ICT Research and Innovation Trends in EEMS (as seen in the Reports on ICT R&D in the EU)*

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Abstract

The IPTS has been publishing data on ICT R&D on an annual basis since 2005 and its latest report of 2011 indicates the weakness of the ICT industry and its R&D in several Eastern European Member States (EEMS). Our macro and microeconomic analyses show that EEMS ICT shares in EU ICT totals are systematically below the EEMS economic weight. Particularly, the EEMS are lagging behind the rest of the EU in BERD, GBAORD, among top R&D investors, R&D intensity, and patents (all related to ICT). What is, on the other hand, optimistic is the fact that the share of the EEMS in EU ICT production has been steadily increasing and that the growth of ICT BERD in the EEMS is much bigger than in the EU15. Moreover, the share of EEMS ICT companies in the top EU ICT R&D has doubled since 2004.

Keywords: productivity, R&D, innovation, patents
JEL classification: D22, E2, L2, O3

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1 Introduction & Motivation

This paper summarizes and highlights the main findings from the 2010 and 2011 reports on ICT R&D in the EU (see Turlea et al., 2010 and 2011) related to the Eastern European Member States (EEMS). For the purpose of this study the group of the EEMS comprises Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. These reports provide an analysis of EU R&D investments in the Information and Communication Technology industry sector (ICT sector[1]).The research and analysis on these reports was carried out by the Information Society Unit at JRC-IPTS in the context of PREDICT[2], a research project co-financed by IPTS and the Information Society & Media Directorate General of the European Commission. These reports combine in a unique way three complementary perspectives: national statistics, company data, and technology-based indicators such as patent data.

The paper is organized as follows. It starts with a description of ICT R&D in the EEMS from a macroeconomic perspective. Next section then provides a microeconomic perspective. Section 4 focuses on performance of ICT R&D in the EEMS. The last section concludes and raises several open questions.

[1]The ICT sector, as defined in this paper, includes all firms, whose principal activity is in the following NACE rev.1.1. classes:

- NACE 30 (IT Equipment): computers, printers, scanners, photocopiers
- NACE 32 (Components, Telecom and Multimedia Equipment): semiconductors, printed circuits, LCDs, TV tubes, diodes, TV, VCR, cameras, cassette players, CD and DVD players, telephones, faxes, switches, routers, TV and radio emitters
- NACE 33 (Measurement Instruments): measurement instruments (sensors, readers), industrial process control equipment.
- NACE 642 (Telecommunication services) or NACE 64 (including both post and telecom services, due to data availability, particularly for international comparisons)
- NACE 72 (Computer Services and Software): hardware consultancy, software consultancy and supply, database activities, Internet, maintenance and repair.

[2]Prospective insights on R&D in ICT

2 Macroeconomic Perspective

This section compares the Eastern European Member States by their contribution to the EU total figures in three indicators - Value Added, BERD, and GBAORD. The analysis is based on Eurostat data.

Figure 1 plots the distribution of EU ICT value added by Member State, in PPP. Four countries - Germany, the UK, France and Italy – cover two thirds of EU total ICT production.[3] European countries traditionally known for their ICT specialisation, such as Finland, Ireland, Hungary, Malta and Sweden, produce less than 7% of the total European ICT value added. The share of the EEMS in total EU ICT value added (10.97%) is almost on a par with the share of their GDP in EU GDP (12%), which suggests that, at the level of the ICT sector as a whole, the level of specialisation of these countries is similar to those of the EU15 countries.[4] On the other hand, the share of the EEMS in the EU population is about twice as big (20%). The group of the EEMS is led by Poland (3.25%) which is then followed by the Czech Republic, Romania, and Hungary (all between 1.7-2.0%).

