THE ICT SECTOR AND R&D&I

- Recent developments in ICT include social networks, smart phones, apps stores, e-readers and cloud computing. For the global ICT industries, this innovation wave came at the same time as the economic slow down.

- The benefits of this innovation wave have not been reaped equally globally. The share of the ICT sector in the United States has increased more rapidly than in Europe. In the United States, the value-added at current prices increased by 8% between 2007 and 2010. This compares with a 5% decrease in the EU. In real terms, the value added by ICT increased by 18% in the United States and 7% in the EU.

- The US performance relied on a spectacular improvement in ICT manufacturing. Between 2007 and 2010, the value-added in this sector increased by 34% at current prices and by 60% in volume.

- Business ICT R&D intensity (measured by Business R&D over ICT value-added) has been resilient with only a minor decrease from 5.35% in 2008 to 5.33% in 2009.

- In the EU, out of the 7 million jobs in ICT in 2010, 5.7 million were in ICT services.

- Innovation has contributed to welfare gains and economic growth in a far more visible way. Investments in intangibles are now making an average 25% contribution to labour productivity growth.

ICT is pervading modern life and has become a general-purpose technology. Its impact on the growth of modern economies has taken place in different waves. First, during the late 1990s, an impressive increase in computing power led to a huge decline in the price of ICT goods, giving investors an incentive to replace other forms of capital with ICT equipment. These productivity dynamics led to an increasing contribution from the ICT sector to economic growth. After 2000, ICT also created economic growth in other sectors of the economy as declining prices made ICT an attractive factor of production for the whole economy and led to even greater investments in ICT, stimulating labour productivity growth, especially in the services industries. The increased use of ICT has also contributed to higher efficiency gains (total factor productivy growth), an effect more visible in the United States than in the EU. This required a broader investment strategy, encompassing intangible capital such as research and development, workforce skills, organisational capital, and marketing and branding. Whatever the size, the business and the location of the enterprise, the ICT part of its equipment and the efficiency with which firms and organisations are using it is shaping new processes in reaching suppliers and customers and in developing new products and services.

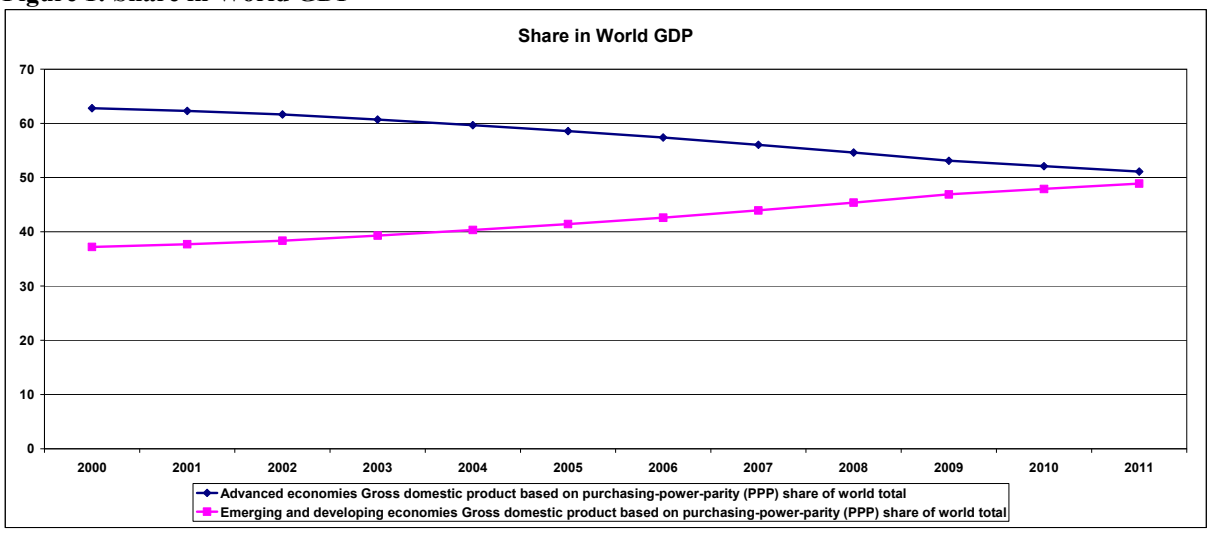
This chapter looks at the performance of the ICT sector in Europe during the economic crisis relative to that of the United States. It assesses its impact on R&D, growth and it provides evidence on the role of intangibles as the impact of ICT spills over to other sectors of the economy.

1.1. The ICT industry in the economy and during the business cycle 2007-2008

This chapter measures and analyses the performance of the ICT sector and the trends in investment in ICT R&D while taking into account three recent developments:

- **The financial crisis led to the current economic slowdown.** The European ICT sector weathered the crisis but its recovery is weaker than in the United States.
- **The spread of new applications.** The internet 'new wave' has led to the development of social networks, smartphones, apps stores, e-readers and cloud computing. For the global ICT industry, this innovation wave came at the same time as the economic crisis. Market structures in the ICT sector have been deeply shaken, yielding truly disruptive changes with big winners and big losers. It has led to bankruptcies, exits (divestitures), acquisitions, new entrants and a significant wave of patent litigation. Changes in the relative positioning are visible at country level. The United States has improving its position as market leader while the EU and Japan remain weaker.
- **The new economic geography**. In 2012, developing and emerging market economies together accounted for one half of global economic activity as measured by gross domestic product (GDP), up from less than one-third in 1980, according to the IMF (Figure 1).

Figure 1: Share in World GDP



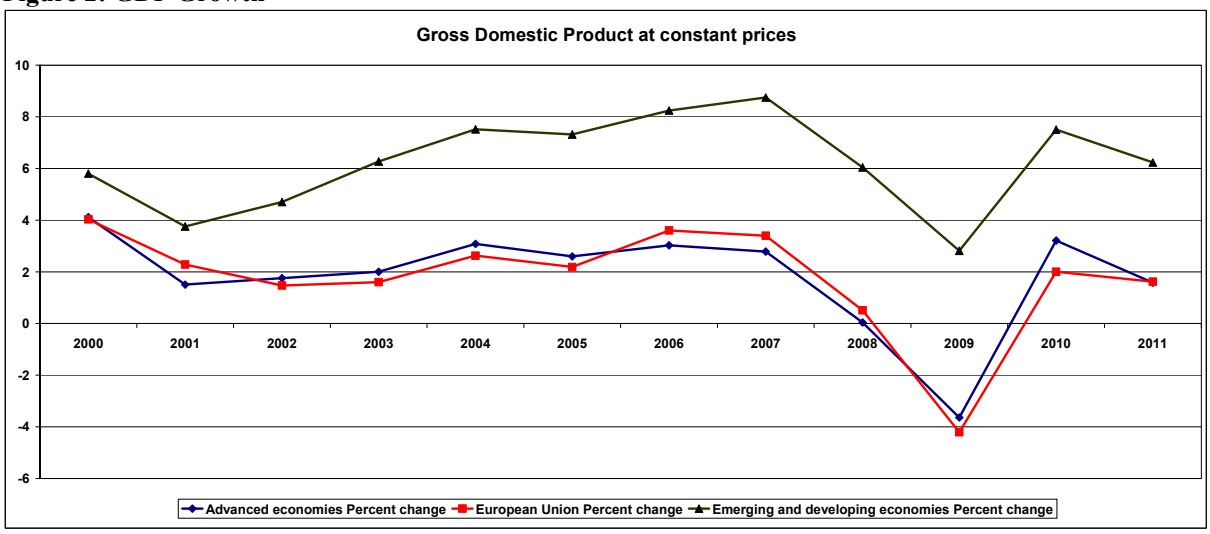
Source: International Monetary Fund, World Economic Outlook Database, April 2012

The growth potential of the internal market of developed countries such as the United States, the EU or Japan, given different factors such as demographic trends, will nearly exclusively rely on technological progress (productivity gains). By contrast, developing and emerging countries still have a huge 'catching-up' growth potential. Access to these markets and the competitiveness of Europe's industries will be a key component of future economic growth.

1.1.1. ICT and the economic slowdown

The financial crisis of 2008-2009 led to a free fall in confidence of both consumers and businesses. As a result, the crisis spread to the real economy, generating a fall in production, trade, investment and a massive de-stocking of inventories[1]. Although Europe's economy quickly started to recover, the European sovereign debt crisis brought about new uncertainties and weaker growth prospects (Figure 2). EU GDP is now expected to stagnate and shrink by 0.3% in the euro area in 2012[2].

Figure 2: GDP Growth

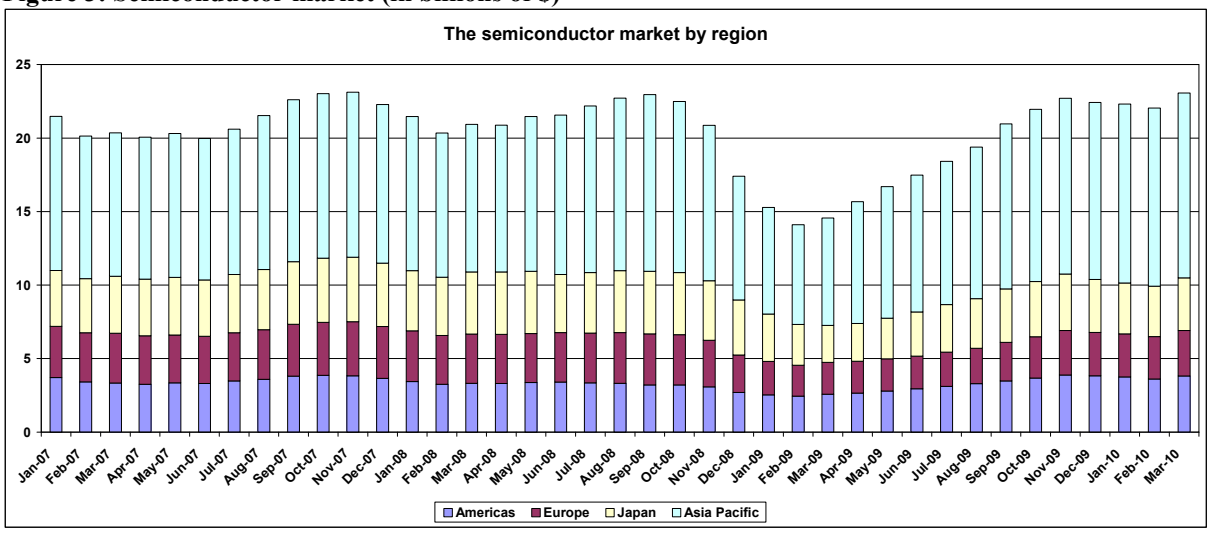


Source: International Monetary Fund, World Economic Outlook Database, April 2012

[1] DG ECFIN, Economic crisis in Europe: Causes, consequences and Responses, European economy 7/2009
[2] DG ECFIN, Interim Forecast February 2012

The ICT industries did not escape the crisis. The fall in production and in trade during the last quarter of 2008 and the first quarter of 2009 was significant. The semiconductor industry is a good leading indicator of the overall ICT industry (hardware) business cycle (Figure 3). Between the third quarter of 2008 and the first quarter of 2009, combined sales declined by 40%. After this near-record[3] decline, sales rebounded as spectacularly as they fell and already by the end of 2009, combined sales had reached their pre-recession level, showing that the crisis had indeed been one of confidence (inventory cycle).

