SECTORAL INNOVATION SYSTEMS IN EUROPE: THE CASE OF THE ICT SECTOR

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Executive Summary

ICT contributes significantly to economic and productivity growth in multiple ways. As a pervasive, general purpose technology investments in ICT and the increased use of ICT increase overall efficiency and productivity in all sectors and in all regions and countries of the EU. In this report we have focused on **ICT as a sector**, which is on many aspects the most innovative sector of all in the EU. Because it is also a growing sector, the ICT sector has provided major contributions to economic growth and increasing productivity and innovation in all European countries and regions.

The trend for the European ICT sector is **towards a service sector** (software and services), and less a manufacturing sector of ICT hardware. Because of the very **short life-cycles** in ICT, the sector is almost innovative by definition. Another characteristic of the sector is the high degree of **globalisation** of ICT markets and production.

The EU trade balance in ICT goods is persistently negative and increasingly positive for ICT services. We conclude that the more mature ICT products and services, with lower profit margins, are more likely to be relocated to off-shore locations, than new, innovative and high value added activities.

The ICT sector is **in many ways the most innovative sector** in Europe. Especially the share of employees with higher education is much higher than in most other sectors, with the highest share in the ICT service industry. Also the share of firms with in-house R&D and the share of firms co-operating in innovation with others is in ICT on average higher than in the other sectors. The ICT sector is also leading in terms of strategic and organisational innovation.

There is a large **diversity within the ICT sector**, e.g. the characteristics of ICT services and software are different from those of manufacturing industries. The ICT software and service sector (NACE 72) represents two thirds of the ICT sector in Europe. Some of the main differences between the ICT service firms and those in ICT manufacturing industries are that on average firms in the service sector have: a smaller firm size and lower orientation on international markets, but a higher employment growth and export growth. ICT service firms: have a higher share of high educated employees; a lower share in sales of new products; higher own R&D expenditures, but lower external R&D; less often apply for patents, more often use copyright and informal strategic methods to protect IP; and receive less often public funding for innovation.

From the macro-economic analysis we conclude that in general **competition has a positive effect on innovation**, especially in the ICT sector.

Innovation output in the ICT sector is especially depending on the amount of **innovation expenditures and the share of highly skilled labour**.

The share of Strategic Innovators and Intermittant Innovators is high in the ICT sector, higher than in other sectors. Comparing the Strategic Innovators in the ICT sector with those in other sectors shows that that the ICT Strategic Innovators have a much higher share of high educated employees, higher growth in turnover, higher share of innovative firms, and a higher share of new-to-market turnover. These are characteristic features of the ICT sector in general, and how ICT firms innovate in particular.

The most reported form of formal **Intellectual Property protection** for firms in the ICT sector is, by far, the use of **trademarks**. The most often reported informal mode of IP protection in ICT is through lead-time advantage on competitors, but also the use of secrecy and complexity of design, is much more common in the ICT sector than in most other sectors. The use of patenting is also above the average of all sectors, but the importance of the other forms of protecting IP is an issue that is neglected by policymakers who are all merely focussed on patents.

Among the many Small and Medium sized Enterprises in the ICT sector there is a group of continuous **innovating ICT SME's**, a dynamic group that is oriented on global markets, have shown increasing profits and who co-operate with universities.

Out of the innovative ICT companies 26 percent report that innovation is hampered due to the lack of funds within the enterprise or group. The access to external sources of financing such as public money, venture capital or loans is a serious problem for 18 percent of the enterprises. On the other hand, compared to most other sectors the ICT sector shows a rather good internal financing situation, and regarding external funding the ICT sector has attracted the largest (of all sectors) fraction of private equity investment in the EU25 over the past 10 years.

For innovative ICT SME's in Europe human resources are by far the most mentioned driver of innovation, but lack of human resources is also the most mentioned barrier.

In terms of **productivity** the ICT sector in Europe is lagging the ICT sectors of the US and especially Japan. A major dis-advantage for EU ICT companies is the relatively **small market** size in EU countries. We can conclude that the degrees of knowledge-intensity and economies of scale are main determinants of the localisation of ICT activities in Europe; the less knowledge-intensive production and the higher the degree of economies of scale, the easier it is to re-locate production of ICT goods or services to low-cost, off-shore locations.

Europe's **ICT research** is strong, but it is weak in bringing inventions successfully to the market. Co-operation matters in ICT research. In-house R&D is essential in the ICT sector. A considerable share of ICT companies in Europe co-operate with universities, but the share of co-operation with government research institutes is rather low. A major challenge for Europe is to make better use of the results of the research community as a whole, including both public and private research. A future challenge is that private–public partnerships with regard to R&D collaboration are to be improved.

Regarding the prospective view on Europe's ICT the regulatory incoherence is an innovation challenge as companies often can still not implement strategies or solutions on a European or global scale, but tend to adapt to local laws and business habits, generating numerous obstacles to European competitiveness.

A major challenge for the EU ICT sector will be to address the problems with the availability of **high educated human resources** for the ICT sector. The problem has many aspects: e.g.: the declining numbers of students of scientific and engineering disciplines, the brain drain to the US, the shortage of experts with specific skills, the shortage of the absolute number of ICT-workers in general, the abundant supply of high educated labour in emerging economies, such as China and India.

Benchmarking the national ICT innovation systems in Europe (based on patenting, export and total factor productivity) has shown that the leading EU countries in terms of innovation performance in the ICT sector are **Finland, the Netherlands and Germany**. The ICT sectors of these three countries have both a high overall level of innovative performance and a high rate of growth in innovative performance. In terms of the relationship between innovation performance and characteristics of the national innovation system, the study shows that a high level of innovation in the sector is strongly associated with two dimensions of the knowledge base of the economy: **R&D intensity and the level of skills**.

Countries with a high level of innovation performance in the ICT sector are also likely to have the following characteristics in terms of agents and interactions: domestic firms with a high level of **international orientation, availability of venture capital and smaller sized firms**.

Socio-cultural factors are important for the future of the ICT sector in Europe. Regarding cultural and human capital the importance of **entrepreneurial behaviour** of all the involved actors and levels of society is emphasized, not only in relation to diffusion and ICT-uptake, but also within the ICT sector itself. Also the importance of multi-disciplinary human capital for the ICT sector is an important challenge for the future. More and more the enhancement of innovation in the ICT sector is depending on the linkages between knowledge of ICT and other types of knowledge, and the linkages with and embeddedness in other sectors. The importance of innovative networking and open innovation puts a premium on multi-disciplinarity.

Although the use of ICT has changed the importance of distance, some **regions** in Europe have a large concentration of ICT production. The regional concentration of ICT manufacturing and ICT services depends on several factors of which the availability of highly skilled people and research friendly surroundings are the most important ones.

We have seen that the importance of the relation between the density in services and manufacturing doesn't work both ways, since high density in ICT services does not seem to be hampered by low ICT manufacturing density.

We have noted in chapter seven that for the ICT sector most public support in the form of funding of research and innovation comes from regional and national governments. In general ICT firms more often have received public funding than the average for all sectors, but there are differences by sub-sector. Firms in NACE 32, producing communication equipment, have received most public funding for research and innovation. Innovative **ICT service firms have less often received public funds** for innovation than innovative firms in other sectors. Surprisingly low is the share of firms in NACE 30 (manufacturing of computers and office machinery) that have received public funds for innovation from EU sources.

EU policy support to ICT comes **from several DGs** (especially: DG Enterprise, DG Infso, DG Research and DG Regio), and many different programmes, e.g. the Competitiveness and Innovation Programme (CIP), the 7th Framework Programme and the Structural Funds programmes. A large part of the public support is aimed at enhancing the diffusion and the society wide uptake of ICT. Apart from the myriad of individual policies and measures cooperation and **systemic forms of innovation governance** for the ICT sector is deemed necessary to facilitate appropriate **policy mixes, strategic agendas** and a more **thematic focus** to research and innovation. A good example is the cooperation in research and innovation stimulated by the creation of Technology Platforms and strategic initiatives which combine several projects and many type of stakeholders. The Lead Market Initiatives also seems a very appropriate policy tool for the ICT sector. Also at national policy level such strategic and systemic type of policy instruments seem most suitable for the ICT sector, since we have seen that compared to other sectors, cluster initiatives and technology platforms are more frequent use as policy format for the ICT sector than for other sectors. Good practice national research and innovation programmes are also designed as thematic, Multi-actor and multi-user programmes.

The four most important innovation policy issues for the ICT sector are: research, human resources, European integration, and funding. The two most important drivers of innovation at the level of ICT firms as well as the sector level for EU regions, countries and the Union as a whole are Research and Development and high educated Human Resources. The small scale of national markets and the still lagging integration at the EU level is one of the main barriers. The other main barrier is the lack of funding for innovation. By addressing these four challenges in a systemic way public policy can function as a driver for innovation in the ICT sector.

Systemic forms of innovation governance are most relevant policy tools to promote innovation in the ICT sector. Good practice formats are: cluster policies, technology platforms, thematic collaborative research programmes and Lead Market initiatives. Such systemic tools facilitate: demand-driven co-operation, open innovation; alignment of strategic of agendas and thematic focus to research and innovation; and interaction between ICT producers and users.

In order to promote such systemic forms of public policy, which often consist of a policy mix of existing tools, more horizontal cooperation between policymakers of relevant national ministries and of the most relevant DG's of the European Commission is necessary. More co-ordination is also needed between research and innovation policies at regional, national and EU level, in order to improve the overall benefits of public investments in ICT research and innovation.

We have seen many evidence of the importance of research expenditures for competitiveness in ICT. Not only for large ICT companies, but also for innovative ICT SME's. And not only at firm level, but also national and regional level. And new ICT knowledge is created by both public research institutes as well as private companies.

Concerning **research as a main driver** of innovation the ICT innovation watch panel called for: more co-ordinated research, more mobility of researchers, more excellence in universities, grands for research co-operation, improvement of the linkages between Science and Industry, and more funding in particular of "last stages of research projects".

Concerning **human resources** the importance of the availability of high skilled labour is evidenced at several places in this report. The ICT panel also called for more flexibility of the labour market, accompanied by re-training of employees in order to promote job mobility and knowledge diffusion. Besides the importance of skills development in general, there are also some more specific needs, such as the need for multi-disciplinarity, the need for developing a more risk-taking entrepreneurial spirit, the need to enhance the managerial skills of ICT professionals and vice versa. These needs should be addressed during education. After education the mobility of researchers should be promoted, e.g. between researchers in the public and private domain.

Concerning the lack of European integration, the ICT sector would benefit from more **harmonisation** within the European Union. Harmonisation in regulations, in standards, in spectrum, in IPR, etc. Less regulation can be important to stimulate innovation, but it is more important to remove the barriers of **regulatory incoherence**. The EU still does not function as a single market for ICT goods and services. Also the promotion of one European Research Area (ERA) should be enhanced. Concerning technological standardisation it is especially the efficiency, the **speed of the ICT standardisation processes** in Europe that needs to be improved.

Protection of **Intellectual Property** is essential for enhancing research and innovation in the ICT sector, but it is also a very complex and dynamic issue. It is important that policymakers become aware that the use of trademarks is the most frequently used way of protecting IP in the ICT sector. Regarding patents, reducing the costs and complexity is the most urgently needed improvement. A balanced and effective regime of intellectual property rights is important. Further improvements of the legal certainty and the accessibility of Europe's patent system, especially for SMEs, is recommended.

Innovative ICT SMEs play a vital role in the development of new visions and in transforming them into business assets. This fact that quite a large share of SME's are innovative, is characteristic of the ICT sector. ICT SMEs experience difficulties in access to finance, are often smaller than in the US. We have seen that relevant research and innovation policy projects do not reach many SMEs, and the patents systems are viewed as too complex and time-consuming to apply. Specific needs of innovative ICT SMEs should be mapped and addressed.

Proximity and regional clustering matters, especially regarding research and innovation. Regional cluster policies should be linked to other systemic policies at national or EU level, and at the level of co-operating regions.

It is good to promote the use and uptake of ICT in each and every region of the EU, but not all regions have to become a centre of excellence and be competitive globally in ICT research and innovation. Regions with a high density of ICT manufacturing should promote the development and innovation of their ICT service sector.

Regarding **Venture Capital** it seems that the problem lies in seed capital, in early stage investment capital for businesses. The issue has to be addressed from different angles, also from a socio-cultural point of view, e.g. the image of failure. But also regarding corporate venturing, since, the best thing that can happen to many start-ups (contrary to common perceptions) is being acquired by a big company.

There are some mechanisms that would achieve good effectiveness for encouraging early stage venture capital. As for start-ups, in Europe they tend not to grow beyond a certain size which has a direct impact on venture capitalists which have to take on higher risks and receive limited returns on their investments. Thus, venture capital is usually directed to refinancing existing firms, rather than creating new ones.

In line with the Europe INNOVA thematic priority of: “promotion of innovation in knowledge intensive services” **more support for research and innovation in ICT services** is needed. Although the ICT services is in many ways the best performing, most dynamic, internationally competitive and often the most innovative of the EU ICT sub-sectors, and although in the future the ICT service sector will become even more important for Europe, innovative ICT service firms less often receive public funding than innovative firms in other sectors.

1 Introduction

This paper is the draft version of the sector report for the ICT studied during the course of the Innovation Watch – SYSTEMATIC project. It contains analytical results from all work packages covered by the project. The final version of this report constitutes the final deliverable for the ICT sector. The aim of this sector report is to provide policy-makers and stakeholders in the ICT sector with a comprehensive understanding of the innovation performance and innovation challenges of the ICT sector across the EU-25 member states. Since different sectors have highly specific characteristics, the critical goal of the project is to identify main policy implications that arise and to formulate well-tailored and relevant policy recommendations regarding the European ICT sector.

1.1 The pervasiveness of ICT across all sectors

Before we define the ICT as a sector we point out that one of the key characteristics of ICT as a technology, product or service is its pervasiveness. ICT is an enabling technology that serves many purposes and can therefore be found everywhere in the economy, across all sectors. Moreover the ICT sector as we have defined it in this report, is not the only sector that is engaged in production of ICT hardware, software or services. ICT is also pervasive in terms of research and innovation, since ICT research and innovation can be found across all sectors. This also implies that the size, growth and characteristics of the ICT sector depends on the extent to which ICT activities are taking place in firms that are specialised in ICT production or services.

ICT contributes significantly to economic and productivity growth to one or more of the following effects (OECD, 2003):

1. Investments in ICT contribute as a capital good to capital deepening and raise labour productivity.

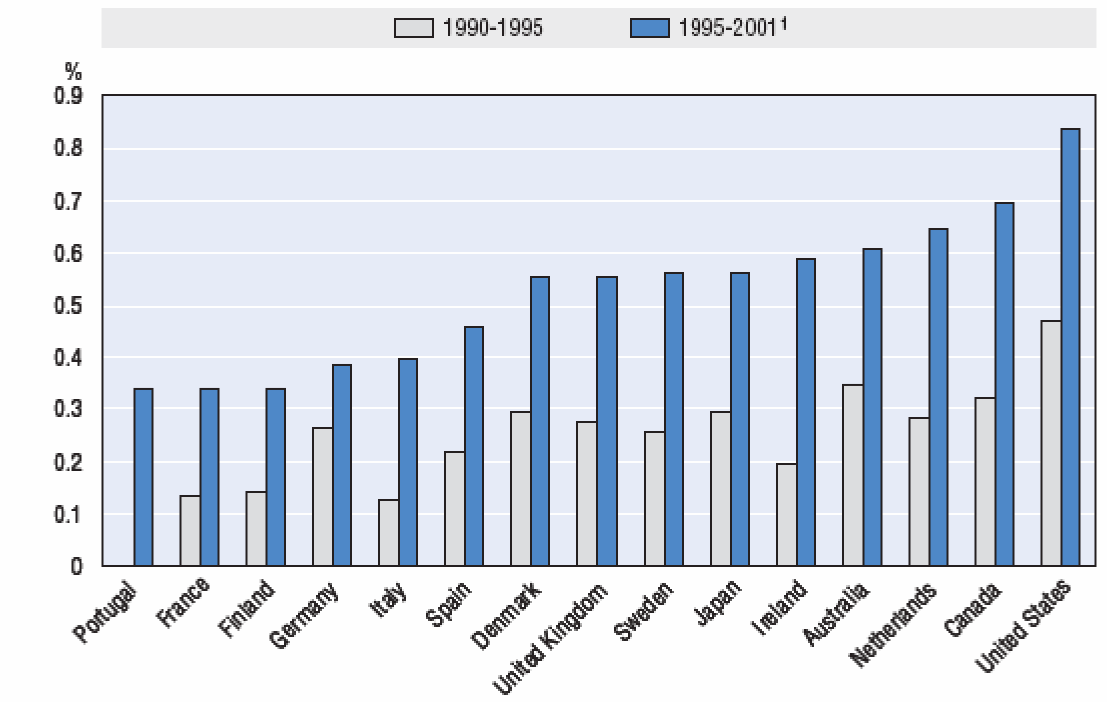
During 1995-2001, the contribution of investment in ICT capital to the growth of GDP amounted to nearly 1% in the US (see figure 1.1) and between 0.5% and 0.6% in Denmark, the UK, Sweden, Ireland and the Netherlands.

2. Technological progress in the production of ICT in the ICT sector contributes to more rapid multifactor productivity (MFP) growth in the ICT sector.

In particular in Ireland and Finland ICT manufacturing made a significant contribution to labour productivity growth in 1996-2001 of nearly 1%. The contribution of the ICT services sector to labour productivity growth is much smaller with contributions between 0.2% and 0.3% for 5 European countries including Ireland and Finland.

3. More rapid diffusion of and increased use of ICT in the economy increases enterprise's overall efficiency and thus Multi-Factor Productivity.

Figure 1.1 The contribution of investment in ICT capital to GDP growth, %-points contribution to annual GDP growth, total economy.



1. Or latest available year, i.e. 1995-2000 for Denmark, Finland, Ireland, Japan, Netherlands, Portugal and Sweden.

Source: OECD, 2003.

The contribution of the key ICT-using services (wholesale and retail trade, finance, insurance and business services) to aggregate labour productivity growth. The UK is the EU leader with a contribution above 0.8%; Germany and Italy are the worst performers in Europe and for both countries productivity gains through the use of ICT should be improved.

1.2 Statistical Definition of the ICT Sector

The Innovation Watch/SYSTEMATIC project has primarily focused on the characterisation and explanation of innovation performance by ICT producing companies, and not on the use of ICT in other industries or by consumers or governments. The definition of innovation applied in the Innovation Watch/SYSTEMATIC project follows that as defined in the Oslo Manual (OECD, 2005): An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations.

Table 1.1 Definition of ICT sector

ICT sector: NACE Rev.1.1		Broad definition	Narrow definition
ICT Manufacturing			
30	Manufacture of office machinery and computers	30	30
31.3	Manufacture of insulated wire and cable	31.3	
32	Manufacture of radio, television and communication equipment and apparatus	32	32
33.2	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment	33.2	
33.3	Manufacture of industrial process control equipment	33.3	
ICT Services			
51.8	Wholesale of machinery, equipment and supplies	51.8	
64.2	Telecommunications	64.2	64
71.33	Renting of office machinery and equipment, including computers		
72	Computer and related activities	72	72

In 1998 the OECD defined "the ICT sector as a combination of manufacturing and services industries that capture, transmit and display data and information electronically" (OECD, 2002). In 2002 the activity-based definition was reviewed and only slightly changed. Table 1.1 gives the ISIC codes and the corresponding NACE codes for each of the manufacturing and services industries. For practical reasons regarding data availability the 4-digit sector 71.33 will be dropped leading to the broad definition of the ICT sector (table 1.1). The econometric analysis on sector innovation performance will largely rely on the CIS (Community Innovation Survey) data at NACE 2-digit level. For CIS data availability reasons, we will have to limit the ICT sector to a narrow definition at the 2-digit level.

1.2 Structure and Content of the ICT Sector Report

The second chapter gives an overview on the general economic performance of the machinery and equipment sector. This is followed by a description and analysis of the innovation performance of the ICT sector in Europe. In this chapter, the relationships between innovative activity, innovative performance, productivity, skills and competition will be elucidated. Moreover, different modes of innovation in the sector as well as the situation for innovative SME's in ICT will be highlighted. The fourth chapter gives an account of the innovation barriers, drivers and challenges of the ICT sector. The fifth chapter identifies innovation champions in Europe, firms with an extraordinary innovation performance. Chapter 6 focuses on the importance of national and socio-cultural environment for innovation in the ICT sector. Chapter 7 gives an overview of EU and national innovation policy programs. The final chapter will formulate conclusions and policy recommendations.

2 General Economic Performance

In this chapter the key economic developments in the ICT sector are described. In particular, the discussion is subdivided into the following topics: structural profile, labour and productivity, trade and competition.

2.1 *Structural profile*

The ICT sector does not have a homogeneous structural profile, since the profile of ICT manufacturing clearly differs from ICT services. Table 2.1 shows for the EU25 data for the sub-sectors on number of enterprises, turnover, value added and number of persons. The ICT services sector is about 3 times as large in size as ICT manufacturing. Regarding the number of enterprises only 8 percent of all ICT firms are in manufacturing.

Table 2.1 Characteristics of EU25 ICT sector, 2000

NACE	Number of enterprises	% share	Turnover (€ million)	% share	Value added at factor cost (€ million)	% share	Number of persons employed	% share
30	6396	1%	94139	6%	15876	4%	202497	3%
31.3	2027	0%	21493	1%	5616	1%	104317	2%
32	21126	4%	250608	16%	61992	14%	817658	14%
33.2	11486	2%	51583	3%	20412	5%	334427	6%
33.3	3964	1%	11176	1%	4104	1%	72101	1%
ICT manufacturing	45000	8%	429000	28%	108000	25%	1531000	25%
51.8	456724	83%	609400	40%	91650	21%	1474032	24%
64.2	1509	0%	264812	17%	117325	27%	1011150	17%
72	44767	8%	233788	15%	116025	27%	2008818	33%
ICT services	503000	92%	1108000	72%	325000	75%	4494000	75%
ICT total	548000		1537000		433000		6024000	

Source: Eurostat (2003).

ICT value added in the EU25 was equal to about € 433 billions as of 2000. ICT services generated about 75% of total ICT value added or € 325 billions while manufacturing generated about 25% of total ICT value added or € 108 billions.

In ICT manufacturing, turnover between 1996 and 2001 has increased by almost 70%, value added at factor cost by almost 40% and labour productivity by 35%. However, the number of persons employed has remained almost the same. In ICT services, turnover between 1996 and 2001 has increased by almost 70%, value added at factor cost by 30% and the number of persons employed by 20%. Labour productivity at first increased, but after 1998 its rate of increase has dropped to 10%. However, the level of labour productivity is for ICT services higher than for ICT manufacturing.

Appendix 4 shows 2001 data for several key structural indicators for each of the European countries. Italy has the largest share (23.4% of EU-25) of ICT enterprises in manufacturing. Five countries, France, Germany, Italy, Poland and the UK, account for nearly 70% of all ICT enterprises in manufacturing. Germany is the largest ICT manufacturer, both in terms of turnover and of value added. Germany, Finland, France, Italy and the UK account for about three-quarters of turnover and of value added. Differences in apparent labour productivity in ICT manufacturing are large, ranging from € 7.000 in Estonia to € 152.000 in Finland.

Apparent labour productivity in ICT services is higher than for ICT manufacturing, with € 50.000 for EU25 manufacturing and € 72.000 for EU25 ICT services.

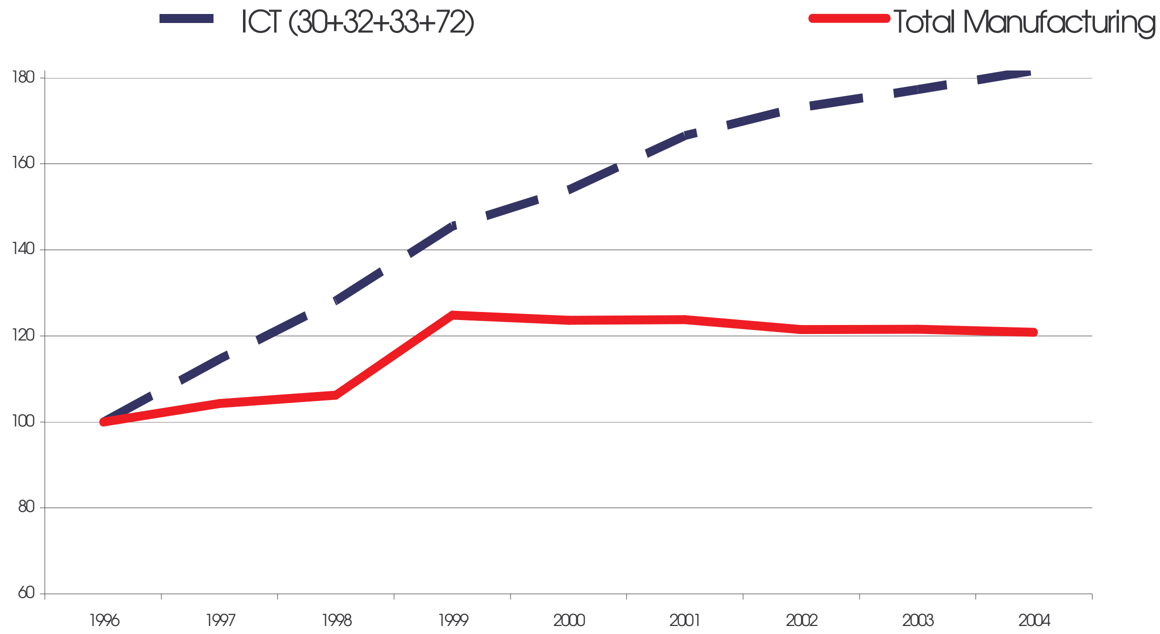
The UK has the largest share (25% of EU-25) of ICT enterprises in services. The largest countries, France, Germany, Italy and the UK, account for 62% of all ICT enterprises in services. These countries also account for 66% of turnover and 71% of value added. Differences in apparent labour productivity are large, ranging from € 16.000 in the Czech Republic and Estonia to € 126.000 in Luxemburg. Labour productivity of ICT services is especially high in Luxembourg, the UK, and Germany. Apparent labour productivity in ICT (both manufacturing and services) in the new Member States is lower than EU average.

Most enterprises in the ICT sector are small, out of 682000 enterprises 99.6% are SMEs and most of these have less than 10 employees (see appendix 5). The share of micro firms is close to 89%. This high percentage is explained by the Computer services industry (NACE 72) which hosts two-thirds of all ICT firms and where the share of micro firms is 93%.

Large firms with more than 250 employees are less common in ICT services than in ICT manufacturing, the share of large enterprises in the latter is more than 5 times as large as that in ICT services. In Insulated wire (NACE 31.3) the share of large companies is highest at almost 5%. Large companies employ more than half of the people working in the ICT sector and produce almost 70% of the sector's value added. We observe this pattern both in ICT manufacturing and in ICT services. Labour productivity in large companies is almost twice that in SMEs. The ICT services sector is more productive than ICT manufacturing; labour productivity in Telecommunications (NACE 64.2) is as high as € 116.000.

While the number of Total Manufacturing enterprises has remained stable after 1999, the number of ICT enterprises has kept on growing (see figure 2.1). The number of enterprises in the ICT sub-sectors of Manufacture of office machinery and computers (NACE 30) and in Computer services and related activities (NACE 72) have doubled between 1996 and 2005. With 103.000 firms the UK has the largest number of Computer service companies (NACE 72), which represents one fifth of the EU total, but this number has hardly changed in the UK. High growth in the number of Computer services has taken place in for instance: Austria, Hungary, Spain, Ireland, The Netherlands, Slovakia, and Romania.

Figure 2.1 Development of the number of firms in ICT versus total manufacturing (Index: 1996=100)

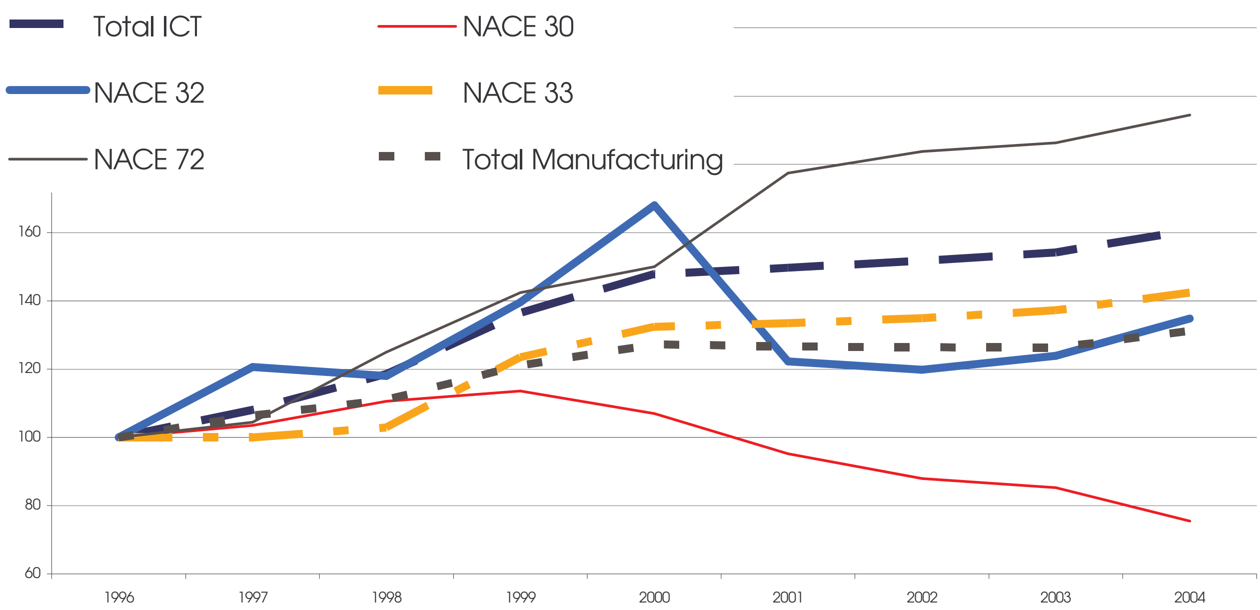


Source: Structural Business Statistics (SBS); Note: It should be noted that the period and country data coverage varies across countries.

The ICT sector of the EU as a whole has grown at a higher rate then total manufacturing, but there are clear differences between the ICT sub-sectors (Figure 2.2). The value added of Manufacture of office machinery and computers (NACE 30) has decreased after 1999, whereas the ICT service sub-sector of Computer and related activities (NACE 72) has maintained a higher growth.

In terms of turnover the more recent results from CIS-4 shows (Annex1) that firms in NACE 32 have reported the highest growth of turnover.

Figure 2.2 Development of value added at factor cost, ICT and sub-sectors versus total manufacturing (index: 1996=100)



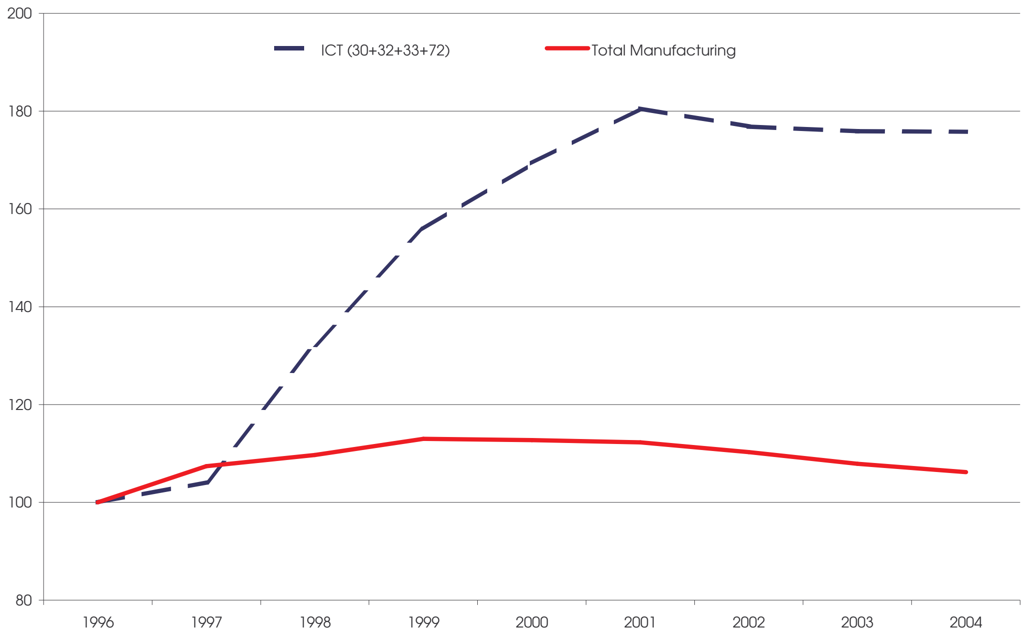
Source: Structural Business Statistics (SBS) Note: the period and country data coverage varies across countries.

2.2 Labour and Productivity

The increase in the number of employees in the ICT sector (see figure 2.3) is largely based on the increase in employment in ICT service sub-sector of Computer and related activities (NACE 72). More recent data of CIS-4 also shows (Annex 1 and 2) that firms in the ICT sector have reported higher growth of employment, especially in NACE 72. The number of persons employed in Manufacturing of office machinery and computers (NACE 30) in the EU has even decreased, from 245.000 persons in 1999 to 158.000 in 2004.

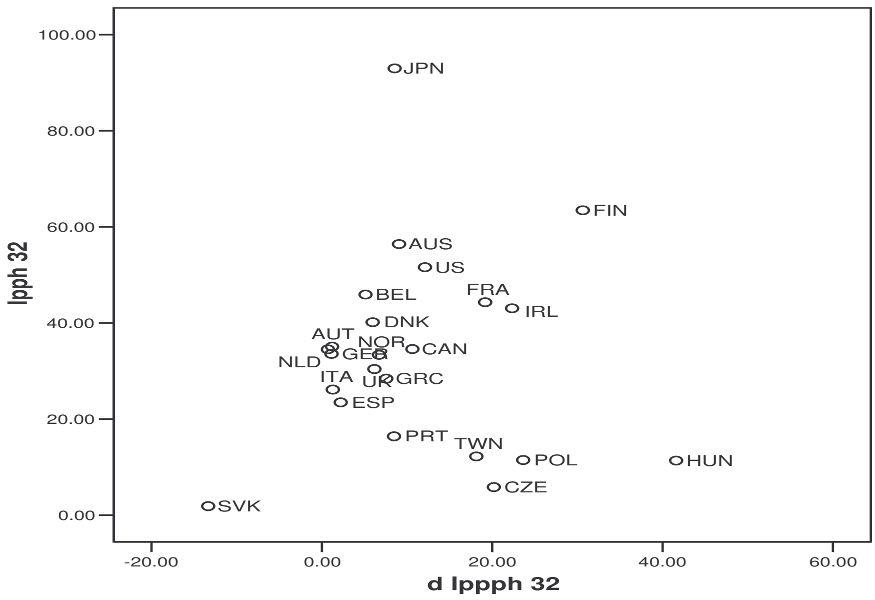
When we look at the labour productivity in terms of value added per hour for the ICT sub-sector of Manufacturing of radio, television and communication equipment and apparatus (ISIC 32) it is obvious that Japan, and to a lesser extent Finland and Austria have the highest productivity; lagging countries are Hungary, Czech Republic, Poland and Taiwan (see figure 2.4), but there are signs of catching-up, e.g., remark that the difference in labour productivity growth between Japan and Hungary is more than 30% over the period 1992 –2002. The labour productivity of Finland in the communication equipment industry is not only one of the highest in level, but also among the highest in growth.

Figure 2.3 Development of number of persons employed: ICT versus Total Manufacturing (Index 1996=100)



Source: Structural Business Statistics (SBS); Note: It should be noted that the period and country data coverage varies across countries.

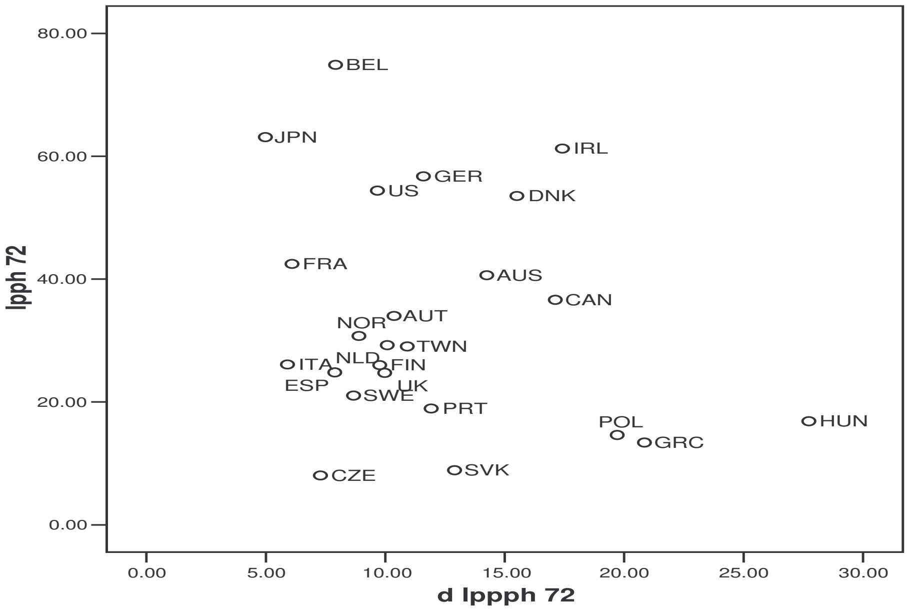
Figure 2.4 Level and growth of value added per hour in radio, television and communications equipment manufacturing (ISIC 32), average 1992-2002



Note: lppph32 = labour productivity per hour in current prices in ISIC 32 industry, dlppph= annual percentage change in lppph

For Medical, precision and optical instruments manufacturing (ISIC33) Japan, Denmark, Canada and US exhibit high levels of productivity, while Hungary, Poland and Czech Republic pair low level with high productivity growth. Note that the growth as well as the level of labour productivity in ISIC 33 is considerably less than in ISIC 30 and ISIC 32. Productivity growth in ICT services is less than in ICT goods production and the relation between productivity growth and its level is less pronounced, but there is catching-up in productivity in each of the ICT sub-sectors. For computer services (ISIC 72) the European catching-up countries are Hungary, Greece and Poland (see figure 2.5).

Figure 2.5 Level and growth of value added per hour in computer services and related activities (ISIC72), average 1992-2002



Note: lppph72 = labour productivity per hour in current prices in ISIC 72 industry, dlppph= annual percentage change in lppph72

Dunnewijk and Meijers (2008) conclude that convergence of labour productivity among countries exists in almost all ICT industries and in goods as well as in services production. ICT activities located in mature economies show, on average, absolute high levels of productivity and low growth, while for example, the new Member States exhibit low levels and high growth of productivity. Japan is still without doubt the labour productivity world champion in all ICT activities, but the picture is very differentiated for the different ICT activities. The strongest convergence can be found in the manufacturing of computers (ISIC 30), the slowest – or no convergence at all – in communication services (ISIC 64).

2.3 Trade and competitiveness

The EU trade balance in ICT goods is persistently negative and increasingly positive for ICT services. The ICT manufacturing sector is extremely exposed to the world market: ICT goods exports accounts for more than 50% of its GDP and imports of

ICT goods account for more than 75%. The ICT services sector is less exposed: 20% of its GDP is exported and 10% imported.

This situation is also supported by data at firm level (see CIS data in Annex 1), since the highest export growth is reported by firms in computer services (NACE 72), but on the other hand only 15% of innovative ICT firms in NACE 72 have reported that the international market is their most significant market, whereas in NACE 30 this is true for 23 % and in NACE 32 for 34%.

Dunnewijk and Meijers (2008) describe for ICT hardware manufacturing the trends in volumes and prices (unit values) in the trade of EU25 with the rest of the world. Table 2.2 shows that the price of aggregate exports of all goods increased (cumulative) by 34 percentage-points, during 1995-2004 while the price of aggregate imports of goods increased by 43 %-points. EU25 trade in ICT goods shows the opposite. While unit value of exports raised by 12 %-points the unit value of imports declined by 47%! Assuming competitive markets in ICT goods, this improvement in the terms of trade of ICT goods of EU25 might be an indication that the quality of EU25 ICT goods exports rises faster than the quality of its imports. The price developments imply that the volumes of trade in ICT goods compared with all goods are much more abundant: the volume of imported ICT goods doubled during period 1995-2004 while the aggregate imports of all goods "only" increased by 43%.

Many ICT products exported by the EU25 have much higher unit values than their imported counterparts. This does not apply to all ICT goods, but according to the international standard classification of goods (SITC), it does especially apply to some subgroups within SITC 75 (parts for computers; SITC 759), SITC 76 telecommunication equipment (especially SITC 764 and SITC 87), products optical instruments (SITC 871) and optical goods (SITC 884).

Illustrative is EU25's trade in ICT goods vis-à-vis China, which for instance clearly differs from the trade of the EU with Japan especially with regard to prices. Average price (unit value) of imported ICT goods from China is 12 € per kilo while EU 25's exports to China buys a price of 43 €/kg, EU25's imports from Japan are valued at 44.5 €/kg while EU25's export to Japan are valued at 143.8 €/kg. This suggests that EU25 exports consists of goods of higher quality compared to the imports of these goods, but another explanation is that EU25 exports are often final goods and imports are often components or intermediate goods to produce these exports.

