Information and Communication Technologies

The information and communication technologies (ICT) are one of the most important engines for innovation in enterprises and growth of economies. ICT enter enterprises as general purpose technologies (GPT) which are integrated in the new production and management processes. ICT also change the organizational boundaries and transform the models for adding value, competitiveness, and consumption. The effects of their use include decreased relative transaction costs, shortened product life cycles and structural changes in markets (convergence, concentration and bargaining power). The expenditure for Research and Development, patent activity and venture financing in the ICT sector exceed substantially that in the other sectors in the OECD countries.[51] R&D focused on ICT, nanotechnologies and new materials, is among the most important driving forces leading to product innovations. The driving forces are connected to the health and leisure industries (including electronic games). Modern processes and marketing innovations cannot exist without ICT. The internet and web-based services have caused important social innovations, including in the political process and state governance. The ICT infrastructure is already considered an essential element of the critical infrastructure of each country, while the issues of digital security are of primary importance for the policy of each country or corporation.

[51] *Information Technology Outlook 2008,* OECD, p. 144.

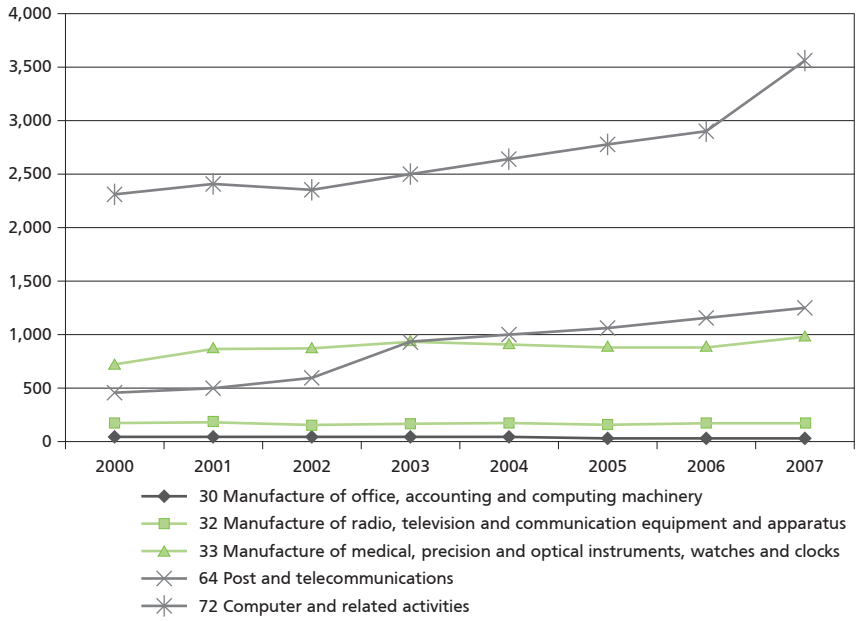
The Information and Communication Technologies Sector

The ICT sector[52] in Bulgaria is distinguished by high levels of entrepreneurship (comparable only to construction and manufacture of furniture as new enterprises, as well as to pharmaceuticals and cosmetics in degree of innovativeness). The majority of telecoms already have their R&D units (laboratories and staff) which mainly work on the convergence and release of triple play services and on the development of new products. Bulgarian telecoms frequently prove to be among the early introducers of new technologies in Europe[53] and thus support Bulgaria's position as an early adopter of new internet technologies[54]. Telecoms commissioned complex systems of payment, thereby causing the emergence of innovations in the sector of "Computer and Related Activities", as well as making it easier for a network of value added SMS companies to appear which, after an initial test period in Bulgaria, entered the European markets. Because of the specific development of broadband access to internet in Bulgaria and the existence of trained users this model of developing and testing new services in Bulgaria and subsequent transfer of technologies or entry into European markets also has substantial potential in other spheres (interactive digital TV, games and broadband networks, among others).