Figure 3: Semiconductor market (in billions of $)



Source: OECD Information Technology Outlook 2010

1.1.2. The European ICT industry

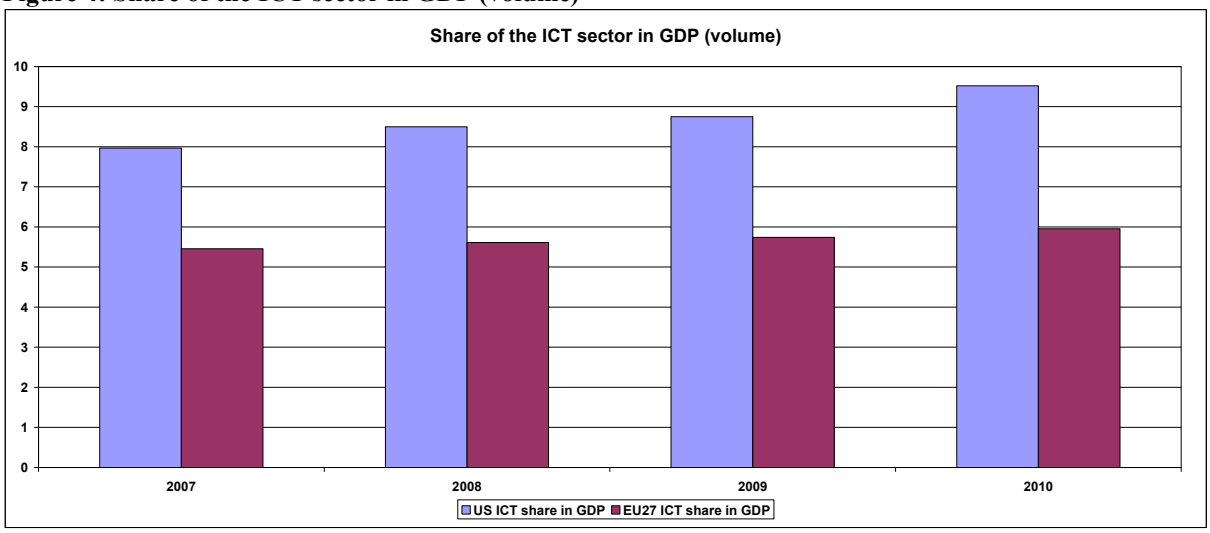
1.1.2.1. The 2007-2010 disruption

Notwithstanding the differences among the different segments of the ICT industry and across firms in the same sector, on aggregate there is some evidence of a weaker recovery of Europe's ICT industry (relative to the 2007 pre-recession level), in particular in comparison with the United States (Figure 4). The European industry did not succeed in harvesting the benefits from the new innovation wave as much as US companies did[4]. In the US, the ICT industry's value-added at current prices increased by 8% between 2007 and 2010. This compares with a 5% decrease for the EU. In *real* terms, ICT value-added increased by 18% in the US and 7% in the EU. As a consequence, the share of the ICT sector in the European economy increased but not by the same proportion as it did in the United States (Figure 4).

[3] Less than after the dot.com crash of 2000

[4] The European and American industrial classification differ from the European classification. To compare the two regions using the most updated statistical releases, we must add to the sensu stricto ICT sectors the content industries: all publishing activities (and not just software publishing), motion picture, video, television and broadcasting programme activities. See annex 1

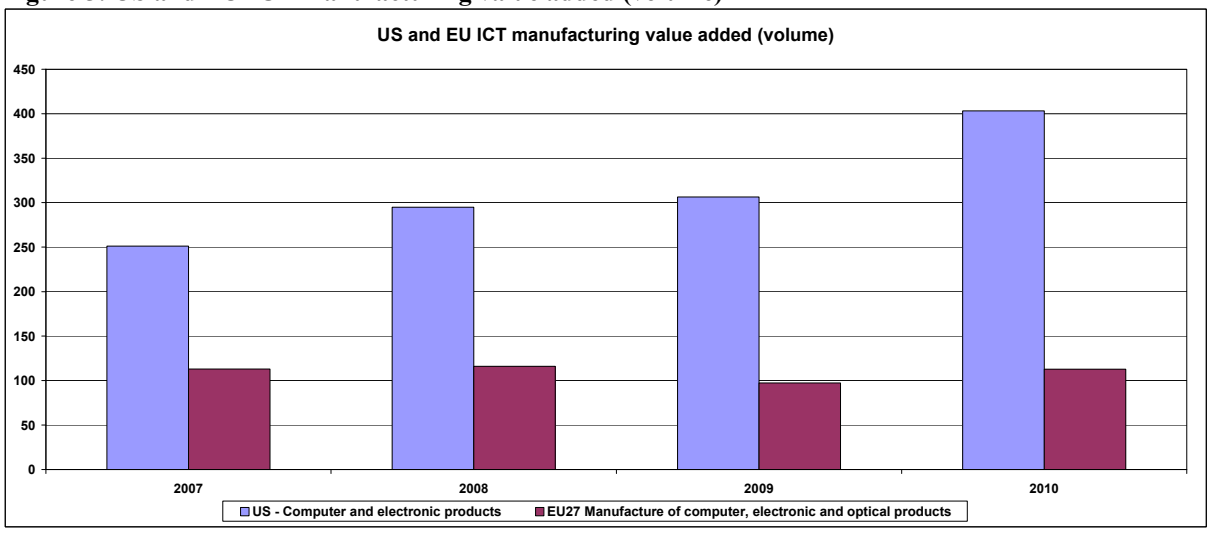
Figure 4: Share of the ICT sector in GDP (volume)



Source: Eurostat and US Department of Commerce (Bureau of Economic Analysis)5, activities based on the definition in footnote 86.

The US performance relies on an increase in the value-added of ICT manufacturing. Between 2007 and 2010, the value-added increased by 34% at current prices and by 60% in volume (chained 2005 dollars) (Figure 5).

Figure 5: US and EU ICT manufacturing value added (volume)



Source: Eurostat and US Department of Commerce (Bureau of Economic Analysis)

[5] For 2010, NACE 58 (Publishing including software) and NACE 95 (Repair of computers) are estimated (extrapolation)

Box 1 ICT share in GDP: nominal versus volume

If, *ceteris paribus*, all prices were to double, nominal GDP would double while real GDP would be unchanged. This is why in most analyses GDP is expressed in real (volume) terms.

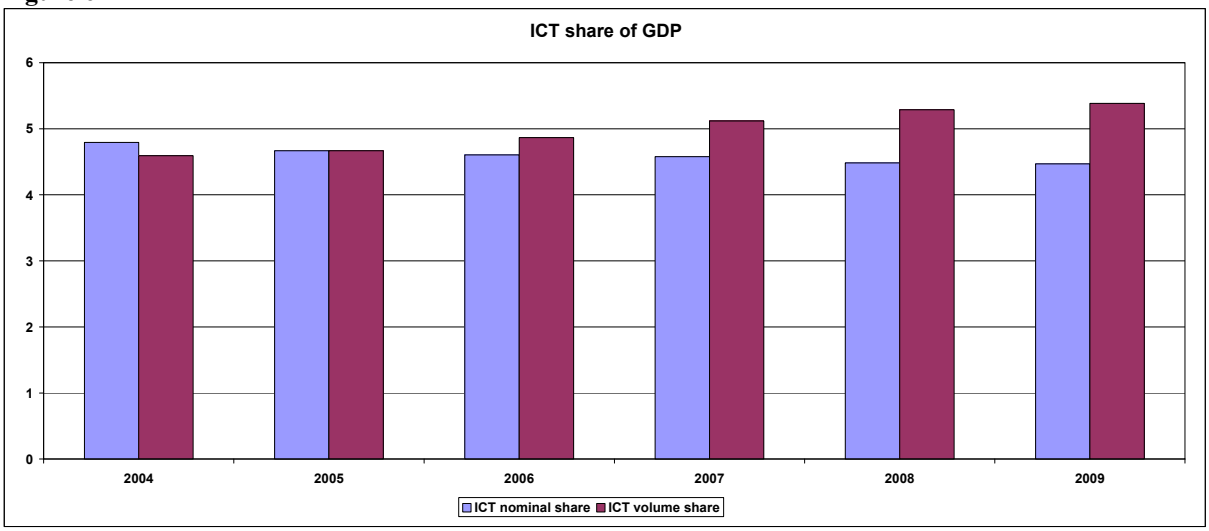
What is particular to most ICT goods is that their price decreases and their quality increases, driven by technological progress and competition. Values expressed in real terms are higher than in nominal value.

ICT price deflators are a proxy of technological progress while the difference between nominal and real value is a proxy of welfare gains (technological progress being forwarded to the consumer in price and in quality).

From the point of view of the production factors, it is the nominal value (turnover, value added) that determines employment, wages and return on capital. This is why employment is related to nominal value-added in the charts' analyses of the ICT industry by sector.

Last but not least, GDP deflators, taking into account quality adjustments, are not harmonised internationally, which casts some doubts on the accuracy of international comparisons.

