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EUROPEAN SKILLS SHORTAGE IN ICT AND POLICY RESPONSES

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European skills shortage in ICT and policy responses

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1. Why has demand for ICT skills increased in the past?

The shortage of ICT (information and communication technology) skills is the direct product of the development and diffusion of new digital technologies. Two intermingled but still separable trends have to be taken into consideration when analysing the impact of new technologies on the demand for highly skilled people: first, the long-term trend towards a greater share of university and college graduates in the economy which is most pronounced in sectors that are among the first users of digital technologies (computers, etc.); second, the more recent increase in demand for ICT skills which is related to the expansion of telecommunications, Internet and new media.

The long-term trend of a steadily growing share of university and college graduates in the economy can be observed at least since the Second World War. Higher shares of "skilled" workers within industries are apparent in most OECD countries (see *Berman – Bound – Machin*, 1998) and are widely associated with skill-biased technological change and the globalisation of the economy. Econometric and case studies suggest that the relative utilisation of more skilled workers is positively correlated with capital intensity and the implementation of new technologies both across industries and across plants within industries (*Autor – Katz – Krüger*, 1998).

The recent spread of computers and computer-based technologies has further accelerated this trend. Autor – Katz – Krüger (1998) find evidence for the US that "...skill-biased technological and organisational changes that accompanied the computer revolution appear to have contributed to faster growth in relative skill demand within detailed industries starting in the 1970s". This rapid skill upgrading was concentrated in the most computer-intensive sectors of the US economy and has resulted – at least in the US – in increasing wage inequality and growing educational wage differentials. It is important not to simplify the relationship between the introduction of computers and demand for "skilled" workers. Several authors (e.g. *DiNardo – Pischke*, 1997, *Haisken-DeNew – Schmidt*, 1999) stress that the causal relationship between computer use and demand for "skilled" workers is not straightforward but rather entangled in

[1] I would like to thank Karin Städtner for helpful research assistance.

complex innovation processes which involve increased computer usage as well as, and more importantly, changes in organisation, production processes, etc.

The relationship between skills upgrading and the introduction of new technologies is supported by studies which analyse the employment impact of innovative activities. Innovations tend to increase overall demand for labour but simultaneously lower demand for unskilled labour (see *Leo – Steiner*, 1994, *Leo, et. al.*, forthcoming).

However, indicators of the use of new technologies (e.g. PCs), innovations and schooling attainment as a proxy for skills and competences may not capture some of the fundamental changes behind the skills upgrade in the economy. Howell and Wolff conclude from case studies that "most jobs require a multitude of different skills for adequate task performance, ranging from physical abilities, like eye-hand co-ordination, dexterity and strength, to cognitive skills (analytic and synthetic reasoning, and numerical and verbal abilities) and interpersonal (supervisory, leadership) skills". Therefore the presumption that educational attainment is synonymous with skills requirements in the workplace does not hold.

In their analysis of the situation in the United States, they "attempt to account for skill composition and its change over time with direct measures of job skills and a more complete model of the demand for skills than appears in previous work". They therefore distinguished between cognitive, interactive and motor skills requirements for different jobs and adjusted their figures for industry characteristics. In their results they obtained little support "for either the standard factor substitution model or the widely accepted capital-skill complementary hypothesis". They found that capital intensity was strongly associated with rising interactive skills and declining cognitive skills. These results are in line with many case studies, in which mechanisation is found to be linked to the deskilling of production workers and to the growing share of managers and supervisors. "With the transition to production methods based on information technologies, it is perhaps increasingly true that it is technical change, not mechanisation *per se* that increases the demand for cognitive skills" (*Howell – Wolff,* 1992).

This line of argument is supported by research on the impact of investment in ICT (*Bresnahan – Brynjolfsson – Hitt*, 1998 and 1999). Firm-level data suggest that ICT use is correlated with increases in the demand for various indicators of human capital and workforce skills. ICT use is also correlated with a pattern of work organisation involving more decentralised decision-making and greater use of teams. Increases in firms' ICT capital stock are associated with the greatest increases in output, which also have high levels of human capital or decentralised work organisation, or both. These empirical results are emphasised by a survey of managers which

found that ICT is skill-increasing, and this tendency is particularly pronounced in high human capital, ICT-intensive, and decentralised firms. Bresnahan, Brynjolfsson and Hitt conclude that "the combination of computerisation, workplace organisation and increased demand for skilled workers appears as a cluster of changes in modern firms, almost certainly because they are complements". This of course implies that the recent changes in the structure of the corporation and the demand for human capital have a common origin in technological change.

The long-term increase in the share of highly skilled professionals and the recent shortage of IT-skilled workers are of course intermingled with technology change as a driving force behind these developments. The long-term trend was matched by a constant increase of output from the educational system. In contrast, the short-term surge in ICT investment in the 1990s led to a constant widening of the ICT skills gap which was broadest in the first half of 2000 and was not accompanied by an increase in the output of the educational system.

The increasing use of ICT goods and services is motivated by high returns on investments which are generated either by technology itself or by changes in the (regulatory) environment. The key causes for the huge increase in ICT investment can be best illustrated by evidence from the ICT sector itself. In the past two decades, five broad developments shaped the demand for ICT investments and consequently for labour and skills in the ICT sector:

1. Digitisation: The number of employees of public telecommunications operators (PTOs) has been falling since the beginning of the 1980s (–8.5 percent between 1982 and 1995). This development is especially apparent in countries which were early in liberalising their markets (New Zealand[2], Japan, and the UK) but also affected countries where liberalisation is in progress (Ireland and Greece). The early onset of this downward trend in employment, and the sizable employment losses in countries with a slower pace of market liberalisation in the telecommunications sector show that it is digitisation of telephony rather than competition which leads to job loss. Liberalisation does play a role, however: it creates incentives – reinforced by outsourcing and privatisation – to invest in new technologies and to develop new organisational structures in order to save resources. In due course, lower skilled personnel which had been necessary for the operation and rollout of an analogue network were set free. Furthermore the skills mixture of former monopolists changed

[2] A large part of the decrease in employment in Telecom New Zealand (TCNZ) took the form of shifting operations to newly established enterprises, steps that had been taken by other providers in earlier reform phases. The total decrease in jobs is thus lower than the numbers suggest. This development is important in other respects as well. TCNZ's process of restructuring was aimed at catching up with other PTOs. In 1994, the number of mainlines per employee was equal to the OECD average of 1992.

dramatically: not only marketing skills but also skills necessary to handle digital equipment were in huge demand. Although the overall employment performance of former monopolists in the telecommunications sector is negative, these companies still recruited a large number of highly skilled persons.

