25. Publishing, audiovisual and broadcasting activities (except ICT industries) (58-60, exc. 582)	0.41	0.07	0.00	0.37	0.60	0.18	0.35	0.03
26. ICT computer and related activities (5820, 62, 631 and 951)	2.55	4.98	0.67	2.18	3.01	3.11	2.39	1.16
27. Telecommunications (61)	0.28	0.22	0.54	0.05	0.32	0.37	0.61	0.39
28. Information service activities (except ICT industries) (63, exc. 631)	0.07	0.08	0.01	0.17	0.07	0.01	0.05	0.01
29. Legal and accounting; management consultancy; ; technical testing and analysis and architectural and engineering activities (69-71)	8.23	11.93	15.53	8.06	12.31	4.99	8.52	7.14
30. Scientific research and development (72)	17.10	19.13	16.56	16.64	1.96	17.46	22.04	21.78
31. Advertising and market research; other professional, scientific and technical activities and Veterinary activities (73-75)	0.40	0.38	0.10	0.29	0.56	0.34	0.59	0.22
32. Administrative and support service activities (77-82)	0.69	0.17	0.11	0.04	0.17	0.42	0.07	0.07
33. Public administration and defence; compulsory social security (84)	7.79	5.42	12.01	5.26	7.06	3.74	2.25	7.63
34. Education (85)	35.26	27.82	27.79	39.77	40.63	51.54	30.07	50.18
35. Human health and social work (86-88)	8.83	5.90	8.79	4.82	10.46	5.26	13.21	1.81
36. Arts, entertainment and recreation (90-93)	0.35	0.13	0.00	0.34	0.48	0.17	0.29	0.07
37. Activities of membership organisations (94)	0.30	0.14	0.00	0.42	0.49	0.16	0.08	0.06
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

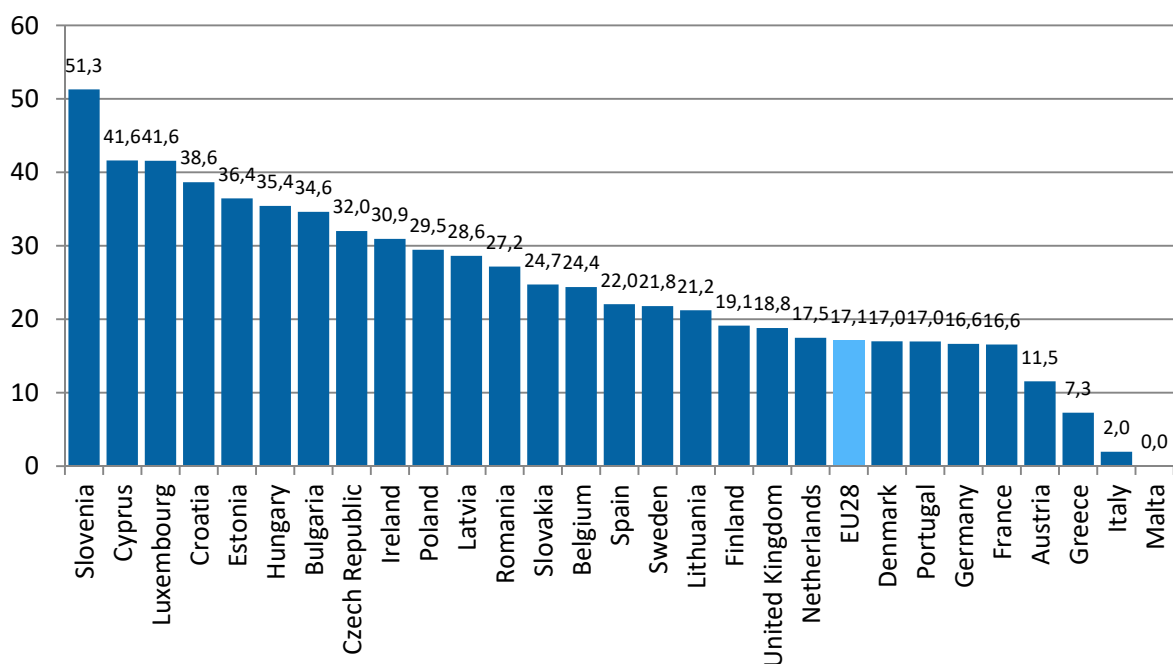
Source: Eurostat and the authors.

