THE IMPACT OF GLOBAL SOURCING ON E-SKILLS

Final report
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Content

Executive summary

Global sourcing of ICT software and services is a relatively new policy concern that has grown out of increasing globalisation of the services sectors.

Global sourcing is enabled by phenomena such as trade liberalisation and technological developments, not least options to codify standardised ICT tasks and ICT-enabled services. These changing market dynamics form a relatively open field offering both challenges and opportunities for the future competitiveness of the European ICT software and services sector.

Since 2003, numerous studies illustrate uncertainties and complexity in forecasting global sourcing evolution and the drivers which are likely to impact the scope and the strategic aims of global sourcing. Main factors at play are cost-cutting measures, the availability of the appropriate skills, market access, and penetration in new growth markets. How market dynamics will unfold in the future is quite uncertain and depends upon a number of inter-related policy responses.

This study addressed these challenges and developed a "global sourcing assessment model" and three scenarios, offering a platform for a deeper understanding of the potential future impact of global sourcing on e-skills in Europe.

Each of the scenarios presents a distinct plausible future development of global outsourcing of ICT and services. These scenarios can be a basis for strategic dialogues at all stakeholder levels on the type of short- to medium term policy instruments which can best promote future competitiveness, growth, and employment opportunities in Europe.

Assessment of the impact of global sourcing

It is a challenge for policymakers to estimate the scope of future employment of ICT practitioners as the basis for evidence based policy making. To that end a relatively simple but robust assessment model has been elaborated, building on existing data and previously developed models.

As the quality of data is improved, the model can be refined. A global sourcing assessment model has been developed as part of this project to provide estimates on the impact of global sourcing on e-skills in Europe.

There are a wealth of drivers affecting global sourcing and the demand and supply of e-skills. In order to limit complexity, and based on existing data sources, three drivers were chosen: level of sourcing, level of demand, and level of supply of e-skills. Three key factors for each driver were then identified and form the basis for the elaboration of the assessment model and the three scenarios:

Table 1. Overview of the selected drivers

	Sourcing	Demand	Supply
Key factors	▪ Domestic supply of ICT practitioners ▪ Investments in European ICT ▪ Relative wages	▪ Demand for ICT services and products in Europe ▪ Level of sourcing ▪ Technological change	▪ Change in number of ICT students ▪ Retirement rate of ICT practitioners in Europe ▪ Net-migration of ICT practitioners

The global sourcing assessment model has been developed on the basis of 1) existing models for forecasting employment trends and 2) the availability of high quality data, and with valuable contributions from the Commission and the expert group.

The assessment model is the basis for three distinct future scenarios providing insights into how the demand and supply of ICT practitioners in Europe may unfold.

Scenarios for the future

The three scenarios combine key uncertainties; variations in market demand for ICT products and services, and variations in the global supply of ICT practitioners. The severity and nature of the skills gap in Europe vary in the scenarios due to company internal and external factors.

These three scenarios are characterised by:

- **Scenario One: Moderate increase in offshoring**
- **Scenario Two: Limited offshoring**
- **Scenario Three: High level of offshoring**

The three scenarios each contain scenario-specific policy challenges as well as horizontal themes relevant to all three outlined futures.

Scenario One: Moderate increase in offshoring

This scenario is characterised by a large supply of ICT practitioners outside Europe and a high demand for advanced ICT products and services in Europe. European companies and foreign companies are eager to connect to the European market and expand their business activities in Europe. The pool of ICT practitioners in Europe is limited, and this inhibits business growth. Some foreign companies refrain from locating activities in Europe due to the problematic supply of ICT practitioners in the EU.

Companies in Europe expand recruitment activities of non-European ICT practitioners willing to locate to Europe. Parallel to this process, low-value activities are increasingly offshored to free up capacity. Increasingly, as there is a continuing lack of ICT practitioners, high value activities that are strategically important to businesses are also offshored.

On the one hand, SMEs in the ICT services sector have many new opportunities in this demand-intensive market; on the other hand, lack of internal capacity to recruit ICT practitioners from abroad or to exploit off-shoring limits their growth opportunities.

Scenario Two: Limited offshoring

This scenario is characterised by a limited supply of ICT practitioners outside Europe and a high demand for advanced ICT products and services in Europe. High demand for products and services makes Europe an attractive market for inward investment by foreign firms – also because of an advanced level of demand in the different market segments. The need for ICT practitioners in Europe has intensified.

The lack of ICT practitioners in Europe seriously hampers growth and market expansion. Countries outside Europe are also affected by a shortage of ICT practitioners, as previous educational strategies have failed in recent years. Massive offshoring of activities or employment of migrant ICT practitioners is therefore not a solution on any larger scale. Offshoring remains minimal and the demand for talent in Europe is intense, particularly by a large group of SMEs within the sector as pressures on wages and creative peer environments have exploded.

Scenario Three: Extensive offshoring

In the third scenario, the demand for advanced ICT products and services is low due to saturated markets and a stagnating economy in Europe. The supply of ICT practitioners outside Europe is high. Due to the limited demand for products and services, companies look to countries outside Europe for new market opportunities and business expansion. Furthermore, due to the availability of qualified ICT practitioners in the new markets outside Europe, the demand for ICT practitioners in Europe is decreasing. Previous years' investments in ICT programmes finally started to pay off, but now result if an oversupply and rising unemployment level of ICT practitioners in Europe. The most talented European ICT practitioners are recruited by foreign companies to work outside Europe.

Estimating the quantitative impact of global sourcing

The rate of offshoring differs in the three scenarios, as does the product price index as a proxy for the scope and nature of market demand. These factors impact the overall demand for ICT practitioners in Europe. Global sourcing will not necessarily lead to a decreased demand for ICT practitioners, but is also highly dependant on market demands for ICT products and services as the future scenarios illuminate.

The differences across the scenarios are substantial, with employment predictions diverging by more than 400,000 employees.

Policy pointers

Proactive policy-making will call for a different mix of policy measures across the scenarios in some fields of action, whereas other policy actions will be relevant in each of the distinct scenario futures. All policy pointers build on a substantive literature review

Scenario One: Moderate Offshoring

Moderate offshoring could impede innovation, since global sourcing can lead to innovation gains. Policy measures could include stimulation and support to company globalisation strategies to harvest the full potentials of a globalised market for ICT products and services. SMEs face a particular challenge of recruiting and retaining high skilled labour in areas where there is a mismatch between supply and demand. One way forward is reform in education and training systems through comprehensive internationalisation measures to attract and retain more high skilled students as they graduate, combined with measures to expand the student base among young women and in the youth population more generally. Continuous reforms of migration policies for selected groupings combined with supportive enabling policies could make Europe an attractive location for longer or shorter periods as researchers or employees in the ICT sector.

Scenario Two: Limited offshoring

Should this scenario unfold with its massive shortage of ICT practitioners on a global scale, it will be essential to expand the recruitment basis in Europe though comprehensive and efficient lifelong learning measures targeting the dynamics in demand from the ICT sector as a whole. Although the recognition of prior learning is perceived as a booster to lifelong learning policies, its impact and uptake across Europe and the OECD more widely is still anecdotal, and lack of permeability between education sectors remains a challenge. As pressures from an aging population grow, policies should address retention of the ICT workforce in the sector, both through company-specific measures aimed to improve the attractiveness of the overall working climate for a sector reputed for its long and stressful working hours, and through national fiscal and labour market policies to improve labour market retention.

Scenario Three: Extensive offshoring

Saturated markets for ICT products and services are no longer considered to be a fluctuating phenomenon by ICT enterprises. Cost-cutting measures furthermore result in a marked oversupply of ICT practitioners across Europe. Proactive forward-looking initiatives both at company, regional, national, and EU level, are central to alleviating the most negative effects of redundancies for individuals and for the affected companies.

Transversal policy pointers

The market for ICT products and services is highly competitive. Deregulation and policies that stimulate demand-oriented innovations are central to the future competitiveness of the ICT sector in Europe, and thus central to employment and employability of ICT practitioners. A broader knowledge base of indirect and direct public policy measures that have a positive impact on the innovation capability and growth of the sector as a whole – including current priorities and design of the framework programme - is urgently called for.

In dynamic and globalised sectors such as ICT products and services, it is difficult to get a coherent picture of current and medium-term e-skills supply and demand in Europe, particularly at the micro level regarding specific occupations within the ICT sector and ICT-intensive businesses. Current statistical methods may give indications of demand that is currently met, but do

not provide information on demands which are not met and which result in alternative firm strategies addressing shortages of ICT practitioners. Because of the global nature of the ICT sector, a forward-looking coordinating platform for understanding drivers and changes over time as a basis for evidence-based policy making is still pending.