2. Liberalisation: The steps towards liberalisation taken so far have sought to create a market for terminal equipment, and telecommunications services, to separate regulatory and commercial activities, to facilitate free access to networks and services, and to create competition in the mobile telecommunications and infrastructure market. Liberalisation in the European telecommunications sectors started on its final phase on January 1, 1998 when the voice communication monopoly disappeared and competing telecommunications infrastructure and service providers entered the market. Since then liberalisation has not only forced former monopolist to introduce cost-saving innovations and new services but has also created a huge number of new competitors: In the European Union alone, 1237 firms have since launched public telecommunications networks. This strong start-up activity has of course intensified demand for skilled labour (*EC*, 2000).

3. Year 2000 hype: The Y2K problems created huge demand for software firms as businesses feared that their IT systems would stop working at the turn of the year 2000. Though the change of date turned out to be no major problem – perhaps because of the general awareness and large investments made before the event – it certainly created demand for specialised software firms and strengthened competition for skilled labour in this area.

4. Internet revolution: The Internet inspired a huge number of start-up activities. Europe has seen a strong upward trend in early-stage investment in high-tech companies over the past five years, and the trend continues unabated. The amount of early-stage investment rose to €3 billion in 1999, more than ten times the amount invested five years ago. In 1999, investment in the technology sectors increased by 94%, and capital committed to start-up ventures rose by 89%. Though this is still behind US levels, the trend toward venture capital remains strong. The increase was fuelled by the huge optimism in Internet start-ups which continued until April 2000. Although venture capitalists are nowadays more risk-conscious, the amount of available capital is still rising. The firms created by this investment of course were all scheduled for rapid growth and consequently hired a large number of skilled personnel.

5. The spread of the Internet and new media was not limited to a small number of highly specialised firms but affected the whole economy. Firms have been investing in their

Internet presence, B2B and B2C activities and thus created additional demand for ICT-skilled labour. It is generally assumed that three quarters of ICT experts work in the ICT sector itself and one quarter in the rest of the economy. If this proportion continues to hold, then demand from the non-ICT sectors of the economy is not dramatic but adds to the existing shortage of ICT skills at a critical point in time.

All five trends cumulated between 1998 and mid 2000. Digitisation, liberalisation and the Internet revolution created strong demand for ICT skills, emanating from a rather small segment of the economy but increasingly spreading throughout the economy.

As supply from the educational system is virtually fixed in the short run, the shortage of qualified IT experts was significantly inhibiting expansion of this sector. Yet there is a positive side to the skills shortage: firms which were not able to recruit desired personnel had to invest in productivity-enhancing management and technology strategies, thus making firms more efficient and less vulnerable to supply shortages on the labour market.

In April 2000 industry dynamics underwent a fundamental change. Technology and Internet stocks suffered massive devaluation on the stock markets as expectations for future profits were substantially lowered. Internet start-ups had to scrutinise their business models and efficiency of operation to secure further funding. Some of them even went bankrupt.

The overall downswing of this market not only shattered the "constant growth without business cycle" myth of the "new economy" but also led to significant layoffs in the ICT sector paired with low recruitment activity. Though not supported by surveys, industry reports of the past months create the impression that the skills shortage has almost vanished. Given the still positive long-term perspectives of the sector, this seems to be only a temporary relief of the problem, i.e. the shortage will be back once the business cycle turns the other way as there seems to be no oversupply of ICT skills but – at best – a balance between demand and supply.

2. Estimates of IT skills shortages in Europe

The ICT skills shortage is felt in all European countries, the US and Japan. Studies to quantify the number of missing ICT qualifications are usually conducted at country level. Currently there are only two studies which focus on the ICT skills shortage and are comparable among European countries. Both were done by IDC, the earlier one (*IDC*, 2000) on behalf of Microsoft, the second for EITO (*EITO*, 2001). Both studies present very detailed estimates of the gap between ICT skills demand and supply even at rather disaggregated levels. Their major

drawback is that the methodology applied to estimate the ICT skills gap is not described in sufficient detail to allow identifying the variables which drive demand for and supply of ICT skills.

Before going into details, some of the possible problems associated with estimates of the ICT skills gap need to be discussed:

1. ICT skills shortages can be measured in different ways, e.g. the number of vacant jobs in the economy, the number of jobs created in the past or in the future, the number of people with specific qualifications demanded. The outcome of the estimates depends significantly on the variable which is measured in the study, as does its relevance for policy makers.

2. The size of the skills gap depends on the scope of the study, e.g. the part of the economy which is analysed. Several studies concentrate on the ICT branches of the industry as these were the first to feel the skills shortage. Of course, the shortage has since spread throughout the economy which renders it increasingly difficult and more tedious to come up with an estimation of the skills gap for the whole economy.

3. The supply of people with the required skills is not easy to measure. First of all, statistics on the output of the educational system have to be analysed at a very disaggregated level. This task demands detailed knowledge of the educational system. It is even more complex to measure the output of re-education or training activities as the market for these services is highly segmented and heterogeneous.

4. Any estimate of future skills demand is highly risky as the overall business cycle and industry developments impact on labour demand. This is even more true for areas like ICT production and consumption where technological change is rapid and the organisation of commercial activities changes at a similarly fast pace. Businesses themselves have problems to forecast their demand for specific skills over a period of more than six months. Consequently, medium term-forecasts are prone to errors.