Table 2.2 EU25 trade with rest of world: volumes and unit values of ICT goods, 1995=100

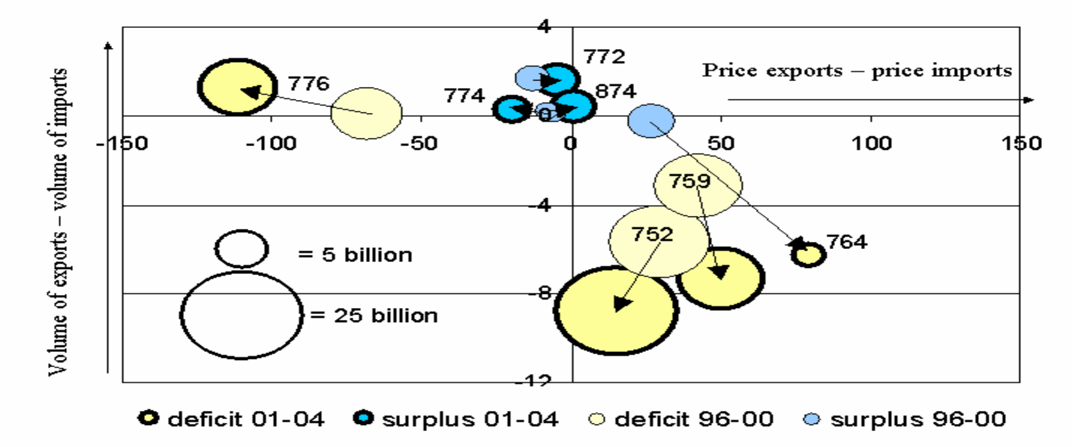
Trade of EU25- with Rest of the world, 1995=100	1996	1997	1998	1999	2000	2001	2002	2003	2004
All exports of goods									
Volume	101	106	104	115	123	118	125	132	138
Unit value	107	117	119	115	134	146	138	128	134
All imports of goods									
Volume	98	101	101	117	125	128	129	136	143
Unit value	109	122	127	127	158	153	145	137	143
Export of ICT goods									
Volume	108	116	119	118	132	143	140	156	184
Unit value	103	115	114	129	154	142	134	118	112
Import of ICT goods									
Volume	111	133	137	152	203	202	188	184	205
Unit value	101	105	97	95	115	92	91	79	53

Source: Eurostat

The main characteristics of the developments in EU25 trade in ICT goods vis-à-vis the rest of the world are visualised in Figure 2.6. In this figure the horizontal axis represents the difference between the price of exports and the price of imports of the same good, the vertical axis shows the difference between volume of exports and volume of imports. The general idea is that when goods are homogenous and when markets are elastic the north-west and south-east quadrant would be populated by the bubbles representing a certain ICT good with regard to price and volume acres. The size of the bubble represent the contribution (deficit or surplus) to the trade balance. What we see is not the expected pattern, on the contrary the centre is densely populated with relative small surpluses of EU25 while the outskirts are populated by the much larger trade deficits of EU25 in ICT goods trade.

The blue bubbles in Figure 2.6 represent the SITC product groups electrical apparatus etc. (SITC772), electrodiagnostic apparatus for medical, surgical, dental or veterinary purposes and radiological apparatus (SITC774) and measuring, checking analysing and controlling instruments etc. (SITC 874) in which groups EU25 has a surplus position that increased somewhat during the period under consideration: Dark bleu bubbles represent trade surplus in 2000-2004, light blue a trade surplus in 1996-2000. EU25's exports of electrical apparatus etc. (SITC 772) and measuring, checking analysing and controlling instruments etc (SITC 874) became relatively more expensive and at the same time its trade surplus rose, but volumes hardly changed. Comparing the periods 1996-2000 and 2001-2004 represented in Figure 2.6 leads to the conclusion that the difference in prices of exports and imports became larger. This is the contribution of cathodes (SITC776), optical instruments and apparatus, n.e.s (SITC 871), due to parts and accessories for computers (SITC759) and telecommunications equipment (SITC 764). The trade surplus of the latter product group turned even into a trade deficit in the more recent years, due to a surge in the imported volumes of relatively cheap telecommunication equipment from abroad.

Figure 2.6 Assignment of shift in the main products involved in extra EU25 trade in ICT goods according to price and volume differentials as well as the contribution to the trade balance (shifts between averages of 1996-2000 and 2001-2004)



Source: Dunnewijk and Meijers (2008)

Our conclusion here is that on the one hand EU25 ICT trade balance deficit is mainly caused by automatic data processing machines etc. (SITC 752), parts and accessories for computers (SITC759) and cathodes (SITC776), while in more recent years telecommunication equipment can be added to this group. On the other hand the EU25 holds a relatively strong position in electrical apparatus etc. (SITC 772), electrodiagnostic apparatus for medical, surgical, dental or veterinary purposes and radiological apparatus (SITC 774) and measuring, checking, analyzing and controlling instruments and apparatus (SITC, 874).

Inter EU trade in ICT goods did not increase very much, at least in a relative sense compared to the trade with non-EU. Inter EU25 trade in radio and television and communication equipment even diminished. In this respect economic integration did not materialise in ICT goods production, and the new Member States found more new markets outside the EU25, than inside the Union.

Recently there has been a considerable shift in global market shares of ICT goods. China is clearly the big winner, while the US, UK and Japan are the losers who have lost on all markets. EU25 as a whole won on all markets mainly thanks to the European Tigers (Czech Republic, Hungary, Ireland and Poland).

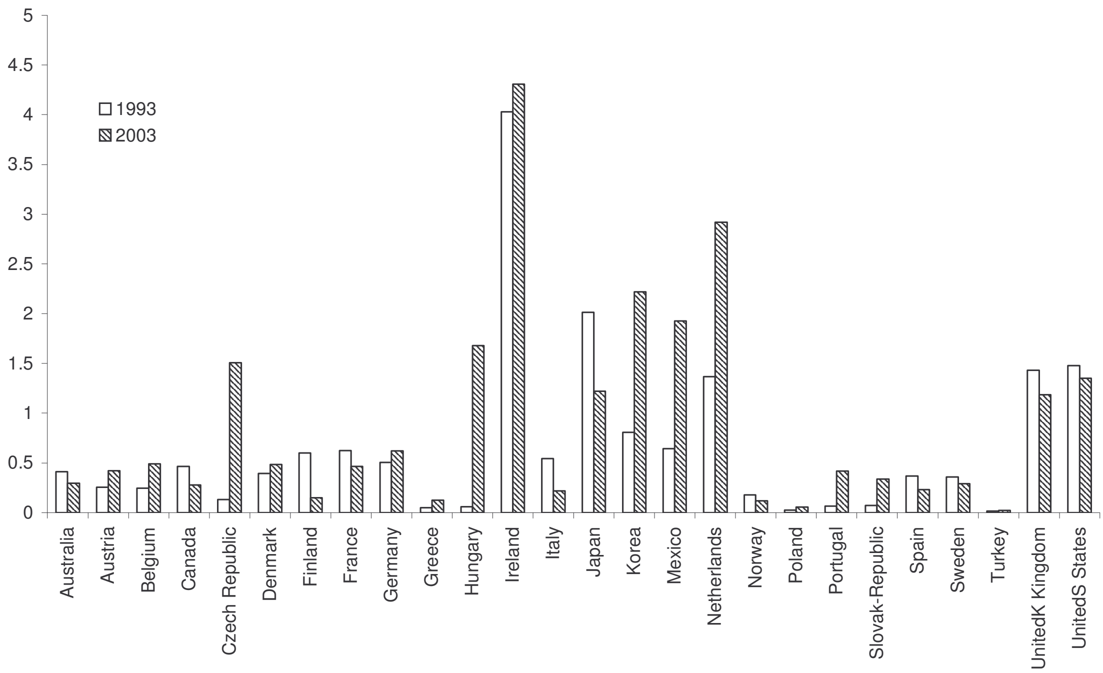
The perspectives for ICT services are different from those for ICT goods. The trade surplus for ICT services of EU25 is growing at a pace of almost 20% per year (over the period 1993-2003). However, not every EU country gains from these trade improvements; in fact it is the specialisation of a few countries, especially Ireland, UK, and the US, which are specialised in the export of computer and related services (ISIC 72). It is within this area that there are large unleashed potentials for other countries too, especially for Poland, Czech Republic, France and Germany, which have shown high growth rates in more recent years.

Although the sectors investigated in this section are still heterogeneous in terms of product characteristics, a general pattern emerges from the trade analysis: Sectors in which the quality of products is relatively high, the sectors which produce goods with relatively high unit values, i.e. medical and optical instruments (33) and computer and related services (72), in general show a more stable position with respect to the trade balance and net volumes sold to the global market. For other ICT goods, cheap imports from non-EU keeps threatening the international trade position of the EU.

Another way to measure competitiveness of industries is by calculating RCA's (Revealed Comparative Advantages) based on the specialisation (in terms of export and import) in that industry. Revealed Comparative Advantage per ICT sub-sector differs very much among countries. Figure 2.7 gives an example of RCA in Computer manufacturing (ISIC 30) in 26 countries during 1993 – 2003. Ireland and the Netherlands show relatively high RCA in ISIC30. Japan, Korea, Mexico, UK and US also have a considerable RCA's for this industry. Some of the countries who had low RCA's are rising stars like: Czech Republic, and Hungary, but Korea, Mexico and the Netherlands still van a higher competitive advantage. RCA for ISIC 30 is falling in Japan and stable to falling in the UK and the US.

Changes in the RCA position among EU Member States show that Czech Republic, Hungary, Latvia, Lithuania, Poland and Slovenia have made huge shifts in competiveness in several ICT industries. Other countries improved on RCA as well: Finland with regard to ISIC32, France and Germany with regard to ISIC 64 and ISIC72, Korea with regard to ISIC30, the Netherlands in all sectors, Slovak Republic with regard to ISIC 30 and ISIC72 and finally Sweden, UK and US have gained competitiveness in ISIC 72.

Figure 2.7 Revealed Comparative Advantages in Computer manufacturing (ISIC 30)

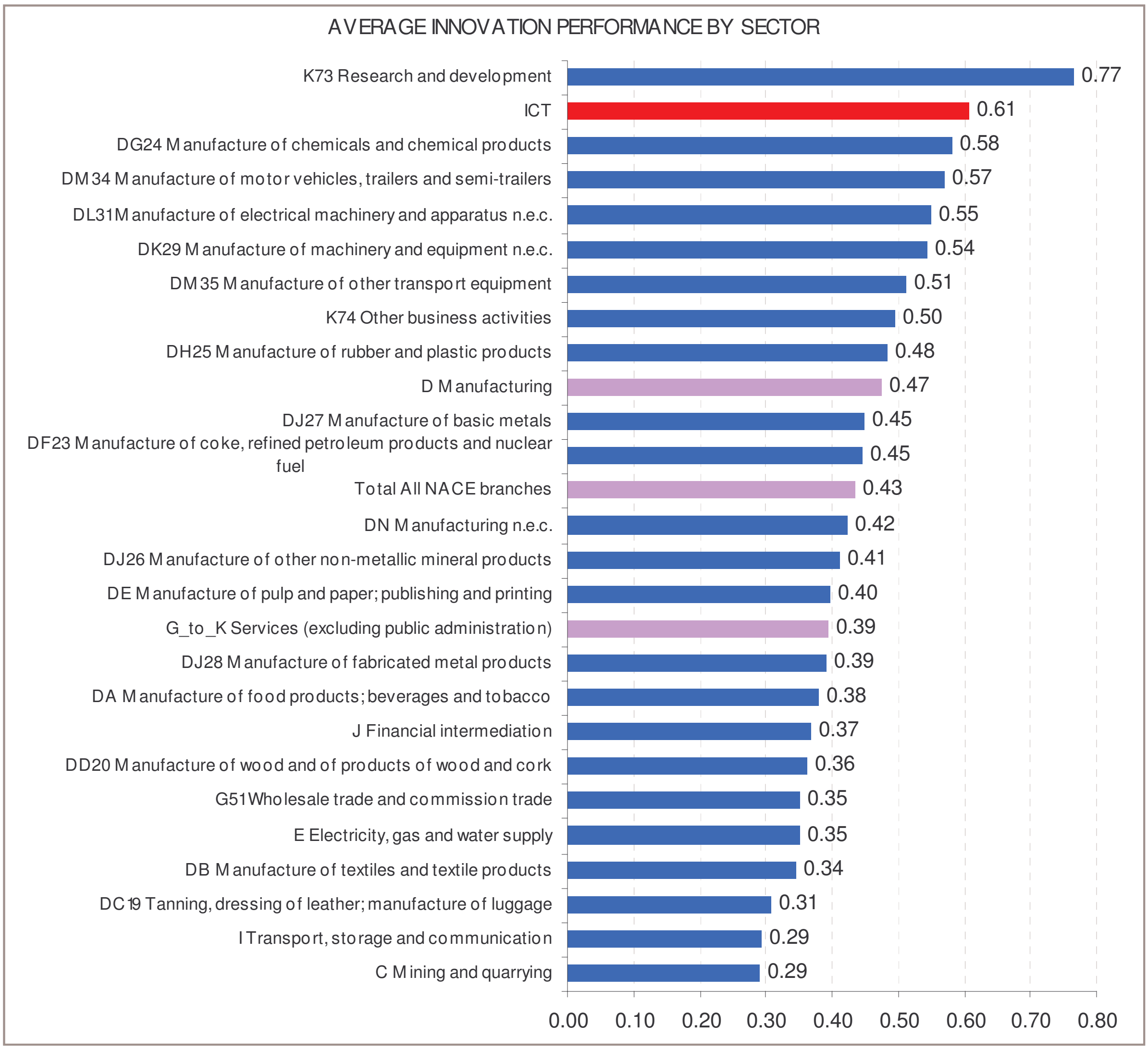


3 Sectoral Innovation Performance

The aim of this section is to analyse the innovation performance of the EU ICT sector. Much of the focus is on analysing some of the key relationships in the sector, for example between innovation performance, productivity, skills and competition. However we begin with a discussion of some of the major features of the innovative activity in the industry. This is followed by a description of some of the major trends and patterns arising form analysing data on R&D, patenting and CIS.

3.1 General Innovation Performance

Figure 3.1: Innovation performance across sectors in the EU



Source: Hollanders and Arundel (2005).

The 2005 Trend Chart report "European Sector Innovation Scoreboards" (Hollanders and Arundel, 2005) analyses the innovation performance of European countries at the sector level. They use 12 indicators for constructing the Innovation Sector Index (ISI) which shows that the ICT sector is one of the most innovative sectors in Europe as shown in Figure 3.1[1].

Table 3.1: Innovation performance of the ICT sector versus all sectors in the EU

	ALL SECTORS	ICT		
		NACE 30	NACE 32	NACE 72
Share of employees with higher education	13.1	17.6	25.5	50.9
Share of firms that used training	17.7	14.7	18.1	38.1
Share of firms that receive subsidies to innovate	12.2	12.6	21.4	13.8
Share of firms innovating in-house	35.4	59.3	57.1	58.4
Share of firms co-operating with other	5.8	12.9	16.4	14.6
Innovation expenditures as a share of total turnover	2.1	0.6	4.2	4.2
Share of sector sales from new-to-market products	6.4	26.5	25.4	12.7
Share of sector sales from new-to-firm products	17.4	44.0	56.6	33.6
Share of firms that patent	8.1	19.0	19.7	9.2
Share of firms that use trademarks	12.3	29.5	15.9	22.8
Share of enterprises that use design registrations	6.9	14.1	10.2	6.8

Source: CIS 3 (own calculations).

For most of the indicators used for the above Innovation Sector Index Table 3.1 provides more detail, which allows us to identify differences in innovation characteristics between ICT (sub-sectors) and other sectors in the EU. It shows that indeed on average the ICT sector is more innovative than the average industry, but the innovation performance gap differs per indicator and per ICT sub-sector:

Regarding the share of employees with higher education and the share of firms that use training the performance is especially high in the Computer service industry (NACE 72), where almost 51% of the employees have a higher education degree, compared to 13 percent in all sectors of the EU.

The share of firms innovating in-house is higher than for all sectors in each of the ICT sub-sectors.

The share of innovative ICT companies innovating in co-operating with others is also above average for ICT and it's sub-sectors. This characterisation of innovation behaviour of ICT firms is in line with the importance of innovation networks, the increasing importance of 'open innovation', as well as the increasing fragmentation and globalisation of the value chain for many ICT products and services.

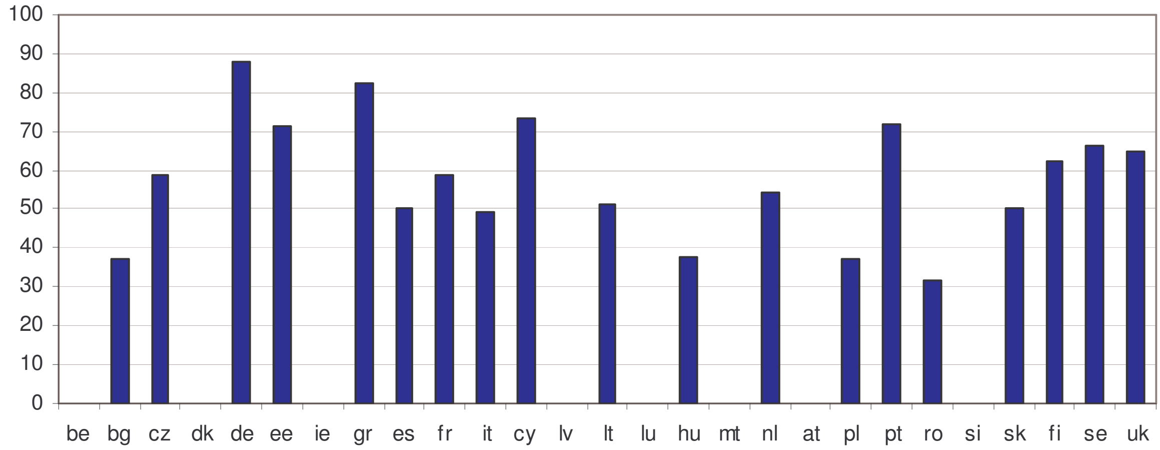
The share of sales due to new-to-market and new-to-firm products is way above average, especially for ICT hardware. This is in line with the notion that the life-cycle of ICT products is very short.

[1] The ICT sector is here defined as the aggregate of NACE sectors 30, 32, 33, 64 and 72.

Innovative ICT companies have reported slightly more often that they have received public subsidies for their innovation efforts.

Concerning IPR we see that a higher percentage of innovative firms in the ICT industry use patents, trademarks or designs to protect their inventions or innovations. Whereas on average 8% of all innovative firms applied for at least one patent, in Office machinery and computers (NACE 30) and Radio, TV and communication equipment (NACE 32) this percentage was 19% or higher. However, Computer service firms do not use patents that much (9%). Trademarks were used by 12% of all innovative firms, whereas in NACE 30 and NACE 72 these shares were much higher with 30% and 23% respectively.

Figure 3.2 Innovating firms as a share of all ICT firms*



* ICT here includes: NACE 30+32+33+64+72

For several of these CIS indicators we will discuss the performance per country. A more general innovation performance indicator is the share of innovating firms (Figure 3.2). In this respect the ICT sectors of Germany, Greece, Cyprus, Portugal and Estonia show a high shares of innovative firms.

Innovation Input

R&D is of the most commonly used indicators to measure input into the innovation process. Higher R&D expenditures are expected to result in more inventions and innovations. Europe‘s ICT sector spends relatively less on R&D than its major competitors Japan and the US. Within Europe, Germany, France, the UK and Sweden account for 70% of EU R&D investments (Table 3.2).

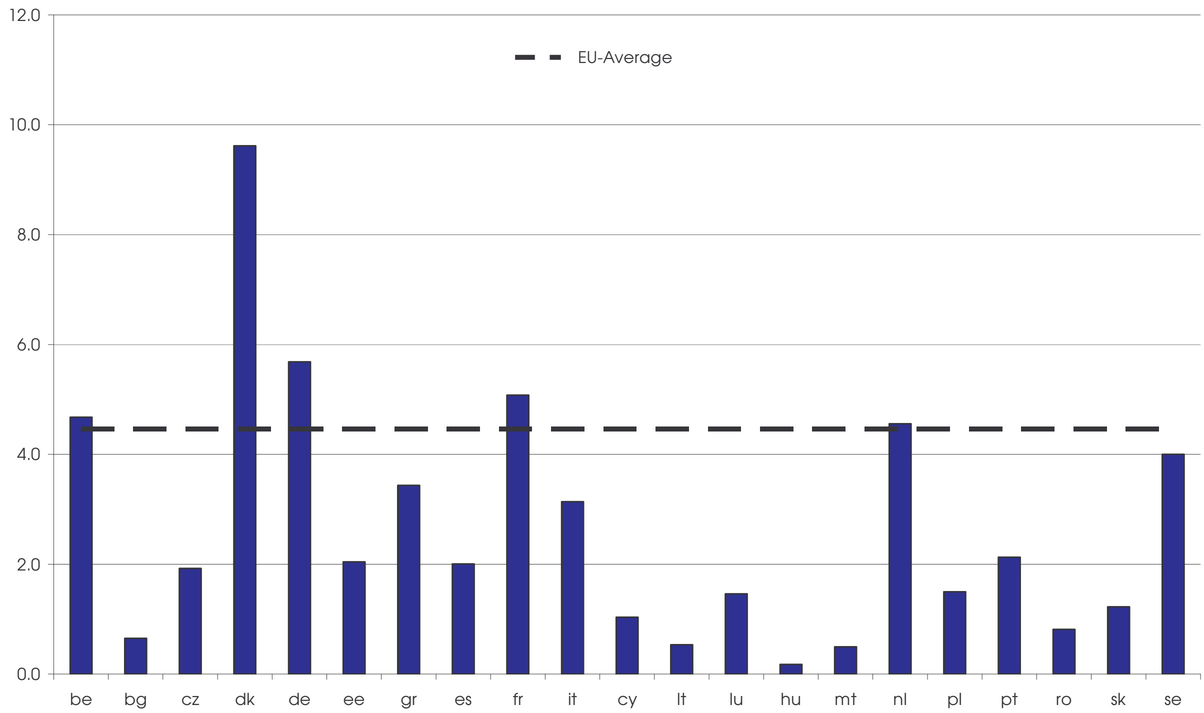
Expenditures in intramural R&D/total turnover are especially high in the ICT sector of Germany, France, Belgium and the Netherlands, with a percentage over 4 (Figure 3.3).

Table 3.2 R&D expenditures by country and ICT industry

	NACE 30	NACE 32	NACE 33	NACE 642	NACE 72	R&D	EU share
	2001	2001	2001	2001	2001	2001	
Australia	37.4	222.2	209.6	270.7	546.2	1015.5	
Belgium	13.1	791.6	54.1	68.5	175.9	1034.6	3.5%
Canada	393.7	3299.6	222.1	-	1067.2	4982.7	
Czech republic	0.5	33.9	16.7	0.1	28.9	80.0	0.3%
Denmark	11.4	115.7	203.1	154.6	314.5	644.7	2.2%
Finland	5.7	1597.9	82.2	-	151.2	1837.1	6.2%
France	307.1	2976.1	1488.6	-	780.1	5551.8	18.8%
Germany	625.7	3885.0	2492.0	-	1073.0	8075.6	27.4%
Ireland	25.7	311.6	60.2	0.6	255.5	653.0	2.2%
Italy	72.2	1200.7	460.6	11.2	318.2	2051.7	7.0%
Japan	10034.3	11821.9	3300.6	-	1236.6	26393.3	
Korea	1254.3	5835.5	224.8	489.7	1039.6	8354.2	
Netherlands	1372.3	9.0	182.0	82.9	296.6	1859.9	6.3%
Norway	7.7	188.8	56.9	83.0	214.5	467.9	
Poland	1.9	56.0	17.9	47.8	0.5	76.3	0.3%
Spain	47.9	250.0	70.1	510.7	272.8	640.9	2.2%
Sweden	62.7	2323.8	383.6	-	324.1	3094.3	10.5%
United Kingdom	168.2	1673.7	782.5	-	1162.0	3786.4	12.8%
United States	8170.0	30949.0	18870.8	1317.9	17279.0	75268.8	
European Union	2719.6	15280.5	6265.5	-	5230.1	29495.7	

Source: OECD (ANBERD).

Figure 3.3 Own R&D expenditures in ICT sector as a percentage of total turnover, 2004*



* mostly NACE 30+32+33+72, but for some countries one or two sub-sectors are not included due to missing data.

The high score on intramural R&D in the German ICT sector is based on a good score in each of the ICT sub-sectors. The R&D intensity of most countries, however, differs per ICT sub-sector. The high R&D intensity of the Dutch ICT sector is for instance highly depending on the R&D expenditures of Office machinery and computers (NACE 30). In terms of intramural R&D expenditures Belgium is leading in the television and communication equipment (NACE 32). Note that for some EU countries, e.g. Finland, data is missing. For some countries data on one or two sub-sectors are missing, e.g. for Denmark the score of 9.6 (figure 3.3) is based on the score of 5.96 for NACE 30 and 10.17 for NACE 33 (see Table 3.3), but data on the other sub-sectors is missing for Denmark. High scores on own R&D expenditures in new Member States can be found in Computer services (NACE 72). An explanation for some of the exceptionally high scores in certain subsectors is due to the spatial fragmentation of the value chain, or in other words the regional division of labour in production and innovation processes, e.g. multinational companies, such as Philips still have a lot of R&D concentrated in their 'home-country', but production and turnover have often globalised to a higher degree.

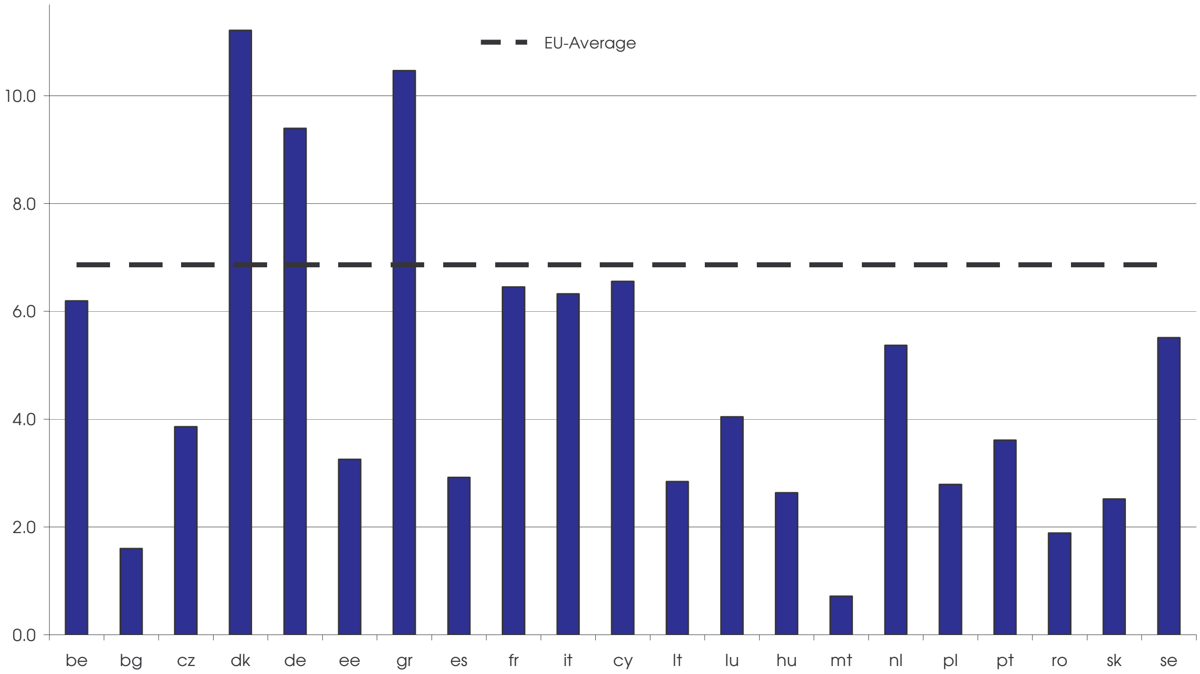
Table 3.3 Own R&D expenditures by ICT industry, top-5 performing countries, as a percentage of total turnover, 2004

NACE 30		NACE 32		NACE 33		NACE 72	
NL	8.40	BE	9.38	DK	10.17	MT	7.11
DK	5.96	NO	8.42	SE	6.92	CZ	6.75
SE	5.58	FR	6.11	NO	6.46	DE	6.14
DE	5.58	DE	5.84	FR	5.94	NO	5.35
NO	4.77	IT	5.09	DE	4.89	EE	4.33

The EU Industrial R&D Investment Scoreboard provides R&D spending data at firm level for the 700 largest EU and non-EU companies (see appendix 3). In interpreting these data it is important to point out that data are classified by registered office (while we know that not all activities of multinationals take place in the country where ownership is registered), and that only R&D data are included financed by a company's own funds. Within Electronics & Electrical Equipment there are 2 EU global R&D leaders: Siemens and Philips. On average R&D expenditures are falling for the largest companies. For Telecommunication Services there is a large gap with the global leader NTT from Japan. Europe has 6 global R&D leaders. Within IT Hardware, we find 2 EU global R&D leaders: Nokia and Ericsson. Large EU firms are more R&D intensive than non-EU firms. On average R&D expenditures are falling for the largest companies. Within Software & Computer Services Europe has 1 global R&D leader: SAP. In chapter 5 we will come back to the 'leadership' issue when we identify innovation champions in Europe.

Although on average ICT SME's invest less in R&D as a share of turnover than large firms do, there are R&D intensive ICT SME's in Europe. Based on a large EU wide survey among ICT SME's, IDC/MERIT (2007) found that 42% of ICT SME's invest more than 5 percent of turnover to R&D.

Figure 3.5 Share of innovation expenditures of ICT sector in the EU, as percentage of turnover*



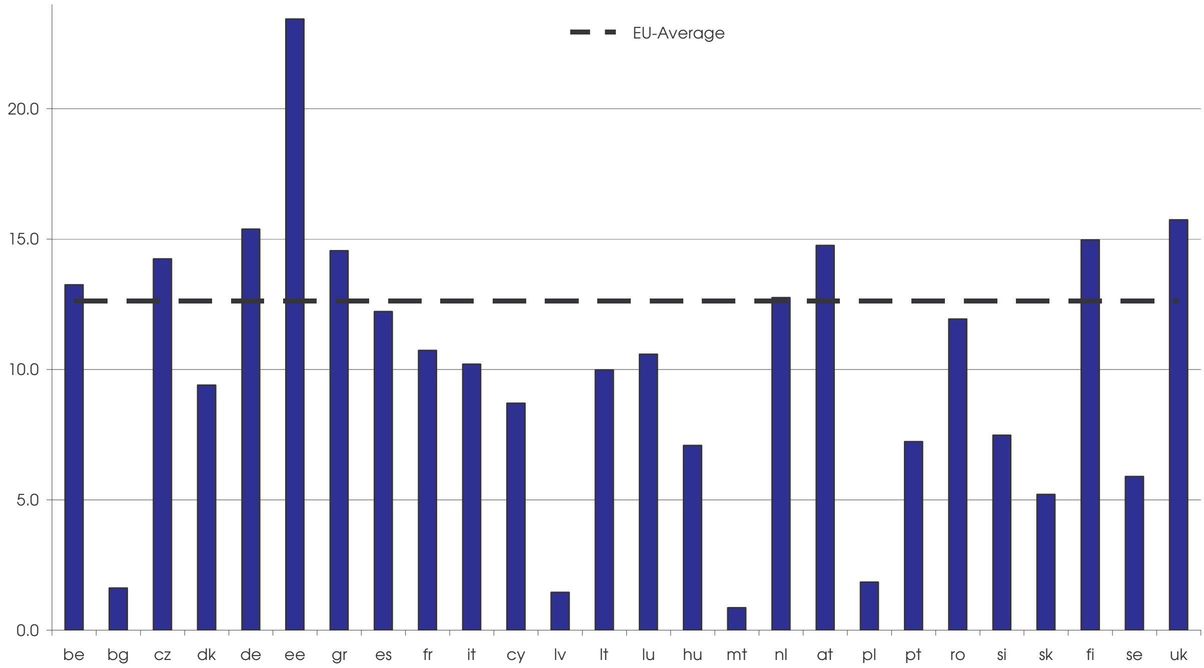
* mostly NACE 30+32+33+72, but for some countries one or two sub-sectors are not included due to missing data.

When we also include other innovation expenditures as inputs into the innovation processes in firms some countries such as Greece and Cyprus also appear to have a high innovation intensity of its ICT sector (Figure 3.5).

An indication of the innovation output performance is given by the Community Innovation Survey (CIS) question concerning the share in turnover of products that was new to the firm over the last three years. ICT companies in Estonia have reported the highest shares (Figure 3.6). ICT companies in Bulgaria, Latvia, Malta and Poland reported very low shares.

Patents are another form of innovation output, or actually of research output. Patenting of ICT related technologies is a geographically highly concentrated activity. A relatively small number of countries account for the vast majority of ICT patent inventions. Engineers from Germany, France, the UK and Sweden together have invented 75% of all ICT patents in the EU 25.

Figure 3.6 Products new to the firm



However, Table 3.4 shows signs of a de-concentration of patenting in Europe, as we will also see when we discuss regional data in Chapter 6.

Also at company level there are signs of a slow geographical de-concentration or globalization in patenting activity. That is, when we look at the location of the ICT patent inventions of four mayor European ICT companies: Nokia, Philips, Siemens and STMicroelectronics. In the 1980s and 1990s, all four enterprises expanded R&D activities to locations outside of the EU. The most important host country outside the EU was – and still is – the US by far. The US share on all ICT patent inventions at Philips rose from 8% (1984/87) to 20% (1996/99). A similar development could be seen at Siemens (1996/99: 20%), Nokia (1996/99: 10%) and STMIcroelectronics (1996/99: 19%). On the other hand US and Japanese companies have also increasingly expanded R&D activities in Europe.

Figure 3.7 Member States share in EPO patents (2003) for ICT

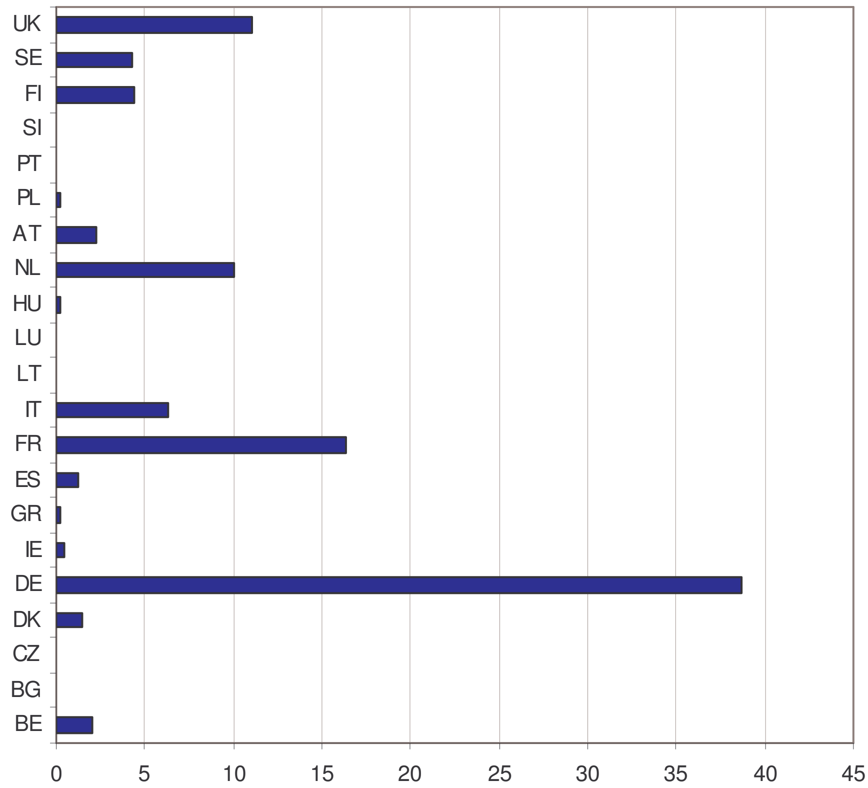


Table 3.4 Concentration in ICT patents for various time periods, EU 25

	Semiconductors	Consumer electronics	Computers	Telecom	Other ICT
1985-'89	0.37	0.37	0.34	0.34	0.37
1990-'94	0.34	0.33	0.31	0.26	0.33
1995-'99	0.36	0.30	0.28	0.26	0.34

Source: UNU-MERIT, ARC & EIIW (2006) based on OECD Triadic Patents database. Maximum value is 1, minimum value is 0.

The Revealed Technological Advantage Index (RTA)[2] can be used to determine relative specialization patterns of countries in technology fields. Table 3.5 shows that the US has a stronger specialization in ICT patents than the EU25. Only for Ireland, the Netherlands, Finland and Sweden the RTA is positive and increasing over time. For the other EU25 countries the RTA is negative and the ICT industries in these coun-

[2] The Revealed Technological Advantage Index (RTA) index is a country's share of patenting in a particular sector relative to its share of all patents: $RTA = \left(P_i^X / P_i^{TOT}\right) / \left(\sum_i P_i^X / \sum_i P_i^{TOT}\right)$ where P_i^X is the total number of patents in sector X in country i. The Standardized Revealed Technological Advantage Index is equal to (*RTA*-1)/(*RTA*+1).

tries thus account for a below average share of all EPO patent applications. China is catching up in terms of specialization as shown by its positive trend in RTA values over time.

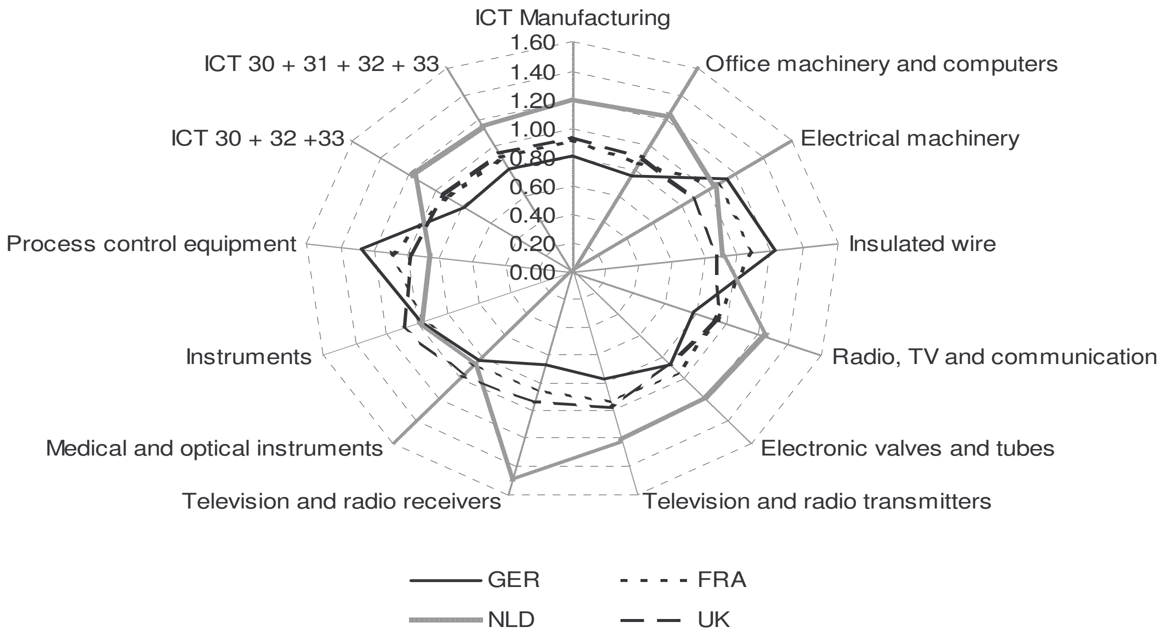
Table 3.5 Revealed Technological Advantage (RTA) in ICT (EPO), by Member State and period

	1980/1985	1985/1990	1990/1995	1995/2000	1998/2002	2000/2002
European Union (25 countries)	-0.05	-0.08	-0.09	-0.07	-0.06	-0.06
European Union (15 countries)	-0.05	-0.07	-0.09	-0.06	-0.06	-0.06
Belgium	-0.18	-0.20	-0.15	-0.18	-0.20	-0.20
Czech Republic	NA	-0.09	-0.19	-0.26	-0.25	-0.23
Denmark	-0.21	-0.29	-0.33	-0.23	-0.18	-0.16
Germany	-0.07	-0.09	-0.12	-0.10	-0.10	-0.10
Estonia	NA	NA	-0.27	-0.12	-0.11	-0.26
Greece	-0.32	-0.23	-0.22	-0.26	-0.19	-0.13
Spain	-0.25	-0.21	-0.21	-0.19	-0.18	-0.19
France	0.02	-0.02	-0.04	-0.06	-0.05	-0.04
Ireland	-0.09	-0.09	-0.02	0.02	0.07	0.10
Italy	-0.14	-0.17	-0.16	-0.19	-0.22	-0.22
Cyprus	0.27	-0.21	-0.38	-0.19	-0.24	-0.17
Latvia	NA	-1.00	-0.50	-0.48	-0.44	-0.38
Lithuania	NA	NA	-0.16	-0.23	-0.24	-0.26
Luxembourg	-0.26	-0.36	-0.31	-0.26	-0.29	-0.28
Hungary	-0.16	-0.32	-0.30	-0.21	-0.12	-0.08
Malta	-0.28	-0.28	-0.09	-0.49	-0.20	-0.10
Netherlands	0.07	0.07	0.05	0.08	0.12	0.14
Austria	-0.22	-0.20	-0.18	-0.18	-0.15	-0.13
Poland	-0.20	-0.23	-0.35	-0.26	-0.23	-0.21
Portugal	-0.53	-0.18	-0.23	-0.33	-0.32	-0.33
Slovenia	NA	-0.19	-0.05	-0.22	-0.20	-0.18
Slovakia	NA	NA	-0.53	-0.35	-0.26	-0.26
Finland	-0.23	-0.20	0.07	0.20	0.21	0.20
Sweden	-0.15	-0.17	-0.08	0.06	0.05	0.03
United Kingdom	-0.05	-0.03	-0.06	-0.03	-0.02	-0.01
Iceland	-0.19	-0.47	-0.13	-0.01	-0.09	-0.19
Norway	-0.21	-0.20	-0.23	-0.19	-0.18	-0.16
Switzerland	-0.13	-0.16	-0.17	-0.16	-0.13	-0.12
Canada	-0.05	-0.08	-0.09	-0.01	0.01	0.03
United States	0.04	0.02	0.02	0.03	0.03	0.02
China	-0.16	-0.16	-0.12	-0.21	-0.14	-0.09
Japan	0.15	0.17	0.18	0.13	0.10	0.09

Source: Eurostat (own calculations). For those EU25 countries not listed data were not available.

Figure 3.8 exhibits the technological positions of Germany, France, the Netherlands and UK with regard to ICT patents. A country has a technological advantage (compared to the rest of the world) if the value of RTA is larger than 1.0. From Figure 3.8 it might be clear that the Netherlands occupies a comfortable RTA position with regard to a broad range of ICT products: Office machinery, Radio and TV, Electronic valves and Medical and Optical Instruments. Germany's position is strong with regard to electrical machinery, insulated wire and process and control equipment. The technological position of France indicates strength in process control equipment and UK in Instruments, patents of other ICT goods are more or less in line with the world average of 1.0.