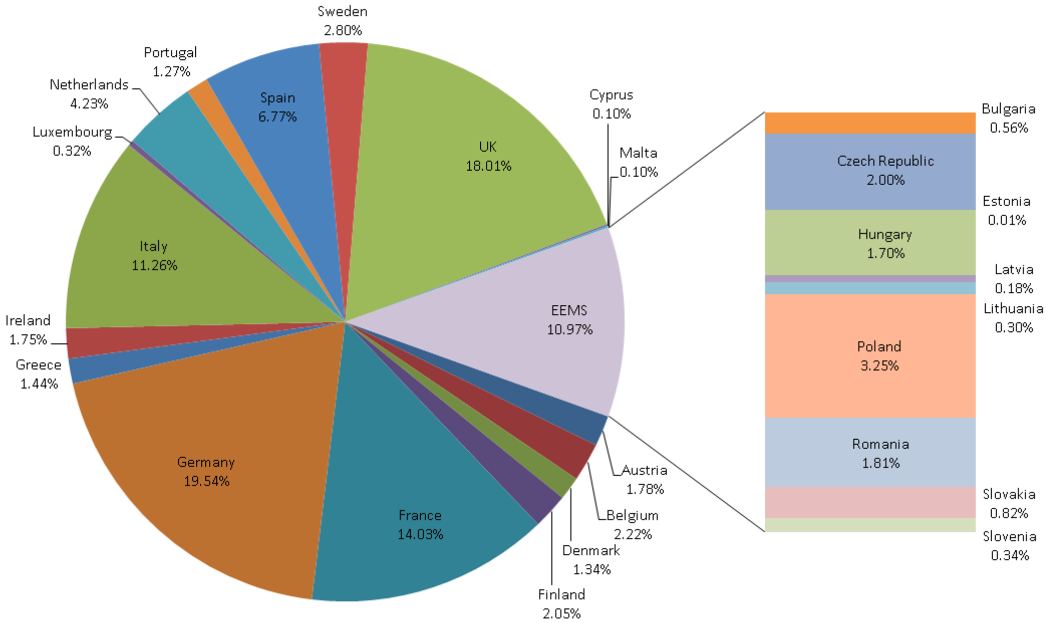
Regarding ICT sector BERD, the EU is heavily dominated by some of the largest economies, i.e. Germany, France and the UK (which together cover more than half of the total EU ICT BERD), followed by Sweden, Finland and Italy. When compared with the 2004-2005 period, the results for 2006-2007 show changes in national shares in ICT BERD than can be less attributed to price convergence than before. The shares in the EU of the three biggest investors taken together slightly increased between 2005 and 2007 (by 1%) but this is almost entirely due to a surge in R&D investment in the UK Telecom sector. In fact, both France and Germany decreased in share, but this was due to faster growth in the rest of the EU, compared with their steady, but moderate, growth in the R&D of their

[3]Data expressed in PPP terms (for comparability) may lead to different results from those obtained using nominal values.

[4]EU15 Member States refers to those countries that were already EU Member States before May 1, 2004.

Figure 1: ICT value added shares produced by EU countries.

% from EU ICT value added, PPP, 2008 (Total EU ICT VA = 574 bil. EUR PPP)

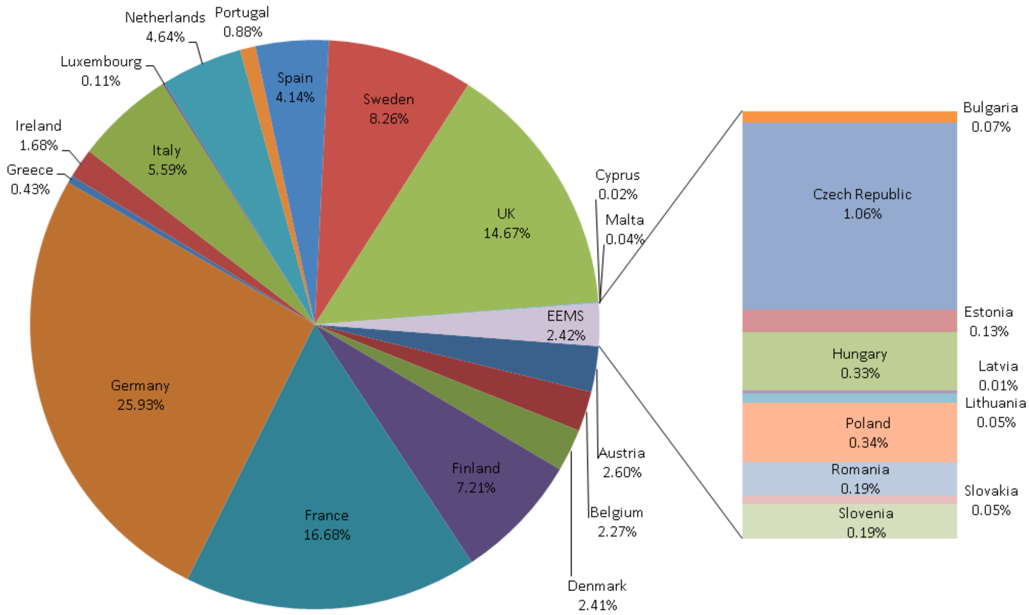


Source: Eurostat

ICT sectors. The significant increase of Spain's and Portugal's shares in total EU BERD is explained by the dynamics in specific sectors: the Computer Services and Software sub-sector in Spain (with a growth of over 50% in real terms in BERD), the Portuguese Telecom Services (almost 7-fold growth) and the Portuguese Computer Services sector (almost 4-fold growth). The decline in the share of Austrian ICT BERD in total is explained by a sudden drop of R&D investment in the Multimedia and Telecom Equipment sector. EU15 Member States contributed 97.5% of the ICT business R&D expenditures and the EEMS contributed only 2.42% (see Figure 2). Almost half of this value is attributed to the Czech Republic. With the exception of the Czech Republic, the bulk of increase of ICT sector R&D in the new Member States is also to be found in the services sectors, and particularly in Computer Services and Software. In fact, services sectors in the new Member States perform more than half of the total national ICT R&D, whereas in the EU15, the same share is below 40%. The smooth evolution of the EU as a whole hides quite interesting structural volatility which suggests relocation and specialisation and also catching up, especially in the services sectors.

