



The Top World R&D-investing Companies from the ICT Sector: A Company-level Analysis

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Preface

It is an undisputable fact that the ICT industry and ICT-enabled innovation in non-ICT industries and services make an important contribution to the economic growth of advanced economies. In the EU, and also in the USA and Japan, the ICT sector is by far the largest R&D-investing sector of the economy. The EU ICT sector is therefore a significant contributor to the ambition of achieving the target of investing 3% of GDP in R&D in the EU. But, when comparing ICT expenditures over GDP, the USA, Japan, and also Taiwan and Korea, are investing significantly more in ICT R&D than the EU. These characteristics and observations have provided the rationale for the PREDICT research work (PREDICT stands for "Prospective insights on ICT R&D") with a view to gaining a deeper understanding of the dynamics of research in the ICT industrial sector, which in turn can provide important policy insights and options.

The PREDICT research and analysis is carried out by the Information Society Unit at JRC-IPTS and co-financed by IPTS and the Information Society & Media Directorate General of the European Commission. PREDICT combines in a unique way three complementary perspectives: national statistics, company data, and technology-based indicators such as patent data. It relies on the latest available official statistics delivered by Member States, Eurostat and the OECD. Where this data still contains gaps, rigorous cross-checking and estimating methods are applied by JRC-IPTS to provide the study with the necessary set of data. PREDICT results have been reported in a series of reports published annually since 2008. This multiannual analysis allows us to confirm the consistency of the data over time and offers a privileged view of the major ICT R&D trends across recent years. PREDICT results have been used, among others, in the preparation of EU policy initiatives aimed to support ICT R&D in Europe.

2011 marks the publication of the fourth annual report. For the first time, this year's PREDICT report is complemented by three thematic reports presenting more detailed analyses of some of the themes included in the annual report, namely: R&D investment by top ICT R&D companies worldwide, performance of ICT R&D analysed through ICT patenting, and internationalisation of ICT R&D. This report presents the results of a multiannual analysis of R&D investment by top ICT R&D companies worldwide.

All reports published under the PREDICT project are available at: <http://is.jrc.ec.europa.eu/pages/ISG/PREDICT.html>

Table of Contents

Preface	1
Executive summary	7
1. Methodological introduction	11
2. Global perspective	15
2.1 ICT and non-ICT company R&D investments across world regions	15
2.2 Trends in R&D investments of the ICT sector across world regions	16
3. Country-level perspective	19
4. Company-level perspective	21
4.1 Top 30 ICT R&D-investing companies: ranking	21
4.2 Top 30 ICT R&D-investing companies: growth and performance	22
5. Sub-sector analysis perspective	25
5.1 The IT Equipment sub-sector (NACE 30)	27
5.2 The IT Components sub-sector (NACE 32.1)	31
5.3 The Telecom Equipment sub-sector (NACE 32.2)	36
5.4 The Multimedia Equipment sub-sector (NACE 32.3)	41
5.5 The Telecom Services sub-sector (NACE 64.2)	44
5.6 The Computer Services and Software sub-sector (NACE 72)	49
6. Summary of main findings and conclusions	55
Annex I: Methodology for company data	59
Annex II: Definition of world regions	63
Annex III: Methodological note for Telecom Services R&D investments data .	65
References	66

List of Figures

Figure 1:	R&D investments in the ICT sector and non-ICT sectors by EU, US, Japanese, Asian and RoW Scoreboard companies, in billions of € (2008).....	8
Figure 2:	R&D intensities (R&D investment / net sales) in EU and US <i>ICT Scoreboard</i> companies (2008)	8
Figure 3:	R&D investments in the ICT sector and non-ICT sectors by EU, US, Japanese, Asian and RoW <i>Scoreboard</i> companies, in billions of € (2008).....	15
Figure 4:	R&D Investment in the ICT-sector and non-ICT sectors by EU, US, Japanese, Asian and RoW companies, as a % of total R&D investment (2008).....	16
Figure 5:	R&D investments in the ICT-sector by EU, US, Japanese, Asian and RoW <i>ICT Scoreboard</i> companies, in millions of € (2005-2008)	17
Figure 6:	R&D investments by <i>ICT Scoreboard</i> firms per country of registered headquarters in the EU and the Asia & RoW, in millions of € (2005-2008).....	19
Figure 7:	Top 30 R&D-investing ICT companies divided by R&D and sales growth rates (2005-2008)	24
Figure 8:	R&D investments in the ICT sub-sectors by EU, US, Japanese, Asian and RoW <i>ICT Scoreboard</i> companies, in billions of € (2008).....	25
Figure 9:	R&D intensities (R&D investment / net sales) in EU, US, Japanese, Asian and RoW <i>ICT Scoreboard</i> companies (2008).....	26
Figure 10:	R&D investments in the IT Equipment sub-sector by EU, US, Japanese, Asian and RoW <i>ICT Scoreboard</i> companies, in millions of € (2005-2008)	27
Figure 11:	Top R&D-investing companies in IT Equipment within each world region (2008)	30
Figure 12:	Top 20 IT Equipment companies in sales growth (2005-2008).....	31
Figure 13:	R&D investments in the IT Components sub-sector as divided into Electronic Equipment and Semiconductors, by EU, US, Japanese, Asian and RoW <i>ICT Scoreboard</i> companies, in millions of € (2005-2008).....	32
Figure 14:	Top R&D-investing companies in IT Components within each world region (2008)	35
Figure 15:	Top 20 IT Components companies in sales growth within Groups I to IV (2005-2008)	36
Figure 16:	R&D investments in the Telecom Equipment sub-sector EU, US, Japanese, Asian and RoW <i>ICT Scoreboard</i> companies, in millions of € (2005-2008)	37
Figure 17:	Top R&D-investing companies in Telecom Equipment within each world region (2008)	40
Figure 18:	Top 20 Telecom Equipment companies in sales growth within each Group I to IV (2005-2008).....	41
Figure 19:	R&D investments in the Multimedia Equipment sub-sector by EU, US, Japanese, Asian and RoW <i>ICT Scoreboard</i> companies, in millions of € (2005-2008)	42
Figure 20:	R&D-investing companies in Multimedia Equipment (2008)	44
Figure 21:	R&D investments in the Telecom Services sub-sector by EU, US, Japanese, Asian and RoW <i>ICT Scoreboard</i> companies, in millions of € (2005-2008)	45
Figure 22:	Top R&D-investing companies in Telecom Services within each world region (2008)	47
Figure 23:	R&D investments in the Computer Services and Software sub-sector by EU, US, Japanese, Asian and RoW <i>ICT Scoreboard</i> companies, in millions of € (2005-2008)	50
Figure 24:	Top 10 R&D-investing companies in Computer Services and Software within each world region (2008)	53

Figure 25: Top 20 Computer Services and Software companies in sales growth within each Group I to IV (2005-2008).....	54
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List of Tables

Table 1: Distribution of <i>ICT Scoreboard</i> companies by sectors and regions of registered headquarters (2008).....	12
Table 2: Top 30 R&D-investing ICT sector companies (2008).....	21
Table 3: Top 10 US and Asian, plus other R&D-investing companies in IT Equipment from the EU, Japan and the RoW (2008).....	28
Table 4: Top 10 EU, US, Japanese, Asian and RoW R&D-investing companies in IT Components (2008).....	33
Table 5: Top 10 EU and US, plus 11 R&D-investing companies in Telecom Equipment from other regions (2008).....	38
Table 6: R&D-investing companies in Multimedia Equipment (2008).....	43
Table 7: Top 10 EU, and remaining US, Japanese, Asian and RoW R&D-investing companies in Telecom Services (2008).....	46
Table 8: Top 10 EU and US, plus other R&D-investing companies in Computer Services and Software from Japan, Asia and RoW (2008).....	51

Executive Summary

This report analyses R&D investments by top R&D-investing companies from the ICT sector, for the period 2005-2008. It focuses on the distribution of R&D investments by firms in specific ICT sub-sectors¹ from the five main world regions,² paying special attention to R&D investments by ICT companies from the EU. In addition, company demographics of a number of firms were researched and analysed. The relationship between R&D growth and company sales growth is also addressed. Finally, an extended section on Telecom Services aims to shed some light on the interplay between manufacturing and service companies in the Telecom sub-sectors, opening up the field to an analysis of other similar interdependencies across sub-sectors and with other industries.

The analysis is based on company data from the *2009 EU industrial R&D Scoreboard* (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 in 2008. The *Scoreboard* covers about 80% of all company R&D investments worldwide. From the *Scoreboard*, we have extracted the sub-set of ICT sector companies, which we refer to in this report as the *ICT Scoreboard*.

Regarding the geographical origin of *ICT Scoreboard* companies, more than half (52%) of the companies have headquarters in the US, while 15% are from the EU and 14% are from Asia, excluding Japan which accounts for 12% of companies in the sample. The remaining 7% are located in countries included in the RoW group. As regards the type of business activity of the firms in the *ICT Scoreboard* dataset, more than two thirds of the companies are in the IT Components (43%) and the Computer Services and Software sub-sectors (26%).

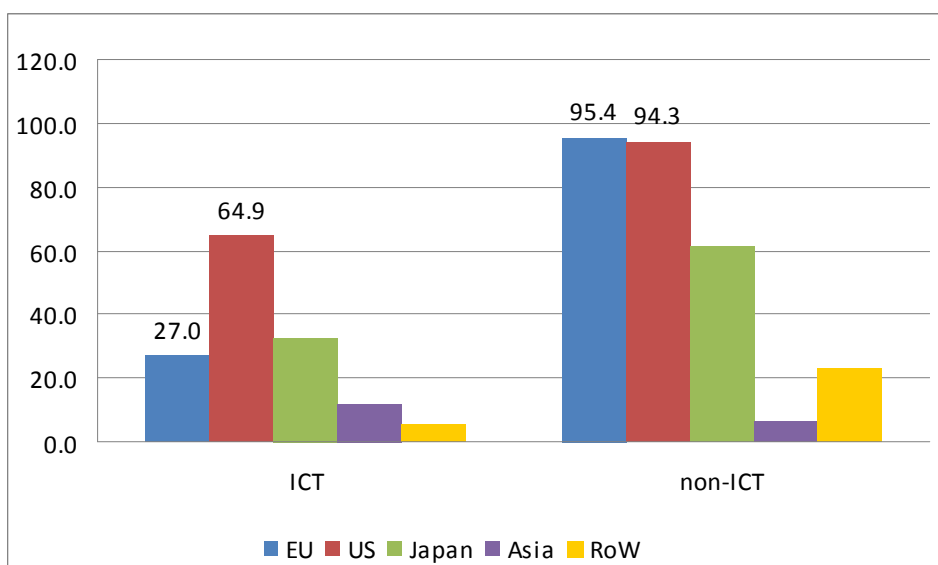
The main findings of the analysis are summarised below.

First of all, as shown in Figure 1, EU ICT sector companies make very substantial R&D investments (€ 27 billion). At an aggregate level, however, they invest less in R&D than companies from the US (€ 64.9 billion) or Japan (€ 32.6 billion), and they contribute a smaller share of total R&D in the EU than ICT companies do in other regions. In comparison with the US, there is a € 38 billion gap in ICT sector R&D (for the analyzed sample of companies) and detailed analysis suggests that, in absolute terms, US companies have further increased their R&D investment lead (in volume), although EU companies show a very positive trend with similar relative growth rates.

¹ Following NACE Rev.1.1 classes: 30 (IT Equipment), 32.1 (IT Components), 32.2 (Telecom Equipment) 32.3 (Multimedia Equipment), 64.2 (Telecom Services) and 72 (Computer Services and Software).

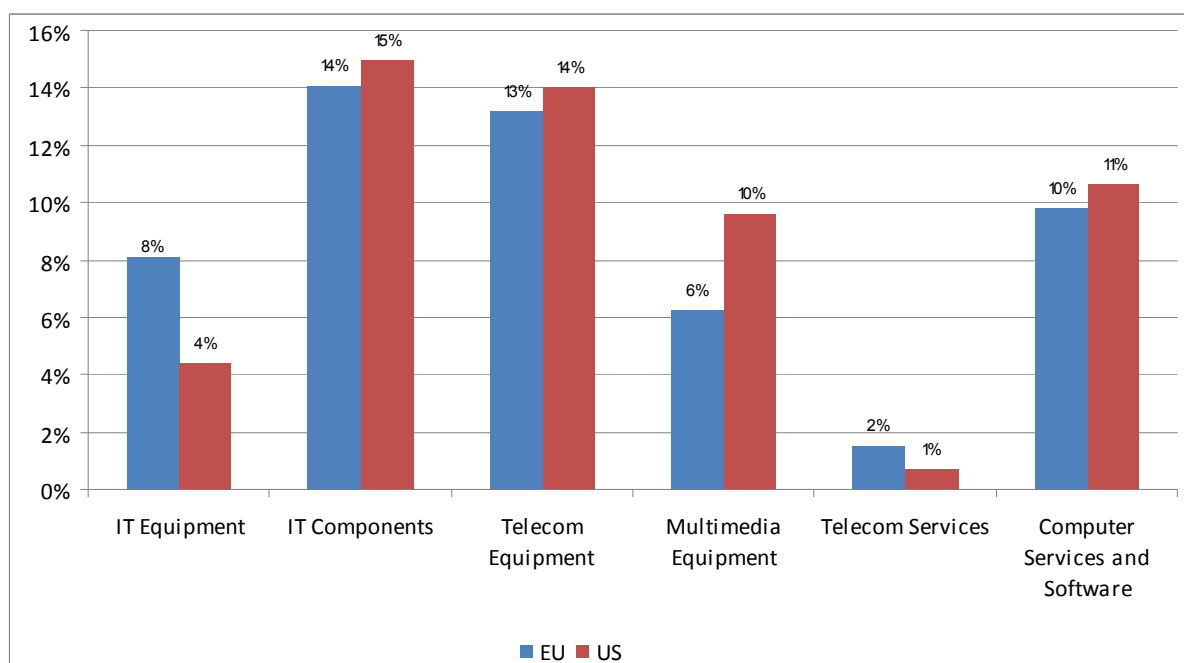
² These five regions are the EU, the US, Japan, Asia (excluding Japan) and the Rest of the World (RoW). The RoW region includes, among others, countries such as Australia, Brazil, Canada and Switzerland.

Figure 1: R&D investments in the ICT sector and non-ICT sectors by EU, US, Japanese, Asian and RoW Scoreboard companies, in billions of € (2008)



However, as shown in Figure 2, this is not necessarily because individual US companies are more R&D intensive than EU ones. R&D intensity (i.e., R&D investment to sales ratio) is instead more likely to be sector-specific than region-specific. In other words, it is an industrial and market characteristic, rather than a national one (at least in the comparison between the US and Europe). This suggests that this company-level ICT R&D gap is, in fact, mostly due to the presence of a large number of top R&D-investing ICT sector companies from the US. This is perhaps the most striking and important observation from the *ICT Scoreboard* –that more than half the top global R&D-investing ICT companies are from the US.

Figure 2: R&D intensities (R&D investment / net sales) in EU and US *ICT Scoreboard* companies (2008)



Further analysis of the 2009 *ICT Scoreboard* data allows us to draw a number of detailed conclusions regarding the levels and trends in ICT R&D investments across the major world regions that can be summarised as follows:

- Shares of ICT R&D in total R&D investments: Asia (excluding Japan) shows a very high concentration of R&D in ICT: around 65% of all companies' R&D investments are devoted to ICT. For US and Japanese companies, the shares of ICT R&D in total R&D investments are around 40% and 35% respectively. For EU companies, this share is around 20%, suggesting the presence of a smaller number of large companies in the ICT sector.
- Growth of R&D investments: from 2005 to 2008, Asian and RoW companies report the highest relative increase in their R&D investments (14% and 17% respectively) but from rather low previous values. EU and US firms show similar growth rates (10% and 11% respectively). The R&D growth rate of Japanese companies was the lowest (3%).
- Sub-sector specialisation: EU companies' R&D investments are concentrated in the Telecom Equipment and Telecom Services sub-sectors, whereas US, and to some extent, Japanese companies show strong presence in the most prominent ICT sub-sectors such as IT Components, Computer Services, and Telecom Equipment.
- Concerning EU and Asian companies, ICT R&D investments are made mostly by companies headquartered in a small number of developed countries (e.g., Finland, Netherlands, France, Germany, Sweden, UK, South Korea, and Taiwan).

Concerning particular ICT sub-sectors, the following can be noted:

- Worldwide, the most important sub-sector in terms of R&D investment is IT Components. It accounts for over one third of global R&D investments in the ICT sector. IT Components is followed by Computer Services and Software and Telecom Equipment.
- The above three sectors show a strong presence of US firms with high R&D investments and growth. The top EU R&D-spending companies are mainly in Telecom Equipment, IT Components and Telecom Services. Japanese companies, on the other hand, hold very strong R&D positions in IT and Multimedia Equipment and in IT Components. The latter shows a very strong presence of Asian companies, predominantly from South Korea and Taiwan.
- Multimedia Equipment is the only sub-sector that experienced a decline in R&D investments in the analysed period. R&D investments in this sub-sector is dominated by Japanese companies.
- The Software and Internet segments of Computer Services and Software are the most dynamic in terms of R&D investment, displaying high R&D intensities as well as high growth rates. However, EU companies' absolute R&D investments remain very much lower than those of US companies.

Growth rates analysis offers additional insights:

- In the analyzed period, average R&D and sales growth rates were 16% and 14% respectively. Looking at particular sub-sectors, three sub-sectors had higher average growth rates (Telecom Equipment, Computer Services and Software in both indicators and Telecom Services in one indicator).

- US companies (and also some Asian ones) dominate sales growth in all the analyzed sub-sectors. The biggest company in each of the sub-sectors, except for Multimedia Equipment, also comes from either the US or Asia.
- High/low R&D and sales growth rates seem to go together. One usually cannot expect to observe high sales growth without corresponding high R&D growth.

Finally, analysing R&D investments within an ecosystem approach, we have seen that in the case of the Telecom industry, a historically-rooted division of labour between two interdependent sub-sectors explains an important part of what can be interpreted as an under-investment in R&D on behalf of the Telecom Services sub-sector. Currently, there is a surge of new interdependencies – and competition – that may similarly affect the overall R&D landscape in the longer term. Technological changes, market demands and company strategies are generating growing and broader interdependencies between the Telecom Services and Equipment industries and neighbouring industries such as the Software and Internet/Content industries.

This in turn generates a revamping of the ‘division of labour’ described above. Revenue streams, investment volumes, R&D investments and priorities are being redistributed across an emerging "*New ICT ecosystem*", created by increasingly interrelated industries.

In such a complex environment, the approach followed so far may not suffice to capture the dynamics of the ICT sector, as the level of interrelation and exchanges between formerly separated actors increases. An additional approach, that of the ICT ecosystem, could help us to better track the way players are climbing up (or down) the value chain, integrating applications and services they did not provide before. This approach complements the company-level data analysis.

1. Methodological introduction

The analysis presented in this report is based on company data from the *2009 EU industrial R&D Scoreboard*³ (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 in 2008. The *Scoreboard* covers about 80% of all company R&D investments worldwide. From the *Scoreboard*, we have extracted the sub-set of ICT sector companies, which we refer to in this report as *ICT Scoreboard*. This dataset serves for the following analysis that aims to benchmark R&D investments of EU ICT companies against those of non-EU companies.

This report is an update and an extension of a chapter of the 2010 PREDICT report (Turlea et al., 2010).⁴ It is mainly based on data from 2008 (whereas the 2010 PREDICT report was based on data from 2007) and it analyses R&D investments for the time series between 2005 and 2008.

Furthermore, compared to the 2010 edition, there are a number of methodological modifications. First, the current report expands the analysis to all ICT sub-sectors listed in the *Scoreboard*. Second, due to the emerging role of Asian economies on the ICT landscape, Asian companies are clustered into one regional group. As a result, companies from five world regions are analysed: the EU, the US, Japan, Asia (excluding Japan) and the Rest of the World (RoW).⁵ The RoW region includes, among others countries such as Australia, Brazil, Canada and Switzerland. Third, the analysis was broadened to address the relationship between R&D growth and company sales growth. Fourth, company demographics of a number of firms was researched and analysed (i.e., determining the age of companies, and the US state where US companies have their headquarters). Lastly, an extended section on Telecom Services aims to shed some light on the interplay of manufacturing and service companies in the Telecom sub-sectors, opening up the field to an analysis of other such interdependencies across sub-sectors and with other industries.

In the *Scoreboard*, the groups of 1 000 EU and 1 000 non-EU top R&D spending companies include companies with different volumes of R&D investment. In 2008, the R&D investment threshold for the EU group (of 1 000 companies) was about € 4.3 million while that for the non-EU group (also of 1 000 companies) was about € 31.5 million. In order to compare EU and non-EU companies on a similar basis, it is advisable⁶ to use the same R&D investment

³ European Commission (2009).

⁴ When analyzing trends based on *Scoreboard* data, it should be noted that yearly data are not completely comparable, since the *Scoreboard* includes only top investors of a given year, e.g. 2008. Therefore, the set of top investors varies from one year to the next and those companies that invested most in, say 2008, are not necessarily the same companies as the ones that invested most in 2005. Additionally, there may also be other companies not included in the *Scoreboard* because their financial reporting practices are different (e.g. R&D is reported as a separate expenditure category).

⁵ See Annex II for the full list of countries.

⁶ The elimination of companies below the same threshold guarantees consistent treatment for each region. Otherwise, the EU region would be favoured by having 650 extra companies. And although these extra companies are characterized by very small R&D investment (almost two thirds of the EU 1 000 group represent only 5% of total R&D investment by this group), their inclusion in our analysis would have resulted in biased conclusions. For example, if there were many big firms among those excluded, we would underestimate EU R&D intensity compared to other regions; or by including all these companies, we would overestimate EU R&D investments by 5%. Moreover, by having many low R&D investing firms in our sample, we would end up with an inconsistent panel – given their small R&D investments and the fact that the number of companies grows rapidly with decreasing R&D investments, it is likely that the sample of those 650 firms should be totally different for each year of our analysis.

threshold for both groups, and therefore to consider only EU companies with R&D investments above the non-EU threshold of € 31.5 million. This comprises a group of 350 EU companies, representing approximately 95% of total R&D investment by the EU 1 000 group. Hence, there are 1 350 (ICT and non ICT) companies in total in the group of *Scoreboard* companies analysed in this report.

In order to create the dataset of ICT top R&D-investing companies (henceforth *ICT Scoreboard*) from the *Scoreboard*, only the companies belonging to the following NACE Rev.1.1 classes have been extracted from the *Scoreboard*: 30 (IT Equipment), 32.1 (IT Components), 32.2 (Telecom Equipment) 32.3 (Multimedia Equipment), 64.2 (Telecom Services) and 72 (Computer Services and Software).⁷ Extracting the relevant ICT companies generates the *ICT Scoreboard*, a sub-set of 428 ICT companies out of the 1 350 ICT and non-ICT companies mentioned above.

The population of these 428 *ICT Scoreboard* companies is distributed as indicated in Table 1.

Table 1: Distribution of *ICT Scoreboard* companies by sectors and regions of registered headquarters (2008)

ICT NACE class		EU	US	Japan	Asia	RoW	Total	
30	IT Equipment	3	25	7	12	3	50	12%
32.1	IT Components	19	89	35	29	10	182	43%
32.2	Telecom Equipment	10	32	1	3	7	53	12%
32.3	Multimedia Equipment	2	2	4	3	1	12	3%
64.2	Telecom Services	10	2	2	4	3	21	5%
72	Computer Services & Software	21	72	3	8	6	110	26%
Total ICT sector		65	222	52	59	30	428	
		15%	52%	12%	14%	7%		

Source: Authors' elaboration

Regarding geographical origin of the *ICT Scoreboard* companies, it can be seen that more than half (52%) of the companies have headquarters in the US, while 15% are from the EU and 14% are from Asia, excluding Japan which accounts for 12% of companies in the sample. The remaining 7% are located in countries included in the RoW group. Concerning the type of business activity of the firms in the *ICT Scoreboard* dataset, it can also be noted that more than two thirds of the companies are in the IT Components (43%) and the Computer Services and Software sub-sectors (26%).

It must be noted that the (company level) data presented in this report 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 (ICB⁸ and NACE class), regardless of whether some of the performed 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

⁷ In the *Scoreboard*, there are no companies classified in NACE 33.2-33.3 (Electronic Measurement Instruments – EMI). This is mainly due to the classification method of the *Scoreboard*. The *Scoreboard* assigns companies to primarily ICB-sectors, and only as a second step, it uses correspondence tables, to also assign the companies to NACE-sectors. Companies classified by the *Scoreboard* in other sectors appear to conduct large R&D investments in EMI. This poses an analytical problem in comparing with BERD data, which does include this EMI sector.

Second, the EMI sector shows some specificity: it is fragmented with many SMEs (Lindmark et al. 2008). Moreover, in terms of classification, it is no longer included within the new OECD definition of the ICT sector (ISIC Rev.4) (See: <http://www.oecd.org/dataoecd/49/17/38217340.pdf>), even though it is today a clearly important part, as recognised in other sections of this report.

⁸ The Industry Classification Benchmark - see <http://www.icbenchmark.com/>

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).⁹

⁹ For a fuller methodological description, including a discussion of the differences between *Scoreboard* data and BERD data, see Annex I. For a discussion on the issue of BERD versus company R&D data, see e.g. Azagra Caro and Grablowitz (2008), European Commission (2009) or Lindmark *et al.* (2008) and Annex I.