Figure 8. Education sector (NACE 85) share in GBARD. EU and Member States (2013).
Percentage



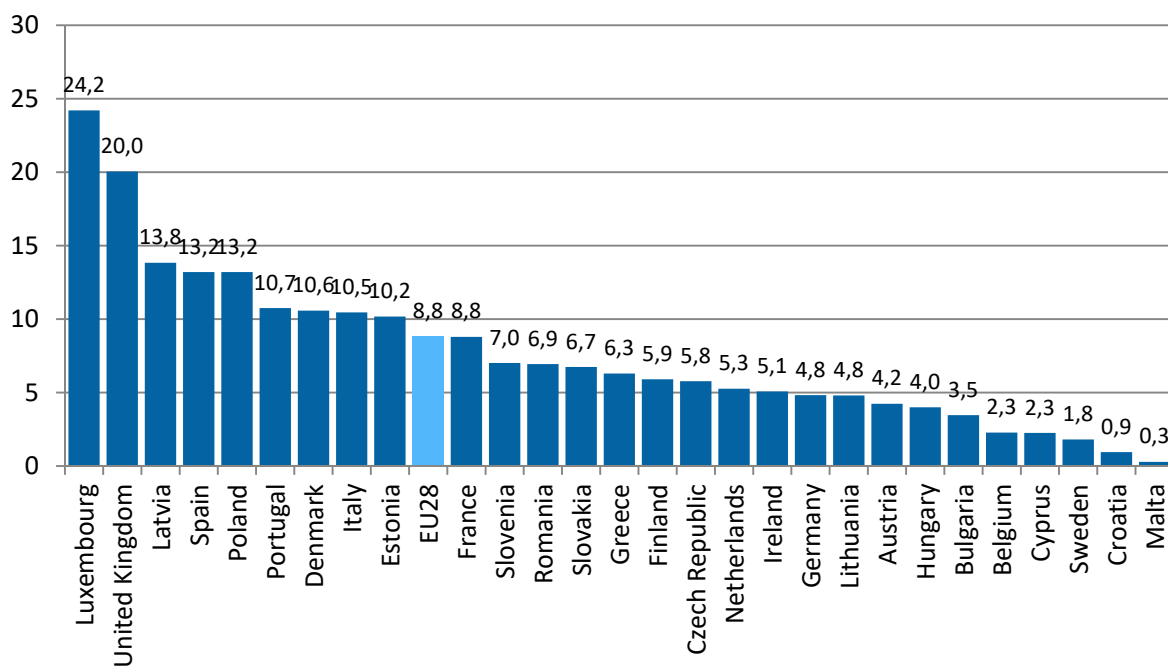
Source: Eurostat and the authors.

Figure 9. Scientific research and development sector (NACE 72) share in GBARD. EU and Member States (2013). Percentage