Figure 2: ICT BERD shares by EU countries.

% of total EU ICT BERD, PPP, 2007 (Total EU ICT BERD = 34.1 bil. EUR PPP)

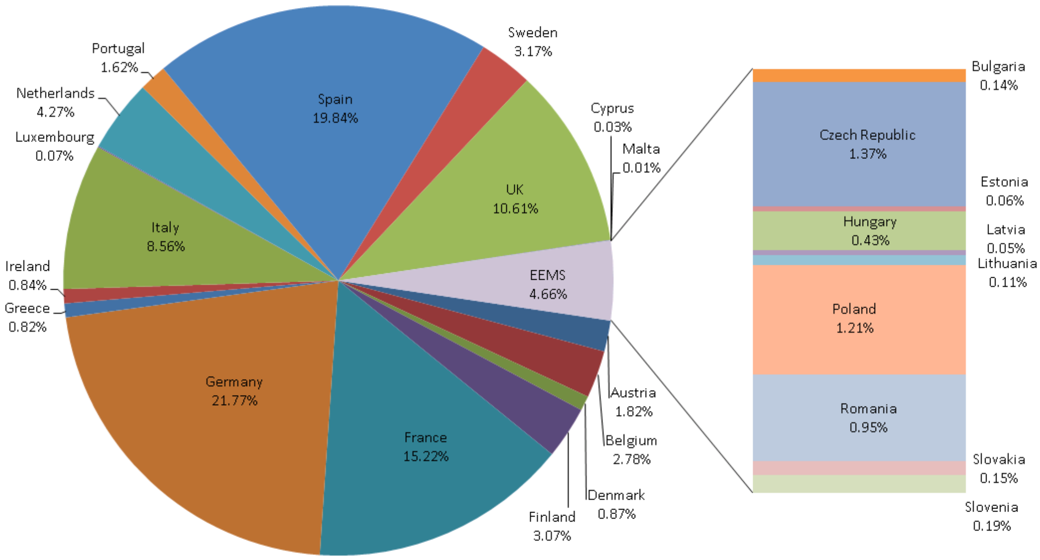


Source: Eurostat

This paragraph presents EU Member States data on ICT GBAORD or government ICT R&D financing: Government Budget Appropriations and Outlays in Research and Development related to ICT. As observed above with ICT BERD, ICT GBAORD in the EU is dominated by the largest economies (see Figure 3). Germany (21.8% of the total EU ICT GBAORD), Spain (19.8%) France (15.2%), the UK (10.6%), and Italy (8.5%) represent together 76% of EU ICT GBAORD. As expected, governments invest in proportion to their financial capacities. The EEMS contributes only 4.7% of the total EU ICT GBAORD, which is a share far below their economic weight (almost 12% of the total EU GDP).

Figure 3: ICT GBAORD shares by EU countries.

% of total EU ICT GBAORD, PPP, 2007 (Total EU ICT GBAORD = 5.3 bil. EUR PPP)



Source: Eurostat

3 Microeconomic Perspective

The analysis presented in this section is based on company data from the annual EU Industrial R&D Scoreboard databases (henceforth the *Scoreboard*) in which R&D investment data, and economic and financial data from the last four financial years are presented for the 1,000 largest EU and 1,000 largest non-EU R&D investors.[5] The limits for EU companies to be included into these top R&D investors lists vary by years but they are typically about $3-4$ mil. EUR. This database covers about 80% of all company R&D investments worldwide.

It must be noted that this company level data is not directly compatible with (BERD) data. The *Scoreboard* attributes each company's total R&D investment to the country in which the company has its registered headquarters and to one single sub-sector (ICB[6] and NACE class), regardless of whether some of the performed

[5] The first issue, the 2004 Scoreboard (covering the period 2000-2003), comprises only the top 500 EU and 500 non-EU R&D investors. Later, since the 2005 Scoreboard till the 2007 version it comprises the top 700+700 R&D investors. Only starting in 2008, it comprises the top 1000+1000 R&D investors.

[6] The Industry Classification Benchmark.