As a whole, the relative significance of production sub-sections in ICT has dropped from 28 % to 20 % in respect to the number of companies and remains stable – but also low – in respect to the share of added value (9 %) and turnover (13 %) in the ICT sector. For example, companies in the "Manufacture of Office, Accounting and Computing Equipment" sector have declined by 40 %. A number of sector migrations took place in the past ten years. Some of the producer companies (for example, manufacturing radar equipment, controller or computer components) stopped production and replaced it with importing and distribution of such products in the country. In the case of a second group of companies, activities other than production grew gradually and took a larger share. In the third place, formal sector migration was due to incorrect reference to the respective sections at different times.[55] Typical examples are companies from one and the same group when a certain type of service is organized as a separate business (warranty service repairs).

The relative size of ICT companies measured through their turnover practically doubled in eight years – 84 % growth after 2000. The largest companies are in the "Post and Telecommunications" sector and the smallest – in the "Computer and Related Activities" sector. The concentration in the sub-sections is also quite different. Slightly over 100 companies cover nearly 80 % of the entire turnover in the sector, while just 9 companies cover 60 % of the turnover in sub-sec-

Figure 41. DYNAMICS OF COMPANY NUMBER BY ICT SUB-SECTIONS



Source: NSI, 2009

[52] Defined as NACE sections 30, 32, 33, 64 and 72.

[53] For example, the introduction of PON by Spectrum Net.

[54] Although at the beginning many of the large telecoms regarded LAN and small internet suppliers with LAN-like model of growth and technologies with contempt, it was precisely this group of companies which proved to be real-world laboratories for ICT and practically prepared the market and experts for the large companies. At the moment, too, some large suppliers are stretching cables through the air, in violation of requirements – something of which they usually aggressively blame the small ones.

[55] By expert estimation, some 30 % of all classifications at 4-digit NACE code level are wrong, and quite frequently the mistakes are found at 2-digit code level.

tor "Manufacture of Office, Accounting and Computing Machinery."

The fastest growth is observed in sectors "Instruments and Appliances for Measuring, Testing and Navigation" and "Machinery and Other." This growth is largely due to the increase in exports (5- to 10-fold) of the respective groups of products – printed circuit boards, microscopes and measuring equipment. In these two groups of enterprises there are a number of Bulgarian companies which have their own laboratories and staff. Some of the local manufacturers became suppliers of large multinational companies.

The only group with declining turnover per enterprise is in the "Posts and Telecommunication" sector mainly among the new companies, while the old one usually had stable growth.

Added value in the ICT sector remained stable at levels of about half of the turnover over all the years from 2000 through 2009. The most significant drop in added value as a share of turnover is observed in sector „Television and Radio Receivers, Recording and Broadcasting Equipment" – from 41 % in 2000 to 20 %.

At the same time, section "Computer and Related Activities" enjoyed a quick growth from 26 % to 44 %. In this case, the gradual departure of the sector from the grey economy is also an essential factor for growth. Most of the legal information systems have small R&D units aimed at developing value added services based on public data. Some local ERP manufacturers also invested in R&D as a reaction to the demand of their existing clients. Some traditionally outsourcing companies released their own new services on the market. This group of companies also includes innovation hubs (companies which, by providing technologies and services, actually make innovations at their clients), as well as companies specialized in R&D (by participation in framework programs or as a model of growth), at which over half of the staff is constantly or partially engaged in R&D.