Context and acknowledgements

The e-skills domain has received much attention at the European level due to its importance to employability, competitiveness, and growth across all sectors of the economy. For instance, the European Commission established the European e-Skills Forum in 2003, and an ICT Task Force was launched in 2006 with the aim of creating a more favourable environment for business in the EU. In 2007, the European Commission released the Communication "e-Skills for the 21st Century - Fostering Competitiveness, Growth and Jobs".

This study on the impact of global sourcing on e-skills in Europe was launched by the European Commission as a follow up to the recommendations of the European e-Skills Forum. In the Forum's 2004 report "e-Skills in Europe: Towards 2010 and beyond", the Forum recommended to monitor the supply and demand of e-skills, to develop foresight scenarios and to analyse the impact of global sourcing on e-skills.

The activities and analyses carried out in relation to this study have been guided by a Steering Committee consisting of:

- Bruno Lanvin — Director e-Lab, INSEAD, Fontainebleau
- Caroline Jacobsson — Information and Communication Adviser, EMF, Brussels
- Elena Bonfiglioli — Director of Corporate Citizenship, Microsoft EMEA, Brussels
- Graham Vickery — Head of Information Economy Group, OECD, Paris
- Jacob Funk Kirkegaard — Research Associate, Peter G. Peterson Institute for International Economics, Washington

Our contact point within the European Commission was André Richier, Directorate General Enterprise and Industry. In addition, representatives from different Commission's services (in particular Jurand Drop from the Directorate General Information Society and Media) as well as a range of National, European and international experts and stakeholders have also provided valuable contributions to the study.

The Danish Technological Institute would like to acknowledge the immense contributions and insights provided by the members of the steering Committee as well as from involved experts and stakeholders interviewed.

1. Introduction

This is the second and final report related to the study "Impact of global sourcing on e-skills". In this report we analyse the expected impact of global sourcing on employment of European ICT practitioners in three different scenarios and present policy recommendations which address key challenges identified in each scenario.

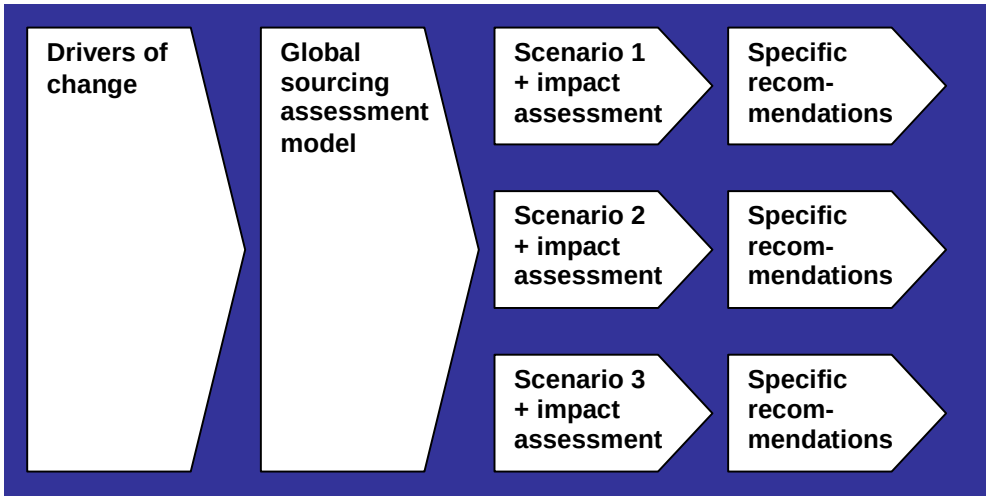
The report is based on two analytical elements: a global sourcing assessment model and three scenarios.

- The aim of the global sourcing assessment model is to provide estimates on the impact of global sourcing on e-skills in Europe. The model presented in this report is founded in existing models. It may be further refined in line with new empirical findings and as better data becomes available.
- Scenarios offer a strategic and robust framework for policy makers and stakeholders to anticipate future changes, identify relevant policy actions, and adjust policies and priorities as the future may unfold. In each of the three scenarios, the impact on the employment of ICT practitioners in Europe is estimated using the global sourcing assessment model. Further, a range of scenario-specific policy recommendations are presented to facilitate a strategic dialogue about scenario-specific and general challenges posed to policy makers and stakeholders at all governance levels.

The drivers of change identified in the synthesis report function as the means for structuring the development of a global sourcing assessment model as well as the point of departure for the development of three scenarios.

The relationship between the drivers of change, the assessment model, the scenarios, and the policy recommendations is illustrated in figure 1 below:

Figure 1. Main elements of the analysis



Global sourcing refers to 1) the relocation of activities from Europe to countries outside Europe (offshoring) and 2) the relocation of activities from non-European countries to Europe (onshoring). This definition excludes per se the relocation of activities from European countries to other European countries (known as 'nearshoring').[1] In our understanding of offshoring and onshoring, we do not distinguish between the transfer of production abroad to own affiliates and transfer of production abroad to non-affiliated firms (see OECD 2007a).

Global sourcing is sometimes confused with global business expansion, as both types of corporate restructuring involve the setting up of business activities in foreign countries. However, while global business expansion is a question of setting up new operations that complement existing activities, global sourcing refers to the relocation of existing domestic activities to foreign countries resulting in the termination or refocusing of the domestic activities. Global sourcing can – at least in the short term – lead to job losses, but can as well 'merely' lead to a change in the domestic demand for certain occupations and skills.

Policy context

Globalisation, global sourcing, and the impacts on labour markets and competitiveness are part of the policy agenda in many European countries and in the US, but policy responses vary in terms of the mix of instruments and strategies adopted.[2]

In Europe, education, training and lifelong learning form an integral part of the answer to the challenges of globalisation.[3] More specifically, changing skills demands in Europe affected by the globalisation processes such as the global sourcing of activities has been addressed in the Council resolution of 15 November 2007 on new skills for new jobs.[4] The resolution emphasises the need to:

- Provide all European citizens with new opportunities to improve their knowledge, skills, and competence levels and to adapt to new requirements and move to new and better jobs, by combining the instruments which already exist at European and national level;
- Anticipate the skills needs — and also the skills gaps — which are emerging in the European labour markets;

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1 Due to the limited availability of detailed national data, the global sourcing assessment model will include offshoring and onshoring as well as nearshoring. Although European companies increasingly source activities to non-European countries, the nearshoring of activities is still the dominant sourcing strategy in Europe. By including nearshoring in the analysis, we risk biasing the estimates - for instance by overestimating the employment effect of 'global sourcing'. An in-depth investigation of the implications of including nearshoring in the analysis requires a comparison of the employment effects of nearshoring and offshoring respectively, which is outside the reach of this study.

2 See synthesis report for examples on national approaches to global sourcing

3 Council resolution of 15 November 2007 on education and training as a key driver of the Lisbon strategy, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2007:300:0001:0002:EN:PDF

4 Council resolution of 15 November 2007 on new skills for new jobs http://www.skillsweb.eu/Portals/0/new%20skills%20for%20new%20jobs%2015%20Nov%202007.pdf

- Improve the matching of knowledge, skills and competences with the needs of society and the economy as a means to increased competitiveness and growth as well as to greater social cohesion in Europe.

The ongoing activities and studies on future skills needs in Europe initiated by Cedefop, Eurofound, and the European Commission, contribute to the achievement of the above outlined objectives by providing evidence on future skills needs situated within a context of changing demands driven by globalisation processes.