R&D concerns products or services related to other sectors than the one the company is attributed to. Also, "R&D investment" in the *Scoreboard* is the investment funded by the companies themselves, and is subject to R&D accounting definitions. It excludes R&D carried out under contract for customers such as governments or other companies. Thus, *Scoreboard* R&D investment data is different from BERD data, which includes all expenditures related to R&D performed in the business sector in a given country, regardless of the source of funds or the location of registered headquarters. BERD data also typically allocates the BERD to a sector either by 'principal activity' (the sector corresponding to the main activity of the company) or by 'product field' (the sector for which the R&D has been conducted).

The analysis starts with Figure 4 that presents the number of EEMS companies in the *Scoreboard* during the analysed period (blue vertical bars). There are $12-18$ EEMS companies in the *Scoreboard* each year, which corresponds to about 1.5%. These numbers can be again compared with reference values such as the EEMS population or GDP shares (20%, resp. 12%). The picture is very similar for ICT EEMS companies – there are only $2-5$ ICT companies coming from the EEMS (depicted by green bars) which represents $1-2\%$ from the full EU sample (orange line). What is positive, this share has been increasing over the analysed period and has actually doubled since 2004. This is, however, also partially caused by a decreasing overall number of ICT companies in the *Scoreboard*.

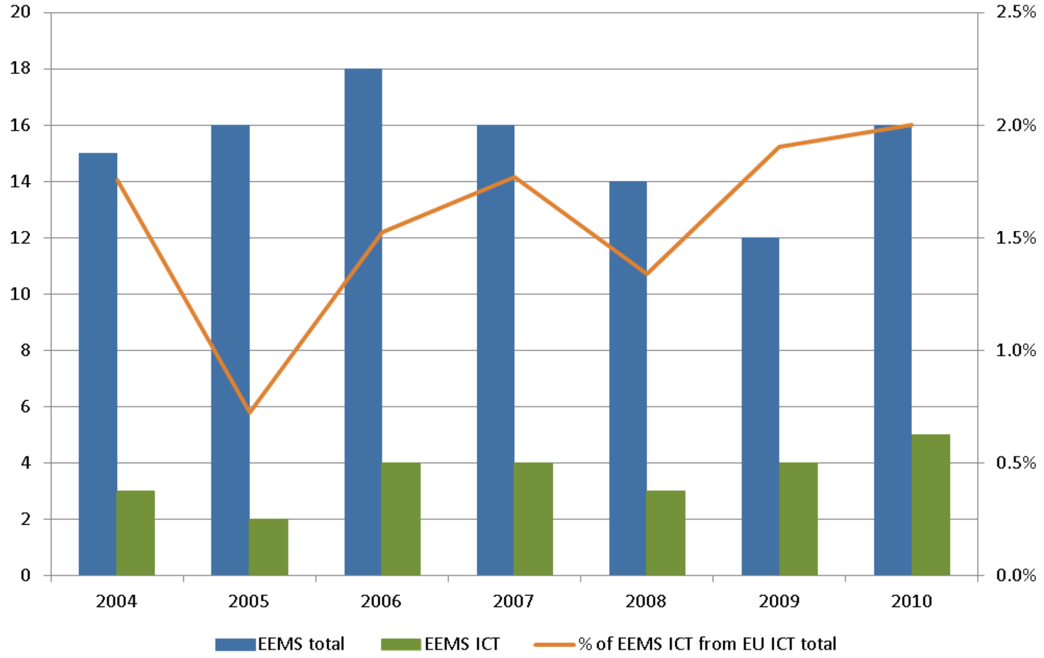
The list of all EEMS companies included in the *Scoreboard* is provided in Table 1. As mentioned before, overall there are only 6 ICT EEMS companies ever included in the *Scoreboard*. All of them belong to ICT service sub-sectors. One can also see there the difference in R&D intensity (defined as a share of R&D from Sales) between *Computer Services and Software* (NACE 72) and *Telecom Services* (NACE 642). While the former one can be characterized by a relatively high R&D intensity (about 10% at the EU level), for the latter one it is only about 2% at the EU level. The same pattern is visible also in this table.

Table 1: EEMS ICT and non-ICT *Scoreboard* companies.