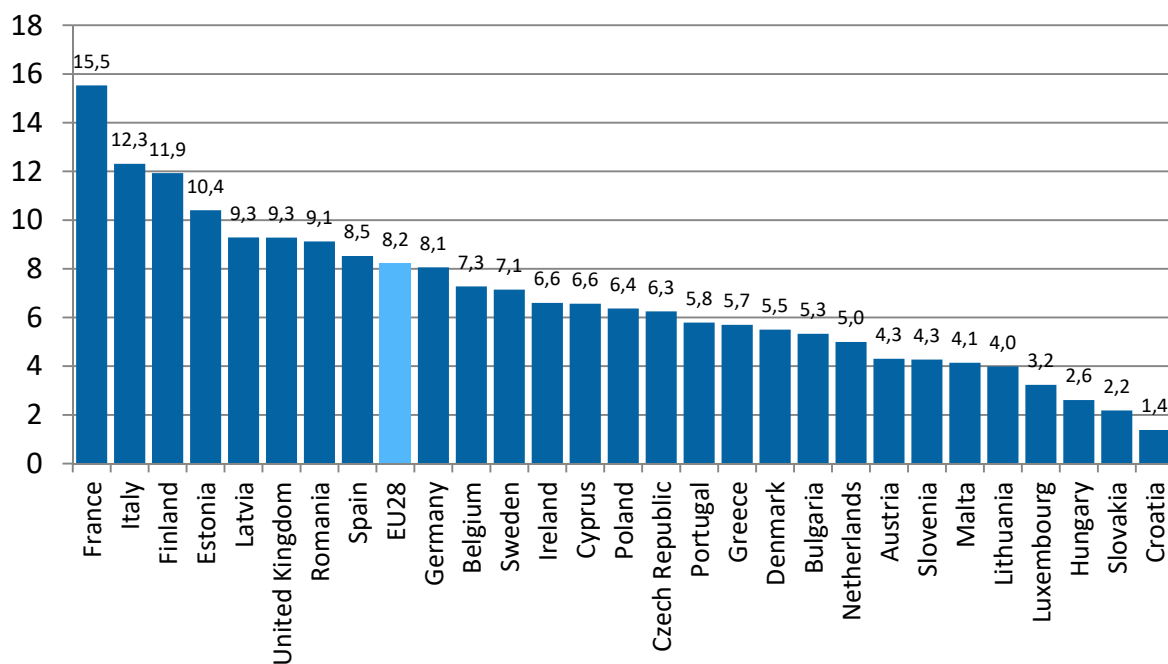
Source: Eurostat and the authors.

Figure 10. Human health and social services sector (NACE 86-87) share in GBARD. EU and Member States (2013). Percentage



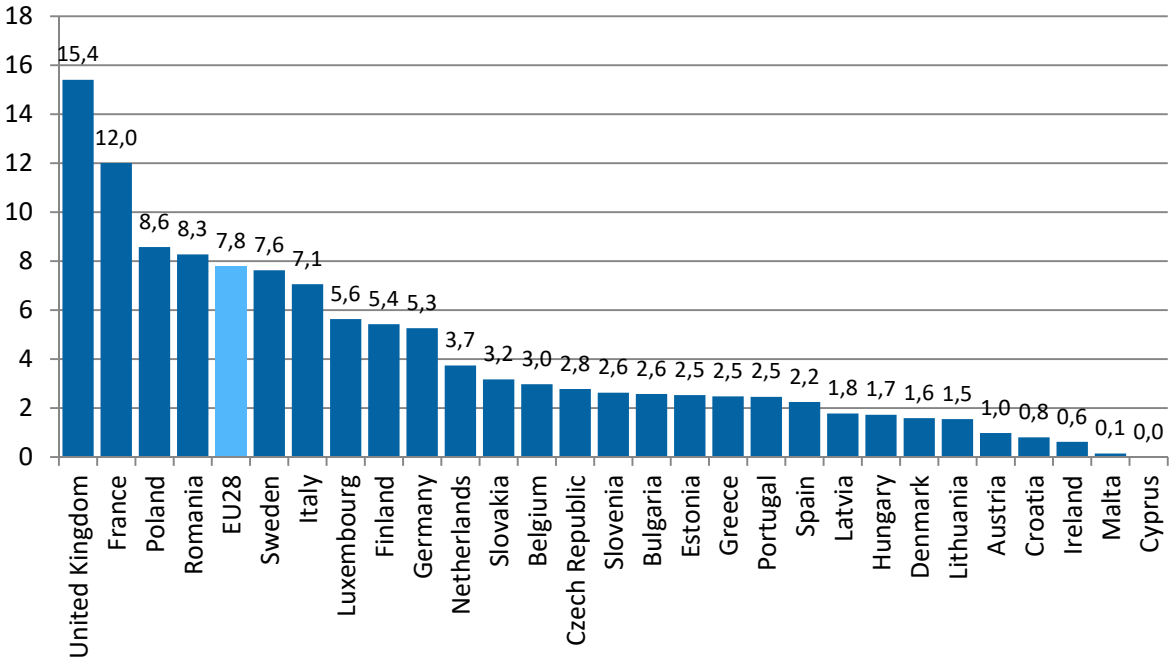
Source: Eurostat and the authors.