Given these problems attached to measuring ICT skills shortages, estimates discussed in this section should be viewed rather as broad indications of major trends in this area and not as accurate projections of shortages.

In the following section the results of both IDC studies will be discussed at some depth. The first study will be analysed in more detail as if offers data on all Western European countries. This information is lacking in the second study, or to be more precise, detailed information on

the country level was supplied only for France, Germany, Italy, Spain and the UK. This change in the aggregation of country information renders the results obviously less relevant for countries not included.

A simple framework is applied in analysing the results of the IDC studies. First, information on demand, supply and shortage of ICT employment will be expressed as a share of total employment in all countries surveyed. This seems to be a better benchmark for indicating the magnitude of the skills problem in Western Europe. Second, a correlation analysis is performed to get indications of which variables impact on the demand, supply and shortage of ICT skills. Two sets of indicators are included in the correlation analysis: indicators on the use and production of ICT goods and services and indicators on the education system. The correlation analysis is done only for the first study, which has information available at country level.

The next chapter compares the results of the ICD studies with studies performed at country level. All problems related to an estimation of the skills gap outlined above similarly apply when trying to compare different studies. Therefore this chapter calls for a co-ordinated approach among EU member states rather than each member state following its own route. Finally, a number of possible actions to combat the skills gap is outlined. In addition to basic models to counteract the skills problem, some initiatives in member countries will be described for illustrative purposes. As information on policy responses to this problem is given in all countries at different levels and by different actors, it is almost impossible to present a complete survey.

2.1 IDC estimates for Microsoft

In the first study, IDC concentrated on people for *Internetworking Environments* (i.e. Internet related activities), *Technology Neutral Environments* (i.e. IT-supported business processes) and *Other Technology Environments* (i.e. host-based, distributed and applications environments). IDC expects demand for IT skills to grow from approximately 9.47 million IT professionals in 1998 to 13.07 million in 2003, while supply is set to grow from 8.61 million in 1999 to 11.33 million in 2003. Consequently, the Western European skills shortage is estimated to reach 1.7 million IT professionals by 2003 (13% of demand).

Demand for ICT professionals is rather heterogeneous among European countries. This is obvious when demand is expressed as a percentage of total employment, which can be interpreted as a measure of the magnitude of the problem in each country (see Figure A1.1). Overall demand for ICT specialist amounts to 5.7% of employment in Western European

countries but is almost at twice this level in the Netherlands, Belgium, Sweden and – though slightly lower – Austria and Switzerland. Somewhat surprisingly, demand is below this level in the UK, Finland, Ireland and Norway. The demand for skilled ICT personnel is not strongly related to ICT spending and the size of sectors producing and using ICT (see correlation analysis below). Consequently, Scandinavian countries – with the exception of Sweden – which are among the big investors in ICT are obviously not confronted with above-average demand for these qualifications.

Box 1: IDC's Methodology to Determine the IT Skills Shortage

As part of its continuous tracking of the IT services industry, IDC reviews, on a bi-annual basis, the level of demand for and supply of skilled professionals. From more than 12,000 interviews with information systems (IS) managers across Europe, IDC translates IS spending intentions into the amount of work needed to be done in order to assimilate acquired technology.

IT work is segmented into activities that have to be performed during the planning, implementation, maintenance, management and training phases. For example, in networking environments, these activities would include needs assessment, network design, configuration, capacity planning, optimisation, network monitoring, maintenance and management. This segmentation, along with trends in IT investments, is analysed by company size band for each country, generating a picture of demand for skills over the years.

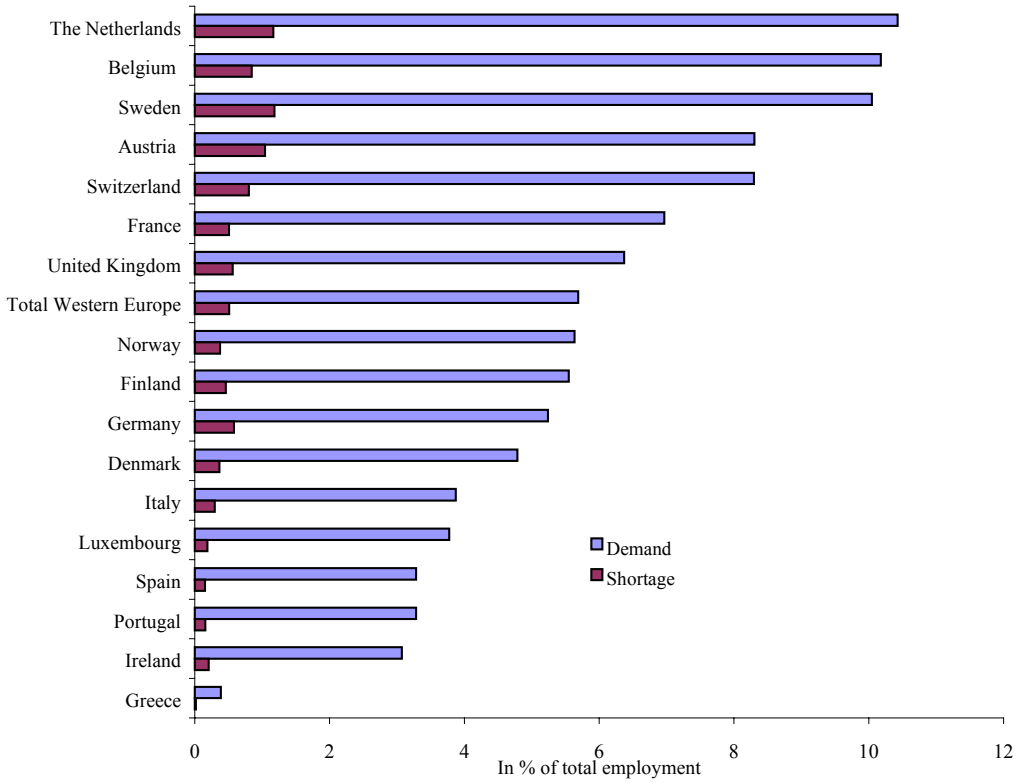
Validation of this demand profile is performed by investigating trends among "intermediaries", typically recruitment agencies. IDC estimates that 40–70% of vacancies (depending on the country) are filled by these intermediaries, and trends in their activities provide valuable validation of the demand profile generated by IT spending patterns.