More specifically, the e-skills domain has received much attention at the European level due to its importance to employability, competitiveness, and growth across all sectors of the economy. An overview of the most recent milestone events and key studies in the e-skills domain is provided in table 2 below:

Table 2. Overview of milestone events and key studies in the e-skills domain since 2000

Year	Milestone events and studies
2000	*European Council in Lisbon*
2001	*e-Economy in Europe Conference*
	Communication of the Commission on "The impact of the e-Economy on European Enterprises: Economic Analysis and Policy Implications"
	Career Space Conference
2002	Council Conclusions on “The Impact of the e-Economy on the Competitiveness of European Enterprises”
	eEurope 2005 Action Plan
	Technopolis report on “ICT and e-business skills in Europe”
	European e-Skills Summit in Copenhagen
	Council conclusions on “ICT and e-business skills in Europe”
2004	Cedefop report on ICT and e-business skills and training in Europe
	European e-Skills Forum report on "e-Skills in Europe: Towards 2010 and Beyond”
	European e-skills 2004 Conference in Thessaloniki
2005	Rand report on the supply and demand for e-skills in Europe
	i2010 – A European Information Society for growth and employment
2006	*ICT for an Inclusive Society Conference in Riga*

Year	Milestone events and studies
	ICT Task Force report: “Fostering the Competitiveness of Europe’s ICT Industry”
	European e-Skills 2006 Conference in Thessaloniki
2007	CEPIS, PREST and Eurochambres report on ”Thinking Ahead on e-skills for the ICT Industry in Europe”
	MENON EEIG report on “Benchmarking Policies and Initiatives in Support of e-Learning for Enterprises in Europe”
	PAU Education and Danish Technological Institute report on a “European e-Skills and Career Portal” (feasibility study)
	Empirica report on “Benchmarking Policies on Multi-Stakeholder Partnerships for e-skills in Europe”
	Communication by the Commission on “e-Skills for the 21st Century: Fostering Competitiveness, Growth and Jobs”
	Competitiveness Council Conclusions on a long term e-skills strategy
2008	Cedefop report on “Future skill needs in Europe. Medium-term Forecast”
	CEN/ISSS CWA on a “European e-Competence Framework”
	Danish Technological Institute report on “The impact of global sourcing on e-skills”
	European e-Skills 2008 Conference in Thessaloniki

Understanding the impact of global sourcing on e-skills

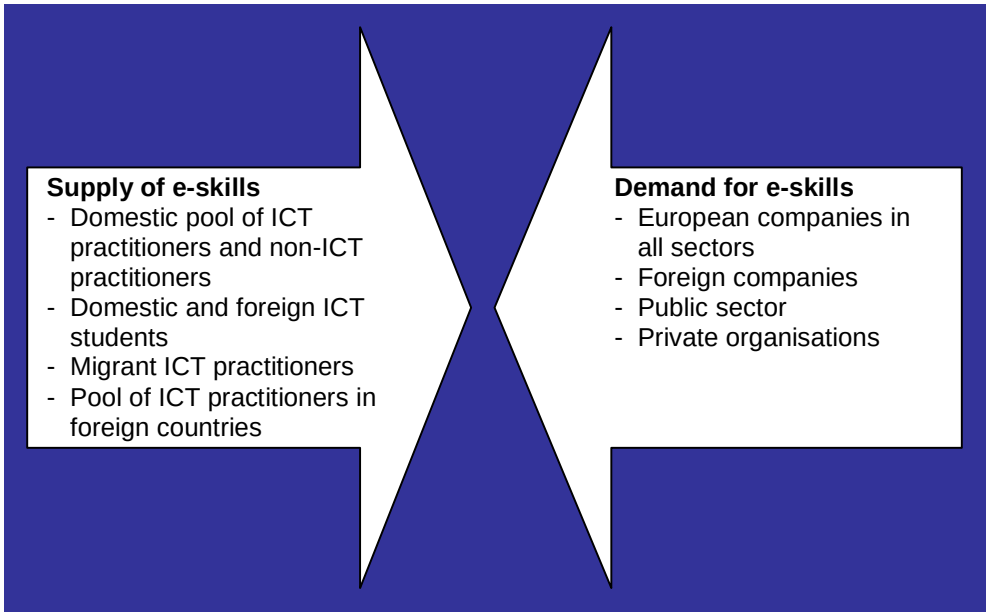
A market perspective has been applied in the analysis of the impact of global sourcing on skills demands. The question of skills is therefore situated in a context of those factors which shape supply and demand and changes in these, so as to address the overall policy challenge of ensuring adequate and dynamic matching mechanisms and policies concerning the supply of and demand for ICT practitioners.

There is a domestic and foreign (e.g. non-European) dimension to both supply and demand. The domestic supply includes ICT practitioners employed in different economic sectors as well as non-ICT practitioners who may qualify for positions as ICT practitioners through upskilling or retraining. European ICT students and foreign ICT students studying in Europe can also be considered a part of the domestic supply – for instance through internships. The foreign supply of e-skills consists of migrant ICT practitioners (temporary or permanent) who travel to Europe to work, and the pool of ICT practitioners in foreign countries who provide services to European companies engaged in offshoring or global business expansion.

The demand side in Europe is represented by European companies in all economic sectors and by foreign companies that decide to either onshore activities or to locate activities in Europe.

The public sector and private organisations are also a source for both domestic demand and for demand for e-skills in foreign countries – for instance when using a foreign supplier of ICT services. Figure 2 below indicates the domestic and foreign sources of e-skills supply and demand:

Figure 2. Domestic and foreign sources of e-skills supply and demand



Quantitatively, global sourcing may affect demand for skills in Europe by reducing the need for ICT practitioners and/or certain specific occupations (e.g. programmers, call centre staff) in Europe – at least in the short term – when companies decide to relocate activities to foreign countries and terminate activities in Europe. However, global sourcing may also result in an increasing demand for ICT practitioners in Europe. For instance, global sourcing could increase the demand for ICT practitioners in Europe due to an increased competitiveness of European companies or due to global specialisation of activities which subsequently may lead to the onshoring of certain activities to Europe from foreign countries (Statistics Denmark 2008). Global sourcing of activities can also in the long run increase economic growth in sourcing destinations and thus potentially increase the demand for European ICT products and services. As regards the qualitative dimension, global sourcing can affect the relative demand for low and high skilled employees in Europe as well as the demand for certain types of skills (e.g. language skills, business understanding, organisational skills, and mathematical skills).

Global sourcing may negatively affect supply by increasing the (perceived or real) risk of unemployment, with potential ICT students questioning the realities of a career in the ICT sector. On the positive side, global sourcing is associated with the internationalisation of European companies, thus adding an international dimension to work as an ICT practitioner. The

internationalisation process could also make work as an ICT practitioner more attractive by increasing the opportunities of working outside Europe and exploring new cultures and countries.

Structure of the report

The first section of the report provides an overview of key literature on global sourcing and impacts on labour markets. Key drivers of change are identified, and the underlying methodology for the global sourcing assessment model based on key literature and available data is elaborated. Section two contains three scenarios and the provision of estimates concerning the impacts of global sourcing on employment of ICT practitioners in Europe. These estimates are based on the global sourcing assessment model. Finally, we present a range of policy recommendations – both general and scenario-specific recommendations linked to addressing key challenges identified in the different scenarios.

2. Global sourcing assessment model and scenarios

The provision of robust quantitative estimates on the current and expected future impact of global sourcing on e-skills in Europe can assist European policymakers and companies to take appropriate measures concerning an adequate supply of e-skills in the medium term. In particular, reliable quantitative evidence can help policymakers and stakeholders to monitor and anticipate developments in the supply of and demand for ICT practitioners, thus enabling policy makers to dynamically adjust policies and improve framework conditions in Europe as changes occur, in line with the overall policy objectives of the European Union as embodied in the European Commission's long term e-skills agenda (European Commission 2007a).

Currently, there exists no reliable mathematical model for assessing the quantitative impact of global sourcing on employment of ICT practitioners in Europe. This negatively impacts the evidence base on global sourcing phenomena available to inform policy making. In order to improve the evidence base, the European Commission has contracted Danish Technological Institute to develop a mathematical model in order to quantify and forecast the impact of global sourcing on employment of ICT practitioners in Europe. The model presented in this chapter has been developed by the Danish Technological Institute together with Centre for Economic and Business Research, Copenhagen.