Figure 3.8 Revealed Technological Advantage in ICT (average (1992-2002)



Source: EUROSTAT, Patent applications to the EPO by priority year at the national level by sector of economic activity (NACE class derived through concordance with IPC); total number

Other innovation characteristics of innovative ICT firms

At the beginning of this chapter we have seen that the ICT sector hast the highest share of firms that innovate in collaboration with others. However, some type of collaborators are more common than others. Although it has increased over time, and it is higher than in other sectors, the large majority of innovative ICT firms still do not collaborate with national research institutes. On average only 18% of all innovative ICT firms in Europe collaborate with universities and 11% with research institutes. Collaboration with clients and suppliers is with 28% on average more common, most common is collaboration with other (firms): 42% of the ICT firms collaborate with other (firms).

The national differences in collaboration of innovative ICT frims with third parties are remarkably large (table 3.6). ICT firms that collaborate with others are most often found in Norway, UK, Sweden, Hungary, Lithuania, Cyprus and Estonia. Less collaborative however are innovative ICT firms in Germany and Spain. All other countries exhibit much less collaboration with almost all parties mentioned in table 3.6.

Least collaboration with research institutes are reported by ICT companies in Southern European countries like Italy, Cyprus and Portugal.

Table 3.6 Collaboration of ICT firms with others, universities, research institute, suppliers and clients

	bg	cz	de	ee	gr	es	fr	it	cy	lt	hu	nl	pl	pt	sk	fi	se	uk	no
Others	34	45	25	58	45	25	43	27	50	48	51	41	49	37	48	49	48	40	36
Universities	:	22	16	:	24	11	:	12	14	24	20	16	8	17	:	40	20	11	16
Research Institutes	:	12	7	:	12	7	10	2	0	17	:	12	11	6	:	27	:	:	14
Suppliers	25	37	8	:	20	10	26	11	41	45	37	30	32	28	38	41	33	27	24
Clients	:	35	12	41	28	10	26	11	14	36	:	29	20	25	41	48	39	28	30

: =no data available

Public funding is available on average for 26% of the innovative ICT firms in Europe. Norwegian and Finnish ICT firms are the most successful in attracting public funding: 56% of the innovative ICT firms got funding from that sources this is exhibited in Table 3.7 (first row from the right). In the New Member States like Poland, Estonia, Lithuania, Romania public funding seems harder to get. It might be clear that these difference are more caused by the different funding regimes and less by difference in the degree of innovativeness.

Bottlenecks with regard to internal or external funding and or qualified personnel vary widely among the European countries. The narrowest financial bottlenecks are located in Greece, and Cyprus. Financial bottlenecks are much less severe in Czech Republic, Germany, Hungary and Finland, while Italy and Poland are in a quite average position with regard to internal finance. Lack of qualified personnel is quite large in Cyprus, Lithuania, and Portugal and much more relaxed in Germany, Poland and Norway.

Table 3.7 Public funding, lack of funding and qualified personnel in innovative ICT firms in Europe

	cz	de	ee	gr	es	fr	it	cy	lt	hu	nl	pl	pt	ro	fi	se	no
public funding	22	21	0	41	32	23	41	41	7	23	49	9	17	8	48	0	56
lack of external finance	:	14	:	35	31	:	27	27	26	20	17	23	17	27	11	19	16
lack of internal finance	10	18	23	54	35	34	25	45	42	:	26	29	20	:	18	27	19
lack qualified personnel	15	5	:	13	10	13	11	27	26	11	12	5	31	:	11	:	4

3.2 Innovation Performance on the sectoral level

The importance of the ICT sector for the innovativeness of different Member States has been analyzed. This degree of innovativeness is broken down into three dimensions: Innovation inputs, innovation outputs and the resulting economic performance.

Aggregate innovation and economic performance measures were decomposed into a structurally adjusted part and a residual. Important sector specific deviations from the structurally adjusted values were taken as indicators for important sector contributions to innovation indicators calculated for single countries. The structurally adjusted measures can be analysed to give an indication on the importance of the contribution of a sector to the country indicator. For this purpose the weight the sector has in the aggregate structurally adjusted indicator has been calculated and the cross-country average of the sector specific weight from the country specific value of that indicator was subtracted.

Innovation input is measured as the expenditures on R&D. Positive deviations indicate that the sectoral R&D intensity has a higher than average weight in the national R&D indicator, whereas negative deviations indicate a lower than average weight. The ICT sector has a relatively high importance in terms of R&D as innovation input in France and Sweden, and to a lesser extent in Norway, Belgium and Germany (see Figure 3.9). Hungary, Czech Republic and Lithuania are least dependent upon the ICT sector for R&D as innovation input. All new Member States show negative values.

Figure 3.9 Importance of the ICT sector in the structurally adjusted R&D indicator, compared across European countries

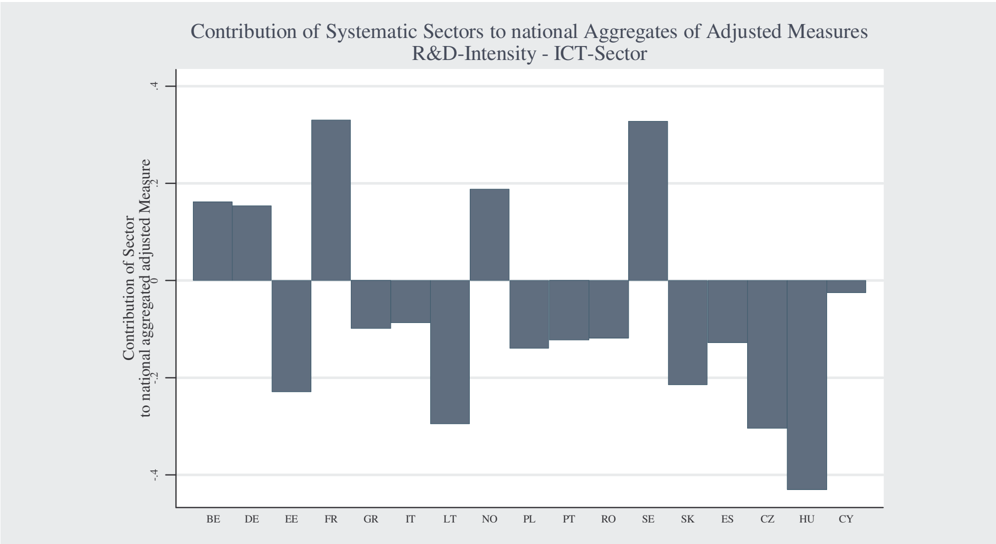
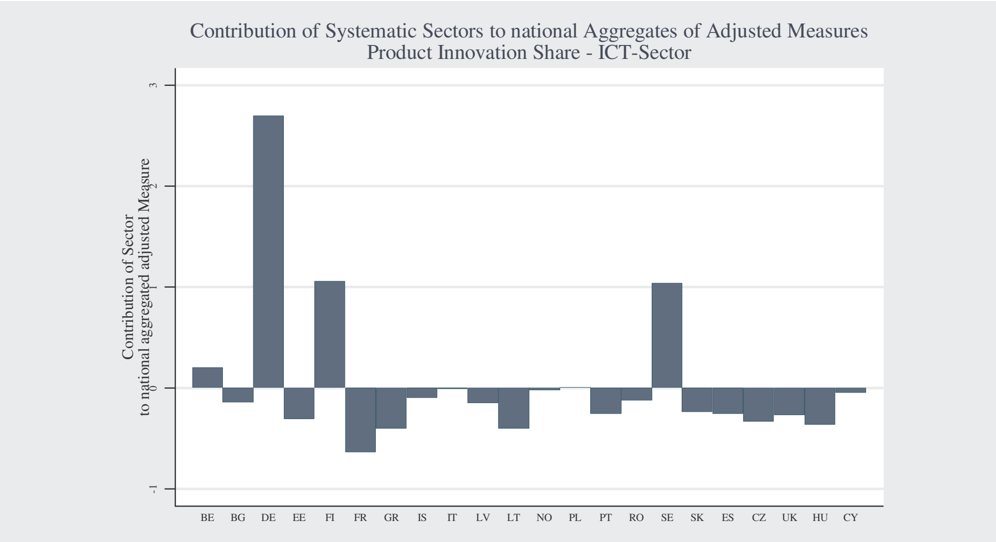


Figure 3.10 Importance of the ICT sector in the structurally adjusted share of sales due to product innovations growth across countries



However, R&D as innovation inputs are just the fuel that drives innovation activities. They do not guarantee success. Hence, a look at the results of innovation activities may be more revealing. The innovation output in terms of the share of sales due to product innovations is in Germany, Sweden and Finland largely depending on ICT companies (Figure 3.10). Striking is the low performance of the French ICT sector in terms of innovation output, bearing in mind the high importance of ICT in the R&D activities in France (compare Figure 3.9 and 3.10).

3.3 Innovation, Productivity and Competition[3]

The relationship between competition and innovation has an inverted U shape, where competition has a positive effect on innovation up to a certain point, after which competition results in a decreased level of innovation. This in short is the opinion of several well known economists (e.g. Aghion et al., 2005). In order to explain this (non-linear) relationship, it is assumed that innovation efforts are an increasing function of the difference between post- and pre- innovation profits. Threat of entry is seen as the main driving force on the innovation efforts of the incumbent firms. The higher the threat from technologically advanced entrants, the more incumbents invoke innovation as a reply especially in enterprises that are initially close to the technological frontier, whereas it may discourage innovation in enterprises that are initially behind the technological frontier.

The evidence confirms that competition and innovation are indeed positively correlated. Empirical analysis shows the inverted U shape relationship between competition and R&D across the sample. However, results show a linear pattern for the ICT sector. This is a remarkable result because it means that more competition is always a good thing for innovation in ICT. In general more competition is good only up to a given threshold. However, these results are not the same for different countries. That

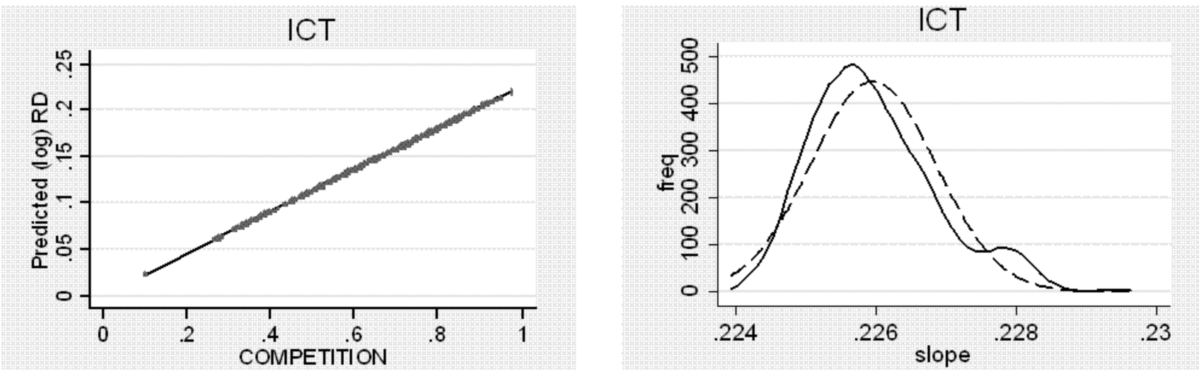
[3] This section reflects the Innovation Watch report on the Sectoral Knowledge Production Function (Crespi et al., 2007).

is, within each sector, the effect of competition on innovation weakens when a given country falls further behind the technological frontier. The fact that competition negatively interacts with the technological gap means that an increase in competition induces more innovation in frontier countries. It also suggests that increasing competition for lagging countries only makes sense once they have built a minimum threshold of absorptive capacities. For countries very far from the world technological frontier it makes little sense to increase competition to stimulate innovation.

The result of the empirical analysis for the ICT sector is shown in Figure 3.11. In the left part of this figure the predicted value for R&D expenditures is higher the more competition. In the right part of the figure the frequency distribution of firms that spend a certain amount of R&D is given by the solid bell shaped line. The dotted line gives the impact of more competition. The figure clearly shows that the majority of firms shift towards more R&D expenditure as a consequence of more competition.

So, we find quite convincing evidence that, in general, competition is good for innovation, and in particular for the ICT sectors.

Figure 3.11 Competition and R&D expenditure in ICT



3.4 Innovation Output and sectoral performance

The driving forces behind innovation success in the Europe's ICT sector have been estimated based on innovation survey data.

3.4.1 The link between innovation input and innovation output

All innovation input indicators are important for market success with market novelties in ICT. For the sales share with product imitations, only the amount of innovation expenditure (both with respect to R&D and non-R&D components) as a percentage of sales as well as the share of highly skilled labour exert a positive influence.

Being able to cut costs, even for innovative products is a major competitiveness factor in ICT since product cycles are short and low-price competition is rapidly evolving in most product markets within ICT, causing product prices to fall. In order to achieve high unit cost reductions, high investment in non-R&D innovation (e.g. new production technologies, and marketing) and co-operation with other firms are successful strategies. At the same time, a high share of graduated employees is likely to reduce rationalisation effects of process innovations. This can be explained by specialisation of firms in different innovation strategies, e.g., firms with a very high share of skilled labour attempting to focus on niche markets within ICT that are less subject to cost pressure.

ICT firms that apply for patents have a higher R&D intensity and more often invest in training.

3.4.2 The link between innovation output and economic performance

ICT firms with market novelties slightly perform better in terms of labour productivity levels.

A striking result is the fact that the sales share from product imitations does not pay off for ICT firms' productivity since their effect is even negative.

Besides the textile industry and the gazelles, the ICT sector is the only sector where patents don't play an important role in explaining labour productivity. This might be explained by the fact that this industry, in general, is characterised by rather short product life cycles and do not want long, and costly patent approval procedures and hence use other methods to protect their innovations, in particular secrecy and time-lead advantage. A second explanation refers back to the fact that patents are less relevant for an important part of the ICT's output, namely software and services.

Another striking result is the fact that the ICT sector is the only sector where a larger rationalisation success leads to a decrease in employment while increasing labour productivity growth. This implies that displacement effects of efficiency gains are not fully compensated by price effects and corresponding higher competitiveness. This might be explained by a rather high price elasticity of demand or fast reactions of competitors.

Profitability in the ICT sector is stimulated by the introduction of new products, both market novelties and product imitations, but there is no measurable effect from the sales share generated from these products. This means that firms with a high sales share from new products can not obtain higher profits than those with a small one. Increasing sales shares of new products thus seem to be achieved at the cost of lowering prices and profit margins. Firms with a large patent stock show lower profit margins.

3.5 Skills and sectoral (productivity) performance[4]

Productivity growth is Europe's weak spot, but once EU was a leading economy as far as labour productivity in ICT production is concerned. Figure 3.12 shows the development of labour productivity and total factor productivity in the ICT sector for USA, Japan and EU-15, during more than two decades. The message is very clear: EU lost its position as a world leader in labour productivity (figure to the right) during the 1980's. USA first catched up, Japan did the same some years later.

[4] This section reflects the Innovation Watch report on Productivity and Skills (Crespi et al., 2007b)

Figure 3.12 Total factor productivity (figure left) and labour productivity (figure right) in ICT

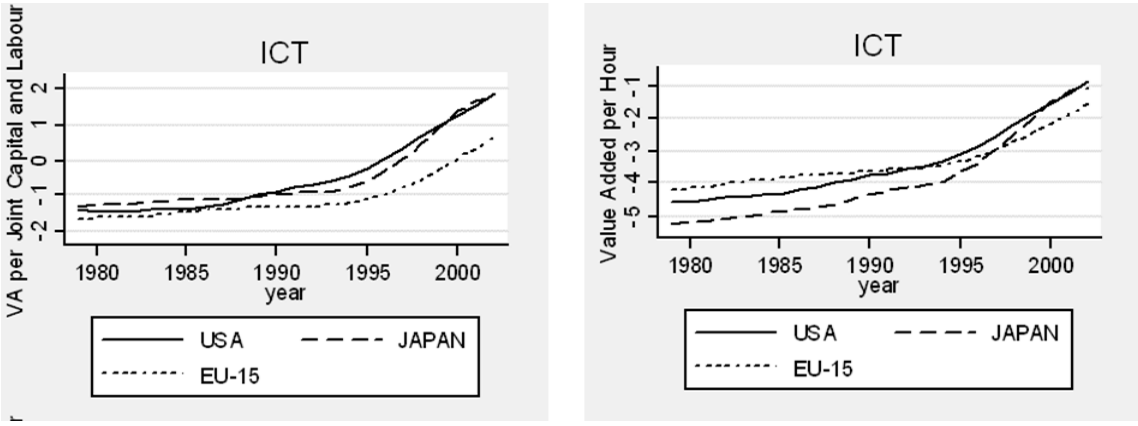
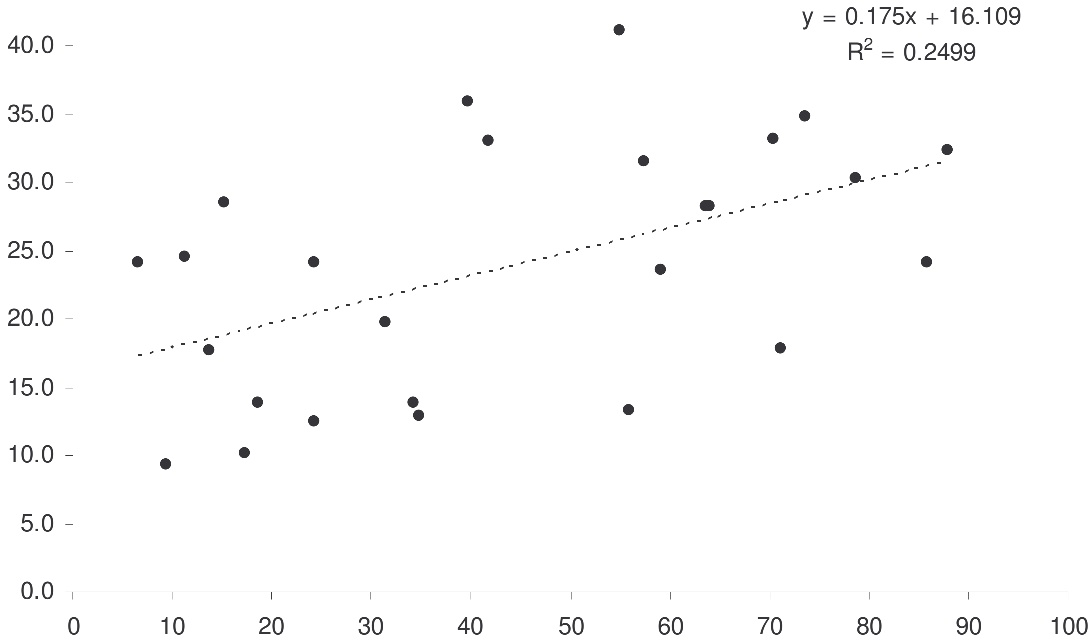


Figure 3.12 (left part) shows the evolution of total factor productivity for ICT over time, the USA is consistently becoming more productivity in ICT, while EU definitely lagged behind in ICT.

The Transition European countries are not included in these figures. Although their relative productivity is very low: 50% below the EU-15 average, their catching-up records are very promising (Dachs, Meijers and Welffens, 2008). Among the myriad of factors that determine the level and course of productivity is the supply of skilled people that are available for the ICT sector in an economy. ICT production is very knowledge intensive and as a matter of fact ICT is the most human resource (in science and technology) intensive sector of all Systematic sectors. This intensity is still steadily increasing. Hence, productivity levels and growth crucially depends on the availability of these human resources.

Figure 3.13 Supply of young tertiary educated people (vertical axis) and productivity in Computer services sector (horizontal axis)



Source: Data source for Young tertiary educated people: Eurostat Eurydice, Key data on education, 2005, Percentage of people with tertiary education qualifications (ISCED 5 and 6) in the population aged 30-34, 2002, the level of productivity per employee (*1000 €) of the computer and related activities sector (NACE72) is the average over 1995-2004 or a shorter period for the younger Member States.

Figure 3.13 exhibts the relation between the level of productivity in the EU-25 countries and their supply of young teriary educated people.

European Countries in transition such as Latvia, Lithuania, Estonia and Bulgaria experience a relatively large gap between the supply of tertiary educated young people and the level of productivity in computer services. These countries are located in Figure 2 close to the origin and under the regression line. Leading EU Member Sates like UK, Denmark and Belgium are well supplied with tertiary educated young people and are located in the north-eastern corner of Figure 3.13 and well above the regression line.

Higher education skills in general affect productivity growth though technology transfer only, but in ICT sectors higher education impacts productivity growth through innovation only.

Furthermore, the analysis in the Systematic project (and other studies) clearly reveals that not only the ICT sectors have the highest productivity level and the highest pace in productivity growth, but also that ICT occupations (ISCO 213, 312, 313, 724) are on the increase in all sectors of the economy, and have themselves become drivers of productivity growth in other sectors as well. R&D might be an independent driver of productivity, but, it is hard to single out its impact independently from the impact of higher education. And as Europe's ICT sector keeps on shifting towards a service sector, the impact of higher education will probably increase.

3.6 Modes of Innovation[5]

ICT firms are highly innovative, they top the bill on the European Innovation Scoreboard (EIS). The EIS includes innovation indicators and trend analyses and attempts to benchmark, on a yearly basis, the innovation performance of Member States, drawing on statistics from a variety of sources, primarily the Community Innovation Survey. Innovation performance at the sectoral level was measured in an EIS 2006 thematic paper (note) using the Innovation Sector Index (ISI). Most innovative ICT sectors as measured by the ISI are Electrical and optical equipment, the total ICT sector and Computer services.

Four types of innovators can be distinguished using the data of the CIS: Strategic innovators, Intermittent innovators, (technology) Modifiers and (technology) Adopters.

• **Strategic innovators** are active on international and national markets and have introduced (at least) a product or process innovation that they developed (partly) in-house. Their R&D is a continuous activity and they did introduce at least one product that is new to their market as well. These firms are the source of many innovative products and processes that are also adopted by other firms.

• **Intermittent innovators** develop innovations at least in partly in-house and have introduced new-to-market innovations. But, they are unlikely to develop innovations that diffuse to other firms.

• **Modifiers** all developed an innovation at least in partly in-house but none of them perform R&D. If they are active on national or international markets, they have not introduced a new to market innovation (otherwise they would be classified as an intermittent innovator). If they are active in local and regional markets, they may have introduced a new to market innovation and have slightly modified it for this market.

• **Adopters** depend on adopting innovations developed by other firms hence innovate through diffusion.

In table 3.8 it is shown that strategic and intermittent innovators in ICT manufacturing as well as ICT services make up 45% of all firms active in these sectors. Intermittent Innovation is the most common mode in ICT production. Across all firms 6% of are strategic innovators, 17% are intermittent innovators, 11% are technology modifiers and 4% are technology adopters.

[5] This section draws on the Innovation Watch report on Innovation Modes (Hollanders, 2007)

Table 3.8 Innovation performance and types of innovators (share of firms)

Industry	Average innovation performance (a)	Type of innovator (b)			
		Strategic	Intermittent	Modifiers	Adopters
NACE 30 Office machine etc.	65%	20%	37%	3%	5%
NACE 32 Radio, TV & Comm Eq.	61%	21%	18%	8%	5%
DL Electrical and Optical	63%	19%	24%	7%	3%
NACE 72 Computer services etc	63%	18%	29%	11%	5%
ICT (total)	61%	18%	29%	10%	5%
D All Firms	47%	6%	16%	11%	5%

Source: (a) 06 WP4 and (b) Hollanders and Arundel (2005)

Strategic innovators receive much more funding from local, regional and national governments as well as from the EU compared with Intermittent and other innovators. Strategic innovators also apply more for patents as well as other methods to protect their intellectual property (by means of registration of designs, trademarks and copyrights)

Table 3.9 summarizes the 'performance' of each innovation mode in ICT compared to the average performance of that mode over all industries. It shows that the share of innovative firms among Strategic innovators and Intermittent innovators are higher than for the same modes in other sectors. The turnover from new-to-market products and the growth of total turnover for Strategic innovators is higher in ICT than in other sectors.

The fact that the average ICT firm is smaller then firms in other sectors is especially true when we compare innovative ICT firms with innovative firms in other sectors, and when one compares strategic innovators in the ICT sector with strategic innovators in other sectors. Strategic ICT innovators have on average 313 employees, whereas for all sectors Strategic Innovators are on average three times larger, with 948 employees. The average size of Strategic innovators in NACE 30 is even 108, and 250 in NACE 72. Strategic innovators in NACE 32 with an average of 699 are also smaller than in other sectors, but almost 7 times as large as strategic innovators in NACE 30.

The share of high-educated employees is for each of the innovation modes for firms in the ICT sector higher then for same modes in other sectors. The share of higher educated employees is especially high in the NACE 72 (computer services).

Among the innovating ICT firms turnover growth is highest in NACE 32, employment growth and export growth is highest in NACE 72. Among the Strategic Innovators in the ICT sub-sectors, those from NACE 72 outperform those in NACE 30 and 32 in terms of growth in turnover, employment and export.

Table 3.9 Summary of 'performance' of each innovation mode for the ICT sector compared to the average of that mode over all sectors

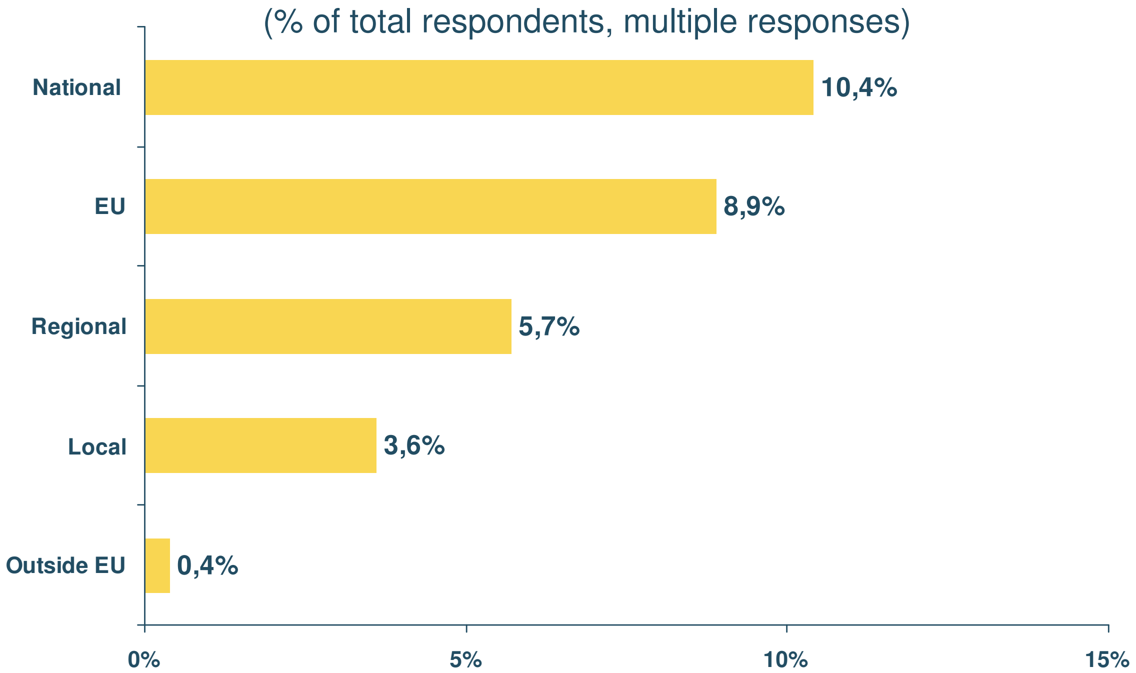
	Strategic innovators	**Intermittent innovators**	**Technology modifiers + Technology adopters**
Share of innovative firms	++	++	-
Turnover of new-to-firm products	+	+	-
Turnover of new-to-market products	++	+	+
Firm size	--	-	--
Turnover growth	++	--	+
Employment growth	+	+	+
Labour productivity	-	-	--
Share of employees with higher education	++	++	++
International markets most significant	--	--	-
Innovate activities (top 3 used by most firms)	- own R&D - buying advanced machinery - training of personnel	- own R&D - training of personnel - buying advanced machinery	- buying advanced machinery - training of personnel - market introductions
Innovation expenditures (top 3 highest spending shares)	- own R&D (64%) - buying advanced machinery (29%) - buying external R&D (4%)	- own R&D (59%) - buying advanced machinery (29%) - buying external R&D (6%)	- buying advanced machinery (54%) - buying other external knowledge (29%) - own R&D (49%)
Use of formal IP (most used)	0 (trademarks)	+ (trademarks)	0 (trademarks)
Use of nonformal IP (used by most firms)	++ (lead-time advantage)	++ (lead-time advantage)	++ (lead-time advantage)
Use of non-technological change (used by most firms)	- (aesthetic changes)	+ (new organisational structures)	0 (new corporate strategies)

3.7 Innovative ICT SMEs

Innovation is a driver of economic growth, but finding the proper way to measure it is difficult, not in the least because large firms innovated differently from small firms. In this paragraph we show that small and medium sized ICT enterprises (ICT SMEs) innovate quite differently from the way large firms do.

IDC & UNU-MERIT (2007) have studied innovative ICT SMEs in Europe (EU25)[6]. Some of the characteristics of the innovation process in ICT SMEs are revealed and these characteristics illustrate how SME's in the ICT sector innovate in Europe. The study is based on data provided by 1283 innovative ICT SMEs in all EU25 Member States. A firm is considered to be innovative when they have confirmed that they either invest in RTD (internal or external) and/or did introduce products new to the firm or new to the market. Firms that did not meet these two criteria were rejected from the sample. The results showed that these ICT SMEs have a low propensity to patent. Of the sample 22% have requested in the last 3 years patents or licences, protecting their own know-how or acquiring the know-how of others. This might be a sign that firms included in the sample are more inclined to use sophisticated tools such as IPP tools than the European average, but the absolute level of patents generation in the EU is quite low. This low propensity to patent is understandable because only 22% of innovative SMEs did receive any funding from research and or innovation programs in the last 3 years, mostly from National and EU programmes (Figure 3.15). Among the SME who did receive funding most are large and medium sized SMEs.

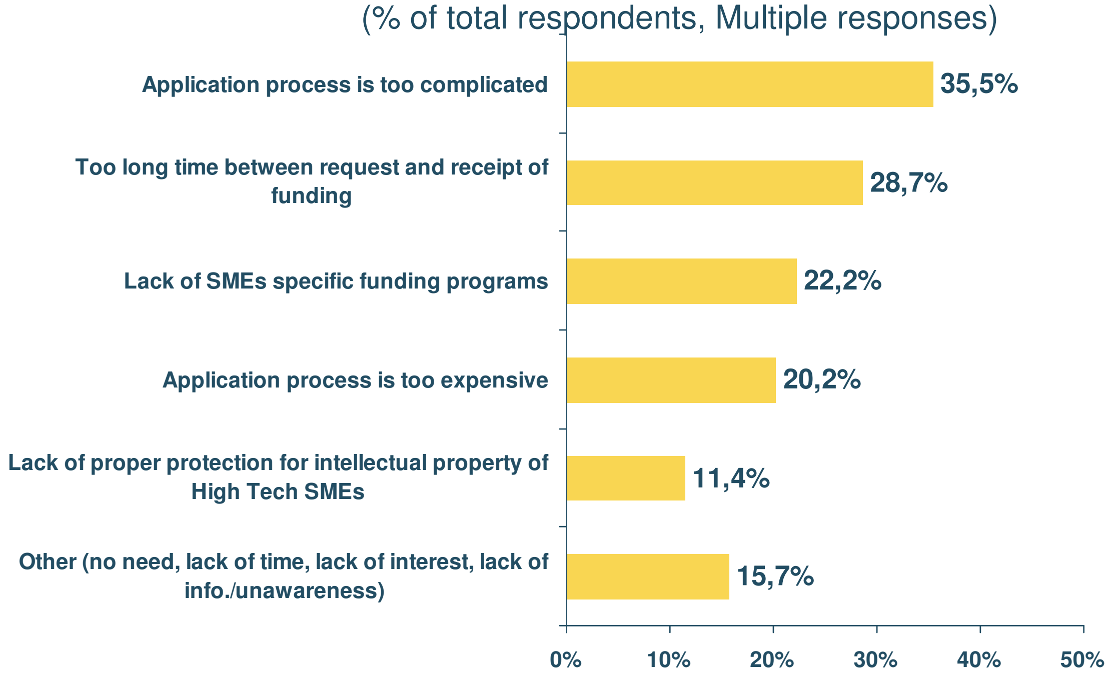
Figure 3.15   ICT SMEs that received funding from RTD programmes in 2006-2003



Source: Inventory of Innovative ICT SMEs in Europe, IDC & UNU-MERIT (2007)

[6] Innovative ICT SMEs in Europe (EU25), Final Study Report, D. 5. 3. Contract Nr 30-CE0067591/00-41 DGINFSO-C2, Strategy for ICT Research and Development, 2007, written by and available from IDC EMEA, October 2007.

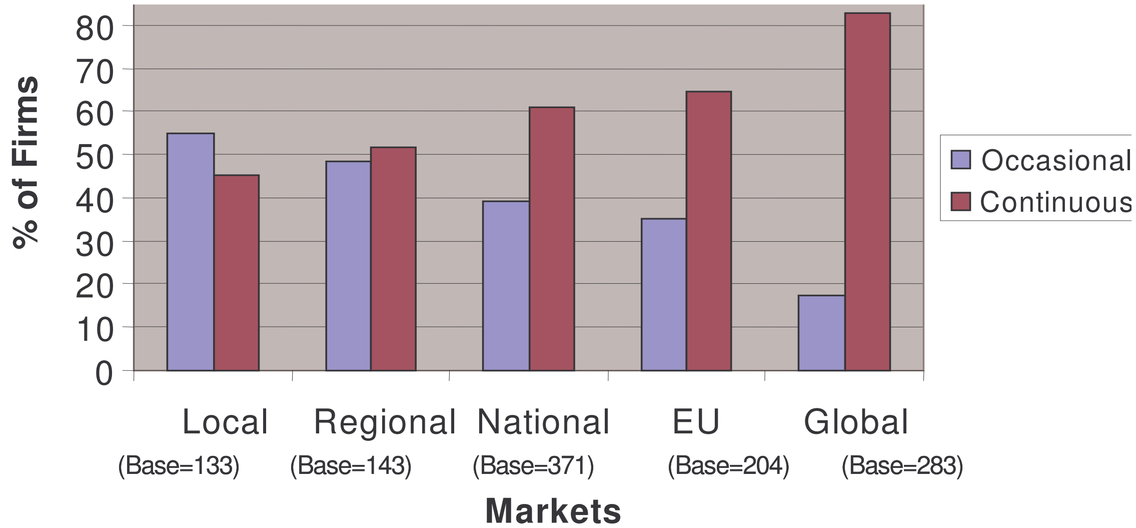
Figure 3.16 Reasons for No Participation to RTD Programmes in 2006-2003 mentioned by innovative ICT SME's



Source: IDC & UNU-MERIT (2007)

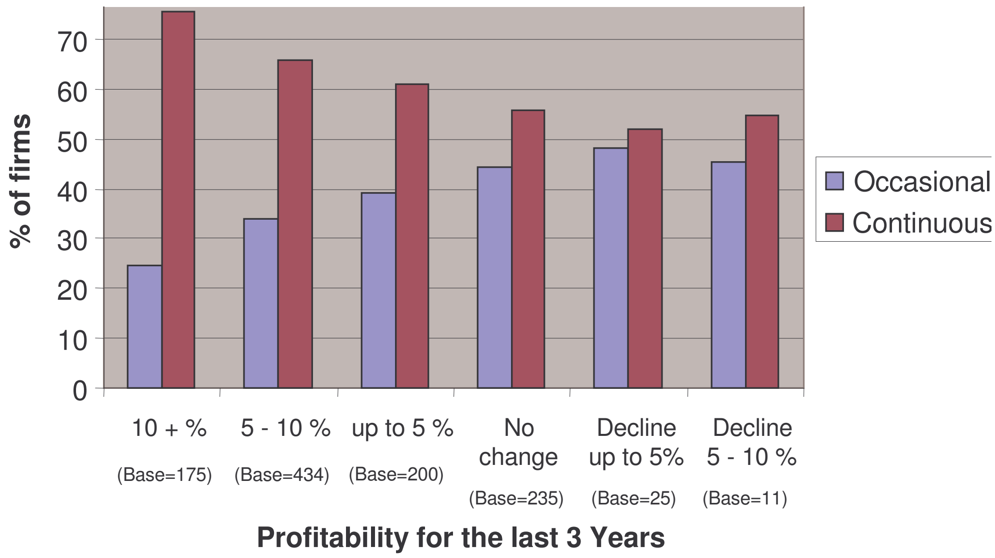
A too complicated application process for participation in public funded RTD programmes is for SMEs the main reason of not participating in these programmes. Other important reasons for not participating are financial in character (the lead time of receiving the funds and the costs to apply).

Figure 3.17 Continuous innovating ICT SME's by geographical scope of the market (% respondents for each type of market)



Source: IDC & UNU-MERIT (2007)

Figure 3.18 Continuous innovating ICT SME's by profitability growth (% respondents for each level of profitability growth)



Source: IDC & UNU-MERIT (2007)

ICT SMEs that continuously innovate are much more active abroad than ICT SMEs that occasionally innovate (Figure 3.17). If ICT SMEs aim for international markets they have to make continuous innovation efforts in order to compete on quality rather than price. Continuous innovating ICT SMEs are also more profitable than their occasionally innovation counterparts (see Figure 3.18). The data shows that innovative ICT SMEs make an important contribution to Europe's competitiveness.

Innovative ICT SMEs also fullfill an important role in innovation networks and regional innovation clusters. In the CIS, of all innovative ICT firms in Europe (large and small) on average only 18% have reported collaboration with universities and 11% with research institutes. The most recent data tell us that this type of cooperation has increased for ICT SMEs, as in 2007 40 percent of innovative ICT SMEs have reported research cooperation with universities. Research labs are still a less frequent partner for ICT SMEs.

4 Sectoral Innovation Barriers, Drivers and Challenges

4.1 Innovation Barriers and Drivers[7]

The three most important barriers to innovation as perceived by ICT companies are related to finance (see table 4.1). Out of the innovative ICT companies 26 percent report that innovation is hampered due to the lack of funds within the enterprise or group. For 24 percent the too high costs of innovation are a high barrier. The access to external sources of financing such as public money, venture capital or loans is a serious problem for 18 percent of the enterprises. Non-innovative ICT companies perceive fewer barriers as high, than innovative ICT companies. In other sectors it is the opposite: the non-innovative enterprises more often report high barriers.

Table 4.1 Innovation barriers perceived as high in the ICT sector, in % of responding companies

Innovation barriers (high)	**ICT sector**		**All sectors**	
CIS-4 data	Innovative	Non-Innovative	Innovative	Non-Innovative
Lack of funds within enterprise or group	26.1	21.7	23.8	25.2
Innovation costs too high	23.7	21.3	25.0	27.7
Lack of finance from sources outside the enterprise	18.1	15.6	17.8	17.3
Market dominated by established enterprises	14.8	14.3	15.3	17.3
Uncertain demand for innovative goods	14.7	13.1	14.7	18.2
Lack of qualified personnel	10.5	7.9	11.4	11.3
Difficulties in finding co-operation partners	8.6	7.2	9.1	11.2
Lack of information on markets	6.1	3.5	6.6	7.7
Lack of information on technology	3.0	3.2	5.3	7.5

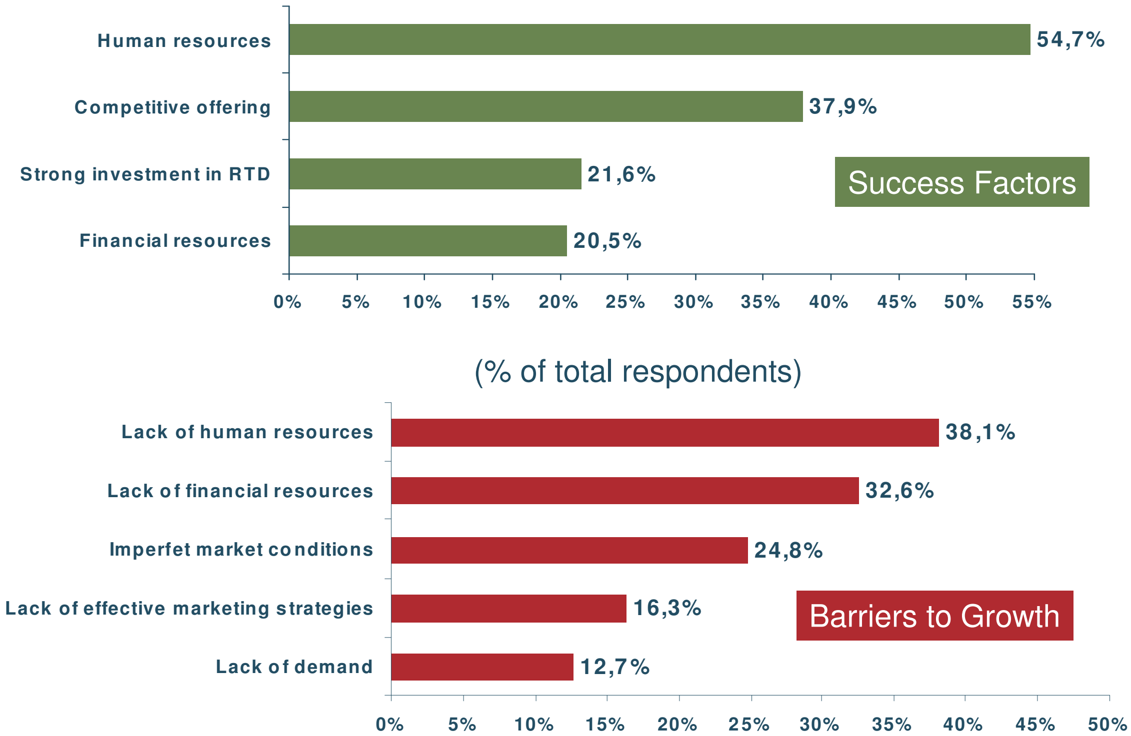
Innovative ICT companies, especially those that conduct their own R&D, are affected significantly more strongly by financial problems and innovation costs in the innovation process than non-innovative firms or firms without continuous R&D.