2. Global perspective

This section aims to assess the size of R&D investments by ICT companies in the global context. According to the *Scoreboard* data, the ICT sector is clearly a key R&D-investing sector in the world economy. In 2008, to put the ICT figures in perspective, the 1 350 top global R&D investing companies spent € 423 billion on R&D, out of which € 142 billion (or 34%) were invested by 428 ICT sector companies.

2.1 ICT and non-ICT company R&D investments across world regions

Figure 3 compares the R&D investments of ICT and non-ICT sector companies for 2008, showing the size of those investments for EU, US, Asian and RoW companies.

In 2008, the total R&D investments of EU *ICT Scoreboard* companies amounted to € 27 billion, as compared to € 95.4 billion for *non-ICT Scoreboard* companies. Comparatively, US ICT companies spent € 64.9 billion on R&D, while their non-ICT counterparts invested € 94.3 billion that same year. EU ICT firms, as a whole, invested far less in R&D than their US counterparts while EU non-ICT firms, as a whole, spent more than their US counterparts. In 2008, there was an ICT R&D differential with the US of nearly € 38 billion. However, the figure also shows that EU non-ICT company investments are higher than in any other world region, including the US. EU non-ICT companies, as a whole, invested about € 1 billion more than their US counterparts in 2008. As a result, the EU vs. US R&D ICT company R&D investment gap (€ 38 billion) is slightly larger than the Total R&D company investment gap (€ 37 billion). Still, as explained in Section 5 below, this gap is however not necessarily due to lower R&D investment by EU companies taken individually, but rather due to the differing size and composition of the sectors and industries in the two regions.

Figure 3: R&D investments in the ICT sector and non-ICT sectors by EU, US, Japanese, Asian and RoW *Scoreboard* companies, in billions of € (2008)

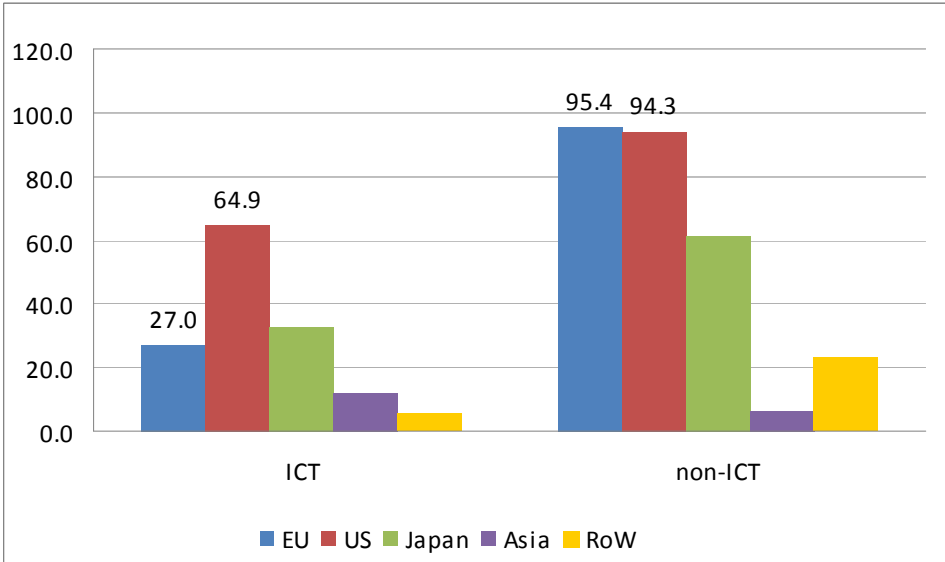
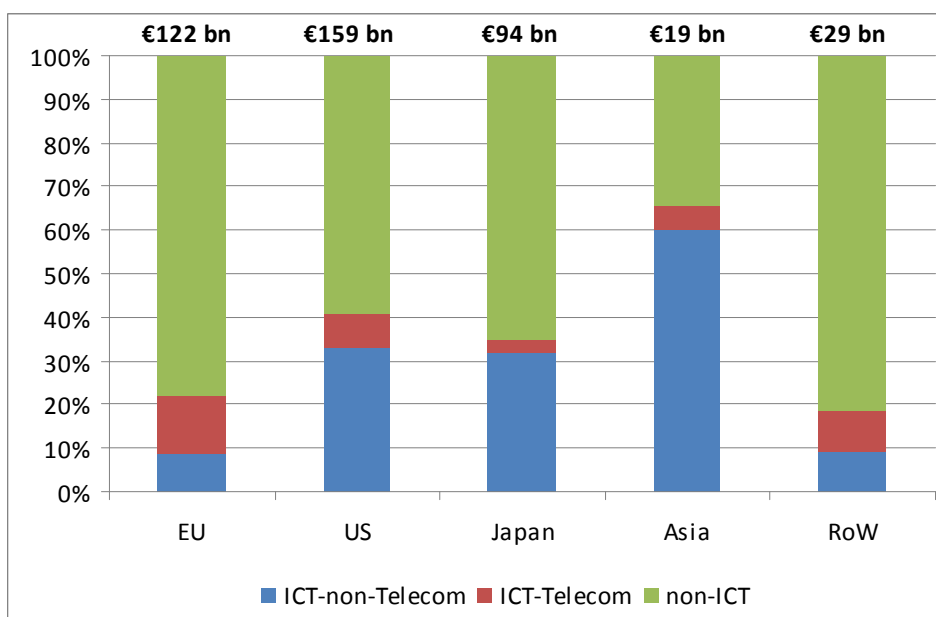


Figure 4 compares the shares of ICT and of non-ICT R&D investments by the *Scoreboard* companies, from different world regions: the EU, US, Japan, Asia and RoW, for 2008. It also distinguishes between Telecom and non-Telecom R&D investment shares.

Figure 4: R&D Investment in the ICT-sector and non-ICT sectors by EU, US, Japanese, Asian and RoW companies, as a % of total R&D investment (2008)



Note: Bold numbers above bars represent total R&D investments.

Figure 4 shows that the ICT sector's R&D investment share (as a percentage of total R&D investment) is different when looking at EU companies and companies from other regions. This share is only 22% for EU companies. Except for firms located in the RoW, ICT-related R&D company investments play more important roles in the US, Japan and particularly in Asia than in the EU. In all three regions, ICT sector company R&D investments account for at least one third of the total R&D investments. The case of Asia is particularly interesting, as ICT companies from this region contribute over 65% of total company R&D investments. Despite the overall small value, this shows a strong specialization among Asian companies.

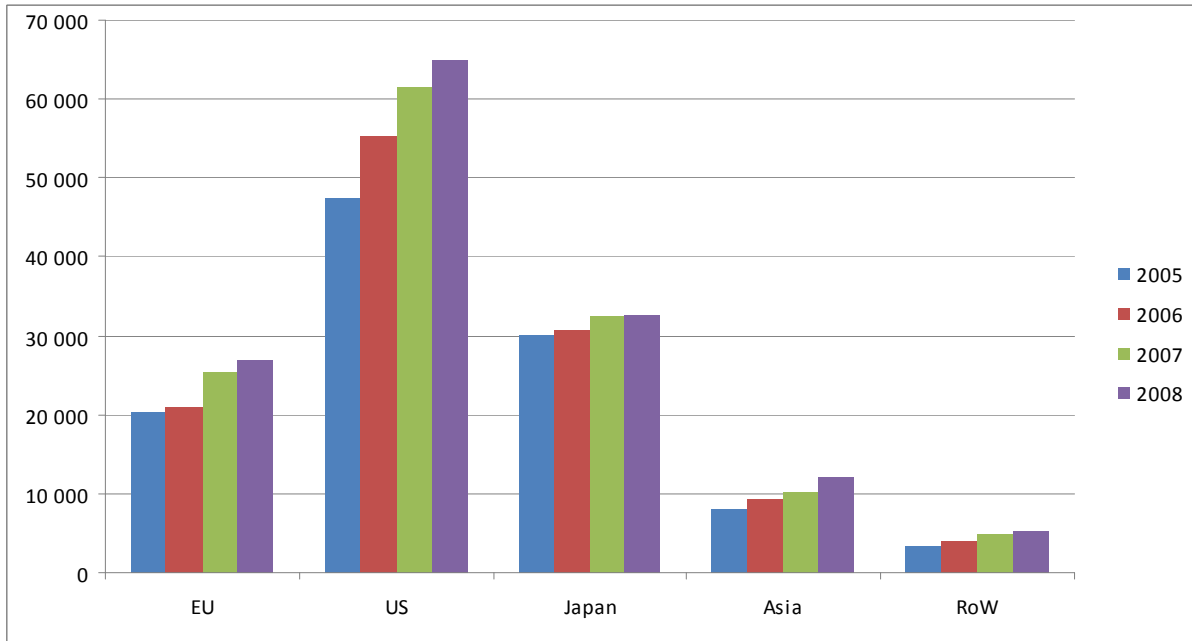
Comparatively also, the ICT R&D investments by EU companies seem very much concentrated in the telecom-related sub-sectors, i.e. Telecom Equipment and Telecom Services taken together, and especially Telecom Equipment.¹⁰ Almost 60% of total R&D investments by EU ICT companies, that is € 16.5 billion out of € 27.6 billion, are invested by Telecom Services and Telecom Equipment companies. The corresponding rates in other regions are much lower. Hence, while the proportion of ICT R&D as part of total R&D is lower for EU companies than for rest of the world, the Telecom part within the EU ICT company investment is even higher. The report further investigates this EU specificity in Section 5.5.

2.2 Trends in R&D investments of the ICT sector across world regions

Figure 5 shows the evolution of R&D investments by ICT companies with headquarters in the different geographical regions between 2005 and 2008.

¹⁰ Figure 4 contrasts an "ICT-Telecom" group aggregating data of companies from NACE, 32.2 (Telecom Equipment) and NACE 64.2 (Telecom Services) and an "ICT-non-Telecom" group aggregating data of companies from NACE 30 (IT Equipment), 32.1 (IT Components), 32.3 (Multimedia Equipment) and 72 (Computer Services and Software). This aggregation helps us to appreciate the specific importance of Telecom activity (Manufacturing and Services) in Europe.

Figure 5: R&D investments in the ICT-sector by EU, US, Japanese, Asian and RoW ICT Scoreboard companies, in millions of € (2005-2008)



Note: Nominal terms, not adjusted for inflation.

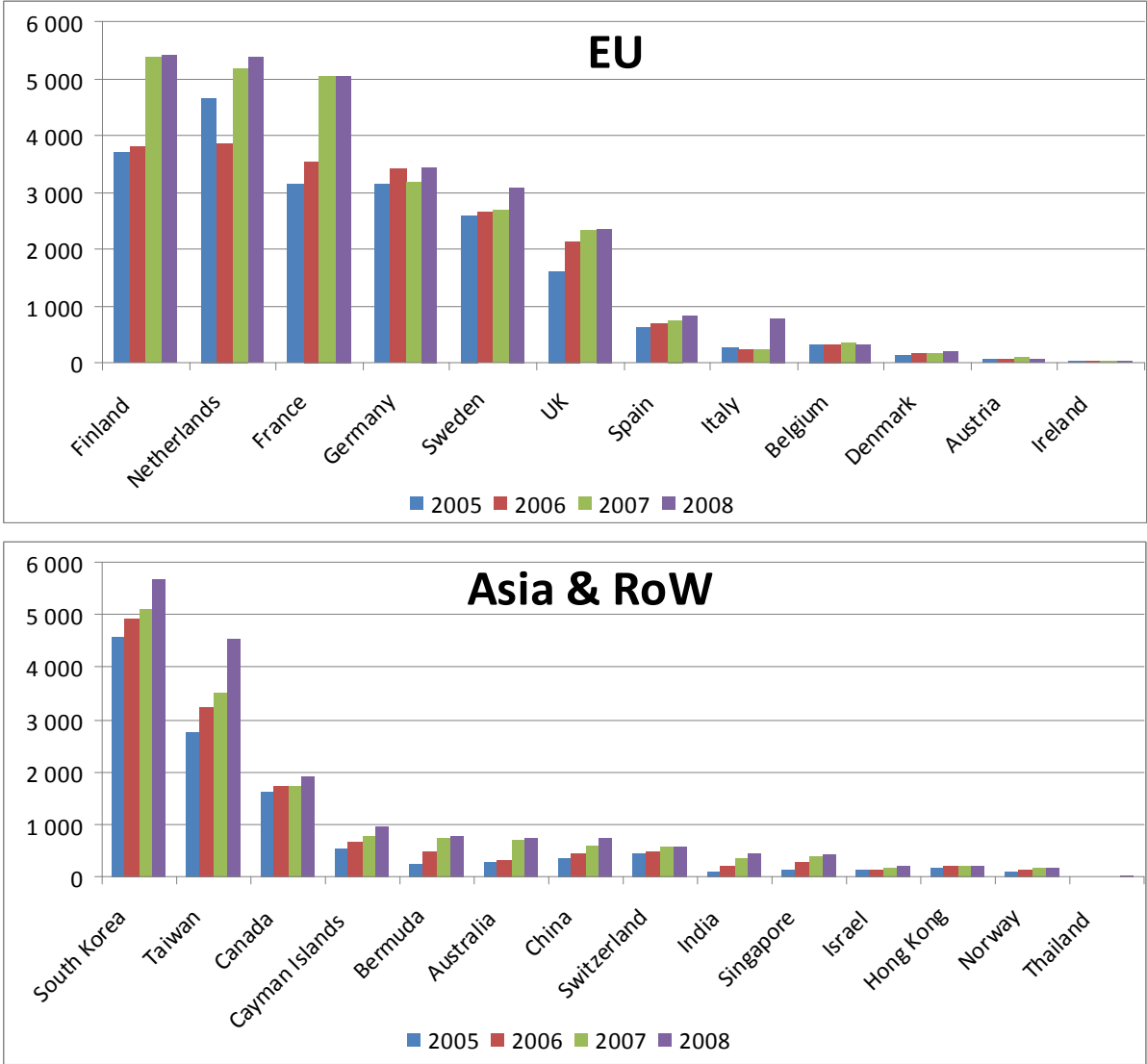
According to Figure 5, R&D investments by EU ICT firms increased year by year (Compound Annual Growth Rate from 2005 to 2008 – CAGR 10%) and this increase in R&D spending accelerated in 2007, when it reached a 22% growth rate, and then decelerated in 2008 to 6%. The increases shown by US companies were at a comparable level to EU companies (CAGR 11%). Companies from the other regions also consistently increased ICT R&D investments during the same time period. Here, however, some differences can be observed. For example, whereas R&D growth in Japan appeared to be relatively modest (CAGR 3%), Asia and the RoW increased R&D investments relatively rapidly (CAGR 14% and 17% respectively). It must be noted that these high growth rates apply to relatively small absolute values of R&D investments. More on ICT R&D in some emerging economies is developed in a separate report on the internationalisation of ICT R&D.¹¹

¹¹ G de Prato, D Nepelski, and J Stancik (2011). ‘The Internationalisation of ICT R&D’ JRC Scientific and Technical Report, JRC-IPTS, European Commission (forthcoming).

3. Country-level perspective

Figure 6 offers a breakdown of R&D investment by ICT companies per country of registered headquarters in the EU, Asia and the RoW (excluding US and Japan, already presented above) for the period 2005-2008.

Figure 6: R&D investments by ICT Scoreboard firms per country of registered headquarters in the EU and the Asia & RoW, in millions of € (2005-2008)



Note: Nominal terms, not adjusted for inflation.

Breaking down R&D figures of the EU, Asia and RoW to country level, the figure indicates that the major R&D-investing ICT companies outside the US and Japan are registered in Finland, the Netherlands, France, Germany, Sweden and the UK within the EU; and in South Korea, Taiwan and Canada, respectively for Asia and the RoW. This confirms that globally ICT R&D activity is mainly financed by companies whose headquarters are concentrated in a small number of developed economies, while companies in emerging economies, such as China and India still show lower levels of ICT R&D investments.

Concerning the absolute growth of company R&D spending between 2005 and 2008, French companies stand out with an increase of R&D investment of € 1.8 billion, followed by

Finnish companies (€ 1.7 billion). This level of growth is also observed for Taiwanese companies, which increased their R&D spending by € 1.8 billion in the same period of time. In relative terms, Indian and Singaporean companies increased their R&D investments four- and threefold respectively. It must, however, be noted that company R&D investments in these countries are still very low in absolute terms.

As a word of caution, it needs to be mentioned that the picture presented by the above figures at the country level is strongly influenced by both industry dynamics and by changes in the way R&D is accounted for in company accounting systems. The former is illustrated by the impact of mergers and acquisitions on the assignment of company R&D spending to a certain country. For example, within the EU, the rapid growth of France-based companies in 2007 is partly due to the Alcatel merger with Lucent, which resulted in the ICT R&D of Lucent, previously a US firm, being attributed to France, where the headquarters of the new firm is. Similarly, Finland's R&D growth in 2007 is largely a result of the creation of Nokia Siemens Networks: in the *Scoreboard*, Siemens' Telecom Equipment R&D spending was attributed to Finland and to the Telecom Equipment sub-sector, instead of being attributed to Germany (and to Electrical Components & Equipment) as before. Another example is Dutch NXP, a spin-off from Philips Electronics, which only started to report R&D in 2007. This led to a decline in R&D figures in Netherlands for 2006, compensated in 2007 by a sudden rebound.

4. Company-level perspective

4.1 Top 30 ICT R&D-investing companies: ranking

The top 30 R&D-investing ICT companies of the 2008 *ICT Scoreboard* are listed in Table 2. Of these, seven are EU-based (shown in red): Nokia, Alcatel-Lucent, Ericsson, SAP, Philips Electronics, STMicroelectronics and BT. Most of the remaining companies have their headquarters in the US (13, close to half of the top 30) and Japan (8). The remaining two companies are from South Korea. Of the seven EU firms, three are in the Telecom Equipment sub-sector and the four remaining respectively in Telecom Services, Computer Services and Software, Multimedia Equipment, and IT Components.

Table 2: Top 30 R&D-investing ICT sector companies (2008)

#	Company	NACE sub-sector	4 digit ICB sub-sector	Country	R&D 2008 (€ m)	R&D growth 2005-2008 (€ m)	CAGR 2005-2008 (%)
1	Microsoft	Computer Services and Software	Software	USA	6482	1745	11.0%
2	Nokia	Telecom Equipment	Telecommunications equipment	Finland	5321	1692	13.6%
3	Matsushita Electric (now Panasonic)	Multimedia Equipment	Leisure goods	Japan	4401	-484	-3.4%
4	IBM	Computer Services and Software	Computer services	USA	4327	458	3.8%
5	Sony	Multimedia Equipment	Leisure goods	Japan	4132	147	1.2%
6	Intel	IT Components	Semiconductors	USA	4117	415	3.6%
7	Cisco Systems	Telecom Equipment	Telecommunications equipment	USA	3707	1317	15.8%
8	Samsung Electronics	IT Components	Electronic equipment	South Korea	3469	669	7.4%
9	Hitachi	IT Equipment	Computer hardware	Japan	3398	314	3.3%
10	Alcatel-Lucent	Telecom Equipment	Telecommunications equipment	France	3167	1375	20.9%
11	Ericsson	Telecom Equipment	Telecommunications equipment	Sweden	2975	644	8.5%
12	Canon	IT Components	Electronic equipment	Japan	2969	695	9.3%
13	Motorola	Telecom Equipment	Telecommunications equipment	USA	2956	309	3.7%
14	NEC	IT Equipment	Computer hardware	Japan	2795	610	8.6%
15	Hewlett-Packard	IT Equipment	Computer hardware	USA	2549	38	0.5%
16	NTT	Telecom Services	Fixed line telecommunications	Japan	2151	-373	-5.2%
17	Fujitsu	Computer Services and Software	Computer services	Japan	2053	147	2.5%
18	Google	Computer Services and Software	Internet	USA	2010	1578	67.0%
19	Oracle	Computer Services and Software	Software	USA	1991	644	13.9%
20	Qualcomm	Telecom Equipment	Telecommunications equipment	USA	1641	914	31.2%
21	SAP	Computer Services and Software	Software	Germany	1627	538	14.3%
22	Philips Electronics	Multimedia Equipment	Leisure goods	Netherlands	1613	-1013	-15.0%
23	Sharp	IT Components	Electronic equipment	Japan	1557	381	9.8%
24	STMicroelectronics	IT Components	Semiconductors	Netherlands	1545	427	11.4%
25	EMC	IT Equipment	Computer hardware	USA	1473	630	20.4%
26	Texas Instruments	IT Components	Semiconductors	USA	1396	-54	-1.3%
27	Sun Microsystems	IT Equipment	Computer hardware	USA	1394	109	2.8%
28	Advanced Micro Devices	IT Components	Semiconductors	USA	1330	506	17.3%
29	LG	IT Components	Electronic equipment	South Korea	1304	81	2.2%
30	BT	Telecom Services	Fixed line telecommunications	UK	1157	405	15.5%

Note: Nominal terms, not adjusted for inflation. Red: EU headquartered companies.
CAGR = Compound Annual Growth Rate.

These top 30 ICT R&D investors report diverse rates of R&D growth. For example, between 2005 and 2008, the unquestioned leader in increasing R&D investments was Google. The CAGR (Compound Annual Growth Rate) of Google's R&D investments was close to 70%. Google is then followed by Qualcomm and Alcatel-Lucent from Telecom Equipment industry with CAGR of 31% and 21% respectively. Alcatel-Lucent has also the highest growth in R&D investments among the EU companies listed in Table 2. However, the high 2005-2008 CAGR of Alcatel-Lucent is essentially the result of the 2007 merger of Alcatel and Lucent, as indicated in Section 3. Other top growing EU companies are BT, SAP and Nokia with a CAGR of around 14-15%.

The double-digit R&D growth rates are mainly to be found in Services and the Telecom Equipment sector, with a few notable exceptions (STMicroelectronics, EMC and Advanced Micro Devices). This table also illustrates indirectly the very high level of concentration of R&D investments, declining by a factor range 6, from € 6 482 million (Microsoft) to € 1 157 million (BT) within the first 30 top ranking companies, out of a total of over 400.

4.2 Top 30 ICT R&D-investing companies: growth and performance

This section analyses the link between R&D growth and sales growth of *ICT Scoreboard* companies.

For all firms in the *ICT Scoreboard*, in the period between 2005 and 2008,¹² average R&D and sales growth rates were 16% and 14% respectively.¹³ Based on these values, companies can be categorised into four groups:

- Group I: with R&D growth rate **above** 16% and sales growth rate **above** 14%,
- Group II: with R&D growth rate **above** 16% and sales growth rate **below** 14%,
- Group III: with R&D growth rate **below** 16% and sales growth rate **below** 14%,
- Group IV: with R&D growth rate **below** 16% and sales growth rate **above** 14%.

When applying this categorisation to the full sample of 428 companies of the *ICT Scoreboard*, it appears that:

- Group I, with both indicators above the sample average, includes 27% of all *ICT Scoreboard* companies.
- Over a half of the 428 companies belongs to Group III, with both growth rates, R&D and sales, lower than the sample average.
- The remaining two groups – Group II characterised by above the sample average R&D growth and by below the sample average sales growth, and Group IV with below the sample average R&D growth and above the sample average sales growth, comprise only a small share of companies (13% and 6% respectively).

¹² The period 2005-2008 serves mainly to smooth circumstantial results of any specific year. It also intends to capture some of the possible time-lag effects, if any, between R&D expenditures and sales.

The methodology used is largely inspired by: Lim Tae-Yun, 2009. Global IT Industry Earnings and Prospects for Structural Reorganization, "Korea Economic Trends – Weekly Insight", n° 566, April 27, 2009. Samsung Economic Research Institute. See:

<http://www.seriworld.org/03/wldKetV.html?mn=E&mncd=0302&key=db20090427003§no=3>.

¹³ These values are calculated as simple averages across all firms in the *ICT Scoreboard*. Therefore, they may be affected by a distribution of these companies. Since this distribution with respect to sales – representing the size of a company – is not normal but rather skewed towards lower values, a comparison between small (below € 1 billion sales in 2008) and big companies (above € 1 billion sales in 2008) is provided as well. While the R&D and sales growths for small companies (50% of our sample) were 19% and 18% respectively, for big ones these growths were a bit lower, 14% and 10%.

These results suggest that, when observing the behaviour of top R&D spending companies such as those of the *ICT Scoreboard*, it appears that R&D and sales growth/decline go together.

The RoW is the region with the biggest share of the Group I companies (above/above: more than 46%). On the other hand, almost 80% of Japanese companies belong to Group III (below/below), and with only 6% Group I share. The EU, the US and Asia regions are in a similar situation. Their Group I share varies between 20-30%, while the Group III share is about 50%. Regarding broad sector division, the Group I and III ratio for manufacturing sectors¹⁴ is about 24%-58%. In comparison for service sectors,¹⁵ this ratio is slightly more favoured towards Group I (34%-47%).