The development of the global sourcing assessment model has been divided into six steps:

1. Review of existing studies
2. Development of theoretical model
3. Development of operational model
4. Estimation of effects of key factors
5. Development of scenarios
6. Assessment of the impact on global sourcing on the supply of and demand for ICT practitioners in each scenario

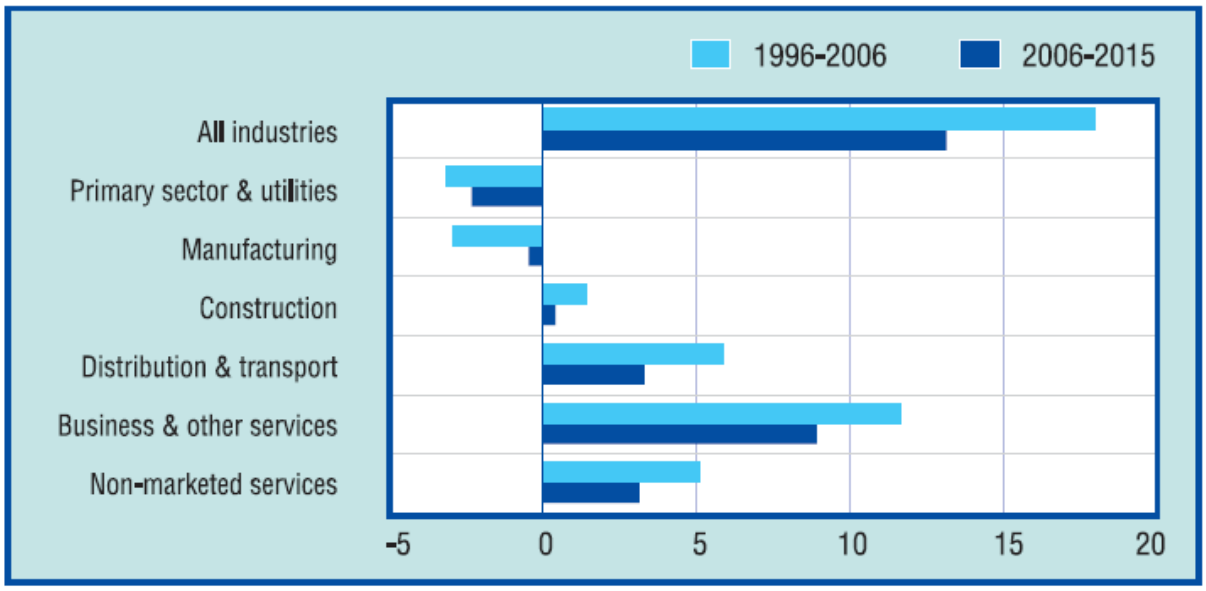
First, a global sourcing assessment model and the underlying methodology is presented (step 1-3). The model is then applied to European data to estimate the impact of global sourcing on e-skills in Europe (step 4). Subsequently, three scenarios are developed (step 5), and the assessment model is used to estimate the impact of global sourcing on e-skills in each of the three scenarios in a 5 year time horizon (step 6).

Step 1: Review of existing literature on demand and supply of e-skills

One of the most recent European-wide forecasts of skill needs in Europe is "Future skill needs in Europe" (Cedefop 2008). This study provides a medium-term forecast of occupational skill needs in Europe. It distinguishes between different sectors, countries and occupations. In total, the EU-25 is expected to experience a net increase of more than 13 million jobs in 2006-2015, according to the study. Almost 9 million of these jobs are expected to be created within the business and

other services sector. Expectations to job creation vary between countries, with Cyprus, Austria and Poland among the European countries with the highest expected job growth (2010-2015).

Figure 3. Employment trends by broad sectors (change in millions), 1996-2015, EU-25, Norway and Switzerland



Source: Cedefop 2008

The Cedefop study does not focus specifically on ICT employment or e-skills, but its employment forecasts for the business and other services sectors do provide an indication of future employment developments for ICT practitioners.

Recent literature on e-skills in Europe

A range of studies have focused specifically on developments in the supply of and demand for e-skills in Europe. RAND (2005) discusses different approaches used in the analysis of the e-skills supply and demand. It describes and analyses the current situation relating to the supply of and demand for practitioner skills in the European Union and its Member States, and for comparative purposes the RAND analysis provides data on the situation in the United States. RAND also reviews different studies on expected future trends in supply and demand, but does not provide any forecasts of the future e-skills demand and supply in Europe. In fact, only few studies have attempted to systematically identify and analyse drivers of ICT employment with the purpose of predicting future developments.

An analysis by CEPIS (2007) is among the few European-wide studies that seek to estimate the future employment perspectives for ICT practitioners. In the study, multiple drivers are identified and three of the 'core' drivers are included in a mathematical model. The three drivers are:

- ICT innovation rate
- Economic growth

- Off-shoring pace

The equation used by CEPIS to estimate employment is as follows:

$$\text{Employment}_{y+1} = \text{Employment}_{y} * ((\text{software investment as \% of non-residential fixed capital formation})_{y+1} / (\text{software investment as \% of non-residential fixed capital formation})_{y}) * (1 + \%\text{real GDP growth})_{y+1} * (1 + \%\text{growth in real Gross Private Non-Residential Fixed Capital Formation after controlling for GDP growth})_{y+1} * (1 - \%\text{ net loss of employment to off-shoring})_{y+1} * (1 + \%\text{ increase in real compensation})_{y+1}$$

where y is the year for which employment statistics or a projection of employment already exist, and y+1 is the next year, for which a projection is being calculated (CEPIS 2007).

The CEPIS study provides estimates for supply and demand levels of ICT practitioners in 2010 and 2015 for a total of six scenarios. According to this approach, the ICT industry could be facing shortages of up to 70,000 ICT practitioners in Europe, as supply falls short of demand. In another scenario, which is perceived as highly unlikely, there is a drop in ICT activity which could result in an oversupply of 1,000 ICT practitioners per year. However, the selection of drivers is not substantiated in the theoretical literature, and there is no indication of the relative importance and impact of the included determinants.

There is also a range of national forecasts on employment of ICT practitioners. For instance, e-UK has published a report providing forecast for the employment of a range of IT occupations for the period 2007-2016 (e-skills UK 2008). However, the model that constitutes the basis for these forecasts is not described in detail. In Ireland, Forfás recently developed three scenarios and provided forecasts of demand and supply of high-level e-skills for each of the scenarios over the period to 2013 (Forfás 2008). The forecast of (domestic) supply is based on the expected number of future graduates in computing and electronic engineering, and the forecasts of demand are based on different estimates of employment growth rates in different ICT sub sectors.

The three scenarios are:

- "Continuing recovery": the scenario assumes a continuation of the employment growth experienced between 2005 and 2006, adjusted so that the growth rate in web-based operations falls over time, growth in electronic hardware moderates, and employment in semiconductors remains constant.
- "Accelerating recovery scenario": the scenario assumes a higher rate of growth, but still a rate that falls far short of that experienced in the latter half of the 1990s.
- "Loss of competitiveness": the scenario assumes that growth rates fall, and (for most subsectors) turn negative by 2013 due to a loss of competitiveness.

According to the report, the projected domestic supply of graduates alone will not be sufficient to meet the demand under either of the two more positive demand scenarios, and will roughly meet demand under the negative "loss of competitiveness" scenario.

The forecasts by Forfás are not based on a mathematical model, but on a set of possible employment growth rates. Furthermore, the differences between the growth rates in the scenarios are not explicitly related to any changes in the factors affecting the demand for high-level e-skills.

Literature on the impact of sourcing on employment

There are numerous empirical studies and forecasts of the impact of global sourcing on employment (see Brainard and Litan 2004 for an introduction to some of these studies), but the reliability of the different findings is often difficult to assess because sources and methods applied are not sufficiently transparent. Furthermore, many studies of global sourcing only focus on job loss while net job creation due to sourcing is often a neglected factor, making studies that provide empirical estimates of the net-effect of global sourcing "extremely rare" (Kirkegaard 2007).

According to a 2002 Forrester report, 3.3 million US services industry jobs and $136 billion in wages will move offshore by 2015 to countries such as India, Russia, China, and the Philippines, and the IT industry will play a leading role in this development.[5] However, a large body of literature on the impact of global sourcing on employment suggests that the impact on employment is far less dramatic than proposed by the Forrester study:

- McKinsey Global Institute's report (2003) is a widely quoted study on service outsourcing. According to the report, the amount of job losses due to outsourcing is a relatively trivial share of the overall job losses during the normal course of a business cycle.
- A study of the effects of service outsourcing on employment using US data concludes that there is a small negative effect of service outsourcing on employment (Amiti and Wei 2005).
- According to a survey of companies in a Danish region, in 2002–05 more jobs were created as a result of offshoring of activities from foreign countries into Denmark than were lost due to offshoring from companies in the region (Jensen et al. 2006).
- ITPS (2006) investigates the consequences of offshoring of IT services for Sweden. The study finds that the numbers of jobs that are thought to be offshored are fairly limited across all labour market occupations.
- Ovum (2006) studies the impact of global sourcing on the UK software and IT services sector. OVUM concludes that the number of UK-based employees in the ICT sector will fall by some 6 %, but this reduction will be somewhat offset by an increase in UK-based staff of supplier companies from other countries (OVUM 2006).[6]

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5 Forrester website, "3.3 Million US Services Jobs To Go Offshore": http://www.forrester.com/ER/Research/Brief/Excerpt/0,1317,15900,00.html

6 There is a great deal of discussion of different factors which are thought to impact onshore employment levels, however, details of the statistical model which is generating Ovum's predictions are not given.