Focussing on ICT SMEs (Figure 4.1) we see that product market conditions are imperfect according to about 25% of innovative ICT SMEs. However competition in other markets like the labour market and financial market is a more frequent tougher for innovative ICT SMEs. Compared to the CIS data the more recent data on innovative ICT SMEs data suggests that the lack of human resources have become more severe. In the labour market: almost 40% of ICT SMEs experience a lack of human resources, while almost a third experience a lack of financial resources. The other

[7] This section draws amongst others, on Cleff et al. (2007)

side of the coin is that these two factors are also the most important success factors for SMEs.

Figure 4.1 Success Factors and Barriers to Growth for Innovative ICT SMEs



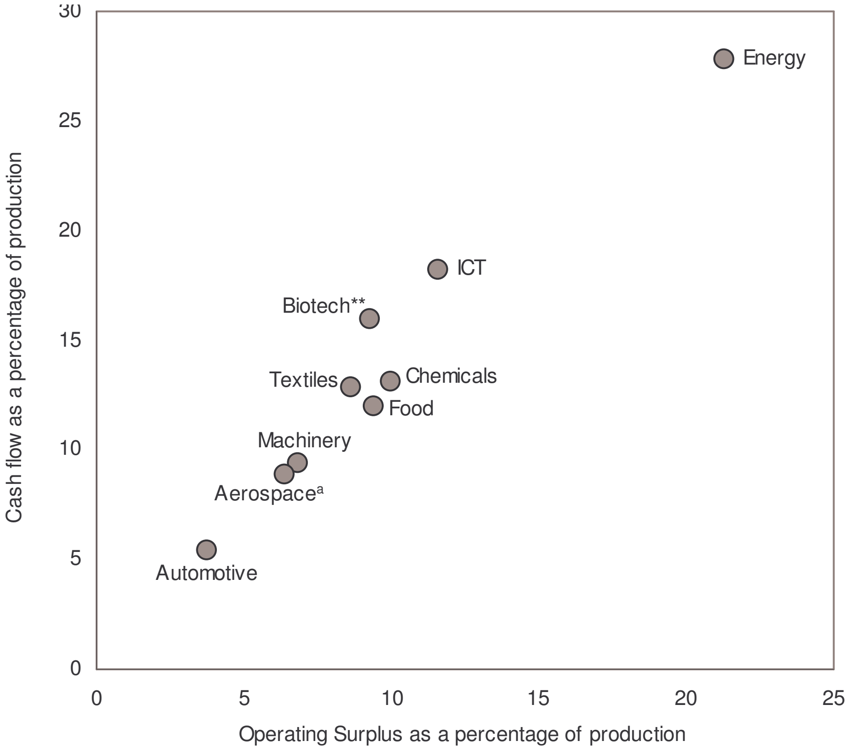
Source: IDC-MERIT, 2007

4.1.2 Finance

In order to assess the availability of internal funds in the ICT sector, data was use from the OECD's STAN database. Two indicators for the internal funding situation can be calculated: the operating surplus is defined as earnings before interest and taxes (EBIT). Adding depreciation to this figure gives a rough estimate of cash flow, though some components such as changes in long-term provisions typically added to cash flow are not considered while interest payments are included. Both variables are expressed as a percentage of total production (see Figure 4.2). The ICT sector shows a rather good internal financing situation, yielding an 11 per cent operating surplus ratio, and a 17 per cent cash flow ratio.

Still, external sources of funding are also important. There are two main channels to access external equity: placing company shares at stock markets, or acquiring investment from investment banks and in particular private equity companies. While the former is open to a small number of publicly listed firms only, the latter has become an increasingly important source for corporate financing within the last ten years in Europe, including SMEs and start-up companies. Private equity is traditionally separated into two types of investment: venture capital and later stage. Venture capital is used to finance the start-up of new, typically technology-based firms as well as the expansion of fast growing companies. Later stage investment represents financial investment into companies that promise growing profits and is often associated with restructuring. From an innovation financing perspective, venture capital is the most important component of private equity. It represents, on average, about a quarter of total private equity investment in Europe.

Figure 4.2 Operating surplus and cash flow as a percentage of production by sectors (weighted averages, 1995-2002, EU-25*)*



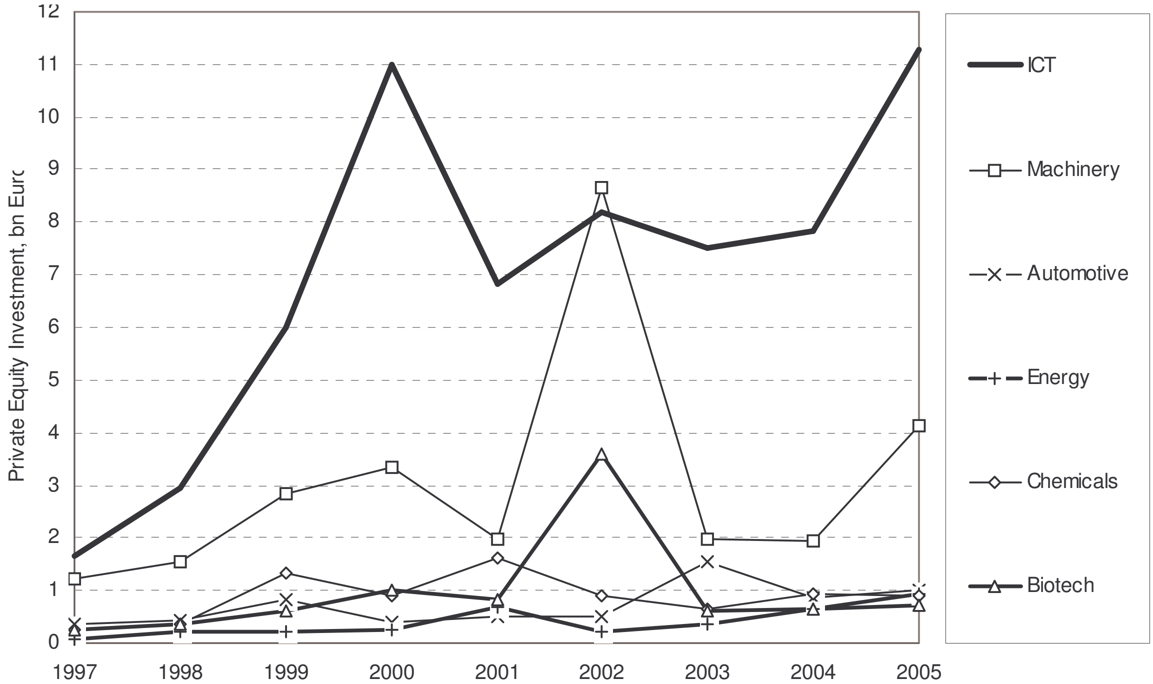
Notes: * See the appendix of 15b for the countries and time periods available for each sector. ** NACE 24.4 (pharmaceuticals) plus NACE 73 (R&D services), i.e. it includes a number of non-biotechnology activities. a) Cash flow for Aerospace not available in STAN, for presentation purposes it was estimated as 1.4 times operating surplus. Source: OECD - STAN database

The ICT sector has attracted the largest fraction of private equity investment in the EU-25 over the past nine years (Figure 4.3). Investment grew rapidly from 1997 to 2000, sank significantly in 2001, remained rather stable until 2004 and reached a new peak in 2005, with more than €11bn. The annual average of private equity investment in the ICT sector within the EU-25 was about €7bn.

The European Investment Fund[8] takes stakes in venture capital and private equity funds in European high-tech early stage investment. In 2005 SME guarantees totalled about €8 billion mainly for ICT and Biotech SMEs. The relatively high importance of public sources of funding manifests itself in the proportion of firms that have made use of public funding programmes: 28% of innovating firms in the Community Innovation Survey reported that they had received public subsidies.

[8] EIF is a finance body of he EU established to support SMEs (especially the innovative SMEs). Main shareholders of the EIF are the EIB, EC and public and private financial institutions from across EU25. The EIF also manages the funds under the CIP 2007-2013 programme.

Figure 4.3 Volume of private equity investment in Europe by sectors 1997-2005 (EU-25)*



Note: * New member states CZ, ET, LV, LT, PL, HU, SK only from 2003 on, no data for SV, MT, CY, LU. Source: EVCA, OECD - STAN database, ZEW calculations.

The share of ICT firms that have reported lack of internal and external sources of funding as a highly important barrier to innovation differs per country (Figure 4.4). Firms from Cyprus, Poland, Romania and Germany complain more about lack of internal sources, while in Greece, Spain, Italy, Lithuania and Hungary, the lack of external sources seem to outweigh the problem of internal sources as a factor hampering innovation.

Figure 4.4 Lack of finance from external and internal sources in the EU ICT sector, share of ICT firms reporting it as highly important factor hampering innovation

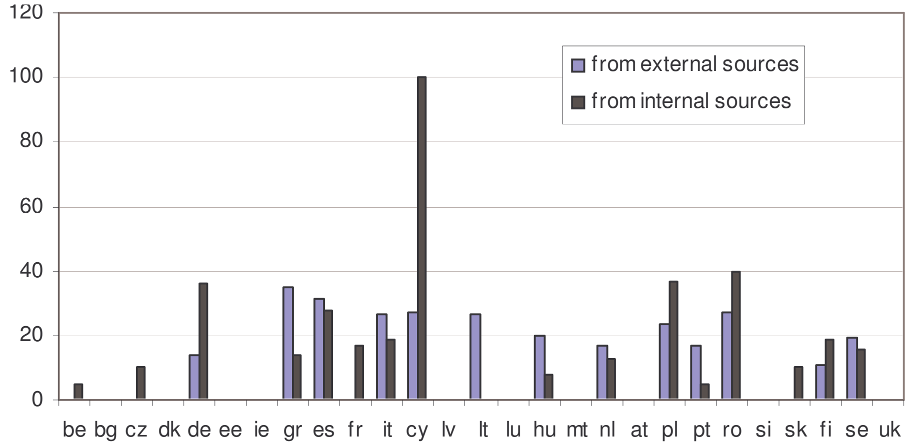
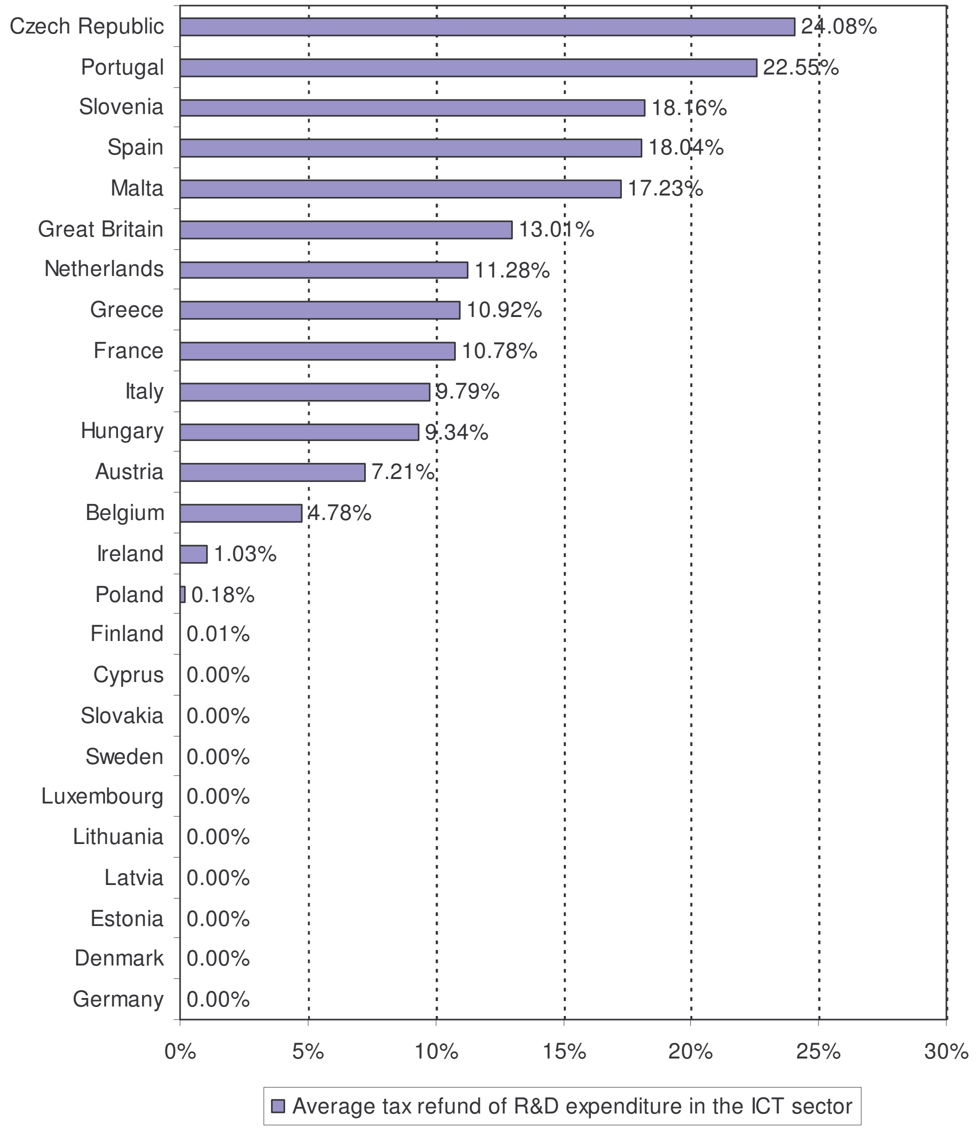


Figure 4.5 Average tax refund of R&D expenditure in the ICT sector



Source: European Tax Analyser, ZEW calculations

4.1.3 Taxation

The European Tax Analyser is a computer program for calculating and comparing effective average tax rates (EATRs) for companies located in different countries. The shows that the potential for companies to gain tax refunds on their R&D expenditure differ considerably among member states. There are also differences between sectors. On the one hand there are differences due to the industry-specific propensity to conduct R&D activities. On the other hand, the analysis shows that there are sector-specific regulations in each country that effect the obtainable tax refund. The analysis makes clear that the incentives to innovate and to locate their R&D operations may vary by country and by sector. In figure 4.5 the ETA is applied to the ICT industry.

Particularly high refunds are shown for the Czech Republic and Portugal with more than 20 percent of R&D expenditure. The 11 percent for the ICT sector in the Netherlands is lower that the almost 18 percent which was calculated as the average for all sectors in the Netherlands. An explanation could be that there is a maximum amount of refund for individual companies. As the largest ICT research performer in the Netherlands the tax refund to Philips is limited to this maximum and therefore the average percentage for the ICT sector is lower.

4.1.4 Competition

Among the barriers covered in CIS, market dominance by established enterprises is the second most important barrier to innovation, right after the three financing barriers (high innovation costs, lack of internal, and external funds). Of all innovative enterprises in EU-25 15 percent cited this factor as highly important for hampering their innovation activities in 2002-2004 (and 17 percent of all non-innovative enterprises). The result for the ICT sector is similar (see table 4.2), except that fewer non-innovative ICT firms reported market dominance by established firms as a high barrier for innovation.

Table 4.2 Market dominance by established enterprises as a barrier for innovation in innovative and non-innovative companies (1998-2000)

Sector	Innovative	Non-innovative
Food	17.5	16.9
Textiles	13.2	21.3
Chemicals	21.0	16.6
Machinery	13.9	14.0
Automotive	15.6	15.3
ICT	14.8	14.3
Energy	7.3	8.0

Source: CIS-3

While competitors can hinder innovation activities in case they exert market dominance, competitors can also serve as a source or driver for innovation. Using impulses from competitors, is typically associated with imitation strategies, i.e. enterprises copy innovations already introduced by their competitors, or learn from their innovation efforts (including failures) for their own activities.

The significance of competitors as a source of innovation is slightly less than of suppliers (Table 4.3). Most important information source for innovation is the firm itself. Second in importance are clients. Except suppliers, all the other mentioned sources are more often reported by innovative ICT firms as relevant, than innovative firms in general, in all sectors. Most specific for the innovative ICT companies compared to innovative firms in other sectors is the high use of universities as source of innovation, respectively 40 and 28 percent.

Co-operation with competitors in innovation projects is rather rare. About 10 percent of all innovative enterprises co-operated with competitors in the time period 1998-

2000. For the ICT companies this percentage is 12, but also for the ICT sector it is the lowest share among all possible partners to co-operate with regarding innovation.

Table 4.3 Information sources for innovation

Information source	Share of all innovative companies	Share of innovative ICT companies?
Own enterprise	85.1	89.4
Other firms within group	20.4	25.3
Clients	74.9	83.4
Suppliers	76.2	74.7
Trade fairs, exhibitions	74.0	79.0
Competitors	66.4	71.3
Conferences, Journals	64.4	77.5
Universities	27.8	40.2
Research institutes	20.7	23.2

Source: CIS-3

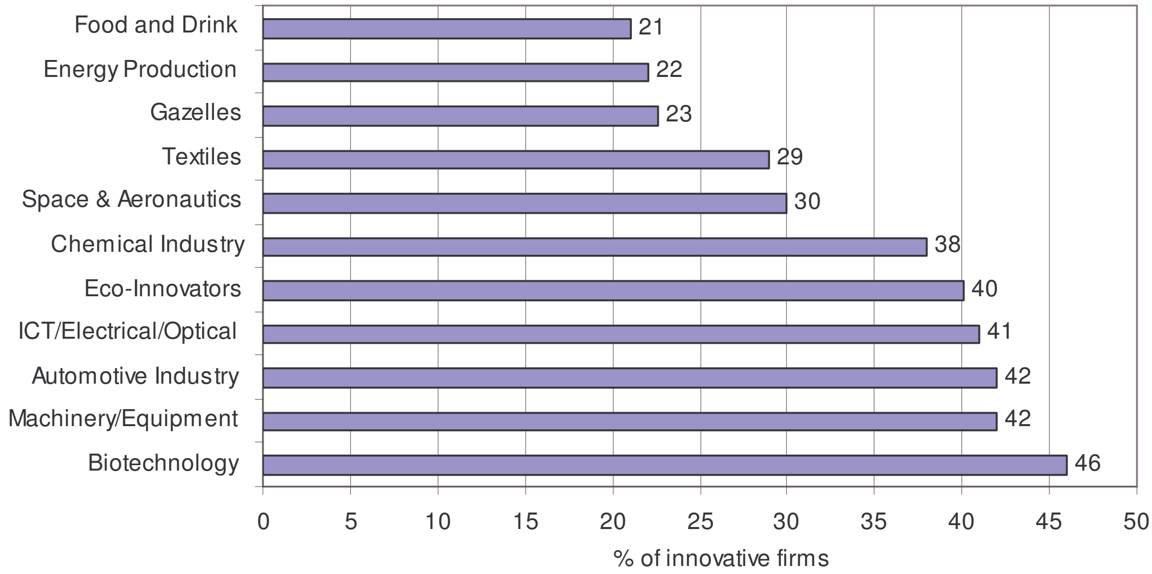
4.1.5 Demand and lead markets

In the evaluation of technological performance, there has, for many years, been a tendency to concentrate on “supply-side” assessment of national innovative potential. It is often assumed that the supply of innovations created by a “technology push” will be matched by demand on the market, but there are numerous examples in which products that - from a technological point of view - were superior, failed to become the standard on the world market (see e.g. Beise, 2001). Innovation policies and company innovation strategies that define success only in terms of technology run the risk of producing goods for which there is no demand.

A large number of empirical studies show that customer proximity is of great importance for the innovation process. The results of the third Community Innovation Survey (CIS-3) once again confirm the prominent role of clients in providing momentum for the innovation process. A total of 26 percent of innovators assess their customers’ role as high. Only 12 percent of companies judged competitors and other firms from the same industry to be a high important source of innovation, while 20 percent gave this rating to suppliers and 14 percent to fairs and exhibitions. Only 5 percent of innovators received their most important impulse to innovate from universities or other education institutes and only 4 percent from government or non-profit research institutes.

It is in the field of product innovations that customers have the most influence. Nearly 33 percent of such innovations and nearly 35 percent of the market novelties can be traced back to customer input. Whether or not it is considered necessary to intensively involve customers in the innovation process varies from sector to sector (see Figure 4.3). It is among the highest for the ICT sector.

Figure 4.3 The importance of a high customer acceptance for innovative firms

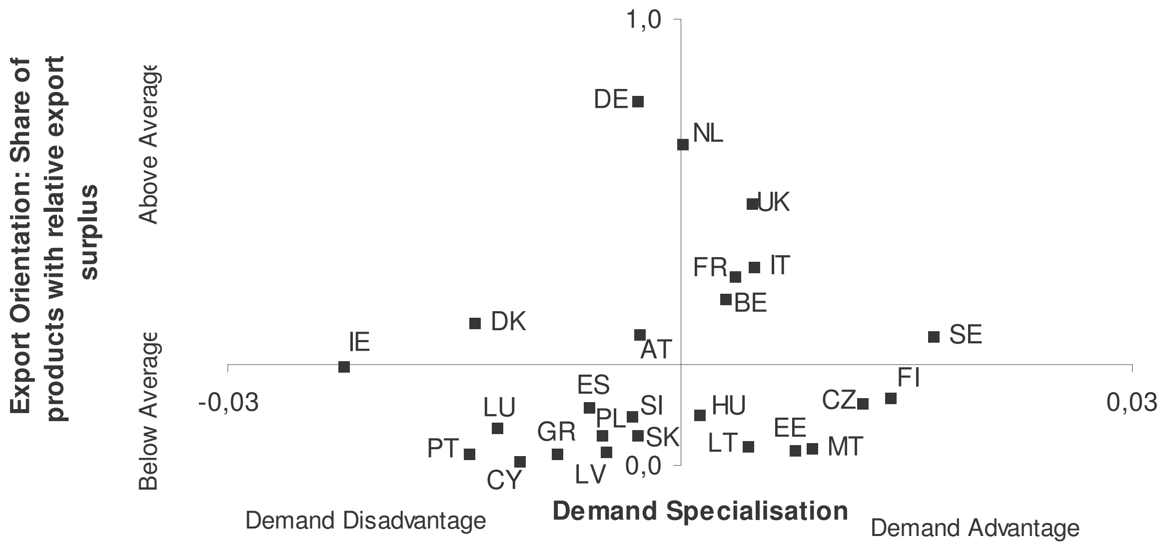


Source: CIS-3, unweighted, ZEW calculations

In a more aggregate form the importance of demand in relation to innovation is captured by the concept of Lead Markets. It refers to regional or national markets that generally take up a particular innovation design earlier than other countries. They have specific properties (Lead Market factors) that increase the probability of a wide take-up of the same innovation design in other countries (Commission of the European Communities, 2006). Where the scientific and technical knowledge for this purpose was actually generated is mostly not relevant, as companies in the Lead Market can appropriate this knowledge. More important for competitiveness is the ability to learn on this market about the applications and production of innovations (Meyer-Krahmer, 1997). In this section we will analyse which countries in particular have Lead Market properties in the ICT Industry (NACE sectors 30, 31, 32, 33, and 72). It should be noted that the Lead Market potentials established are for the aggregated sector. In reality, Lead Market potentials within a sector can vary from one product group to another, or even between individual products.

Figure 4.4 shows the extend of demand advantage against the size of the export advantage for the ICT sector in the form of a portfolio. In the upper right quadrant of the portfolio are countries that develop technologies driven by demand and at the same time exploit the lead-market properties of home demand for successful exports. The home markets in these countries – Belgium, the Netherlands, UK, Italy, Sweden and France - offer particularly favourable conditions for the launch and testing of new ICT products, with the aim of successfully marketing the innovation designs tested at home in other countries.

Figure 4.4 Lead Market Matrix in the ICT sector: classification according to export orientation and utilisation of home market demand



Source: Cleff et al. (2007), based on Global Sourcing Management Tool, 2007 and Eurostat/OECD PPP-Statistics for 2000 to 2004

4.1.6 Regulation

The results of the CIS-3 survey showed that the industry with the smallest effect of innovation activities to comply with formalities and regulations is the ICT sector (see table 4.5). Obviously there is not a great deal of product regulation that is specifically directed to the ICT sector and that could have lead to regulation becoming a driving force for innovation.

Table 4.5 Effects of innovation activities

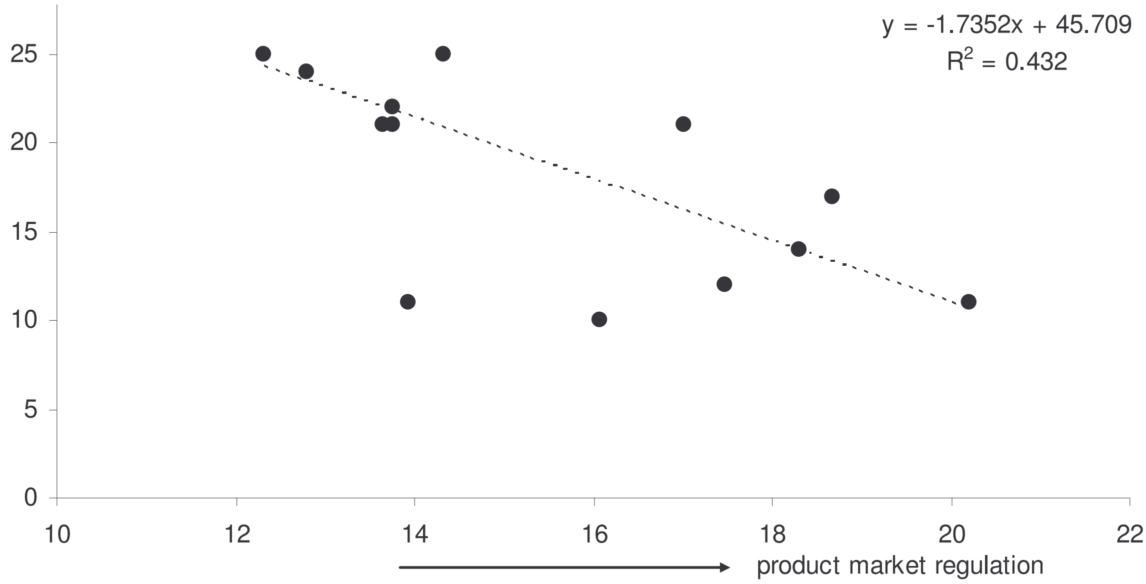
	Food	Textiles	Chemicals	Machinery	ICT	Auto-motive	Energy
Increased range of goods	36.8	32.9	42.6	37.8	48.8	40.8	15.0
Increased market share	32.2	23.1	36.2	32.4	40.7	35.3	17.2
Improved quality	40.9	33.4	39.3	36.4	45.4	42.6	30.2
Improved production flexibility	22.9	24.1	20.3	22.0	26.6	24.3	18.4
Increased production capacity	29.5	20.5	23.7	17.8	21.1	28.1	14.0
Reduced labour costs	21.9	16.2	18.2	13.1	15.1	23.3	10.4
Reduced materials	13.3	9.9	13.1	8.2	4.8	14.6	13.7
Improved environmental impact	20.0	12.0	25.8	14.0	4.9	20.4	31.3
Met regulations	*26.9*	*14.1*	*28.2*	*14.9*	*14.2*	*20.4*	*26.0*

Source: CIS-4, ZEW calculations.

Regulation could also be a barrier to innovation. E.g. in the CIS-3 survey 8 percent of the responding companies saw "Insufficient flexibility of regulations or standards" as a barrier to innovation. For the ICT sector this percentage was slightly lower. Product regulation does not seem to be that important in influencing innovation activities.

However, when we include other types of regulation, it seems to become important. Countries with low (overall and product) market regulation exhibit more strategic and intermittent innovators in the ICT sector than in countries with stringent regulatory regimes. In Finland, Germany, Sweden, Luxemburg, the Netherlands, Belgium and Austria regulation is less stringent than in Italy, Greece, Czech Republic, Hungary, Slovak Republic and Spain. France has a clear position between these two groups. All countries are plotted in figure 4.5.

Figure 4.5 Product market regulation (horizontal axis) and (strategic and intermittent) innovators (vertical axis) in selected countries



Burgelman and Barrios (2007) show that regulatory strictness impact economic growth negatively. They use more measures of strictness of regulation like business regulation, credit market regulation, and labour market regulation. They have shown that the more stringent the regulation is, the higher the negative impact on GDP growth and the more application of ICT is hampered.

4.2 Innovation Challenges[9]

4.2.1 Structural features

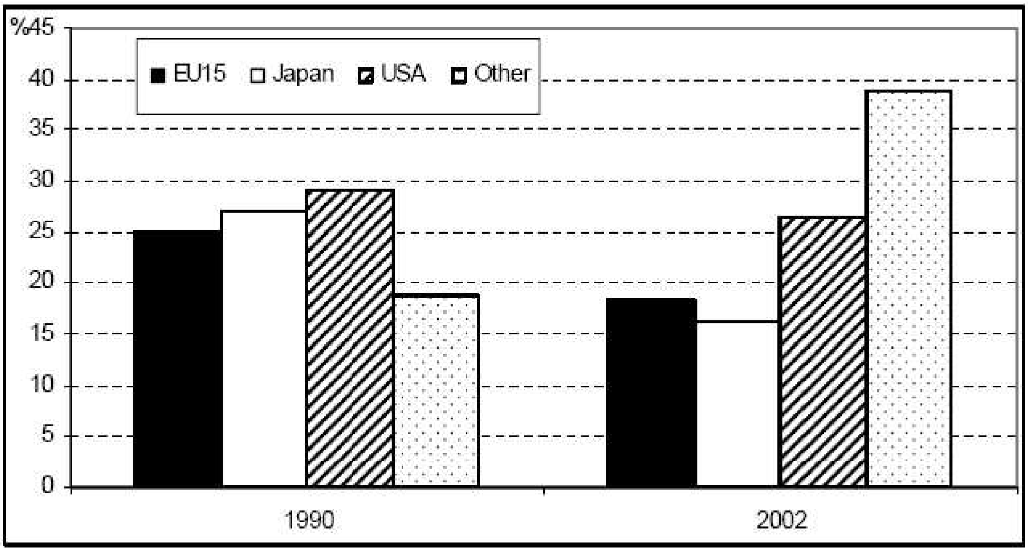
Prospective innovation challenges for the ICT industry lie both in ICT as a product, a technology and a sector. As a product, a key characteristic of ICT is its pervasiveness. ICT as a technology is characterised as enabling and a general purpose tech-

[9] This section reflects the Innovation Watch report on prospective innovation challenges in the ICT sector (Wiig Aslesen, 2008)

nology with large effects for the rest of the economy. The decline in labour productivity in the EU relative to the US can be attributed to the lack of investment in and uptake of ICT in various segments of the economy (EU ICT Task force report, 2006).

A structural innovation challenge for the ICT industry is that most of the firms in the sector (especially in ICT services) are micro firms, with labour productivity almost half of that found among larger firms. However, the SME part of the sector also includes many highly innovative companies. Especially the ICT SMEs that innovate on a continuous basis are important sectoral assets in that they in general contribute with new visions, have a capacity to focus their research effort and to promptly take technical and business decisions. Even though many ICT SMEs are major sources of entrepreneurial skills and innovation, there are still challenges to growth, expansion and entrepreneurship in the sector. As many SMEs lack the entrepreneurial skills and mindset, the prospective innovation challenges lie in how to achieve this. A general challenge is also access to finance and high skilled human resources.

Figure 4.6 Share of world ICT production accounted for by EU15, Japan, USA and other countries, 1990 and 2002.



Source: OECD (2004) Information Technology Outlook 2004, OECD, Paris. Reproduced from the European Competitiveness Report, 2006. Note: No data were available for Greece and Portugal in 1990. No data available for Luxembourg for any of the years.

The European ICT industry faces an increasing competition from emerging economies (Figure 4.6). The ICT industries of Korea, China and India have made tremendous progress. The Chinese ICT sector is dominated by hardware products, whilst the Indian ICT industry is represented by software products. More than 80% of Indian electronic and IT exports is contributed by software. As of 2004, China has become the biggest exporter of ICT goods (USD 180 billion), surpassing Japan and the European Union in 2003 and taking the lead over the United States in 2004 (USD 149 billion in 2004). Worth less than USD 35 billion in 1996, China’s ICT goods trade reached almost USD 329 billion in 2004, growing at almost 38% a year since 1996 (OECD, 2005). In order for EU to cope with its relative decrease in world ICT production, a prospective innovation challenge lies in how to raise the knowledge intensity in its ICT products and services.

Degrees of knowledge-intensity and economies of scale are main determinants of the localisation of ICT products; the less knowledge-intensive production and the higher the degree of economies of scale, the easier it is to re-locate products or parts of products to low-cost locations (Meijers et al., 2006).

The wide array of new technologies creates plenty of opportunity for European gazelles in this sector. Technology and co-operation platforms might initiate this process. Critical for the growth potential in many sub groups of the ICT sector is the regulatory development and the specialisation of ICT products and services customised for other important sectors in the EU-economy.

ICT SMEs in Europe have specialised in Telecommunications, embedded computing, micro- and nano-electronics, micro-systems, 'smart' integrated systems and rich audiovisual content and constitute Europe's main industrial and technology strengths. The weaknesses are computers and packaged software.

The main threats for the ICT industry in Europe originate from ongoing industrial investments in emerging economies in Asia (China, India), in the expansion of US dominance in computing, and in a lack of user acceptance and uptake of new technology. ICT SMEs must deal with increasing international competition, keep up with the technological innovation pace, which is heating up again, and adapt to the reorganization of world supply chains. Moreover, ICT SMEs cannot afford to focus only on local markets, as the push of globalization is increasing trade openness, forcing greater specialization and the elimination of less efficient firms.

4.2.2 Innovation characteristics

ICT is one of the most innovative and productive sectors of the EU. A higher than average percentage of innovative firms in the ICT industry use patents, trademarks or designs to protect their inventions or innovations. In order to foster investment and innovation, it is important that Europe maintains a balanced and effective regime of intellectual property protection that takes into account various business models in the ICT sector. Patenting in the ICT sector is very polarised; some countries and regions are persistent leaders while others keep lagging behind.

Even though the ICT sector is R&D intensive compared to other industries in Europe, it spends relatively less on R&D than its major competitors (EU ICT Task Force Working Group 3, 2006). If the current trend continues, China will have caught up with the EU by 2010 in terms of GDP allocated to R&D. A prospective innovation challenge for the ICT industry is how to change this trend whereby EU leadership in some areas is being challenged. Europe is vulnerable to increased competition, and a challenge for the ICT industry is for research laboratories to keep pace with an ever-accelerating scientific development of emerging new technologies.

The ICT manufacturing sector in EU Member States covers a very large range of activities and even though its share of GDP is not more than 10% on average, the sector plays a vital role in part of other European industries. Semiconductors are at the heart of the ICT value chain. Innovation in the semiconductor industry rests on the most advanced and innovative process technologies. In order to face the competitive challenge, innovation and investment in most advanced process technologies capable to manufacture the complexity of chip is critical (EU ICT Task Force, Working Group 3, 2006). There is a pressing need from both industry and research labs to keep pace with an ever-accelerating scientific development of emerging new technologies. However, in the meantime manufacturing of semiconductors is shifting towards China.

Innovation in services is important as competitors catch up even faster as know-how becomes easier to duplicate. The challenge to transform to a European service economy lies in both a technological and in socio-economic and human capital perspectives. According to the EU ICT task force, it will require a paradigm shift through complementary investment and changes, e.g. in human capital, organisational change, education, trust and security.

A prospective innovation challenge for the ICT sector is the insufficient collaboration between public sector and business sector researchers (Wintjes, 2006). The link between research and industry is poor, especially for SMEs. Private–public partnerships are needed to keep Europe in the centre of (global) developments. Innovation challenges can also be related to unattractive conditions for the knowledge infrastructure and the brain drain and the insufficient number of skilled researchers in Europe – factors that must be seen in relation to each other. Furthermore, a challenge for the industry is how to turn inventions into successful innovations, e.g. research initiatives do not properly address the market side of the value chain (from research to market).

Important challenges which need to be address in order to increase the level of innovation in the ICT sector are also related to fragmentation of technology policy; there are few really large scale projects funded in the EU; that the research programmes initiated are too bureaucratic; and that the decision-making processes are too slow.

4.2.3 Technologies

The EU has comparative advantages in the ICT sector in the production of differentiated goods of higher quality, commanding higher prices.

(EU Competitiveness Report 2006 and INTICT) Globalization has multiplied the possibilities to fragment the production process and locate the production of components according to the comparative advantages of the different locations. As a consequence, chip design is made in Europe while mass production of chips takes place in South-East Asia; software development is carried out in European software labs while the coding and testing of software is done in India.

The new technological cycle of the industry is driven by digital convergence and the complete diffusion of the Internet as the main architectural network, launching a new wave of applications under the label of the so-called Web 2.0 or social computing. The software industry is undergoing a deep transformation process. In order to respond to customers needs to deal with IT complexity and infrastructure optimization, new business models are emerging, characterized by greater service content (“software as a service") and ever closer interaction with customers. This requires investments in R&D and innovation, as well as continuous skills upgrading. European markets fragmentation and still insufficient investments in ICT research and new skills are weaknesses affecting especially ICT SMEs.

Innovation in ICT is crucial for Europe's competitiveness. In this respect, the EU has a number of strategic advantages including worldwide leadership in ICT equipment and services. In general, the EU has social and economic challenges such as an ageing population, high expectation in regard to quality of life, in particular in healthcare, environmental and transportation concerns (EU ICT TASK Force Report, 2006 p. II). ICT can provide a number of solutions to these challenges if a strong, more company driven, "Push-Pull Innovation Policy" that focuses on regional best practice and the human dimensions of ICT are put in place. Factors shaping the future of the ICT industry are:

- The convergence of technologies
- The deeper embedding and wider integration of technology into products, services and processes
- Closer links between technology and its application.

According to the EU ICT Task Force Report (2006, p. 5), the following four prospective trajectories are noted:

1) Networked, Mobile, Seamless and Scalable; The next generation of ICT will take networking and mobility to new levels and will continue to benefit from digital convergence (fusing of computing, communications and content). With many potential configurations of access platforms, applications, services and market players' conditions are ripe for 'creative destruction' necessary for successful innovation to emerge.

2) Embedded and Invisible; Future systems will be integrated into everyday objects and the complexity of these systems presents profound technical challenges as they will need to "know" themselves, their environment and the context surrounding their use and act accordingly.

3) Intelligent and Personalised; The next generation ICT will be more centred on the user. The overall system complexity will be hidden and functions will be revealed "on demand".

4) Content-rich, Interactive and Experiential; Future ICT systems will be visual, interactive and content-rich.

Europe's main industrial strengths in the ICT sectors lie in the following technology areas;

- telecommunication;
- embedded computing;

- micro- and nano-electronics;
- micro-systems;
- ‘smart’ integrated systems;
- rich audio-visual content.

The ISTAG Working Group (2007) on 'New Business sectors in ICT' states that we are entering a period which is particularly promising for the content industry. This is due to the convergence of challenging and enabling facts such as: the wide diffusion of broadband networks in Europe, the switch from analogue to digital TV, the explosion of user generated content and services through e.g. web2.0, and the advent of new business models related to the digital opportunities and the new user behaviour.

For Europe to play a central role in this new paradigm, the working group recommends:

- to establish a cluster network to monitor and benchmark the European content sector,
- to develop a European-wide incubator based within the Member States to offer entrepreneurs access to best practise and support,
- to create a European standardisation initiative on multimedia annotation and interoperability,
- to exploit the switch-off of analogue TV to consolidate the digital economy,
- to move from copy right to right to copy, by developing new mechanisms to protect the creators within the new paradigm,
- to support R&D initiatives that combine technology, business models, services and creativity,
- to stimulate new cross-disciplinary educational approaches.

For the industry, prospective challenges lies in how the European ICT sector can continuously build upon its ability to develop frontier technologies and to further facilitate the demand for these in potential leading markets.

According to the ICT Work Programme in EU’s Seventh Framework Programme (FP7), European researchers and engineers have to master three ICT challenges, identified in particular with the help of the European Technology Platforms in ICT. These are as follows:

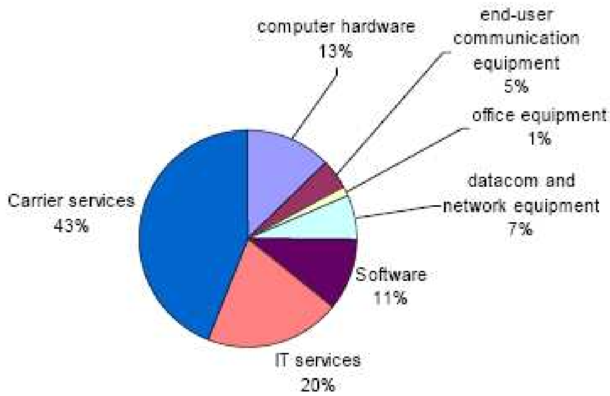
- The converged communication and service infrastructure that will gradually replace the current Internet, mobile, fixed and audio-visual networks;
- The engineering of more robust, context-aware and easy-to-use ICT systems that self improve and self-adapt within their respective environments;

- The increasingly smaller, cheaper, more reliable and low consumption electronic components and systems that constitute the basis for innovation in all major products and service.

4.2.4 Demand and Market Issues

The European Competitiveness Report's (2006, p. 175) analysis of the demand side of ICT shows that the EU ICT market amounted to 600 billion euros in 2005. Carrier services (fixed data services and fixed and mobile telephone services) accounted for the largest share of the market, 43% (Figure 4.7).

Figure 4.7: The European ICT market by product



Source: EITO (2006).Cited from the European Competitiveness Report (2006, p. 175). Market values (percentages) represent end-user spending. Carrier services include fixed and mobile telephone services and fixed data services. ICT equipment includes server systems, PCs and printers, fax machines, and audio and video conferencing, office equipment and data and telecommunications networks. Software products include software and software infrastructure. IT services include consulting, implementation, operations management and support services.

Germany is still the largest ICT market in the EU. European ICT markets constitute around a third of the global ICT market; the US and Japanese markets amount to 28 and 15 per cent respectively. There is a large trade deficit in EU as consumption of ICT within the EU widely exceeds EU production of ICT goods.

The European ICT market is still a fragmented market where national interests dominate. There is a need for a real single internal market, both in production and in research (Reding, 2005). The ICT sector is making a major contribution to the increased international specialisation through its production and services, and is possibly the most internationalised industry sector.

ICT is generally perceived as a critical factor in improving business processes and in developing innovative and more competitive business strategies. Business model innovation is replacing product innovation as a primary driver for competitiveness (NESSI, 2005).