	company	country	sub-sector	R&D (mil. EUR)	R&D/Sales	year
ICT	ComArch	Poland	Computer services	23.42	12.2%	2010
↓	Asseco Poland	Poland	Software	18.52	2.3%	2010
	Telekomunikacja Polska	Poland	Fixed line telecom	15.14	0.4%	2010
	Netia	Poland	Fixed line telecom	6.72	1.7%	2010
	Graphisoft	Hungary	Software	6.36	19.3%	2007
	Bulgarian Telecommunication	Bulgaria	Fixed line telecom	4.59	0.9%	2010
non-ICT	Gedeon Richter	Hungary	Pharmaceuticals	97.46	9.9%	2010
↓	Krka	Slovenia	Pharmaceuticals	90.92	9.0%	2010
	Komercni Banka	Czech Rep.	Banks	61.62	4.7%	2010
	Egis Pharmaceuticals	Hungary	Pharmaceuticals	42.24	9.9%	2010
	CEZ	Czech Rep.	Electricity	28.26	0.4%	2010
	Zentiva	Czech Rep.	Pharmaceuticals	22.84	4.1%	2008
	BRE Bank	Poland	Banks	16.67	2.1%	2010
	Bioton	Poland	Pharmaceuticals	11.09	10.7%	2010
	Matador	Slovakia	Automobiles & parts	9.83	2.4%	2005
	Helios	Slovenia	Pharmaceuticals	8.29	2.8%	2010
	Ceske Drahy	Czech Rep.	Industrial transportation	8.24	0.8%	2010
	Bank Ochrony Srodowiska	Poland	Banks	7.81	6.8%	2010
	AERO Vodochody	Czech Rep.	Aerospace & defence	5.38	4.9%	2007
	Sava	Slovenia	Chemicals	5.15	3.0%	2009
	Gorenje	Slovenia	Household goods	5.00	0.6%	2004
	ORLEN	Poland	Oil & gas producers	4.95	0.0%	2008
	ACH	Slovenia	Automobiles & parts	4.62	0.6%	2008
	Trinecke Zelezarny	Czech Rep.	Industrial metals	4.57	0.4%	2006
	KGHM Polska Miedz	Poland	Mining	4.21	0.2%	2005
	Grindeks	Latvia	Pharmaceuticals	3.48	5.8%	2006

Note: Variable *year* indicates the latest year when a company appeared in the *Scoreboard*. Values of R&D and R&D/Sales refer to this year.

Figure 4: Number of EEMS companies in the *Scoreboard* by years.

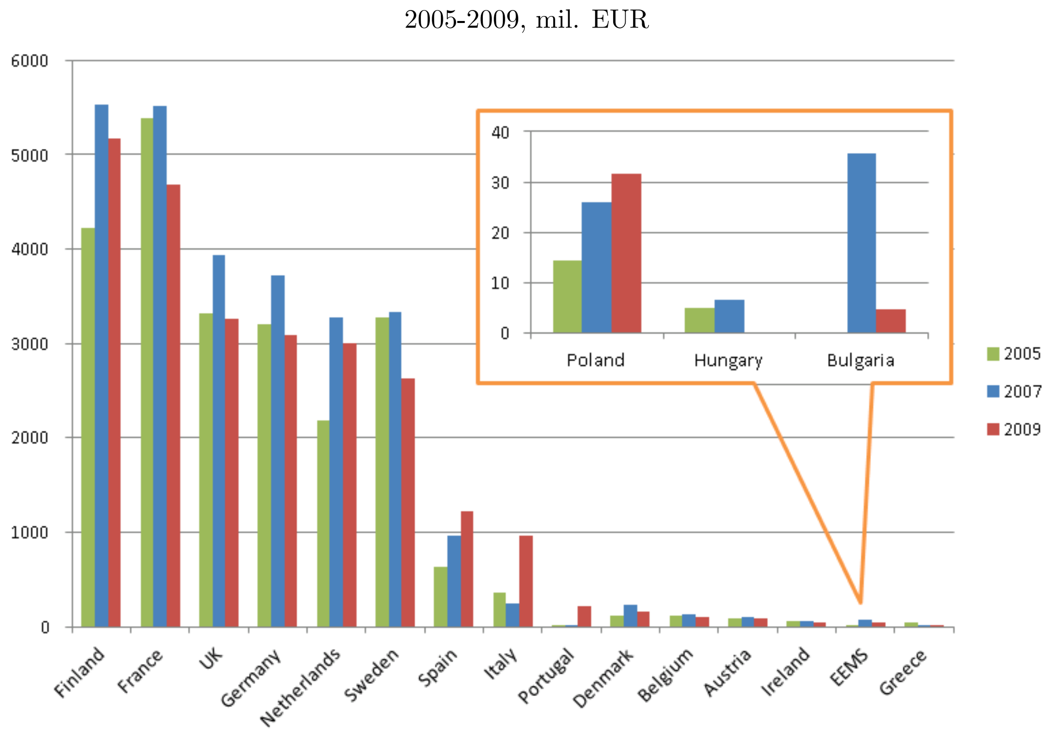


Source: EU Industrial R&D Scoreboard and author's calculations

Figure 5 offers an aggregation of R&D investment by ICT companies per country of registered headquarters in the EU for the period 2005-2009. The figure indicates that the major EU R&D-investing ICT companies are registered in Finland, the Netherlands, France, Germany, Sweden and the UK. This confirms that, globally, ICT R&D activity is mainly financed by companies whose headquarters are concentrated in a small number of developed economies (worldwide, this list would include also USA, Japan, South Korea, Taiwan and Canada). The figure also indicates that 13 out of 15 old EU Member States (EU15) invest individually more into ICT R&D than the whole group of the EEMS. *ICT Scoreboard* companies registered in Finland invested more than 5 bil. EUR into R&D in 2009, while *ICT Scoreboard* companies registered in the EEMS as a group invested in the same year only 36 mil. EUR. It is also worth to note that there are only 3 Eastern European countries represented in the *ICT Scoreboard* - Bulgaria, Hungary and Poland.