- According to the European Restructuring Monitor, the impact of offshoring on employment is relatively limited. The figures for information technology covering 2002-2008 reveal that total job creation outweighs total job loss, and that the job impact of offshoring is relatively small compared to the job impact of internal restructuring and bankruptcy/closure.[7]
- OECD (2007a) argues that there may be short-term negative effects of offshoring on employment due to an immediate reduction in certain activities. However, according to the analysis new job creation in the service sector offsets job destruction from all causes combined, including offshoring. It is important to note that the creation of jobs in the service sector could be a result of a general economic upturn, and that job creation may not be able to offset job destruction during an economic recession.
- Jensen and Kletzer (2008) argues that the number of jobs in the US at risk of being offshore to low-wage, labour-abundant countries is about 15–20 million. However, the job "losses" will be offset by job "gains" from services exporting.
- Research by the Work Foundation (2008) finds that 5.5% of job losses across Europe in the first quarter of 2007 were due to offshoring compared with 3.4% in 2005, but it suggests the speed of job loss due to offshoring is not dramatic.
- A recent survey of Danish companies concerning the impact of international sourcing on employment has shown that international sourcing in 2001-2006 had a negative impact on employment. However, the impact was relatively limited. According to the survey, Danish enterprises estimate gross job losses due to international sourcing to amount to 25,000-35,000 during 2001-2006, while the enterprises report job creations levelling to 7,000-10,000 jobs during the same period due to their sourcing of business functions abroad (Statistics Denmark 2008).

What these and other studies suggest is that sourcing may have both positive and negative effects on ICT employment, hence, rigorous empirical analysis is called for to determine the net effect.

Limitations of previous studies

Despite an increasing focus on ICT employment in recent years, there is limited knowledge of the determinants of ICT employment based on theoretical reasoning and solid econometric testing. Furthermore, only few studies have attempted to include and estimate the impact of global sourcing when forecasting ICT employment. Those studies that do address the impact of global sourcing have no transparent methodology which can be used to assess crucial statistical properties of the numbers such as significance and precision (e.g. Ovum 2006). Furthermore, assumptions about future developments often have no theoretical underpinnings (e.g. CEPIS 2007). This is arguably a weakness, as results may be difficult to replicate and/or test on new datasets. Further, the robustness of the findings will be difficult to assess. Finally, an important limitation which existing studies have faced is a lack of high-quality and adequate data (e.g. RAND 2005).

A brief outline of weaknesses of the existing literature is as follows:

- Lack of theoretical underpinnings

[7] European Restructuring Monitor: http://www.eurofound.europa.eu/emcc/erm/

- Lack of rigorous and transparent methodology
- Lack of high-quality data

In the following section, we intend to develop a theoretically based model that is able to provide estimates on the impact of global sourcing on the future demand for ICT practitioners in Europe, subject to limitations imposed by lack of high quality data. We will describe the model development process in detail to ensure that experts can comment on the model and provide suggestions for improvements. Such an approach also makes it possible for others to assess the reliability of the model's estimates.

Step 2: Developing the theoretical model of ICT employment

The development of a reliable global sourcing assessment model is a complex task, and the lack of high quality data imposes some unfortunate limitations on the model (such as the exclusion of important factors and limited geographical coverage). As a result, the global sourcing assessment model presented in this chapter is thus a relatively simple econometric model covering the EU-15, and must be considered a first step in the continuous development of an impact assessment model, as the model may be refined with improvements in the theoretical and empirical understanding of main determinants and key relationships and – not least – improvements in the quality and availability of national data on key determinants. These limitations mean that the model and estimates derived from the model should be used and treated with caution.

Furthermore, the level of aggregation is Europe and national differences are therefore not reported. However, the model allows for an analysis at national levels as well as a segmentation of countries which permits more detailed analyses of trends within Europe (for instance, comparing North and South European countries) that could be of interest to policy makers and stakeholders.

Compared to previous studies and approaches, the global sourcing assessment model presented in this chapter also constitutes an improvement on several dimensions:

- The empirical model has a solid theoretical underpinning.
- The model represents a simple, econometrically sound regression approach to estimating effects of different factors influencing ICT employment.
- The model is capable of assessing the size of these effects regarding different factors linked to ICT employment.
- Comparison of the relative empirical importance of different factors on ICT employment is feasible.
- Arguments of previous studies of the impact of global sourcing on ICT employment can be tested against data.
- The model can be used for forecasting the future impact of global sourcing on ICT employment

On this basis, the proposed model is perceived to provide a robust basis for estimating the current and future impact of global sourcing on employment of ICT practitioners.

Identification of key drivers

Drawn from existing literature, this section synthesises main findings which feed into a theoretical model of ICT employment. Clearly, there are numerous potential determinants of ICT employment. Further compounding the complexity: many of these determinants affect not only ICT employment, but there are also the causal relationships between many of these. It will be the case that some factors have indirect effects. This issue is addressed in the following, but it is evident that a substantial simplification and synthesis of the numerous potential determinants is necessary in order to arrive at a tangible theoretical model which can be made operational.

Three core dimensions are proposed as a point of departure, namely the demand for ICT practitioners, the supply of ICT practitioners, and the level of sourcing. The following briefly outlines what we consider to be the most important drivers of these three core dimensions.

What determines the level of sourcing?

As literature shows, there is a host of potential reasons for offshoring activities. In a report by Statistics Denmark (2008), some of the main factors driving international sourcing are placed within four groups:

- Efficiency-seeking factors (e.g. reduction of labour costs and other types of costs, focus on core business)
- Market-seeking factors (e.g. access to new markets)
- Resource-seeking factors (e.g. access to specialised knowledge/technologies)
- Strategic factors (e.g. following the behaviour/the example of competitors / clients, improved quality or introduction of new products, strategic decisions taken by management, tax or other financial incentives)

According to the report, companies in Denmark, Norway, Sweden, Finland, and the Netherlands most often refer to reduction of costs, in particular reductions in labour costs, as the key driver for sourcing production or support functions abroad (Statistics Denmark 2008). This emphasises the importance of relative wages for location decisions by companies. Interestingly, the importance of reductions in labour costs differs across the five countries. In Denmark, Sweden and the Netherlands close to 60% of the enterprises cite labour cost savings as a very important driver of international sourcing compared to around 40% of the enterprises in Finland and Norway (Statistics Denmark 2008).

Institutional factors such as the contracting environment (Grossman and Helpman 2002), technological developments in the area of communication, liberalisation of trade and markets, and a supply of well-educated, English-speaking labour, are also important for global sourcing decisions (ITPS 2006). For a survey of recent literature see for example Manning et al (2007) or, more generally, for a great number of factors affecting the location choice of production activities see Graf and Mudambi (2005).

What determines the demand for ICT practitioners?

A wealth of factors affects demand for ICT practitioners. Among the most important is the demand for ICT services and products in Europe, since this determines the level of activity in the sector. Different restructuring processes such as increasing automation of production and the

sourcing of activities to non-European countries can also affect the demand for ICT practitioners by reducing the need for employees in Europe. Moreover, technological change may speed up skills depreciation among European ICT practitioners, resulting in a reduction of the employability of ICT practitioners that have not updated their skills through vocational training.

Prices affect employment levels in several ways. A change in the relative prices of ICT may lead firms to change investment levels which in turn will translate into changes in demand for ICT practitioners. Price developments of ICT products reflect changes in demand and competitive pressures; all else equal will increasing prices lead to higher production levels, firm entry, firm growth, and, thus, higher ICT employment levels.

What determines the supply of ICT practitioners?

The pool of ICT practitioners in Europe is determined by a range of demographic developments, such as decreased birth-rates and increased life expectancy in Europe. Overall, the European population is getting smaller and is aging, and despite measures to increase labour force participation rates and the length of time it remains economically active, these developments affect the pool of potential ICT practitioners. In recent years, ICT educational institutions have had problems recruiting students. There is a general lack of interest in natural sciences and technical education programmes among young people, and ICT employment is often not considered an attractive career opportunity. ICT education providers therefore have to expand measures aimed at improving the attractiveness of ICT programmes. Likewise ICT companies need to make career paths and working conditions visible and attractive in a life trajectory perspective. Key supply factors also include the retirement rate and age of ICT practitioners as well as the net migration of ICT practitioners.

The European ICT industry is currently concerned about labour shortages, and recruitment challenges reported could imply that companies in the sector face even more serious shortages of ICT practitioners. Measures have already been taken to expand the recruitment base, to retain ICT practitioners, to re-train non-ICT practitioners, and to open up for recruiting ICT practitioners outside the EU. The relative wages – domestic vs. international as well as between different economic sectors in Europe – can affect the recruitment and re-training efforts by impacting the perceived attractiveness of working in Europe and more specifically the European ICT labour markets as opposed to other sectors of economic activity.