Figure 11. Legal and accounting, management consultancy, technical testing and analysis and architectural and engineering activities (NACE 69-71) share in GBARD. EU and Member States (2013). Percentage



Source: Eurostat and the authors.

Figure 12. Public Administration sector (NACE 84) share in GBARD. EU and Member States (2013). Percentage



Source: Eurostat and the authors.

The second objective of the methodology developed is to disentangle the part of the public funding devoted to ICT assets. Our methodology allows this calculation to be made, assuming that the greater the share of labour costs for people with higher education doing ICT-related activities, the greater the investment in ICT assets. Table 8 shows raw values resulting from the methodology. ICT GBARD in 2013 was 4,194 million euros in the EU, which represented 4.6% of total GBARD. This share remained stable throughout the period, as in 2006 the percentage was 4.5%. The largest share across industries (Table 9 and Figure 13) corresponded to the ICT industries. In the Computer and related activities industries public R&D funding was largely devoted to ICT assets (64%). In Computers and peripheral equipment (40%), Communications equipment (32%), Telecommunications (24%), and in Information service activities (24%) the share was also high. That is, the ICT industry concentrates the first positions of the ranking of industries according to their use of public funding of R&D to finance the acquisition of ICT assets.

As with total GBARD, the variation among countries is also a key characteristic in the case of ICT GBARD. Belgium devoted the highest proportion of its R&D funds to acquiring ICT assets with a percentage of 10%, followed by Slovenia (8.6%), Finland (7.7%), Ireland (7.1%) and Sweden (7%). At the other end of the scale, five countries fell below 2%: Lithuania (1.5%), Portugal (1.4%), Cyprus (0.7%), Malta (0.4%) and Croatia (0.3%). The shares of the largest countries in the European Union were Spain (5.1%), Italy (4.8%), United Kingdom (4.7%), France (3.4%) and Germany (3.2%).

Table 8. ICT GBARD by NACE Rev. 2 industries in the EU. 2006-2013. Millions of euros