The supply of resources has been analysed and forecast by researching output levels in the network of universities and other educational establishments. IDC conducted a survey of the academic community in Western Europe; the primary research was with administrators with insights on intake trends, evolution of courses and the subsequent employment tracks of graduating students. This data has been used to compile baseline trends in the supply of fresh professionals to the IT sector. In addition to data from the academic community, IDC has also factored in a contribution (12% of new supply) from the reskilling of workers from other industries, for example the defence and manufacturing sectors.

Source: IDC 2000.

The shortage – when expressed as percentage of total employment – is not as alarming as the estimates in absolute numbers. In Western European countries it ranges from Greece, where supply and demand are balanced, to the Netherlands, where it is set at 1.2% of total employment. The magnitude of the skills shortage is closely linked to the level of demand and supply for ICT-skilled personnel expressed as a percentage of total employment. From Figure A1.1 it follows that the skills shortage should be most severe in the Netherlands and Sweden, followed by Austria, Belgium, Germany, UK, Finland, France, Denmark, Italy, Ireland, Luxembourg, Portugal, Spain and Greece.

Figure A1.1: Demand for and shortage of ICT skills as percentage of total employment, 1999

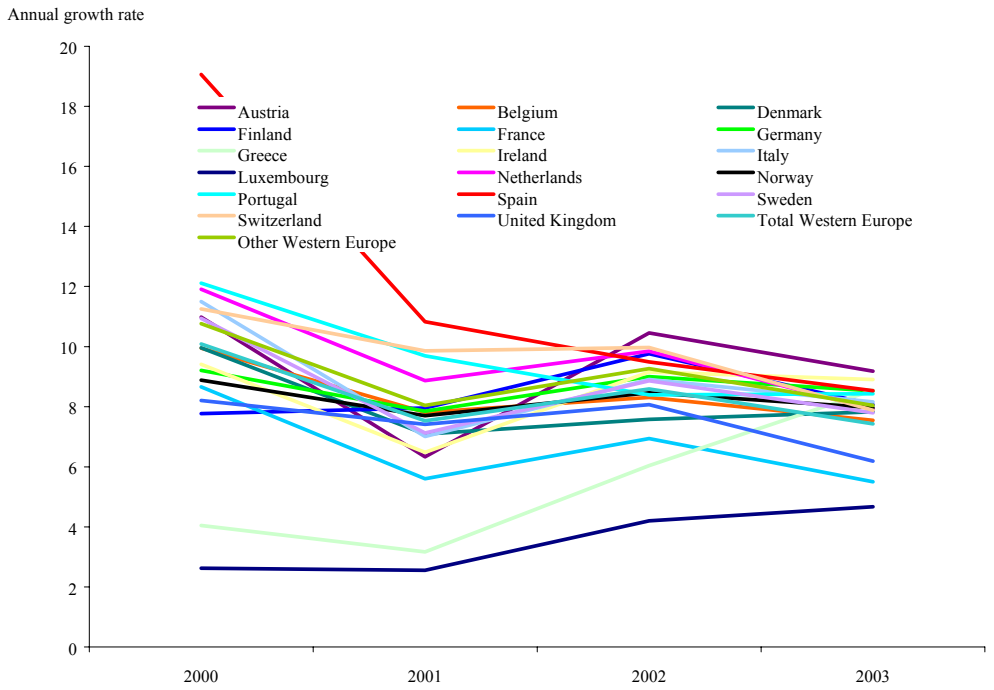


Source: WIFO calculations using IDC, 2000; European Commission, 2001.

The evolution of demand up to 2003 more or less complies with the same pattern in all countries included (see Figure A1.2). Growth rates of demand are highest in the 1999/2000 and 2001/2002 periods. Over the 1999 to 2003 period, growth rates of demand remain high and – given the increased absolute level of demand – no substantial decline in demand is forecast. Only Spain, which has significantly higher growth rates for the 1999–2000 period, as well as Luxembourg and Greece, which reveal lower than average growth rates, deviate from this pattern.

In order to obtain some indication of the factors impacting on demand and supply of ICT skills, we conducted a correlation analysis with two different sets of variables (see Table A1.1). In the first set of variables, demand, supply and shortage expressed as percentage of total employment are correlated with variables for the production and use of ICT at country level: The second set of variables correlates ICT demand, supply and shortage with variables measuring the output and investment of the education sector.

Figure A1.2: Annual growth rate of demand for ICT skills



Source: WIFO calculations using IDC 2000.

The correlation analysis with variables for ICT production shows that demand, supply and shortage of ICT qualifications are strongly correlated with each other. This relationship indicates that countries with a high level of demand (expressed as percentage of total employment) also exhibit high levels of supply but at the same time a high level of missing ICT-skilled labour. The fact that correlation between these variables is almost perfect might point to a common factor which drives the level of those indicators. Given the poor documentation of the methodology applied to estimate demand and supply, it cannot be ruled out that this result is due to methodological shortcomings.

The latter interpretation is supported by the lack of significant correlations with variables describing demand for ICT skills: the rather high and positive correlation with ICT spending and ICT employment is not significant. The missing significance level for ICT spending and employment may be due to the high aggregation level of the data. GDP growth is negatively correlated – although again insignificantly – with demand, supply and shortage of ICT skills. It is far rather difficult to find an explanation for the negative correlation between demand for ICT qualifications and GDP growth.