A prospective innovation challenge for the economy in general, and for the further innovative activities of the ICT sector, is the topic of ICT-uptake in the economy. The challenges refers to both the skills needed in order to use ICT, the lack of awareness and demand for ICT, the difficulties for businesses to implement the necessary organisational changes in order to benefit from ICT investment, and the lack of internal expertise to choose the appropriate technology.

ICT-uptake in the public sector is an important driver of innovation in the ICT sector. The main innovation challenge lies in how to change the culture of public procurement to favour innovative solutions and at the same time focus on support for R&D and innovation, and the harmonisation of regulation in these sectors.

In the health, automotive and security sector, ICT is emerging as a key driver of technology development and innovation. Future progress in these sectors depends on the ability to tailor technology development to meet the specific needs of the final applications. Prospective challenges for ICT firms are the need to be increasingly aware of these shifting global value chains and to position themselves within them.

4.2.5 Skills and Human Capital

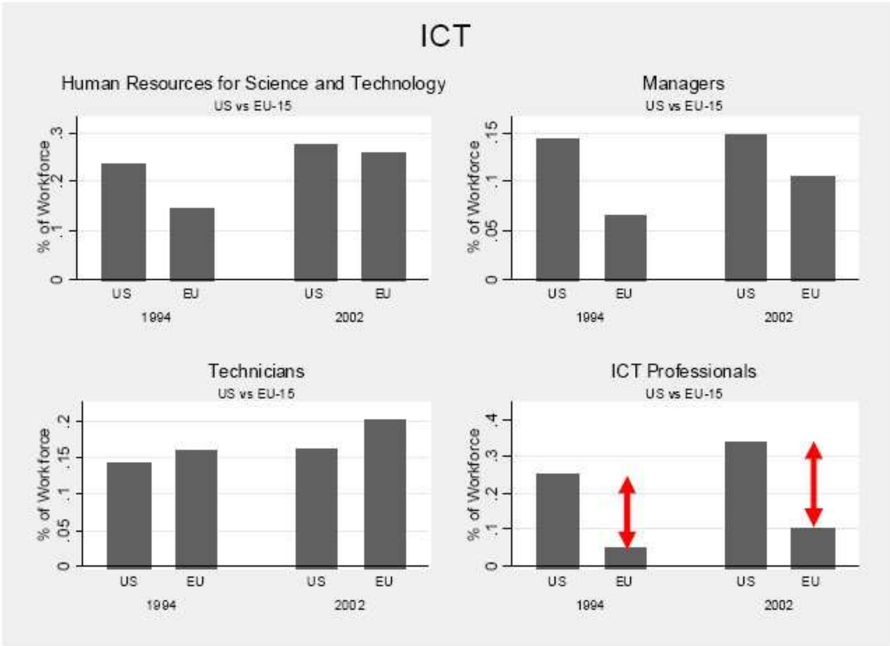
The challenge to transform to a European service economy lies in both a technological and in socio-economic and human capital perspectives, requiring a paradigm shift through complementary investment and changes, i.e. in human capital, organisational change, education, trust and security.

A prospective challenge for the ICT industry is the falling numbers of students of scientific and engineering disciplines and the brain drain of academics and researchers. As entrepreneurship is a missing skill that must be added to the curricula of technical disciplines at higher education institutes, this is a challenge that needs to be addressed in order to encourage and promote an “entrepreneurial mindset” in Europe. Another set of skills that is needed in the sector is project, technology and business management.

The sectoral Innovation Watch project identified shortages of various kinds of ICT skills in the European economy, a factor that can be an underlying cause of the above mentioned EU productivity slowdown. The growing ICT skills gap, understood as a shortage of absolute numbers of ICT workers, a mismatch between supply and demand for specific skills, and a decline in the number of students studying IT and computer science, is an innovation challenge in that it can slow the speed of adoption of new technologies and reduce the “go-to-market skills” needed to drive business growth.

Compared to the ICT sector of the US the European ICT sector still has a very low share of ICT professionals (Figure 4.8).

Figure 4.8 Skills indicators, % of sector workforce, EU-15 vs. USA



4.2.6 Policy challenges

Based on an assessment of National policy experts' we conclude with their vision on the future innovation policy challenges in the ICT sector.

In order to address prospective innovation challenges, policy should include the following:

General issues

- Promote the development of a knowledge-based economy and raising the quality of life by way of providing everyone with resources for and seizing opportunities presented by ICT and contents thereof.
- Promote every aspect of ICT technology adoption in SMEs with the objective of enabling them to harvest productivity gains.
- The ICT sector's position is under threat of fierce competition from the emerging economies. It is therefore essential that the sector maintains its competitive advantage by investing in top quality research and education.
- Increase ICT application in organisation and production processes in all industry sectors as well as in private and public service domains.

Technology

- Provide subsidies for enterprises for the adoption of ICT so as to boost demand and ensure the sustainable development of the sector.
- Promote investment in state-of-the-art infrastructures by providing a

supportive legislative and regulatory environment and by developing a leading edge research and development reputation in the information, communications and digital technologies. • Enable and empower local businesses to gain access to the larger global market by participating in the eBusiness community. • Make the Internet a secure place, build confidence, trust and security in the use of ICTs. • Increase the quantity and quality of research in future emerging information and communication technologies such as photonics. • Regulation of new technical standards. • Regulation of innovations in telecommunication networks (i.e. incentives to develop and implement new ICT infrastructures).
Skills and collaboration
• Increase the quantity and the quality of both engineers and blue-collar workers in the ICT sector. • Encourage the training of new ICT users, developing integrated information and communication systems, providing Public Administration Services, in real time, which can create new conditions for the development of the ICT sector. • Improve the market acquiring capability of domestic software development companies; increasing the technology and skill intensities of the tasks performed by ICT manufacturing subsidiaries. • Establish focus and strategic relationships across the whole of the industry • Increase the quality of communication between the industry and the government.
Suppliers, demand and market issues
• From the point of view of the User, to promote the adoption of Information Society “resources” (knowledge, skills, devices, infrastructure, etc.) by the different agents in the economy and the society (businesses, citizens, associations and administrations).

5 Innovation Champions[10]

5.1 What makes an Innovation Champion?

Being an innovation champion means either being a good example for others or being a top performer in the art of innovation. Innovation can be done in multiple ways while the innovator might be a large or a small company. An innovative leader is a firm (small, medium or large) which is able to create new knowledge in multiple ways and diffuse it successfully (technologically or economically) in the market. An innovation champion might engage in research and development but its innovation strategy can also be based on using already existing knowledge and being able to absorb it more quickly (than others) in order to introduce a new or improved product in the market. A general definition of an Innovation Leader features continuously excellent technological and economical performance compared against its global competitors. Innovation Leaders are those firms that, by showing continuous good technological and economical performance, have become competitors at worldwide level.

The definition of the Innovation Leader we adopt here follows the so-called linear definition of innovation. The starting point is research activity as an investment which eventually leads to patents and financial gains. In practice this sequence might not be followed and there is more that drives innovation than research and development only, especially in the ICT sector, and especially in SMEs.

An innovation leader thus:

- Can innovate in multiple ways. Linear as well as multi facetted (innovation is a learning process with multiple inputs, but also a global problem solving process involving many interactions and feedbacks).
- Can innovate in an idiosyncratic way due to the specificities of the particular manufacturing or the service sectors in which it is active. Dependent on the sector the R&D intensities can differ while as a consequence of the dynamics of the market innovation can be characterised as creative destruction among many small firms or creative accumulation among the large few. Sources of innovation and appropriability mechanisms can also differ: Science based, scale intensive, specialised suppliers and supplier dominated sector regimes have been distinguished in innovation research.
- Can be a big or a small firm and firm size strongly impacts the way firms innovate. Small firms innovate less frequent than large firms and rely more on in-house expertise and less formal R&D. The size of the company limits its capacity to absorb knowledge and use licenses. Customers, suppliers and management are the major sources of innovation in small companies except in high technology SMEs, there the successful firms (or Gazelles) follow similar patterns as large firms.

[10] This section reflects the Innovation Watch report on Identifying Sectoral Innovation Leaders (Ugalde et al., 2007)

- Must generate successful and sustained outputs of innovation. Patents are one of the most widely acknowledged technological outputs, but patent data is limited by variations in firms' and industries' propensity to patent. Some sectors patent most: pharmaceuticals and ICT other hardly: textiles and clothing and basic metals (Arundel and Kabla, 1998).

Two kinds of samples are constructed according to the strict definition of Innovation Leader while other firms are selected as being good examples. Innovation Leaders are those European champions that, by showing continuous good technological and economical performance, have become competitors at worldwide level. This group of enterprises is identified eminently through statistical methods although they are confirmed using so-called qualitative tools.

The instrumental definition used to identify Innovation Leaders follows the parameters of the linear model since it describes Innovation Leader as those firms who achieve the best techno-economical performance at global level. Innovation performance is measured in terms of positive relationships amongst the following traditional indicators: R&D investment; Patent applications; Profits and Turnover.

Table 5.1 Characteristics of Innovation Leaders and Good Innovation Exemplars

INSTRUMENTAL DEFINITION	MAIN CONTENTS	METHODOLOGY	DEFINITION OF INNOVATIVE FIRM
INNOVATION LEADERS- EUROPEAN CHAMPIONS	Real ILs meet the following characteristics: - Good technological and economical performance (champions) - Global competitors - Continuous good innovative results.	IL is identified eminently through so called statistical methods but they are contrasted with results provided by qualitative methods.	Linear model translated into the following indicators: - R&D investment - Application patent - Financial indicators
EXAMPLES OF GOOD PRACTICES IN INNOVATION	Second category: - Good examples of innovative practices to emulate from the evolutionary perspective	Results achieved through qualitative methods, and those used to identify horizontal issues.	Evolutionary approach according to terms defined in the general definition

The linear definition instead of an evolutionary one is more convenient from a measurement point of view. A statistical approach clearly has its advantages to identify innovation leaders but has also its limits especially in identifying innovation leaders from an evolutionary point if view.

Available data to measure innovation leadership are the Community Innovation Survey (CIS), R&D data, science publication (citations), technometric indicators, synthetic indicators and specific databases

5.2 ICT Innovation Champions

To select the Innovation Leaders and Good Exemples, firm level data has been used from several sources, in particular the following data has been used:

- (consolidated) R&D expenditures from the R&D scoreboard of DTI[11] for up to 1250 mainly large companies over the years 1991-2005;
- European Patent Office (EPO) patent data over the years 2000-2003.

The final lists (Table 5.2) of innovative firms have been compiled according to the chosen methodology. The best performers in this sector are not concentrated in a particular country or European area since they can be identified in a wide variety of European countries.The qualitative-quantitative coincidences happen in the most recognised multinational brands such as Infineon Technologies (DE), Alcatel (FR), Nokia (FI), Philips Electronics (NL) Siemens (DE). Four cases match with other international rankings: Nokia, Philips Electronics, Siemens, and Sony Ericsson Mobile Communications AB.

Table 5.2 Summary table of most innovative ICT Firms

Quantitative Results			
FDH: Analysis of R&D, patent and profit data for the group of large R&D performers			**FDH**: Analysis of patent and economic data for the group of large technological patenting performers
Most 'R&D productive ' companies	Most 'patent productive' companies	Link of R&D to profits	
TTP Communications(UK) Spectris (UK), EPCOS (DE), Gemplus International (LU), Telia Sonera (SE), Océ (NL), Thomson (FR), Infineon Technologies (DE), Alcatel (FR), Nokia (FI), Philips Electronics (NL) Siemens (DE)	Software (DE), Telefonica (SP), Telecom Italia (IT)	TTP Communications (UK), Spectris (UK), Sage (UK), Telefonica (SP), Telecom Italia (IT)	The Swatch Group Sa, Synthes Holding Ag, Bsh Bosch Und Siemens Hausgeräte Gmbh, Nobel Biocare Ab, Somfy Sa, Nds Group Plc, Sony Ericsson Mobile Communications Ab, Rohde & Schwarz Gmbh & Co. , Hager Ag, Fujitsu Siemens Computers Gmbh
Gazelles selection			
Isra Vision Systems AG (Germany), Native Instruments Software Synthesis GmbH (Germany), Xsil Ltd (Ireland), Boss Media AB (Sweden), Gameloft SA (Gameloft), Cambridge Silicon Radio (CSR) (UK), Wavelight AG (Germany), In Tech Medical (France)			
Qualitative Results			
Firms selection from new European countries			

[11] Department of Trade and Industry (DTI) in the UK

[14] Based on the Innovation Watch report "Innovation leader Showcases" by Katrin Männik, Technopolis Group Belgium, Tallin (2008)

Spidernet Public Ltd (Cyprus); Grisdoft s.r.r., Tescan s.r.o., LogicaCMG s.r.o., Microrisc s.r.o., Elis Plzeï s.r.o., Moravia IT (Czech Republic); Eesti Telekom AS, Artec Group, Mobi Solutions, Cybernetica AS (Estonia); Kürt Zrt., 77 Elektronika Kft. (Hungary); UAB „Sonex Software Development“, UAB „Penkių kontinentų komunikacijų centras“, UAB „Teltonika“, UAB „Sintagma“, UAB „Algoritmų sistemos" (Lithuania); Prokom Software S.A., Ericpol Telecom, Rodan Systems, Bonair S.A., ATM S.A., Comarch (Poland),
Gazelles selection
MYSQL AB (Sweden)

5.3 Case studies[14]

The case studies are based on interviews with appropriate company representative(s). The interview was built on firm-specific and external (sectoral and socioeconomic and 'cultural') driving factors for innovation. Selected innovation best performers are further used as examples for identifying most relevant factors of innovation originating from the company or caused by the environment where it is performed. Company-specific and external drivers of innovation were listed and lead questions worked out on the basis of a wide range of area-specific and practical material as well as experience on working on the theme.

Table 5.3 Most important innovation drivers and barriers (7 ICT showcase firms)

Type of factor	**Most important innovation drivers and barriers in the past and for the future (7 ICT showcase firms)**	
	Drivers for innovation	**Barriers to innovation**
Internal	1- management capabilities/leadership/support of owners 2- in-house R&D and technological capacities 3- specialist knowledge and skills 4- capacity for building relationships with external partners	1- resources available for testing new ideas 2- organisational structures 3- intellectual property management
External	1- customer involvement in R&D and innovation activities 2- international partnerships with firms 3- cooperation with research and technology organisations	1- appropriate laws, regulation at EU level 2- access to top-level human resources 3- Innovation culture for ICT in Europe

The 7 ICT case companies in show a high consensus regarding the internal drivers of innovation. The most important are (see table 5.3): management capabilities, in-house R&D and technological capacities, specialist knowledge and skills, and capacity for building relationships with external partners. Most important external drivers are: more intense and systematic customer involvement in R&D and innovation activities, and partnerships and cooperation. Most important internal barriers are: lack of resources for testing new ideas, organizational structures, IP management, regulation at EU level, access to top level human resources, and a lacking innovation culture for ICT in Europe.

Vaisala (FI) has been a science-driven company operating in global markets since it was established in 1936 and was long considered the flagship of technology industries in Finland for decades before the rise of telecommunications and Nokia. Vaisala has been a pioneer in its sector, basing its competitive advantage on long traditions of developing innovative products that are based on the latest scientific research. As the company operates in a field where competitive advantage can only be gained through large investments in new technology, Vaisala has actively invested in R&D throughout its history and continues to do so today. In 2007, Vaisala's R&D expenses totalled €23.5 million, which was 10.5 per cent of the company's net sales. The measurement instrument industry is a very scientific and technology-intensive one. Managing knowledge, skills and innovation processes is vital to the company internally as well as its external connections with lead users and public research organisations such as universities and state research institutes. Therefore, it is no surprise that the main concerns for companies such as Vaisala in the sectoral innovation system are how to secure access to high level knowledge and skills and how to set up and maintain cooperation with top research groups locally, nationally and internationally. The big challenge for companies such as Vaisala, who are innovation leaders in global niche products, is that there are not enough good partners or high level research available locally or nationally for all competence areas. This calls for the development of high level internal competence connected with international knowledge production networks.

TomTom (NL) has made car navigation attractive, easy, available and affordable. Over the years, TomTom has consistently delivered impressive organic growth. TomTom has achieved this by being an innovative company with a strong brand, clear customer focus, and high quality products and services. Car navigation fulfils a real and fundamental need. It is proven that car navigation solutions save time, reduce mileage, ease the driver's workload, reduce stress and enhance safety. TomTom is the leading brand – and as a result, TomTom is the world's largest personal navigation company. TomTom refers to the name of a reliable pal 'Tom' that helps you to reach your destination. In general, customers are enthusiastic about the comfort provided by their TomTom navigation device ('no stress' driving). TomTom navigation devices are helping road safety, they are reducing stress, and they are reducing the number of miles people are driving in their cars. What is the success of TomTom products? TomTom serves a real customer need and thus is building a strong client base – growing through word of mouth advertising and personal recommendation. TomTom will further increase market penetration levels to very substantial proportions of the driving population. TomTom navigation devices are intuitive products with excellent human interfaces (keep it simple). Markets are expanding both car navigation and personal (hand-held) navigation. In a few years, most cars will have a 'built-in' navigation device on board. Today's penetrations are relatively low. In-hand devices will create a second new product line for TomTom. The user interface will be completely different from the car device – e.g. joystick. KISS – 'Keep it simple Stupid' in combination with fun, and strong branding is the success formula of TomTom. The technology of TomTom was not really new – the success was in clear messages, an intuitive user interface and excellent ease of operation by a car driver.

"*Successful innovation is about understanding people's needs*".

The Global Positioning System (GPS) which was an enabler for the navigation devices of TomTom was not new. The Navstar GPS system has been operating since 1973 and is a global system that uses a constellation of 24 satellites operating in 6 orbits above the earth. A navigation device receives the GPS signals and can calculate the exact location. Since May 2000, the US government has stopped scrambling satellite signals and as a result, they have become much more accurate (sub-five metre accuracy). Another critical element for success is the availability of reliable digitalized roadmaps, an enormous job, first executed in the 1990s by large companies such as

Philips (Philips has since sold this digitizing roadmap activity). Third, affordability was realized. Handheld devices could be produced at acceptable costs and TomTom decided to develop handheld devices fully dedicated to navigation with no compromises to other functions. TomTom's founders correctly anticipated the rapid decrease of component prices from the year 2000 and succeeded in optimizing assembly and production of the device – fully outsourced to partners in Asia. As a result of this smart combination of success factors, TomTom succeeded where large companies, such as Philips and Siemens (VDO) were less successful. Their devices were too complex, too expensive and their focus on distribution of their built-in car devices via official car dealer networks proved less successful. TomTom chose a mass market strategy and developed main retail networks oriented to car drivers (shop floors such as Halfords) not car buyers. The simple messages did the rest: 'Get home safe', 'Get there on time' and 'Find your way the easy way'.

MySQL AB (SE) has a strong position as a first mover in the open-source relational database (OSRDB) market. Though still a small company, it has become a serious challenger to the Oracle, IBM and Microsoft dominance of the relational database market. It has not done so with a better and cheaper product, but rather by redefining what a relational database is; in doing so, it has found new uses and new users for this technology. In this sector, the terms 'open source' and 'community' are fundamental and closely connected issues. Open source is a set of principles and practices on how to write software, meaning that the source code is available to the users who also have the right to use it. Any one person can download, change and use a source code, as long as any changes introduced are fed back to the community. What singles out MySQL in the OSRDB market is how the company develops and sells its product and the way it uses the 'community' to its own ends. MySQL has built up a base of users that is fast and easy to use. Other database companies have not worked in this way – they are 'closed source'. From a business model perspective, MySQL stands out from other sectoral players in using the community as its principal base for new recruitments. The company uses the community as a nursery to test and select possible new recruits to the company. Most of the company staff has been recruited this way, and this is something other companies in the sector do not do. MySQL is neither a traditional, commercial company, nor an altruistic open source player, but rather moves in a terrain half-way between the traditional commercial companies in the sector. The 'pure' commercial players in this sector – mainly Microsoft, IBM and Oracle – own and have their source codes patented, and do not share them with anyone. MySQL AB is the sole owner of the MySQL server source code, the MySQL trademark and the mysql.com domain worldwide, but leaves the source code open for interventions from the community. Any modifications and improvements to the MySQL source code are used by the company for commercial purposes. This way, MySQL has been able to keep in close contact with its users, which in turn has served the company's commercial ends. At the same time, MySQL is not a typical open source project as all the software is owned and supported by MySQL AB. Because of this, a cost and support model is available that provides a unique combination of open source freedom and trusted software with support. This means MySQL does not make its profits mainly from selling software applications, but rather from the different service arrangements the company provides. Partly as a consequence of this intermediate position between pure open source and closed source, MySQL finds itself in a different position to its competitors. MySQL is innovative not only in terms of business model but also in terms of business philosophy applied by venture capitalists. This is another feature which makes the company unique and an innovation leader.

6 Innovation Environment

6.1 National ICT Profiles[15]

The objectives of the study this section is based on, were to identify leading and laggard countries in terms of innovation performance in the ICT sector and to evaluate how these countries perform with respect to a set of national characteristics (or benchmarks) considered to be important for innovation in this industry.

6.1.1 Identification of Leading Countries in the ICT Sector

The following three indicators are used to identify leading countries in terms of innovation performance in the ICT sector:

1) Index of Patenting Advantage (PA): For each country this is the number of EPO patent applications per employee in the ICT industry as a proportion of the total number of EPO patent application in this industry (across all countries) per employee.

2) Total Factor Productivity (TFP): For each country TFP has been calculated using index number approaches. It is based on data for value-added at constant prices, number of hours worked and value of capital stock at constant prices (Crespi and Patel, 2006).

3) Index of Market Advantage (MA): For each country this is simply total exports (data from the World Trade Organization) per employee in the ICT industry divided by total exports in the industry per employee.

Using these three indicators two composite indexes of innovation performance are calculated: one capturing static performance and the other the dynamics. The first is based on the average levels of the 3 indicators between 2000 and 2003; the second is based on the changes in these variables between 1990 and 2003.

In Table 6.1 we identify the leading countries according to the level of innovation performance in the ICT industry in the period 2000-2003 (column 1). Thus the leading countries in the EU are Finland and the Netherlands. Five other countries also have a high level of innovation performance: France, UK, Belgium, Germany and Austria. At the other end of the spectrum, with low levels of performance, are Slovakia, Czech Republic, Poland, Hungary, and Norway. In-between are 5 countries with performance around the median, namely Spain, Sweden, Denmark, Portugal and Italy.

Columns (1a), (1b), and (1c) show the performance of different countries with respect to the individual indicators of innovative performance included in the index. The overall leadership of Finland in the ICT sector is based on a strong performance with respect to all three indicators of innovative activities included in the index. Thus Finland is among the top five countries with respect to patent advantage, market advantage and total factor productivity. Netherlands performs particularly well with respect to patent and market advantage, and Belgium with respect to market advantage and total factor productivity. France and UK are amongst the leading countries in terms of total factor productivity.

[15] This section draws on the report (work package 8) from Anabel Marin, Pari Patel and Caroline Paunov (2008), "Benchmarking National Sector Specific Environments in the ICT Industry".

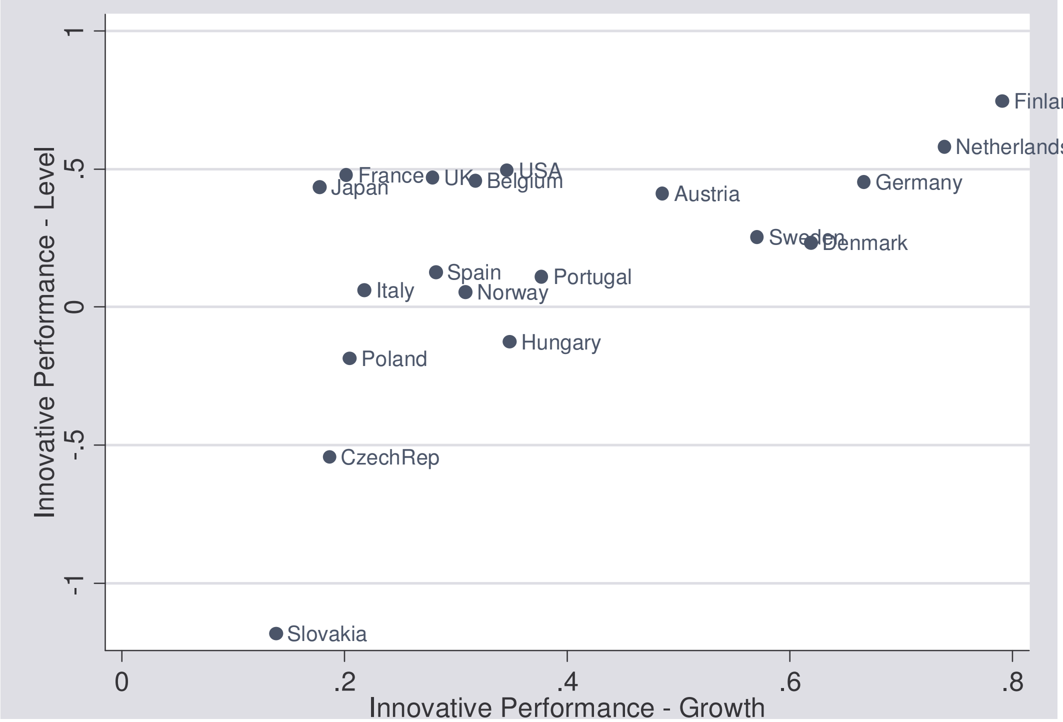
Table 6.1: Innovative performance in the ICT Industry

Country	**Index Level of innovation (1)**	Patenting Advantage (1a)	Market Advantage (export) (1b)	Total Factor Productivity (1c)	**Index of Growth in innovation performance (2)**
Finland	**0.75**	**2.33**	**2.94**	**3.66**	**0.79**
Netherlands	**0.58**	**1.93**	**4.50**	1.50	**0.74**
France	0.48	0.91	0.82	**3.97**	0.20
UK	0.47	0.66	1.11	**4.15**	0.28
Belgium	0.46	0.72	**2.26**	**3.29**	0.32
Germany	0.45	**1.75**	1.11	1.94	**0.67**
Austria	0.41	0.99	1.49	**2.61**	**0.49**
Sweden	0.25	**1.55**	**1.66**	-0.46	**0.57**
Denmark	0.23	**1.04**	1.30	0.37	**0.62**
Spain	0.13	0.27	0.50	0.84	0.28
Portugal	0.11	0.05	0.66	0.96	0.38
Italy	0.06	0.49	0.39	-0.30	0.22
Norway	0.05	0.62	0.46	-0.68	0.31
Hungary	-0.13	0.12	**1.69**	-2.66	0.35
Poland	-0.19	0.04	0.19	-2.53	0.20
Czech Rep	-0.54	0.05	0.60	-7.24	0.19
Slovakia	-1.18	0.03	0.20	-15.08	0.14
Ireland		0.45	**7.68**		
Greece		0.18	0.22		
USA	0.50	0.97	0.56	**4.19**	0.35
Japan	0.43	1.45	1.24	2.20	0.18
Average	**0.17**	**0.76**	**1.83**	**0.02**	**0.38**

The last column (2) lists the countries according to the index of change. In particular it shows that Finland, Netherlands, Germany, Denmark, Sweden and Austria have seen large increases in their level of innovation performance in the ICT sector since the 1990s. On the other hand Slovakia, Japan, Czech Republic, Poland, France, Italy Japan and Slovakia have been growing at rates well below the median.

Graph 6.1 shows the position of countries with respect to the level and the growth of the index of innovative performance. It suggests that countries can be grouped into different clusters in relation to their overall performance. A first cluster of countries with high values with respect to both the level and the growth of innovative activities can be identified in the top right of the graph. This cluster includes Finland, Netherlands, and Germany, which can be classed as innovation leaders in the ICT sector. A second cluster of good performers includes Denmark, Sweden and Austria, with levels and growth of performance just below the leading group. At the other extreme are two countries, Slovakia and Czech Republic, with low values for both innovation indexes that could be considered as laggards in this industry.

Figure 6.1: Position of countries according to the Index of Innovative Performance - ICT



The graph also shows that many of the 'large' countries in the ICT industry, e.g. Japan, USA, France and the UK, have similar levels of performance: reasonably high levels but low growth rates. The final cluster comprises countries with average levels of performance both in terms of levels and growth: Poland, Hungary, Norway, Italy, Spain, and Portugal.

6.1.2 Dimensions Characterising the Innovation System in the ICT Industry

The next step in the analysis identifies the dimensions characterising national systems of innovation which are important in explaining innovation performance in the ICT industry. According to the literature on industrial systems of innovation industries are characterised by specific knowledge bases, technologies, production processes, products, inputs, complementarities, demand, and a set of firms and other organizations. Following Malerba (2005) these dimensions are classified into three broad categories: (a) those related to the knowledge base, (b) those related to characteristics of agents and interactions, and (c) those related to characteristics of demand and institutions.

Table 6.2 Benchmarking countries according to indicators of the Knowledge Base: ICT Industry

Country	Knowledge base						
	R&D activities (1)	Skills 1 Profes-sionals (2)	Skills 2 Managers (3)	Skills 3 Engineers (4)	Non-R&D Exp. (5)	Market in-troduc-tion of in-nova-tions (6)	Training
Finland	0.21	0.34	0.08	0.23			
Netherlands	0.34	0.25	0.05	0.16		0.48	0.64
France	0.27	0.26	0.03	0.17	0.003	0.50	0.64
UK	0.12	0.28	0.08	0.16			
Belgium	0.20	0.34	0.06	0.16		0.73	0.87
Germany	0.27	0.28	0.03	0.14	0.008	0.41	0.72
Austria	0.17	0.13	0.02	0.05			
Sweden	0.35	0.267	0.024	0.17	0.002	0.50	0.72
Denmark	0.14	0.251	0.044	0.17		0.60	0.65
Spain	0.08	0.35	0.03	0.13	0.002	0.52	0.58
Portugal	0.04	0.122	0.017	0.13	0.005	0.62	0.81
Italy	0.12	0.11	0.011	0.04	0.015	0.39	0.65
Norway	0.24			0.13	0.004	0.36	0.55
Hungary	0.01			0.07	0.014	0.31	0.65
Poland	0.02			0.13		0.27	0.37
Czech Republic	0.03			0.08	0.003	0.61	0.65
Slovakia	0.06			0.15	0.004	0.44	0.74
Testing independency							
IIP[a]- Levels	64% (***)	58% (**)	86%(***)	57%(**)	-39%	38%	6%
IIP - Growth	53% (**)	12%	24%	28%	15%	8%	14%

(1) R&D is Business R&D intensity.

(2) Proportion of highly qualified professionals employed in the ICT industry.

(3) Proportion of highly qualified managers in the ICT industry.

(4) Engineers in the workforce (HRST: EUROSTAT)

(5) Intensity of expenditures in Acquisition of machinery and External knowledge

(6) Proportion of firms engaged in market driven innovations

(7) Proportion of firms that provide training relative to total number of enterprises in the ICT industry.

a IIP: index of innovative performance

The results in Table 6.2 indicate that differences in four out of the seven dimensions characterizing the knowledge base are important in explaining differences in the level of innovation performance of countries in the ICT industry. Thus countries that are ranked highly in terms of R&D intensity and the three indicators of the availability of skills, are also those that ranked highly in relation to innovation performance. This is confirmed by the Spearman rank correlation coefficients reported in the last two rows of Table 6.2. This analysis also shows that there is very little association between knowledge base indicators and the growth in innovation performance. The only indicator with a positive correlation coefficient is R&D intensity.

The analysis in Table 6.3 indicates that 3 dimensions related to agents and interactions are correlated with innovation performance in the ICT industry: average size, international orientation and venture capital. Thus for example the results of the correlation analysis show that countries ranked highly in terms of venture capital and international orientation are also ranked highly in terms of both levels and growth of the innovation performance index. In relation to average size the result only holds for levels and not for growth. The higher the proportion of small firms in the ICT industry in a country the higher the level of innovative performance in that sector.

Table 6.3 Benchmarking countries according to indicators related to Agents and Interactions: ICT industry

Country	**II- Agents and interactions**				
	Average size (1)	**Foreign participation (2)**	**International orientation (3)**	**Co-operation universities (4)**	**Venture capital (5)**
Finland	4.04	0.01		0.55	0.04
Netherland	0.97	0.01	0.20	0.12	0.07
France	1.26	0.01	0.31	0.14	0.02
UK				0.12	0.03
Belgium	1.05	0.01	0.26	0.36	0.04
Germany	1.21	0.01	0.28	0.13	0.05
Austria				0.29	0.01
Sweden	0.95	0.03	0.28	0.23	0.04
Denmark		0.02	0.35	0.12	0.04
Spain	1.48	0.01	0.19	0.12	0.01
Portugal	0.83	0.01	0.41	0.17	0.01
Italy	2.25	0.01	0.09	0.11	0.01
Norway	2.86	0.01	0.28	0.26	0.02
Hungary	0.45	0.03	0.18	0.16	0.01
Poland	0.95	0.01	0.13	0.12	0.01
Czech Republic	0.74	0.03	0.07	0.21	0.01
Slovakia	0.50	0.01	0.10	0.24	0.00
Testing independency					
IIP - Levels	65%(**)	8%	57%(**)	14%	65% (***)
IIP - Growth	23%	31%	58%(**)	16%	68% (***)

(1) Index of average size, the larger the index the smaller the average size of firms in the industry.

(2) Proportion of companies that have a foreign office

(3) Proportion of firms that sell products to international markets and co-operate with firms outside Europe.

(4) Proportion of ICT firms that co-operate with universities to innovate.

(5) Venture capital to GDP.

Appendix 6 shows that there is no association between the dimensions related to demand (i.e. size of the domestic market, favourable demand and product competition) and the levels and growth of the innovation index. However indicators related to institutions (i.e. effectiveness of the IPR system, existence of industry specific policies and access to credit) show significant association with the level of innovation performance. In particular, the effectiveness of IPR system has the highest correlation with both the level and growth of the innovation index. The existence of industry specific policies oriented to give support to firms in the ICT industry and the availability of credit to private industry are both significantly associated with the level of the index of innovative performance.

We can conclude that the results of this analysis indicated that in general differences in all three dimensions are important in explaining the level of innovative performance of countries in the ICT sector. However, the relationship between these benchmarks and changes in innovative activities is weak, with the only significant association in relation to indicators characterising agents and interactions. More specifically the main results of the analysis are as follows:

- The leading EU countries in terms of innovation performance in the ICT sector are Finland, Netherlands and Germany. These three countries have both a high overall level of performance and a high rate of growth. Further they excel in a number of different dimensions of performance.
- In terms of the relationship between innovation performance and characteristics of the national innovation system, the study shows that a high level of innovation in the sector is strongly associated with two dimensions of the knowledge base of the economy: R&D intensity and the level of skills.
- Countries with a high level of innovation performance in the ICT sector are also likely to have the following characteristics in terms of agents and interactions: domestic firms with a high level of international orientation, availability of venture capital and smaller sized firms.
- Finally with respect to demand and institutions, three dimensions are important for innovation performance: effectiveness of the IPR system, the presence of industry specific policies and the availability of domestic credit.

6.2 ICT Innovation Environment[16]

Innovation processes are influenced by a range of socio-cultural factors. Various dimensions can be used to describe the socio-cultural characteristics of a community (whether it be geographically or professionally defined):

[16] This section draws on the Innovation Watch report on Socio-cultural determinants of innovation (Bruno et al., 2008).

- cultural capital and consumer behaviour,
- human capital,
- social capital, and
- organisational capital & entrepreneurship.

Within each of these dimensions specific elements can be distinguished that are considered relevant to innovation.

The **cultural capital** and consumer behaviour category encompasses factors (and related indicators) which describe certain basic attitudes of people that influence innovation: the interest in and the attitude towards science and technology, the attitude towards risk from new technologies, the attitude towards the future, the attitude of people towards the environment, the attitudes towards other cultures, the consumer's responsiveness to new technologies.

Human capital, a more familiar concept, is defined by the OECD (2005) as the knowledge, skills and attributes derived from education, training and work experience. The literature on knowledge economics (Cowan, David, Foray, 2000) emphasises the point that knowledge plays a central role in innovation and production; while the evolutionary literature (Nelson, 1995) underlines that sectors and technologies differ greatly in terms of the knowledge base and learning processes related to innovation. Several factors linked to human capital may influence innovation in companies, namely: the availability of human resources in science and technology (HRST) (national and international resources) and in knowledge-intensive services; the provision of higher educated people in the country; the job-to-job mobility of HRST.

The concept of **social capital** is about the nature and intensity of relationships. The essential assumption is that social networks have value, which means that social contacts affect the productivity of individuals and firms.

The impact of social capital on innovation can be measured though different aspects: the cooperative behaviour of firms; the main sources of information for innovation; the extent of collaboration with competitors and academia, the level of trust in other people, the importance of informal networks. Our explicit hypothesis is that social capital (propensity to network) differs from sector to sector and hence is a more or less important barrier or driver to innovation. This assumption is comforted by a relatively large literature on co-operation and networking of enterprises.

Organisational capital may have an important impact on the innovation capacity of a company. Organisation's resources are not just the obvious ones like cash flow or R&D personnel, but also the company's culture, routines, structure, morality and management styles.

The results of the analysis for each country across all capitals allow an overview of the general socio-cultural environment (Figure 6.2), which might have an impact on the innovativeness of companies. The variances of indexes of cultural and organisational capitals appear smaller across EU countries than for social and human capitals. Finland, Denmark, Luxemburg, Sweden and the Netherlands have the most favourable socio-cultural environments for innovative activities when compared to all EU25 Member States. At the other extreme, Italy, Portugal, Poland, Malta and

Greece have the least favourable socio-cultural environments for innovation (Figure 6.3).

Figure 6.2 The four socio-cultural capitals across EU25 countries (basis 100: European mean)

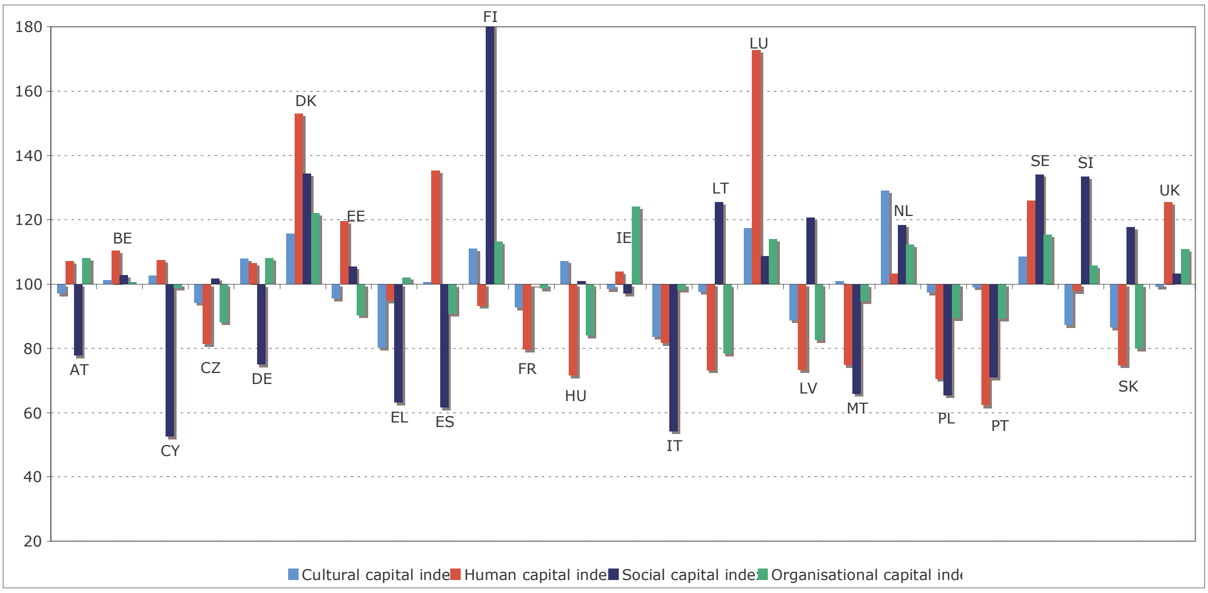
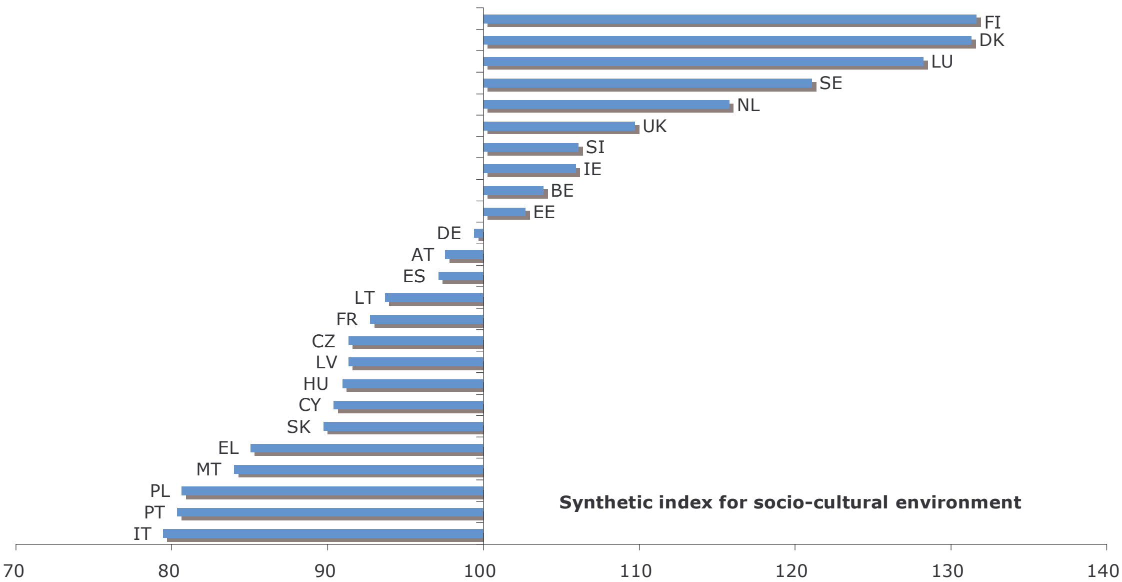


Figure 6.3 Indexes of socio-cultural environment across EU25 countries (basis 100: European mean)



Grouping the countries in terms of their socio-cultural environment through a cluster analysis provided the following three groups:

- Rigid socio-cultural environment: these countries do not attain high performance for neither cultural, human nor organisational capital.

- Closed socio-cultural environments: this group of countries share a low performance in terms of social capital.
- Strong socio-cultural environment: these countries perform well on average for all four socio-cultural capitals considered by this study.