Figure 6

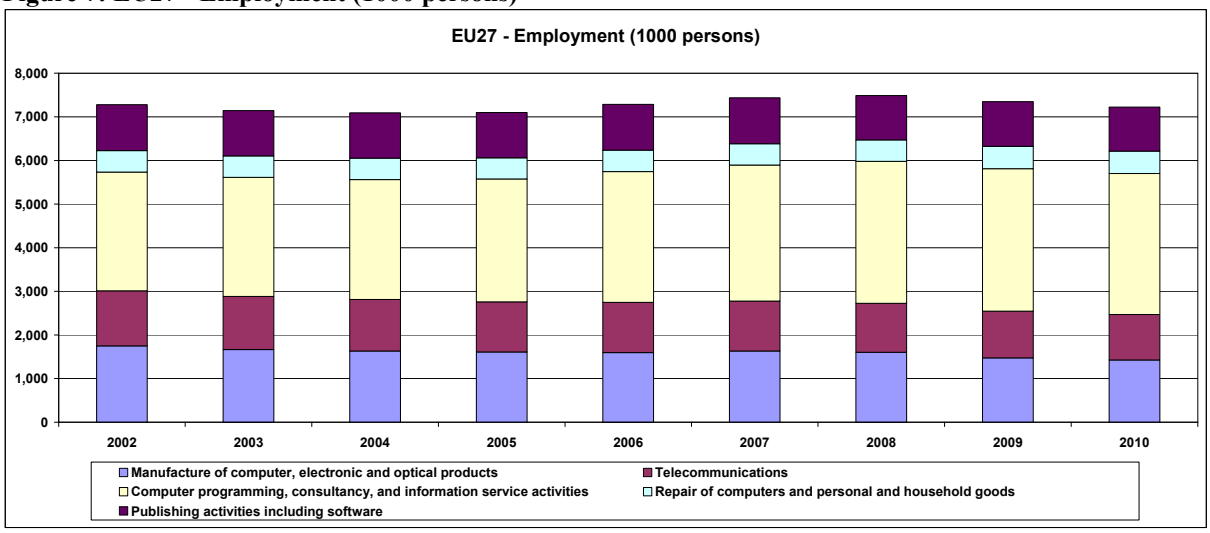


Source: Eurostat; Volume at 2005 prices

1.1.2.2. The European ICT sectors

The EU's ICT industry provides jobs to about 7 million people. Most jobs are in software and IT services; the trend shows there is continuous job creation while the number of jobs created in ICT manufacturing and telecommunications is declining due to international trade specialisation, productivity gains (technological progress) and internal market efficiency gains (competition) (Figure 7).

Figure 7: EU27 - Employment (1000 persons)

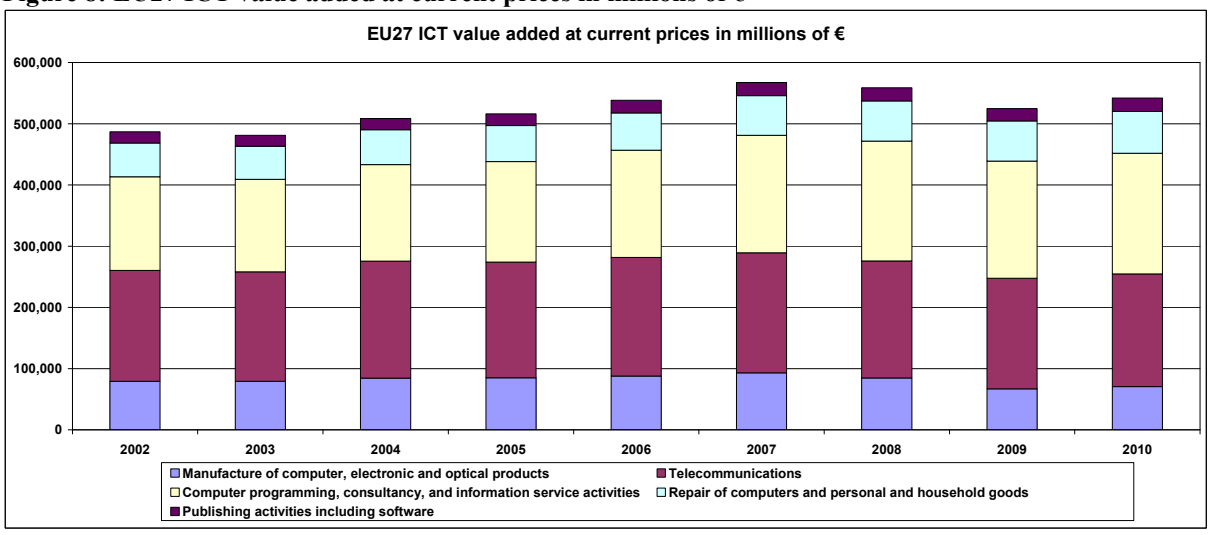


Source: Eurostat, national accounts by industry (NACE Rev.2 by 64 braches)6

As ICT spreads to nearly all activities, ICT-related employment is much higher than that of just the ICT sector. According to the OECD, the share of ICT-intensive occupations in the total economy amounted to 22% in 2009 for the EU15[7].

In the EU27, the ICT industry's value-added at current prices exceeded EUR 500 billion with significant differences between ICT segments, similar to the employment picture, although telecom services have a much higher share in terms of value-added than in employment (Figure 8).

Figure 8: EU27 ICT value added at current prices in millions of €



Source: Eurostat, national accounts by industry (NACE Rev.2 by 64 braches)[8]

Economic activities in the EU are classified according to NACE Rev. 2, which is the outcome of a major statistical revision which took place between 2000 and 2007 and which reflects the technological developments and structural changes of the economy (see annex 1). For the year 2010, not all data are available at a sufficient level of disaggregation to follow the OECD

[6] For 2010, Publishing, including software (NACE 58), and Repair of computers (NACE S95) are estimated (extrapolation)

[7] OECD Information Technology Outlook 2010

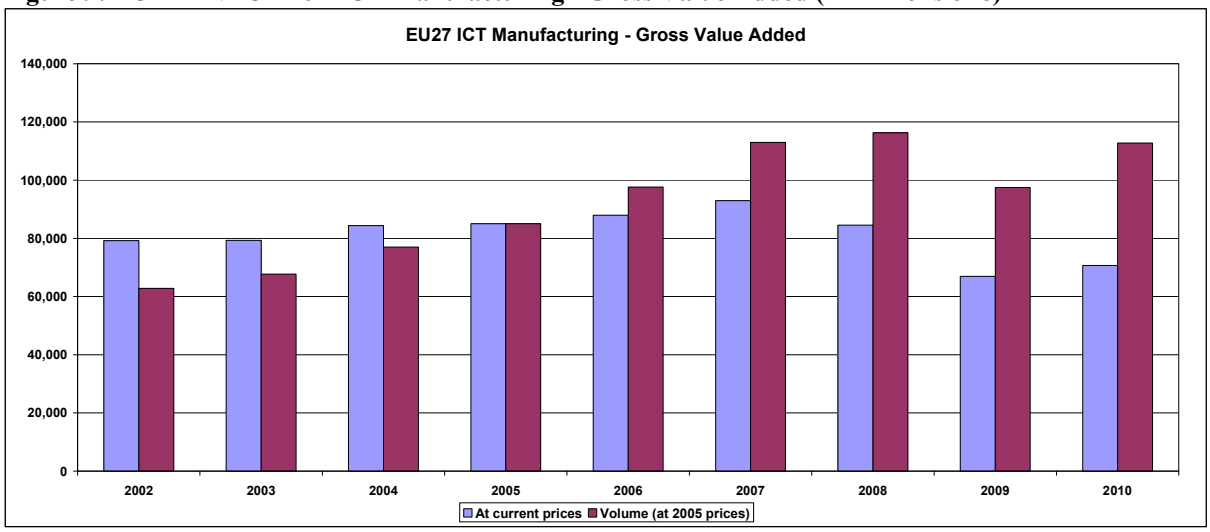
[8] For 2010, Publishing, including software (NACE 58), and Repair of computers (NACE S95) are estimated (extrapolation)

harmonised definition of ICT activities (see annex 1). In order to cover the recession (2009) as well as the recovery (2010), the classification had to be adapted and some data have to be extrapolated. [9] The following analysis is organised around three main categories of ICT activities: ICT manufacturing, telecommunications, and ICT services other than telecom services.

ICT manufacturing (NACE 26) [10]

The year 2008 had already been a disappointing one for the ICT sector but when the crisis broke out in 2009, the value-added at current prices declined by 21% year-on-year. During the recovery of 2010, value-added increased by 6%, still leaving a 24% gap relative to the peak year of 2007 (Figure 9).

Figure 9: EU 27 - NACE 26 - ICT Manufacturing - Gross Value Added (in millions of €)



Source: Eurostat, national accounts by industry (NACE Rev.2 by 64 braches)

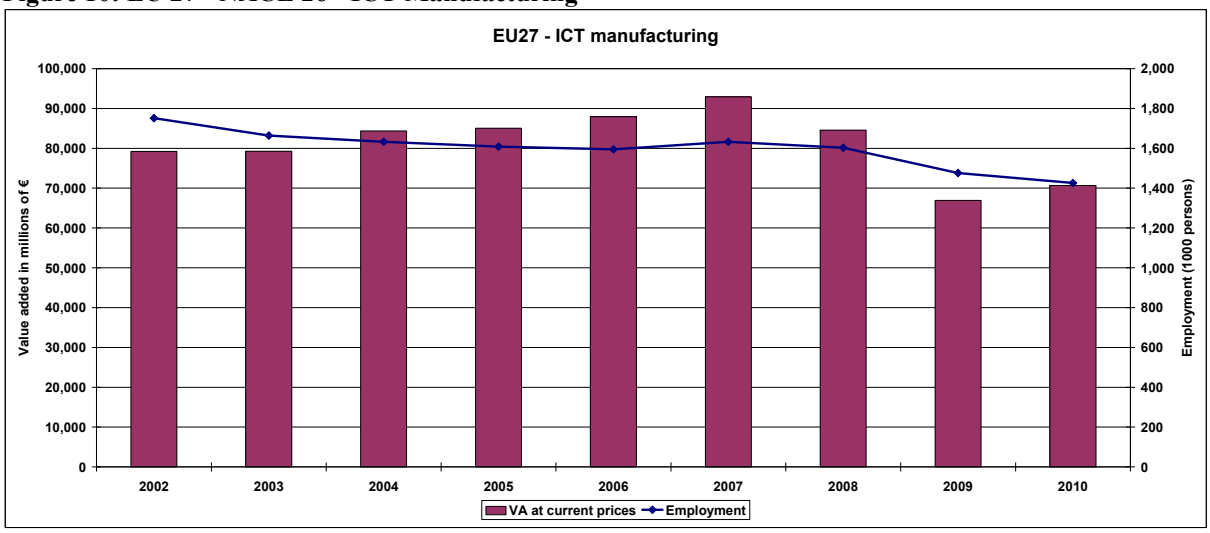
The value-added in volume is higher than at current prices reflecting decreasing prices due to technological progress, particularly in semiconductors (Moore's law). The competitive market structure and global supply chains allowed advanced economies to use cheap labour in developing and emerging countries, additional factors contributing to welfare gains for ICT users.