Theoretical model

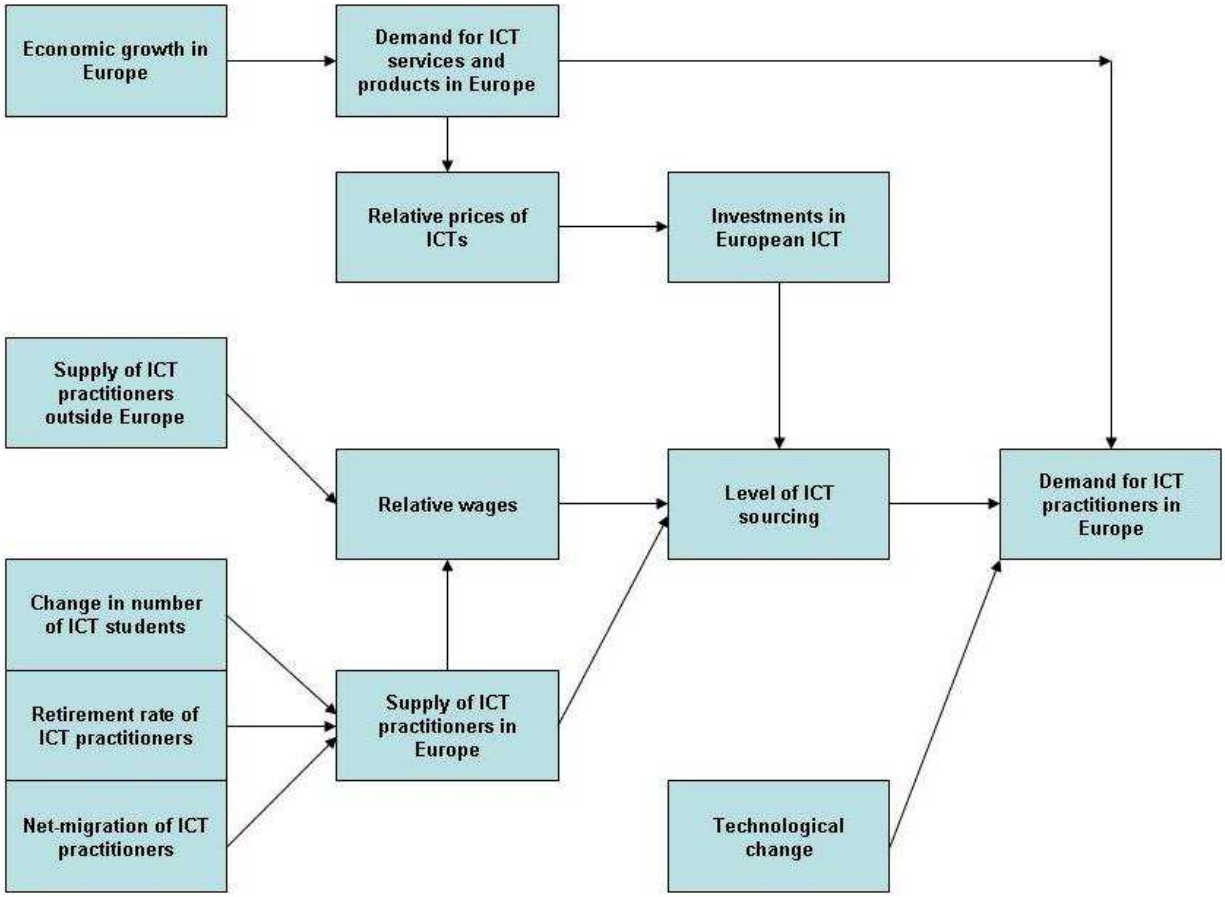
The development of a global sourcing assessment model is a complex task due to the large number of relevant factors pertaining to the demand and supply of e-skills, and the limited availability of reliable data has to be considered. To limit the complexity level, we have identified three key themes in the literature on the impact of global sourcing on demand for ICT practitioners and supply of these: level of sourcing, demand for ICT practitioners, and supply of ICT practitioners. Other factors could have been included in the model, and the proposed model must be considered a point of departure for the development of a more complex model that includes a broader range of factors as a robust evidence base over time my evolve not least due to current consolidated joint efforts between the EU, the OECD and national statistical offices concerning the development of the statistical base.

Table 3. Overview of the selected drivers

	Sourcing	Demand	Supply
Key factors	• Domestic supply of ICT practitioners • Investments in European ICT • Relative wages	• Demand for ICT services and products in Europe • Level of sourcing • Technological change	• Change in number of ICT students • Retirement rate of ICT practitioners in Europe • Net-migration of ICT practitioners

The tentative relationships between the different variables are shown in the figure below. A range of background variables have also been included in the figure to illustrate key dynamics.

Figure 4. Theoretical model – tentative relationships between key factors



The depicted model is merely a simple illustration of some of the key dynamics related to global sourcing and e-skills. The causal relationship between factors is somewhat more complex than

depicted in the model. For instance, the development in relative wages can affect the supply of ICT practitioners in Europe by impacting the s attractiveness to work as an ICT practitioner in the European ICT sector versus finding employment elsewhere. Also, the level of ICT sourcing can deter potential employees from choosing a career in the ICT sector due to perceived uncertain job perspectives. These complexities are not dealt with in the theoretical or the operational models.

Step 3: Developing the operational model of ICT employment

This section derives an operational model based on the theoretical underpinnings presented above. The aim has been to arrive at a model which is able to explain a significant proportion of the factor variations of ICT employment in Europe over time and subsequently use the resulting model to make quantitative predictions of the future development of ICT employment.

Modelling strategy

In setting up the empirical model, parsimony has been an important objective. This is to facilitate the model's replicability and to enable an open model structure that over time may be elaborated further, building on other factors than those in this study, as the empirical evidence base on global sourcing grows. In addition, a simple and concise model puts lowest possible demands on the data (as it turns out, we only have approximately 300 observations - with considerable unobserved heterogeneity), and it generates results which are most robust to changes in the model set-up (for example the sampling criteria, the treatment of outliers, and the list of factors included in the model). Finally, by applying a standard and well-known modelling technology, our results are comparable with other previous studies, and presumably with future studies.

Holding these objectives up against the theoretical considerations in section 2, an approach has been adopted similar to the one of Amiti and Wei (2005) whose model follows the seminal works of Feenstra and Hanson (e.g. Feenstra and Hanson (1996)). Thus the empirical model is a linear least squares regression, with the labour market variable, in our case – growth in ICT employment - being the dependent variable. As a point of departure, this model is purely descriptive, and the parameter estimates of the model are simply statistics (functions) of the data. The model can provide us with the statistical correlations between key variables (such as growth in offshoring or change in demand for ICT products and services) and ICT employment.

The interpretation of these correlations will depend on the additional assumptions one is willing to make, in particular, 'ceteris paribus' assumptions, and assumptions regarding the exogeneity of explanatory factors. These conditions would allow us to trace causality, and would rule out other potential explanations for our findings than just the specific factor under consideration having a *causal effect* on the number of persons who are active in the ICT industries.

Our aim is to be able to rule out a number of straightforward alternative explanations by including additional control variables; however, given that we deal with non-experimental data (or data that resembles an experimental set-up), no watertight statements regarding causality will be possible. In short, we can learn about the presence and strength of relationships – which is an improvement compared to earlier studies - but we will have to be conservative regarding the interpretation of what drives these relationships.

The empirical model

The specification of the empirical model was guided by a number of considerations. First, the data are trended: The time dimension in the data implies that a number of variables follow trends over time. These are often driven by the same underlying mechanism such as growth in GDP, technological progress, or demographic change. Sometimes these underlying factors are observed in the data and thus can be controlled for, but often they are not, leaving correlations in the data without interpretation. A strategy to avoid measuring these 'spurious' relationships is to consider (percentage point) *changes* in variables rather than their levels, in other words to relate changes in the dependent variable (here: the change in ICT employment) to changes in the potential drivers (e.g., changes in the offshoring intensity).

Second, there may be trends in employment growth which are left unexplained by the factors which are included in the model. A simple way to accommodate this potential problem is to include time trends in the regressions.