Figure 7 represents a graphic illustration of these groups on the sample of the top 30 R&D-investing ICT sector companies listed in Table 2. Except for a few 'outliers', they are presented as a dense cloud, close to each other. The vast majority of them, including companies like Microsoft, Nokia, Panasonic, IBM, Sony or Intel, belong to Group III (23 companies), which is characterised by below average R&D and sales growths (these average growth values are based on the full sample of 428 companies of the *ICT Scoreboard*). This is not surprising, since the companies presented in this figure are the top R&D spenders, and also leaders in net sales.¹⁶ Therefore, it would be a surprise if a well-established company, with high R&D investments and high sales, achieved significant growth.¹⁷

It is also important to stress that in Figure 7 we are comparing the top 30 companies with a sample of the top R&D-spending companies worldwide! One has to note, that although some companies have below the sample average growth rates, almost all of them show positive growth rates. Three examples, in which both R&D and sales growths are negative, are Philips Electronics,¹⁸ NTT, and Texas Instruments.

Regarding the 7 EU companies (blue dots), they are located around the sample average values in the upper-right corner of category III, which points to a rather good growth performance. They seem to do rather better than companies from all other regions but the US (red dots).

On the other hand, only three companies of this Top 30 belong to Group I, with both indicators above the sample average – Google, Qualcomm and EMC (again, these average growth values are based on the full sample of 428 companies of the *ICT Scoreboard*). Especially the first two distinguish themselves significantly from the rest as 'positive' outliers. Qualcomm has almost 30% average year-to-year R&D and sales growth rates, due mostly to the recent boom in 3G smartphones demand. And finally, Google is by far the best performer in this Top 30 with almost 70% R&D growth rate and more than 50% sales growth.

¹⁴ IT Equipment, IT Components, Telecom Equipment, Multimedia Equipment.

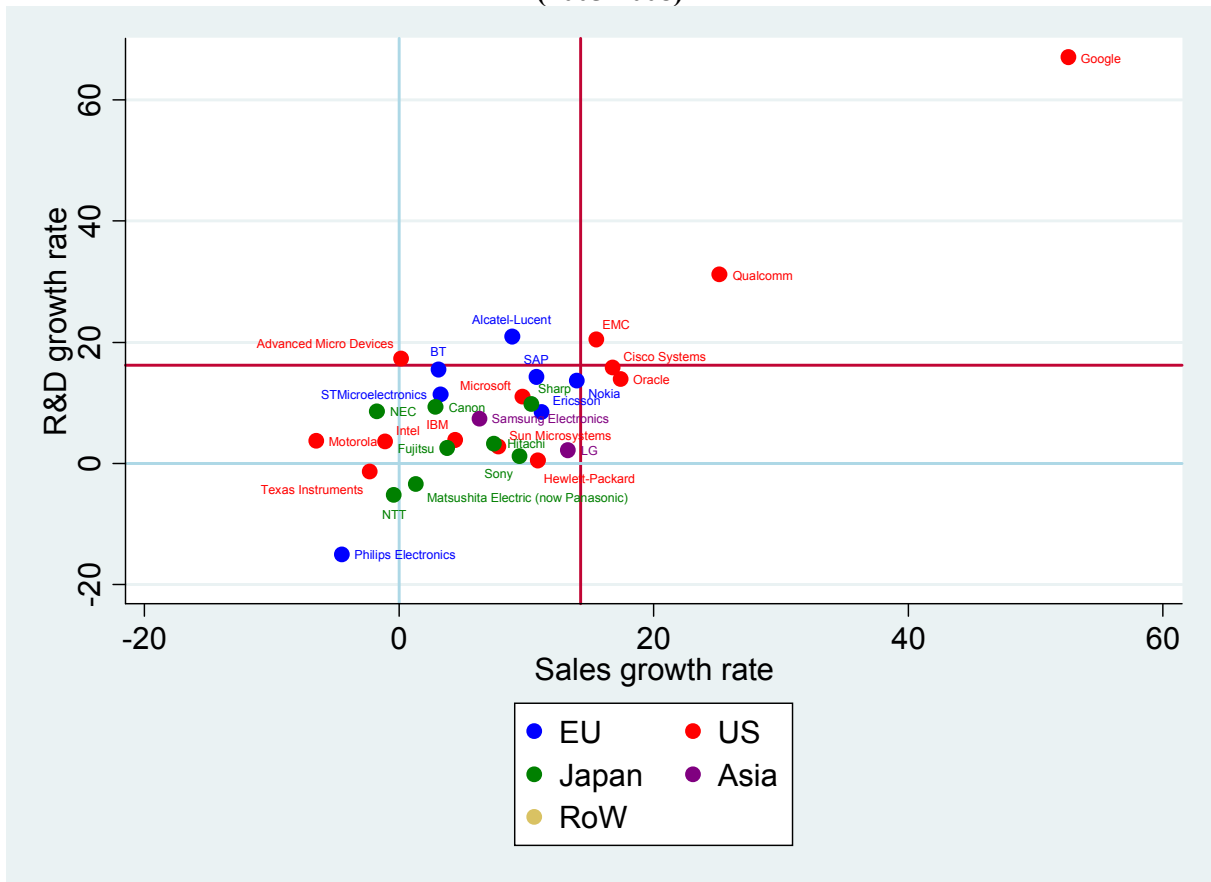
¹⁵ Telecom Services, Computer Services and Software.

¹⁶ 19 out of this top 30 R&D spending companies in 2008 are also among the top 30 companies in net sales in the same year; except one (Cisco Systems), all of them belong to Group III.

¹⁷ There may be other companies with higher/lower sales or R&D growth rates in the *ICT Scoreboard* that are not depicted in this graph because of their lower R&D investments. This graph focuses strictly on the top 30 R&D-investing ICT companies. Additionally, there may also be other companies with higher/lower sales or R&D growth rates that are not included in the *ICT Scoreboard*.

¹⁸ This is, however, partially a consequence of ongoing structural changes (a creation of its spin-off NXP, as mentioned in Section 3) as well as a change of strategy.

Figure 7: Top 30 R&D-investing ICT companies divided by R&D and sales growth rates (2005-2008)



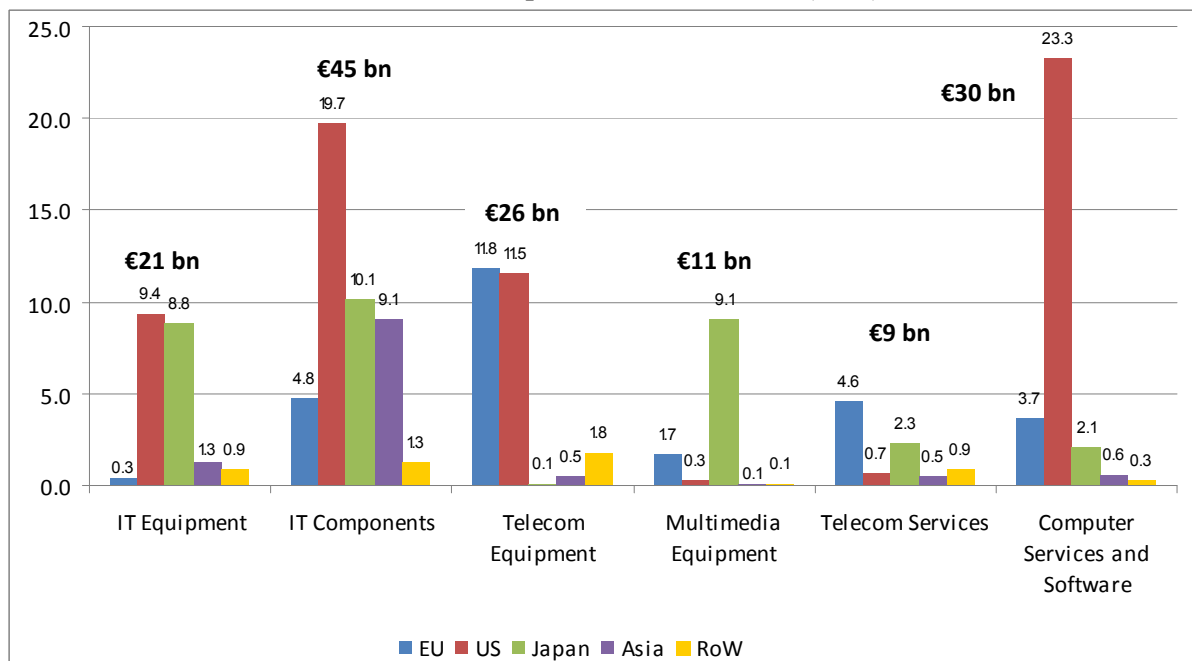
Note: Based on nominal values, not adjusted for inflation. Average R&D and sales growth rates: 16% and 14%. These averages are represented by red horizontal and vertical lines.

5. Sub-sector analysis perspective

Whereas the previous sections aimed to assess the overall importance of ICT R&D investments at the global and individual company levels, this section takes a closer look at each *sub-sector* of the ICT industry and describes the level of ICT company R&D investments and their evolution over the period between 2005 and 2008. In addition, lists of major R&D spenders in each sub-sector are presented, and their R&D and sales growth rates compared.

Figure 8 shows the size of R&D investments in the ICT sub-sectors by EU, US, Japanese, Asian and RoW *ICT Scoreboard* companies for year 2008.

Figure 8: R&D investments in the ICT sub-sectors by EU, US, Japanese, Asian and RoW *ICT Scoreboard* companies, in billions of € (2008)



Note: Bold numbers above bars represent total sectoral R&D investments.

According to Figure 8, overall, the most important sub-sector in terms of R&D investment is **IT Components**. In 2008, it accounted for € 45 billion, which represents over one third of the global ICT R&D investments. Another characteristic of the IT Components industry is that it is also the only sub-sector where companies from all regions display large R&D investments. US, Japanese and Asian companies clearly dominate in the IT Components sub-sector. In 2008, EU IT Components companies spend around € 5 billion in ICT R&D versus almost € 20 billion for US companies. Regarding EU companies, STMicroelectronics has the highest investments and is the only EU company in this sub-sector that appears in the top 30. A more detailed analysis of this sub-sector can be found in Section 5.2

Second in size and growth come the R&D investments in **Computer Services and Software**. In 2008, companies active in this sub-sector spent over € 30 billion. Most of the dynamics of the sector develop in the Software and Internet segments. Here, US firms strongly dominate, while firms from other regions are far behind. Regarding EU companies, SAP shows the highest investments and is the only EU company of the sub-sector appearing in the top 30. This sub-sector is further analyzed in Section 5.6.

The third largest R&D investing sub-sector, slightly below Computer Services and Software, is **Telecom Equipment**. In 2008, it accounted for nearly € 26 billion in R&D spending, most of which spent by EU (Nokia, Alcatel-Lucent, Ericsson) and US companies, clearly dominating this industry. This sub-sector is further analyzed in Section 5.3.

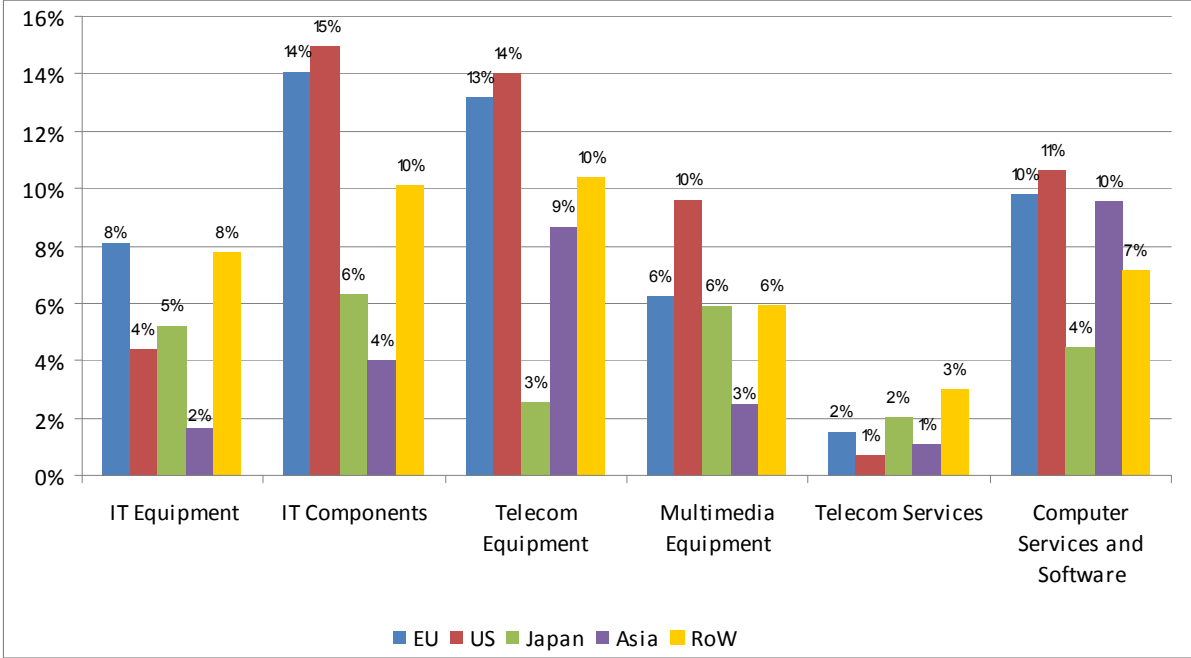
IT Equipment occupies the next rank, displaying relatively high total R&D investment of over € 21 billion in 2008. In this sector, it is Japanese companies that are challenging the US for the global R&D investment leadership position. There are no EU companies in the top 30. This sub-sector is further analyzed in Section 5.1.

The only sub-sectors where US companies have a weak R&D presence are **Multimedia Equipment** and **Telecom Services**. Both these sub-sectors show lower levels of total R&D investment. R&D investments in **Multimedia Equipment** is led by Japanese companies. Regarding EU companies, Philips shows the highest investments and is the only EU company in this sub-sector that appears in the top 30. The Multimedia Equipment sub-sector is further analyzed in Section 5.4.

Telecom Services, the sub-sector with the smallest total R&D investment, is, with Telecom Equipment, the second sector where EU R&D investment levels are the highest among the analysed regions. Regarding EU companies, BT shows the highest investments and is the only EU company in this sub-sector that appears in the top 30. This sub-sector is further analyzed in Section 5.5.

Figure 9 shows R&D intensities (R&D investment/net sales) for ICT sub-sectors for EU, US, Japanese, Asian and RoW companies, as determined by the *ICT Scoreboard* for 2008.¹⁹ Relating R&D investments to net sales (R&D intensity) shows divergent patterns across the sub-sectors and across the regions.

Figure 9: R&D intensities (R&D investment / net sales) in EU, US, Japanese, Asian and RoW ICT Scoreboard companies (2008)



¹⁹ Here, R&D intensities of sub-sectors have been calculated on the basis of the following ratio: total R&D investments of the companies of the *ICT Scoreboard* and pertaining to a given sub-sector, 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.

An essential observation is that, in most sub-sectors, the EU and the US show very similar R&D intensity levels. This similarity indicates that the *ICT Scoreboard* R&D gap between the US and the EU is not due to the lower R&D intensities (i.e., R&D to sales ratio) of the EU sub-sectors. The gap may instead be due to the differing size and composition of the ICT industries in the two regions.

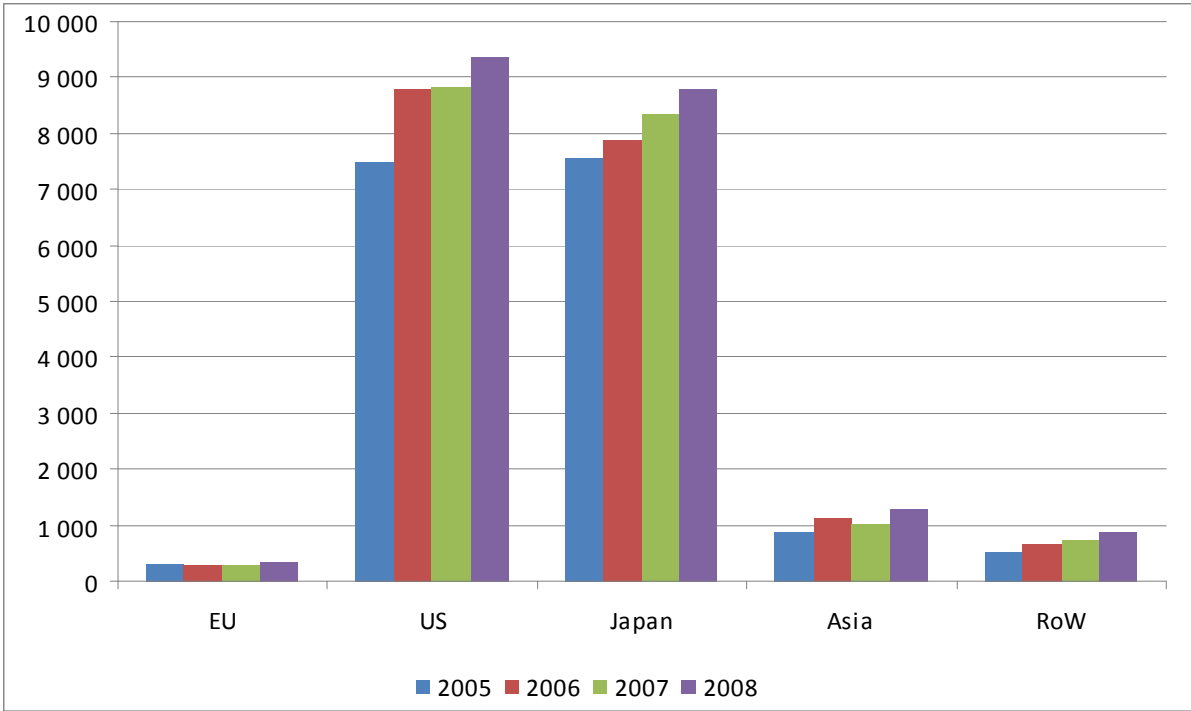
The other regions differ quite a lot from this EU/US pattern. On the one hand, in IT Components and Telecom Equipment, EU and US R&D intensities are well above those of Japan. On the other hand, Japan shows close or higher R&D intensities in IT Equipment and Telecom Services. These results must be interpreted with caution. For example, the Japanese figures appear to vary less across the sub-sectors. This may be due to their relatively high level of diversification across the ICT subsectors, which would tend to make their R&D intensities converge across sub-sectors. Asia, with the exception of its Computer Services and Software firms, shows lower R&D intensities than the EU and the US. In conclusion, it appears that EU and US ICT sub-sectors have, on average, higher R&D intensities than these sub-sectors in Asia, Japan and the RoW.

5.1 The IT Equipment sub-sector (NACE 30)

5.1.1 Top companies' R&D investments (2008)

Figure 10 reports R&D investments for world regions by companies in the IT Equipment ICT sub-sector from 2005 to 2008. US and Japanese firms invest by far the largest amount of R&D in this sub-sector. In terms of R&D investments, second and third positions belong to companies from Asia and the RoW. EU firms are, as a whole, those that invest the lowest amount of R&D in this sub-sector and their investment seems to be stable, while it is increasing for the firms of the other regions.

Figure 10: R&D investments in the IT Equipment sub-sector by EU, US, Japanese, Asian and RoW ICT Scoreboard companies, in millions of € (2005-2008)



Note: Nominal terms, not adjusted for inflation.

5.1.2 Top companies' R&D investments ranking (2008)

Table 3 casts more light on the composition of the IT Equipment sub-sector across the five world regions. It includes the top 10 firms in the US and Asia and the largest ICT R&D investors from the remaining regions included in the ICT Scoreboard database.

Table 3: Top 10 US and Asian, plus other R&D-investing companies in IT Equipment from the EU, Japan and the RoW (2008)

Company	ICB sub-sector	Country/State	R&D 2008 (€ m)	R&D 2005-2008 (€ m)	RDI 2008	R&D CAGR	Net Sales 2008 (€ m)	Age
EU								73.3
Oce	Electronic office equipment	Netherlands	255	35	8.8%	5.0%	2909	84
Neopost	Electronic office equipment	France	48	-1	5.2%	-0.8%	918	87
Kontron	Computer hardware	Germany	47	15	9.5%	13.7%	497	49
US								46.9
Hewlett-Packard	Computer hardware	California	2549	38	3.0%	0.5%	85155	72
EMC	Computer hardware	Massachusetts	1473	630	13.8%	20.4%	10702	32
Sun Microsystems	Computer hardware	California	1394	109	14.0%	2.8%	9986	29
Apple	Computer hardware	California	806	422	3.4%	28.0%	23366	35
Xerox	Electronic office equipment	New York	540	-4	4.3%	-0.2%	12668	105
Dell	Computer hardware	Texas	477	144	1.1%	12.7%	43958	25
NetApp	Computer hardware	California	359	184	14.6%	27.1%	2451	19
Western Digital	Computer hardware	California	334	162	5.7%	24.8%	5809	41
Lexmark	Computer hardware	Kentucky	305	63	9.3%	8.0%	3258	20
Pitney Bowes	Electronic office equipment	Connecticut	153	29	3.4%	7.4%	4505	91
Japan								84.4
Hitachi	Computer hardware		3398	314	3.8%	3.3%	89103	101
NEC	Computer hardware		2795	610	7.6%	8.6%	36645	112
Ricoh	Electronic office equipment		1000	123	5.7%	4.5%	17619	75
Seiko Epson	Electronic office equipment		658	-49	6.1%	-2.4%	10697	69
Konica Minolta	Electronic office equipment		646	122	7.6%	7.2%	8505	88
Brother Industries	Computer hardware		271	96	6.0%	15.8%	4495	103
Eizo Nanao	Computer hardware		50	21	7.0%	19.7%	709	43
Asia								25.9
ASUSTeK Computer	Computer hardware	Taiwan	316	182	2.2%	33.2%	14636	22
Quanta Computer	Computer hardware	Taiwan	160	44	0.9%	11.3%	17949	23
Lenovo	Computer hardware	Hong Kong	158	20	1.5%	4.6%	10721	27
Wistron	Computer hardware	Taiwan	141	82	1.4%	34.0%	9758	10
Inventec	Computer hardware	Taiwan	115	56	1.4%	24.8%	8313	36
Lite-On Technology	Computer hardware	Taiwan	101	37	1.8%	16.6%	5733	22
Qisda	Computer hardware	Taiwan	80	-89	2.2%	-22.0%	3716	27
Micro-Star International	Computer hardware	Taiwan	54	19	2.4%	15.7%	2234	26
Creative Technology	Computer hardware	Singapore	46	-13	8.7%	-8.1%	530	30
Lite-On It	Computer hardware	Taiwan	45	23	3.6%	26.3%	1238	36
RoW								26.3
Seagate Technology	Computer hardware	Cayman Islands	740	276	8.1%	16.8%	9143	32
Logitech International	Computer hardware	Switzerland	93	29	5.8%	13.5%	1589	30
Xyratex	Computer hardware	Bermuda	63		8.3%		755	17

Note: Nominal terms, not adjusted for inflation. Annual reports, company information and Wikipedia have been used for determining the age of the companies. Age is 2011 minus the birth year. The resulting average age has been calculated per region. Average ages for each region (in bold) are calculated from the sample of companies listed in this table. Colours: Blue: Companies older than 50 years. Black: Companies between 30 and 50 years old. Red: Companies younger than 30 years, and older than 15 years. Green: Companies 15 years or younger.

Regarding the EU companies, there are only three firms in the list (OCE, Neopost and Kontron), and these have relatively low R&D investments. Furthermore, after Japanese firms, EU firms are, on average, the oldest in the sample. Their average age is nearly three times higher than the age of their Asian counterparts, or the firms registered in the RoW. In 2008, the ratio of R&D to sales for EU firms was above 8% and, thus, was nearly twice as high as the same ratio for US or Japanese companies. Indeed, EU firms exhibit the highest R&D intensity (on sales) among the companies included in the set, with rather low sales numbers. These are comparatively small firms but very active in R&D.²⁰

The top US R&D investors in the IT Equipment sub-sector are mainly major computer and computer hardware manufacturers, e.g. Hewlett-Packard, EMC or Sun Microsystems. One can observe very heterogeneous patterns of R&D investments both with respect to R&D intensity and R&D growth rate. The value of the former ranges between 1% (Dell) to nearly 15% (NetApp) and of the latter from a negative 2% (Xerox) to nearly 30% (Apple).

Japanese firms are typically older and relatively stable in terms of R&D growth. For example, in 2008, the levels of their average R&D intensity and R&D growth rates were only around 5%.

Major Asian R&D investors in the IT Equipment sub-sectors are mainly from Taiwan and, on average, are considerably younger than the companies from the other regions. In addition, though starting from very low absolute levels, they exhibit very high R&D growth rates, with the exception of a few companies that have significantly reduced their R&D investments, i.e. Qisda and Creative Technology.²¹

5.1.3 Top companies' growth rates (2005-2008)

The figures in this section illustrate the link between IT Equipment companies' R&D growth and sales growth.

For all IT Equipment firms in the *ICT Scoreboard*, from 2005 to 2008, average R&D and sales growth rates were 10% and 8% respectively.²² Based on these values, companies can be categorised into four groups:

- Group I: with R&D growth rate **above** 10% and sales growth rate **above** 8%,
- Group II: with R&D growth rate **above** 10% and sales growth rate **below** 8%,
- Group III: with R&D growth rate **below** 10% and sales growth rate **below** 8%,
- Group IV: with R&D growth rate **below** 10% and sales growth rate **above** 8%.

Further analysis shows that most IT Equipment companies are located either in Group I or III (almost 80%) showing again that R&D and sales growth go together. Another general observation is that, on average, IT Equipment companies show lower R&D and sales growth rates than the average calculated above for the full *ICT Scoreboard*.