Employment in ICT manufacturing is more related to technological progress (productivity gains) and international trade (global supply chains) than to the business cycle (Figure 10).

[9] The changes are as follows: (i) an extension of ICT manufacturing activities to optical and magnetic equipment (ii) wholesale and retail trade of ICT are not analysed by lack of data, meaning that the analysis focuses on the production of ICT value rather than on the value created in its distribution (iii) software publishing cannot be separated from the broader division covering all publishing activities (iv) an extension of "repair of computers and communication equipment" to repair of all other household goods.

[10] NACE 26 is broader than ICT activities defined by the OECD and includes the following additional activities:
Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks
Manufacture of irradiation, electro medical and electrotherapeutic equipment
Manufacture of optical instruments and photographic equipment

Figure 10: EU 27 - NACE 26 - ICT Manufacturing



Source: Eurostat, national accounts by industry (NACE Rev.2 by 64 braches)

The two main sub-sectors of the European ICT manufacturing industry are microelectronics and telecoms equipment.

Microelectronics

Europe's leadership in semiconductor R&D is undisputed and recognised worldwide. From a commercial point of view, the European industry had nevertheless to specialise in high margin products through divestitures. This reflects a more general trend in favour of lighter asset strategies (lower capital expenditures), in particular by relying on leading-edge foundries' capacities. There is only one European company left in the world's top 10 semiconductor companies (in terms of net sales).

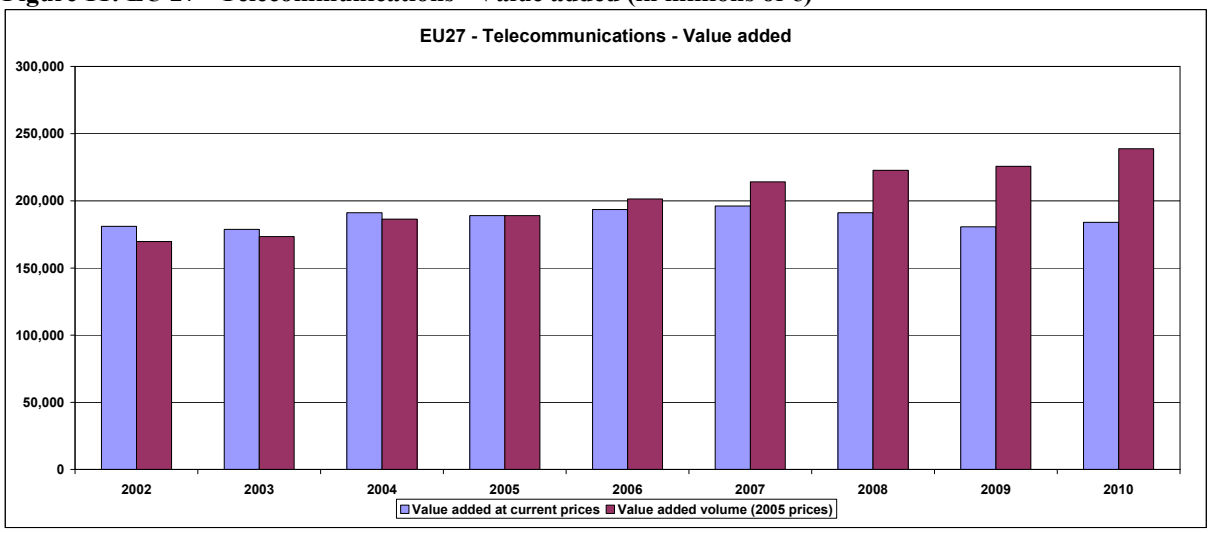
Telecommunication equipment

With the rise of smartphones, Europe lost its leadership in mobile devices, while keeping it in networks. The industry suffers from a legacy problem as the end of the deployment of 3G networks has not yet been fully compensated by the deployment of next-generation networks. Competition from Asian entrants such as Huawei and ZTE is also challenging the European market share, although Europe consolidated its position through acquisitions of North American telecom network business units. Nokia Siemens Networks acquired the majority of the wireless network infrastructure assets of Motorola Solutions in the United States while Ericsson acquired the wireless equipment unit of insolvent Nortel Networks Corp in Canada.

Telecommunications (NACE 61)

The years of recession and consequent uncertainties have coincided with one of the most vigorous waves of innovation in telecommunications: the uptake of mobile broadband devices and services. These add new market opportunities on top of the structural trend of digitalisation of our society. The surge in new devices such as smartphones and tablets, combined with an increasing number of multimedia applications, has led to exponential growth in data traffic volumes and increased spending on wireless and IP networks. The fourth generation wireless network is being adapted faster than expected. Telecoms operators are nevertheless constrained in their capital investments by their operating income given increasing network costs (Figure 11).

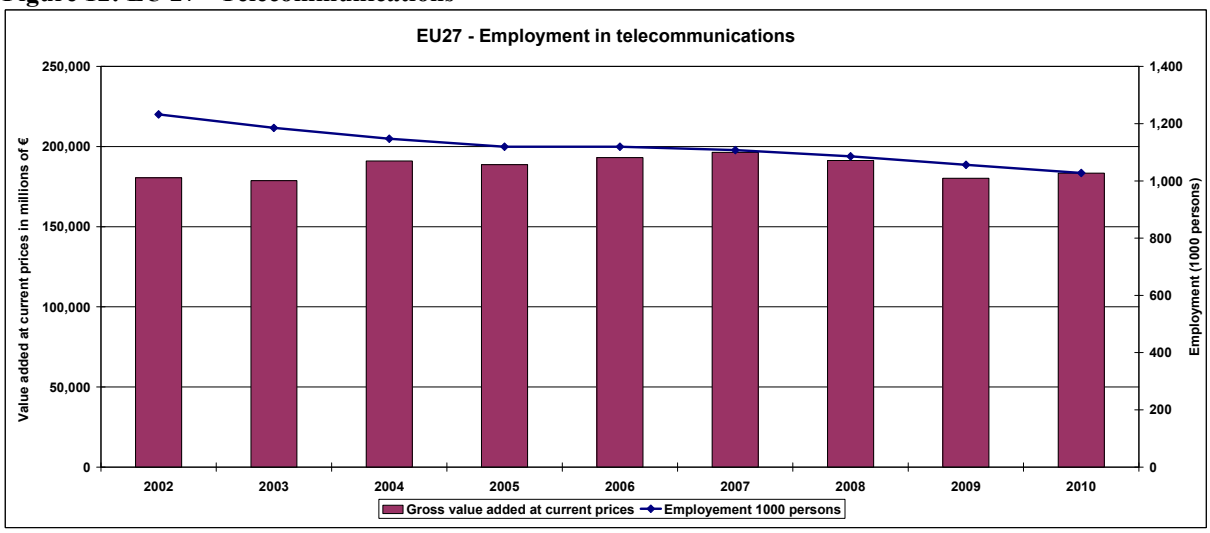
Figure 11: EU 27 - Telecommunications - Value added (in millions of €)



Source: Eurostat, national accounts by industry (NACE Rev.2 by 64 braches)

In 2008 and 2009 the value-added at current prices decreased. It recovered by 2% in 2010 year-on-year. The difference between nominal and real value-added increased significantly over the same years, reflecting regulatory and market pressures on prices. Employment followed structural factors rather than the business cycle (Figure 12).

Figure 12: EU 27 - Telecommunications



Source: Eurostat, national accounts by industry (NACE Rev.2 by 64 braches)

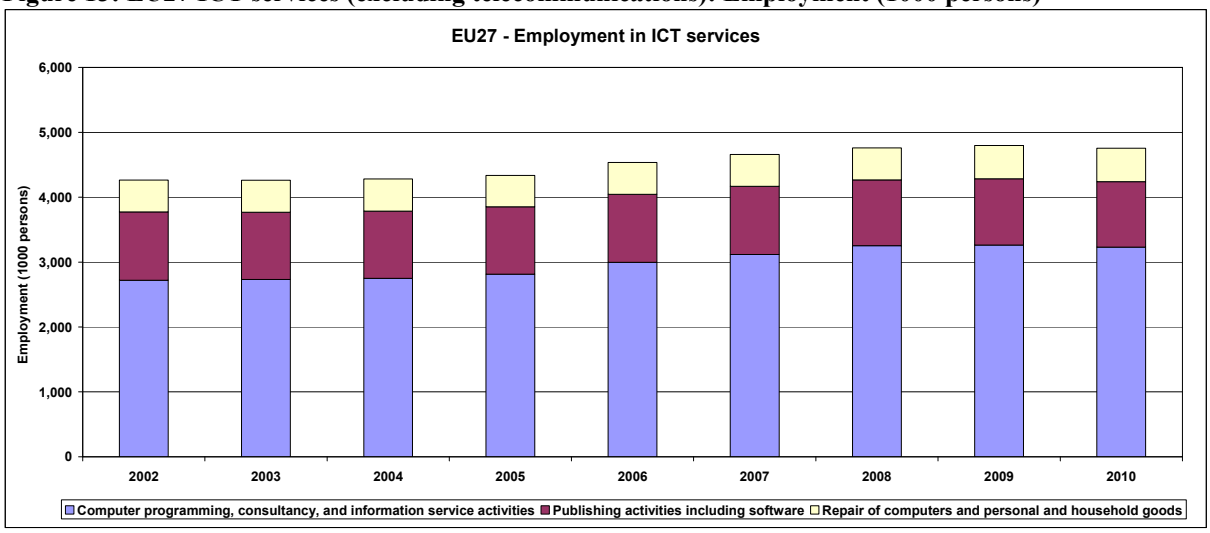
ICT services excluding telecoms (NACE 58, 62, 63 and 95)

For the EU, out of the 7 million jobs in ICT in 2010, 4.7 million were in ICT services (excluding telecoms). In terms of value-added at current prices, they represented around 50% of the total ICT value-added [11] (Figure 13). In terms of employment and value-added, computer, data processing and web portals services were by far the most important.[12]

[11] Section 4 analyses the diffusion of ICT in all economic activities and how this implies complementary investments, for example in software. The development of ICT services directly relates to the development of the information and online society.