The model which is the point of departure of this analysis can thus be expressed as:

$$\Delta_{it} = const + \alpha_1 \Delta x_{1it} + \alpha_2 \Delta x_{2it} + ... + \alpha_k \Delta x_{kit} + \alpha_t + \varepsilon_{it} \qquad (1)$$

with L being employment, and Δ denoting log growth in the variable which follows. In other words, $\Delta L_{it}=\log(L_t/L_{t-1})$, $\Delta x_{it}=\log(x_t/x_{t-1})$, etc., where t is the year index. This implies that the coefficient estimates describe the relationships between percentage point changes in the drivers and percentage point changes in employment.

Further, in model (1), *i* is the country index, $x_1,\ldots,x_k$ are the potential drivers included in the model, and *T* is the time trends variable. ε_{it} is the error term in year t, which captures the effect of factors which are not included in the model. The parameters to be estimated are the constant term (*const*), and the α's.

We refer to model (1) as the "basic model". The robustness of this model's estimates is tested by estimating two additional model specifications. The first takes account of industry differences in the constant term and time trends, the second allows for country (and industry) specific errors.

We consider three different industries with potentially different employment growth rates. This is accommodated by defining one base category - in this case NACE 72 – and including dummy variables for the other two industries. Further, the time trends of the different industries may follow different patterns. For this reason, we also estimate industry specific time trends.

This leads to the following model, which will be referred to as "the extended model":

$$\begin{aligned}\Delta L_{ijt} &= \alpha_1 \Delta x_{1ijt} + ... + \alpha_k \Delta x_{k\,ijt} \\ &+ const_{INDUSTRY=1} + \beta_1 D_{INDUSTRY=2} + \beta_2 D_{INDUSTRY=3} \\ &+ \lambda_1 T_{INDUSTRY=1} + \lambda_2 T_{INDUSTRY=2} + \lambda_3 T_{INDUSTRY=3} \\ &+ \varepsilon_{ijt}\,,\end{aligned} \qquad (2)$$

with the β 's and γ 's being additional parameters to be estimated. We have added the subscript j, which is an industry index, to the exposition of the extended model to emphasise that this model

recognises the potential existence of industry specifics. Thus, ΔL_{ijt} is log employment growth in country i in industry j at time t.

Note that there may be country specifics which are both unobserved, and correlated to both employment growth and the potential drivers. These may violate the ceteris paribus assumption, the realism of which we aim to maximise. As another extension of the model – which also may be considered a way of testing the robustness of results with reference to this potential problem - we follow a simple way to accommodate this potential problem.

As a second extension of the basic model, the variations in both employment growth and the potential drivers *over time within countries* are considered, rather than the variation of these variables across countries. This modified model can answer the following question: for a given country, are years of high growth in one of the potential drivers related to years with high (low) employment growth? This is achieved by including country specific dummy variables, or 'country fixed effects', in the regression.

This modified model will be referred to as the "fixed effects model", and can be expressed as:

$$\begin{aligned} \Delta L_{ijt} = {} & \alpha_1 x_{1ijt} + ... + \alpha_k x_{kijt} \\ & + const_{ALL\ INDUSTRIES} \\ & + \lambda_1 trend_{INDUSTRY=1} + \lambda_2 trend_{INDUSTRY=2} + \lambda_3 trend_{INDUSTRY=3} \\ & + u_{ij} + \varepsilon_{ijt}\ , \end{aligned} \tag{3}$$

where u_{ij} has the interpretation of an unobserved constant which is specific to employment growth in country i in industry j. The model corrects for the potential problem that the differences in the u_{ij}'s could be related to the other drivers (and thus bias results).

To sum up, the first regression pools all observations across all countries, and all three industries. It does not take into account any country and industry specific effects. Thus, this regression's estimates are average effects across industries. The second regression takes into account that there may be systematic differences across industries in the average employment growth rates and/or changes in these growth rates over time. The third regression corrects for the potential problem of the existence of systematic differences in employment growth rates across countries. For instance, some countries may always have - for some (unobserved) reason - high or low growth rates, and this would be a problem if these unobserved factors were related to the drivers.

Below, we will see that the results are not sensitive with respect to correcting for potential misspecification of the first model. For this reason we stick to the first model - which is the most simple and most intuitive one - when we discuss results, and set up the scenarios.

Strengths and limitations of the model

Note this model is a reduced form model, i.e., it makes no explicit distinction between the supply of and the demand for e-skills. Obviously, it would have been useful had we been able to distinguish between the two sides of the market; however, this would have required robust instruments, i.e., information on variables that affect one side of the market but not the other. For example, with regards to estimating the demand side of the market, we would have needed data

on factors that have influence on the supply of skills, and – at the same time – could be assumed to be unrelated to the demand for e-skills. We made an effort in this direction, e.g., testing the explanatory power of the number of graduates in tertiary education with regards to variation in the wage measure (which may be assumed to be endogenously determined). However, the correlations proved to be too weak to allow for identification of any structural supply and/or demand side parameters. Furthermore, the empirical model allows us to identify the relationships in the data which may be given a tentative interpretation. However, we cannot hope to formally identify any complex underlying mechanics from a dataset which is limited in size and subject to large unobserved heterogeneity.

In sum, the model's strength is its reliability even with modest sample sizes, and the absence of any brute force interpretation of results – which would be based on strong assumptions. Its weakness is the absence of any distinction into the supply of and the demand for ICT practitioners. However, some of the variables in the model will have a clear demand side interpretation, for example, variables related to the demand of ICT-skill intensive products.

Data and variables

Data sources and sampling

Publicly available data from EUROSTAT have been used, including information from the EU-KLEMS database. Data is typically available on an annual basis, which leads us to adopt the year as the unit of time of the analysis. Further, most data is only available at the national level, which leads us to adopt country as the cross-sectional unit.

Annual data for the EU15 group of countries (Austria, Belgium, Denmark, Finland, France, Greece, Germany, Ireland, Italy, Luxemburg, the Netherlands, Spain, Sweden, Portugal, and the U.K.) were collected. For this group of countries, data series of sufficient length were available for most of the variables of interest.

Included drivers of ICT employment

The theoretical discussion notwithstanding, there may be many more factors than the ones mentioned which have an effect on ICT employment. However, the precision by which the relationships between the different factors may be assessed suffers from including too many factors as explanatory variables in the empirical model. Obviously, there are also restrictions with regards to the existence and accessibility of data, so in any case we will have to simplify the model.

Furthermore, the explanatory factors are interrelated. This does not bias results, but has implication for the interpretation of results. One should be aware that coefficients have the interpretation of being the partial derivatives of the dependent variable, in this case, employment (growth), keeping the other factors fixed; this interpretation may not always be meaningful. For example, if one includes both the level of exports and the level of production in the regression model, then the coefficient estimate of the export measure is the derivative of employment with regards to exports for a given level of production. This will typically underestimate the effects of exports on employment, as there is obviously an effect of export on level of production (which again is positively related to employment). Excluding the production level from the model would

avoid this problem. However, in this case the model would no longer be able to catch changes in the production for domestic consumption.

As this discussion indicates, some trade-offs will have to be made. We aim at achieving a model which is able to explain a reasonable proportion of the variance of ICT employment across time and country/region. There will, inevitably, remain some unexplained 'statistical noise' due to factors which we were not able to take account of, essentially due to the model's inability to fully account for real world complexity.

The potential drivers which we have included in the empirical model were chosen on two grounds: first, previous studies along with our own theoretical considerations (cf. section 2) and second, data availability.

The following section outlines the drivers that have been included in the model and offers some discussion of measurement and interpretation.

Variable definitions

ICT employment

The choice of operational definition for this study has been guided to a large extent by availability of data. We prefer data which have been collected by the same (or at least similar) criteria, thus comparable across countries. Further, they have to be available for a large sample of countries and preferably for a long observation period.

The ICT employment measure which we consider the best compromise between these criteria and a reasonable description of ICT skill content is employment in a set of ICT skill-intensive industries. This measure has the advantage of consistent data collection across countries and the disadvantage that not all jobs in these industries are ICT skill intensive (e.g., the janitor in a software company may not have above average e-skills).

Another advantage of this definition is that it has been used by earlier studies, thus, allowing us to compare and benchmark our results with earlier findings. One of these earlier studies is CEPIS (2007), which concentrates on the industries categorised as NACE 30 (office, accounting, and computing machinery), NACE 32 (radio, television, and communication), and NACE 72 (computer and computer related services). We follow its choice of industries for this analysis, and will in the remainder refer to these industries as the 'ICT industries'[8]. The inclusion of both ICT hardware and software in the analysis could pose a problem, as the employment dynamics in the ICT hardware and ICT software and services sectors may be very different. Sub sector differences will not be explored in this study, but may be addressed in future analyses. Moreover, the exclusion of ICT intensive sectors such as the financial sector implies that employment trends in these sectors are not considered even though that these sectors are characterised by a relative large share of ICT practitioners in the total sector workforce.