NACE Rev. 2 industries	2006	2007	2008	2009	2010	2011	2012	2013
1. Agriculture, forestry and fishing (01-03)	1	1	1	1	1	1	1	1
2. Mining and quarrying (05-09)	3	4	5	6	7	8	9	10
3. Manufacture of food products, beverages and tobacco products (10-12)	9	9	10	10	10	10	10	10
4. Manufacture of textiles, apparel, leather and related products (13-15)	0	1	1	2	2	2	3	3
5. Manufacture of wood and paper products, and printing (16-18)	8	9	9	9	9	9	9	8
6. Manufacture of coke, and refined petroleum products (19)	0	0	1	1	2	2	2	3
7. Manufacture of chemicals and chemical products (20)	20	21	22	22	22	22	22	22
8. Manufacture of pharmaceuticals, medicinal chemical and botanical products (21)	13	13	14	14	14	14	14	14
9. Manufacture of rubber and plastics products, and other non-metallic mineral products (22-23)	4	4	5	5	5	5	5	5
10. Manufacture of basic metals and fabricated metal products, except machinery and equipment (24-25)	18	17	17	16	14	13	12	11
11. Manufacture of computer, electronic and optical products (except ICT industries) (26, exc. 261-264 and 268)	28	32	35	38	40	42	43	45
12. Manufacture of electronic components and boards (261)	14	16	17	18	19	19	19	19
13. Manufacture of computers and peripheral equipment (262)	0	5	15	23	31	37	42	46
14. Manufacture of communication equipment (263)	26	31	35	39	43	46	48	51
15. Manufacture of consumer electronics (264)	4	4	4	4	4	4	4	4
16. Manufacture of magnetic and optical media (268)	0	0	0	0	0	1	1	1
17. Manufacture of electrical equipment (27)	13	14	15	16	16	16	16	16
18. Manufacture of machinery and equipment n.e.c. (28)	43	47	51	54	57	58	59	60
19. Manufacture of transport equipment (29-30)	67	64	61	58	54	50	46	43
20. Other manufacturing, and repair and installation of machinery and equipment (31-33)	13	16	19	21	24	25	26	28
21. Electricity, gas, steam and air-conditioning supply (35)	109	117	124	128	131	132	130	131
22. Water supply, sewerage, waste management and remediation (36-39)	27	23	19	15	12	8	5	2
23. Construction (41-43)	17	17	17	16	15	15	14	13
24. Transportation and storage (49-53)	94	80	68	55	44	33	23	15
25. Publishing, audiovisual and broadcasting activities (except ICT industries) (58-60, exc. 582)	13	17	20	24	27	30	32	34
26. ICT computer and related activities (5820, 62, 631 and 951)	1,071	1,192	1,306	1,383	1,432	1,461	1,457	1,474
27. Telecommunications (61)	108	102	97	90	83	76	69	63
28. Information service activities (except ICT industries) (63, exc. 631)	6	8	10	12	13	14	15	15
29. Legal and accounting; management consultancy; ; technical testing and analysis and architectural and engineering activities (69-71)	416	419	423	418	408	395	377	367
30. Scientific research and development (72)	817	860	903	925	933	931	913	910
31. Advertising and market research; other professional, scientific and technical activities and Veterinary activities (73-75)	1	1	1	1	1	1	0	0
32. Administrative and support service activities (77-82)	0	0	0	0	0	6	10	11
33. Public administration and defence; compulsory social security (84)	249	250	252	249	244	237	227	223
34. Education (85)	361	403	442	467	481	487	483	485
35. Human health and social work (86-88)	22	26	31	34	37	40	41	44
36. Arts, entertainment and recreation (90-93)	4	4	4	4	4	4	3	3
37. Activities of membership organisations (94)	2	3	3	3	3	3	3	4
TOTAL	3,601	3,829	4,054	4,183	4,241	4,259	4,192	4,194