Finally, Figure 6 compares R&D intensities between the EU15 and the EEMS,

Figure 5: R&D investments per country of registered headquarters



Source: EU Industrial R&D Scoreboard

highlighting the ICT sector.[7] Globally, EU15 *Scoreboard* companies are about twice as much R&D intensive than their EEMS counterparts. However, when focused only on ICT sector, the difference increases and EU15 *Scoreboard* companies are almost eight times more R&D intensive.

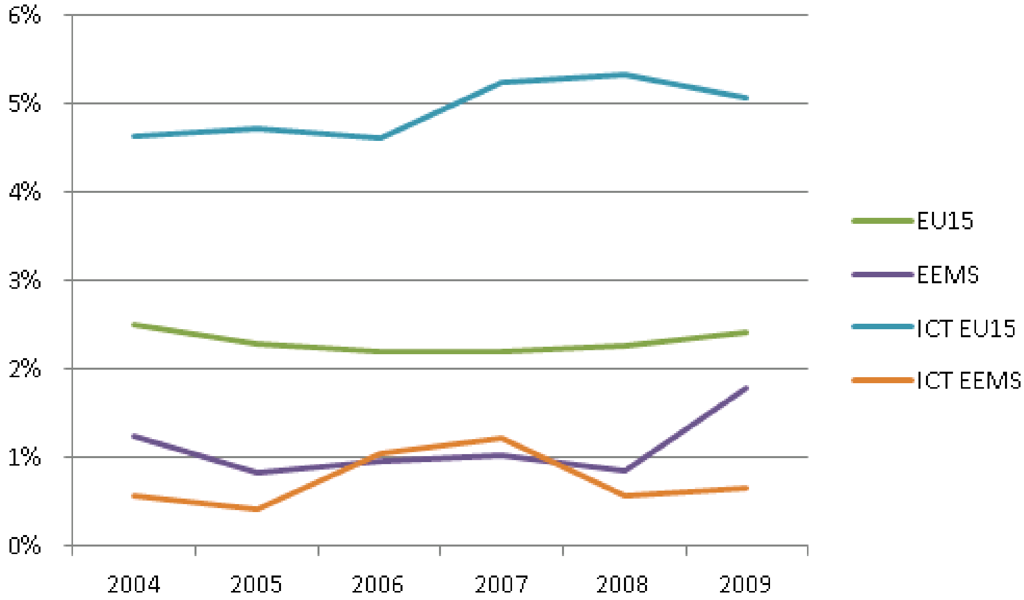
4 Performance of ICT R&D

This section extends the analysis of ICT R&D by presenting patent statistics as a measure of output of the R&D process. Patent statistics are particularly informative about inventions specific to ICT. The OECD finds that countries with strong specialisation in ICT are turning to patents as a prime method of securing rights

[7]Here, R&D intensities have been calculated on the basis of the following ratio: total R&D investments of the companies of the *Scoreboard* divided by their total net sales. Hence, it is different from the approach based on aggregated data from national statistics that establishes a ratio, also called R&D intensity but based on BERD and Value added (VA) data for each sub-sector.

Figure 6: R&D intensity comparison between EU15 and EEMS.

R&D intensity = R&D/Sales, 2004-2009



Source: EU Industrial R&D Scoreboard and author's calculations

on new knowledge.[8] Various studies[9] have already addressed the numerous advantages coming from the exploitation of patent data as a measure of inventive output. Patent data provide increasingly detailed and wide information on what the results of research and development efforts and of inventive activity in general are expected to be. Moreover, the type of information they provide is seen as 'objective', as it offers quantitative results and can be effectively combined with other indicators for cross-validation. Patent data are built from the administrative data compiled by patent offices for their internal purposes of managing the patenting process. Thus, they can provide wide coverage at relatively low cost and, importantly, for long time series.

However, the use of patent data as a proxy of inventive output also has several shortcomings. On the one hand, not all the inventions (and related innovations) are

[8](OECD, 2010). See also Rassenfosse and Potterie (2009) and Picci (2008) for further empirical analysis.