According to NSI data, the expenditure for R&D in the ICT sector doubled in 2000 – 2007 and reached some €9 million, with average for the period expenditure for R&D in ICT standing at about 20 % of R&D expenditure in all sectors. On average, this constitutes a mere 0.3 % of the turnover of one company. The

Table 9. SECTOR LEADERS IN EXPORTS, MLN OF EURO

SITC	2000 Import	2000 Export	2003 Export	2003 Износ	2006 Import	2006 Export
Printed circuit boards	2.613	8.876	20.231	22.621	15.753	39.298
Microscopes, diffraction apparata and parts	0.063	0.008	0.051	0.137	0.733	2.757
Control and measuring instruments and apparata	41.022	9.534	70.026	26.798	101.268	103.231
Optical products	3.596	7.123	5.659	7.091	10.359	10.937

Source: National Statistical Institute

Table 10. SELECTED R&D INDICATORS IN THE ICT SECTOR

	2000	2001	2002	2003	2004	2005	2006	2007
Turnover of one company (€, thousands)	277	331	495	380	403	448	489	510
Added value as a share of turnover	47	51	39	53	52	48	47	45
Expenditure for R&D (% of turnover)	0.46	0.30	0.14	0.11	0.14	0.16	0.25	0.29
Expenditure for R&D per company (€)	1,274	1,008	686	416	563	703	1,220	1,467
R&D staff	840	810	714	396	370	305	398	460
Expenditure for R&D per employed in R&D (€)	5,760	5,090	3,944	4,790	7,378	11,639	15,975	19,198

Source: National Statistical Institute and own calculations and estimations of lacking or confidential data, 2009

low level of expenditure for R&D is also demonstrated by the fact that R&D expenditure per employed in the same activity are comparable to the salary of the said employee, which means that either the employed actually engage in R&D in a very small portion of their time, or that nearly no funds are set aside for investment in technologies necessary for R&D. In-depth interviews with representatives of various companies (not only ICT) with R&D show, however, that most of the companies do not report their R&D at the National Statistical Institute or keep special account of it which may help them to constantly have an adequate picture of their own R&D from the point of view of invested resources (including number of staff). If by 2000 tax considerations for preferring accounting direct costs for the respective period to expenditure for R&D for future periods had a considerable role, at the end of the first decade of the 21st century the problem is rather that inertia has settled in, as well as the lack of accounting and organizational capacity to follow and record these indicators. By rough estimates, the real share of R&D in ICT turnover is underestimated 3 to 10-fold, but more detailed research is necessary for a precise evaluation. It is expected that the data for 2009 and the following years will feature many more companies reporting R&D, as well as innovation activity in ICT, because state institutions began to use the statements filed with the National Statistical Institute as source of information for some requirements in cases where companies applied for financing from the structural funds.[56] A problem yet to be resolved[57] in this respect is the application of a methodology for software innovativeness assessment aligned with international definitions in applications to the Operational Program Competitiveness.

The future of R&D in ICT depends on endogenous factors like human capital/university systems (which produce a maximum of 3,500 IT specialists a year[58]), local demand by other industries and public procurement for electronic management systems, as well as on exogenous factors like the decisions of foreign companies about the future of their branches,[59] the EU framework programs and the coordination activities in European Research Area in the field of ICT.

In Bulgaria the patent activity of enterprises in the ICT sector is very low, with an average of some 20 patents a year for the period 2000 – 2007 (with about 10 patents a year registered at the end of the period) or about 2 % of the total registered patents a year. This is largely due to the fact that the greater frequency of innovations in ICT is associated with the production of software which cannot be patented anyway (in Europe). At the same time, nearly all applications and registered patents in the USA in recent years, for which Bulgarians (or foreigners living in Bulgaria) have been entered as inventors, are in the field of ICT. The leader in terms of patents is SAP (for 2009). Another leader is RaiSat (with an equal number of applications along with SAP in 2009). Both companies have sustainable connection with scientific institutions (Sofia University's Faculty of Mathematics and Informatics and the Faculty of Physics, as well as the Technical University in Sofia) in Bulgaria – their leading specialists are established scientists or promising young people (doctoral students).