Figure 11 maps a sample of the top 10 (if available) R&D-investing IT Equipment companies

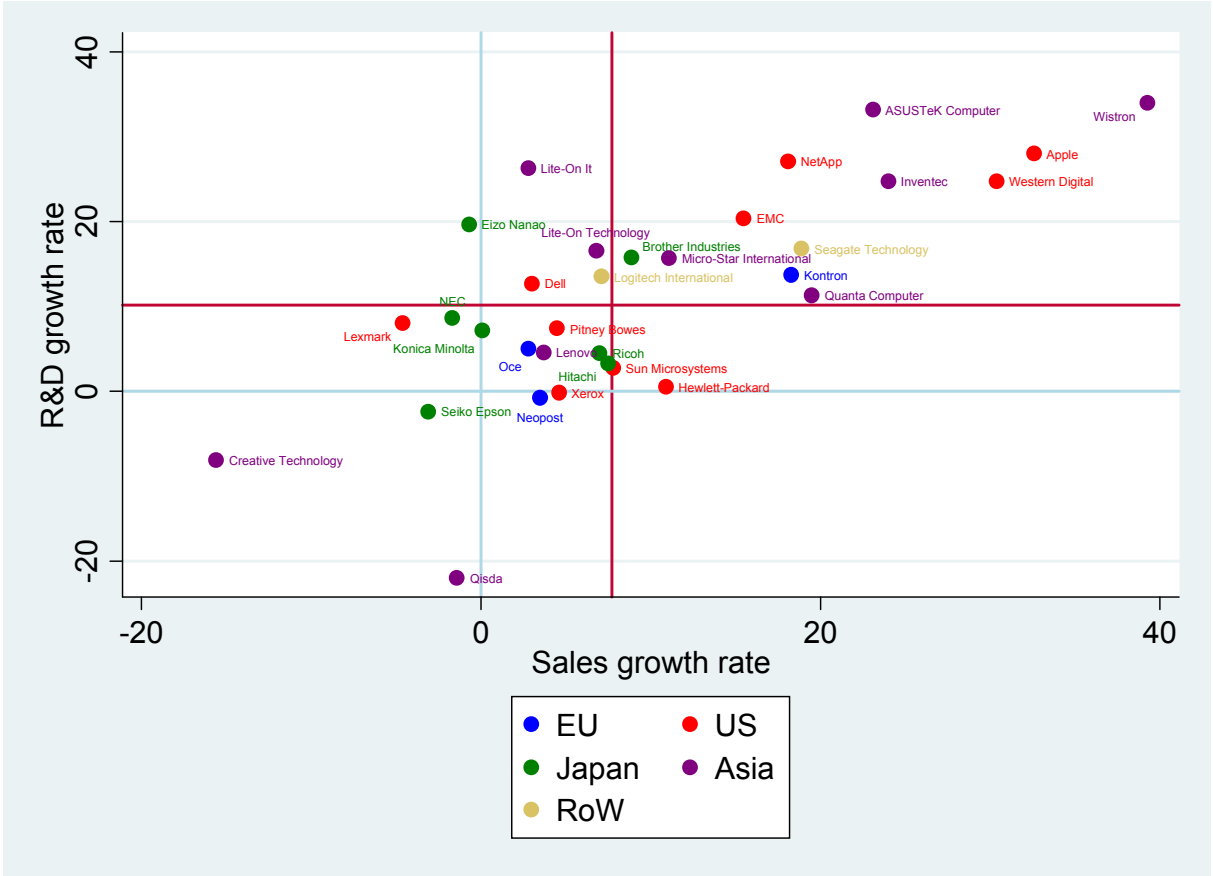
²⁰ The hypothesis that this might reflect a niche market position would need to be corroborated by a company investigation.

²¹ For Qisda, this reduction was mainly caused by an unsuccessful venture of BenQ-Siemens Mobile in Germany and the subsequent spin-off of Qisda from the BenQ Corporation in 2007.

²² These values are calculated as simple averages across all IT Equipment firms in the *ICT Scoreboard*. Therefore, they may be affected by a distribution of these companies. Since this distribution with respect to sales – representing the size of a company – is not normal but rather skewed towards lower values, a comparison between small (below € 1 billion sales in 2008) and big companies (above € 1 billion sales in 2008) is provided as well. While the R&D and sales growths for small companies (38% of this sample) were 7% and 3% respectively, for big ones these growths were a bit bigger, 12% and 10%.

from each world region (as listed in Table 3), according to their R&D growth/sales growth.²³ Although these companies are the top R&D spenders within their sub-sector, there are huge differences in their sales and R&D growth. While Wistron shows almost 40% growth in both parameters, companies like Creative Technology, Qisda or Seiko Epson have negative values for both parameters. Furthermore, it is interesting that these top R&D-spending companies are spread almost equally between Groups I and III. In other words, almost one half of them are located below average and the other half above average. Here, one has to keep in mind that these average growth values are based on the full sample of all *ICT Scoreboard* companies within this sub-sector. Thus, this result suggests that high/low R&D and sales growth rates go together. There are only a few exceptions to this pattern.²⁴

Figure 11: Top R&D-investing companies in IT Equipment within each world region (2008)



Note: Based on nominal values, not adjusted for inflation. Average R&D and sales growth rates: 10% and 8%. These averages are represented by red horizontal and vertical lines.

Focusing on sales growth, Figure 11 represents the top 20 companies per sales growth for the sub-sector during the period 2005-2008. Again, while the overall framework of the figure is identical to Figure 11, the sampling methodology differs. In Figure 12, the sub-sector companies of the *ICT Scoreboard* are first ranked in terms of sales growth rates, and then the top 20 companies are plotted onto the graph. This allows us to observe the fastest growing companies in the sub-sector worldwide, and their respective behaviour concerning R&D

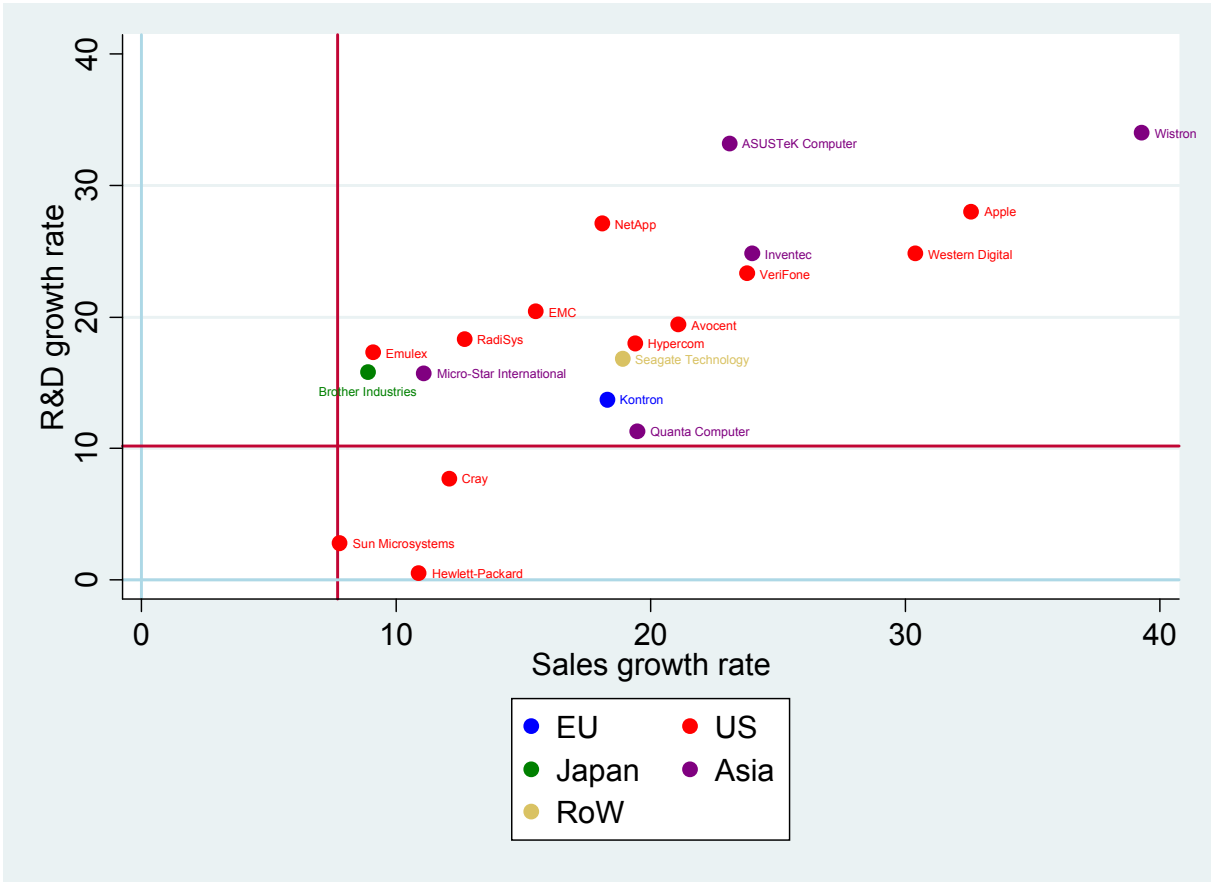
²³ Xyratex is not included here because its data is available only for 2008 and therefore it is not possible to calculate its growth values.

²⁴ There may be other companies with higher/lower sales or R&D growth rates from IT Equipment sub-sector that are not depicted in this graph because of their lower R&D investments. Additionally, there may also be other companies from IT Equipment sub-sector with higher/lower sales or R&D growth rates that are not included in the *ICT Scoreboard*.

investments.

Figure 12 shows several interesting facts. First, the general pattern of high/low R&D and sales growths going together also holds in this case – 17 out of the top 20 companies in sales growth are located in Group I. Moreover, levels of sales growth for these top 20 companies roughly correspond to levels of R&D growth. Further, although the company with the fastest growing sales comes from Asia, twelve companies come from the US. The remaining three regions have only one company each in this Top 20. Finally, when comparing this graph with Figure 11 one can see that all top R&D-spending companies from Groups I and IV (Figure 11) are also present here. Thus, those top R&D investors (nominally) from this sub-sector, which have above the sample average sales growths, can also be characterized by sub-sector-leading sales growths. Again, these average growth values are based on the full sample of all *ICT Scoreboard* companies within this sub-sector.

Figure 12: Top 20 IT Equipment companies in sales growth (2005-2008)



Note: Based on nominal values, not adjusted for inflation. Average R&D and sales growth rates: 10% and 8%. These averages are represented by red horizontal and vertical lines.

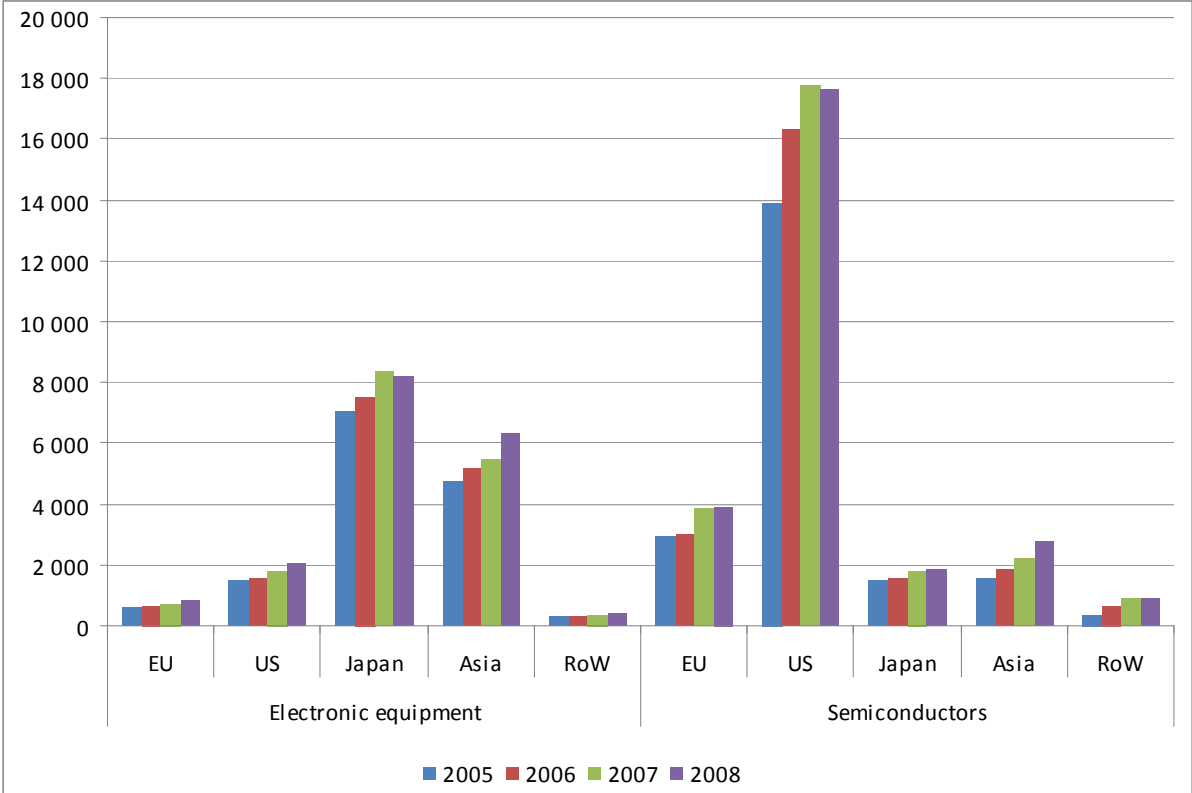
5.2 The IT Components sub-sector (NACE 32.1)

5.2.1 Top companies' R&D investments (2008)

As mentioned above, IT Components is the most important ICT sub-sector in terms of R&D investment. This sub-sector may be subdivided into the "ICB sub-sectors" of (1) Electronic Equipment and (2) Semiconductors. Figure 13 presents R&D investments by world regions according to this breakdown.

Whereas Japanese and Asian companies are major R&D investors in the Electronic Equipment sub-sector, US, and to a much lesser extent EU companies, seem to be the major drivers of technological progress in the Semiconductor industry. Interestingly, the role of Asian companies in Semiconductors has been clearly increasing, as over the last few years their R&D investments have exceeded those of Japanese companies and, in 2008, represented 70% of R&D investments made by EU companies in this industry.

Figure 13: R&D investments in the IT Components sub-sector as divided into Electronic Equipment and Semiconductors, by EU, US, Japanese, Asian and RoW ICT Scoreboard companies, in millions of € (2005-2008)



Note: Nominal terms, not adjusted for inflation.

5.2.2 Top companies' R&D investments ranking (2008)

Table 4 reports the sub-sectoral compositions, demographics and dynamics of the Top 10 R&D investors for IT components in the five regions. It is notable that there is a more sizable presence of EU firms (e.g. STM, NXP and Infineon) and US firms (e.g., Intel, TI, AMD) in Semiconductors than in Electronic Equipment, confirming the observations made above. Electronic Equipment is primarily dominated by Japanese firms (such as Canon, Sharp and Sanyo), Korean firms (such as Samsung and LG) and Taiwanese firms.

Table 4: Top 10 EU, US, Japanese, Asian and RoW R&D-investing companies in IT Components (2008)

Company	ICB sub-sector	Country/State	R&D 2008 (€ m)	R&D 2005-2008 (€ m)	RDI 2008	R&D CAGR	Net Sales 2008 (€ m)	Age
EU								50.5
STMicroelectronics	Semiconductors	Netherlands	1545	427	21.9%	11.4%	7045	54
NXP	Semiconductors	Netherlands	863		22.0%		3916	58
Infineon Technologies	Semiconductors	Germany	673	-570	11.0%	-18.5%	6106	59
ASML	Semiconductors	Netherlands	534	205	18.1%	17.5%	2954	27
Agfa-Gevaert	Electronic equipment	Belgium	179	-23	5.9%	-3.9%	3032	144
TomTom	Electronic equipment	Netherlands	143	133	8.6%	141.3%	1674	20
CSR	Semiconductors	UK	110	66	22.0%	36.3%	500	13
Gemalto	Electronic equipment	Netherlands	98	49	5.9%	25.6%	1659	32
ARM	Semiconductors	UK	79	7	25.7%	3.0%	309	21
Barco	Electronic equipment	Belgium	78	5	10.0%	2.1%	778	77
US								48.0
Intel	Semiconductors	California	4117	415	15.2%	3.6%	27041	43
Texas Instruments	Semiconductors	Texas	1396	-54	15.5%	-1.3%	8994	81
AMD	Semiconductors	California	1330	506	31.4%	17.3%	4231	42
Broadcom	Semiconductors	California	1077	609	32.2%	32.0%	3351	20
Freescale Semiconductor	Semiconductors	Texas	820	-40	21.8%	-1.6%	3760	81
Applied Materials	Semiconductors	California	794	118	13.6%	5.5%	5848	44
Nvidia	Semiconductors	California	616	362	25.0%	34.5%	2464	18
Danaher	Electronic equipment	DC	522	249	5.7%	24.2%	9135	42
Agilent Technologies	Electronic equipment	California	506	-24	12.2%	-1.6%	4154	72
Micron Technology	Semiconductors	Idaho	489	55	11.6%	4.0%	4202	33
Japan								73
Canon	Electronic equipment		2969	695	9.1%	9.3%	32494	74
Sharp	Electronic equipment		1557	381	5.7%	9.8%	27125	99
Sanyo Electric	Electronic equipment		570	-476	3.4%	-18.3%	16535	61
Tokyo Electron	Semiconductors		507	159	7.1%	13.3%	7191	48
Pioneer	Electronic equipment		471	28	7.7%	2.0%	6147	73
TDK	Electronic equipment		455	167	6.6%	16.4%	6875	76
Omron	Electronic equipment		409	16	6.8%	1.4%	6056	78
Murata Manufacturing	Semiconductors		336	75	6.7%	8.8%	5013	67
Yokogawa Electric	Electronic equipment		324	94	9.3%	12.1%	3472	96
Rohm	Semiconductors		262	6	8.9%	0.7%	2964	53
Asia								31.0
Samsung Electronics	Electronic equipment	South Korea	3469	669	6.2%	7.4%	56268	42
LG	Electronic equipment	South Korea	1304	81	2.5%	2.2%	51535	53
Hon Hai Precision Industry	Electronic equipment	Taiwan	519	327	1.2%	39.4%	42760	37
Taiwan Semiconductor Manufacturing	Semiconductors	Taiwan	471	164	6.4%	15.3%	7304	24
MediaTek	Semiconductors	Taiwan	466	308	23.5%	43.3%	1982	14
Hynix Semiconductor	Semiconductors	South Korea	438	249	11.2%	32.3%	3894	28
HTC	Electronic equipment	Taiwan	205	152	6.1%	57.4%	3340	14
Avago Technologies	Semiconductors	Singapore	191		15.6%		1225	40
United Microelectronics	Semiconductors	Taiwan	181	-30	8.5%	-4.9%	2122	31
Compal Electronics	Electronic equipment	Taiwan	165	86	1.6%	27.6%	10495	27
RoW								25.8
Marvell Technology	Semiconductors	Bermuda	669	444	31.5%	43.8%	2123	16
Kudelski	Electronic equipment	Switzerland	150	38	21.6%	10.2%	695	20
Endress & Hauser	Electronic equipment	Switzerland	89	15	7.3%	6.2%	1211	58
Micronas Semiconductor	Semiconductors	Switzerland	83	-20	20.5%	-7.1%	404	22
Himax Technologies	Semiconductors	Cayman Islands	63	62	10.5%	311.4%	599	10
Orbotech	Electronic equipment	Israel	55	14	17.8%	10.5%	309	30
Advanced Digital Broadcast	Electronic equipment	Switzerland	50	20	19.1%	18.2%	260	16
TPV Technology	Electronic equipment	Bermuda	48	27	0.7%	32.1%	6653	23
SEZ	Semiconductors	Switzerland	43	13	19.4%	12.9%	224	25
Zarlink Semiconductor	Semiconductors	Canada	33	6	20.2%	7.0%	163	38

Note: Nominal terms, not adjusted for inflation. Annual reports, company information and Wikipedia have been used for determining the age of the companies. Age is 2011 minus the birth year. The resulting average age has been calculated per region. Average ages for each region (in bold) are calculated from the sample of companies listed in this table.

Colours: Blue: Companies older than 50 years. Black: Companies between 30 and 50 years old. Red: Companies younger than 30 years, and older than 15 years. Green: Companies 15 years or younger.

Regarding the EU IT Components sector, it can be seen that it is largely dominated by three semiconductor companies. Two of them (NXP and Infineon) have been spun-off by Philips and Siemens while the third one - STM - is the result of merger of French and Italian chipmakers. Down the list there are examples of younger, often fabless semiconductor firms, such as ARM and CSR.²⁵ Although EU companies are the smallest R&D investors in the developed regions, they achieved the highest R&D growth rate. For example, between 2005 and 2008, their R&D spending increased on average by over 11%, as compared to around 7% by US and 5% by Japanese companies. Moreover, the EU IT Components sector achieves (together with the US) the highest R&D intensity of all ICT sub-sectors from all regions (14% and 15% respectively).

The top US R&D investors in the IT Components sector are mainly major semiconductor manufacturers, e.g. Intel, Texas Instruments and AMD, with a few relatively young companies from Silicon Valley (California). Japanese firms are typically older.

The largest Asian R&D investors are mainly from South Korea and Taiwan and, on average, are younger than the companies from the other regions. This is particularly visible for the Taiwanese firms and can be considered to be part of the reason for the rapid and intensive growth of R&D investments by companies from this region.

5.2.3 Top companies' growth rates (2005-2008)

The figures in this section illustrate the link between IT Components companies' R&D growth and sales growth. For all IT Equipment firms in the *ICT Scoreboard*, in the period between 2005 and 2008, average R&D and sales growth rates were 15% and 13% respectively,²⁶ which corresponds to all-ICT growth rates. Based on these values, companies can be categorised into four groups:

- Group I: with R&D growth rate **above** 15% and sales growth rate **above** 13%,
- Group II: with R&D growth rate **above** 15% and sales growth rate **below** 13%,
- Group III: with R&D growth rate **below** 15% and sales growth rate **below** 13%,
- Group IV: with R&D growth rate **below** 15% and sales growth rate **above** 13%.

Further analysis shows that most of the all IT Components companies are located in Group III (more than 61%). From the regional perspective, almost 75% of Japanese companies belong here. They are then followed by US (63%) and EU companies (61%). On the other hand, more than 30% of Asian or RoW companies belong to Group I, while only 11% of EU companies does so.

Figure 14 maps a sample of the top 10 (if available) R&D-investing IT Components companies from each world region (as listed in Table 4), according to their R&D growth/sales growth.²⁷ The majority of these companies belong to Group III – with both parameters below the sample average values. Here, one has to keep in mind that these average growth values are based on the full sample of all *ICT Scoreboard* companies within this sub-sector. There are

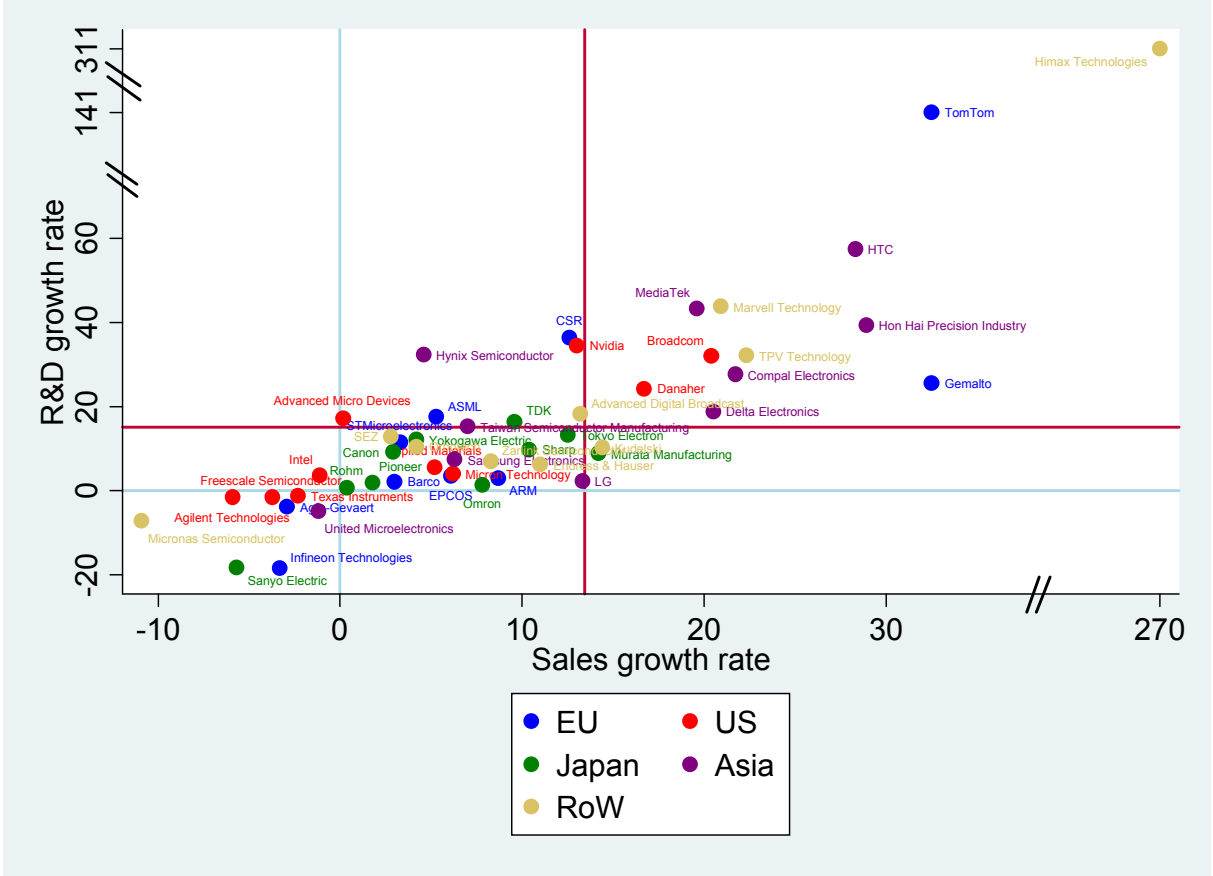
²⁵ See Tuomi (2009) for a recent overview of the current state and potential future developments in semiconductor IP firms.