[9]Among many others, Griliches (1990), Smith (2005), Guellec and van Pottelsberg (2007), Picci (2009).

patented, and on the other hand, not all patented inventions turn into innovations. In fact, some innovations cannot be screened by means of patent data (production process innovation, for example), and firms often opt for different strategies to protect and exploit their inventions (keeping them secret is the most obvious way). Furthermore, the value of patents can be very different, as strategic or defensive patenting is a widely applied strategy to slow down competition in specific markets or as patent portfolios can be accumulated to be used as bargaining power. Differences in patenting fees and rules also affect the propensity for patenting innovations in different countries.[10]

In this section, I employ the EPO Worldwide Patent Statistical Database (known as the PATSTAT database), developed and updated by the European Patent Office (EPO), providing worldwide coverage of patent applications submitted to around 90 patent offices in the world.[11] The present analysis is based on indicators built by extracting and elaborating patent application data from the April 2010 release of the PATSTAT database. The analysis takes into account priority patent applications[12] filed at 59 patent offices worldwide: the EPO itself and 58 national patent offices including those of the 27 EU Member States, the US Patent and Trademark Office (USPTO), the Japan Patent Office (JPO) as well as the OECD countries' patent offices and other patent offices with the highest number of patent appli-

[10]See Rassenfosse and Potterie (2009) and Rassenfosse and Pottelsberghe (2010).

[11]PATSTAT updates are released twice per year by the EPO. PASTAT contains worldwide coverage of information on patent applications. The database is designed and maintained by the EPO, as member of the Patent Statistics Task Force led by the Organisation for Economic Co-operation and Development (OECD). Other members of the Patent Statistics Task Force are the World Intellectual Property Organisation (WIPO), the Japanese Patent Office (JPO), the US Patent and Trademark Office (USPTO), the US National Science Foundation (NSF) and the European Commission (EC), which is represented by Eurostat and by DG Research. Data are mainly extracted from the EPO's master bibliographic database DocDB and cover nearly 90 national Patent Offices, the World Intellectual Property Organisation (WIPO) and, of course, the EPO. The database provides a 'snapshot' of data available in the sources database at a specific point in time, and is updated twice per year.

[12]A patent application for a given invention first filed at any of the patent offices worldwide by an applicant seeking patent protection is assigned a priority date (in case of first filing in the world) and is known as the 'priority application'. Counting priority applications only, rather than all patent applications, avoids multiple counting of the same inventions and is a better proxy measure of inventive activity.

cations, including China and India.[13] The time period taken into account covers from 1 January 2000 to 31 December 2007.[14] Patent applications data from the PATSTAT database provide information on the country of residence of the inventors and of the applicants who have legal title to the patent, therefore patents are usually attributed to countries using either the 'inventor criterion' or the 'applicant criterion'.

In order to better understand the prowess of individual Member States in the production of ICT inventions, it is relevant to weight the number of ICT patent applications by the country size measure, either by GDP or population. Figure 7 shows a grouping of EU Member States by number of ICT priority patent applications in 2007 for each EU Member State, divided by their population (darker colours show the higher values).

When weighting the number of ICT applications by the country population, Finland-based inventors take the EU lead, with almost 140 ICT patent applications per million inhabitants. Germany comes next with about 100 ICT applications per million inhabitants, and Sweden and Austria follow with numbers above 50 ICT applications per million inhabitants. Then, above the European average of 34 ICT applications per million inhabitants, come France and Ireland. They are followed by the Netherlands, UK, Denmark and Belgium immediately below the EU average. Among the EEMS, the leading country is Slovenia (18 ICT applications per million inhabitants), followed by the Czech Republic and Estonia (11 each).

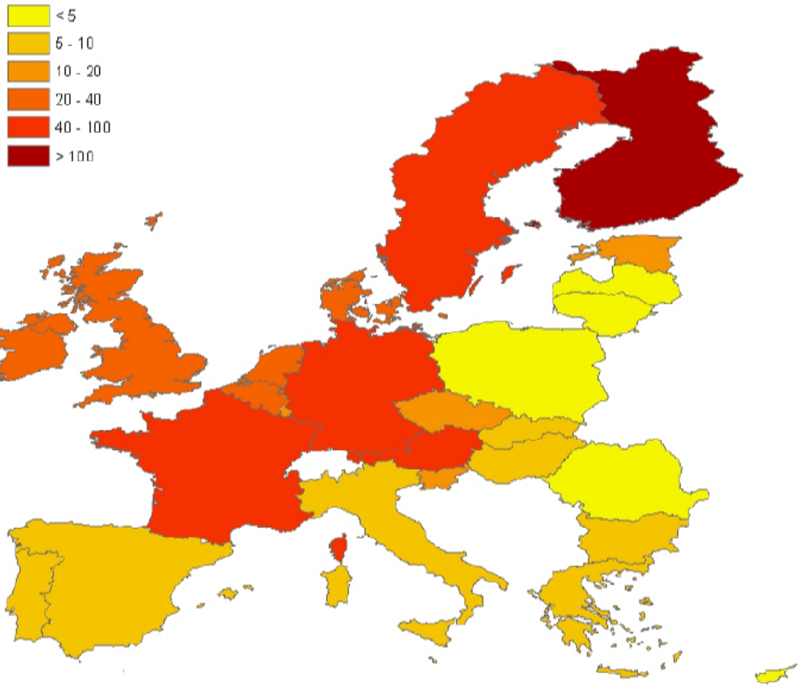
Additionally, Figure 7 also shows a table grouping of the Eastern European Member States by compound annual growth rate (CAGR) between 2000 and 2007 of ICT patent applications. According to the table, Estonia, Bulgaria and the