The leading Bulgarian ICT companies participating in R&D funded under the framework programs of the EU also have a close partnership with academic institutions and laboratories. A case in point is Sirma Solutions in which lecturers in the field of software engineering work and staff (frequently doctoral students) publish in prestigious international journals with a high impact factor (Sirma is the Bulgarian company with the largest number of publications in the field of ICT). More detailed research is needed in respect to the connection of science (publication activity and teaching), patents and innovations with business, but qualitative studies unequivocally demonstrate that recognized scientists in the field of ICT work jointly (and frequently also have their own firms) with leading companies in the sector and vice versa. The situation in other high-tech fields of science and the economy is similar. The ICT sector is in the unique position of balancing interaction between the educational system (even from secondary schools), science and business – there are other sectors (for example, biotechnologies, chemistry and others) that cannot have the existing R&D potential used for developing local production and scientists work for foreign contracting agents. The problems are largely due to the lack of institutional opportunities for this interaction and it remains in most of the cases at personal level, as well as to the fact that the state has not invested in infrastructure for education for years.

[56] In 2009, many companies controlled by famous entrepreneurs in the sector were registered in order to be able to meet the requirements for a start-up company, because they cannot receive funding with those established on the market. This process will also continue in 2010.

[57] For 2009. It is expected that the problem will be overcome in the first half of 2010 with the active intervention of the Ministry of Transport, Information Technologies and Communications.

[58] The total shortage of IT specialists in the economy for 2012 is estimated at some 10-15,000.

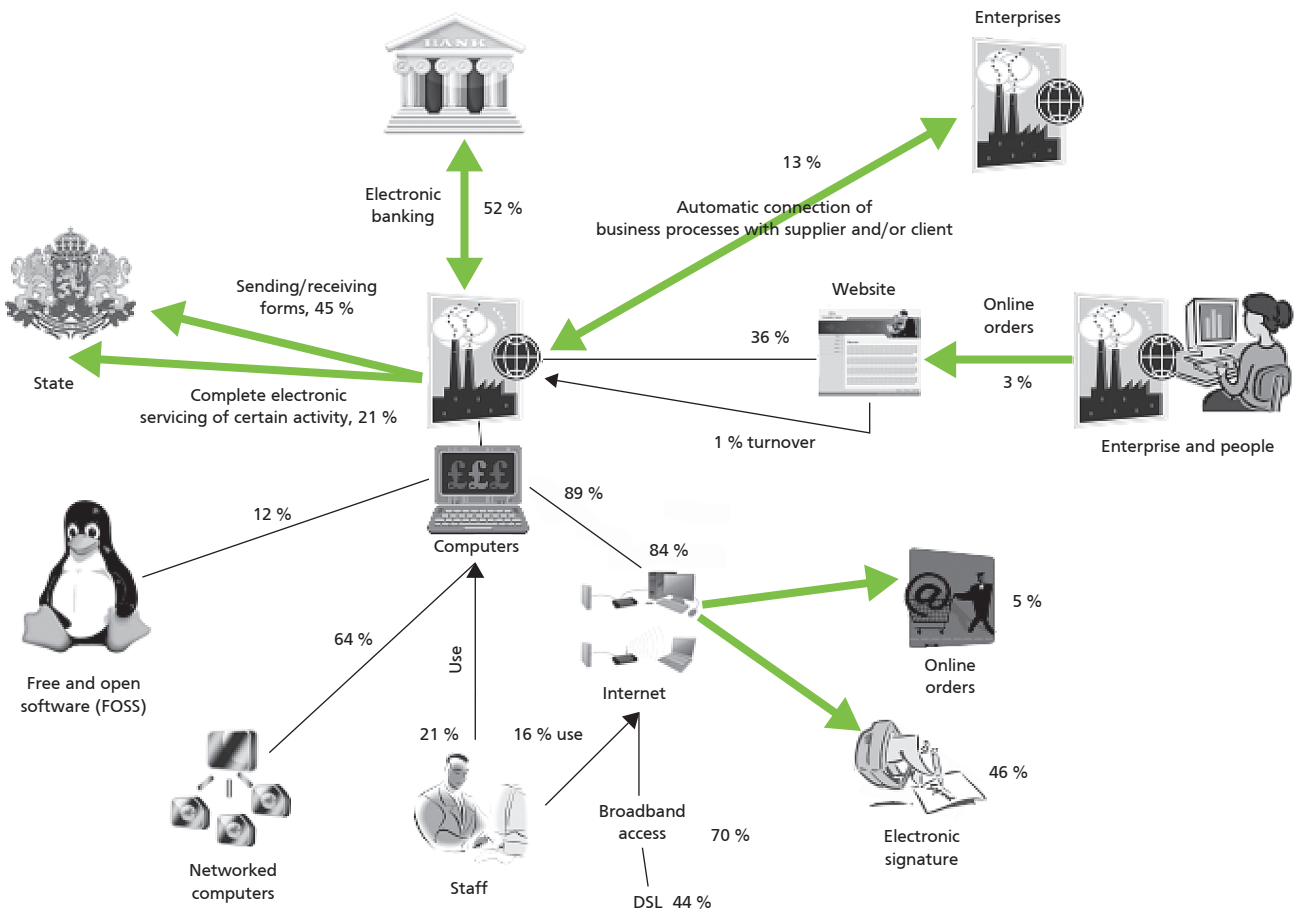
[59] For example, the German Intercomponentware closed its branch in Bulgaria in 2009 as a result of the crisis, while an American company for casino IT systems expanded its staff significantly.