[12] In order to present data for the EU27, the OECD definition cannot be fully met. NACE 58.2 - Software publishing is not released separately from the whole NACE 58 which includes NACE 58.1 - Publishing of books, periodicals and other publishing activities. As already mentioned, by taking the full NACE 58 activities,

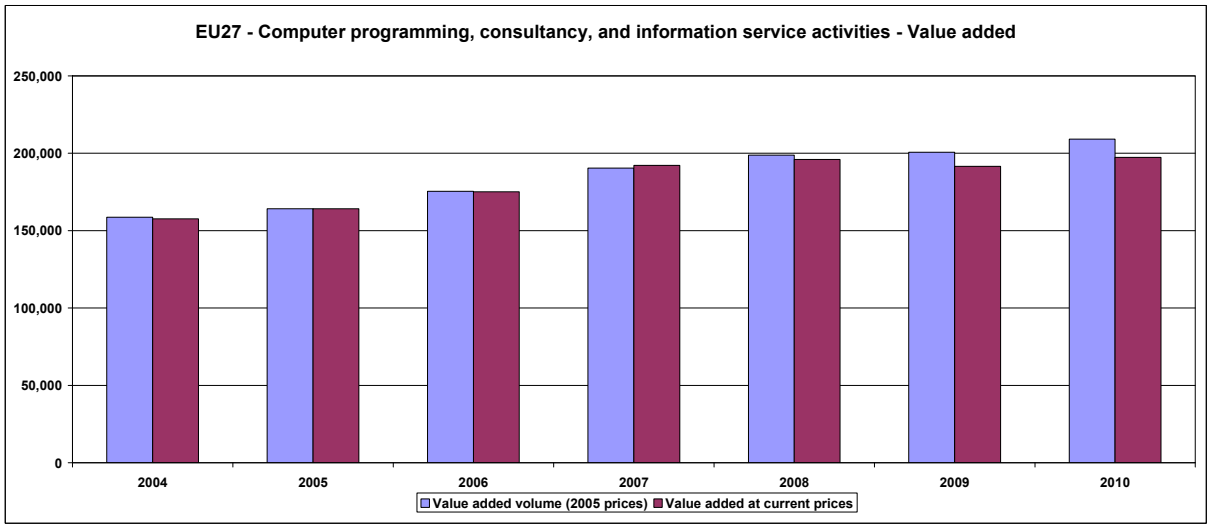
Figure 13: EU27 ICT services (excluding telecommunications): Employment (1000 persons)



Source: Eurostat, national accounts by industry (NACE Rev.2 by 64 braches). For 2010, NACE 58 and NACE 95 are estimated (extrapolation)

These activities are labour intensive and Figure 14 shows that welfare gains are small when estimated by comparing the nominal and real value-added.

Figure 14: EU27 Computer programming, consultancy, and information service activities – Value-added in millions of €

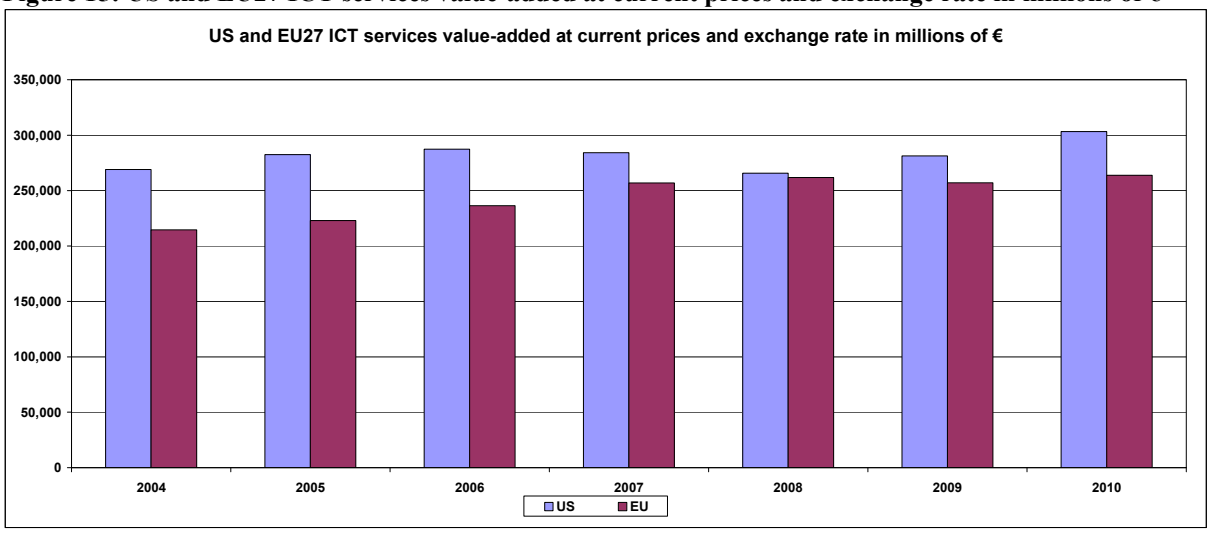


Source: Eurostat, national accounts by industry (NACE Rev.2 by 64 braches)

ICT services are mainly provided by thousands of small and medium-sized enterprises, mostly competing at national and local level. In 2008, their combined value-added was very similar to the combined value-added of their US counterparts, although the gap has been increasing in recent years (Figure 15).

the impact of "creative destruction" of the digitalisation of publishing is included in the data. Data is available only for the combined NACE 62 and 63 activities. Data for NACE 95.1 - Repair of computers and communication equipment is not available as such but is included in NACE 95 that also includes repair of all other household goods

Figure 15: US and EU27 ICT services value-added at current prices and exchange rate in millions of €



Source: Eurostat, national accounts by industry (NACE Rev.2 by 64 braches)

The size of EU software companies is, in most cases, considerably smaller than that of their US or Japanese counterparts. Europe has only one software company with sales exceeding EUR 10 billion and none that integrates hardware and software. This means that European cloud computing services have to be developed through collaborations with non-European enterprises.

1.2. ICT Research and Development

This section analyses the most recent data available from Eurostat on Business R&D expenditures (BERD) in the European ICT sector (ICT BERD)[13]. ICT BERD is analysed first at the EU level, then at Member State level, and finally at ICT manufacturing and services sub-sector level, including a comparison with the United States.

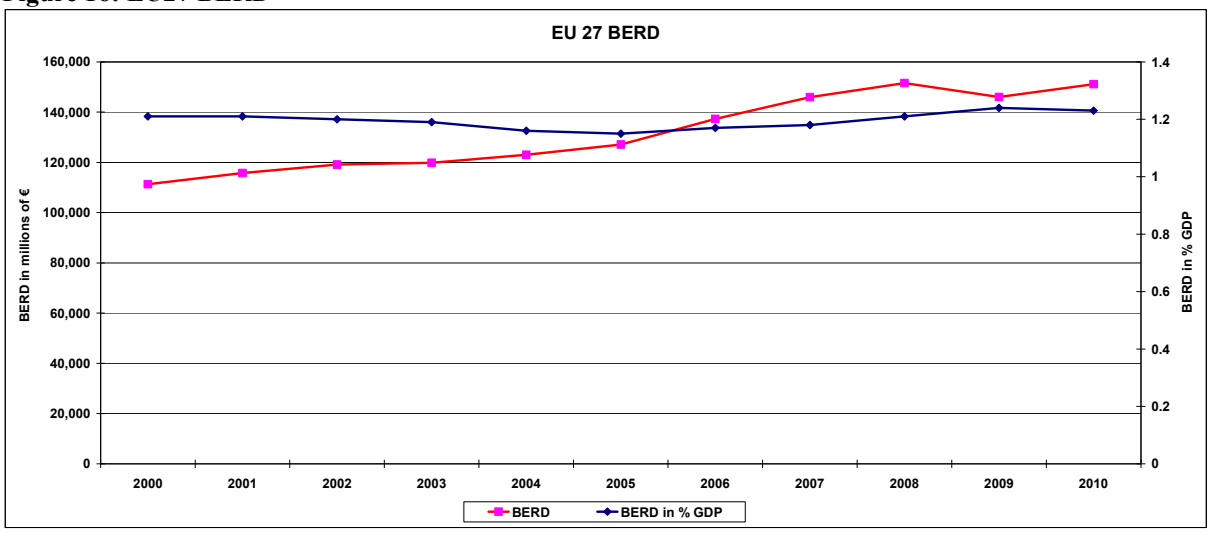
1.2.1. ICT R&D at EU27 level[14]

In 2009, the EU27's total BERD decreased by 3.7% year-on-year; in 2010, it increased by 3.5%, amounting to EUR 151.1 billion (EUR 151.6 billion in 2008). At the same time, R&D intensity (expressed as a percentage of GDP) increased slightly from 1.21% in 2008 to 1.24% in 2009 and stabilised at 1.23% in 2010 (Figure 16).

[13] This analysis is based on the most recent definition of the ICT Sector adopted by EUROSTAT and the OECD, according to the NACE Rev. 2 classification. See Annex 1 for more information on this definition.

[14] Most of the data and analysis on ICT R&D come from PREDICT (Prospective Insights on R&D in ICT), a joint project by JRC-IPTS and DG Information Society and Media. For more information see: http://is.jrc.ec.europa.eu/pages/ISG/PREDICT.html

Figure 16: EU27 BERD



Source: Eurostat

R&D expenses by the ICT industry alone experienced a similar pattern. In 2009, business ICT sector R&D (BERD) declined by 7.37% (from EUR 27 billion to EUR 25 billion), mostly due to lower spending in ICT manufacturing activities (-16.84%). In ICT services, R&D increased by 2.2%, driven by spending in Computer programming, consultancy and related activities (+5.6%), and Data processing, hosting and web portals (+28%). Meanwhile, R&D spending in telecommunications was stable and decreased in the software publishing sector (-9%).

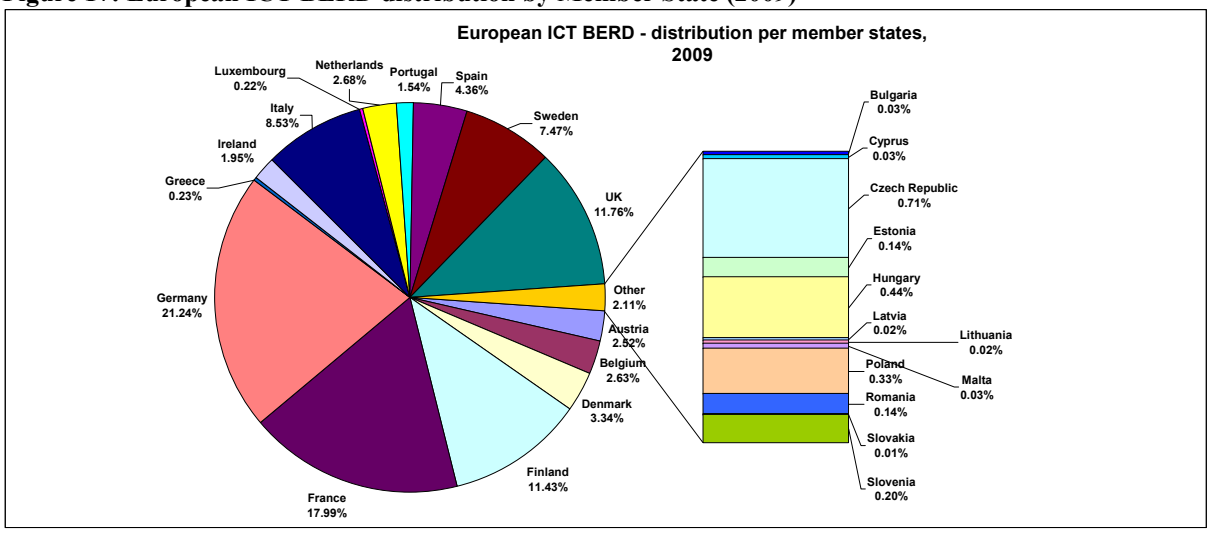
Since the ICT value-added declined by a similar percentage (7%), from EUR 505 billion to EUR 470 billion, R&D intensity remained almost stable.