Table 6.4 Typology of EU25 countries for socio-cultural environment

Rigid socio-cultural environment	Closed socio-cultural environment	Strong socio-cultural environment
Czech Republic	Austria	Belgium
France	Cyprus	Denmark
Hungary	Germany	Estonia
Lithuania	Greece	Finland
Latvia	Spain	Ireland
Portugal	Italy	Luxembourg
Slovakia	Malta	The Netherlands
	Poland	Sweden
		Slovenia
		United Kingdom

The considerations below represent some stylised features of socio-cultural determinants of innovation in the ICT sector, which can be drawn from the existing literature, the Europe Innova panel meetings and recent surveys.

6.2.1 Cultural capital

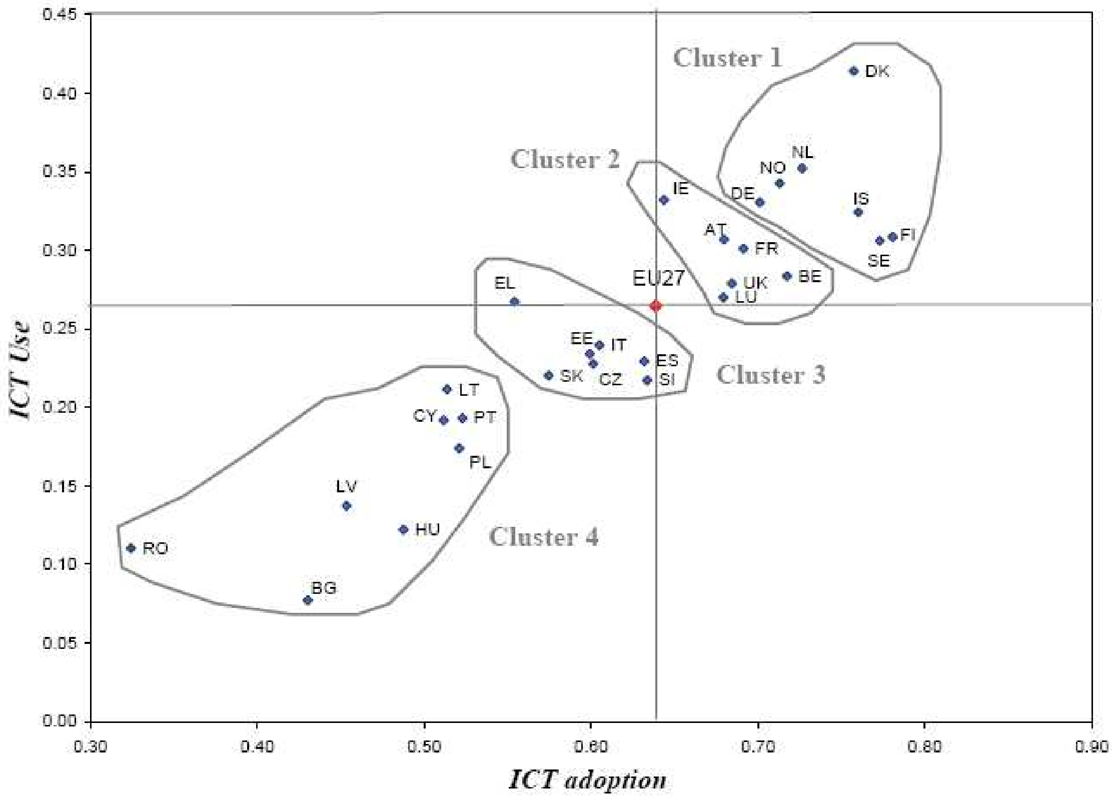
As ICT becomes more deeply embedded into European society it starts to unleash massive and far-reaching social change. The increased use of ICT has a radical impact on the way people live, and especially in enterprises. As underlined by the ISTAG (2006), ICT are notably a source of increased productivity, of advanced solutions for societal problems, and of new services to consumers. A key characteristic of ICT products is their pervasiveness in the whole economy.

However, the pace of development into a knowledge-based economy varies between EU countries. The European Competitiveness report (2006) highlights that in order to answer to the challenges raised by low cost producers, European producers have to climb up the quality ladder and offer new innovative products satisfying the growing demand for advanced goods and services. The role of policies in this respect would be to ensure the availabilities of e-skills required by the European industry in the years to come, and in particular, the skills-sets promoting ICT uptake and usage in all sectors by SMEs.

According to the results of Eurostat's ICT surveys conducted among households and enterprises in 2005 (2006a), for most EU Member States Internet adoption in companies was approaching saturation point in 2005. Just under half of all households (48%) in the EU25 had Internet access at home while 91% of companies had Internet access. Iceland and the Netherlands have the highest Internet access rates for households, while Finland has the highest rate for enterprises. Regarding firms the European e-Business Readiness Index shows that the Nordic countries and the

Netherlands are best performing in terms of ICT adoption and ICT usage. Comparing Figure 6.4 with the above Table 4 shows that most countries with high scores on the e-Business Readiness Index are countries that have a strong socio-cultural environment. Except for the e-Business Readiness of Germany, Ireland, Austria and France, which is higher then could be expected based on their characterisation as a closed or rigid socio-cultural environment.

Figure 6.4 The 2007 European e-Business Readiness Index, ICT adoption scores vs. ICT use scores employing the budget allocation weighting scheme



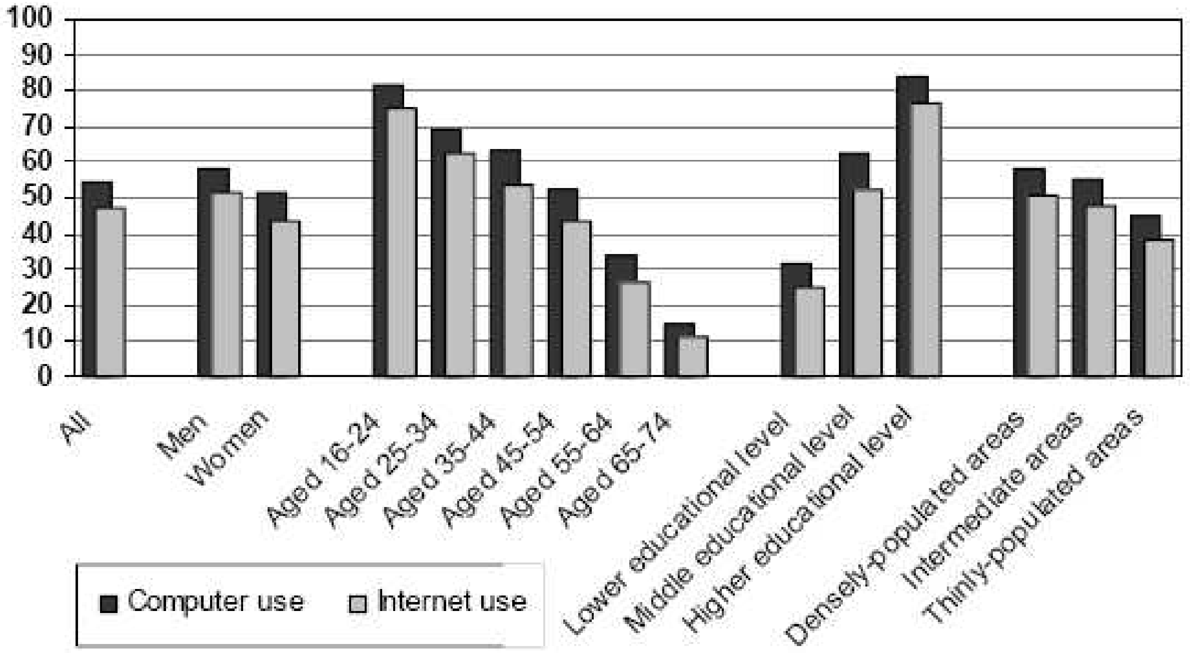
Source: Castaings & Tarantola 2008

As reported by Friedewald et al. (2004), a shift is occurring in the emphasis of many national ICT policies from targeting the supply side to supporting the demand side. Many initiatives in the EU involve stimulation of the market for ICT by encouraging ICT take-up in the economy. ICT can serve as a means of achieving both social and economic policy goals and the best possible degree of inclusion, even though the prime objective of ICT industry is not to bridge social divides (ISTAG, 2006). The acceptance of ICT and the take-up of internet usage and of broadband, in particular by people with lower levels of education, by senior citizens and people living in rural areas, are regarded as essential in overcoming disadvantages that these groups of the population face on labour markets and in society.

According to the European Competitiveness Report (2006), given social trends, European R&D in favour of ICT would be more efficient if it would take into account the specificities of European societies and their specific current and expected demands. Many societal challenges require new, creative and innovative solutions (ageing population, healthcare, education, social inclusion, transport, environment, etc.). Often in the past ICT systems were developed with no reference to the social or organisational context in which they would be used.

As an illustration of the numerical divide, Eurostat data (2006a) provides some useful information. In 2005, 43% of private individuals accessed the Internet on average at least once a week and an identical number declared never to have used it. In the new Member States (except Slovakia and Estonia), the proportion of individuals never having used the Internet is higher than that of regular users, as is the case in Greece, Spain, Italy and Portugal. It may be further noted that the level of Internet access remains lower in sparsely populated rural regions (40%) than in heavily populated urban areas (52%). With regard to the occupation of Internet users in the EU25, students are proportionately the most regular users of the Internet. In contrast, 48% of unemployed persons claimed never to have accessed the Internet. As regards regular Internet use by unemployed persons, the highest level was recorded in the Netherlands (87%), followed by Sweden (80%). These two countries register rates well above the average for all Member States, which stands at 32%. With regards to gender issues, the figure for persons never having used the Internet stands at an overall 47% for women as against 39% for men. Young people are leading the way to a broad take-up of new electronic devices, often seen as status symbols that facilitate social interaction (see also figure 6.4). All generations have embraced the web and mobile phones, and other applications are increasingly popular.

Figure 6.4 Community survey on ICT usage by private individuals in 2005, data for EU-25



According to the results of a Delphi survey reported by Popper and Miles (2005), two key topics emerge in ICT to be addressed by R&D activities, namely establishing more user-friendly systems and enhancing security of transactions and personal information. These issues were mentioned by more than half of all respondents. In terms of the former, the so-called 'media consumer' is becoming increasingly an active creator. Friedman et al. (2003) take the example of the update of software to illustrate that, through human interaction, technology changes over time. Innovation in the ICT sector is indeed increasingly based on iterative processes of invention and redesign based on interactions.

The experts of the Europe Innova panel confirmed that security issues, and notably privacy concerns, are key determinants of innovation in the sector. As ICT technology becomes ever more closely entwined in society, so it becomes indeed more closely related with people's political and ethical values (ISTAG, 2006).

Several empirical studies reported by Lasch (2004) acknowledge the role of three determinant factors at the local level for the emergence of new ICT companies: a growing market demand (measured through growth of population and household incomes), a local/regional economy dominated by small firms, and a high degree of urbanisation (geographically concentrated urban demand). The example of France in the study of Reynolds and Storey (1993) show that population growth (source of new users) is the major determinant followed by population density, the proportion of graduates from higher education institutions, the share of population aged 20 to 40 years as well as middle managers' share in the working population.

Finally, according to the experts of the Europe Innova panel, with respect to the role of demand in innovation, the size of the market is a very important factor. However, looking at demand from private consumers' perspective is not enough since demanding public procurement for innovation is also an important driver in the sector. The experts agreed that early involvement of suppliers is the key to innovative public procurements. Recent roaming legislation by the European Commission was also mentioned as an example of public intervention that may increase demand and thus generate innovation in the form of new services.

6.2.2 Human capital

The study of Corrocher (2001) insists on the point that specialised competencies and specific knowledge has increasingly become a key asset for firms' survival and growth in the ICT sector. As emphasised in the European Competitiveness Report (2006), rapid technological progress in the sector reduces life cycles for many ICT products that become rapidly mature and standardised. Production is often knowledge-intensive in the early stage of a product's life cycle and dependent on access to human capital and facilities for R&D and innovation. Mature and standardised products are mass-produced in locations where access to cheap labour is more important. Continuous innovation in Europe is therefore essential. In particular, low- and medium-skilled jobs, which are not culturally, time-zone, geographically, or language dependent may be provided from any location.

Concerning higher skilled human resources, the current shortages of highly skilled workers in the European Union as well as a lack of mobility of people, both between departments and sectors and between the business and public sector, are presently a challenge in the ICT industry (ISTAG, 2006). In order to get access to highly skilled labour force as the same time as accessing new markets, companies tend to be attracted by near-shore (Eastern Europe) and far-shore (Far East) operations (European Commission, 2006)

According to Eurostat data (2003), while the number of computer professionals, as a share of total EU employment, rose by 0.4 percentage points between 1999 and 2001, there was a decline of 0.1 points in 2002. The highest proportion of computer professionals (more than 2 %) was recorded in the countries where the use of ICT was also highest, especially the Netherlands and Sweden (more than 3 % of the workforce was computer professional). Among the candidate countries, the share of computer professionals in total employment was usually lower than the EU average (except for the Czech Republic: 1.8 %).

In order to reduce the recourse to off-shoring industrial R&D, the Europe Innova Panel experts agreed that the support to ICT-related innovation has to be increased in the EU. Continuous training of the workforce was furthermore regarded as a crucial element to exploit the full potential of ICTs. Finally, a gender imbalance (a relatively small share of women in the workforce) in the sector is also considered an impediment to innovation and growth, even if there are some national differences.

6.2.3 Social capital

Meijers et al. (2006) argue that degrees of knowledge-intensity and economies of scale are main determinants of the localisation of ICT products. The less knowledge-intensive production and the higher the degree of economies of scale, the easier it is to re-locate products or parts of products to low-cost locations. Strategic R&D is often conducted within the EU close to the production of knowledge intensive products. Costs of co-ordination and control are lower and information about and access to skilled labour and systems of innovation is easier.

According to Lasch (2004), the concentration of innovative firms in a regional economy stimulates and promotes the formation of other, new local ICT firms, independently of the sub-sector under consideration. High quality technical and human resources and the proximity to various incubators make easier the access to information and reduce uncertainty and technological risk. Nevertheless, the service sub-sectors appear more sensitive to the local context, since their need of integration and local networking is high and crucial for their survival and growth. Proximity effects, localization economies (presence of the same type of firm) and the regional knowledge potential would be crucial for the ICT services branches. The results of the study of Czarnitzki and Spielkamp (2000) highlight that 54% of companies specialised in computer services maintain informal contacts with other firms in the sector, and consider them as the most important information source for their innovation activities. These contacts would be even more important than those with universities and supplier-customer relationships.

The study of Corrocher (2001) highlights that networks among a variety of actors, not only firms, but also standard setting organisations and research organisations, are highly relevant to innovation in the ICT sector. The growth of technological complexity, the internationalisation process as well as increased interdisciplinary thinking requires firms in the sector to be continuously involved in innovative activities and to enter in cooperation.

The experts of the Europe Innova panel underlined that public authorities should further foster co-ordinated research in order to maximise benefits of investment at regional and national level but also at sectoral level. Increased collaboration among public and business sector researchers would be especially needed. In this regard, the experts considered grants for co-operation as a good way of encouraging innovation in the ICT sector. Also, much will depend on the capacity of the ICT industry to develop interdisciplinary co-operation. According to the ISTAG (2006), there is firstly a need for stronger involvement of domain expertise, since more and more innovation comes from the use of ICT in a broadening range of application domains. Secondly, there is a need for greater interaction with other science and technology disciplines, since further advances rely increasingly on exploration at the frontiers between ICT and other fields.

The involvement of the users in the innovation process is also a critical issue. According to the ISTAG (2006), new and open means of engagement need to be found between ICT developers and users, since users should be at the centre of the innovation process. Some companies and cities have already gone a step in this direction, by involving the users in iterative processes of innovation (e.g. in test-beds or living labs).

6.2.4 Organisational capital and entrepreneurship

Some industries in the ICT manufacturing sector are rather concentrated, in the sense that large firms are dominant players. In Manufacture of telecommunications equipments, for instance, 80% of value added is produced by the largest firms (more than 250 employees) who employed 75% of all employees in the industry. In Manufacturing of office machinery, electronic valves and tubes, radio and TV receivers, large firms are also dominant. This concentration in large firms is due to the existence of high sunk costs and economies of scale (see e-business watch, 2006).

In a geographical sense the ICT sector is perhaps not concentrated enough. A study of the Pro-Inno Cluster Observatory[17] shows that Europe lags behind US in terms of cluster strength. European regions tend to be less specialised and this gap is larger in innovative clusters like ICT. The low level of concentration may have hampered the generation and innovative capabilities of new knowledge intensive firms, since regional ICT cluster-environments are important seed-beds for new ventures and innovative SME-networks.

According to Lasch (2004), the inherent characteristics of highly innovative ICT firms make them face higher risk of failure and difficult financing. Many European innovative ICT firms are indeed start-ups, which tend not to grow beyond a certain size, either because of capacity or reluctance to do so, which has a direct impact on venture capitalists who have to take on higher risks and receive limited returns on their investments. Thus, venture capital is usually directed to refinancing existing firms, rather than creating new ones.

The experts of the Europe Innova panel were of the opinion that people's passion and belief in their own inventions are the key drivers of innovation in the ICT sector. Even if ideas exist in Europe, the problem lies in turning them into innovations. Management skills and management experience are still lacking, especially in SMEs. The

[17] Innovation Clusters in Europe: A statistical analysis and overview of current policy support, DG Enterprise and Industry Report, October 2007

entrepreneurial gap in the sector in comparison with the United States could be explained by the different approaches to lifestyle and relative availability of risk capital.

The results of the study carried out by Lasch et al. (2005) highlight that industry specific experience and previous working experience in SMEs appear as most important factors for successful entrepreneurs in the ICT sector. Significant influence on growth is negatively measured for ICT firms having a too small number of employees, starting with business partners, dealing with mainly private customers and competing essentially on international markets.

As emphasised in the European Competitiveness Report (2006), success and competitiveness still belong to innovative companies acting in markets with high rates of entry and exit (“creative destruction”, e.g. social computing) or relying on rapid value accumulation based on high sunk costs, mostly R&D-related (“creative accumulation”, e.g. ambient intelligence), which creates an advantage for large established firms and corresponding barriers to entry for new innovators. Nonetheless, the report also underlines that socially driven Internet based trends are also a factor of structural change. They act on markets by lowering entry costs, they promote new business models largely relying on advertising as an effective source of revenue and they give rise to new players. Their influence is felt beyond the ICT industry insofar as they provide new channels of delivery for traditional services.

6.3 Regional ICT Profiles

The regional concentration of ICT manufacturing (NACE 30, 32 and 33) and ICT services (NACE 64 and 72) depends on several factors of which the availability of highly skilled people and research friendly surroundings are the most important ones. Because large parts of ICT activities have a knowledge intensive character the availability of highly skilled people and sufficient research friendly surroundings is a necessary precondition for these activities to settle in a certain region.

Clusters settle in fecund regions and fecundity is defined as the density[18] of ICT employment and the quality of the surroundings or contextual quality taken together[19]. Ranking the most fecund European regions (EU25) which have above average contextual quality and above average ICT employment density (at the Nuts 2 level) reveals that Stockholm (se01), two Finnish regions Pohjois-Suomi (fi1a) and Etelä-Suomi (fi18), Île de France (fr10), Oberbayern (de21), Hampshire and Isle of Wight (ukj1), Dresden (ded2), Vienna (at13), Surrey, East and West Sussex (ukj2) hold the top-10 positions of this list. Figure 6.2 exhibits all the regions[20] with above average contextual quality and density of ICT manufacturing activities.

Although most of the regions obey the rule of thump that high contextual quality goes along with high ICT manufacturing density, there are some outliers in Figure 6.2:

[18] Densities are defined as the ratio of ICT employment in a region to total employment for the manufacturing and service sectors.

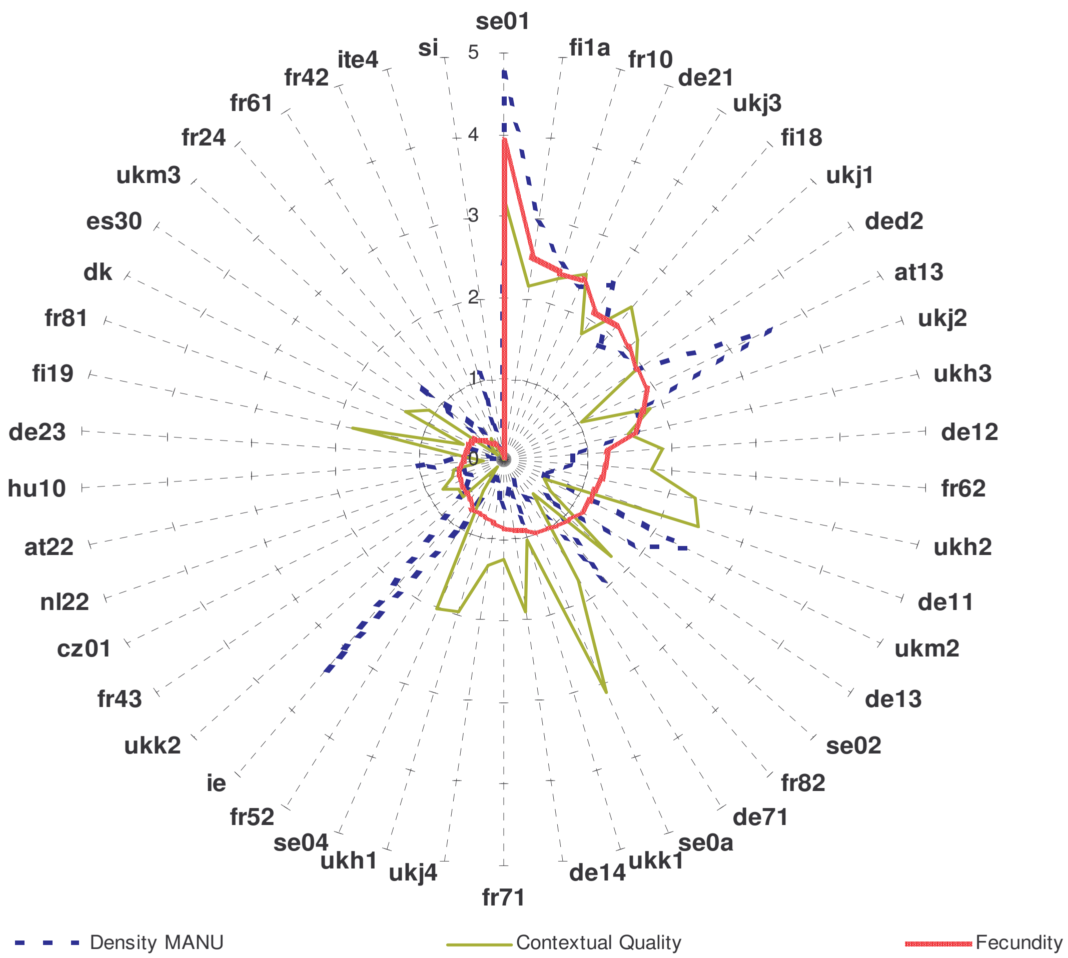
[19] The relation is Z(Fecundity) = Z(ICT density)^1/2 * Z(Contextual Quality)^1/2

[20] These regions have been selected from all the regions in the EU25. For Ireland and Denmark only national data have been included while for some EU Member States or individual regions not all data was available. The data covers the averages over the period 2001-2003, source is EUROSTAT.

Wien (at13), Eastern Scotland (ukm2), South Western Scotland (ukm3), Provence-Alpes-Côte d'Azur (fr82) and Ireland (ie). These outlying regions combine very high ICT manufacturing density with rather low contextual quality; this might be an indication that these regions are knowledge extensive ICT manufacturing regions.

Another characteristic of the regions with a high incidence of ICT activities analysed above is the coincidence of ICT manufacturing and ICT services production. Figure 6.3 exhibits this coincidence between the two. In most of the regions there is a strong correlation between the densities of ICT manufacturing and ICT services. However in some regions this correlation is lacking. These are situated below the X-axis in Figure 6.3. In these eleven regions the incidence of ICT manufacturing is high but ICT services are far below the average. All these regions are more or less peripheral regions specialised in ICT manufacturing without a high density of co-located ICT services, and this lack of ICT services seems to hamper the density in ICT manufacturing. We conclude that the importance of the relation between the density in services and manufacturing doesn't work both ways, since high density in ICT services does not seem to be hampered by low ICT manufacturing density.

Figure 6.2: Top fecund ICT manufacturing regions in EU25 (Z-scores)



R&D friendly regions are characterized with more than average patenting effort. When we look at the IPC classes of the European Patent Office “Computing; calculating; counting” (g06) is the technology field that has shown the highest increase in the number of patents. In terms of patents per million of inhabitants table 6.5 shows the regional distribution. Some of the regions that feature in Figure 6.3 showed fast growth in ICT patents originating in the region indeed, but as the case of Noord-Brabant shows, a high density in patenting does not necessarily lead to high density in ICT manufacturing or services.

Figure 6.3: ICT manufacturing density (X-Axis) vs ICT service density (Z-scores)

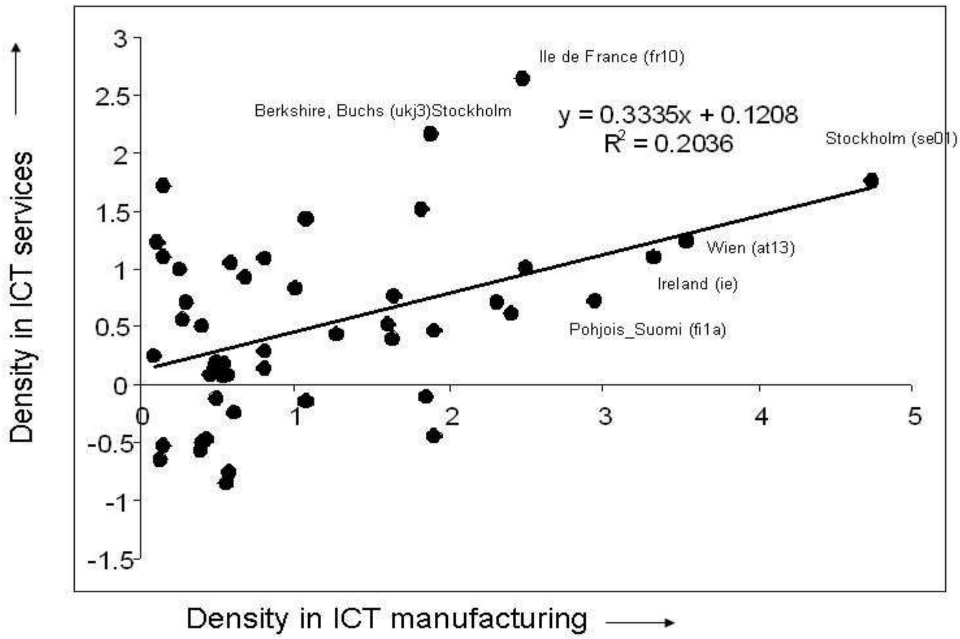


*Table 6.5: Regions with high growth in patent applications (EPO) in IPC class "Computing; calculating; counting" (g06) per million of inhabitants**

EPO patent applications in IPC class: "Computing; calculating; counting" (g06)

		average 2001-03	average 1990-92	growth in percentages
SE04	Sydsverige	40	1	3927
FI	Finland	26	1	1837
DE25	Mittelfranken	37	3	1401
DE23	Oberpfalz	12	1	1083
DE12	Karlsruhe	49	5	1069
NL41	Noord-Brabant	111	11	1002
DE27	Schwaben	12	2	804
DEA2	Köln	14	2	749
DEB3	Rheinhessen-Pfalz	10	1	703
SE01	Stockholm	31	5	654
FR52	Bretagne	10	1	652
AT13	Wien	10	2	610
FR71	Rhône-Alpes	14	2	550

* only IPC fields with an average for 1990-'92 of more than one patent per million inhabitants are mentioned; data available for 104 regions

7 ICT Innovation Policy

Most public support in the form of funding of research and innovation comes from regional and national governments. This is the case in all sectors and in all ICT subsectors. In general ICT firms more often have received public funding than the average for all sectors. Firms in NACE 32, producing communication equipment, have received most public funding for research and innovation. Computer service firms (NACE 72) have less often received public funding then the average for the ICT sector. As a percentage of innovating firms, firms in the ICT service sector even reports to have received public funds less often then firms in other sectors (table 7.1). Surprisingly low is the share of firms in NACE 30 (manufacturing of computers and office machinery) that have received public funds for innovation from EU sources.

Table 7.1 Share of firms reported to have received funds from governments for innovative activities, by ICT sub-sector, as % of all firms and % of innovative firms

	% of all firms					% of innovative firms				
	all sectors	ICT sector	NACE 30	NACE 32	NACE 72	all sectors	ICT sector	NACE 30	NACE 32	NACE 72
Receive funds from local or regional authorities	5.7	8.6	9.9	13.3	7.0	15.0	13.7	14.6	21.6	10.8
Receive funds from central government	5.1	9.7	8.3	17.3	7.1	13.1	15.6	12.1	27.6	11.1
Receive funds from EU	2.3	4.2	1.6	5.9	3.9	5.9	6.6	2.5	9.6	5.8

Whereas in other sectors local and regional funds are most often reported source, for the ICT sector the central government is the most important source of public funding, except for firms in NACE 30, where the share of innovative firms having received funds from local or regional authorities are even 6 times higher than from EU sources.

When we consider all firms (both innovative and non-innovative) firms in the ICT sector report more often than in other sectors to have received public funding, but this sector-difference is less obvious when we only look at innovative firms. The fact that innovative ICT firms more often reported that they have received funds for innovation from regional and national governments as sources of public funding, indicates that national and regional/local authorities favour innovative firms. The EU however seems less strategic concerning public funding, since the share (of 4.2%) of all ICT firms that received funding from EU sources is only slightly below the share (of 6.6 %) of innovative ICT firms that received EU innovation support.

7.1 Overview of EU policy addressing innovation in the ICT sector

7.1.1 Introduction

Promoting "faster growth and more jobs" is the main goal of the policies that target advancing knowledge and innovation. These policies come at three levels (i.e. EU, Members States and Regions) and aim at promoting the necessary (contextual) change to achieve the targeted growth and jobs.

European industrial policy itself has three dimensions:

A *framework dimension*: The EU consists of the internal market and a set of cohesion policies. Cohesion policy amounts to a long run strategy of catch-up growth in the relatively poor regions of the EU. These policies are aimed at infrastructure (hard and soft: human capital, technical schools, (re)training facilities, administrative capacity)

A *horizontal dimension*: deepening the internal market by less 'red tape', better laws and an integrated approach to competitiveness. Integration is carried out at three levels: the Union, the Member Sates and the Regions. This integrated approach embraces several domains: the European Research Area (ERA), innovation policy, human capital and skills, competition policy for innovation and technology transfer, merger control, cohesion and industrial clusters and Trans European Networks (TENs[25] that consist of TEN-Transport, TEN-Energy and e-TEN) as well.

A *vertical dimension* embraces sectoral or specific policies; these policies are often executed at the three levels mentioned above. However Member States discretion for these policies is very limited and EU cohesion policies cannot be sector specific, unless they are not anticompetitive. Cohesion policies consist mainly of compensating measures (retraining, upgrading, etc,), while infrastructural support in under-equipped regions is provided under regional and cohesion policies.

Apart from these dimensions of European industrial policy there is a strong consensus to strengthen research and innovation in Europe in general and in particular more effort is needed in order to broaden access of firms to finance, research and innovation and ICT's and to lessen the burden of red tape for small and medium sized enterprises[26].

ICT has been broadly embraced as a key element in the so-called renewed Lisbon strategy, which essentially is a growth and competitiveness strategy aiming at job creation and boosting productivity eventually determining EU's capacity to innovate[28]

[25] http://ec.europa.eu/ten/index_en.html

[26] Modern SME policy for growth and employment, COM (2005) 551 DD. 10.11.2005

[28] i2010: A European Information Society for Growth and Employment, COM (2005) 229 final, see for a theoretical underpinning of the impact of ICT on growth and jobs: Dunnewijk, Meijers and van Zon, 2006 and for the policy implications Barrios and Burgelman, 2007.

and compete. This has led to the promotion of the development, production and use of ICT which became a policy line of its own. This policy line is broadly accepted by the Member States and implemented in National Information Society and Innovation policies.

One of the most outspoken ICT centered programme is the ICT Policy Support Programme. This programme is one of the means to support the renewed Lisbon agenda stressing the ICT dimension explicitly. It will build on the lessons learned from previous programmes like eTen[29], eContent[30] and MODINIS[31] whilst improving synergies between them and improving their impact. This programme provides for the following actions:

- Development of the single European information space and to strengthening of the internal market for information products and services;
- Stimulation of innovation through a wider adoption of and investment in ICTs;
- Development of an inclusive information society, more efficient and effective services in areas of public interest and improvement of the quality of life

Several DGs, especially: DG Enterprise[32], DG Infso[33], DG Research[34] and the DG Regio[35] are involved in implementing policies addressing the ICT sector, e.g.: CIP, the Framework Programme and the Structural Funds programmes. It is far beyond this paper to provide a comprehensive overview of all ICT related polices and initiatives, however using the web sites of these DGs provides ample possibilities to arrive at the multitude of initiatives and polices that these DGs undertake.

Apart from these polices and measures cooperation is deemed necessary to facilitate strategic agendas and a more thematic approach to research. An example is the European born success in mobile communication by the GSM standard. Therefore Cooperation in research is stimulated by the creation of *Technological platforms*[36] and *strategic initiatives* which combine several large research projects.

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[29] eTEN (formerly TEN-Telecom) was supporting the deployment of trans-European e-services in the public interest. The programme aimed to accelerate the take-up of services to sustain the European social model of an inclusive, cohesive society. eTEN's six themes included eGovernment, eHealth, eInclusion, eLearning, Services for SMEs and Trust & Security. Admitted projects can have up to 50% of the costs or 30% of initial deployment costs eligible for refunding.

[30] The eContentplus Programme, (2005-2008) aims to support the development of multi-lingual content for innovative, on-line services across the EU, part of the eContentplus programme is the Digital Libraries Initiative.

[31] A multi annual programme (2003-2005) for the monitoring of eEurope 2005 action plan, dissemination of good practices and the improvement of network and information security (MODINIS), see Official Journal of the European Union 23.12.2003, L 336/1-5

[32] http://ec.europa.eu/enterprise/ict/index_en.htm

[33] http://ec.europa.eu/dgs/information_society/index_en.htm

[34] http://ec.europa.eu/dgs/research/index_en.html

[35] http://ec.europa.eu/dgs/regional_policy/index_en.htm

[36] http://cordis.europa.eu/ist/about/techn-platform.htm

[38] This Charter was adopted at the Feira Economic Council, 19-20 June 2000, http://ec.europa.eu/enterprise/enterprise_policy/charter/docs/charter_en.pdf

7.1.2 Technology platforms and Lead Markets Initiative

To bring together companies, research institutions, and any other organisations, with a view to defining, at European level, a common strategic research agenda which should mobilise a critical mass of national and European public and private resources technological platforms were created. These platforms also address technological and non-technological issues for implementing the research agenda. The goals of these platforms are to improve the impact of public and private research, to increase investment in European research, and to facilitate common approaches to technology progress and uptake. The Strategic Research Agenda's will be considered as an important input in preparing the Work Programmes of the IST thematic priority of the EU Framework Programmes. However, the Commission is in no way committed to incorporating general outcomes from the Technology Platforms.

However, systemic policy programmes based on Technology platforms, thematic research networks or lead market initiatives are important tools of governance, that match the sector specific characteristics of the ICT sector, see also Dunnewijk and Wintjes (2006).

The Technological Platforms in ICTs currently are:

- Artemis (Embedded Systems Unit), (see the below box for a description)
- eMobility (Communication Technologies Unit)
- ENIAC (Nanoelectronics and Photonics Unit)
- EUROP (Future and Emerging Technologies Unit)
- ISI (Communication Technologies Unit)
- NESSI (Grid Technologies Unit and Software Technologies Unit)
- Networked and Electronic Media (Networked Audiovisual Systems Unit)
- Photonics21 (Nanoelectronics and Photonics Unit)
- EPoSS (Micro- and Nanosystems Unit)

ARTEMIS – Advanced Research and Technology for Embedded Intelligence and Systems

Web-site: http://www.artemis-office.org/

Objective: Europe currently leads the world in embedded electronics and software for aerospace, automotive, consumer and communications markets. This leading position is threatened by global competition, fragmentation of efforts and insufficient research investment. The platform will provide the technology to tackle a broad range of social challenges including the aging population, safety of citizens and security of physical infrastructure.

With the constant evolution of electronics and software technologies, there will be more and more Embedded Systems integrated into products and infrastructure. Already today 90% of computing devices are in Embedded Systems. Moreover, the value added to the final product by embedded software is often higher than the cost of the embedded devices themselves. For example, 20% of the value of each car today is due to embedded electronics and this will increase to an average of 35-40% by 2015. The vision driving ARTEMIS is a major evolution of our society in which all electronic objects will become digital and communication-enabled with self-managed resources.

The ARTEMIS approach is to remove barriers between application sectors, stimulating creativity and yielding multi-domain reusable results. This will be achieved by specifying an ARTEMIS reference architecture. ARTEMIS will seek maximum commonality across application sectors, however recognising that different application domains impose differing demands on the technology to be developed. ARTEMIS has therefore identified a number of representative 'Application Contexts':

• "Industrial systems" - large, complex and safety critical systems, that embraces Automotive, Aerospace, Manufacturing, and growth areas such as biomedical

• "Nomadic Environments" – enabling portable devices and on-body systems to offer users access to information and services while on the move

• "Private Spaces", - such as homes, cars and offices, that offers systems and solutions for improved enjoyment, comfort, well-being and safety.

• "Public Infrastructure" – major infrastructure such as airports, cities and highways that embrace large scale deployment of systems and services that benefit the citizen.

ARTEMIS strategy is to establish common technology, including:

• reference designs, that offer standard architectural approaches for a range of applications to address the complexity challenge and build synergies between market sectors;

• middleware that enables seamless connectivity and wide-scale interoperability to support novel functionality, new services and build the ambient intelligent environment;

• systems design methodologies and associated tools for rapid design and development;

• generic enabling technologies derived from foundational science.

The third panel meeting in the Innovation Watch/Systematic project included an update, debriefing, and consultation by the European Commission concerning its development of the lead market initiative. The 2007 communication "A lead market initiative for Europe" launches a Lead Market Initiative and identifies a first set of markets with potential to become Lead Market. It calls for urgent and coordinated action through ambitious action plans for these markets, to rapidly bring visible advantage for Europe's economy and consumers. The Commission undertook intensive stakeholder consultations, thus identifying and applying the following set of criteria for the Lead Markets:

- Demand driven instead of technology push: The range of potential customers and the needs addressed by the market indicate that there is a strong market potential both in Europe and on a global level within a rather short time span.
- Broad market segment: The market segment is rather broad as opposed to building on 1 single product. A significant impact on markets can only be achieved if a range of interconnected products and services are offered simultaneously.

- Strategic societal and economic interest: The market segment provides wider strategic economic or societal gains, such as public health, environment and climate protection, security or employment.
- Added value of prospective, concerted and targeted, but flexible policy instruments: In the identified markets, there is no single policy measure which could remove the barriers that block the emergence of strong demand. The barriers identified are such that only a flexible combination of different public measures and incentives can make a difference.
- No "picking of the winners": Industrial potential and sufficiently mature new technologies or ideas for new use of existing technologies are available in Europe, on which the product or service range for the emerging market can build. The characteristics of the market avoid the risk of de facto favouring specific companies, to ensure fair and open competition and to avoid dictating the technological choices.

Six markets have been identified for the initial stage of the initiative - eHealth, protective textiles, sustainable construction, recycling, bio-based products and renewable energies. They are highly innovative, respond to customers' needs, have a strong technological and industrial base in Europe and depend more than other markets on the creation of favourable framework conditions through public policy actions. This lead market initiative has implications for innovation in the ICT sector, especially with relation to e-Health.

7.1.3 The ICT Taskforce

The ICT Task-Force was one of several initiatives taken under the Commission's industrial policy, which aims to help create a more favourable environment for business in the EU, and was designed to complement the Commission's main ICT-related initiative, i2010.

The European Commission established the ICT Task Force, set up to recommend policy actions that seek to improve the ICT sector's competitiveness and remove obstacles to greater ICT uptake. The Task Force was made up of 24 high-level representatives from the ICT sector and civil society.

The key suggestions and observations from the ICT Task Force are: (1) Europe urgently needs to increase the employability skills to and opportunities for millions of low-skilled people. (2) The legislation should support the enterprises and organisations to perform changes for increased productivity, integration and networking available via ICT. (3) Public-service-side demand is also a key driver of innovation in ICT and is at present not effectively deployed.

7.1.2 EU Policies relevant to ICT SMEs

The unifying principle of the single market of the European Union is the free movement of labour, capital, goods and services, delivering the free circulation of knowledge in the EU. Important players on the large single European market are the SMEs, and they are considered by the European Commission (EC) as important drivers of innovation, employment as well as social and local integration in Europe.

Therefore SMEs need the best possible environment a goal set by the EC and explained in the "European Charter for Small Enterprises"[38] and in the Communication "A Modern SME Policy for Growth" [39].

Despite the awareness of the importance of innovation, knowledge and ICT for productivity and competitiveness investment in R&D and ICT in Europe is persistently lower than in the US. The reason for this lagging behind in ICT is burdensome market regulation in the EU. Labour market rigidities and the highly regulated services sector prevent a larger contribution of ICT to GDP in Europe (Barrios and Burgelman, 2007)

To stimulate innovation in SMEs in general and lower the hurdles that SMEs face with regard to access to capital and finance the EC developed specific policies aimed at ICT SMEs along the following three lines:

- Policies aimed at improving access to markets and finance: cheaper and faster start-ups, better access to loans, more efficient taxation and less burdensome regulation[40].
- Policies aimed at boosting public and private R&D, technology development, (technological and managerial) and innovation including absorption capacity of SMEs and top class SME support for these matters.
- Policies aimed at human capital: entrepreneurship[41] , skills and training[42].