Diffusion of Information and Communication Technologies

The influx of general purpose technologies (mobile phones, PCs, access to internet) has more or less reached its peak (practically no changes were registered in 2009 as compared to 2008). According to NSI, some 90 % of the enterprises have computers and 84 % have access to internet. According to expert estimates of ARC Fund, these data should be interpreted carefully, as the NSI sample covers enterprises with staff of 10 and more and excludes the enterprises from agriculture, forestry and fisheries sector, culture, sports and entertainment, and education. Moreover, according to the survey, there are enterprises with over 250 employees in which there are no computers and 15 % of the companies in the sector of generation and supply of electricity, water and gas do not have computers, while 100 % computer coverage was registered in 2007. The Applied Research and Communications Fund assumes that there are practically no companies with staff of over 10 that do not have computers. Comparison of the survey for Bulgaria and those of other countries reveals numerous mistakes in the survey (possibly resulting from wrong NACE codes, as well as not understanding many of the questions), but they should be analyzed more carefully elsewhere.

According to NSI, 70 % of the enterprises have access to broadband internet. The survey does not measure speed but technologies of access, which means that some 14 % of the enterprises responded that they have dial-up or ISDN access, which in turn does not seem realistic against the backdrop of accessible broadband internet (at least as type of technology and cost). Slightly over half of the enterprises with broadband ac-

Figure 42. USE OF ICT IN AND BY ENTERPRISES IN BULGARIA



Sources: National Statistical Institute/Eurostat, 2010

cess use ADSL. About 15-20 % use more than one access technology as backup.

Nearly all employed (94 %) work at an enterprise with at least one computer but only 21 % of the employed have routine access to a computer a week within their official duties. A total of 16 % of the employed have routine access to computers connected to the web at the workplace. By these two indicators Bulgaria ranks at the bottom among European Union member-states, but there are serious grounds to doubt the reliability of the data. For example, Romania, where 19 % of the enterprises do not have a computer at all, registered that 51 % of the employed routinely use computers at their workplace at least once a week. In Croatia this share is even 65 %, and in Slovakia – 70 % (in comparison, Austria and Germany registered about 40 %).