Table A1.1: Correlation between IDC estimate for demand, supply, shortage and variables on ICT and education

	IDC in % of total employment			Average ICT expenditure	Share of ICT producers in business sector		Average GDP growth	Higher education	Public expenditure on education	Schools linked to internet	Number of pupils
	demand	supply	shortage	in % of GDP	Employment	Value added		per GDP	per GDP	in %	per PC
IDC in % of total employment demand	1.00										
IDC in % of total employment supply	1.00 *	1.00									
IDC in% of total employment shortage	0.95 *	0.93 *	1.00								
Average ICT expenditure in % of GDP	0.46	0.46	0.45	1.00							
Share of ICT producers in business sector - employment	0.36	0.35	0.39	0.33	1.00						
Share of ICT producers in business sector - value added	0.12	0.11	0.22	0.38	0.77 *	1.00					
Average GDP growth	-0.36	-0.37	-0.31	0.10	-0.22	-0.21	1.00				
Higher education per GDP	0.82 *	0.80 *	0.89 *	0.60 *	0.63 *	0.52	-0.35	1.00			
Public expenditure on education per GDP	0.23	0.22	0.25	0.34	0.70 *	0.64 *	-0.18	0.63 *	1.00		
Schools linked to internet in %	-0.38	-0.37	-0.41	-0.10	0.30	0.06	0.48	0.32	0.62 *	1.00	
Number of pupils per PC	-0.32	-0.31	-0.34	-0.50	-0.73 *	-0.27	0.06	-0.50	-0.30	-0.18	1.00

Source: WIFO calculations using European Commission, 2001; Daveri, 2001; OECD, 2000A.

There is a high, positive and significant relationship between expenditures for higher education (as percentage of GDP) and supply, demand and shortage of ICT skills but also with other variables measuring the size of the ICT producing sector and ICT diffusion. Public spending on education per GDP is also positively correlated with demand, supply and shortage of ICT skills, but the relationship between these variables is neither very strong nor significant. In contrast this variable is significantly correlated with employment and value added in the ICT producing sector.

Somewhat surprisingly, the number of schools (primary and secondary) linked to the Internet is negatively correlated with ICT skills indicators, which is somewhat difficult to interpret. First, the negative correlations with shortage and demand for ICT skills suggest that countries with high access of schools to the Internet do have lower demand and lower shortages. The interpretation, that investment in computer and Internet literacy in primary and secondary schools reduces the ICT skills shortages, is – given the time lag between primary and secondary education and its impact on the labour market – rather far-fetched and may only be relevant for low skilled ICT workers. On the other hand, the negative correlation with ICT skills supply indicates that high access to the Internet in schools decreases supply or the other way round. These relationship holds also for the number of pupils with PCs.

Generally, this analysis of correlations does not reveal factors which impact separately on demand, supply and shortage of ICT qualifications as measured by IDC because these three indicators are highly and positively correlated with each other. Some of the difficulties in analysing these results may be caused by the methodology applied to estimate demand, supply and shortage of ICT and by measurement errors of the indicators itself.

2.2 IDC estimates for EITO

The second ICD study was made on behalf of EITO (see *EITO*, 2001). The IDC studies are, with some limitations, comparable, as different segmentations of the labour market for ICT-qualified personnel were used.

The study for EITO uses the following segmentation to study supply of and demand for ICT skills:

- ICT professionals who support and develop technology environments in the industries that use ICT (or service vendors selling their ICT professional resources time).
- E-business professionals focused on supporting business strategies related to the Internet.
- Call centre professionals providing sales and support activities in the emerging phone channels.

The first segment of this study, ICT professionals, roughly equals the narrower scope of the first ICT skills study.

According to IDC, between 1999 and 2003 the demand for ICT employment will grow by 7.4 million jobs in Western Europe. By 2003, demand for ICT in Western Europe will be over 21.9 million jobs, whereas supply will be at 18.1 million, creating a gap of 3.8 million (18% of demand – see Table A1.2). The greater skills gap stems mostly from the inclusion of e-business professionals and call centre professionals. The gap of ICT professionals reflects that of the previous study (1.686 million in the 2001 study vs. 1.740 million in the 1999 study).

Table A1.2: Demand, supply and shortage of ICT skills in Western Europe

	1999	2000	2001	2002	2003
			1000 persons		
Demand					
ICT skills	9450	10397	11170	12127	13030
E-business	1812	2800	3914	5084	6327
Call centre	1000	1300	1690	2113	2577
Total	12262	14497	16774	19324	21935
Supply					
ICT skills	8613	9188	9815	10609	11344
E-business	1481	2255	3040	3761	4347
Call centre	900	1183	1546	1954	2397
Total	10994	12626	14401	16324	18088
Shortage					
ICT skills	837	1208	1355	1519	1686
E-business	331	546	874	1324	1980
Call centre	100	117	144	158	180
Total	1268	1871	2373	3001	3846
Shortage in % of demand					
ICT skills	8.9	11.6	12.1	12.5	12.9
E-business	18.3	19.5	22.3	26.0	31.3
Call center	10.0	9.0	8.5	7.5	7.0
Total	10.3	12.9	14.1	15.5	17.5
In % of total employment					
Demand	7.4	8.9	10.2	11.6	
Supply	6.6	7.7	8.7	9.8	
Shortage	0.8	1.1	1.4	1.8	

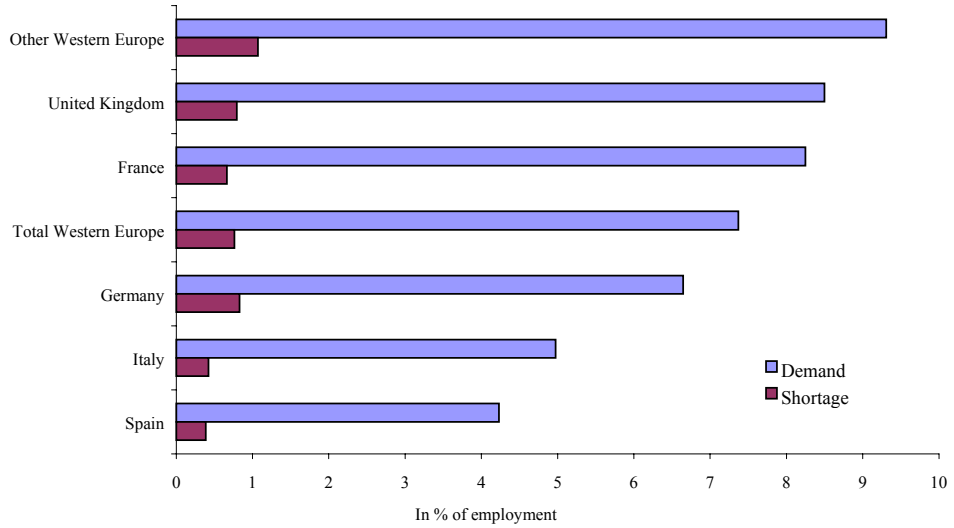
Source: WIFO calculations using EITO, 2001.