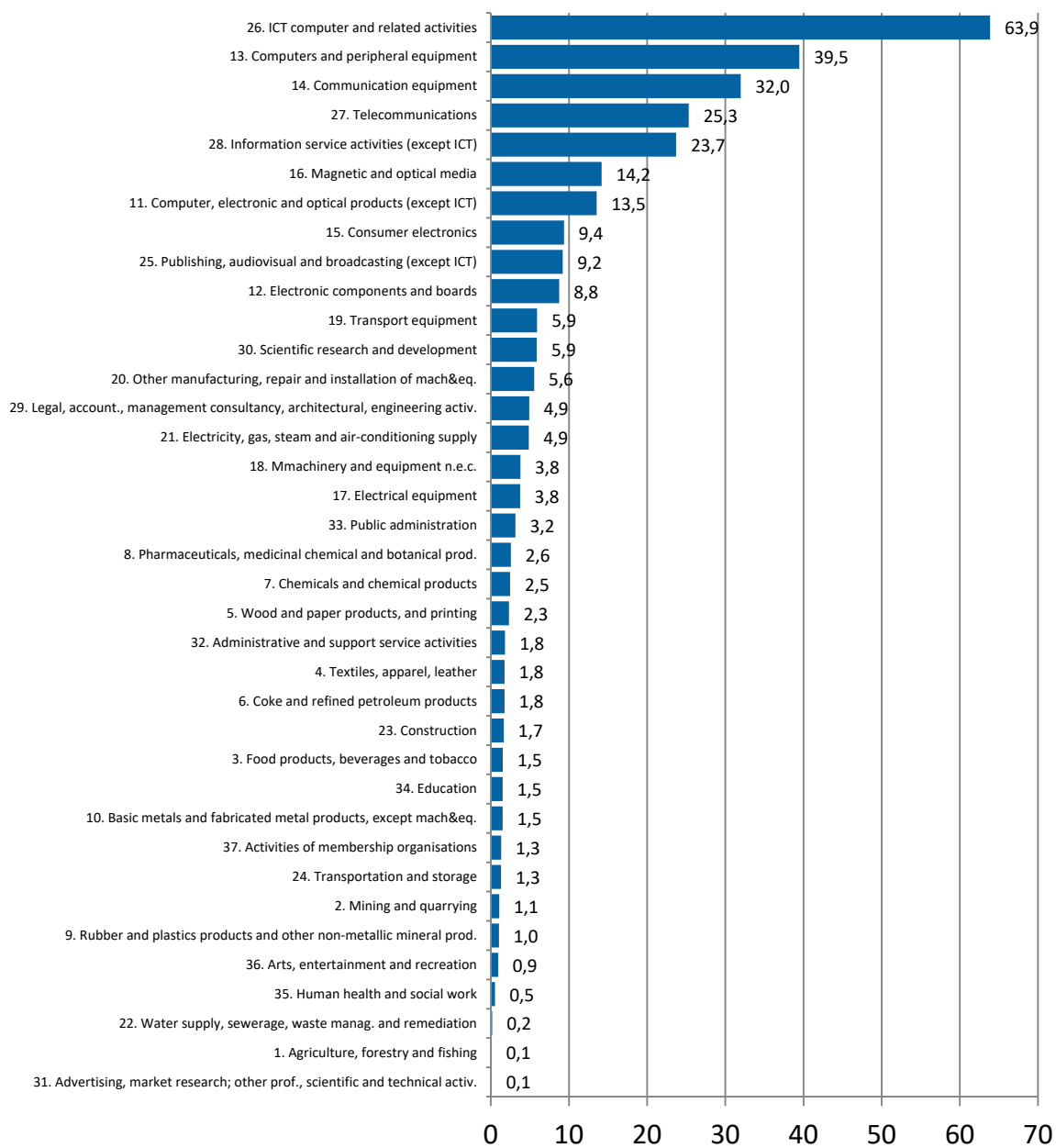
Source: Eurostat and the authors.

Table 9. Percentage structure of ICT GBARD by NACE Rev. 2 industries in the EU. 2006-2013. Percentage