A total of 36 % of the enterprises have websites (NSI/Eurostat). Here again it can be assumed that the data are significantly underestimated as even in 2006 38 % of the enterprises with over 10 employees had websites *(eBulgaria 2006),* and in 2007 more than half (55.36 %) of all enterprises (including with less than 10 employees) had websites. INA-4 shows that 48 % of the enterprises have a website, and even in the case of the least innovative enterprises those with a website are 37 %. These differences are probably mostly due to the samples, but it is possible that part of the lower values in the latest surveys are due to the fact that the respondent considers that the existing website is not of sufficiently high quality (about 10-15 % of the enterprise websites in INA-4 have errors, are in the process of development and so on). According to INA-4 data, 35 % of the companies have websites which allow online placement of orders, but those where online payment is possible are less than 1 %. The total turnover of enterprises generated by online orders is about 1 %. By all of these indictors Bulgaria (with the exception of Romania where 28 % of the enterprises have websites) ranks at the bottom among other member-countries.

Bulgaria ranks best by broadband access indicators, outstripping more than half of the EU countries in terms of connections alternative to DSL, although it is lagging behind in DSL. Another indicator where Bulgaria traditionally registers high values is the use of electronic signature (46 % of enterprises). The reason for this, as has repeatedly been analyzed in all editions of *Innovation.bg*, is the saving of time, effort and bureaucratic red tape related to accounting of social security, health and tax dues. To a large extent this is precisely what the communication using various forms between enterprises and state institutions is (45 % of enterprises) as well as complete electronic service of an individual activity (21 %).

The use of open code and free software systems is still slow in entering enterprise operation (12 % say they use such), but Bulgaria nevertheless has better results than 7 countries, including Spain which is frequently quoted as an example for using open source and free software.

Impact of Information and Communication Technologies on Innovation

The intensive introduction of technologies into the business environment, the convergence of the various information and communication technologies and the structural changes in consumer demand are the three most significant external forces which determine contemporary product, process, organizational and marketing innovation.[60] **Around half of the product and three-quarters of the process innovations**[61] **in Europe are based on the innovative use of ICT at some of the stages** – from R&D and prototypes, through including ICT components in the new products and production processes to release of the new products and services on the market. The latest empirical data from 2009 for the European Union, which show the influence of ICT on innovations, pertain to section 35 ("Manufacture and Distribution of Electricity, Gas, Steam and Air-Conditioner Gases"), where 71 % of the R&D-based innovations and an equal number of new products and services are based on

[60] *Innovation.bg 2007*.

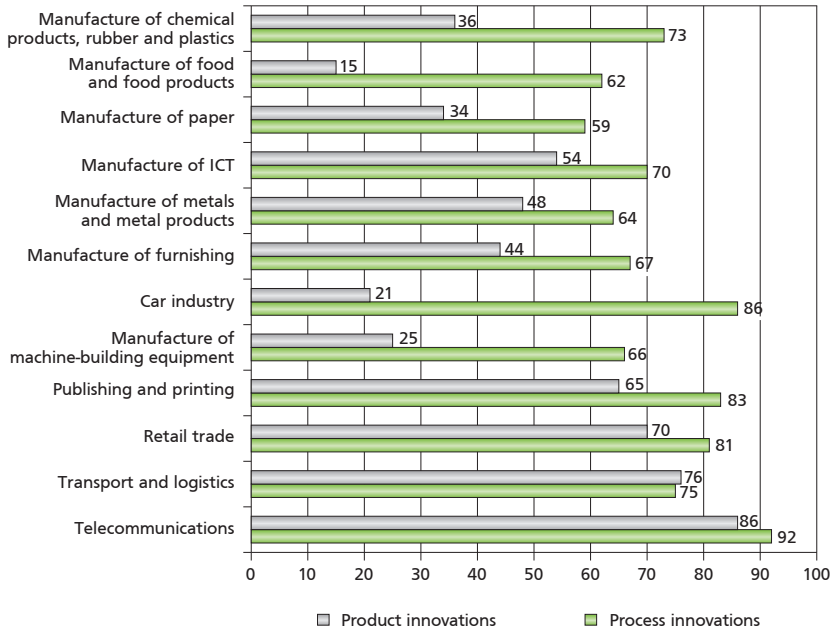
[61] e-Business W@tch, 2007. The data are for the period 2005-2007, resulting from sample surveys for several large or leading EU countries. The USA is also included in some cases. For more information about the surveys visit http://www.ebusiness-watch.org