With a value-added share in GDP of 4%, ICT drives as much as 17% of total BERD.

Analysis at Member State level

Six EU countries -- Germany, France, the UK, Finland, Italy and Sweden -- are responsible for almost 80% of total ICT BERD. Half of this is invested in Germany and France. Finland's share of 11.43% of ICT BERD is way above its share in EU GDP (1.5%). The cumulative share of the 12 Member States that most recently joined the EU is 2.11% of the EU ICT BERD; a figure that is still very low (Figure 17).

Figure 17: European ICT BERD distribution by Member State (2009)



Source: Eurostat, JRC-IPTS and IVIE

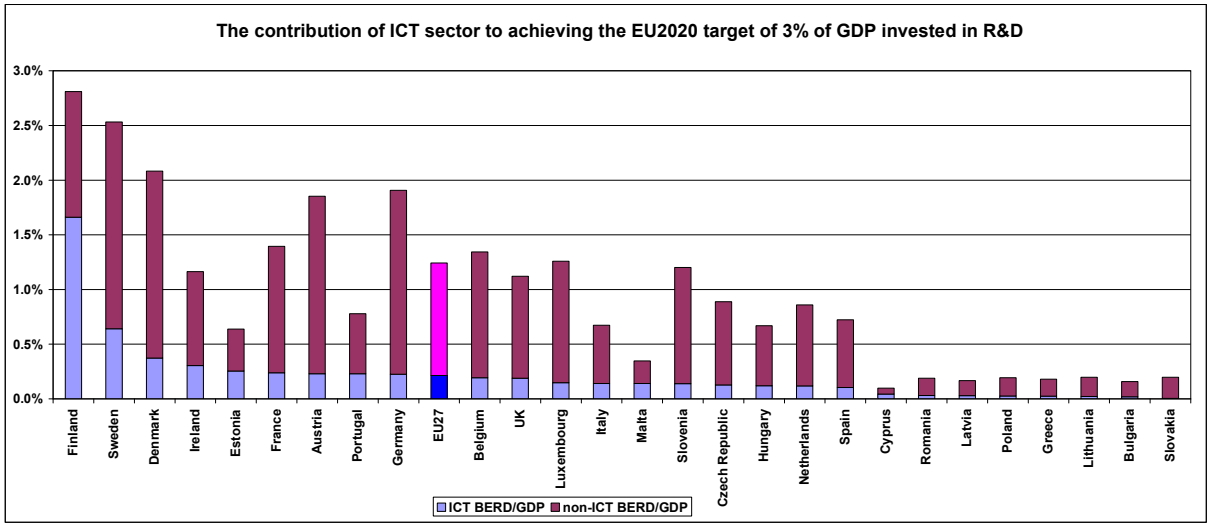
The share of ICT BERD in total BERD reflects both the size of the sector in the economy and the R&D intensity of ICT compared with others. Finland is the EU leader with almost 60% of its BERD invested by the ICT sector (as compared with a share in ICT value-added of 5.3% of GDP). Several of the newer EU Members States are also highly placed in this table (Cyprus, Malta, Estonia), while the three largest EU Members States -- Germany, France and the UK -- have a BERD that is below the EU average. In 2009, eleven Member States had a higher share of ICT BERD in total BERD than they had in 2008.

The Europe 2020 strategy has confirmed the EU objective of investing in R&D the equivalent of 3% of GDP. This includes R&D investments both in the public and the private sector. Considering R&D expenditures in the private sector alone, total EU BERD in 2009 represented 1.24% of GDP, of which 0.21% was contributed by the ICT sector (this is the ratio of ICT BERD in GDP) (Figure 18).

With an ICT BERD of 1.7% of GDP in 2009, Finland had the highest ratio of all EU countries. It also had the highest share of total BERD as a percentage of GDP (2.8%). Apart from Finland and Sweden, all other Member States had a ratio of ICT BERD below 0.5%. "Nokia's impact on Finland's high R&D intensity is significant. When Nokia's R&D activity is deducted from the calculation, Finland's R&D expenditures relative to GDP are 2.4 percent for 2008. However, it must be noted that even this share is well above the EU average."[15]

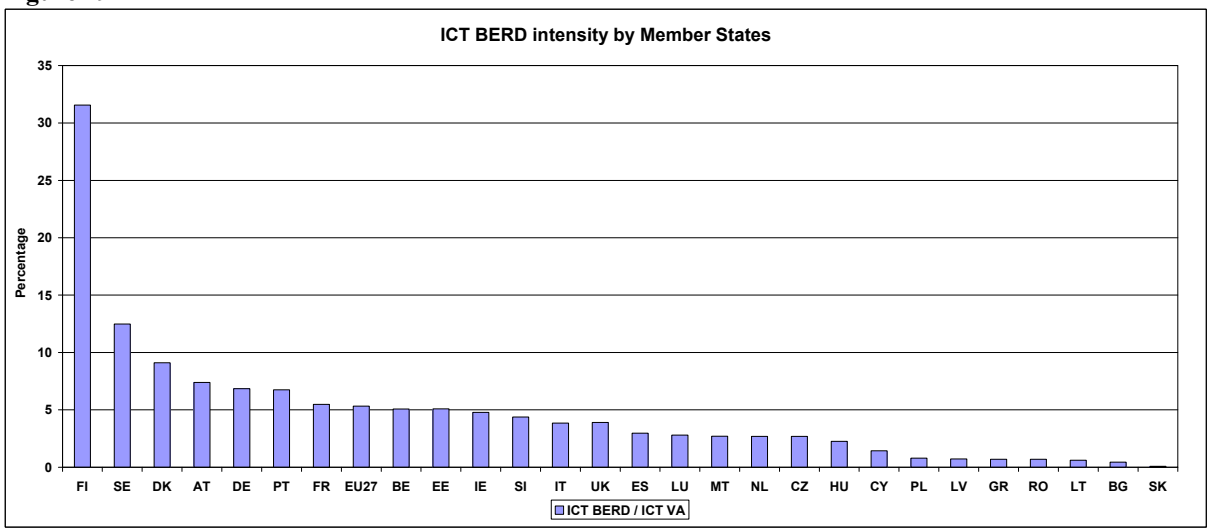
[15] Jyrki Ali-Yrkkö (2010), Nokia and Finland in a Sea of Change: The Role of Nokia in the Finnish Economy

Figure 18: **The contribution of the ICT sector to achieving the EU2020 target of 3% of GDP invested in R&D, 2009**



Source: Eurostat, JRC-IPTS and IVIE

Figure 19



Source: Eurostat, JRC-IPTS and IVIE

The share of ICT BERD in ICT value-added reflects the R&D intensity of the ICT sector of a country or a region. Here again Finland is the leading country in the EU with 2009 ICT BERD intensity above 30%. Finland[16] is followed by Sweden, with ICT BERD intensity above 10%. The average ICT BERD intensity for the EU is 5.3%. 18 EU Member States have an ICT BERD intensity lower than 5%.

1.2.2. Analysis by sector

When considering the EU ICT industry sub-sectors, ICT Manufacturing and ICT Services, each have a similar share of total ICT R&D expenditure. However, they have a very different share of the ICT total value-added. While ICT manufacturing accounts for a relatively small share in total ICT value-added (8% in 2009, down from 11% in 2008), it accounts for 45% of ICT BERD (down from 50% in 2008). ICT services represents 92% of total ICT value-added

[16] Finland's lead in ICT owes not only to the activities of its largest R&D investor, Nokia, but also to ICT R&D performed in a network of traditionally vibrant poles of excellence located, for example, in Tampere, and Espoo Helsinki. G. De Prato, D. Nepelski, Empirical identification and analysis of >European ICT poles of Excellence, JRC IPTS Report (Forthcoming).

in 2009 (up from 89% in 2008) and accounted for the remaining 55% of total ICT BERD in 2009.

Table 1 – ICT Value-Added and BERD in the EU by ICT sub-sectors (NACE Rev. 2), 2009

NACE	Description	ICT VA 2009 Mill. euro	ICT BERD 2009, mill. euro
	ICT Total	470 014.74	25 064.34
	ICT manufacturing industries	38 156.54	11 334.33
261	**Manufacture of electronic components and boards**	11 761.75	3 400.72
262	**Manufacture of computers and peripheral equipment**	5 660.69	1 096.92
263	**Manufacture of communication equipment**	16 425.06	6 316.56
264	**Manufacture of consumer electronics**	4 231.43	514.38
268	**Manufacture of magnetic and optical media**	77.61	5.75
	ICT total services	431 858.20	13 730.01
	ICT trade industries	42 472.72	503.94
4 651	**Wholesale of computers, computer peripheral equipment and software**	28 046.12	na
4 652	**Wholesale of electronic and telecommunications equipment and parts**	14 426.60	na
	ICT services industries	389 385.48	13 226.06
5 820	**Software publishing**	11 340.47	999.20
61	**Telecommunications**	180 246.50	4 322.72
62	**Computer programming, consultancy and related activities**	165 809.85	7 526.66
631	**Data processing, hosting and related activities; web portals**	20 868.30	362.12
951	**Repair of computers and communication equipment**	11 120.36	15.36

Source: Eurostat, JRC-IPTS and IVIE

1.2.3. Comparison with the US

In 2009 the EU ICT sector's value added amounted to EUR 416,422 million while in the United States in amounted to EUR 510,472 million[17]. This comparison excludes the ICT Trade and Repair sub-sectors since data on value-added and BERD in these sub-sectors were not available for the United States,

ICT BERD was respectively EUR 24,545 million for the EU and EUR 62,680 million for the US. Therefore, the US ICT BERD intensity (measured by the share of ICT BERD in ICT value-added) was twice that of the EU (12% vs. 6%), and was higher than in any EU country with the exception of Finland.