[13] The selected patent offices cover 99.7% of the total number of priority patent applications worldwide in 2007. The complete list includes: EPO, EU27 Member States, USPTO, JPO, Arab Emirates, Australia, Brazil, Canada, Chile, China, Columbia, Croatia, Hong Kong, Iceland, India, Indonesia, Israel, Korea, Malaysia, Mexico, New Zealand, Norway, Pakistan, Philippines, Puerto Rico, Russia, Singapore, South Africa, Switzerland, Taiwan, Thailand, Turkey, and Vietnam.

[14] The accuracy of data for more recent years could suffer from delays in the collection process and updating procedure of the PATSTAT database (even if the updating of data appears to have remarkably improved in the latest releases of the database).

Figure 7: ICT priority patent applications.

per million inhabitants, 2007



CAGR ICT patent applications (2000-2007)	
EE	36%
BG	22%
CZ	11%
LT	8%
SI	8%
SK	5%
HU	-2%
RO	-3%
LV	-12%
PL	-31%
EU27	0%

Source: JRC-IPTS calculations based on IMF data on population, and on the PATSTAT database

Czech Republic grew in the given period at compound rates higher than 10% in terms of CAGR, and they all recovered from the very low values reached in the previous decade. These three countries, together with Portugal and Greece, are also leading the whole EU in this respect.[15] They are then followed by countries with growth rates higher than 5% – Latvia, Slovenia and Slovakia. This group of countries is characterised by the fact that they all started from low figures and rapidly increased their output in terms of ICT priority patent applications. For instance, the number of ICT patent applications grew for the Czech Republic from 57 in 2000 to 116 in 2007. On the other hand, 31% annual drop in Poland is alarming.

[15]The European average over the considered period is -0.4%.

5 Conclusions

This paper aims at summarizing the ICT R&D activity in the Eastern European Member States as seen in the 2010 and 2011 reports on ICT R&D in the EU. The results from three considered perspectives – macro-analysis, micro-analysis and performance – suggest that EEMS ICT shares in EU ICT totals are systematically below the EEMS economic weight. Particularly, the EEMS are lagging behind the rest of the EU in all analyzed indicators - ICT BERD, ICT GBAORD, the list of top ICT R&D investors, ICT R&D intensity, or ICT patents.

On the other hand, dynamics of the ICT sector in the EEMS looks more positive. The most important structural trend is the steadily increasing share of the EEMS, before and after the year of their accession, from approximately 8% in 2000 to almost 11% in 2008. Then, the growth of ICT BERD in the EEMS is also bigger than in the EU15. Furthermore, the share of EEMS ICT companies in the list of top EU ICT R&D investing companies has more than doubled since 2005. Finally, our priority patent applications analysis reveals that there is a huge growth in several Eastern European countries. Here, it is, however, necessary to admit that there are also big contrasts among the particular EMMS.

The objective of this paper is also to raise several open questions. Why are there only very few EEMS ICT companies among the top R&D investors? Although the answer to this question was beyond the scope of our Reports on ICT R&D in the EU, its policy relevance is undisputable. Often, it tends to be explained by an unfavourable political situation before 1990s in these countries and by a consequent transition period. But 20% of the EU15 ICT top R&D investors were established within the last 20 years and the transition period in the EEMS is rather a history. One of the possible explanations could be maybe seen in the less friendly business environment for young companies? How difficult is to establish a company in the EEMS compared to the EU15? How difficult is obtain enough credit, especially at the early stages of a company's life? Finally, instead of trying to increase the share of the EEMS in the EU totals, we should first answer the question if it really matters that there is not enough ICT R&D in the EEMS? In the short run, it might be enough to focus mostly on catching-up with more advanced EU15 economies and keep improving EEMS companies' performance by purchasing rather than innovating new technologies. Obviously, this strategy cannot work in the long run.

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