NACE Rev. 2 industries	2006	2007	2008	2009	2010	2011	2012	2013
1. Agriculture, forestry and fishing (01-03)	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03
2. Mining and quarrying (05-09)	0.08	0.10	0.12	0.14	0.17	0.19	0.21	0.23
3. Manufacture of food products, beverages and tobacco products (10-12)	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
4. Manufacture of textiles, apparel, leather and related products (13-15)	0.01	0.02	0.03	0.04	0.05	0.05	0.06	0.07
5. Manufacture of wood and paper products, and printing (16-18)	0.23	0.23	0.22	0.22	0.21	0.21	0.20	0.20
6. Manufacture of coke, and refined petroleum products (19)	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07
7. Manufacture of chemicals and chemical products (20)	0.56	0.55	0.54	0.53	0.53	0.53	0.53	0.53
8. Manufacture of pharmaceuticals, medicinal chemical and botanical products (21)	0.35	0.35	0.35	0.34	0.34	0.34	0.33	0.33
9. Manufacture of rubber and plastics products, and other non-metallic mineral products (22-23)	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.12
10. Manufacture of basic metals and fabricated metal products, except machinery and equipment (24-25)	0.50	0.45	0.41	0.37	0.34	0.31	0.29	0.27
11. Manufacture of computer, electronic and optical products (except ICT industries) (26, exc. 261-264 and 268)	0.78	0.82	0.86	0.91	0.95	0.99	1.03	1.07
12. Manufacture of electronic components and boards (261)	0.38	0.41	0.42	0.43	0.44	0.45	0.45	0.45
13. Manufacture of computers and peripheral equipment (262)	0.00	0.14	0.37	0.56	0.72	0.87	0.99	1.11
14. Manufacture of communication equipment (263)	0.73	0.80	0.87	0.94	1.01	1.07	1.14	1.20
15. Manufacture of consumer electronics (264)	0.10	0.10	0.10	0.10	0.10	0.10	0.09	0.09
16. Manufacture of magnetic and optical media (268)	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02
17. Manufacture of electrical equipment (27)	0.36	0.37	0.37	0.37	0.38	0.38	0.38	0.38
18. Manufacture of machinery and equipment n.e.c. (28)	1.19	1.23	1.26	1.30	1.34	1.37	1.40	1.44
19. Manufacture of transport equipment (29-30)	1.86	1.67	1.51	1.38	1.27	1.17	1.09	1.02
20. Other manufacturing, and repair and installation of machinery and equipment (31-33)	0.36	0.41	0.47	0.51	0.55	0.59	0.63	0.67
21. Electricity, gas, steam and air-conditioning supply (35)	3.04	3.05	3.06	3.07	3.08	3.09	3.11	3.12
22. Water supply, sewerage, waste management and remediation (36-39)	0.74	0.60	0.47	0.37	0.27	0.19	0.12	0.05
23. Construction (41-43)	0.47	0.44	0.41	0.38	0.36	0.34	0.32	0.31
24. Transportation and storage (49-53)	2.62	2.10	1.67	1.32	1.03	0.77	0.56	0.37
25. Publishing, audiovisual and broadcasting activities (except ICT industries) (58-60, exc. 582)	0.36	0.43	0.50	0.56	0.63	0.69	0.76	0.82
26. ICT computer and related activities (5820, 62, 631 and 951)	29.75	31.14	32.21	33.06	33.76	34.30	34.75	35.15
27. Telecommunications (61)	2.99	2.66	2.39	2.16	1.96	1.79	1.64	1.51
28. Information service activities (except ICT industries) (63, exc. 631)	0.17	0.22	0.26	0.29	0.31	0.33	0.35	0.37
29. Legal and accounting; management consultancy; ; technical testing and analysis and architectural and engineering activities (69-71)	11.56	10.94	10.42	9.99	9.62	9.28	8.99	8.74
30. Scientific research and development (72)	22.68	22.46	22.27	22.12	22.00	21.87	21.77	21.70
31. Advertising and market research; other professional, scientific and technical activities and Veterinary activities (73-75)	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01
32. Administrative and support service activities (77-82)	0.00	0.00	0.00	0.00	0.00	0.14	0.23	0.27
33. Public administration and defence; compulsory social security (84)	6.93	6.53	6.21	5.95	5.75	5.57	5.43	5.31
34. Education (85)	10.01	10.53	10.89	11.15	11.34	11.45	11.52	11.55
35. Human health and social work (86-88)	0.61	0.68	0.76	0.82	0.88	0.94	0.99	1.04
36. Arts, entertainment and recreation (90-93)	0.10	0.10	0.10	0.10	0.09	0.08	0.08	0.07
37. Activities of membership organisations (94)	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.09
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