The shortage, expressed as a percentage of demand, will intensify for ICT skills and e-business skills until 2003. The growth of the ICT-skills gap will decelerate as of 2000. For e-business skills, ICD forecasts a constantly and sharply widening gap until the end of the period. Call centre skills will be also in demand but supply will increase faster than demand, which will result in a narrowing of the gap.

The ICT shortage is not distributed equally over the three analysed segments. The gap is highest for e-business skills at 31% of demand, 13% of demand in ICT skills and 7% of demand for call centre professionals. When we look at subcategories for ICT skills, we find that business are primarily looking for Internet specialists (where the shortage is 32% of demand).

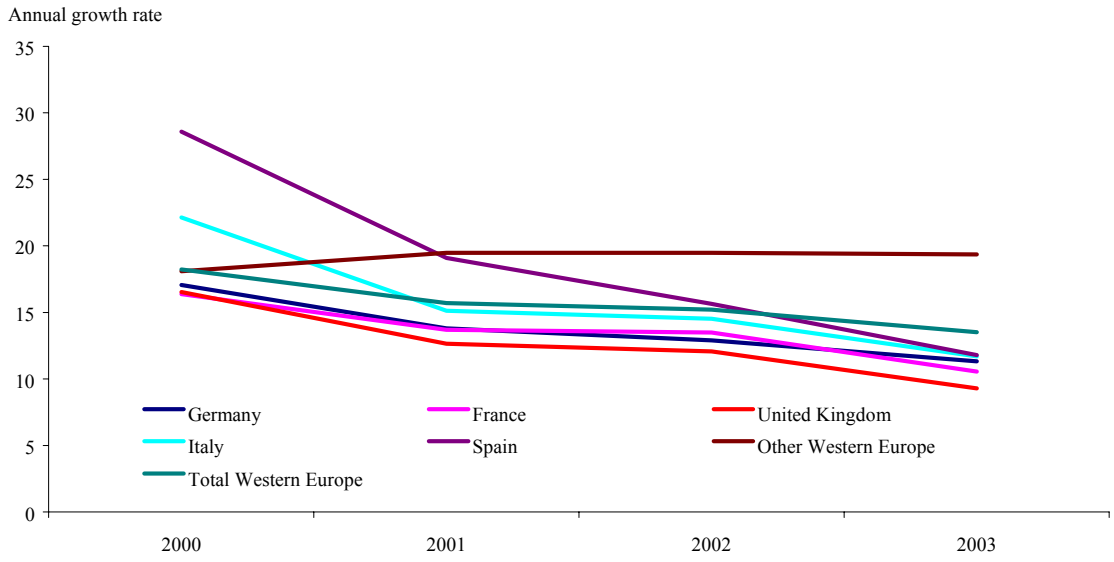
The overall demand for ICT skills amounts to 11.6% of total employment in 2002 (no estimates of total employment are available for 2003 – see Figure A1.3). Supply for these skills will increase strongly over that period, although not fast enough to narrow the gap. This results in a shortage of ICT skills of 1.8% of total employment in 2002, with a tendency to increase further.

Figure A1.3: Demand for and shortage of ICT skills as percentage of total employment, 1999.



Source: WIFO calculations using EITO, 2001; European Commission, 2001; OECD 2000.

Figure A1.4: Annual growth rate of demand for ICT skills



Source: WIFO calculations using EITO, 2001.

The growth pattern of demand is rather similar across the countries (see Figure A1.4). The highest annual growth rates are found at the beginning of the period surveyed. From 1999 to 2000, demand for ICT skills should have increased by around 20%. The annual growth rates are lower for the following years at around 15%. Germany has significantly stronger demand growth for the 1999 to 2000 period but later on converges towards the growth pattern of other countries. Other Western Europe reveals a different growth pattern: demand is generally developing fast and still increasing at about 20% annually for the countries included in this category.

Following the forecast of IDC, the shortages persists even as most governments and businesses are striving to narrow the gap thus indicating that the increased efforts to increase the skills base and to introduce productivity enhancing innovation are not paying off. Given the time of second estimate the downswing of the business cycle is not mirrored in the estimates which might be taken as evidence that these estimates mark the upper level of the skills demand

2.3 Studies from member countries

The ICT skills problem has surfaced in almost all member countries of the European Union, leading to a number of studies which analyse and measure the ICT skills gap at country level. The methodological approaches towards the problem are diverse and so are the results. Country estimates are usually not directly comparable but indicate the overall size of the problem. The scope of these studies ranges from a straightforward estimation of demand for or shortage of ICT skills to very detailed analyses of the causes and consequences of increased usage of ICT in firms.

We limit our analysis of these studies to the quantitative estimates of skills demand or shortages. This information is used to get an impression of the level of demand or shortage in the different countries and is then compared with the shortage estimates by IDC (see – Table A1.3).

Studies on this subject were obtained by searching the Internet. Consequently, we missed studies which are not found in the Internet, so that we can present only part of the overall picture.