ICT upon release on the market. The values in section 23 ("Manufacture of Non-Metal Mineral Products – Glass, Ceramics and Cement")[62] are slightly lower (respectively 56 % and 54 %), but they also demonstrate the significant role of ICT. Earlier data (albeit not allowing one to follow where precisely in the life-cycle of innovation ICT have the greatest influence) for sub-sections of the processing industry show that 38 % of the product and 70 % of the process innovations[63] are IT-based.

Although there is no specific survey for Bulgaria, it can be assumed on the basis of expert assessments that these data are close to the values for Bulgaria, particularly in the case of sub-sectors integrated with world markets (manufacture of chemical products, rubber and plastics, glass, ceramics and cement, ICT hardware, car manufacturing, transport and logistics, telecommunications), while the differences should be sought mainly in the less technological and insufficiently clustered branches such as manufacture of furniture/furnishing, retail trade (not the large international chains), manufacture of metals and metal products and paper industry, where there are considerably less ICT-based product innovations, but it is possible to have more process ones because of catching-up development and the introduction of quality control systems in enterprises of the type of small dairies.

Practically the entire technological innovation in all sectors in Bulgaria in 2009 tacitly includes ICT (for example, introduced process innovations and installations in the production of alcoholic drinks, technological lines for the manufacture of foods and food products, wood processing and the manufacture of furniture, etc.). In spite of the crisis, the last year will be remembered with the numerous completed integration projects for enterprise management software, including such for local production

Figure 43. Share of ICT-based innovations compared to the total number, by sector



Source: e-Business W@tch, 2007

Box 7. ICT and innovation diffusion

Technologies increase skills. Computer skills are associated significantly with the increase of skills related to certain jobs.[64] The influence of ICT runs along two lines – as a general-purpose technology of users gradually increase their skills to work with them and the requirements for taking a certain job increase. There was a typical manifestation of this phenomenon over the past few years in the production of soft drinks and beer. On the other hand, some high-tech productions, which traditionally required specialized knowledge from the workers, can already use less qualified workers because of the complete automation of production processes. At the same time, technologies to a certain extent level skills in various sectors and thereby ease migration of employment from sector to sector. Where there is a greater difference in levels of remuneration between two sectors this could lead to grave problems. A case in point was the siphoning of people from the banking sector towards call centers.

Technologies influence structure. The early users of computer information technologies in an organization increase their central role as hubs[65] and, as a consequence, their power.[66] The introduction of complex enterprise management systems (ERP, CRM) and more generally organizational innovations

[62] e-Business W@tch, 2009. A survey conducted in 2009 covering 1,027 enterprises in France, Germany, Italy, Poland, Spain and the United Kingdom.

[63] Average, without weighing the data by significance of sub-sectors.

[64] Francis Green, Alan Felstead and Duncan Gallie, *Computers Are Even More Important Than You Thought: An Analysis of the Changing Skill-Intensity of Jobs,* paper by Centre for Economic Performance, London School of Economics, 1999.

[65] In graph or network theory a measure of the "importance" of a given hub is its connection – both as local, direct connection and in terms of structure (overall connection in the network).

[66] Marlene Bukhardt, Daniel Brass, *Changing Patterns or Patterns of Change: The Effects of a Change in Technology on Social Network Structure and Power,* Administrative Science Quarterly, March, 1990.

developed by foreign companies (not only in their local outlets in Bulgaria). A large portion of these, however, were planned in 2008 and some even in 2007.