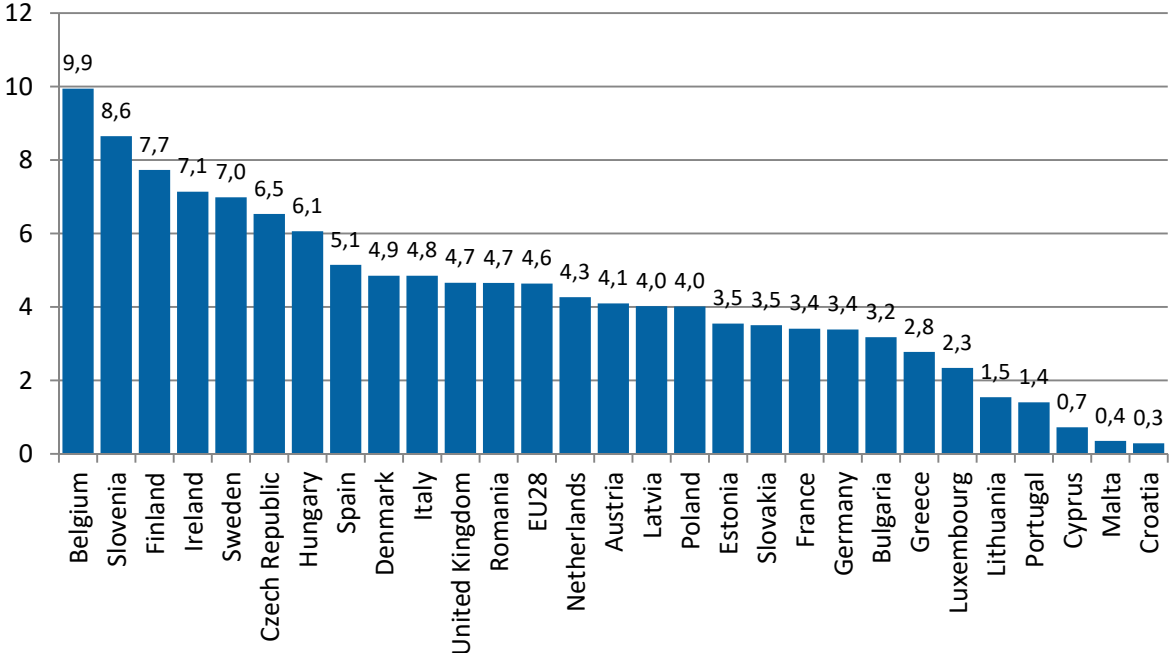
Source: Eurostat and the authors.

Figure 13. ICT GBARD / Total GBARD by NACE industries. 2013. Percentage



Source: Eurostat and the authors.

Figure 14. ICT GBARD / Total GBARD by EU country. 2013. Percentage



Source: Eurostat and the authors.

4. CONCLUSIONS

This paper proposes a methodology to estimate R&D public sector transfers by NACE industries and to identify which part corresponds to ICT assets. The methodology is based on GBARD data, which account for the sums governments commit to fund other industries' R&D. The methodology closely follows Stančík (2012) and Stančík and Rohman (2014).

Our methodology consists of the following steps. First, we use the correspondence between the NACE classification (Rev 1.1 and Rev 2) and the NABS-2007 chapters at the three-digit level proposed by Stančík (2012). Once the correspondence is defined, the second step consists of constructing weights to assign official GBARD by NABS to each NACE industry. The weights are based on the assumption that R&D intensity in each industry is related to the share of labour costs of employees with higher education (ISCED codes 5a, 5b and 6) of total labour costs. Finally, to compute the part of R&D expenditure devoted to ICT assets in each NACE industry, it is assumed that the proportion of R&D investment in ICT assets is equal to the share of labour costs of employees with higher education performing ICT occupations (based on ISCO-07 and ISCO-88 codes) over total labour costs. To calculate the shares, we use tailor-made information on employee hours worked by 3-digit industries and by occupational attainment from Eurostat's Labour Force Survey and on average earnings of employees with higher education and occupations from the Structure of Earnings Survey. The methodology is applied to the European Union and the Member States from 2006 to 2013. The database comprises 37 NACE Rev. 2 industries, including 7 ICT industries.

Results show that R&D transfers are concentrated in a small number of industries. Only 5 industries account for 77% of total GBARD (Education; Scientific Research and development; Health; Public Administration, including defence; and Legal, accounting, technical testing and analysis, architectural and engineering activities). As expected, ICT GBARD intensive industries (in terms of the percentage of total GBARD) are the ICT sectors. There are considerable differences across countries in term of the industry structure of GBARD and of ICT GBARD.

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