These three policy lines are supported in several Community spending programmes. In the near future more emphasize will be given to SMEs in these programmes (for 2007-2013) and more funds will be channelled towards SMEs. The most important programmes/policies are: Cohesion (Regional) policies the largest funding instruments for SMEs in general: € 59 billion. The Seventh Framework (Research) Programme (FP7: € 9 billion for 2007-2013) as well in the Competitiveness and Innovation Framework programme (CIP: € 0.7 billion), SAFER Internet Plus and MEDIA (€ 0.7 billion for 2007-2013), are also important. In these programmes access to finance and the conditions to support SMEs are much better than before. More than €2 billion is available for ICT R&D from the FP7 programme (for the period 2007-2008) and more than €1 billion has been earmarked for financial instruments within the CIP framework programme (from the total of €3.6 billion for the period 2007-2013). This amount will enable financial institutions to provide about €30 billion of new finance to SMEs. The so-called JEREMIE initiative, jointly launched by EC, the European Investment Bank (EIB) and the European Investment fund (EIF), in October 2005, improve the availability of sustainable finance for SMEs considerably. Additional to FP7 and CIP there is the PRO INNO Europe initiative[43] which is a focal point for innova-

[39] Modern SME policy for growth and employment, COM (2005) 551 final.

[40] The European Council (Spring 2006) agreed to take the following priority actions to unlock unleashed potentials of SMEs in the Union by lowering administrative hurdles: one stop shopping for setting up a company, encourage entrepreneurship, recruitment of a first employee should not involve more than one public administration point, think small as a guiding principle and facilitate SMEs to access to public procurement.

[41] In the Community Integrated Guidelines for Growth and Jobs especially guideline 10 call for a more entrepreneurial culture and create a supportive environment for SMEs. The SME dimension in EU's innovation policy is especially present in the Entrepreneurship and Innovation Programme (EIP)

[42] For an overview of these SMEs policy projects see:
http://ec.europa.eu/enterprise/entrepreneurship/support_measures/index.htm

[43] http://www.proinno-europe.eu/

tion policy analysis, learning and development in Europe. One of the dedicated themes is gazelles, i.e. fast growing SMEs and several actions are focusing on networking and design in SMEs.

The main research and innovation policies in the EU are embedded in FP7 and CIP. SMEs are increasingly encouraged to participate in research actions, also by means of innovation vouchers[44]. The proposed rules for participation in FP7 specify a funding rate of 75% for research and development activities of SMEs, rather than the 50% currently applicable in FP6. This should make it more attractive for SMEs to participate in the FP7 by lowering their financial burden. The FP7 programme builds on the aims of the previous programmes and will support the aims of the new integrated strategy i2010 - European Information Society 2010.

It might be clear that EU's policy aimed at innovative ICT SME's is rather complicated and very versatile. Because these policies and initiatives are recently introduced and are implemented now or in the near future, therefore we cannot expect them have much impact right now. Most important is that Member States align their (innovation and information society) policies with these of the EC. At the moment the differences between the National and Regional policies are large and we cannot speak of a level playing field as far as these policies are concerned. This is an important source of differences in participation of SMEs in the above mentioned programmes.

According to national policy makers and representatives of SMEs, national innovation policies aimed at ICT SMEs have a very high relevance in Sweden, and are highly relevant in Denmark, Finland, France, Germany, Luxembourg, Spain and the UK, while these policies are absent in the New Member States like Cyprus, Czech Republic, Estonia, Lithuania, Malta, Poland and Slovakia. This can be taken as an indication that sophisticated policies comes with sophisticated industries, thus we can expect that these polices become more sophisticated in the coarse of time due to the catching up in New Member States. In this respect the EU can gain substantially if the new Members States develop more sophisticated policies that enhance innovation in ICT SMEs.

This short overview of EC initiated policies to stimulate innovation in SMEs shows clearly the complicated structure of these policy measures[45]. Small and medium sized entrepreneurs very likely cannot oversee all the existing possibilities to get risky innovative projects financed. However, it seems that SMEs that participate in EU funded research programmes are not the small ones but tend to be the medium or large sized and these SMEs have relatively high RTD budgets. From all ICT SMEs only 22% received funding from an EU sponsored programme. Getting funding is a real problem for SMEs, while protection of property rights is insufficient guaranteed if an SME takes part in a research programme carried out by a consortium. Participation of SMEs in EU sponsored programmes is rather low and there are serious hurdles for SMEs to take part in EU sponsored RTD projects. Since funded enterprises exhibit higher growth rates, and have relatively large R&D budgets we can conclude that these innovative ICT SMEs are the ones that can bring the Barcelona target closer to reality.

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[44] See: SME TechWeb at http://ec.europa.eu/research/sme-techweb/index_en.cfm

[45] It is beyond the scope of this paper to elucidate the inns and outs of EU policies aimed at innovative ICT SMEs

7.2 *Overview of National ICT innovation policy programmes*

A mapping of national policy measures addressing innovation in the ICT sector shows that the measures are not sector-specific, but mainly addressing all sectors. An above average share of measures is also addressed at research organisations and 'other' (25%) (Table 7.2). By analysing the description of the programs, a lot of the 'other' can be attributed to governmental initiatives to provide access to the internet at schools, the wider public or to provide training. These initiatives are connected to the notion of 'development of an information society', but these policies do not directly or specifically address the ICT sector, nor do they promote innovation in industry. Several measures are aimed at individuals – often researchers or graduates. Compared to other sectors, cluster initiatives and technology platforms are ticked above average for ICT while innovation programs are ticked as often as for other sectors. Almost half of all the measures consist of research or innovation programmes.

Table 7.2 Policy measures per sector and share of targets and types in % (Number of cases: 1157)

Sector	ICT	aero-nautics	bio-tech	chemicals	auto-motive	food	ga-zelles	ma-chin-ery	eco-inno	en-ergy	tex-tile	Total num-ber
What are the targets of the measures?												
All industry sectors	36	24	30	37	40	28	41	41	49	36	47	433
particular industries	25	44	38	49	38	44	19	38	32	38	34	416
large companies	36	59	45	43	45	34	17	46	38	45	42	466
SMEs	57	67	59	59	61	61	85	59	61	45	65	710
Research organisations	39	56	64	49	46	39	26	39	49	42	30	502
Individuals	21	13	22	20	18	27	20	20	30	35	15	258
Other	25	21	18	14	10	11	8	23	18	16	12	181
What are the types of measures?												
Cluster initiative	23	24	32	21	24	22	16	13	29	7	14	241
Technology platform	26	24	16	24	18	14	14	17	31	25	14	235
Innovation program	45	35	45	43	56	43	45	48	49	35	47	520
Regulation	9	11	6	9	3	10	6	3	9	13	3	85
Competition regulation	1	3	2	0	1	6	0	0	1	5	2	22
Quality regulation	2	8	3	6	4	13	1	4	5	7	9	64
Fiscal initiative	16	24	26	21	30	23	38	24	31	35	20	302
Other	24	25	18	23	21	17	25	28	15	15	20	237
Number of measures	121	63	125	111	120	109	105	71	115	110	107	1157

Good innovation policy practises

An earlier policy benchmarking study identified policy programmes and initiatives from the EU15 countries. 176 programmes were benchmarked against a small set of qualitative criteria that included a mix of general and specific good practices. Eleven policy initiatives and programmes were identified that, according to one or more of benchmarking criteria, can be considered to be examples of good practice (Table 7.2).

Table 7.2 Eleven Good Practice Examples of National and regional ICT sector policies

Innovation Policy	Kplus competence centre programme, Austria Interuniversity MicroElectronics Centre (IMEC), Belgium Tekes Technology Programmes, Finland The National Software Technology Research and Innovation Network (RNTL) and the National Telecommunications Network (RNRT), France Action plan for ICT innovation in the enterprises, Italy GigaPort, The Netherlands PROgramme for Research on Embedded Systems (PROGRESS),The Netherlands
Human Capital Policy	Programa Form@cion TI – FORINTEL, Spain SwIT (Sweden Information Technology), Sweden GoOnline programme, Greece
Inward Investment Policy	Semiconductor Region Dresden, Germany

Source: Benchmarking national and regional policies in support of the competitiveness of the ICT sector in the EU, European Commission 2004

A more recent example of a typical national thematic research programme in ICT is described below:

Country	Netherlands
Name	Freeband Knowledge Impulse
Initiating body	Ministry of Economic Affairs, Ministry of Education, Culture and Science
Website	http://www.freeband.nl/kennisimpuls/ENindex.html
Targets	patticular industries, large companies, SMEs, research organisations
Type of measure	Technology platform
Evaluation	Planned (mandatory)
Description	Freeband Kennisimpuls (Knowledge Impulse) is a joint initiative of the Dutch Government, knowledge institutions and industry. As a research programme it forms part of the Government action plan 'Competing with ICT Competencies' (CIC). The programme's objective is to raise knowledge regarding modern telecommunications within Dutch knowledge institutions (universities and institutes) to an international top level. Within this objective, the programme focuses specifically on the enormous new challenges emerging in telecommunications. The development of knowledge relating to '4G' or 'fourth generation telecommunications' in particular will be given a lot of attention.

Recent sector policies in Europe regarding research and innovation more and more address the interaction between several existing policies in a systemic way, e.g. under the umbrella of a technology platform, a thematic research programme or regional 'poles of competitiveness'. See for instance the analysis of the policy mix in the Netherlands regarding ICT research and innovation policy (Wintjes 2007). Interesting good practices regarding national research programmes and their impact on innovation can also be found outside the EU (Wintjes and Schindler 2007).

8 Conclusions and Policy recommendations

8.1 Summary of main results and conclusions

It is widely known that ICT contributes significantly to economic and productivity growth in multiple ways. As a **pervasive general purpose technology** investments in ICT and the increased use of ICT increase overall efficiency and productivity in all sectors of economy and society and in all regions and countries of the EU. In this report we have focused on ICT as a sector. We can conclude that in many respects **ICT is the most innovative sector** of all in the EU. By increasing productivity throughout the economy and because it is also a growing sector in itself, the ICT sector has provided major contributions to economic growth.

The trend for the growth of the European ICT sector is towards an **increase in** the level of **software and services** (including developing and deploying more applications), but a reduction in the level of manufacturing of hardware. Because of the very **short life-cycles** in ICT, the sector is almost innovative by definition. Another characteristic of the sector is the high degree of **globalisation** of ICT markets and production. The value-chains of ICT goods and services have become geographically fragmented into global networks.

The **EU trade balance in ICT goods is persistently negative and increasingly positive for ICT services**. The unit value of exported ICT goods raised by 12 %-points, whereas the unit value of imports declined by 47 percent. This might be an indication that the quality of EU25 ICT goods exports rises faster than the quality of its imports. Data on Foreign Direct Investments (FDI) show a similar pattern: FDI concentrates on those ICT sectors with a relative low R&D intensity. Moreover, for the more “traditional scale” sectors outward FDI is about three times higher as compared to inward FDI. Finally, analysis of R&D patterns shows that European multinational ICT companies still perform most R&D activities in their home countries or in other EU countries. Strategic R&D, of which patents issued by a.o. the European Patent Office protect the results, is still mostly located in Europe. We conclude that the more **mature products and services** (and parts thereof), with lower profit margins are **more likely to be relocated** to off-shore locations, than new, innovative and high value added activities.

We have seen that the ICT sector is indeed in many ways the most innovative sector in Europe. Especially the share of **employees with higher education** is much higher than in most other sectors, with the highest share in the ICT service industry. Also the share of firms with **in-house R&D** and the share of firms **co-operating** in innovation with others is in ICT on average higher than in the other sectors. Such characteristics also differ per country, e.g. ICT firms in Germany and Spain seem less collaborative. ICT firms in Finland have most often reported to collaborate with universities. Another sector specific characteristic of ICT firms is the very high incidence of newly implemented corporate strategies and changes in organisational structures. We conclude that the ICT sector is not only leading in terms of technological innovation, but the **ICT sector is also leading in terms of strategic and organisational innovation and developing new business models**. Digitisation has changed the strategies and structures of firms and this can most pertinently be witnessed in the ICT sector.

There is also a large **diversity within the ICT sector**, e.g. the characteristics of ICT services and software are different from those of manufacturing industries. The **ICT software and service sector (NACE 72) represents two thirds** of the ICT sector in Europe. Some of the main differences between the ICT service firms and those in ICT manufacturing industries are that on average firms in the service sector have a smaller firm size and lower orientation on international markets, but a higher employment growth and export growth. Furthermore, ICT service firms: have a higher share of highly educated employees; a lower share in sales of new products; higher own R&D expenditures, but lower external R&D; less often apply for patents, more often use copyright and informal strategic methods to protect IP; and receive less often public funding for innovation. Although many ICT hardware producers also produce software and provide services and the distinction is therefore blurring, we conclude that on average there is a large difference between the ICT hardware industries and ICT software & service industries.

From the macro-economic analysis we conclude that in general **competition has a positive effect on innovation**, especially in the ICT sector. Although there are many ways to measure and approach competition, the members of the Innovation Watch ICT Panel agreed with this general conclusion.

Innovation output in the ICT sector is especially dependant on the amount of **innovation expenditures** and the share of **highly skilled labour**. Availability of high level of human resources is essential for future productivity and competitiveness in ICT. As Europe's ICT sector keeps on shifting further towards a service sector, the impact of higher education will probably increase even further.

The share of **Strategic Innovators and Intermittant Innovators** is high in the ICT sector, higher than in other sectors. Comparing the Strategic Innovators in the ICT sector with those in other sectors shows that the ICT Strategic Innovators have a much higher share of high educated employees, higher growth in turnover, higher share of innovative firms, and a higher share of new-to-market turnover. This doesn't indicate better performance of ICT firms, but it shows characteristic features of the ICT sector in general, and how ICT firms innovate in particular.

The most reported form of formal IPR protection for firms in the ICT sector is, by far, the use of **trademarks**. The most often reported informal mode of IPR protection in ICT is through **lead-time advantage** on competitors, but also the use of secrecy and complexity of design, is much more common in the ICT sector than in most other sectors. The use of patenting is also above the average of all sectors.

Among the many Small and Medium sized Enterprises in the ICT sector there is a group of **continuously innovating ICT SME's**, a dynamic group that is oriented on global markets, have shown increasing profits and who co-operate with universities.

Out of the innovative ICT companies 26 percent report that **innovation is hampered due to the lack of funds** within the enterprise or group. The access to external sources of financing such as public money, venture capital or loans is a serious problem for 18 percent of the enterprises. On the other hand, compared to most other sectors the ICT sector shows a rather good internal financing situation, yielding an 11 per cent operating surplus ratio, and a 17 per cent cash flow ratio. Moreover, regarding external funding the ICT sector has attracted the largest fraction of private equity investment in the EU25 over the past 10 years.

For innovative ICT SME's in Europe human resources are by far the most mentioned driver of innovation, but lack of human resources is also the most mentioned barrier.

In terms of productivity the ICT sector in **Europe is lagging** the ICT sectors of the US and especially Japan. The EU ICT Task force report (2006) attributed this to the lack of investments in and uptake of ICT in various segments of the economy. China and India have been catching up very fast, specialising in respectively ICT hardware and ICT software. In the ICT domain, the EU is also lagging with regard to R&D expenditures which are higher in the US and Japan than in the EU.

A major dis-advantage for EU ICT companies is the relatively **small market size in EU countries and the lack of a large homogeneous market**. Regarding scale differences we also noted that European SMEs are smaller than their counterparts in the USA, and grow less.

We can conclude that the degrees of **knowledge-intensity and economies of scale** are main determinants of the localisation of ICT activities in Europe; the less knowledge-intensive production and the higher the degree of economies of scale, the easier it is to re-locate production of ICT goods or services to low-cost, off-shore locations.

Qualitatively speaking, Europe's ICT **research** is strong and performs very well, but it is weak in bringing inventions successfully to the market. **Co-operation matters in ICT research, also in view of standardardisation**. In-house R&D is essential in the ICT sector as we have seen in several analyses. One of the likely functions is the capacity it provides to absorb results of R&D performed by others. Considerable shares of ICT companies in Europe co-operate with universities, but the effectiveness of technology transfer between industry and universities is generally poor. The share of co-operation with government research institutes is rather low. A major challenge for Europe is to make better use of the results of the research community as a whole, including both public and private research. A future challenge is that private–public partnerships with regard to R&D collaboration are to be improved.

Regarding the prospective view on Europe's ICT discussed in paragraph 4.2 we recall that **regulatory incoherence** is an innovation challenge as companies often can still not implement strategies or solutions on a European or global scale, but tend to adapt to local laws and business habits, generating numerous obstacles to European competitiveness. This makes Europe a less interesting market compared to some other parts of the world.

A major challenge for the EU ICT sector will be to address the **problems with the availability of high educated human resources** for the ICT sector. The problem has many aspects: e.g.: the declining numbers of students of scientific and engineering disciplines, the brain drain to the US, the shortage of experts with specific skills, the shortage of the absolute number of ICT-workers in general, the large supply of high educated labour in emerging economies, such as China and India.

Important prospective technological innovation challenges in ICT are related to the **convergence of technologies** and to the wider integration of technology into products, services and processes and the tighter links between technology and its specific use in applications of ICT.

Benchmarking the national ICT innovation systems in Europe (based on patenting, export and total factor productivity) has shown that the leading EU countries in terms of innovation performance in the ICT sector are **Finland, the Netherlands and Germany**. The ICT sectors of these three countries have both a high overall level of innovative performance and a high rate of growth in innovative performance.

In terms of the relationship between innovation performance and characteristics of the national innovation system, the study shows that a high level of innovation in the sector is strongly associated with two dimensions of the knowledge base of the economy: **R&D intensity and the level of skills**.

Countries with a high level of innovation performance in the ICT sector are also likely to have the following characteristics in terms of agents and interactions: domestic firms with a high level of **international orientation, availability of venture capital and smaller sized firms**.

Socio-cultural factors are important for the future of the ICT sector in Europe. The diversity in Europe on the four socio-cultural capitals identified in this study could be turned into a strong asset, e.g. when the sector manages to satisfy specific user needs with tailored applications.

Regarding **cultural and human capital** the importance of **entrepreneurial** behaviour of all the involved actors and levels of society is emphasized, not only in relation to diffusion and ICT-uptake, but also within the ICT sector itself. Also the importance of **multi-disciplinary** human capital for the ICT sector is an important challenge for the future. More and more the enhancement of innovation in the ICT sector is depending on the linkages between knowledge of ICT and other types of knowledge, and the linkages with and embeddedness in other sectors. The importance of innovative networking and **open innovation** puts a premium on multi-disciplinarity.

At the European level we have mentioned examples of important **social and organisational capital** referring to the institutionalised cross-country cooperation in EU research under the Framework Programme, and for example Initiatives such as the Marie Curie Fellowships can be regarded as a good way to improve social capital in the sector through the stimulation of trans-national and trans-sectoral mobility of researchers.

Although the use of ICT has changed the importance of distance, some regions in Europe have a large concentration of ICT production. Apparently, proximity still matters in innovation, even in the ICT domain. The **regional concentration** of ICT manufacturing (NACE 30, 32 and 33) and ICT services (NACE 64 and 72) **depends on** several factors of which the **availability of highly skilled people and research friendly surroundings** are the most important ones.

We have seen that the importance of the relation between the density in services and manufacturing doesn't work both ways, since high density in ICT services does not seem to be hampered by low ICT manufacturing density. However, since the **top regions in ICT manufacturing also have a high density of ICT services**, we conclude that for many EU regions it is difficult to have a sustainable dynamic ICT manufacturing industry without furthering their ICT service industries.

We have noted in chapter seven that for the ICT sector most public support in the form of funding of research and innovation comes from regional and national governments. In general ICT firms more often have received public funding than the average for all sectors, but there are differences by sub-sector. Firms in NACE 32, producing communication equipment, have received most public funding for research and innovation. Computer service firms (NACE 72) have less often received public funding, less than the average for the ICT sector. Innovating **ICT service firms have less often received public funds** for innovation than innovative firms in other sectors. Surprisingly low is the share of firms in NACE 30 (manufacturing of computers and office machinery) that have received public funds for innovation from EU sources.

EU policy support to ICT comes from several DGs (especially: DG Enterprise, DG Infso, DG Research and DG Regio), and many different programmes, e.g. the Competitiveness and Innovation Programme (CIP), the 7th Framework Programme and the Structural Funds programmes. In addition to supporting R&D and innovation, a large part of the public support is aimed at enhancing the diffusion and the society wide uptake of ICT. We have shown that this is also the case for the national policy support for ICT, since only a limited number of national policy measures are specifically aimed at innovation in the ICT producing sector.

Apart from the myriad of individual policies and measures cooperation and **systemic forms of innovation governance** for the ICT sector is deemed necessary to facilitate **strategic agendas** and a more **thematic focus** to research and innovation. A good example is the cooperation in research and innovation stimulated by the creation of European **Technology Platforms** and Joint Technology Initiatives which combine several projects and many type of stakeholders. The **Lead Market Initiative** also seems a potentially very appropriate policy tool for the ICT sector, as well as pre-commercial procurement of R&D services. Also at national policy level such strategic and systemic types of policy instruments seem most suitable for the ICT sector, since we have seen that compared to other sectors, **cluster initiatives** and technology platforms are more frequently used as policy format for the ICT sector than for other sectors. Good practice national research and innovation programmes are also designed as thematic, multi-actor and multi-user programmes.

8.2 Policy recommendations

ICT innovation policy is often focused on diffusion, and the up-take by SMEs in all sectors, and not specifically and directly addressing the research and innovation activities of firms in the ICT sector. The fact that the ICT sector is in many ways the most innovative sector in Europe already justifies a sector specific promotion of research and innovation capacities of the ICT sector itself. **Enhancing innovation in the ICT sector is at the benefit of all sectors in Europe**.

The four most important innovation policy issues for the ICT sector are: research, human resources, European integration, and funding. The two most important drivers of innovation at the level of ICT firms as well as the sector level for EU regions, countries and the Union as a whole are Research and Development and high educated Human Resources. The small scale of national markets and the still lagging integration at the EU level is one of the main barriers. Another main barrier is funding for risk-taking activities of innovative ICT companies. By addressing these four challenges in a systemic way public policy can function as a driver for innovation in the ICT sector.

In the next paragraph (8.2.1) we first discuss the more general recommendations based on the study results. Subsequently we highlight some more concrete recommendations from the ICT Innovation Watch panel in paragraph 8.2.2

8.2.1 Policy recommendations based on the study results

Systemic forms of innovation governance are most relevant policy tools to promote innovation in the ICT sector. Good practice formats are: cluster policies, technology platforms, thematic collaborative research programmes, and demand-side measures such as the Lead Market Initiative and pre-commercial procurement of R&D services. Such systemic tools facilitate: demand-driven co-operation, open innovation; alignment of strategic research agendas and thematic focus to research and innovation; and interaction between ICT producers and users.

In order to promote such systemic forms of public policy, which often consist of a policy mix of existing tools, more horizontal cooperation between policymakers of relevant national ministries and of the most relevant DG's of the European Commission is necessary. Maybe the existing regular meetings of DG Infso with the national ICT directors could be broadened for this purpose. More coordination is also needed between research and innovation policies at regional, national and EU level, in order to improve the overall benefits of public investments in ICT research and innovation.

We have seen much evidence of the importance of research expenditures for competitiveness in ICT. Not only for large ICT companies, but also for innovative ICT SME's, and not only at firm level, but also national and regional level. And new ICT knowledge is created by both public research institutes as well as private companies.

Concerning **research as a main driver** of innovation the findings of this study show the need for more ICT research in Europe in view of the gap vis-à-vis other parts of the world. Especially regarding public funded research it is important to reduce fragmentation and to promote co-operation and coordination in order to increase focus and critical mass. In addition, the ICT innovation watch panel called for more mobility of researchers, more excellence in universities, grants for research co-operation, improvement of the linkages between Science and Industry, and more funding in particular of “last stages of public funded research projects”. In addition, alongside the research it is important to develop more effective systems for technology transfer, research exploitation and valorisation.

Concerning **human resources** the importance of the availability of highly skilled labour is evidenced at several places in this report. The ICT panel also called for more flexibility of the labour market, accompanied by (re-)training of employees in order to promote job mobility and knowledge diffusion. Besides the importance of skills development in general, there are also some more specific needs, such as the need for multi-disciplinarity, the need for developing a more risk-taking entrepreneurial spirit, the need to enhance the managerial skills of ICT professionals and vice versa. These needs should be addressed during education. After education the mobility of researchers should be promoted, e.g. between researchers in the public and private domain.

Concerning the **lack of European integration**, the ICT sector would benefit from more harmonisation within the European Union in regulations, standards, spectrum, IPR, etc. Less regulation can be important to stimulate innovation, but it is more important to remove the barriers of **regulatory incoherence**. The EU still does not function as a single market for ICT goods and services. Also the promotion of one European Research Area (ERA) should be enhanced.

Concerning technological standardisation it is especially the efficiency, the **speed of the ICT standardisation processes** in Europe that needs to be improved.

Regarding **funding** it seems that a problem lies in seed capital, in early stage investment capital for businesses. The issue has to be addressed from different angles, also from a socio-cultural point of view, e.g. the image of failure. The encouragement of seed-funds being established in collaboration with business incubators should help in focusing finance towards the stronger and more capable companies as well as increasing the overall supply. An increase in the success level of the ICT companies leading to an increase in the financial return level to investors will inevitably result in an increase in the level of funding available. Another important mechanism for funding new business ventures is through corporate venturing, since, the best thing that can happen to many start-ups (contrary to common perception) is being acquired by a big company.

There are some mechanisms that would achieve good effectiveness for encouraging early stage venture capital. The first is the use of fiscal measures to encourage early stage investors, in particular business angels. The reduction of tax liabilities on profits from this type of investment and the ability to offset losses from one investment against the profits from another can have a major impact on the encouragement of this important area of early stage investment. Another activity is the establishment of seed-funds linked to business incubators; in these cases we have new ventures that are in a position to be provided with coaching and mentoring at the same time as adequate levels of funding.

As for start-ups, in Europe they tend not to grow beyond a certain size which has a direct impact on venture capitalists which have to take on higher risks and receive limited returns on their investments. Thus, venture capital is usually directed to refinancing existing firms, rather than creating new ones.

Besides these four main policy issues, there are a few more specific issues that deserve more attention from European policy makers.

Protection of **intellectual property** is essential for enhancing research and innovation in the ICT sector, but it is also a very complex and dynamic issue and also within the ICT sector there are differences of views regarding intellectual property, e.g. from the viewpoint of R&D in open source communities. Another sector-specific issue is that the most reported form of formal Intellectual Property protection for firms in the ICT sector is, by far, the use of **trademarks**. An issue that is neglected by policymakers who are all focussed on patents.

Regarding the patent system, reducing the costs and complexity is the most urgently needed improvement. A balanced and effective regime of intellectual property rights is important. Further improvements of the legal certainty and the accessibility of Europe’s patent system, especially for SMEs, is recommended.

Innovative ICT SMEs play a vital role in the development of new visions and in transforming them into business assets. The analysis has shown that among EU Member States the ICT sector is more innovative when the share of SME is higher. This fact that quite large shares of SME’s are innovative, is characteristic of the ICT sector. ICT SMEs experience difficulties in access to finance and are often smaller than in the US. This difficulty in accessing funding is particularly acute for early stage businesses. We have seen that relevant research and innovation policy projects do not reach many SMEs, they are viewed as too complex and time-consuming to apply for. The same holds for the patents system. Specific needs of innovative ICT SMEs should be mapped and addressed. E.g. Innovative ICT SMEs often can not afford not to operate on international markets. Due to short life-cycles, ICT ventures have to mature fast and one possibly relevant policy support could be to provide internationalisation and export support to young innovative ICT firms.

Proximity and regional clustering matters, especially regarding research and innovation. Regional cluster policies should be linked to other systemic policies at national or EU level, and at the level of co-operating regions. In many Member States there are improved linkages between regional and national innovation strategies, e.g. due to the involvement of regions in the implementation of National Reform Programmes reporting on the progress in relation to the Lisbon Agenda, but this should be promoted even more and at EU level as well. E.g. some regional ICT clusters can play an important role in national thematic programmes or the EU Lead Market Initiative, coordinated efforts from SF, FP, and CIP could increase the focus and efficiency of public investments, e.g. in the form of trans-national networking of innovative regional ICT clusters (e.g. Eindhoven-Leuven-Aachen), which could function as a pilot or lead network for more European integration, mobility and cooperation in ICT research and innovation.

It is good to promote the use and uptake of ICT in each and every region of the EU, but not all regions have to become a centre of excellence and be competitive globally in ICT research and innovation. In this respect cohesion policy should not hamper the development of EU centres of excellence. Regions with a high density of ICT manufacturing should promote the development and innovation of their ICT service sector.

In line with the Europe INNOVA thematic priority of: “promotion of innovation in knowledge intensive services” **more support for research and innovation in ICT services** is needed. Although the ICT services is in many ways the best performing, most dynamic, internationally competitive and often the most innovative of the EU ICT sub-sectors, and although in the future the ICT service sector will become even more important for Europe, innovative ICT service firms less often receive public funding than innovative firms in other sectors.

8.2.2 Recommendations of the ICT Innovation Watch panel

At the 5th Innovation Watch ICT sector panel the participants have worked on providing more concrete recommendations on the four main policy issues of research, human resources, European integration and financing.

I Better valorisation of research

The present problem is not the lack of ideas or basic research but the insufficient commercialisation of research results that determines Europe's position in the worldwide ICT market.

The objective should be to transform ideas into marketable products and services and thus, unfold the full innovation potential of the European ICT sector through a better valorisation and exploitation of research results.

This brings us to the following policy recommendations:

- Foster an entrepreneurial culture at universities through student companies, spin-off programmes that promote professors to act as entrepreneurs, and mobility programmes that bring entrepreneurs to universities.
- Foster demand-driven public-funded research through focused thematic platforms which integrate research institutions, companies and public authorities.
- Increase the utilisation of results from collaborative large-scale R&D projects with public funding by developing and implementing suitable IPR arrangements in case of non-utilisation of project results. Access to idle results should be granted against terms and conditions to be agreed.
- Because of the integrated nature of hardware, software and services it is important for future competitiveness of the Europe's ICT sector– not in the least regarding design and service sub-sectors - to perpetuate its ICT manufacturing knowledge, irrespective of shifting of ICT hardware production. Without ICT manufacturing knowledge it is difficult to fully exploit ICT research results.

II Future competences in Europe

The quantitative and qualitative deficits in terms of Human Resources regarding ICT in Europe need to be tackled in order to create the future competences in Europe which are vital in enhancing innovation in ICT, to the benefit of all sectors of Europe's economy and society.

The following policy activities are recommended:

- Provide appealing science and technology educational programs which attract more European students;
- Organise European "Science & Tech Olympic games" to promote development of top-quality education programs;
- Harmonise diploma levels and increase the possibility to tailor education, including mandatory international training;
- Promote the effective use of (ICT) technologies to provide flexible-, and life-long- learning;
- Organise a European Science fair system starting at the age of 7;
- Integrate entrepreneurial project work into the educational system in order to foster entrepreneurship on a learning-by-doing base;
- Promote cross-disciplinarily projects including those that integrate business teaching with science and engineering and teach the management of risk and risk levels;
- Stimulate mobility of highly skilled people between academia and industry;
- Introduce a "merit scheme" promoting a change in career;

- EU-level harmonized policy of principals to attract international highly educated people/researchers

III ”One Europe”

Several barriers to enhance innovation in the ICT sector in Europe relate to the lack of European integration. In order to be competitive on international markets the objective should be to reduce the fragmentation of Europe and enhance integration in the following ways:

- **Create one EU market;**
  To fully exploit the potential of ICT to address the grand challenges Europe is facing, a true SINGLE market approach is Europe’s only option, because investments will not come about if markets remain fragmented.
- **Speak with one voice;**
  Addressing the grand challenges that Europe is facing requires one holistic policy approach to those grand challenges (healthcare, energy efficiency, security, etc.), integrating the efforts of all relevant EC Directorates-General concerned.
- **Develop one Research Area;**
  Also in the domain of ICT, Europe's R&D efforts have so far been scattered over a variety of programmes at Community level (ICT part of FP7), intergovernmental level (ICT clusters of EUREKA) and national and regional levels. In this respect, the recently established Joint Technology Initiatives (JTIs) in the ICT domain (e.g.:ARTEMIS for embedded computing systems and ENIAC for nanoelectronics) are really major steps forward, as for the first time Community and national resources will be combined into single programmes to co-fund industrial R&D and establish a true European Research Area (ERA) in the domain of ICT. The new Treaty – once ratified – will for the first time provide a legal basis for the European Research Area. Nevertheless, based on our recent experiences in the difficult process of establishing the ICT JTIs within the institutional constraints and legal complexity of the European Union, we sometimes wonder whether the EU has the right instruments at its disposal to create a true European Research Area. The current institutional system seems caught in itself, paralysed by the political necessity to avoid mistakes rather than managing risks. For Europe to become a better place for research and innovation in the future, the risk that is inherent to these activities should be better taken into account in the Financial Regulation applicable to the general budget of the European Communities and its Implementing Rules.
- **Think global, act European;**
  With Europe as a home market, ICT products, applications and services should be developed with global markets in mind. This requires a more international approach to teaching ICT skills, whereas at the same time full advantage should be taken of Europe’s multicultural and multilingual capabilities.
- **Improve standardisation processes;**
  The efficiency of ICT standardisation processes in Europe needs to be im-

proved. The very short life-cycles in ICT call for faster standardisation processes.

- **More innovative public procurement;**
  As public procurement in the EU amounts to 16 % of total GDP, public administrations can play an important role in fostering R&D and innovation by acting as launching customers of innovative ICT solutions. The recent Communications on the Lead Market Initiative and on pre-commercial procurement of R&D services are important steps forward. These novel concepts now need to be put in practice.

IV Improve the Financial Support Mechanisms

In order to increase the business R&D expenditures in Europe in the light of the Lisbon Agenda a major contribution is to come from the ICT sector. In order to manage risk, improvements have to be made regarding the Financial Support Mechanisms and cultural biases with regard to innovation induced risk have to be modified. This brings us to the following recommendations:

- Develop fiscal mechanisms to support and encourage investment in innovation;
- Increase liquidity through a range of linked public/private activities;
- Implement Fiscal Incentives Roll-over schemes to encourage Angel investors R&D tax credit;
- Develop funding mechanisms to encourage early stage investment funding including: new seed-funds linked to business incubators financed by public-private partnerships; support for secondary market launch; simplifying the regulatory requirements or providing ‘agency support’;
- Introduce EU wide entrepreneurship educational programmes at all levels: a range of entrepreneurship programmes targeted at specific age and interest groups; incentivise schools and universities to run entrepreneurial programmes; introduce ‘business clubs’, business plan competitions, etc.; develop and provide contact, e-learning and social network based teaching;
- Address the cultural bias and fear vis-à-vis failure/bankruptcy;
- Strengthen support for start up companies: Implement a Senior business person support system in all EU countries.

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Appendix 1 Characteristics of ICT industries by sub-sector and innovation mode

	All firms			**Innovators**			**Strategic innovators**			**Intermittent innovators**		
	NACE 30	NACE 32	NACE 72	NACE 30	NACE 32	NACE 72	NACE 30	NACE 32	NACE 72	NACE 30	NACE 32	NACE 72
FIRM CHARACTERISTICS												
Share of all firms				65.4	60.9	62.8	19.6	20.6	17.5	37.2	27.5	29.1
Share of innovative firms							30.0	33.9	27.9	56.9	45.2	46.3
Product only innovator (% share)	38.4	24.9	30.6	58.8	40.9	48.7	51.5	34.8	43.2	69.7	45.8	50.6
Product and process innovator (% share)	23.1	27.2	27.0	35.3	44.6	43.0	48.5	65.2	56.8	29.6	40.7	44.3
Process only innovator (% share)	3.8	8.9	5.1	5.9	14.5	8.1	0.0	0.0	0.0	0.7	13.4	4.8
Average firm size (employee)	76	261	95	90	386	129	108	699	250	86	304	108
Labour productivity (1000's euros per employee)	262	225	179	243	241	194	195	296	204	263	158	201
Turnover growth (%-point)	-10.45	11.81	5.19	-16.39	12.00	4.88	5.15	12.63	14.05	-25.47	9.99	-4.37
Employment growth (%-point)	2.34	2.77	7.32	1.36	2.43	7.65	1.82	2.25	8.36	-1.34	2.27	8.01
Export growth (%-point)	14.44	13.12	18.80	11.33	13.56	19.77	6.77	13.92	20.23	-0.41	11.62	23.52
Share of employees with higher education	30.4	24.9	44.7	33.1	26.7	46.2	48.2	29.5	47.6	27.4	23.3	46.2
SALES												
Sales share due to new-to-firm products	21.7	44.5	17.4	30.4	46.3	18.7	16.9	41.3	20.6	42.1	64.2	16.2
Sales share due to new-to-market products	11.3	24.8	11.8	15.8	25.8	12.7	38.3	31.8	13.4	7.6	8.0	12.2
(Inter)national market most significant market	73.2	74.2	63.8	76.4	85.3	72.7	100.0	100.0	100.0	62.5	84.1	68.4
National market most significant market	*51.2*	*42.9*	*51.5*	*53.0*	*51.6*	*57.8*	*80.5*	*46.3*	*77.4*	*36.8*	*53.4*	*55.5*
International market most significant market	*22.0*	*31.3*	*12.2*	*23.5*	*33.7*	*14.9*	*19.5*	*53.7*	*22.6*	*25.7*	*30.6*	*12.9*
INNOVATION ACTIVITIES												
Share of firms that perform intramural R&D	62.0	45.3	47.8	86.8	73.0	72.0	100.0	100.0	100.0	88.2	77.7	86.5
Share of firms that acquire extramural R&D	17.3	17.1	10.0	25.3	27.2	15.5	43.0	40.5	24.9	17.6	24.9	16.4
Share of firms that buy advanced machinery and equipment	42.7	45.2	38.6	64.8	73.7	57.8	65.6	75.9	63.2	60.8	73.0	53.6
Share of firms that buy other external knowledge	19.1	12.9	21.4	28.1	20.7	33.0	44.1	27.8	34.9	22.5	20.7	33.4
Share of firms that train personnel	43.9	30.6	41.7	63.9	49.5	63.1	61.2	55.1	73.3	74.4	54.7	61.6
Share of firms that spend money on market introductions	40.2	23.6	37.0	61.1	38.7	56.2	58.6	47.3	70.6	68.5	40.7	57.7
Share of firms that spend money on design or other preparations for production/deliveries	25.2	20.9	30.2	38.2	34.0	45.5	55.9	53.1	55.6	37.4	29.5	46.4
INNOVATION ACTIVITIES - SPENDING												
Intramural R&D expenditures	60.3	54.4	76.3	58.1	54.3	76.5	66.4	54.4	79.9	58.0	55.6	72.1
Extramural R&D expenditures	10.8	6.1	1.3	11.4	6.1	1.3	3.6	6.2	0.8	27.2	4.3	2.3
Acquisition of advanced machinery and equipment	25.8	37.2	17.6	27.3	37.3	17.4	26.4	37.0	16.6	13.6	39.3	18.0
Acquisition of other external knowledge	2.8	2.2	4.6	3.0	2.2	4.6	3.5	2.4	2.7	0.9	0.4	7.1
Other innovation expenditures	0.2	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.3	0.3	0.4
PUBLIC FUNDING												
Receive funds from local or regional authorities	9.9	13.3	7.0	14.6	21.6	10.8	24.8	36.9	13.2	6.7	12.6	11.3
Receive funds from central government	8.3	17.3	7.1	12.1	27.6	11.1	17.7	50.8	17.7	3.4	21.8	11.1

	All firms			Innovators			Strategic innovators			Intermittent innovators		
	NACE 30	NACE 32	NACE 72	NACE 30	NACE 32	NACE 72	NACE 30	NACE 32	NACE 72	NACE 30	NACE 32	NACE 72
Receive funds from EU	1.6	5.9	3.9	2.5	9.6	5.8	7.0	18.2	9.4	0.7	6.0	5.4
INTELLECTUAL PROPERTY PROTECTION												
FORMAL METHODS												
Applied for patent	11.8	15.9	6.9	17.9	25.8	9.0	17.1	40.3	22.9	22.2	26.5	5.1
Used registration of design patterns	12.2	9.0	6.3	16.0	14.5	7.9	15.7	25.6	15.1	18.6	10.9	7.4
Used trademarks	22.6	13.7	19.8	26.8	19.9	27.9	37.6	33.8	47.4	24.5	14.7	26.4
Used copyright	3.4	4.7	15.7	4.8	7.7	22.6	9.7	17.5	36.8	3.1	3.9	19.9
STRATEGIC METHODS												
Used secrecy	26.5	26.5	31.2	33.9	39.5	43.7	37.6	55.5	62.0	34.3	35.0	42.9
Used complexity of design	18.7	16.5	21.9	24.5	23.3	33.7	28.8	33.7	41.1	25.4	20.6	37.3
Used lead-time advantage on competitors	36.9	28.6	36.8	49.9	40.8	54.2	62.2	62.8	78.7	45.9	30.3	50.6
STRATEGIC OR ORGANISATIONAL CHANGE	77.6	62.3	71.2	89.1	79.3	84.8	96.1	84.6	87.5	93.7	82.6	87.1
Implemented new or significantly changed corporate strategies	*48.2*	*34.0*	*46.7*	*59.8*	*45.4*	*57.9*	*70.4*	*47.7*	*67.2*	*61.2*	*50.3*	*54.2*
Implemented advanced management techniques	*40.1*	*26.1*	*37.4*	*43.8*	*34.3*	*47.3*	*40.9*	*42.7*	*55.9*	*48.8*	*33.4*	*43.1*
Implemented new or significantly changes organisational structures	*50.8*	*39.8*	*45.8*	*59.4*	*49.3*	*57.2*	*67.1*	*54.7*	*67.3*	*61.1*	*48.8*	*61.4*
Changed marketing concepts/strategies	*43.8*	*32.0*	*40.1*	*57.9*	*45.5*	*50.6*	*74.2*	*49.8*	*59.3*	*56.6*	*47.5*	*51.1*
Changed aesthetic appearance or design of products	*37.1*	*32.3*	*38.9*	*46.3*	*42.6*	*51.5*	*60.3*	*62.2*	*65.2*	*42.2*	*38.9*	*50.7*
EFFECTS OF INNOVATION												
PRODUCT ORIENTED EFFECTS												
Increased range of goods or services	56.2	53.7	52.5	82.8	86.3	83.4	81.7	96.5	92.6	89.6	82.6	81.9
High degree of impact	*4.5*	*7.4*	*10.4*	*6.9*	*10.2*	*16.6*	*0.0*	*5.5*	*10.9*	*9.9*	*7.0*	*13.3*
Increased market or market share	59.7	52.0	51.7	88.1	83.6	82.2	95.6	93.7	92.4	92.0	84.6	87.6
High degree of impact	*4.7*	*7.1*	*12.3*	*4.1*	*11.6*	*19.5*	*4.9*	*7.3*	*8.8*	*3.6*	*12.2*	*25.6*
Improved quality in goods or services	65.8	55.7	54.1	97.6	89.6	86.0	98.8	95.3	94.6	99.1	88.2	85.0
High degree of impact	*2.3*	*3.7*	*6.2*	*3.6*	*6.1*	*9.8*	*2.0*	*5.8*	*7.0*	*4.2*	*3.2*	*9.7*
PROCESS ORIENTED EFFECTS												
Improved production flexibility	49.5	47.3	38.9	72.5	75.7	61.8	75.4	83.5	72.1	72.2	72.7	60.1
High degree of impact	*7.2*	*11.5*	*11.4*	*11.0*	*18.8*	*18.2*	*10.5*	*15.6*	*9.6*	*10.0*	*22.1*	*22.0*
Increased production capacity	42.1	50.0	36.3	61.2	80.3	57.6	63.5	82.6	65.8	61.8	77.1	55.0
High degree of impact	*7.3*	*9.7*	*14.1*	*11.1*	*16.0*	*22.4*	*11.4*	*18.3*	*23.8*	*12.2*	*15.8*	*20.5*
Reduced labour costs per produced unit	42.5	48.2	31.0	61.9	77.2	49.2	64.7	81.0	57.5	65.0	74.9	44.6
High degree of impact	*11.7*	*13.3*	*15.0*	*17.9*	*21.8*	*23.8*	*19.4*	*14.3*	*32.2*	*18.2*	*25.5*	*16.0*
Reduced materials and energy per produced unit	36.7	41.4	21.3	53.1	66.0	33.7	58.7	72.4	41.3	54.3	67.4	31.6
High degree of impact	*16.6*	*13.2*	*13.2*	*25.3*	*21.7*	*20.9*	*22.1*	*25.2*	*28.5*	*29.5*	*26.1*	*19.5*
OTHER EFFECTS												
Improved environmental impact or health and safety aspects	28.8	36.3	12.5	41.0	57.7	19.8	51.2	60.9	16.8	39.1	54.3	19.0
High degree of impact	*14.0*	*15.4*	*7.1*	*18.4*	*23.4*	*11.2*	*32.5*	*20.2*	*6.0*	*13.7*	*24.9*	*11.2*
Met regulations or standards	40.0	43.0	26.4	58.0	70.6	42.0	61.2	77.8	39.9	58.6	63.3	43.1
High degree of impact	*6.5*	*11.5*	*8.4*	*10.0*	*18.9*	*13.3*	*13.5*	*17.0*	*13.0*	*9.6*	*17.5*	*11.4*