²⁶ These values are calculated as simple averages across all IT Components firms in the *ICT Scoreboard*. Therefore, they may be affected by the distribution of these companies. Since this distribution with respect to sales – representing the size of a company – is not normal but rather skewed towards lower values, a comparison between small (below € 1 billion sales in 2008) and big companies (above € 1 billion sales in 2008) is provided as well. While the R&D and sales growths for small companies (49% of this sample) were 16% and 17% respectively, for big ones these growths were a bit lower, 14% and 10%.

²⁷ NXP and Avago Technologies are not included here because their data are not available for 2005 and therefore it is not possible to calculate their 2005-2008 growth values.

also huge differences in their sales and R&D growths. While Himax Technologies or TomTom show above 100% growth in at least one parameter (Himax Technologies shows as much as 300% in both parameters), there are eight companies with negative values in both parameters.²⁸

Figure 14: Top R&D-investing companies in IT Components within each world region (2008)

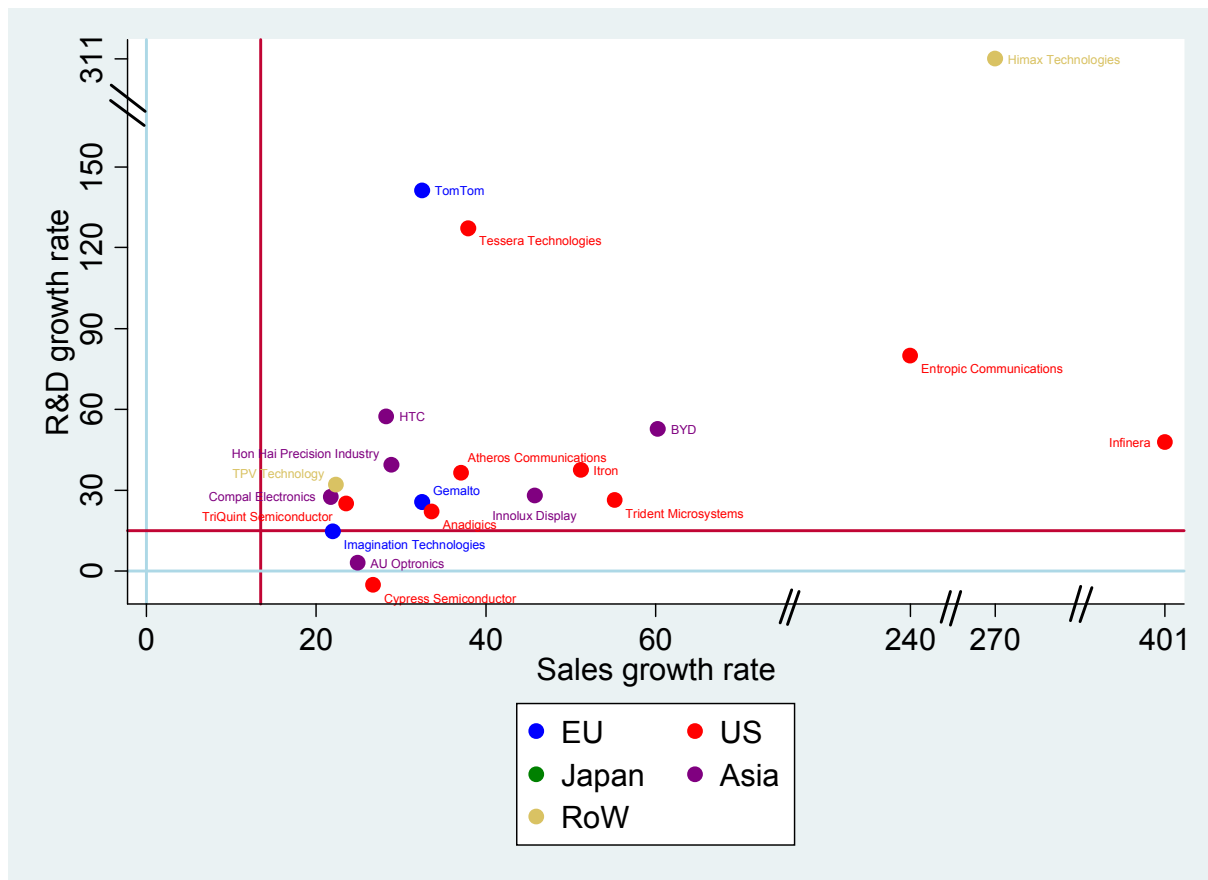


Note: Based on nominal values, not adjusted for inflation. Average R&D and sales growth rates: 15% and 13%. These averages are represented by red horizontal and vertical lines.

Focusing on sales growth, Figure 15 represents the top 20 companies per sales growth for the sub-sector during the period 2005-2008. Again, while the overall framework of the figure is identical to Figure 14, the sampling methodology differs. Here, first, the sub-sector companies from the *ICT Scoreboard* are ranked in terms of sales growth rates, and then the top 20 companies are plotted onto the graph. This allows us to observe the fastest growing companies of the sub-sector, worldwide, and their respective behaviour concerning R&D investments.

²⁸ There may be other companies with higher/lower sales or R&D growth rates from the IT Components sub-sector that are not depicted in this graph because of their lower R&D investments. Additionally, there may also be other companies from the IT Components sub-sector with higher/lower sales or R&D growth rates that are not included in the *ICT Scoreboard*.

Figure 15: Top 20 IT Components companies in sales growth within Groups I to IV (2005-2008)



Note: Based on nominal values, not adjusted for inflation. Average R&D and sales growth rates: 15% and 13%. These averages are represented by red horizontal and vertical lines.

Several observations can be made on Figure 15. First, the general pattern of high/low R&D and sales growths going together also holds in this case – 18 out of top 20 companies in sales growth are located in Group I, although the pattern is not so clearly visible here. There are some companies with only one growth rate very large, while the other remains low. The top company for sales growth - Infirera - has an average sales growth rate of over 400% (mainly due to growing world-wide bandwidth demand). At the same time, however, its R&D growth is on average less than 50%. Other examples like these are Entropic Communications, TomTom or Tessera Technologies. Furthermore, this graph is dominated by US and Asian companies, as 15 companies come from either of these two regions.

5.3 The Telecom Equipment sub-sector (NACE 32.2)

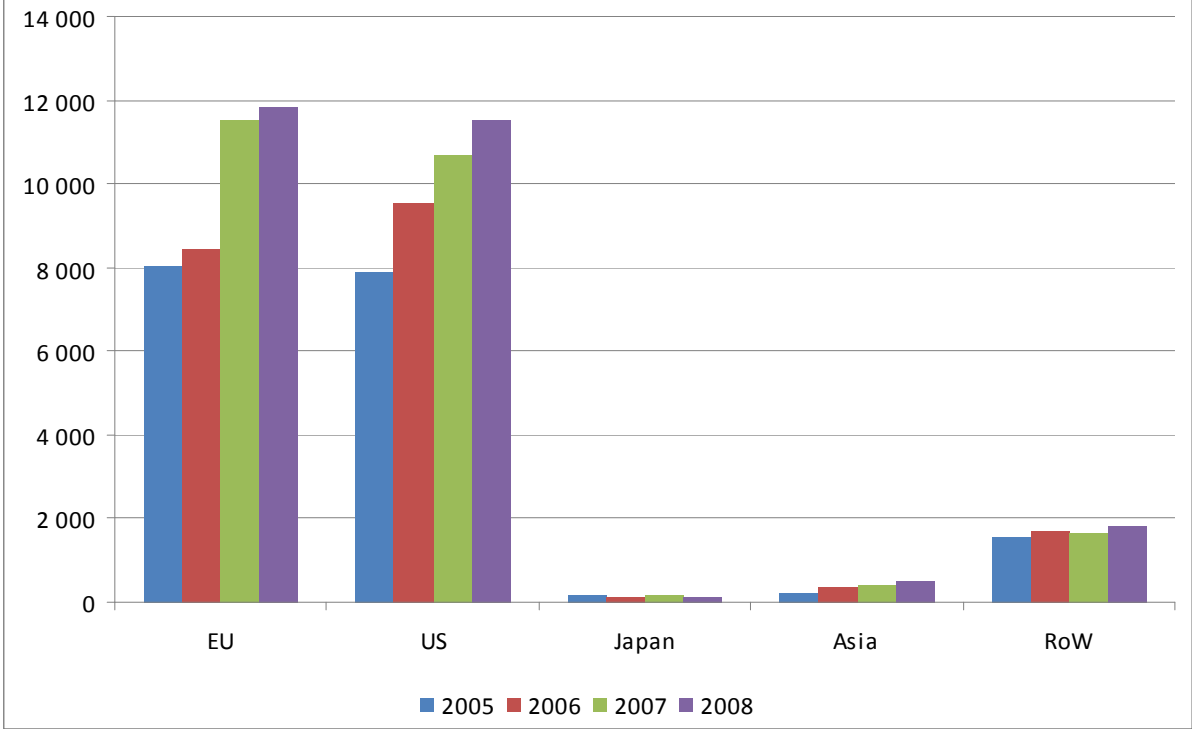
5.3.1 Top companies' R&D investments (2008)

Figure 16 presents R&D investments of the Telecom Equipment sub-sector by world regions. According to the 2009 *ICT Scoreboard* data, this sub-sector is the third largest R&D investing one (after the IT Components and the Computer Services and Software).

As of 2008, EU and US companies are the major R&D investors in the Telecom Equipment sub-sector. Few companies from other parts of the world play a significant role, in terms of R&D investment in this sub-sector. One of them is Nortel, a Canadian company, which in

2009 was acquired partly by Ericsson and partly by US Avaya. Despite the EU lead, US companies (Cisco Systems, Motorola and Qualcomm) have increased their R&D investments since 2006 more rapidly than EU ones and are approaching the investment level of EU companies. In addition, EU R&D growth in this sector can be largely attributed to merger and acquisitions (particular examples were discussed in Section 3).

Figure 16: R&D investments in the Telecom Equipment sub-sector EU, US, Japanese, Asian and RoW ICT Scoreboard companies, in millions of € (2005-2008)



Note: Nominal terms, not adjusted for inflation.

5.3.2 Top companies' R&D investments ranking (2008)

Table 5 reports detailed information on the demographics and dynamics of the top 10 R&D investors for Telecom Equipment. According to this data, it can be seen that in the EU, just three firms (Nokia, Ericsson and Alcatel-Lucent) account for nearly all (96%) of EU Telecom Equipment R&D investments. In the US, some part of the R&D and R&D growth can be attributed to a large number of rapidly growing ‘medium-sized’ companies (e.g., Juniper), but the three biggest companies (Cisco Systems, Motorola and Qualcomm) are still responsible for 83% of all US Telecom Equipment R&D investments. Despite these structural differences, US and EU firms report similar levels of R&D intensity (above 13%), which is also well above the average of firms from the other three regions.

Concerning Japan, Asia and the RoW, these regions are listed together in Table 5, because of their relatively limited number of major R&D investors. It should be noted however, that several other major Asian electronics firms such as, NEC and Samsung have a strong presence in the Telecom Equipment sub-sector as well. The fast-growing ZTE, a Chinese firm, is emerging as an important manufacturer of Telecom Equipment.

Table 5: Top 10 EU and US, plus 11 R&D-investing companies in Telecom Equipment from other regions (2008)

Company	ICB sub-sector	Country/State	R&D 2008 (€ m)	R&D 2005-2008 (€ m)	RDI 2008	R&D CAGR	Net Sales 2008 (€ m)	Age
EU								86.4
Nokia	Telecommunications equipment	Finland	5321	1692	10.5%	13.6%	50710	146
Alcatel-Lucent	Telecommunications equipment	France	3167	1375	18.6%	20.9%	16984	139
Ericsson	Telecommunications equipment	Sweden	2975	644	15.7%	8.5%	19008	135
Italtel	Telecommunications equipment	Italy	94	3	20.1%	1.1%	468	90
GN Store Nord	Telecommunications equipment	Denmark	71	36	9.4%	26.7%	756	190
Pace	Telecommunications equipment	UK	62	32	8.0%	27.5%	771	29
Spirent Communications	Telecommunications equipment	UK	47	-18	17.6%	-10.3%	267	75
ADVA	Telecommunications equipment	Germany	41	25	18.8%	35.6%	218	17
Option	Telecommunications equipment	Belgium	37	22	13.8%	36.1%	268	25
Wavecom	Telecommunications equipment	France	34	-14	16.6%	-10.7%	202	18
US								54.1
Cisco Systems	Telecommunications equipment	California	3707	1317	13.0%	15.8%	28446	27
Motorola	Telecommunications equipment	Illinois	2956	309	13.6%	3.7%	21688	83
Qualcomm	Telecommunications equipment	California	1641	914	20.5%	31.2%	8016	26
Juniper Networks	Telecommunications equipment	California	526	270	20.5%	27.2%	2570	15
Coming	Telecommunications equipment	New York	451	132	10.5%	12.3%	4279	160
Tellabs	Telecommunications equipment	Illinois	220	-28	17.7%	-3.9%	1244	36
Harris	Telecommunications equipment	Florida	198	99	5.2%	26.1%	3821	116
Brocade Communications	Telecommunications equipment	California	184	90	17.4%	25.0%	1055	16
JDS Uniphase	Telecommunications equipment	California	135	68	12.3%	26.1%	1101	30
3Com	Telecommunications equipment	Massachusetts	129	56	13.7%	20.9%	947	32
others								48.0
OKI Electric	Telecommunications equipment	Japan	145	-30	2.5%	-6.1%	5712	130
ZTE	Telecommunications equipment	China	451	244	9.6%	29.7%	4671	26
VTech	Telecommunications equipment	Hong Kong	41	12	3.9%	12.2%	1042	35
ZyXEL Communications	Telecommunications equipment	Taiwan	33		10.0%		331	22
Nortel Networks	Telecommunications equipment	Canada	1132	-204	15.1%	-5.4%	7497	116
Research In Motion	Telecommunications equipment	Canada	493	379	6.2%	63.2%	7961	27
Aastra Technologies	Telecommunications equipment	Canada	57	27	11.8%	24.4%	485	16
Tandberg	Telecommunications equipment	Norway	49	28	8.3%	33.8%	582	78
Alvarion	Telecommunications equipment	Israel	43	15	21.2%	15.3%	202	19
Sierra Wireless	Telecommunications equipment	Canada	35	13	8.5%	16.7%	408	18
Eltek	Telecommunications equipment	Norway	33	21	5.3%	40.8%	612	41

Note: Nominal terms, not adjusted for inflation. Annual reports, company information and Wikipedia have been used for determining the age of the companies. Age is 2011 minus the birth year. The resulting average age has been calculated per region. Average ages for each region (in bold) are calculated from the sample of companies listed in this table.

Colours: Blue: Companies older than 50 years. Black: Companies between 30 and 50 years old. Red: Companies younger than 30 years, and older than 15 years. Green: Companies 15 years or younger.

5.3.3 Top companies' growth rates (2005-2008)

The figures in this section illustrate the link between Telecom Equipment companies' R&D growth and sales growth.

For all Telecom Equipment firms in the *ICT Scoreboard*, in the period between 2005 and 2008, average R&D and sales growth rates were 19% and 26% respectively,²⁹ which is higher than corresponding all-ICT growth rates. Based on these values, companies can be categorised into four groups:

- Group I: with R&D growth rate **above** 19% and sales growth rate **above** 26%,
- Group II: with R&D growth rate **above** 19% and sales growth rate **below** 26%,
- Group III: with R&D growth rate **below** 19% and sales growth rate **below** 26%,
- Group IV: with R&D growth rate **below** 19% and sales growth rate **above** 26%.

Further analysis of all Telecom Equipment companies shows that although about 20% of all companies are located in Group I (a share which corresponds to that observed for other sub-sectors), almost 30% of all companies are located in Group II (which contrasts with other sub-sectors). This result, together with an increased average R&D growth, points to the fact that R&D activities play a significant role in this sector.

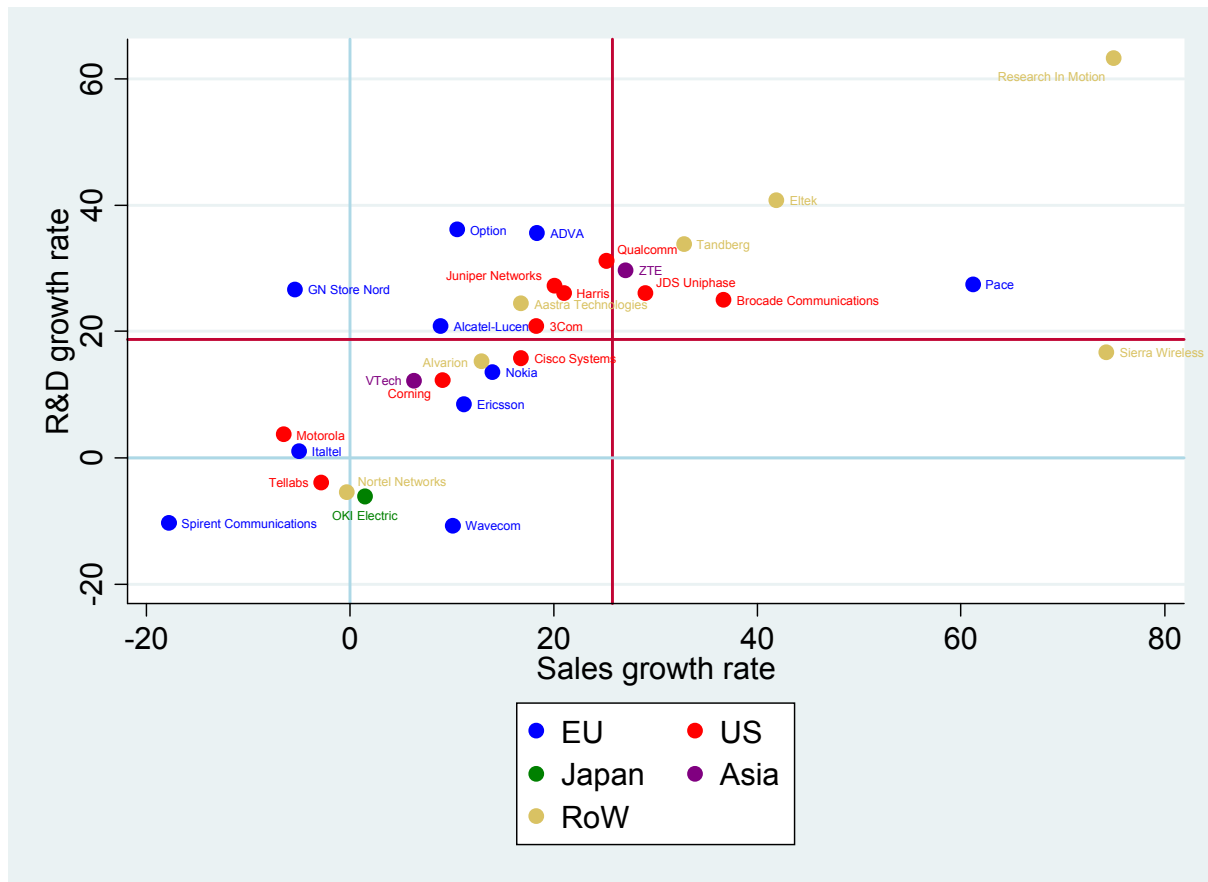
Figure 17 maps a sample of the top 10 (if available) R&D-investing Telecom Equipment companies from each world region (as listed in Table 5), according to their R&D growth/sales growth.³⁰ Similarly to previous sub-sectors, there are huge differences in the sales and R&D growth rates of these companies. While Research in Motion shows above 60% growth in both parameters, there are eight companies with negative values in at least one parameter. Furthermore, most of these companies belong to Group II and III (75%), meaning that they have below sub-sectoral average sales growth rates. It is, however, necessary to add here that the sub-sectoral average is based on the full sample of all *ICT Scoreboard* companies within this sub-sector and that it is by far the highest of all six analyzed sub-sectors. Therefore, despite the fact that the distribution has shifted towards below sample average sales growth values, the rule of high/low R&D and sales growth rates going together still holds. Another interesting fact is that 9 out of 10 EU companies have below the sample average sales growths. The only exception here is Pace with above 60% growth.³¹

²⁹ These values are calculated as simple averages across all Telecom Equipment firms in the *ICT Scoreboard*. Therefore, they may be affected by the distribution of these companies. Since this distribution with respect to sales – representing the size of a company – is not normal but rather skewed towards lower values, a comparison between small (below € 1 billion sales in 2008) and big companies (above € 1 billion sales in 2008) is provided as well. While the R&D and sales growths for small companies (64% of this sample) were 21% and 32% respectively, for big ones these growths were lower, 15% and 15%.

³⁰ ZyXel Technologies is not included here because its data is not available for 2005 and therefore it is not possible to calculate its 2005-2008 growth values.

³¹ There may be other companies with higher/lower sales or R&D growth rates from Telecom Equipment sub-sector that are not depicted in this graph because of their lower R&D investments. Additionally, there may also be other companies from Telecom Equipment sub-sector with higher/lower sales or R&D growth rates that are not included in the *ICT Scoreboard*.

Figure 17: Top R&D-investing companies in Telecom Equipment within each world region (2008)



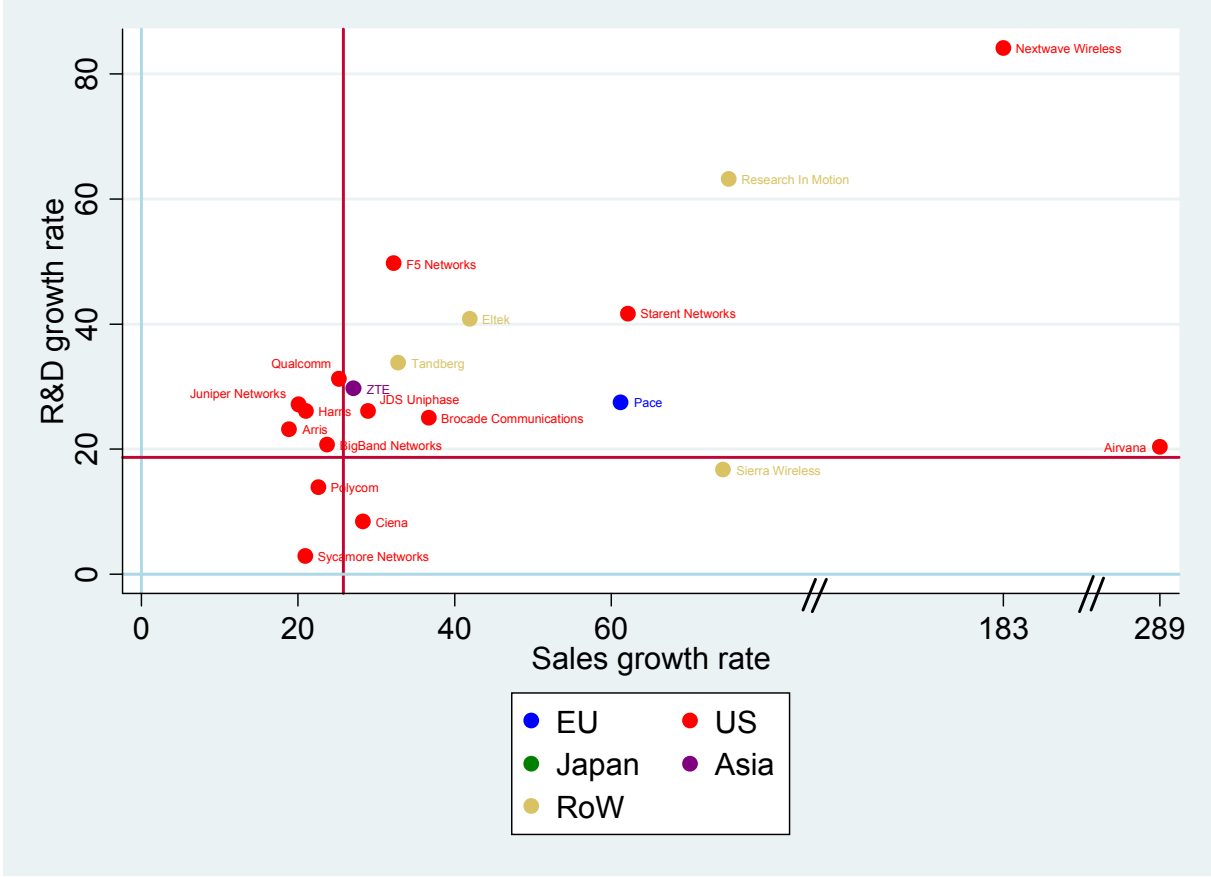
Note: Based on nominal values, not adjusted for inflation. Average R&D and sales growth rates: 19% and 26%. These averages are represented by red horizontal and vertical lines.