R&D intensity is sector specific; it is much higher in ICT manufacturing than in ICT services. The higher ICT BERD intensity in the United States can be partly explained by the fact that in 2009, the share of ICT manufacturing in total ICT value-added was more than double that of the EU (18% in the United States compared with 8% in the EU).

Among the ICT manufacturing subsectors, there were also differences in size and intensity. The Telecommunications equipment sector represented a similar share of value-added in the

[17] These two sub-sectors perform very little R&D, although together they produced 11% of the total ICT sector value-added in 2009. Please also note that in order to stick to the OECD definition of ICT activities, the value-added considered in this section is narrower than in section 1.2.1 which included all publishing activities (and not just software publishing), motion picture, video, television and broadcasting programme activities

EU as it did in the United States (4%). But in terms of BERD, the share of this sub-sector was higher in the EU (26%) than in the United States (15%). Both the Electronic components and boards, and Computers and peripheral equipment ICT sectors had, however, higher value-added and higher BERD shares in the United States than in the EU.

In ICT services, the Telecommunication sector represented similar shares of ICT value-added in the EU as in the United States (43% in the EU and 40% in the United States). Its share of BERD was however much higher in the EU (18%) than in the United States (2%). The Computer programming, consultancy and related activities sector had higher shares of value added (40%) and BERD (31%) in the EU than in the United States (24% value-added and 14.5% of ICT BERD). Meanwhile., the Software publishing sector was responsible for 10.5% of US ICT value-added and as much as 30% of US ICT BERD while in the EU the corresponding figures were 2.7% and 4.1%.

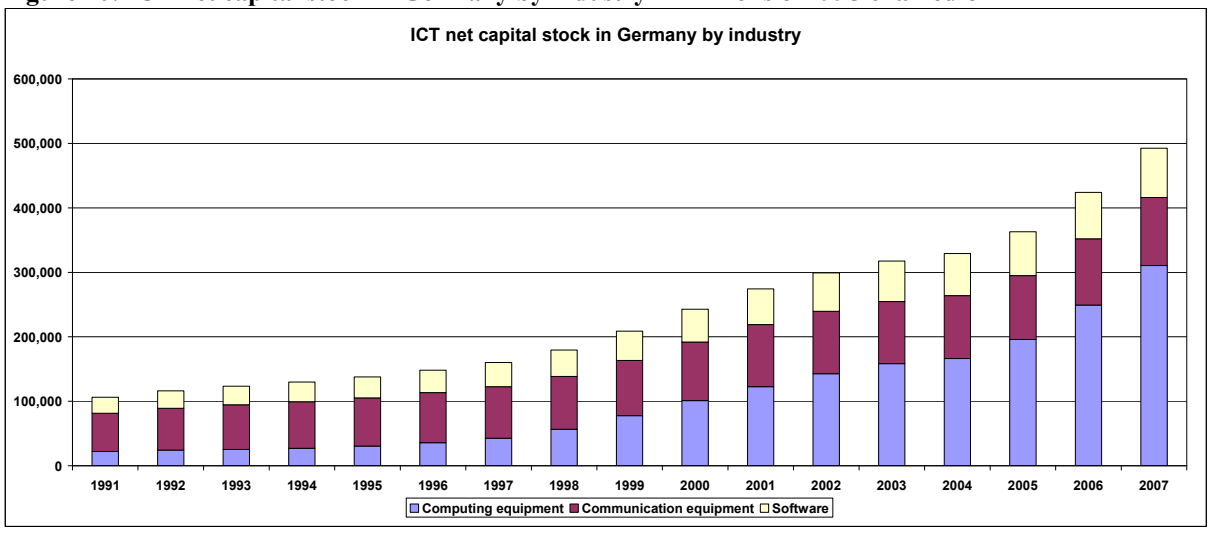
1.3. ICT diffusion, innovation and economic growth [18]

1.3.1. ICT investment

Economic value is created by combining labour and capital, which includes any possible piece of equipment in terms of plant, vehicles, and buildings.[19] The 1990s saw the share of ICT in the aggregate capital stock increase in virtually all economies and with such intensity that ICT capital deepening became a major source of productivity growth. In Europe, in the period 1995-2000, productivity increased at a rate of 1.43%. Capital contribution was 0.71% of which ICT capital contributed 0.37%[20].

Figure 20 illustrates the proportion of ICT equipment in the capital stock by industry for Germany. This trend was reflected across most countries[21]

Figure 20: ICT net capital stock in Germany by industry in millions of 1995 chained €



Source: EU KLEMS

Enterprises are still devoting a significant part of their investments to the ICT platform. In 2007-09, it represented over 30% in the United States, about 25% in Sweden and Denmark, and over 20% in the United Kingdom (Figure 21).

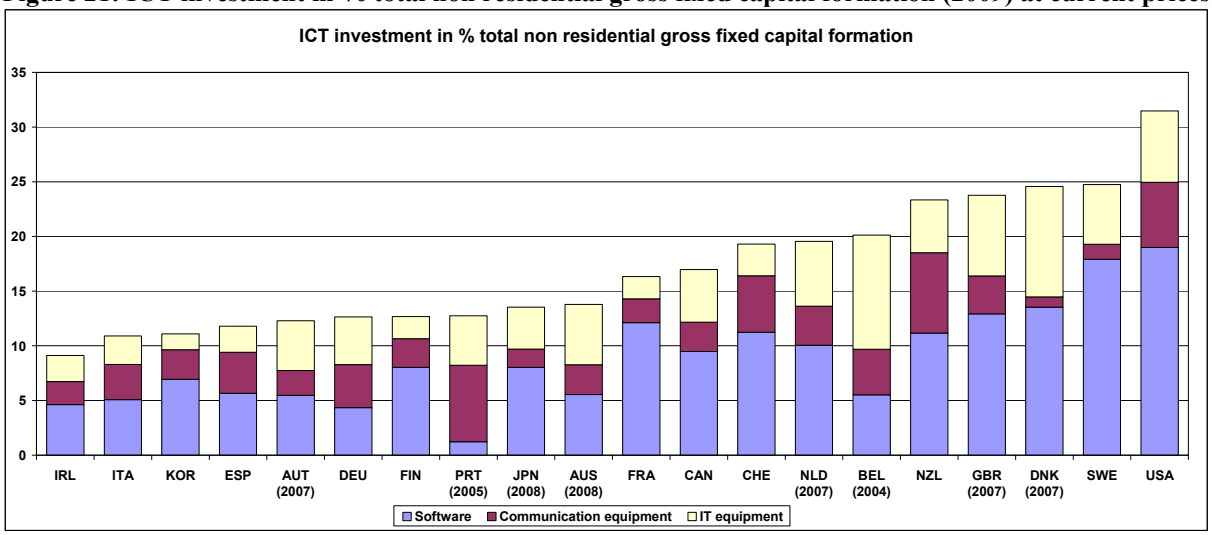
[18] For an in-depth analysis, please refer to the ICTNET website, a FP 7 funded coordination action to support research in the economics of ICT. - http://www.ict-net.eu/

[19] The capital stock is the sum over time of the annual flow of investment (gross fixed capital formation), adjusted by the depreciation rate of the different equipments (perpetual inventory method).

[20] source EU KLEMS

[21] EU KLEMS database provides the net capital stock only for a few countries, due to confidentiality.

Figure 21: ICT investment in % total non residential gross fixed capital formation (2009) at current prices

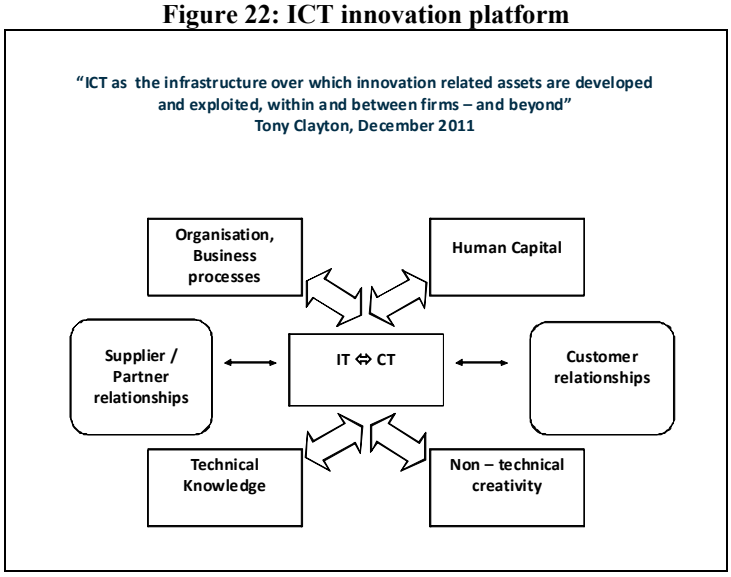


Source: OECD Science, Technology and Industry Scoreboard 2011

1.3.2. Investment in intangible assets

The successful adoption and use of ICT by businesses requires complementary investments. From the design of a website to electronic exchanges with suppliers and customers, each enterprise and institution has to "rethink and reshape" its organisation in a context that is far more competitive due to easier and costless access to information on products and suppliers (Figure 22).

Figure 22: ICT innovation platform



Source: Tony Clayton (2011) 22

As part of the increasing interest for these complementary investments (defined in as investment in intangibles), ICT has received special attention for at least three reasons: first, computerised information (software and databases) accounts for a significant proportion of total intangibles; second, successful adoption and use of ICT by businesses requires complementary investments in intangibles, like training, management and organisation;

[22] http://ec.europa.eu/research/social-sciences/events-197_en.html

finally, ICT itself raises the economic value of information. The data gathered on the purchase preferences of e-customers has become a business asset for on-line retailers[23].

ICT has the potential to increase innovation by speeding up the diffusion of information. It favours networking among firms, enables closer links between businesses and customers, reduces geographic limitations, and increases efficiency in communication. A recent survey from the Dutch statistical office (CBS) confirms the importance of ICT for innovation (table 2) [24].