Table A1.3: Country level studies of the ICT skills gap

Country	Authors	Period covered	Shortage Demand	Comments[3]	Sector
Belgium	IDC (2000)	2003	72,932	shortage	total economy
	INSEA[1)]	annually	5,000	shortage	software engineers
Denmark	IDC (2000)	2003	24,679	shortage	total economy
	SHAPIRO (1998)	1998-2002	40,000	demand	employees MA level computer skills
Germany	IDC (2000)	2003	404,951	shortage	total economy
	EITO (2001)	2003	353,900	shortage	total economy
	D21 (2001)	currently	150,000	shortage	total economy
	BMWI & bmb+f (1999)	currently	75,000	shortage	total economy
	BMWI (1999)	1999-2002	350,000	demand	total economy
	ZEW	2000-2002	340,000	demand	total economy
Greece	IDC (2000)	2003	2,005	shortage	total economy
Spain	IDC (2000)	2003	101,011	shortage	total economy
	EITO (2001)	2003	107,100	shortage	total economy
France	IDC (2000)	2003	223,709	shortage	total economy
	OECD (2000B)	currently	25,000	shortage	total economy
Ireland	IDC (2000)	1998-2003	9,881	shortage	total economy
Italy	IDC (2000)	2003	167,439	shortage	total economy
	EITO (2001)	2003	161,300	shortage	total economy
	Ministry of	currently	50,000	shortage	total economy
Luxembourg	IDC (2000)	2003	967	shortage	total economy
Netherlands	IDC (2000)	2003	118,882	shortage	total economy
	FENIT (2000)	End of 2000	14,500	demand	Telecom sector
	Dutch Ministry	2000-2003	24,000	shortage	total economy

[3] The comparison and interpretation of these figure is rather difficult. In most cases demand is to be interpreted as "additional" to the already existing employment in the relevant part of the economy.

Country	Authors	Period covered	Shortage/ Demand	Comments	Sector
Austria	IDC (2000)	2003	85,013	shortage	total economy
	Leo (2000)	1997-2003	13,000	demand	ICT
	Synthesis (2001)	2002	7,400	shortage	total economy
Portugal	IDC (2000)	2003	21,913	shortage	total economy
Finland	IDC (2000)	2003	21,314	shortage	total economy
	Ministry of Labour (2000)	2002	8,000-12,000	shortage	computer experts in the total economy
	Employers Confederation of Services Industry [1)]	2001	2,500–3,000	demand	IT service sector in member companies
Sweden	IDC (1999)	2003	67,092	shortage	Total economy
	Swedish National Labour Market Board (2001)	annually 2001-2011	10,500	demand	total economy
United Kingdom	IDC (2000)	2003	329,573	shortage	total economy
	EITO (2001)	2003	326,700	shortage	total economy
	IER [2)]	1997-2006	340,000	demand	IT Service Industry
	Cambridge Econometrics[2)]	2010	421,000	demand	computer services
Japan	Ogura – Suzuki (1999)	1996	9,000	shortage	system engineers & programmers
USA	ITAA (2000)	2001	843,000	shortage	total economy
	ITAA (2001)	2001	900,000 425,000	demand shortage	total economy

1) Cited from WITSA 2001

2) Cited from Department for Education and Employment, 1999

3) Cited from Ministero del Tesoro, del Bilancio e della Programmazione Economica

A comparison of the studies cited above leads to some tentative conclusions:

1. Even estimates conducted at country level come up with diverging estimates of the skills shortage. This may be a result of differences in scope of studies, sector definition, time horizon, data gathering method, period of study, etc. All of these factors may have a significant impact on the results.

2. The country estimates of ICT skills shortage or demand are in most cases substantially lower than the IDC estimates, which leads to the conclusion that the ICD estimates either indicate the upper level of the skills problem or – in the worst-case scenario – grossly overstate the problem.

3. Recent studies – like those by ITAA in the US – come up with a substantial decline in demand for ICT skills. In their view this is due to the recent downswing of the industry. Nonetheless even when taking the developments into consideration, the labour market is currently balanced at best, but the shortage will return once a new upswing sets in.

Generally speaking and without paying attention to methodological differences, country estimates of demand and shortage are in most cases substantially lower than ICD estimates. They are mostly at levels which seem to be achievable if action is taken with sufficient determination to allow swift changes.

The contraction currently affecting technology and Internet firms offers a break for politicians to prepare for a new upswing of the industry in the near future. This applies most of all to measures which impact on the supply of ICT skills in the short term (see below). Overall monitoring of supply and demand for skills – not restricted to the field of ICT skills – would be of advantage if carried out in a co-ordinated manner across all EU member states. Forecasts of demand for skills are always prone to error, and consequently making a wrong decision based on these estimates can be costly in terms of wasted potential for economic growth. Nevertheless, the cost of making no decision and of not trying to adapt the educational and training system to future demand seems to be even riskier.

3. Policy responses to the ICT skills gap

In the past years, measures to combat the shortage of ICT skills topped the agenda in European member states and in ICT firms. Both sides were active in designing strategies, occasionally by co-operative arrangements, to increase the supply of ICT-skilled labour. At European level, the Commission started the Initiative for New Employment, the eLearning Initiative and the

European Computer Driving Licence. Member states have been trying hard to bring changes to their educational systems and to intensify training and requalification activities. Businesses have introduced new ways to recruit skilled people (most notably online recruiting) and to keep their employees "on board" by offering stock options. They have also invested in technology-focused alliances with partners, launched e-learning systems, virtual learning centres, etc. Some EU member countries have also tried to solve the ICT-skills problem by encouraging immigration, and some firms have established learning centres outside Europe or transferred part of their development and production units to non-EU member countries (for examples see *EITO*, 2001).

Coping with the ICT skills gap demands some analytical and strategic actions based on two dimensions: 1. What are the numbers required by the economy, and – more importantly – are they required either in the short or in the medium term? 2. What skills are requested, i.e. high-, medium- or low-skilled ICT personnel? If the problem is structured this way a simple matrix can be drawn up which integrates the different options to find solutions for the skills gap (see Table A1.4).