Focusing on sales growth, Figure 18 represents the top 20 companies per sales growth for the sub-sector during the period 2005-2008. Again, while the overall framework of this figure is identical to Figure 17, the sampling methodology differs. Here, first, the sub-sector companies of the *ICT Scoreboard* are ranked in terms of sales growth rates, and then the top 20 companies are plotted onto the graph. This allows us to observe the fastest growing companies of the sub-sector worldwide, and their respective behaviour concerning R&D investments.

The most obvious observation from this graph is that this sub-sector is absolutely dominated by US companies (14 out of the top 20). Four other companies are from the RoW, only one is from the EU and one from Asia. Moreover, the two outlying leaders in this sample, Airvana (289%) and Nextwave Wireless (183%), are from the US as well. Airvana, however, does not follow the general pattern as its R&D growth rate (20%) does not correspond to its enormous sales growth. Another contrast to other sub-sectors is that many of these top 20 companies are located (in terms of their sales growth) around the sample average sales growth level of the whole sub-sector. On the other hand, like other sub-sectors, the general pattern of high/low R&D and sales growths going together also holds also here. What is more, levels of sales growth for these top 20 companies roughly correspond to levels of R&D growth. There are only a few exceptions to this *pattern*, as mentioned above. Finally, when comparing this graph with Figure 17 one can see that all top R&D-spending companies from Groups I and IV are also present here. Thus, those top R&D investors (nominally) from this sub-sector, which

have above the sample average sales growth, can also be characterized by sub-sector-leading sales growth. Again, these average growth values are based on the full sample of all *ICT Scoreboard* companies within this sub-sector.

Figure 18: Top 20 Telecom Equipment companies in sales growth within each Group I to IV (2005-2008)



Note: Based on nominal values, not adjusted for inflation. Average R&D and sales growth rates: 19% and 26%. These averages are represented by red horizontal and vertical lines.

5.4 The Multimedia Equipment sub-sector (NACE 32.3)

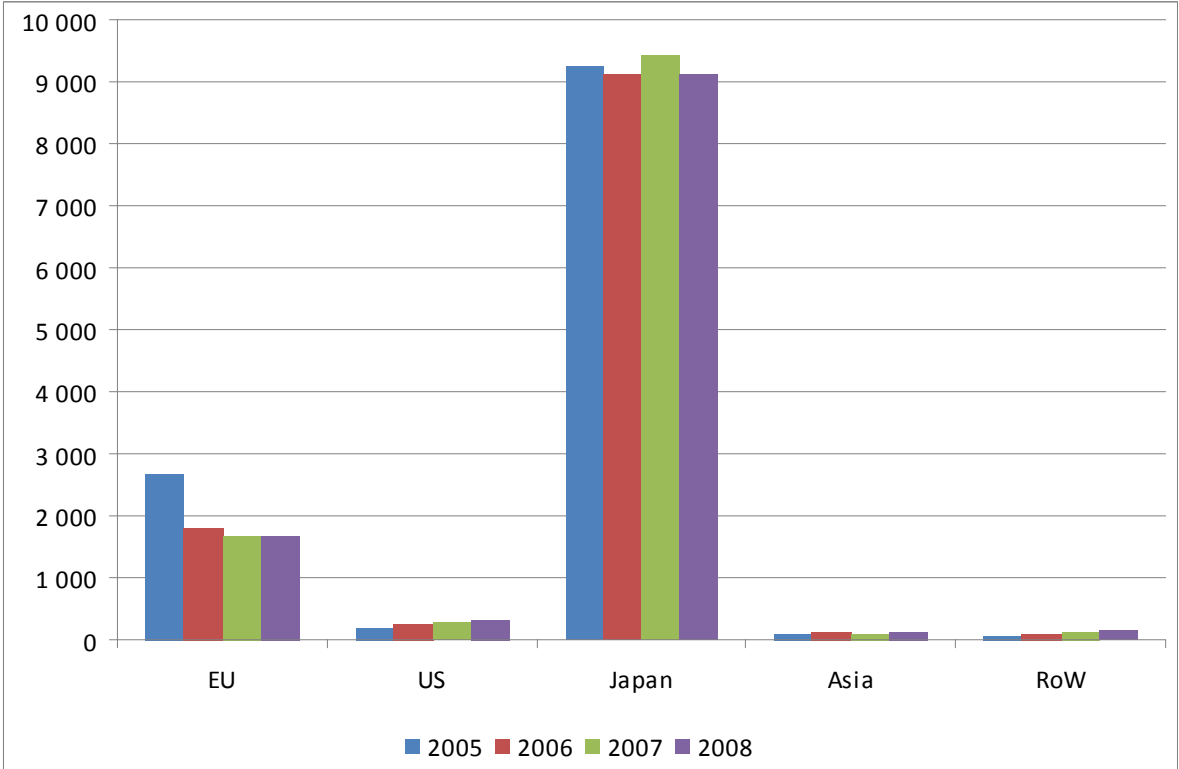
5.4.1 Top companies' R&D investments (2008)

Figure 19 reports R&D investments by world regions by companies in the Multimedia Equipment sub-sector from 2005 to 2008. Japanese companies, followed by EU firms, play the most significant role in this industry in terms of R&D investments. The R&D investments of companies from the US, Asia and the RoW are marginal. However, only companies from these regions show a growth in R&D investments. Whereas Japanese firms have maintained their R&D expenses at broadly the same level, EU firms have considerably decreased their spending on research and development over the last few years, especially from 2005 to 2006. As a result, the total level of R&D investments in this sub-sector decreased by over 2% between 2005 and 2008. This development is unique, compared to all other sub-sectors in which companies' average R&D investments increased in the same period.³²

³² Since there is only one company representing the EU here, Philips Electronics, this development is solely caused by NXP which spun off from Philips Electronics in 2006.

Although the R&D investments by US companies are only marginal, this region has the highest R&D intensity level (10%). The EU, Japan, and the RoW follow, with the same R&D intensity levels (around 6%). This is an interesting observation, given the huge difference in R&D investments between these three regions.

Figure 19: R&D investments in the Multimedia Equipment sub-sector by EU, US, Japanese, Asian and RoW ICT Scoreboard companies, in millions of € (2005-2008)



Note: Nominal terms, not adjusted for inflation.

5.4.2 Top companies' R&D investments ranking (2008)

Table 6 reports detailed information on R&D investments by major R&D investors in the Multimedia Equipment sub-sector from 2005 to 2008. Overall, there are only 12 Multimedia Equipment companies in the *ICT Scoreboard 2009*. These include only two EU companies. With 4 firms, Japan holds the prime position in this sub-sector. As in other sub-sectors, the youngest firms are from Asia and regions other than the EU, the US or Japan.

Table 6: R&D-investing companies in Multimedia Equipment (2008)

Company	ICB sub-sector	Country/State	R&D 2008 (€ m)	R&D 2005-2008 (€ m)	RDI 2008	R&D CAGR	Net Sales 2008 (€ m)	Age
								57.5
Philips Electronics	Leisure goods	Netherlands	1613	-1013	6.1%	-15.0%	26513	120
Bang & Olufsen	Leisure goods	Denmark	71	4	13.0%	1.8%	550	86
Harman International Industries	Leisure goods	USA/Connecticut	285	125	9.6%	21.2%	2959	31
Dolby Laboratories	Leisure goods	USA/California	45	23	9.7%	26.7%	461	46
Matsushita Electric (now Panasonic)	Leisure goods	Japan	4401	-484	6.1%	-3.4%	71977	93
Sony	Leisure goods	Japan	4132	147	5.9%	1.2%	69486	65
Nikon	Leisure goods	Japan	463	197	6.1%	20.3%	7586	94
Casio Computer	Leisure goods	Japan	117	-15	2.4%	-3.9%	4945	65
Inventec Appliances	Leisure goods	Taiwan	52	15	2.6%	11.6%	2031	36
Coretronic	Leisure goods	Taiwan	44	14	2.5%	13.1%	1752	19
Hannstar Display	Leisure goods	Taiwan	32	-3	2.4%	-2.8%	1326	13
Garmin	Leisure goods	Cayman Islands	148	94	5.9%	40.1%	2514	22

Note: Nominal terms, not adjusted for inflation. Annual reports, company information and Wikipedia have been used for determining the age of the companies. Age is 2011 minus the birth year. The resulting average age has been calculated per region. Average ages for each region (in bold) are calculated from the sample of companies listed in this table.

Colours: **Blue:** Companies older than 50 years. **Black:** Companies between 30 and 50 years old. **Red:** Companies younger than 30 years, and older than 15 years. **Green:** Companies 15 years or younger.

5.4.3 Top companies' growth rates (2005-2008)

The figure in this section illustrates the link between R&D growth and sales growth in Multimedia Equipment companies.

For all Multimedia Equipment firms in the *ICT Scoreboard*, from 2005 to 2008, average R&D and sales growth rates were 9% and 11% respectively,³³ which is lower than corresponding all-ICT growth rates. Based on these values, companies can be categorised into four groups:

- Group I: with R&D growth rate **above** 9% and sales growth rate **above** 11%,
- Group II: with R&D growth rate **above** 9% and sales growth rate **below** 11%,
- Group III: with R&D growth rate **below** 9% and sales growth rate **below** 11%,
- Group IV: with R&D growth rate **below** 9% and sales growth rate **above** 11%.

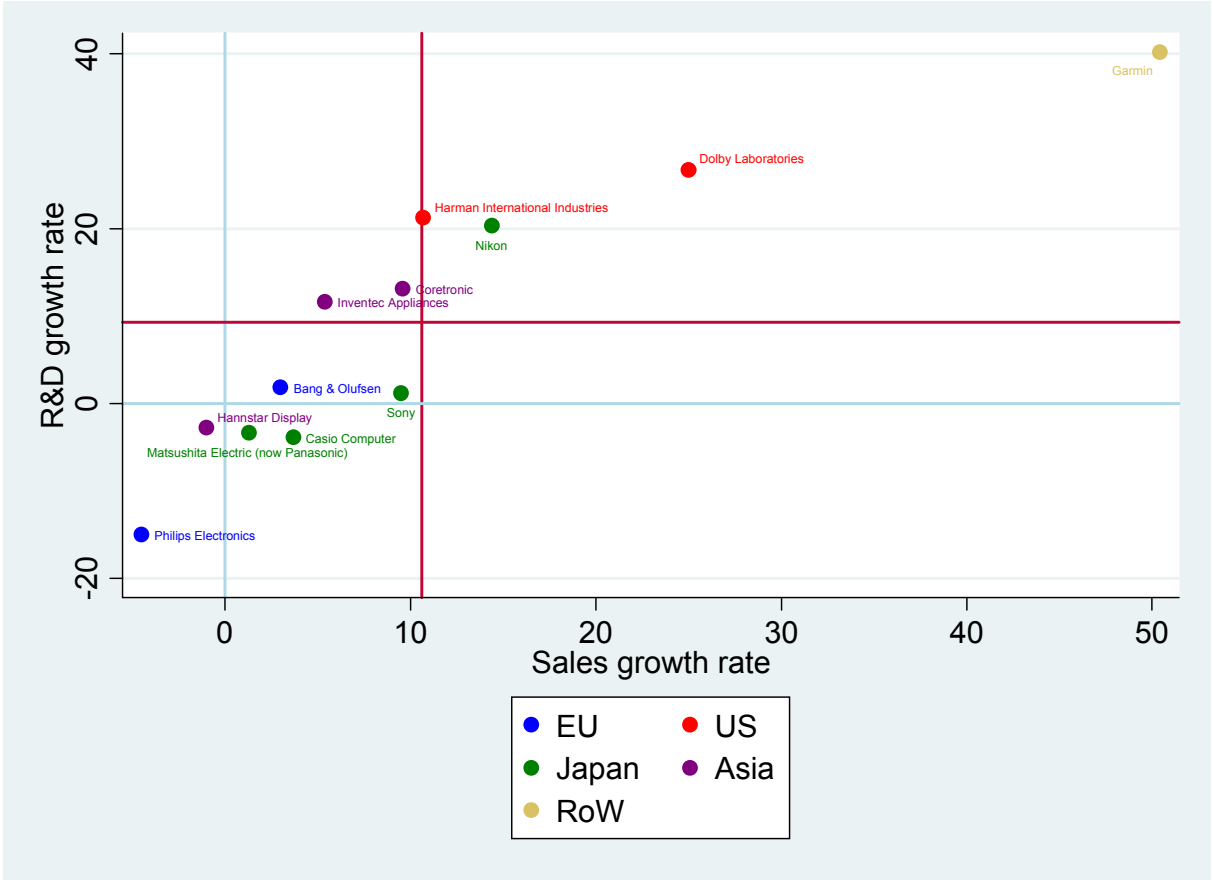
Figure 20 maps a sample of the top 10 (if available) R&D-investing Multimedia Equipment companies from each world region (as listed in Table 6), according to their R&D growth/sales growth. Note that this sample includes all twelve Multimedia Equipment companies listed in the *ICT Scoreboard*.

Looking at this graph, one can see that the general pattern of high/low R&D and sales growths going together holds in this case as well and levels of sales growth roughly correspond to levels of R&D growth. This also holds for the only outlier here, Garmin, with its 40-50% growth rates. Moreover, as a consequence of Garmin's relatively high growth

³³ These values are calculated as simple averages across all Multimedia Equipment firms in the *ICT Scoreboard*. Therefore, they may be affected by the distribution of these companies. Since this distribution with respect to sales – representing the size of a company – is not normal but rather skewed towards lower values, a comparison between small (below € 1 billion sales in 2008) and big companies (above € 1 billion sales in 2008) is provided as well. While both R&D and sales growths for small companies (17% of this sample) were 14%, for big ones these growths were a bit lower, 8% and 10%.

rates, the majority of Multimedia Equipment companies are located (in terms of their growths) below sub-sectoral average values.

Figure 20: R&D-investing companies in Multimedia Equipment (2008)



Note: Based on nominal values, not adjusted for inflation. Average R&D and sales growth rates: 9% and 11%. These averages are represented by red horizontal and vertical lines.

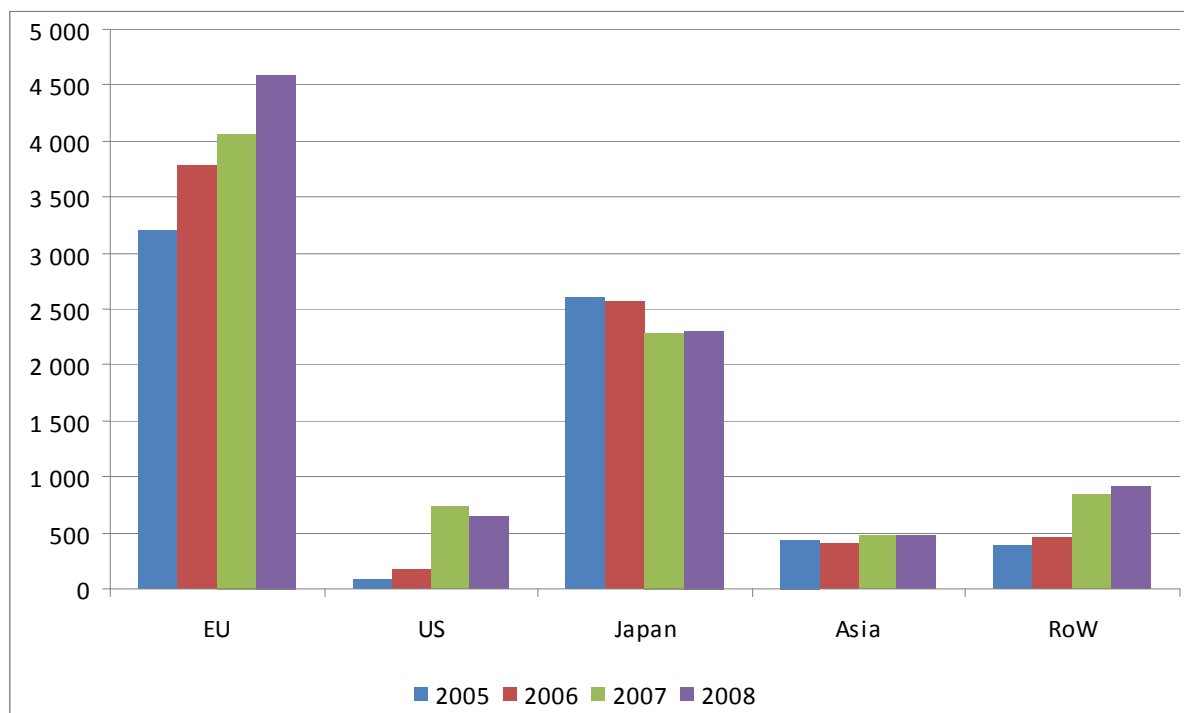
The analysis of the Multimedia Equipment sub-sector ends here because it contains only twelve companies in total. Following the approach applied in previous sections would not bring any new information.

5.5 The Telecom Services sub-sector (NACE 64.2)

5.5.1 Top companies' R&D investments (2008)

Figure 21 reports R&D investments by world regions by companies in the Telecom Services sub-sector from 2005 to 2008. According to these data, EU companies, followed by their Japanese counterparts, are the biggest R&D investors. Their cumulative R&D investments are higher than those of the remaining companies from US, Japan, Asia and the RoW taken together. Moreover, they also exhibit a very strong positive growth trend.

Figure 21: R&D investments in the Telecom Services sub-sector by EU, US, Japanese, Asian and RoW ICT Scoreboard companies, in millions of € (2005-2008)



Note: Nominal terms, not adjusted for inflation.

5.5.2 Top companies' R&D investments ranking (2008)

Table 7 gives more insight into the R&D investments by companies from the Telecom Services sub-sector from 2005 to 2008 across the five world regions. It can be seen that EU companies dominate this set of companies. Out of 21 telecommunication services providers included in the *ICT Scoreboard*, nearly half are EU companies. The high number of telecommunication services providers in Europe partly explains the overall high R&D investments, as compared to the other regions.

Regarding the level of R&D intensity, this sub-sector is characterised by a low level of the ratio of R&D investments to sales. For example, in 2008, the average level of RDI for EU companies in the Telecom Services sector was at 1.5%. In contrast, the value of the same ratio for EU companies of the Telecom Equipment sector was slightly above 13%. This is certainly attributable to the different activities of companies operating in these two sectors. For example, in contrast to Telecom Equipment manufacturers, telecom operators do not perform capital intensive R&D activities related to manufacturing. And, in addition, they also exhibit relatively large amounts of sales compared to manufacturers. This partly explains the large gap in R&D intensities between the Telecom Services and Telecom Equipment sub-sectors (see also Methodological Note in Annex III).

Table 7: Top 10 EU, and remaining US, Japanese, Asian and RoW R&D-investing companies in Telecom Services (2008)

Company	ICB sub-sector	Country/State	R&D 2008 (€ m)	R&D 2005-2008 (€ m)	RDI 2008	R&D CAGR	Net Sales 2008 (€ m)	Age
EU								46.0
BT	Fixed line telecommunications	UK	1157	405	5.2%	15.5%	22126	165
France Telecom	Fixed line telecommunications	France	900	184	1.7%	7.9%	53488	23
Telecom Italia	Fixed line telecommunications	Italy	704	524	2.3%	57.6%	30468	17
Telefonica	Fixed line telecommunications	Spain	668	124	1.2%	7.1%	57946	87
Deutsche Telekom	Fixed line telecommunications	Germany	614	181	1.0%	12.3%	61666	15
Vodafone	Mobile telecommunications	UK	290	77	0.7%	10.8%	42428	27
TeliaSonera	Fixed line telecommunications	Sweden	103	-159	1.1%	-26.8%	9424	8
KPN	Fixed line telecommunications	Netherlands	75	55	0.5%	55.4%	14427	22
Telekom Austria	Fixed line telecommunications	Austria	46	3	0.9%	1.9%	5170	15
Belgacom	Fixed line telecommunications	Belgium	41	-3	0.7%	-2.3%	5911	81
others								36.6
AT&T	Fixed line telecommunications	USA/Texas	599	505	0.7%	85.7%	89230	28
TerreStar	Mobile telecommunications	USA/Virginia	53	51		216.9%	0	23
NTT	Fixed line telecommunications	Japan	2151	-373	2.5%	-5.2%	84771	26
KDDI	Mobile telecommunications	Japan	155	68	0.5%	21.3%	28542	58
KT	Fixed line telecommunications	South Korea	219	9	2.0%	1.3%	11221	30
SK Telecom	Mobile telecommunications	South Korea	139	-6	1.7%	-1.4%	8075	27
Chunghwa Telecom	Fixed line telecommunications	Taiwan	69	12	1.6%	6.8%	4421	15
China Telecom	Fixed line telecommunications	China	52	24	0.3%	23.4%	19697	9
Telstra	Fixed line telecommunications	Australia	756	480	6.1%	39.8%	12454	18
Telenor	Mobile telecommunications	Norway	103	30	1.0%	12.3%	9987	156
Swisscom	Fixed line telecommunications	Switzerland	63	25	0.8%	18.4%	8245	13

Note: Nominal terms, not adjusted for inflation. Annual reports, company information and Wikipedia have been used for determining the age of the companies. Age is 2011 minus the birth year. The resulting average age has been calculated per region. Average ages for each region (in bold) are calculated from the sample of companies listed in this table.

Colours: Blue: Companies older than 50 years. Black: Companies between 30 and 50 years old. Red: Companies younger than 30 years, and older than 15 years. Green: Companies 15 years or younger.

5.5.3 Top companies' growth rates (2005-2008)

The figures in this section illustrate the link between R&D growth and sales growth in Telecom Services companies. For all Telecom Services firms in the *ICT Scoreboard*, in the period between 2005 and 2008, average R&D and sales growth rates were 27% and 2% respectively.³⁴ Based on these values, companies can be categorised into four groups:

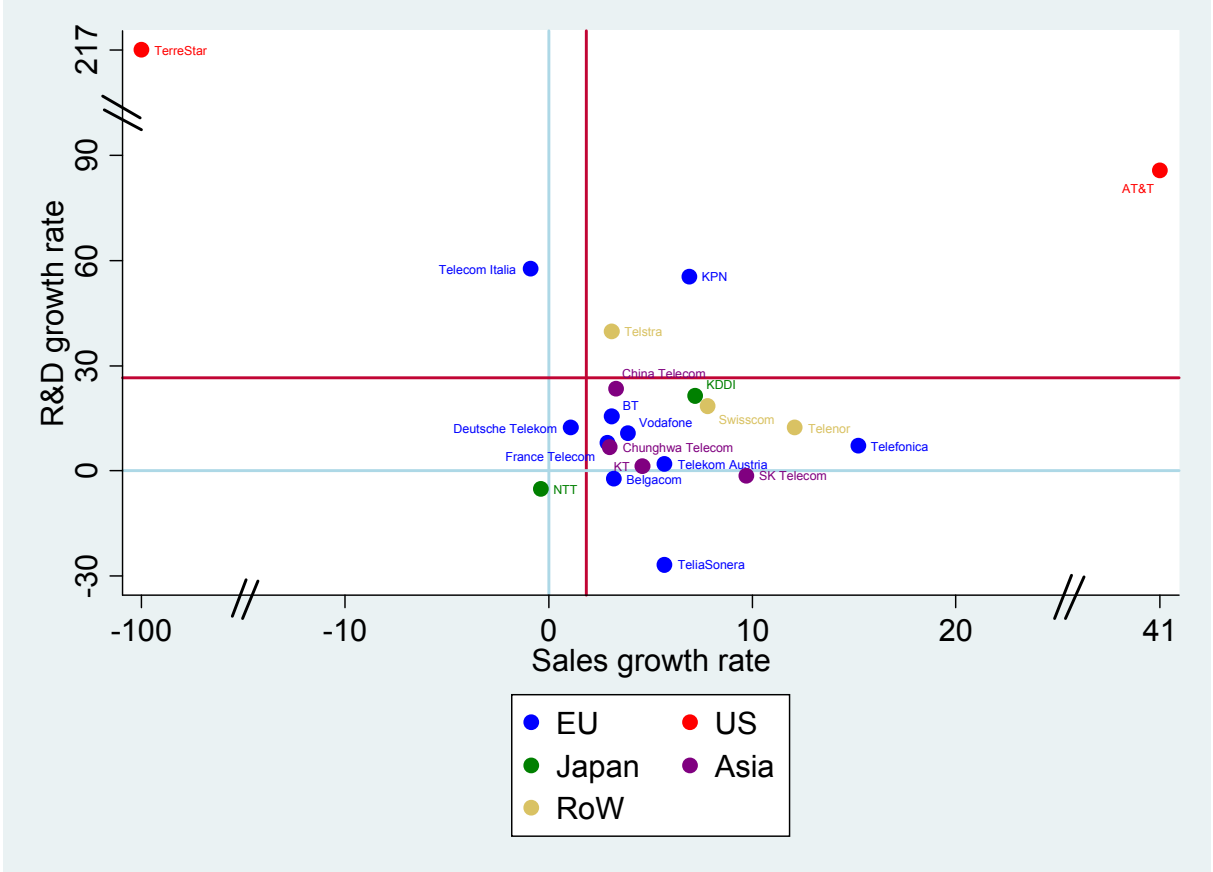
- Group I: with R&D growth rate **above** 27% and sales growth rate **above** 2%,
- Group II: with R&D growth rate **above** 27% and sales growth rate **below** 2%,
- Group III: with R&D growth rate **below** 27% and sales growth rate **below** 2%,
- Group IV: with R&D growth rate **below** 27% and sales growth rate **above** 2%.