	All firms			Innovators			Strategic innovators			Intermittent innovators		
	NACE 30	NACE 32	NACE 72	NACE 30	NACE 32	NACE 72	NACE 30	NACE 32	NACE 72	NACE 30	NACE 32	NACE 72
INFORMATION SOURCES USED												
INTERNAL SOURCES												
Within the enterprise	65.4	56.6	58.6	91.6	91.3	88.9	97.0	93.4	90.4	96.2	94.9	88.6
High degree of importance	*5.3*	*4.8*	*11.0*	*4.9*	*7.7*	*15.7*	*4.1*	*5.2*	*9.8*	*5.8*	*9.7*	*12.4*
Other enterprises within the enterprise group	16.7	14.0	18.0	25.3	22.5	26.2	30.7	31.9	31.0	22.7	22.8	30.2
High degree of importance	*3.8*	*3.7*	*3.9*	*5.8*	*6.1*	*5.4*	*18.3*	*5.7*	*5.2*	*0.0*	*8.5*	*7.5*
MARKET SOURCES												
Suppliers of equipment, materials or software	52.9	52.4	47.5	77.5	84.9	71.6	68.1	81.3	62.7	83.5	85.8	72.9
High degree of importance	*7.5*	*12.7*	*21.8*	*11.4*	*20.5*	*31.8*	*15.6*	*26.1*	*28.0*	*10.2*	*22.1*	*38.7*
Clients or customers	55.6	49.7	56.6	76.8	80.1	85.0	89.2	86.9	90.9	78.1	78.0	82.6
High degree of importance	*14.7*	*6.0*	*12.5*	*18.2*	*9.1*	*19.9*	*25.8*	*8.2*	*16.6*	*11.0*	*11.5*	*17.3*
Competitors and other enterprises from the same industry	53.9	46.4	47.1	74.2	74.7	70.0	89.6	79.2	68.1	75.5	79.3	76.1
High degree of importance	*19.3*	*19.5*	*21.0*	*24.7*	*31.0*	*32.6*	*49.4*	*27.5*	*28.4*	*11.9*	*28.1*	*36.8*
INSTITUTIONAL SOURCES												
Universities or other higher education institutes	32.0	24.4	28.2	48.7	39.6	40.7	59.9	54.8	49.7	48.4	40.4	37.8
High degree of importance	*19.6*	*10.9*	*13.9*	*29.8*	*17.6*	*19.9*	*40.6*	*25.3*	*21.7*	*27.6*	*19.2*	*17.9*
Government or private non-profit research institutes	15.9	15.5	14.1	24.3	25.2	21.5	29.5	35.8	24.6	24.6	22.9	26.8
High degree of importance	*7.9*	*8.6*	*9.6*	*12.1*	*14.0*	*14.3*	*14.3*	*19.6*	*15.9*	*13.8*	*11.4*	*18.7*
OTHER SOURCES												
Professional conferences, meetings, journals	50.3	47.4	52.5	73.7	77.1	78.8	70.5	80.7	85.2	77.8	81.0	77.6
High degree of importance	*15.7*	*19.6*	*14.7*	*20.7*	*31.8*	*21.6*	*25.9*	*23.3*	*17.8*	*17.8*	*35.8*	*23.1*
Fairs, exhibitions	59.9	53.1	51.9	85.1	86.3	77.8	94.2	91.0	86.9	86.0	88.1	75.1
High degree of importance	*9.1*	*19.0*	*19.7*	*10.5*	*31.0*	*31.1*	*22.7*	*24.9*	*26.3*	*1.5*	*35.7*	*35.3*
HAMPERED INNOVATION ACTIVITIES												
Innovation activities: seriously delayed	34.1	19.9	37.5	48.3	32.2	56.7	51.4	45.5	69.1	55.2	33.2	56.2
Innovation activities: prevented to be started	14.2	9.6	17.7	21.2	15.1	25.5	6.4	24.2	12.0	31.0	13.3	30.0
Innovation activities: burdened/cumbered with other serious problems	18.7	15.4	14.9	26.5	24.8	23.2	30.4	39.9	23.6	27.2	18.6	28.2
FACTORS HAMPERING INNOVATION												
ECONOMIC FACTORS												
Excessive perceived economic risks	65.6	61.9	55.9	79.8	75.1	68.3	78.6	72.9	76.8	88.3	78.4	64.0
High degree of importance	*16.4*	*23.7*	*13.2*	*19.8*	*30.4*	*15.6*	*25.9*	*27.7*	*16.5*	*17.1*	*26.7*	*13.9*
Innovation costs too high	66.6	65.4	57.5	79.5	78.1	68.6	79.5	77.6	66.6	87.2	83.2	70.6
High degree of importance	*14.4*	*16.7*	*9.8*	*17.3*	*17.9*	*9.9*	*38.7*	*19.8*	*10.2*	*6.7*	*16.7*	*11.2*
Lack of appropriate sources of finance	64.7	58.0	54.2	78.2	70.2	65.5	83.9	71.5	68.8	83.9	73.1	66.1
High degree of importance	*20.9*	*24.1*	*19.6*	*21.3*	*26.8*	*23.7*	*30.0*	*30.6*	*32.4*	*18.5*	*22.8*	*20.7*
INTERNAL FACTORS												
Organisational rigidities within the enterprise	43.4	44.1	40.8	49.7	51.3	50.0	32.1	57.6	54.3	65.2	50.9	51.6
High degree of importance	*23.4*	*26.3*	*23.9*	*27.1*	*30.1*	*29.1*	*15.5*	*37.9*	*25.7*	*37.9*	*26.0*	*35.6*

	All firms			Innovators			Strategic innovators			Intermittent innovators		
	NACE 30	NACE 32	NACE 72	NACE 30	NACE 32	NACE 72	NACE 30	NACE 32	NACE 72	NACE 30	NACE 32	NACE 72
Lack of qualified personnel	60.5	54.4	54.1	74.5	66.0	66.9	82.9	72.1	69.5	81.4	68.1	70.5
High degree of importance	*13.7*	*23.3*	*18.2*	*14.1*	*27.5*	*23.2*	*12.0*	*31.2*	*24.9*	*17.6*	*30.5*	*25.8*
Lack of information on technology	50.5	47.5	37.6	61.7	56.8	44.3	54.6	65.7	41.6	74.4	60.1	45.0
High degree of importance	*28.2*	*28.8*	*26.7*	*34.2*	*33.8*	*33.1*	*32.2*	*37.3*	*32.6*	*42.1*	*43.0*	*35.0*
Lack of information on markets	49.8	51.4	39.6	59.2	62.3	48.4	51.6	69.4	52.9	71.4	64.5	47.7
High degree of importance	*22.9*	*27.7*	*19.6*	*24.2*	*32.8*	*25.1*	*19.2*	*31.1*	*24.4*	*31.3*	*39.0*	*23.6*
OTHER FACTORS												
Insufficient flexibility of regulations or standards	42.7	38.5	32.6	51.4	46.1	38.2	59.9	52.3	42.7	51.3	48.6	41.8
High degree of importance	*23.6*	*17.2*	*15.9*	*27.5*	*21.0*	*20.5*	*27.6*	*28.6*	*24.3*	*31.6*	*20.7*	*23.3*
Lack of customer responsiveness to new goods or services	38.2	43.3	46.4	38.1	52.4	51.7	35.1	56.3	64.5	41.2	57.8	54.0
High degree of importance	*22.2*	*22.2*	*26.5*	*19.9*	*27.4*	*32.8*	*14.0*	*36.0*	*39.1*	*26.8*	*24.8*	*33.5*

Appendix 2 Innovation characteristics of ICT firms and firms in all sectors by innovation mode

	All firms		Non-innovators		Innovators		Strategic innovators		Intermittent innovators		Diffusion innovators	
FIRM CHARACTERISTICS												
Share of all firms			39.1	62.9	60.9	37.1	17.8	5.9	28.5	15.5	14.6	15.7
Share of innovative firms							29.3	15.9	46.8	41.7	23.9	42.4
Product only innovator (% share)	28.5	11.9			46.8	32.1	40.5	32.1	50.8	36.4	46.6	27.9
Product and process innovator (% share)	26.8	16.0			44.0	43.1	59.5	67.7	43.2	49.2	26.6	27.8
Process only innovator (% share)	5.5	9.1			9.1	24.7	0.0	0.0	5.8	14.1	26.8	44.3
Average firm size (employee)	124	140	47	49	174	294	313	948	154	227	43	114
Labour productivity (1000's euros per employee)	194	239	114	178	208	256	239	261	183	242	106	265
Turnover growth (%-point)	6.95	6.53	11.12	5.19	6.59	6.80	12.82	7.19	-1.59	5.97	11.88	7.10
Employment growth (%-point)	4.52	1.86	5.74	0.76	4.32	2.18	5.05	2.45	3.42	1.77	4.34	2.13
Export growth (%-point)	12.91	11.77	9.76	5.81	13.09	12.46	13.54	13.71	10.41	10.97	35.11	10.39
Share of employees with higher education	35.0	14.2	27.8	10.9	36.3	15.1	39.3	16.4	33.4	13.8	29.0	13.6
SALES												
Sales share due to new-to-firm products	25.5	18.2			27.9	21.8	29.5	20.2	26.5	22.9	14.8	24.6
Sales share due to new-to-market products	17.4	7.1			19.0	8.5	23.6	10.4	12.3	7.4	7.4	5.0
(Inter)national market most significant market	67.0	58.6	53.7	53.2	75.6	67.9	100.0	100.0	71.8	76.2	53.3	47.7
National market most significant market	*50.2*	*39.9*	*41.3*	*37.8*	*56.0*	*43.4*	*70.7*	*52.3*	*54.0*	*49.7*	*41.9*	*33.9*
International market most significant market	*16.8*	*18.8*	*12.4*	*15.4*	*19.6*	*24.5*	*29.3*	*47.7*	*17.7*	*26.5*	*11.4*	*13.8*
INNOVATION ACTIVITIES												
Share of firms that perform intramural R&D	46.7	20.5			72.8	51.0	100.0	100.0	84.6	76.7	16.3	7.4
Share of firms that acquire extramural R&D	12.0	7.2			19.2	18.5	30.7	36.3	18.9	22.6	5.5	7.8
Share of firms that buy advanced machinery	38.4	26.3			60.4	66.7	66.4	71.6	57.3	63.7	58.9	68.0

	All firms		Non-innovators		Innovators		Strategic innovators		Intermittent innovators		Diffusion innovators	
and equipment												
Share of firms that buy other external knowledge	18.6	8.5			29.5	21.5	34.5	30.4	28.9	21.3	24.6	18.3
Share of firms that train personnel	36.6	16.9			57.6	42.7	65.3	62.2	58.1	46.4	47.0	31.7
Share of firms that spend money on market introductions	31.8	13.6			50.4	34.6	62.4	58.1	51.5	39.8	33.5	20.7
Share of firms that spend money on design or other preparations for production/deliveries	25.8	13.4			40.6	33.5	51.5	56.0	40.5	37.0	27.2	21.6
INNOVATION ACTIVITIES - SPENDING												
Intramural R&D expenditures	62.3	55.9			62.3	56.1	63.9	67.3	59.2	45.8	9.4	37.9
Extramural R&D expenditures	4.7	5.2			4.7	5.2	4.4	6.8	5.6	5.2	7.8	0.6
Acquisition of advanced machinery and equipment	29.3	32.0			29.4	31.8	29.1	23.9	28.8	40.8	53.5	42.8
Acquisition of other external knowledge	3.3	6.8			3.4	6.8	2.5	2.0	5.4	7.8	28.7	18.5
Other innovation expenditures	0.3	0.2			0.3	0.2	0.1	0.1	1.0	0.4	0.6	0.1
PUBLIC FUNDING												
Receive funds from local or regional authorities	8.6	5.7			13.7	15.0	19.7	22.5	12.2	13.3	9.3	13.9
Receive funds from central government	9.7	5.1			15.6	13.1	27.0	26.1	13.5	12.6	5.6	8.6
Receive funds from EU	4.2	2.3			6.6	5.9	11.1	11.1	5.5	6.0	3.1	3.9
INTELLECTUAL PROPERTY PROTECTION												
FORMAL METHODS												
Applied for patent	9.2	6.2	2.5	1.7	13.5	14.0	26.6	38.6	11.2	14.9	2.0	4.0
Used registration of design patterns	7.4	5.6	3.0	1.8	10.2	12.2	17.8	28.8	9.3	13.5	2.6	4.6
Used trademarks	18.1	9.9	6.0	5.2	25.8	18.0	41.5	34.4	24.2	20.4	9.6	9.4
Used copyright	12.1	2.7	3.3	1.1	17.6	5.4	28.9	11.0	14.8	5.9	9.4	2.7
STRATEGIC METHODS												
Used secrecy	29.3	12.8	8.8	4.8	42.4	26.3	59.0	54.4	41.5	29.7	24.1	12.3
Used complexity of design	20.3	7.7	3.0	2.4	31.4	16.7	39.8	32.1	33.4	19.6	17.3	8.0
Used lead-time advantage on competitors	34.0	15.7	7.5	5.9	51.0	32.4	72.7	61.2	46.9	37.0	32.5	17.0
STRATEGIC OR ORGANISATIONAL CHANGE	68.4	56.5	45.4	43.0	83.1	79.6	87.1	90.2	86.1	82.9	72.5	72.3
Implemented new or significantly changed corporate strategies	42.5	26.5	24.1	16.4	54.3	43.7	63.2	58.8	52.2	46.6	47.5	35.3
Implemented advanced management techniques	34.3	24.3	19.7	15.7	43.7	38.9	51.1	52.2	41.4	40.8	39.0	31.9
Implemented new or significantly changes organisational structures	43.9	35.1	26.3	23.8	55.2	54.2	64.7	68.9	57.4	55.9	39.1	47.1
Changed marketing concepts/strategies	37.2	25.8	19.2	17.3	48.8	40.3	57.9	54.9	49.3	43.0	36.7	32.0
Changed aesthetic appearance or design of products	36.9	29.6	17.2	19.3	49.6	47.1	62.8	60.3	49.2	49.8	34.0	39.5
EFFECTS OF INNOVATION												
PRODUCT ORIENTED EFFECTS												
Increased range of goods or services	52.0	28.2			84.7	75.7	93.1	91.9	84.2	82.3	75.6	63.1
High degree of impact	*8.9*	*4.9*			*14.4*	*13.0*	*9.1*	*8.0*	*11.4*	*15.0*	*26.7*	*12.9*
Increased market or market share	51.5	28.5			83.9	76.5	93.7	93.7	88.5	82.6	62.7	64.1
High degree of impact	*10.2*	*6.1*			*16.6*	*16.4*	*8.6*	*11.3*	*20.6*	*17.6*	*18.5*	*17.1*

	All firms		Non-innovators		Innovators		Strategic innovators		Intermittent innovators		Diffusion innovators	
Improved quality in goods or services	54.1	31.1			88.2	83.7	95.4	94.8	88.0	88.2	79.6	75.2
High degree of impact	*5.5*	*2.9*			*9.0*	*7.9*	*6.9*	*7.4*	*7.9*	*8.8*	*13.5*	*7.2*
PROCESS ORIENTED EFFECTS												
Improved production flexibility	40.5	24.3			65.8	65.3	76.3	78.6	64.4	67.7	55.7	57.8
High degree of impact	*10.7*	*5.2*			*17.5*	*13.8*	*11.9*	*13.1*	*20.6*	*14.5*	*18.3*	*13.4*
Increased production capacity	38.6	25.4			62.8	68.2	70.4	75.4	61.1	69.8	56.8	63.9
High degree of impact	*12.0*	*5.0*			*19.7*	*13.5*	*21.4*	*17.7*	*18.2*	*13.7*	*20.4*	*11.7*
Reduced labour costs per produced unit	34.6	23.8			56.1	63.9	64.1	72.9	53.9	65.3	50.6	59.1
High degree of impact	*13.9*	*6.7*			*22.7*	*18.1*	*27.7*	*21.1*	*18.2*	*19.5*	*25.6*	*15.6*
Reduced materials and energy per produced unit	26.5	19.5			42.9	52.3	51.9	62.2	42.4	55.8	32.9	45.1
High degree of impact	*13.4*	*8.1*			*21.9*	*21.6*	*28.7*	*23.6*	*21.6*	*24.2*	*14.1*	*18.4*
OTHER EFFECTS												
Improved environmental impact or health and safety aspects	19.0	18.2			30.5	48.9	32.2	57.8	30.4	51.7	28.6	42.9
High degree of impact	*8.7*	*5.0*			*13.8*	*13.4*	*12.3*	*17.2*	*13.5*	*13.5*	*16.2*	*11.9*
Met regulations or standards	31.0	20.4			50.5	54.7	53.9	66.7	50.8	57.3	45.8	47.6
High degree of impact	*8.7*	*4.4*			*14.2*	*11.8*	*15.8*	*16.1*	*12.1*	*12.5*	*16.3*	*9.5*
INFORMATION SOURCES USED												
INTERNAL SOURCES												
Within the enterprise	56.9	33.8			89.4	85.1	92.2	94.9	90.5	89.5	83.6	77.1
High degree of importance	*9.0*	*5.0*			*13.3*	*11.8*	*8.1*	*6.3*	*11.5*	*12.1*	*23.0*	*13.5*
Other enterprises within the enterprise group	16.6	8.1			25.3	20.4	30.7	29.5	28.0	22.8	13.5	14.7
High degree of importance	*3.5*	*1.8*			*5.2*	*4.4*	*6.0*	*7.1*	*6.5*	*5.0*	*1.8*	*2.8*
MARKET SOURCES												
Suppliers of equipment, materials or software	47.4	30.0			74.7	76.2	69.1	78.0	76.1	77.3	78.9	74.3
High degree of importance	*18.2*	*7.9*			*28.0*	*19.6*	*26.5*	*26.8*	*33.0*	*20.5*	*19.7*	*15.9*
Clients or customers	53.4	29.8			83.4	74.9	89.7	87.0	81.4	78.9	79.8	66.4
High degree of importance	*11.3*	*8.4*			*18.1*	*21.2*	*14.8*	*14.8*	*17.6*	*21.0*	*23.2*	*23.7*
Competitors and other enterprises from the same industry	45.9	26.4			71.3	66.4	73.4	72.7	76.0	69.4	59.7	61.2
High degree of importance	*19.5*	*11.1*			*30.9*	*28.0*	*28.5*	*30.3*	*33.1*	*28.8*	*29.4*	*26.4*
INSTITUTIONAL SOURCES												
Universities or other higher education institutes	26.3	11.3			40.2	27.8	51.1	50.3	37.8	30.5	31.6	16.6
High degree of importance	*12.5*	*5.6*			*19.1*	*13.7*	*22.3*	*19.6*	*17.8*	*15.6*	*17.4*	*9.5*
Government or private non-profit research institutes	14.6	8.3			23.2	20.7	29.2	36.7	25.7	22.4	11.1	13.0
High degree of importance	*9.1*	*4.6*			*14.3*	*11.6*	*17.1*	*19.8*	*16.6*	*12.7*	*6.5*	*7.5*
OTHER SOURCES												
Professional conferences, meetings, journals	49.4	25.8			77.5	64.4	83.2	78.2	77.3	67.0	70.8	56.8
High degree of importance	*15.9*	*10.3*			*24.6*	*26.1*	*20.5*	*26.3*	*26.7*	*27.0*	*25.6*	*25.2*
Fairs, exhibitions	50.4	29.5			79.0	74.0	87.7	83.3	78.0	77.3	70.1	67.4
High degree of importance	*18.5*	*9.8*			*30.0*	*24.7*	*26.1*	*25.8*	*33.1*	*26.2*	*28.5*	*22.9*
HAMPERED INNOVATION ACTIVITIES												

	All firms		Non-innovators		Innovators		Strategic innovators		Intermittent innovators		Diffusion innovators	
Innovation activities: seriously delayed	31.1	13.6			48.6	33.4	59.2	53.8	48.6	35.3	35.4	23.8
Innovation activities: prevented to be started	14.9	8.4			22.5	20.4	13.7	23.5	26.6	22.4	25.2	17.2
Innovation activities: burdened/cumbered with other serious problems	15.3	9.0			24.6	22.2	28.7	29.6	27.4	25.8	14.1	15.9
FACTORS HAMPERING INNOVATION												
ECONOMIC FACTORS												
Excessive perceived economic risks	55.6	48.4	35.8	40.7	68.2	61.4	73.7	66.9	66.8	62.7	64.4	58.1
High degree of importance	*15.2*	*13.1*	*9.8*	*10.3*	*18.7*	*17.7*	*19.6*	*20.5*	*16.6*	*19.1*	*21.6*	*15.3*
Innovation costs too high	57.8	53.1	39.1	44.9	69.8	67.1	68.7	71.7	72.7	68.9	65.6	63.5
High degree of importance	*11.7*	*10.7*	*10.5*	*8.8*	*12.4*	*14.0*	*14.7*	*17.2*	*12.5*	*15.8*	*9.5*	*11.1*
Lack of appropriate sources of finance	54.0	46.0	35.7	39.4	65.8	57.2	68.7	65.8	67.6	58.9	58.5	52.4
High degree of importance	*19.9*	*14.5*	*14.2*	*12.1*	*23.6*	*18.5*	*31.1*	*23.0*	*20.2*	*18.5*	*21.0*	*16.8*
INTERNAL FACTORS												
Organisational rigidities within the enterprise	40.1	37.0	26.2	30.2	49.0	48.6	52.9	52.4	51.1	50.6	40.0	45.2
High degree of importance	*23.5*	*17.6*	*15.3*	*13.5*	*28.8*	*24.6*	*28.1*	*30.3*	*33.0*	*26.3*	*21.4*	*20.9*
Lack of qualified personnel	51.9	45.2	32.0	37.1	64.7	59.1	68.9	64.4	68.1	61.6	53.1	54.7
High degree of importance	*18.6*	*15.2*	*11.5*	*12.4*	*23.1*	*20.0*	*25.2*	*23.6*	*25.7*	*21.5*	*15.3*	*17.1*
Lack of information on technology	39.1	37.7	26.7	31.4	47.1	48.5	47.7	52.6	49.2	50.7	42.0	44.8
High degree of importance	*26.4*	*19.7*	*16.2*	*15.1*	*32.8*	*27.5*	*33.6*	*34.1*	*35.9*	*29.9*	*25.9*	*22.7*
Lack of information on markets	41.2	37.3	26.5	30.8	50.6	48.4	55.8	54.6	51.4	50.3	42.6	44.1
High degree of importance	*21.0*	*19.7*	*12.7*	*15.6*	*26.4*	*26.6*	*25.8*	*30.0*	*27.0*	*29.3*	*25.9*	*22.7*
OTHER FACTORS												
Insufficient flexibility of regulations or standards	34.0	36.0	24.5	30.7	40.1	45.0	45.7	51.7	43.5	45.9	26.3	41.5
High degree of importance	*16.6*	*14.6*	*9.9*	*12.0*	*20.9*	*19.0*	*25.6*	*24.9*	*23.2*	*20.2*	*10.5*	*15.5*
Lack of customer responsiveness to new goods or services	43.7	39.8	34.7	35.9	49.5	46.5	59.5	54.1	52.2	48.2	32.1	41.9
High degree of importance	*24.5*	*17.9*	*15.5*	*14.6*	*30.4*	*23.4*	*36.5*	*29.4*	*30.8*	*25.5*	*21.9*	*19.2*

Appendix 3 Largest R&D performing companies

Company	Country	R&D Investment 2004 €m	CAGR 3yrs %	Net Sales 2004 €m	Employees 2004 #	R&D/Net Sales ratio 2004 %	2003 %	R&D per employee 2004 €K	2003 €K
Electronics & Electrical equipment									
Siemens	Germany	5,063	-9.3	75,167	419,200	6.7	7.4	12.1	13.1
Philips Electronics	Netherlands	2,534	-8.5	30,319	141,966	8.4	9.0	17.8	17.8
Schneider	France	535	1.4	10,365	84,866	5.2	5.6	6.3	6.7
ALSTOM	France	336	-16.4	13,662	69,594	2.5	2.8	4.8	6.2
Thomson	France	277	-9.0	7,994	49,079	3.5	3.5	5.6	5.1
Matsushita Electric	Japan	4,419	2.9	62,562	334,752	7.1	7.7	13.2	14.3
Sony	Japan	3,604	5.0	47,940	151,400	7.5	6.9	23.8	22.8
Samsung Electronics	South Korea	3,484	25.5	58,251	..	6.0	5.5	..	..
Canon	Japan	1,977	8.0	24,899	108,257	7.9	8.1	18.3	18.1
LG Electronics	South Korea	1,097	..	30,737	..	3.6	3.1	..	..

Sharp	Japan	996	1.5	16,207	46,164	6.1	7.6	21.6	23.4
Sanyo Electric	Japan	899	4.8	18,007	82,337	5.0	5.3	10.9	11.0
Ricoh	Japan	793	11.0	13,025	75,100	6.1	5.2	10.6	9.1
Agilent Technologies	US	686	-11.6	5,283	28,000	13.0	17.4	24.5	26.7
Asea Brown Boveri	Switzerland	508	1.8	15,245	102,537	3.3	3.3	5.0	3.9
Telecommunication Services									
Deutsche Telekom	Germany	900	0.0	57,880	247,559	1.6	1.6	3.6	3.6
France Telecom	France	564	-0.2	47,157	204,826	1.2	1.0	2.8	2.2
Telefonica	Spain	461	-2.1	30,322	156,819	1.5	1.5	2.9	2.9
BT	UK	363	-10.8	26,305	99,600	1.4	1.8	3.6	4.6
Vodafone	UK	309	25.8	48,213	57,378	0.6	0.5	5.4	4.0
TeliaSonera	Sweden	308	28.8	9,071	25,381	3.4	3.1	12.1	10.8
Telecom Italia	Italy	139	..	31,237	88,892	0.4	0.5	1.6	1.5
NTT	Japan	2,284	-6.6	77,584	201,486	2.9	3.2	11.3	12.4
Telstra	Australia	266	-14.4	12,273	38,564	2.2	2.9	6.9	9.2
SK Telecom	South Korea	194	27.9	7,513	7,353	2.6	2.3	26.4	26.7
AT&T	US	123	-19.9	22,467	47,600	0.5	0.8	2.6	3.3
IT Hardware									
Nokia	Finland	3,834	3.9	29,267	53,511	13.1	13.5	71.6	77.1
Ericsson	Sweden	2,436	-22.2	14,611	51,742	16.7	24.9	47.1	56.7
Alcatel	France	1,557	-20.5	12,265	55,718	12.7	12.7	27.9	26.3
Infineon Technologies	Germany	1,219	..	7,195	34,127	16.9	17.6	35.7	34.4
Intel	US	3,515	8.0	25,168	85,000	14.0	14.5	41.4	40.2
Hitachi	Japan	2,790	-2.2	64,813	347,424	4.3	4.3	8.0	8.2
Hewlett-Packard	US	2,579	9.5	58,787	151,000	4.4	5.0	17.1	18.9
Toshiba	Japan	2,418	0.9	40,060	161,000	6.0	5.9	15.0	14.4
Cisco Systems	US	2,348	-6.6	16,219	34,000	14.5	16.6	69.1	67.8
Motorola	US	2,251	-10.8	23,045	68,000	9.8	13.9	33.1	31.5
NEC	Japan	1,977	-6.2	34,859	147,753	5.7	5.2	13.4	12.9
Fujitsu	Japan	1,801	-14.6	34,225	156,169	5.3	6.2	11.5	13.1
Texas Instruments	US	1,455	7.4	9,255	35,472	15.7	17.8	41.0	37.7
Nortel Networks	Canada	1,441	-15.3	6,035	34,150	23.9	19.2	42.2	41.0
Sun Microsystems	US	1,417	-1.5	8,229	32,600	17.2	16.1	43.5	37.4
STMicroelectronics	Switzerland	1,065	14.0	6,442	49,500	16.5	16.1	21.5	18.7
Software & Computer Services									
SAP	Germany	1,020	4.3	7,514	31,224	13.6	14.2	32.7	34.2
Dassault Systemes	France	222	2.0	797	4,456	27.8	28.6	49.8	52.7
Misys	UK	128	2.4	1,255	6,507	10.2	9.8	19.7	19.4
Business Objects	France	111	39.7	681	3,834	16.3	17.0	28.9	17.9
Infogrames Entertainment	France	111	2.9	701	1,511	15.8	10.5	73.1	50.1
Sage	UK	105	14.1	971	7,635	10.8	10.4	13.8	14.1
Microsoft	US	4,550	12.8	29,273	61,000	15.5	21.1	74.6	100.4
IBM	US	4,167	7.0	70,844	329,001	5.9	5.7	12.7	11.7
Oracle	US	1,097	11.5	8,681	49,872	12.6	12.6	22.0	22.6
Computer Associates	US	559	1.3	2,597	15,300	21.5	21.6	36.5	33.9

Reported R&D company data financed out of own funds only and classified by registered office.

Source: EU Industrial R&D Investment Scoreboard 2005

Appendix 4 Key economic ICT indicators: country data

	ICT Manufacturing						ICT Services					
	Value added (€ million)	Number of persons employed	Number of enterprises	Turnover (€ million)	Apparent labour productivity (€ 000s)	Average firm size	Value added (€ million)	Number of persons employed	Number of enterprises	Turnover (€ million)	Apparent labour productivity (€ 000s)	Average firm size
EU25	88720	1771106	63608	398258	50.1	28	358564	4989106	618638	1232842	71.9	8
Belgium	1904	25875	540	6560	73.6	48	11445	145370	15896	50467	78.7	9
Czech Republic	740	65697	4625	3697	11.3	14	684	43031	18220	1965	15.9	2
Denmark	1174	21662	596	3279	54.2	36	7816	116235	10435	28470	67.2	11
Germany	20135	355099	6931	85130	56.7	51	64061	776997	49467	208863	82.4	16
Estonia	40	6104	162	129	6.6	38	110	6806	1180	698	16.2	6
Greece	--	--	--	--		--	--	--	--	--		--
Spain	3484	66177	3115	14390	52.6	21	24727	406810	41885	87518	60.8	10
France	16818	297665	6725	74329	56.5	44	51365	760679	71701	194196	67.5	11
Ireland	4548	37276	218	26294	122.0	171	2649	33790	3805	12073	78.4	9
Italy	8655	179453	14910	29759	48.2	12	40596	586034	106297	128417	69.3	6
Cyprus	3	83	3	--	36.1	28	454	5749	368	787	79.0	16
Latvia	10	675	115	12	14.8	6	532	16672	1316	1521	31.9	13
Lithuania	110	10575	194	307	10.4	55	396	19588	1613	1453	20.2	12
Luxembourg	64	1347	15	147	47.5	90	1254	9960	1782	5638	125.9	6
Hungary	1080	74626	4014	7954	14.5	19	2232	74560	20411	7597	29.9	4
Malta	173	3297	59	1214	52.5	56	63	2512	691	204	25.1	4
Netherlands	1398	66178	1135	4853	21.1	58	16622	343849	29105	100959	48.3	12
Austria	2841	38781	510	9136	73.3	76	8098	109140	12123	30327	74.2	9
Poland	1479	75405	6852	5184	19.6	11	2911	--	25275	7603	--	--
Portugal	743	21494	486	3867	34.6	44	4567	76935	7310	15954	59.4	11
Slovenia	243	--	1022	928		--	351	--	2673	1623	--	--
Slovak Republic	184	24428	310	840	7.5	79	731	31801	1896	2375	23.0	17
Finland	7251	47814	717	26663	151.7	67	5791	86621	7558	20856	66.9	11
Sweden	992	82016	1850	19550	12.1	44	13362	221014	34372	47859	60.5	6
United Kingdom	14650	269379	8504	74037	54.4	32	97749	1114953	153079	275420	87.7	7

Source: European Commission (2005).

Appendix 5 Industrial structure, ICT EU: size distribution of firms (2001)

Number of enterprises (units)	ICT	% share	ICT manu-facturing	% share	NACE 30	NACE 31.3	NACE 32	NACE 33.2	NACE 33.3	ICT ser-vices	% share	NACE 51.8	NACE 64.2	NACE 72
Total	681959		62668		8552	2516	28780	16502	6318	619291		156311	17713	445267
SME (1-249 employees)	679133	99.6%	61521	98.2%	8416	2395	28189	16262	6259	617612	99.7%	155850	17418	444344
Micro (1-9)	604649	88.7%	48778	77.8%	7124	1471	23183	12151	4849	555871	89.8%	126664	14679	414528
Small (10-49)	62296	9.1%	9468	15.1%	955	596	3681	3085	1151	52828	8.5%	25637	2095	25096
Medium-sized (50-249)	12188	1.8%	3275	5.2%	337	328	1325	1026	259	8913	1.4%	3549	644	4720
Large (250+ employees)	2826	0.4%	1147	1.8%	136	121	591	240	59	1679	0.3%	461	295	923
250-499	1546	0.2%	576	0.9%	56	61	277	140	42	970	0.2%	280	135	555
500-999	736	0.1%	309	0.5%	47	37	149	64	12	427	0.1%	113	82	232
1000+	544	0.1%	262	0.4%	33	23	165	36	5	282	0.0%	68	78	136
Value added at factor cost (€ million)	**ICT**	**% share**	**ICT manu-facturing**	**% share**	**NACE 30**	**NACE 31.3**	**NACE 32**	**NACE 33.2**	**NACE 33.3**	**ICT services**	**% share**	**NACE 51.8**	**NACE 64.2**	**NACE 72**
Total	371285		91365		14482	6131	46158	20552	4042	279920		--	139962	139958
SME (1-249 employees)	115745	31.2%	29017	31.8%	3806	2167	10623	9875	2546	86729	31.0%	--	5456	81273
Micro (1-9)	34801	9.4%	4232	4.6%	784	142	1690	1198	417	30569	10.9%	--	1694	28875
Small (10-49)	35046	9.4%	8947	9.8%	1076	524	3226	3067	1054	26099	9.3%	--	1825	24274
Medium-sized (50-249)	45899	12.4%	15838	17.3%	1946	1501	5706	5610	1076	30061	10.7%	--	1937	28124
Large (250+ employees)	255540	68.8%	62348	68.2%	10677	3964	35536	10676	1496	193191	69.0%	--	134507	58685
250-499	24173	6.5%	9447	10.3%	1444	816	3849	2780	558	14725	5.3%	--	2027	12698
500-999	37115	10.0%	13673	15.0%	1566	1459	6903	3296	448	23442	8.4%	--	10269	13173
1000+	194252	52.3%	39228	42.9%	7666	1689	24783	4601	490	155024	55.4%	--	122211	32813
Number of persons employed (000s)	**ICT**	**% share**	**ICT manu-facturing**	**% share**	**NACE 30**	**NACE 31.3**	**NACE 32**	**NACE 33.2**	**NACE 33.3**	**ICT ser-vices**	**% share**	**NACE 51.8**	**NACE 64.2**	**NACE 72**
Total	53793		17923		2249	1506	9524	3724	920	35870		15222	12006	23864
SME (1-249 employees)	25349	47.1%	6747	37.6%	730	541	2782	2063	631	18602	51.9%	12100	1480	17122
Micro (1-9)	8905	16.6%	1165	6.5%	158	47	503	323	134	7740	21.6%	3727	337	7403
Small (10-49)	7571	14.1%	2063	11.5%	206	140	822	651	244	5508	15.4%	5108	443	5065

Medium-sized (50-249)	8873	16.5%	3519	19.6%	366	354	1457	1089	253	5354	14.9%	3265	700	4654
Large (250+ employees)	28444	52.9%	11176	62.4%	1519	965	6742	1661	289	17268	48.1%	964	10526	6742
250-499	4228	7.9%	1967	11.0%	201	207	967	468	124	2261	6.3%	964	468	1793
500-999	4935	9.2%	2523	14.1%	350	263	1365	461	84	2412	6.7%	--	1030	1382
1000+	19281	35.8%	6686	37.3%	968	495	4410	732	81	12595	35.1%	--	9028	3567

Apparent labour productivity (€ 000s)	**ICT**	**ICT=100**	**ICT manu-facturing**	**Manufactu-ring = 100**	**NACE 30**	**NACE 31.3**	**NACE 32**	**NACE 33.2**	**NACE 33.3**	**ICT services**	**Services = 100**	**NACE 51.8**	**NACE 64.2**	**NACE 72**
Total	69.0	100.0	51.0	100.0	64.4	40.7	48.5	55.2	43.9	78.0	100.0	--	116.6	58.6
SME (1-249 employees)	45.7	66.2	43.0	84.4	52.1	40.1	38.2	47.9	40.4	46.6	59.7	--	36.9	47.5
Micro (1-9)	39.1	56.6	36.3	71.3	49.6	30.3	33.6	37.1	31.1	39.5	50.6	--	50.3	39.0
Small (10-49)	46.3	67.1	43.4	85.1	52.2	37.4	39.3	47.1	43.2	47.4	60.7	--	41.2	47.9
Medium-sized (50-249)	51.7	74.9	45.0	88.3	53.2	42.4	39.2	51.5	42.5	56.1	71.9	--	27.7	60.4
Large (250+ employees)	89.8	130.2	55.8	109.4	70.3	41.1	52.7	64.3	51.8	111.9	143.4	--	127.8	87.0
250-499	57.2	82.8	48.0	94.2	71.9	39.4	39.8	59.4	45.0	65.1	83.5	--	43.3	70.8
500-999	75.2	109.0	54.2	106.3	44.7	55.5	50.6	71.5	53.4	97.2	124.5	--	99.7	95.3
1000+	100.7	146.0	58.7	115.1	79.2	34.1	56.2	62.8	60.5	123.1	157.7	--	135.4	92.0

Appendix 6 Benchmarking countries according to indicators related to Demand and Institutions: ICT Industry

Country	III- Demand and institutions					
	Size of the domestic market (1)	Favourable demand (2)	Index of product competition (3)	Effectiveness of the IPR system (4)	Existence of industry specific policies (5)	Access to Credit (6)
Finland	0.23	0.83	0.61	3.4	2.49	69.36
Netherland	0.34	0.89	0.74	4.4	0.41	90.75
France	1.33	0.86	0.71	3.7	0.83	97.17
UK	1.02	0.91	0.86	3.9	2.07	90.44
Belgium	0.23	0.77	0.71	3.8	0.41	9.21
Germany	2.70	0.89	0.77	4.0	0.00	94.28
Austria	0.24	0.94	0.66	4.1	0.83	89.74
Sweden	3.29	0.79	0.21	3.8	0.41	99.01
Denmark	1.02	0.93	0.75	3.8	3.32	44.12
Spain	0.50	0.70	0.64	3.5	1.66	77.18
Portugal	0.11	0.45	0.71	2.5	0.00	76.67
Italy	1.14	0.86	0.60	3.7	0.00	59.46
Norway	0.94	0.93	0.81			71.53
Hungary		0.81	0.60	3.3	0.00	27.80
Poland	0.70	0.78	0.41	2.7	0.41	19.23
Czech Republic		0.82	0.61	3.0	1.24	58.39
Slovakia	1.21	0.79	0.66	2.4	0.00	35.21
Testing independency						
IIP[a] - Levels	-22%	31%	38%	70% (***)	48%**	48% (**)
IIP- Growth	-26%	29%	15%	50% (*)	14%	31%

(1) Production plus imports minus exports, average 1991-2001, Groningen, relative to the mean.

(2) Proportion of firms for which uncertain demand or lack of demand are not a problem for innovate.

(3) Index of product market competition.

(4) IPR protection index taken from Ginnarte and Park, 1997 & Gwartney, Lawson, Edwards, de Rugy, Park and Whag (2006)

(5) Relative to European average number of policies specifically oriented to ICT companies.

(6) Measure of how much industry is given access to credit weighted by GDP

a IPP: Index of innovative performance