In Bulgaria, ICT innovations in the utility sectors[67] "Production and Distribution of Energy," "Supply of Water," "Sewerage Services" and "Waste Management" in 2009 are related to changes in (or the introduction of new) systems for (including mobile, electronic, web) payments and relations with partners who collect payments, consumption accounting systems, the introduction of systems for management of reserves, supplies and business processes, systems for remote consumption accounting, for remote risk surveillance, control and evaluation, the introduction or improvement of centers for work with clients and the introduction of systems or individual elements in the process of management of human resources. All these innovations (and the related changes in business processes) induce and presuppose considerable organizational changes, not only in the energy sector, but in the entire processing industry as well.

In spite of Solow's widely discussed productivity paradox,[68] which generally consists in the apparent contradiction between the measured investments in ICT and the aggregate results (productivity and growth) at national and sector level (particularly with data for the 1980s and the 1990s), at academic and policy level it is accepted as valid (particularly for the future) that ICT are one of the most important motors of innovativeness of enterprises and growth of economies. The effects of their use include reduced relative transaction costs, shortened production cycle, streamlining of production, structural changes in markets. At the same time, a lot of additional risks also appeared (for company security, for example) and threats (in respect to company competitive position).

Box 7. ICT AND INNOVATION DIFFUSION (CONTINUATION)

frequently encounter considerable resistance from employees because they have to change certain business processes or certain employees lose specific power fed by information asymmetry or brokerage.

ICT-intensive sectors grow faster than non-intensive ones. This conclusion was made on the basis of data for the period 1990 – 1999.[69]

ICT boosts competition. ICT boosts competition through a reduction of information asymmetry and the unlimited access of clients to the competitors, including through easier international trade. In turn, **competitive pressure has a retroactive increasing effect of increased ICT use** – for example, a company has a statistically **higher probability of having a website** if its largest direct competitor has a website than if it does not *(Innovation.bg 2008)*. Half of the companies from the sector of manufacture of chemical products, rubber and plastics in Europe think that **ICT have increased competition** in the sector *(e-Business W@tch, 2008)*. The same result was registered a year earlier in retail trade in Europe *(e-Business W@tch, 2007)*. Of course, there are sectors where this influence is practically nonexistent (for example, metallurgy).

ICT increases the probability of innovation, but the power of this influence is greater in the early stages of introduction of the respective type of ICT. When adoptions are made by the late majority or the laggards this connection can be lost. In other words, **the early introducers of ICT are more innovative** *(Innovation.bg 2009)*. For example, the use of software applications for e-business correlates with considerable organizational changes and process innovations, but no correlation is found between the use of internet and the existence of local network infrastructure and organizational changes in several sectors *(e-Business W@tch, 2007, 2008)*. The same surveys register that ICT-based innovations lead to an increase of sales. Enterprises with computers are more innovative than those without, and there is a tangible – albeit weak – correlation between innovativeness of an enterprise and the indicators of number of computers per employed *(Innovation.bg 2009)*. As in the case of computers, the existence of a website, ERP, CRM, joint work and project management systems and open code systems are significant factors which divide enterprises into more innovative and less innovative ones *(Innovation.bg 2009)*.

[67] Although only 325 enterprises with over 10 employees operated there in 2008 and they had only 10 % of the added value in the non-financial sector, they held a considerable portion of the retail electronic payments and were an important factor (maybe second after the state) in the development of local ICT business. Part of these companies in turn own companies in the telecommunications sector, while their problem-free functioning is a condition for the operation of practically the entire economy, which makes them an interesting subject of research about the role of ICT in them.

[68] Brynjolfsson, Erik, *The Productivity Paradox of Information Technology,* Communications of the ACM, December, 1993.

[69] Bart van Ark, Robert Inklaar, Robert McGuckin, "Changing Gear: Productivity, ICT and Service Industries in Europe and United States", in Jens Christensen and Peter Maskell, eds., *The Industrial Dynamics of the New Digital Economy,* Edward Elgar Publishing, 2003.