³⁴ These values are calculated as simple averages across all Telecom Services firms in the *ICT Scoreboard*. Therefore, they may be affected by the distribution of these companies. Since this distribution with respect to sales – representing the size of a company – is not normal but rather skewed towards lower values, a comparison between small (below € 1 billion sales in 2008) and big companies (above € 1 billion sales in 2008) is provided as well. While the R&D and sales growths for small companies (5% of this sample) were 217% and -100% respectively, for big ones these growths were much lower, 17% and 7%.

Further analysis of all the Telecom Services companies shows that more than 80% are located either in Group I or II. However, one has to be cautious here because the average sales growth value is dragged down by the -100% sales year-to-year drop of TerreStar.³⁵

Figure 22 maps a sample of the top 10 (if available) R&D-investing Telecom Services companies from each world region (as listed in Table 7), according to their R&D growth/sales growth. Contrary to all the other five ICT sub-sectors, the top R&D-investing Telecom Services companies are close together in terms of their sales growth rates, which ranged only from 0 to 15%. The only exceptions here are AT&T (41%) and TerreStar (-100%) but the case of TerreStar is explained above. On the other hand, as regards R&D growth, there are huge differences among these companies. Whereas TerreStar shows more than 200% growth in its R&D spending and there are four other companies with 40-90% R&D growth, the majority has only between 0 and 30% growth. R&D investment by TeliaSonera even declined (by almost 30%). Furthermore, two thirds of these top R&D-spending companies are located in Group IV. It means that they are characterized by above the sample average sales growth and below the sample average R&D growth. Here, one has to keep in mind that these average growth values are based on the full sample of all *ICT Scoreboard* companies within this sub-sector. Moreover, the sample average growth values are dragged down/up by TerreStar's enormous sales decline/R&D growth. Nevertheless, one cannot claim that high/low R&D and sales growth rates go together here.

Figure 22: Top R&D-investing companies in Telecom Services within each world region (2008)



Note: Based on nominal values, not adjusted for inflation. Average R&D and sales growth rates: 27% and 2%. These averages are represented by red horizontal and vertical lines.

³⁵ TerreStar did not report any sales in their 31/12/08 and 31/12/07 accounts. On 31/12/06, it sold an operation which accounted for all its sales. In its most recent accounts (31/12/09), it began to report sales again. However, in October 2010, it filed for bankruptcy.

Similarly to Multimedia Equipment sub-sector, the analysis for Telecom Services sector ends here because there are only 21 companies in total in this sub-sector and following the approach applied in previous sections (Top 20 companies in sales growth) would not bring any new information.

Long term dynamics in Telecom R&D investments

EU Telecom Services and EU Telecom Equipment sub-sectors show R&D investment levels and growth trends above those of other world regions. This was also reported in the earlier PREDICT reports.³⁶ A closer look at these R&D figures is therefore worthwhile in order to better understand their long term dynamics.³⁷

Taken together, the figures tend indicate a long-standing division of labour between the Telecom Services and the Telecom Equipment sub-sectors, which allows them to mutually benefit from their investments. The following paragraphs illustrate and explain this division of labour.

Worldwide, leading Telecom operators account for around 45% of global Telecom industry revenues and for more than two-thirds of its capital investments (mainly in the rolling-out of networks) but only for about a tenth of total R&D investment. These capital investments in turn have generated revenues, which were largely spent buying equipment from the Telecom Equipment manufacturers.³⁸

Reciprocally, Telecom Equipment companies, accounting for the other 55% of the global telecom revenues are responsible for close to 90% of the R&D expenses for the whole of the Telecom industry, but only a third of capital investments. These R&D efforts have benefited Telecom Services, allowing them to develop their services and markets.

This ‘division of labour’ builds on the former state of the markets in the EU when each national public Telecom Services provider (the ‘former incumbent’) had a preferential relationship with a corresponding national Telecom manufacturing provider, often dominant as well. Of course, the nature of that relationship varied from country to country. France Telecom maintained preferential relations with Alcatel in France; Deutsche Telekom did the same with Siemens in Germany; etc.

In the EU, liberalisation of the telecommunications markets in 1998 changed the priorities of the incumbent Telecom Services companies. These former public monopolies seized the opportunity to revamp themselves, and become less technology-driven and more customer-oriented. The opening up of markets triggered huge capital investments which reached historical heights.³⁹ This restructuring of the industry could have triggered an immediate shift of resources and accordingly the willingness of Telecom operators to leave the initiative for R&D to the Telecom manufacturing industry. To avoid a massive disinvestment, some Member States imposed on their incumbent Telecom Services company the obligation to

³⁶ PREDICT reports, see at: 2010 Report: <http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=3239>; 2009 Report: <http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=2259>

³⁷ For some specific methodological issues, see Annex III.

³⁸ Source of IPTS calculation: Financial data from company reports based on the aggregation of data from the 60 largest Telecom operators and Equipment companies worldwide (courtesy of FT-Orange).

³⁹ Perspectives économiques de l'OCDE: juin n° 73 Volume 2003-1.

allocate significant amounts to R&D.⁴⁰ This was the case at least until 2001 when the financial crash happened,⁴¹ after which R&D investments declined.⁴²

In the United States, from a different point of departure, we find a similar evolution, marked in particular by the introduction of competition. Initially, all activities were integrated within what was then the largest company in the world, AT&T, acknowledged absolute leader in R&D (carried out by Bell Labs). However, the level of investments of this former telecom R&D leader, during what can be called the "AT&T monopoly period", was low, and the average R&D intensity (on sales) was around 0.8%.⁴³ This figure illustrates the historically low R&D investments made by the Telecom industry during the monopoly period. With the break-up of AT&T (into several 'baby-bells' or smaller US operators), R&D intensity surged to 4% (1982-1995). Finally, during the next period (1996-2003), R&D intensity declined in AT&T to 1.7% after the break away of Lucent Technologies (former Bells Labs) from the AT&T parent. R&D investments were shifted to Lucent Technologies. In this period, the financial crash of 2001 drastically impacted the overall level of R&D spending.

Companies invest in R&D for numerous reasons; competition is certainly one of them, together with product diversification and financial gains.⁴⁴ Companies in a more competitive environment, as illustrated by the AT&T case after the divestiture, may have more incentives to invest.

5.6 The Computer Services and Software sub-sector (NACE 72)

5.6.1 Top companies' R&D investments (2008)

This section analyses in more detail the Computer Services and Software sub-sector, by looking at the R&D investment dynamics in its constituent ICB sub-sectors (Computer Services, Software, Internet).

Figure 23 shows R&D investments by companies from the five world regions between 2005 and 2008. According to these data, US companies, and to a much lesser extent EU companies, together invest the most in R&D in the Computer Services and Software sub-sector. In 2008, US firms accounted for nearly 80% of R&D investments as a whole in this sub-sector, and the share invested by EU firms was the second highest in the world - 12% of the total. Considering that their R&D spending is constantly growing (especially in Internet and Software), the position of US firms in general is unlikely to be challenged by any other region any time soon. Firms from Japan invest less than EU firms and their investment level was stable during this period, while investment levels of US and EU firms increased notably. This is still true, despite the exceptional R&D investment growth rates of firms from Asia and the RoW (although this is hardly visible in Figure 23, due to the absolute size of their investments). The absolute dominance of Computer Services and Software by US companies is visible mainly in Software, where they invested almost two thirds of their total R&D spending in 2008 (more than 80% of global R&D spending in this sub-sector). Their dominance is even more evident in Internet where they invested almost 95% of global R&D

⁴⁰ For instance, France Telecom was mandated to invest up to 4% of its revenues in R&D. Decree n° 96-1225 of 27 December 1996 validating the conditions of contracts between France Telecom and the French State, under the article 19 "Research and development".

⁴¹ Burst of the Internet Bubble, so called 'Boom and Bust' crash. Perspectives économiques de l'OCDE: juin n° 73 Volume 2003-1.

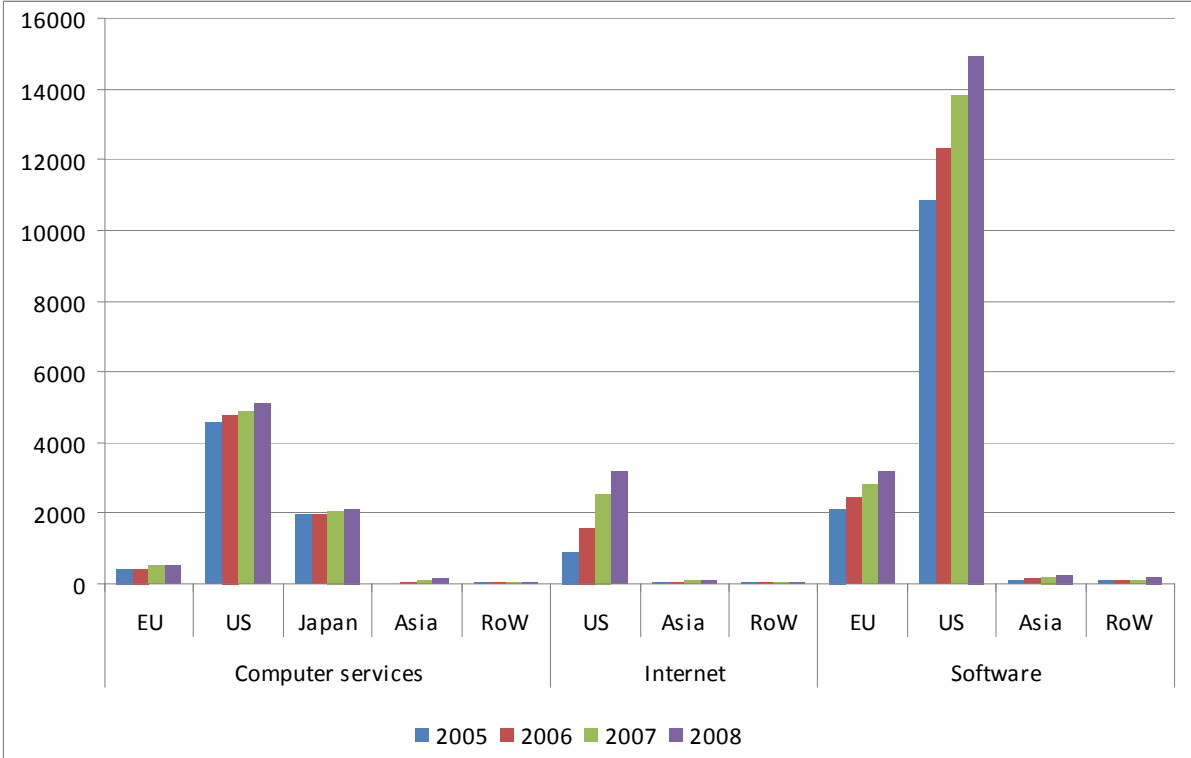
⁴² The floatation of most public incumbents may have had an additional and similar impact on these companies' R&D strategies.

⁴³ Harmantzis and Tanguturi (2005).

⁴⁴ Id.

spending. The Software sub-sector is the main focus of EU companies but to a much lesser extent. Japanese companies, on the other hand, invested mostly in Computer Services. Nevertheless, none of the remaining four regions achieved the US level of R&D investment in any of these three ICB sub-sectors.

Figure 23: R&D investments in the Computer Services and Software sub-sector by EU, US, Japanese, Asian and RoW ICT Scoreboard companies, in millions of € (2005-2008)



Note: Nominal terms, not adjusted for inflation.

5.6.2 Top companies’ R&D investments ranking (2008)

Table 8 illustrates the industry composition, demographics and dynamics of the top 10 R&D investors in Computer Services and Software from the five regions. In order to provide more insights with respect to different types of activities of Computer Services and Software firms, this sub-sector is further split into three ICB categories: Software, Computer Services and Internet.

Looking at the major R&D investors of the Computer Services and Software sub-sector, in the EU and the US, it is clear that the US companies, as an aggregate, still outperform the EU ones, also as an aggregate, in almost every respect: in 2008, their total R&D investments were over € 23 billion compared to € 3.7 billion in the EU. Similarly, the net sales of the US firms from this sub-sector were over 5 times higher than their EU counterparts. Regarding R&D investments growth rate, between 2005 and 2008, US firms increased R&D investment by more than € 5.7 billion, nearly six times as much as that of EU firms, despite the fact that, in terms of R&D investment growth, this sub-sector is the most dynamic in the EU.

The dominance of US firms is also further underlined by their average R&D intensity (11%) which is the highest of all regions. However, EU and Asian firms come close with 10% R&D intensities.

Table 8: Top 10 EU and US, plus other R&D-investing companies in Computer Services and Software from Japan, Asia and RoW (2008)

Company	ICB sub-sector	Country/State	R&D 2008 (€ m)	R&D 2005-2008 (€ m)	RDI 2008	R&D CAGR	Net Sales 2008 (€ m)	Age
EU								37.2
SAP	Software	Germany	1627	538	14.1%	14.3%	11575	39
UBIsoft Entertainment	Software	France	304	201	32.8%	43.5%	928	25
Dassault Systemes	Software	France	284	25	21.3%	3.2%	1335	30
Indra Sistemas	Computer services	Spain	166	80	7.0%	24.6%	2380	90
Amdocs	Software	UK	162	58	7.1%	16.0%	2275	29
Sage	Software	UK	145	60	10.8%	19.6%	1340	30
Fujitsu Siemens Computers	Computer services	Netherlands	134	-9	2.0%	-2.1%	6614	26
Invensys	Software	UK	118	4	5.0%	1.2%	2363	12
Wincor Nixdorf	Computer services	Germany	105	27	4.5%	10.2%	2319	59
Misys	Software	UK	103	-5	14.4%	-1.5%	716	32
US								36.4
Microsoft	Software	Washington	6482	1745	15.4%	11.0%	42041	36
IBM	Computer services	New York	4327	458	5.8%	3.8%	74555	115
Google	Internet	California	2010	1578	12.8%	67.0%	15680	13
Oracle	Software	California	1991	644	11.9%	13.9%	16728	34
Yahoo!	Internet	California	986	564	19.0%	32.6%	5186	16
Symantec	Software	California	633	142	14.3%	8.8%	4424	29
Adobe Systems	Software	California	476	213	18.5%	21.9%	2575	29
Intuit	Software	California	468	225	21.2%	24.5%	2211	28
CA	Software	New York	447	-16	14.5%	-1.2%	3073	35
Autodesk	Software	California	414	197	24.9%	24.1%	1666	29
Japan								82.3
Fujitsu	Computer services		2053	147	4.9%	2.5%	42309	76
Nihon Unisys	Computer services		40	-7	1.5%	-5.3%	2681	125
Nomura Research Institute	Computer services		39	26	1.4%	44.0%	2717	46
Asia								20.0
Prithvi Information Solutions	Computer services	India	117		70.8%		166	13
Polaris Software Lab	Software	India	110	32	67.7%	12.2%	162	18
Mindtree	Software	India	103	79	56.3%	63.0%	183	12
Tencent	Internet	China	59	42	7.9%	51.3%	754	13
NCsoft	Internet	South Korea	51	25	25.9%	25.4%	198	14
HCL Technologies	Computer services	India	46		4.1%		1117	35
Infosys Technologies	Software	India	37	22	1.1%	34.5%	3203	30
Nucleus Software Exports	Software	India	33		67.8%		49	25
RoW								23.3
Open Text	Software	Canada	76	29	14.6%	17.6%	522	20
Check Point Software Technologies	Internet	Israel	66	29	11.3%	20.9%	582	18
Nice Systems	Software	Israel	57	35	12.8%	36.0%	449	25
Constellation Software	Software	Canada	35		14.6%		238	16
Corel	Software	Canada	32	15	16.6%	23.7%	193	26
CGI	Computer services	Canada	32	-14	1.5%	-11.2%	2198	35

Note: Nominal terms, not adjusted for inflation. Annual reports, company information and Wikipedia have been used for determining the age of the companies. Age is 2011 minus the birth year. The resulting average age has been calculated per region. Average ages for each region (in bold) are calculated from the sample of companies listed in this table.

Colours: Blue: Companies older than 50 years. Black: Companies between 30 and 50 years old. Red: Companies younger than 30 years, and older than 15 years. Green: Companies 15 years or younger.

Outside the EU and the US there are few large R&D investors which are included in the *ICT Scoreboard*. This is why fewer than 10 companies are shown in the table for Japan, Asia or the RoW. Interestingly, some new companies located in Asia are emerging in this industry as large R&D spenders, e.g. Prithvi Information Solutions, Polaris Software Lab, Mindtree from India and Tencent and NCsoft from China and South Korea respectively. There are some new and emerging companies in the RoW as well, e.g. Check Point Software Technologies from Israel or Constellation Software from Canada. In absolute values, their investments are, however, very low, if compared to major US R&D performers.

Regarding the specialisation of various regions, information provided in Table 8 also indicates that, among the top ICT R&D investors of the 2008 *ICT Scoreboard*, there are no EU or Japanese companies in the Internet ICB sub-sector and no Japanese firms in the Software ICB sub-sector. Furthermore, two US firms, Google and Yahoo!, together clearly dominate the Internet sector globally.

The Computer Services segment is by nature less R&D intensive (at about 5% on sales) and is also the least dynamic in terms of R&D growth. However, there may be more R&D conducted in the sector than figures suggest. This is because companies in this sector are likely to be involved in development projects financed by their customers, in which case R&D efforts would be accounted for by the customer firms.

According to Table 8, there are also some differences in firm dynamics between various sub-sectors. For example, when comparing Software and Internet with Computer Services, it can be seen that Software and Internet are characterised by very high R&D growth rates, both in absolute and relative terms, and very high R&D intensity. Companies' R&D investments in Software have been growing rapidly for many years, and Internet R&D has grown, mainly through Google and Yahoo!, from almost nothing in the early 2000s to over € 3 billion in 2008. It can also be seen that these sub-sectors include mainly US companies, although EU companies have a significant R&D presence in Software through SAP and also UBISOFT (videogame software). Furthermore, with some exceptions (e.g. IBM), most Computer Services and Software firms are relatively young, i.e. around 30 years old, several of them having taken advantage of the opportunities presented by the growth of the PC software market.

5.6.3 Top companies' growth rates (2005-2008)

The figures in this section show the link between Computer Services and Software companies' R&D growth and sales growth.

For all Computer Services and Software firms in the *ICT Scoreboard*, average R&D and sales growth rates were 18% and 16% respectively between 2005 and 2008,⁴⁵ which corresponds to all ICT growth rates. Based on these values, companies can be categorised into four groups:

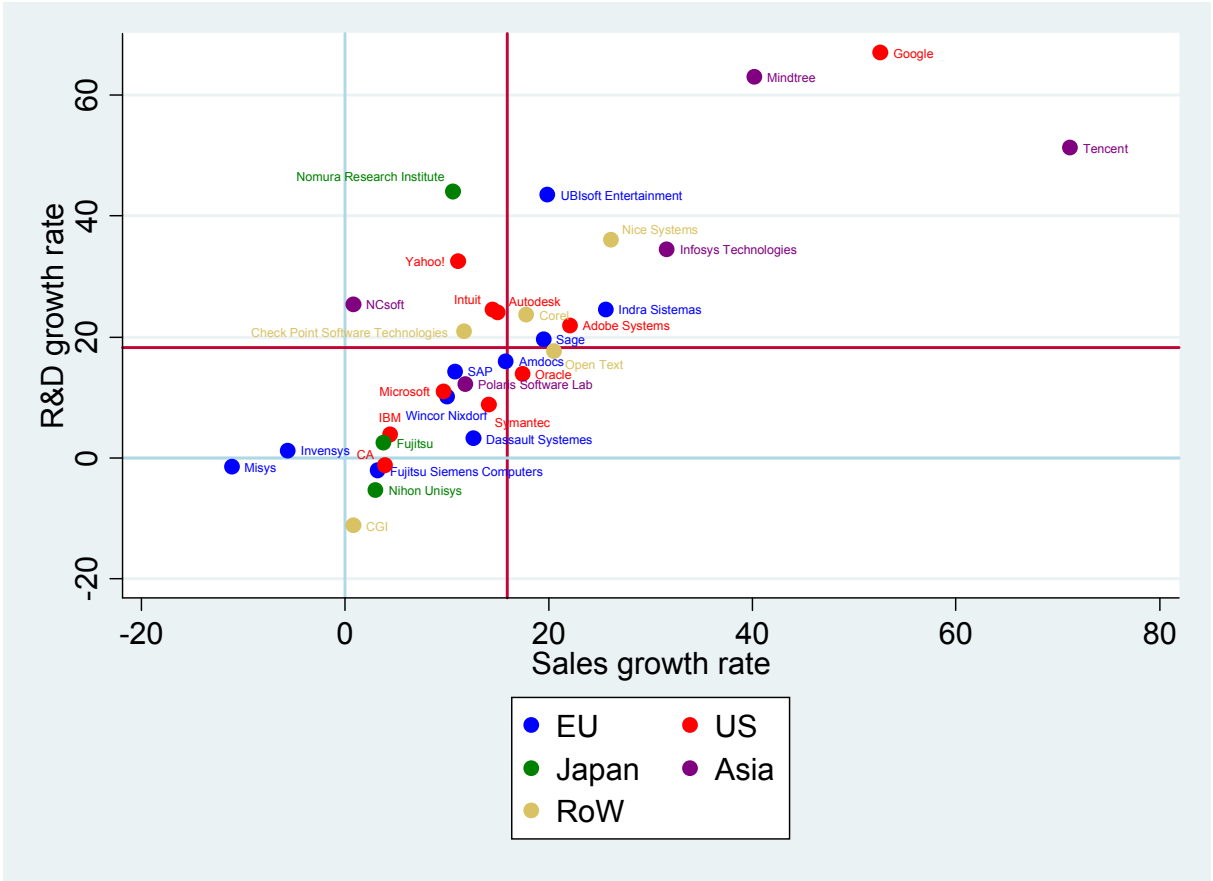
- Group I: with R&D growth rate **above** 18% and sales growth rate **above** 16%,
- Group II: with R&D growth rate **above** 18% and sales growth rate **below** 16%,
- Group III: with R&D growth rate **below** 18% and sales growth rate **below** 16%,
- Group IV: with R&D growth rate **below** 18% and sales growth rate **above** 16%.

⁴⁵ These values are calculated as simple averages across all Computer Services and Software firms in the *ICT Scoreboard*. Therefore, they may be affected by a distribution of these companies. Since this distribution with respect to sales – representing the size of a company – is not normal but rather skewed towards lower values, a comparison between small (below € 1 billion sales in 2008) and big companies (above € 1 billion sales in 2008) is provided as well. While the R&D and sales growths for small companies (65% of this sample) were 22% and 19% respectively, for big ones this growth was a bit lower, 12% and 11%.

Further analysis of all Computer Services and Software companies shows that almost 82% are located in either Group I or III. From the regional perspective, almost 80% of Japanese companies belong to Group III. They are followed by EU (55%) and US companies (53%). On the other hand, almost half of RoW companies belong to Group I, while only 22% of EU companies do so. The US and Asia have approximately 30% of the companies in this group.

Figure 24 maps a sample of the top 10 (if available) R&D-investing Computer Services and Software companies from each world region (as listed in Table 8), according to their R&D growth/sales growth.⁴⁶ This graph also indicates that big differences among companies regarding their sales and R&D growths. While Tencent, Google or Mindtree show almost 40-70% sales and R&D growth, companies like Misys or CGI show a decline of about 10% in at least one parameter. On the other hand, no major outliers can be observed here. Moreover, high/low R&D and sales growth rates go together, this is a general pattern across almost all sub-sectors. There are only minor exceptions to this pattern.⁴⁷

Figure 24: Top 10 R&D-investing companies in Computer Services and Software within each world region (2008)



Note: Based on nominal values, not adjusted for inflation. Average R&D and sales growth rates: 18% and 16%. These averages are represented by the red horizontal and vertical lines.