Table A1.4: Actions against the ICT skills gap

	Short-term demand	**Long-term demand**
High-skilled ICT personnel	Immigration Outsourcing to non-EU member states with highly qualified labour force	Increase output of tertiary education
Medium-skilled ICT personnel	Immigration Outsourcing to non-EU member states with qualified labour force E-learning Training and retraining activities	Increase output of secondary education
Low-skilled ICT personnel	European computer driving licence Training and requalification activities	Increase computer and Internet literacy in primary and secondary education

The policy measures to solve the ICT skills problem depends crucially on the skill level demanded. In most cases the obvious response to skill shortages would be the adaptation of the national educational system to provide more graduates with the required skill level. If highly

skilled ICT personnel with ICT specific training of more than 3 years are demanded changes of the educational system may take to long to reduce the skills problem. Introducing new courses have lead times of 1 to 2 years as new curricula have to be developed and additional resources are needed. Altogether it may take time 5 to 7 years before additional highly skilled graduates leave the education system and enter the labour market. Consequently immigration or outsourcing to countries with sufficient highly skilled ICT personnel may be the only available short time solutions. To a lesser degree the same conclusion applies to medium skill ICT personnel with ICT specific training of 1 to 3 years. In the latter case further measures – like elearning, training and retraining activities – might complement the measure to reduce the gap.

If low-skilled ICT personnel is short than all kind of activities which help people to acquire basic ICT skills are in demand. Training, retraining or requalification initiatives may help to diminish the skills problem and at the same time draw people onto the labour market again. To plan and execute these programmes in co-operation with firms helps to bring the measures in line with actual demand.

In all cases the severance of the skills problem is influenced by the timing of measures to increase the supply out of the educational and training system. Only few government and experts did predict the skills problem in advance and thus many government were surprised by the magnitude of the problem as felt in 1999 and 2000. In any case, shortages which are pressing at the moment might be no longer acute in the medium term, thus creating another skills mismatch. At the same time, as the demand for skills is changing over time, there are far greater risks involved when not taking action on the grounds that demand is changing and difficult to forecast. Consequently, more efforts to forecast future skills changes seem advisable even if it is obvious that correct quantitative estimates are rather the exception than the rule.

4. Conclusions

The shortage of ICT (information and communication technology) skills is the direct product of the development and diffusion of new digital technologies. Two intermingled but still separable trends have to be taken into consideration when analysing the impact of new technologies on the demand for highly skilled people: first, the long-term trend towards a greater share of university and college graduates in the economy which is most pronounced in sectors that are among the first users of digital technologies (computers, etc.); second, the more recent increase in demand for ICT skills which is related to digitisation and liberalisation in the telecommunication sector,

the Y2K problem, the rapid expansion of Internet and new media and the corresponding massive start up activities.

Quantifying the ICT skills gap is not straightforward and associated with a number of problems. First, it is difficult to measure skills directly. Instead studies focus either on the number of vacant jobs in the economy, the number of jobs created in the past or in the future, the number of people with specific qualifications demanded. Second, the size of the skills gap depends on the scope of the study, e.g. the part of the economy which is analysed. Several studies concentrate on ICT branches of the economy as these were the first to feel the skills shortage. Of course, the shortage has since spread throughout the economy which renders it increasingly difficult and more tedious to come up with an estimation of the skills gap for the whole economy. Third, the supply of people with the required skills is not easy to measure. First of all, statistics on the output of the educational system have to be analysed at a very disaggregated level. It is even more complex to measure the output of re-education or training activities as the market for these services is highly segmented and heterogeneous. Fourth, any estimate of future skills demand is highly risky as the overall business cycle and industry developments impact on labour demand. This is even more true for areas like ICT production and consumption where technological change is rapid and the organisation of commercial activities changes at a similarly fast pace. Fifth, businesses themselves have problems to forecast their demand for specific skills over a period of more than six months. Consequently, medium term-forecasts are prone to errors.

Given these problems attached to measuring ICT skills shortages, estimates on the ICT skills gap should be viewed rather as broad indications of major trends in this area and not as accurate projections of shortages.

There are only two studies from IDC which measure the ICT skills gap across Europe. In the first study, IDC expects demand for IT skills to grow from approximately 9.47 million IT professionals in 1998 to 13.07 million in 2003, while supply is set to grow from 8.61 million in 1999 to 11.33 million in 2003. Consequently, the Western European skills shortage is estimated to reach 1.7 million IT professionals by 2003 (13% of demand). According to the second study, between 1999 and 2003 the demand for ICT employment will grow by 7.4 million jobs in Western Europe. By 2003, demand for ICT in Western Europe will be over 21.9 million jobs, whereas supply will be at 18.1 million, creating a gap of 3.8 million (18% of demand). The greater skills gap stems mostly from the inclusion of e-business professionals and call centre professionals which were not included in the first study.

There were a number of studies on the ICT skills gap on the country level. Even these estimates come up with sometimes substantially diverging estimates of the skills shortage. This may be a result of differences in scope of studies, sector definition, time horizon, data gathering method, period of study, time of conduct etc. All of these factors may have a significant impact on the results. The country estimates of ICT skills shortage or demand are in most cases substantially lower than the IDC estimates, which leads to the conclusion that the ICD estimates either indicate the upper level of the skills problem or overstate the problem.

Recent studies come up with a substantial decline in demand for ICT skills. In their view this is due to the recent downswing of the industry. Nonetheless even when taking the developments into consideration, the labour market is currently balanced at best, but the shortage will return once a new upswing sets in.

In the past years, measures to combat the shortage of ICT skills topped the agenda in European member states and in ICT firms. Both sides were active in designing strategies, occasionally by co-operative arrangements, to increase the supply of ICT-skilled labour. At European level, the Commission started the Initiative for New Employment, the eLearning Initiative and the European Computer Driving Licence. Member states have been trying hard to bring changes to their educational systems and to intensify training and requalification activities. Businesses have introduced new ways to recruit skilled people (most notably online recruiting) and to keep their employees “on board” by offering stock options. They have also invested in technology-focused alliances with partners, launched e-learning systems, virtual learning centres, etc. Some EU member countries have also tried to solve the ICT-skills problem by encouraging immigration, and some firms have established learning centres outside Europe or transferred part of their development and production units to non-EU member countries.

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