Table 2 – ICT and innovation

In % of enterprises having innovated in 2009	
ICT for product innovation	
Very important	**33**
Important	**32**
Somewhat important	19
Not important	15
ICT for process innovation	
Very important	**42**
Important	**43**
Somewhat important	12
Not important	4
ICT for organisational innovation	
Very important	**23**
Important	**41**
Somewhat important	24
Not important	13
ICT For marketing innovation	
Very important	**24**
Important	**44**
Somewhat important	24
Not important	7

Source: Statistics Netherlands - CBS

Two projects funded by the European Commission (COINVEST[25] and INNODRIVE[26]) under the 7th Framework Program pioneered the provision of intangible investment databases. Intangible investments have been classified[27] according to three main categories:

[23] For a more detailed analysis, please refer to the ICTNET Assessment Paper 3 ICT R&D and Intangibles https://community.oecd.org/docs/DOC-38254

[24] For more, please refer to the ICTNET Assessment Paper 2 on ICT-enabled innovation https://community.oecd.org/docs/DOC-31259 and for a survey, Brynjolfsson, Hitt and Yang (2002) http://oz.stern.nyu.edu/cite05/readings/brynjolfsson3.pdf

[25] www.coinvest.org.uk

- Computerised information

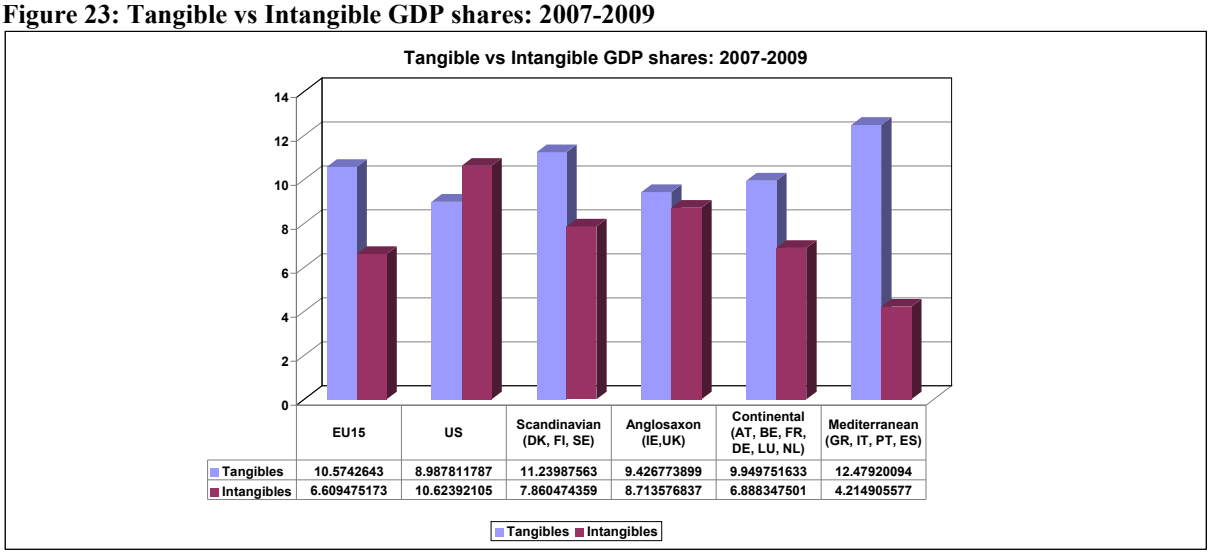
  Software
  Databases

- Technical and non-technical innovative property (R&D expenses)
- Economic competences

  Organisational capital
  Firm specific human capital (e.g. vocational and apprentice training)
  Brand equity (e.g. advertising, market research)

The most recent results[28] show that the share of intangibles in GDP from 1995 to 2009 (average values) amounted to 6.6% in the EU15 and to 10.6% in the United States, which compares with a tangibles share of 10.6% in the EU15 and 9% in the United States (Figure 23)

Figure 23: Tangible vs Intangible GDP shares: 2007-2009



Source: Carol Corrado (The Conference Board), Jonathan Haskel (Imperial College), Cecilia Jona-Lasinio and Massimiliano Iommi (ISTAT and LLEE), ICTNET Workshop, April 2012

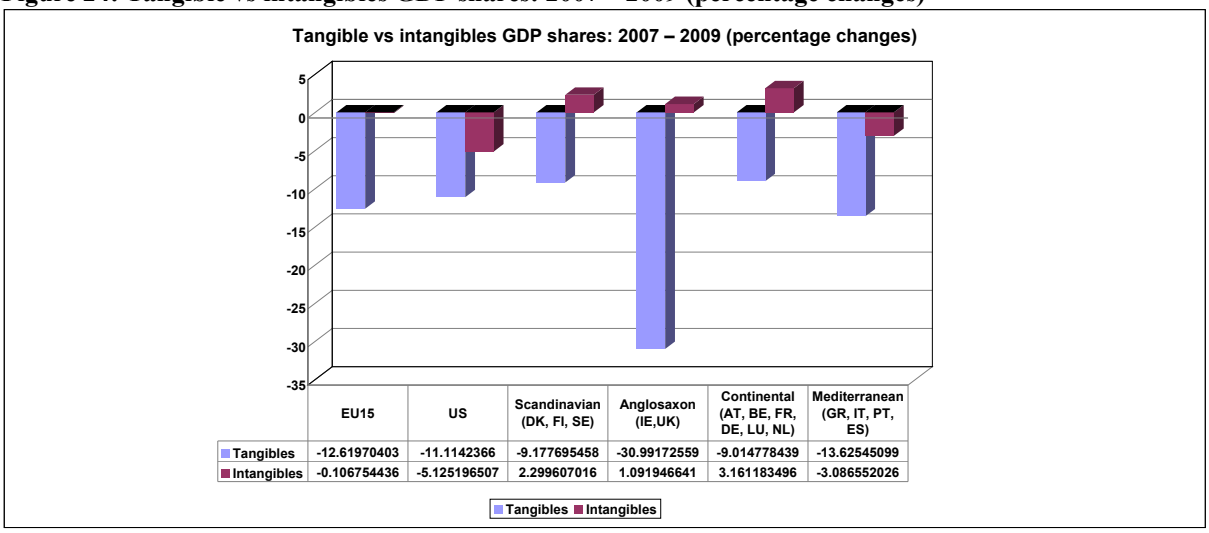
The rate of tangible investment in the EU15 declined sharply from 2007 to 2009 while the rate of intangible investment remained fairly flat. In the United States, intangible investment fell (Figure 24).

[26] www.innodrive.org/

[27] According the seminal paper of Corrado, Hulten and Sichel (2005, 2009)

[28] Please refer to the ICTNET website and to the following paper: Carol Corrado, The Conference Board, New York, Jonathan Haskel, Imperial College, London, Cecilia Jona-Lasinio, ISTAT and LLEE, Rome, Massimiliano Iommi, ISTAT and LLEE, Rome, (2011,2012), Intangible Capital and Growth Strategies for Advanced Economies:Measurement Methods and Comparative Results

Figure 24: Tangible vs intangibles GDP shares: 2007 – 2009 (percentage changes)



Source: Carol Corrado (The Conference Board), Jonathan Haskel (Imperial College), Cecilia Jona-Lasinio and Massimiliano Iommi (ISTAT and LLEE), ICTNET Workshop, April 2012

1.3.3. Conclusions

Between 1995 and 2008, capital deepening in intangible capital made an average 25% contribution to labour productivity[29]. The share of personnel engaged in intangible capital type work is comparable in six European countries, accounting for about 18% of all workers[30]. Hence ICT continues to have an impact on economic performance as its use spreads across all sectors of the economy.

But the ICT producing sector also continues to be a source of growth, despite the changes brought about by the technological waves. Recent technological changes, new markets, and company strategies are generating growing and broader interdependencies between telecom services, equipment industries, and related industries such as software publishing and internet service providers.

These new interdependencies between the ICT sub-sectors, together with increased competition between them, are affecting the overall ICT sector R&D landscape worldwide and are changing the way in which we need to consider R&D intensity. A deeper analysis is needed that goes beyond the boundaries of individual ICT sub-sectors or even of the ICT sector to include other sectors of the digital economy (for example, media and contents)[31].

[29] Carol Corrado, Jonathan Haskel, Cecilia Jona-Lasinio, and Massimiliano Iommi, http://ec.europaipv4.eu/research/social-sciences/pdf/events-197/carol-corrado_en.pdf

[30] According Innodrive

[31] See European Commission JRC-IPTS report on The Top World R&D-investing Companies from the ICT Sector: A Company-level Analysis, Daniel Nepelski, Juraj Stancik EUR 24841 EN, 6/2011; available at http://is.jrc.ec.europa.eu/pages/ISG/PREDICT.html

1.3.4. Annex

For detailed information on changes introduced by the NACE Rev. 2 definitions, see Eurostat http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-RA-07-015/EN/KS-RA-07-015-EN.PDF

For detailed information on changes in coverage of ICT activities introduced by the NACE Rev. 2 definitions, see the OECD *Guide to Measuring the Information Society 2011*, in particular, Annex 7 A1, pp 149-165: http://www.oecd-ilibrary.org/science-and-technology/oecd-guide-to-measuring-the-information-society-2011_9789264113541-en; or OECD document DSTI/ICCP/IIS(2006)2/FINAL of 05 March 2007: http://www.oecd.org/dataoecd/49/17/38217340.pdf

ICT in NACE Rev.2

NACE Rev. 2 code	Description
261	Manufacture of electronic components and boards
262	Manufacture of computers and peripheral equipment
263	Manufacture of communication equipment
264	Manufacture of consumer electronics
268	Manufacture of magnetic and optical media
4651	Wholesale of computers, computer peripheral equipment and software
4652	Wholesale of electronic and telecommunications equipment and parts
5820	Software publishing
61	
6110	Wired telecommunications activities
6120	Wireless telecommunications activities
6130	Satellite telecommunications activities
6190	Other telecommunications activities
62	
6201	Computer programming activities
6202	Computer consultancy activities
63	
6203	Computer facilities management activities
6209	Other information technology and computer service activities
6311	Data processing, hosting and related activities
6312	Web portals
9511	Repair of computers and peripheral equipment
9512	Repair of communication equipment

Harmonising US and EU ICT activities

US (BEA)	EU (Eurostat)
ICT manufacturing	ICT manufacturing
Computer and electronic products	NACE 26 Manufacture of computer, electronic and optical products
Information services	ICT services
Motion picture and sound recording industries	NACE 59_60 **Motion picture, video, television programme production; programming and broadcasting activities**
Publishing industries, including software	NACE 58 Publishing including software
Broadcasting and telecommunications	NACE 61 Telecommunications
Information and data processing services	NACE 63 Data processing, hosting and related activities; web portals
Computer systems design and related services	NACE 62 Computer programming, consultancy and related activities