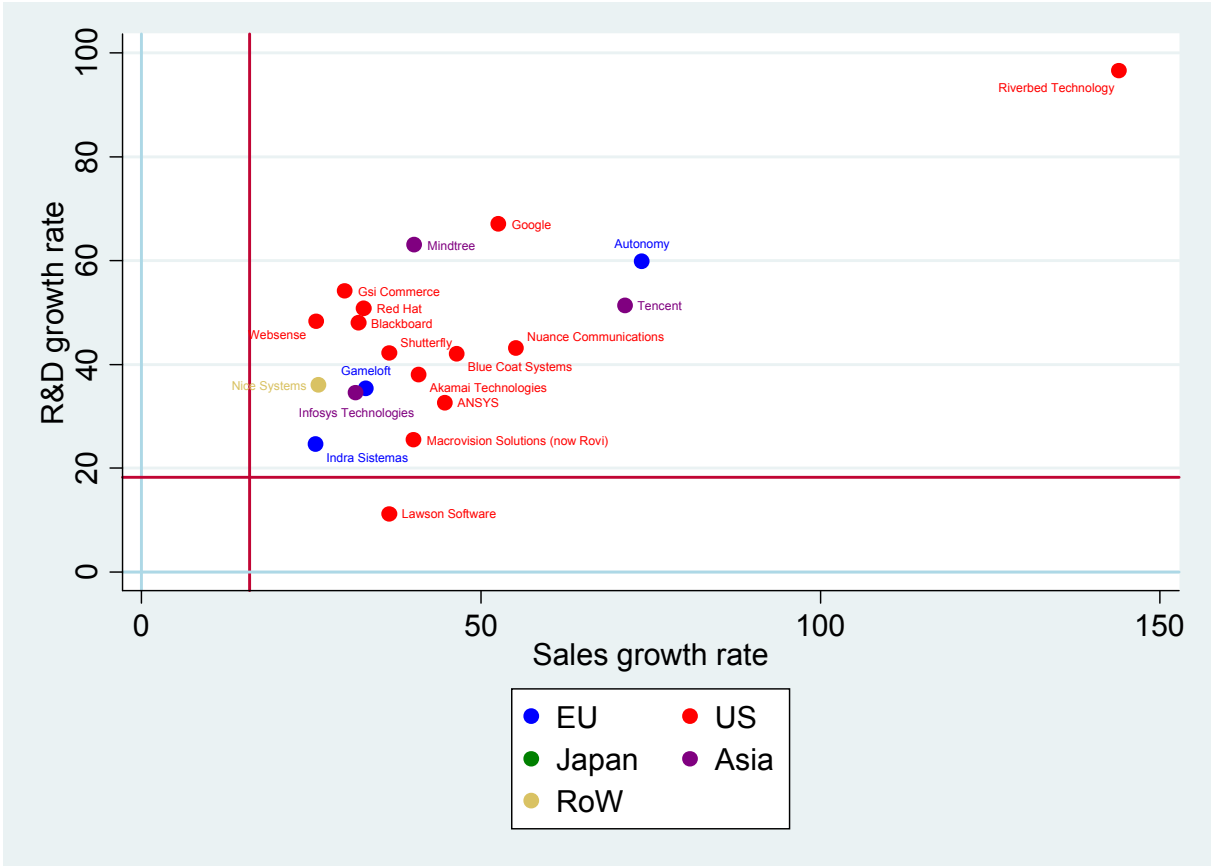
⁴⁶ Prithvi Information Solutions, HCL Technologies and Constellation Software are not included here because their data are not available for 2005 and therefore it is not possible to calculate their 2005-2008 growth values.

⁴⁷ There may be other companies with higher/lower sales or R&D growth rates from Computer Services and Software sub-sector that are not depicted in this graph because of their lower R&D investments. Additionally, there may also be other companies from Computer Services and Software sub-sector with higher/lower sales or R&D growth rates that are not included in the *ICT Scoreboard*.

Focusing on sales growth, Figure 25 presents the top 20 companies per sales growth for the sub-sector during 2005-2008. Again, while the overall framework of the figure is identical to Figure 24, the sampling methodology differs. Here, first, the sub-sector companies of the *ICT Scoreboard* are ranked in terms of sales growth rates, and then the top 20 companies are plotted onto the graph. This allows us to observe the fastest growing companies of the sub-sector worldwide, and their respective behaviour concerning R&D investments.

Similarly to the Telecom Equipment sub-sector, the group of top 20 Computer Services and Software companies in sales growth is dominated by the US – 13 out of 20 companies are based in this region. In addition, the fastest growing company, Riverbed Technology, which had almost 150% sales growth, is also from the US, though it does not belong to the big R&D investors. Asia and the EU are represented by three companies each. The general pattern of high/low R&D and sales growth going together is clearly visible in this case as well – 19 out of the top 20 companies in sales growth are located in Group I. Moreover, levels of sales growth for these top 20 companies roughly correspond to levels of R&D growth. Finally, when comparing this graph with Figure 24, one can see that only five top R&D-spending companies from Groups I and IV are also presented here. Thus, this result indicates that high R&D spending in itself does not guarantee high sales growth, especially not in Computer Services and Software. Under these circumstances, and assuming that a huge portion of sales is reinvested within these fast growing companies, one can expect that the list of top R&D spenders could change significantly in the following years. Dynamics in this sector are enormous.

Figure 25: Top 20 Computer Services and Software companies in sales growth within each Group I to IV (2005-2008)



Note: Based on nominal values, not adjusted for inflation. Average R&D and sales growth rates: 18% and 16%. These averages are represented by red horizontal and vertical lines.

6. Summary of main findings and conclusions

The findings in this report essentially corroborate those reported in the 2010 report (Turlea et al., 2010), with some differences and additions. First of all, EU ICT sector companies make very substantial R&D investments. At an aggregate level, however, they invest less in R&D than companies from the US or Japan, and they contribute a smaller share of total R&D in the EU than ICT companies do in other regions. In comparison with the US, there is a gap in ICT sector R&D (for the analyzed sample of companies) and detailed analysis suggests that, in absolute terms, US companies have further increased their R&D investment lead (in volume), although EU companies show a very positive trend with similar relative growth rates.

However, as shown in Figure 9, this is not necessarily because individual US companies are more R&D intensive than EU ones. R&D intensity (i.e., R&D investment to sales ratio) is instead more likely to be sector-specific than region-specific. In other words, it is an industrial and market characteristic, rather than a national one (at least in the comparison between the US and Europe). This suggests that this company-level ICT R&D gap is, in fact, mostly due to the presence of a large number of top R&D-investing ICT sector companies from the US. This is perhaps the most striking and important observation from the *ICT Scoreboard* –that more than half the top global R&D-investing ICT companies are from the US.

The preceding analysis of the 2009 *ICT Scoreboard* data allows us to draw a number of detailed conclusions with respect to the developments of companies' R&D investments over the last few years. The main conclusions and findings can be summarised as follows:

Regarding the levels and trends in ICT R&D investments across the major world regions:

- Shares of ICT R&D in total R&D investments: Asia (excluding Japan) shows a very high concentration of R&D in ICT: around 65% of all companies' R&D efforts are devoted to ICT. For US and Japanese companies, the shares of ICT R&D in total R&D investments are around 40% and 35% respectively. For EU companies, this share is around 20%, suggesting the presence of a smaller number of large companies in the ICT sector. Other observations tend to confirm this hypothesis.
- Growth of R&D investments: from 2005 to 2008, Asian and RoW companies report the highest relative increase in their R&D investments (14% and 17% respectively) but from rather low values. EU and US firms show similar growth rates (10% and 11% respectively). The R&D growth rate of Japanese companies was the lowest (3%).
- Sub-sector specialisation: EU companies' R&D investments are concentrated in the Telecom Equipment and Telecom Services sub-sectors, whereas US, and to some extent, Japanese companies show strong presence in the most prominent ICT sub-sectors such as IT Components, Computer Services, and Telecom Equipment.
- National behaviour: concerning EU, and Asian companies, ICT R&D investments are made by companies headquartered in a small number of developed countries. For example, in 2008, there were only 6 EU and 2 Asian (excluding Japan) countries with R&D investments exceeding € 1 billion (e.g., Finland, Netherlands, France, Germany, Sweden, UK, South Korea, and Taiwan).
- Young and rapidly growing R&D-investing companies dominate the Computer Services and Software and Internet sub-sectors. So far, most of these companies are located in the San Francisco Bay area (Silicon Valley) and, increasingly, in China and India.

Concerning particular ICT sub-sectors, the following can be noted:

- Worldwide, the most important sub-sector in terms of R&D investment is IT Components. It accounts for over one third of global R&D investments in the ICT sector. IT Components is followed by Computer Services and Software and Telecom Equipment.
- The above three sectors show a strong presence of US firms with high R&D investments and growth. The top EU R&D spending companies are mainly in Telecom Equipment, IT Components and Telecom Services. Japanese companies, on the other hand, hold very strong R&D positions in IT and Multimedia Equipment and in IT Components. The latter shows a very strong presence of Asian companies, predominantly from South Korea and Taiwan.
- Telecom Equipment has long been regarded a stronghold of the EU ICT industry, which includes world leaders such as Nokia, Ericsson and Alcatel-Lucent. In absolute volumes, EU companies still hold the first position in R&D investments in this sector but US companies come close (Cisco Systems, Motorola, Qualcomm).
- Multimedia Equipment is the only sub-sector that experienced a decline in R&D investments in the analysed period. R&D in this sub-sector is dominated by Japanese companies.
- The Software and Internet segments of Computer Services and Software are the most dynamic in terms of R&D investment, displaying high R&D intensities as well as high growth rates. However, EU companies' absolute R&D investments remain very much lower than those of US companies. The US Internet industry also hosts some young companies with high and rapidly growing R&D investments, whereas the EU Internet industry does not. Interestingly, indications of the presence of rapidly growing companies like these can also be seen in India.

Growth rates analysis offers additional insights:

- More than half of the 428 ICT companies (55%) can be characterized by below the sample average R&D and sales growth rates. These average growth values are based on the full sample of 428 companies of the *ICT Scoreboard*. In the analyzed period, average R&D and sales growth rates were 16% and 14% respectively. Looking at particular sub-sectors, three sub-sectors had higher corresponding averages (Telecom Equipment, Computer Services and Software and partially also Telecom Services). On the other hand, companies from IT Equipment and Multimedia Equipment were, on average, below these values.
- US companies (and also some Asian ones) dominate the top sales growth analysis in all analyzed sub-sectors. Usually more than half of the top 20 companies in sales growth come from the US. The biggest company in each of the sub-sectors, except for Multimedia Equipment, also comes from either the US or Asia.
- There are huge differences among the top R&D-spending companies, and also among the top companies in sales growth, in terms of their R&D and sales growth rates. Even within the top 20 companies in sales growth from the same sub-sector, the difference in sales growth between the 1st and 20th company is 400 percentage points (e.g., in IT Components). As regards R&D growth, the difference is more than 300 percentage points, although it comes from a sample of companies which are top in either sales growth or R&D spending (nominally).

- Based on our observations, high/low R&D and sales growth rates seem to go together. One usually cannot expect to observe high sales growth without corresponding R&D growth. The only general exception to this is Telecom Services with several companies with high R&D growth and zero/negative sales growth (or vice versa). Additionally, most of the companies from analyzed sub-sectors (except IT Components) even report roughly similar values of these two growth rates.
- IT Equipment and Telecom Equipment are the only two sub-sectors where the top R&D-spending companies with above the sample average sales growth also belong to the top companies in terms of sales growth. In other sub-sectors, only a few top R&D-spending companies could also be characterized as top in sales growth.
- There are outlying companies (with exceptionally high/low R&D or sales growth rates within their sub-sectors) in every analyzed sub-sector except IT Equipment.

ICT sub-sector interdependencies: analysing R&D investments within an ecosystem approach

We have seen that in the case of the Telecom industry, a historically rooted division of labour of products and of revenues between two interdependent sub-sectors explains an important part of what can be interpreted as an under-investment in R&D on behalf of the Telecom Services sub-sector.

Currently, there is a surge of new interdependencies – and competition – that may similarly affect the overall R&D landscape in the longer term. Technological changes, market demands and company strategies are generating growing and broader interdependencies between the Telecom Services and Equipment industries and neighbouring industries such as the Software industry and the Internet/Content industry.

This in turn generates a renewal of the ‘division of labour’ described above. Revenue streams, investment volumes, R&D investments and priorities are redistributed across an emerging "*New ICT ecosystem*",⁴⁸ created by increasingly interrelated industries.

In such a complex environment, the approach followed so far may not suffice to capture the dynamic of the ICT sector, as the level of interrelation and exchanges between formerly separated actors increases. An additional approach, that of the ICT ecosystem, will help us to better track the way players are climbing up (or down) the value chain, integrating applications and services they did not provide before. This approach complements the company level data analysis.

This analysis of the sub-sectors’ changing interdependencies, building on historical conditions and companies’ strategic choices, is shared by many observers and allows us to better understand the long-term dynamics that have affected the size and source of R&D investment. It aims to capture more accurately the drastic changes that are taking place in the ICT sector, and especially the entry of new players from ICT and non-ICT sectors (Apple, Google, Yahoo, etc.), or to a lesser extent from the Media and Content industries.

⁴⁸ Fransman (2010) introduced this notion. It refers to symbiotic relationships (financial, informational and material flows between the actors), and synergies.

Apple iPhone – a recent example of ecosystem interdependency

We illustrate these changes with one more fairly recent but important example in the Telecom sector. Smartphones continued to outperform the overall mobile device market in 2009 and 2010, and were a key factor in consumers upgrading their devices. The Apple iPhone, a mobile phone designed by a PC equipment provider, played a key role⁴⁹ in triggering these changes and at the same time mitigated the expected negative impact of the financial crisis, as data traffic growth in mature markets accelerated. The smartphone phenomenon not only contributed to the upgrading of devices, but also changed the way customers were using their mobiles, shifting the patterns of use towards the Internet world. The number of applications skyrocketed, generating new sources of revenues.⁵⁰

The smartphone phenomenon is one of the most visible indications of the changes taking place in the ICT ecosystem. Despite Apple's pioneering role, Google, initially a search engine provider, is now overtaking Apple with a different approach and a different business model.⁵¹ This example illustrates how it is necessary to deal with companies that escape a traditional sector-based analysis of ICT R&D investments, as these companies are becoming major investors in ICT R&D.

⁴⁹ Apple has become one of the top-five global handset vendors off the back of its iPhone sales, according to analyst firm Strategy Analytics. It has experienced a shipment volume increase of 91% in one year, due to the expanded availability of the iPhone worldwide. *GSMA Mobile business briefing*, 29 October 2010.

⁵⁰ El-Darwiche et al. (2010) expect that, by 2014, the mobile app business will generate \$ 40 billion in revenue.

⁵¹ Google's Android operating system (OS) is set to overtake Apple's iOS in terms of global shipment volumes during 2012, according to forecasts from iSuppli. According to the company, in 2012 Android will have a 19.4% share of the global smartphone platform market, and iOS will have 15.9%. According to GSMA Mobile Business Briefing 15 October 2010, Google is on track to generate more than US\$ 1 billion in annual mobile search and display revenue.

Annex I: Methodology for company data

The company data set is primarily based on the 2009 EU industrial R&D *Scoreboard* (European Commission 2009⁵²) (henceforth the *Scoreboard*) in which R&D investment and other 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 of 2008.⁵³

Data for the *Scoreboard* are taken from companies' publicly available audited accounts. Most often, these accounts do not include information on the place where R&D is actually performed; therefore, the approach of the *Scoreboard* is to attribute each company's total R&D investment to the country in which the company has its registered headquarters. In addition, all R&D is attributed to one single sub-sector (NACE and ICB), regardless of whether the performed R&D concerns products or services related to other sectors. For example, this means that all the R&D of Philips will be attributed to the Netherlands and to NACE 3230 (here labelled *Multimedia Equipment*) and to ICB 2470 (*Leisure Goods*) in spite of the fact that Philips invests in R&D in other countries and in other sectors as well (primarily in medical/health and lighting equipment).

R&D investment in the *Scoreboard* is the cash investment funded by the companies themselves, and is subject to accounting definitions of R&D. It excludes R&D undertaken under contract for customers such as governments or other companies. It also excludes any R&D investment made by associated companies or joint ventures. It follows that another difference with respect to macro-economic BERD data is that, while BERD considers all R&D expenditure which is performed by companies in a given sector and country regardless of the source of funding, company data concerns R&D expenditure of that company regardless of what entity actually performs the R&D. *Scoreboard* data is therefore not directly compatible with data from national statistics (e.g., BERD).

The table below summarises some of the major methodological differences between *Scoreboard* and national BERD data.

⁵² http://iri.jrc.ec.europa.eu/research/Scoreboard_2009.htm

⁵³ Parts of this Annex draw heavily on the methodological note as provided with the *Scoreboard*. See <http://iri.jrc.es/research/docs/2007/methodology.pdf>.

	<i>BERD data</i>	<i>Scoreboard data</i>
Data collection	Surveys according to the Frascati manual (e.g. including capital expenditure in BERD)	Firms' annual reports and accounts according to accounting standards (IAS) (only including yearly amortization of capital expenditures)
Analyzed companies	Large companies plus representative samples of small ones	Top 1 000 R&D investing companies in the EU and 1 000 companies outside the EU, covering about 80% of the R&D financed.
Money flows	Expenditures for R&D performed (regardless of source of funding)	R&D financed (regardless of where performed)
Economic sectors	ISIC/NACE	ICB (translated to ISIC/NACE in this paper, using correspondence tables)
R&D intensity denominator	Value added	Net sales
Geographical allocation	R&D attributed to country (and sector of performance) for business enterprises (including e.g. local subsidiaries)	R&D attributed to parent company

Note: There are several other differences such as the entity collecting the information (national statistical offices vs. company accounts) and the time period (calendar year vs. financial years). Note also that *Scoreboard* figures are nominal and expressed in Euros with all foreign currencies having been converted at the exchange rate of 31 December 2008.

Source: Adapted mainly from Azagra Caro and Grablowitz (2008).

Scoreboard figures are nominal and expressed in Euros, and all foreign currencies have been converted at the exchange rate of 31 December 2008. For example, a € 1 = \$ 1.39 exchange rate has been used, not only for 2008, but for all previous years as well. This has an impact on firms' relative positions in the world rankings based on these indicators. This needs to be considered when interpreting the data, as well as for the collection of longer-term trend data. Therefore one could consider recalculating *Scoreboard* data based on a purchasing power parity model. At this stage, no such recalculation has been made.

R&D intensity is calculated as the ratio between R&D investment and net sales of a given company or group of companies. Thus, the calculation of R&D intensity of company data is different from that in official statistics, where R&D intensity is usually based on value added, not sales. *Sales* are in turn defined following usual accounting definitions of sales, excluding sales taxes and shares of sales of joint ventures and associates.

In the *Scoreboard*, the EU and non-EU groups include companies with different volumes of R&D investment. In 2008, the R&D investment threshold for the EU 1 000 group was about € 4.3 million and that for the non-EU 1000 group about € 31.5 million. In order to compare EU and non-EU companies on a similar basis, it is preferable to consider only EU companies with R&D above the highest (i.e. non-EU) threshold. This comprises a group of 350 EU companies, representing approximately 95% of total R&D investment by the EU 1,000 group.

In order to create a comparable data set of ICT companies (which we refer to as the *ICT Scoreboard*) from the *Scoreboard*, the following actions have been carried out. First, only the companies belonging to the following NACE classes have been extracted from the *Scoreboard*: 30 (IT Equipment), 321 (IT Components), 322 (Telecom Equipment) 323 (Multimedia Equipment), 332-333 (Electronic Measurement Instruments), 642 (Telecom Services) and 72 (Computer Services and Software). In the *Scoreboard*, these companies are classified in the following NACE classes: 3001, 3002, 3210, 3220, 3230, 3210, 3220, 3230, 6420, 7221 and 7260. There are no companies classified under 3320-3330 in the *Investment Scoreboard*. Extracting the relevant ICT companies generated a sub-set of 428 ICT companies (out of 1 350).

A final note concerns how the age of the companies is determined. Annual reports, company information and Wikipedia have been used as sources for determining company birth dates. Age is stated as 2011 minus the birth year. In many cases, determining the birth year is not a straight forward activity, for instance:

1. when the company is a spin-off from another company (e.g., NXP from Philips),
2. when the company is the result of merger (e.g., ST Microelectronics)
3. when the company changed its main activity (e.g., Nokia and Texas Instruments) (for example, when the company entered the ICT sector from another sector, or moved from one sub-sector to another)

Depending on the purpose of the analysis, different choices can be made. In this report, the following choices have been made:

- In the first of the above cases, we have tried to identify the start of business activity inside the parent company, which later was spun-off as a separate company. For instance, Philips started its semiconductor business 1953, while NXP was not spun-off until 2006. In this case, we used 1953 as the birth year.
- In the case of mergers, the age of the main or oldest ancestor is used. For example, for STM, 1957 - the foundation year of the oldest merging company, SGS - is used, rather than 1987, which is the year STM was formed.
- In the case of change of main business activity, we have not taken this into consideration. For instance, Nokia's birth year is considered to be 1865 although it was not until 1960 that the company diversified into ICT.
- In the case where a choice must be made between two different possible dates, the alternative date has also been proposed and documented, in order to allow alternative analyses. For example, in the case of STM described above, the year 1987 (date of formation of STM) is also provided as an alternative to 1957, which is the date used in the report.

Annex II: Definition of world regions⁵⁴

EU	US	Japan	Asia	RoW
Austria	USA	Japan	China	Australia
Belgium			Hong Kong	Bermuda
Denmark			India	Brazil
Finland			Singapore	Canada
France			South Korea	Cayman Islands
Germany			Taiwan	Croatia
Hungary			Thailand	Iceland
Ireland				Israel
Italy				Liechtenstein
Luxembourg				Mexico
Netherlands				New Zealand
Portugal				Norway
Slovenia				Russia
Spain				Saudi Arabia
Sweden				South Africa
UK				Switzerland
				Turkey

⁵⁴ This list includes all countries from those regions in which are registered headquarters of *ICT Scoreboard* companies.

Annex III: Methodological note for Telecom Services R&D investments data⁵⁵

The data for R&D investments in Telecom Services at company level is difficult to collect and presents some apparently erratic trends. The following case, based on publicly available data from BT and Telecom Italia, serves as an illustration.

First, different sources for company level data will supply different data, which may not always be consistent. The Berr Report (02/2009) yields an R&D intensity ratio (on sales) of 6%. BT's annual reports reflect the same ratio. On the other hand, using the Reuters Company database (2009), an identical calculation leads to a 2.7% R&D intensity ratio. This result looks more in line with the data from other companies, and is rather consistent with the fact that R&D intensities are strongly determined by an average level across one same industry. Finally, the Industrial Scoreboard⁵⁶ indicates 5.2% for 2008.

Second, such figures show, in some cases a high diversity year-on-year. For example, R&D investments for Telecom Italia grew by a CAGR of 57.6% in the period 2007-2008 (see Table 7).

There is a large set of organisational aspects that explain such discrepancies. The way, and for what reasons, resources are allocated within a company for accounting purposes are numerous and vary from country to country and from company to company. This starts with the way R&D itself is perceived and defined within the company. For instance, the inclusion of internal IT services under R&D significantly alters the picture. Also, the development component of R&D tends to be blurred rather than clearly delimited. In addition, companies are permanently reorganising themselves to better achieve their strategic goals,⁵⁷ or to meet with the requirements (taxation benefits, for example) or expectations (creation of an R&D centre) of the host country or region. To finish on a more positive note, many companies fortunately use the OECD Frascati manual, which follows internationally-agreed statistical rules, in order to identify and measure R&D investment made in various business units.

Outlying numbers, such as those of BT which are far above the average, could be explained by the historical absence of a Telecom manufacturing partner to whom to delegate R&D. This historical feature differentiates the UK from other major Member States, for example France Telecom with its natural domestic partner Alcatel in France, or Deutsche Telekom with Siemens in Germany. As BT has not had this historical division of labour, it has had to maintain active R&D, which ends up showing in the figures. Also, as explained in the main text, mergers and acquisitions may affect drastically the figures from one year to another.

To sum up, industrial organisation and organizational aspects influence strongly the identification and measurement of Telecom Services R&D, whether this be in-house, in subsidiaries or outsourced to other (manufacturing) companies.

⁵⁵ This Note is partly based on interviews and meetings held with industrial partners in particular in the frame of ETNO, the European Telecommunications National Operators Association (ETNO) R&D working group with whom IPTS met in May 2010. We are grateful to ETNO members for their helpful advice.

⁵⁶ See: The 2009 EU Industrial R&D Investment Scoreboard, table 5.7.

⁵⁷ The creation of 'technocentres' further contributes to blurring borders as these centres bring together people from marketing and R&D departments, though their activities may not be counted as R&D. This, for instance, is a practice within the Orange FT group. Reorganisation of this kind goes hand-in-hand with the emergence of the "porous enterprise". See "The coming of Porous Enterprise", Orange Labs SF, 2009.

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European Commission

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Abstract

This report analyses R&D investments by top R&D-investing companies from the ICT sector, for the period of 2005-2008. It focuses on the distribution of R&D investments by firms in specific ICT sub-sectors from the five main world regions, paying special attention to R&D investments by ICT companies from the EU. The relationship between R&D growth and company sales growth is also addressed. The analysis suggests that although EU ICT sector companies make very substantial R&D investments, as an aggregate they invest less in R&D than companies from the US or Japan. This is, however, not necessarily because individual US companies are more R&D intensive than EU ones but more because of the presence of a large number of top R&D-investing ICT sector companies from the US. EU companies' R&D investments are concentrated in the Telecom Equipment and Telecom Services sub-sectors, whereas US, and to some extent, Japanese companies show a strong presence in IT Components, Computer Services, and Telecom Equipment. Worldwide, the most important sub-sector in terms of R&D investment is IT Components, which accounts for over one third of global R&D investments in the ICT sector. In the considered period, average R&D and sales growth rates were 16% and 14% respectively, for the sample of analyzed companies.

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