Information on employment in the ICT industries is directly taken from the variable "EMP" of the EU-KLEMS database. This variable counts the number of persons who are active in these industries, i.e., includes both employed and self-employed. We have made no attempts to

[8] See OECD (2004a) for the ICT skill content of different industries. We follow the CEPIS (2007) report to avoid issues of arbitrary sample selection.

consider specific occupation categories in the ICT industries, but this may of course be addressed in future analyses.

Offshore outsourcing (offshoring)

Offshoring describes domestic firms moving all or part of their production activities abroad, or importing intermediate products instead of in-house production. When firms drop home production completely, or production firms are replaced by firms that are specialised in importing, then offshoring is simply a substitution of home production with production abroad.

There are a number of options of defining offshoring; however, without firm-level data there is always an inherent measurement problem. Offshoring implies importing instead of home production. However, it is difficult to assess whether the imported goods are produced by subsidiaries of domestic firms or not and what defines foreign subsidiaries. Offshoring also implies that production firms turn into trade firms; if one is interested in the effects of internationalisation of markets, than only looking at production firms may blur the picture.

When working with aggregate data, a simple way to avoid these confusions is to take a product perspective and to measure offshoring as the share of consumption of specific products which are produced abroad. We follow this approach, and define offshoring as imports over consumption. However, we do not take account of the offshoring of the production of intermediate products from other industries than the ones under consideration.

The main interest is whether products in the specific industries are produced domestically or not, and not whether the supplier industries are offshoring their production. Intermediate goods may not be produced in-house in any case and may be considered to be of completely different skill content, so we decided not to use information of the internationalisation of the markets for intermediate goods in our offshoring measure[9]. Instead, we measure offshoring intensity in a given industry as the value of the imports of the products that define the specific industry over the total domestic supply (value of import plus the value of domestic production) of the products.

The advantage of this definition is that this measure can accommodate offshoring strategies by which firms change status from (ICT-) product firms to trade firms. On the other hand, it may also be the case that the offshoring measure catches changes in product demand (and, thus, changes in imports), so it will be necessary to control for total consumption of the given products – i.e., the market size - in the regressions later on[10]. The information to construct the offshoring measure is taken from EUROSTAT's input-output tables. The import measure is 'Imports cif', the supply measure is 'total supply at basic prices'.

Control variables

We have included three control variables in the model: Labour costs, export, and prices.

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[9] A look at the input outpus tables reveals that e.g. the Computer and related activities industry (NACE72) consumes food products and beverages, pulp, paper and paper products, etc. the location of production may not be relevant w.r.t. ICT offshoring.

[10] Then, the coefficient on the offshoring measure can be given the following interpretation: for *given* product demand, the share of products which is imported instead of produced domestically is related to ICT employment according to the particular parameter estimate.

- Labour costs as a measure of wages is directly taken from the tables of the EU-KLEMS database: We define the wage measure by the variable LAB (labour costs in a given industry) over EMP (number of persons active in the given industry). We include wages in our regression as a determinant of employment. This is justified by the argument that wages are set in related industries, i.e., unrelated to unobserved factors that may also have an effect on employment (Hamermesh 1993). To the extent by which this assumption is violated, the wage is just an alternative measure of the difference between labour demand and supply and, thus, potentially endogenous. Accordingly, the sensitivity of later results with regards to including this variable will have to be tested for.
- Exports are from the EUROSTAT's use tables. We include export activity as a straightforward determinant of product demand- which is a determinant of employment demand. Any (positive) coefficient estimates associated with this variable are lower bounds of the true effects of exports on ICT labour demand. Note that export activity bears the interpretation of onshoring, a term which describes offshoring activity received from abroad.
- Product prices are from the price index variable GO_P of the EU-KLEMS database in the sectors analysed. We have made no attempt to adjust for changes in the quality of ICT products (for instance by using a hedonic price index), although ICT products are characterised by rapid rates of quality change (OECD 2004b).

Supply side variables

We have made some attempts to include supply side variables - such as the number of ICT graduates – in the regression model. However, for these variables there was a large share of missing observations, and often there were large breaks in the data series. We could not detect any statistically significant relationships, and given that the inclusion of these variables implied a considerable reduction in the size of the sample we decided not to include these factors in the regression model.

Table 4 summarises the argumentation for the respective inclusion and exclusion of the different components of the operational model:

Table 4. Empirical drivers of ICT employment

Primary dimension	Indicator	Data source	Included/excluded	Argument
Sourcing	Import	Input-Output tables, Eurostat	Included	Proxy for offshoring
	Export	Use tables, Eurostat	Included	Proxy for onshoring
ICT practitioner demand	Wages	EU KLEMS	Included	Amiti and Wei (2005)
	Prices	EU KLEMS	Included	Amiti and Wei (2005)
ICT practitioner supply	IT Graduates	Eurostat	Excluded	Not sufficient data. Inclusion reduces sample size considerably and prevents us from getting robust results.

The exclusion of important factors due to lack of high quality data is unfortunate as the excluded factors may have altered the estimates generated by the global sourcing assessment model.

The results of the model are descriptive and the model does not analyse in-depth the character of the relationship between factors. For example, a negative relationship between wage costs and employment growth in the data may be due to wage costs being high when labour supply is low. In this case, including a (better) labour supply measure would be expected to reduce the absolute value of the coefficient of the wage cost variable. In general, results would be affected by the inclusion of additional factors if these factors were both correlated to employment growth and the drivers already included in the model.

Descriptive statistics and recent trends of the central components of the model

A look at the last 10 years of the observation period reveals that employment growth has averaged 2.4 percent growth in the offshoring has been positive and about 1.2 per cent per year. The total supply of ICT goods, i.e., the market size, has increased by as much as almost 9 per cent per year, and labour costs have been increasing by 3 percent per year – which must be considered low given that this number has not been deflated. There has been a 10 per cent growth in exports per year, which – joined with the developments regarding the market size – emphasises the high degree of dynamics on the ICT markets.

Table 5. Summary statistics of main variables (1996-2005)

	Number of observations	Mean	Standard deviation	Minimum	Maximum
Growth in ICT employment	440	0.024	0.145	-0.742	0.997
Growth in offshoring measure	343	0.012	0.144	-0.084	0.956
Growth in market size	359	0.087	0.142	-0.420	1.021
Growth in labour cost per employee	410	0.030	0.100	-0.561	0.708
Growth in exports	358	0.107	0.269	-1.605	1.691
Growth in price index	410	-0.010	0.062	-0.208	0.307

Note that there are outliers in the data, as epitomised by large minimum and maximum values, and high variances in the growth rates. For this reason, we estimate the relationships between employment growth and the potential drivers on a sample where we restricted no variables to increase by more than 50% and decrease by more than 25% per year. Obviously, regarding this choice, the robustness of later results will have to be checked.

The ICT industries – see figure below - employ ca. 3.7 million employees in the EU15 (except Luxemburg) with ca. 220,000 in NACE 30, 650,000 in NACE 32, and 2.85 million in NACE 72. In general, employment in the ICT industries has been increasing, but employment growth has been stagnating since 2001 (the 'dot-com' bubble). The upward employment trend in the ICT industries is due to an increase in NACE 72. The other ICT industries have experienced declines in the number of employees over the observation period.

Since 2000-2004, the growth in the share of imports relative to the total supply of computer and related activities (NACE 72) has been positive. It is notable that the surge in the size of the market in the nineties was mostly accommodated by domestic supply growth rather than increasing import volumes.

Note further that the increase in the total supply of NACE 72 products in the last years of the observation period was not matched by (further) growth in employment in NACE 72 – which coincides with– on average – high growth in import shares of ICT products.

Step 4: Estimating the impacts of individual drivers

We estimate the following three models: First, the basic model. We distinguish between two specifications characterised by whether or not wages (defined as labour costs per employee) as a potentially endogenous variable are included. Second, we estimate an 'extended' model, and third we estimate the fixed effects model. Results are displayed in tables 6-8 below:

Table 6. Estimation results – the 'basic model'

Factors	With labour cost included		Without labour costs included	
	Coefficient	Standard error	Coefficient	Standard error
Growth in offshoring measure	-0.193 ***	0.068	-0.211 ***	0.072
Growth in market size	0.192 ***	0.066	0.196 ***	0.071
Growth in labour cost per employee	-0.396 ***	0.065		
Growth in exports	0.119 **	0.051	0.095 *	0.054
Growth in price index	0.388 ***	0.093	0.365 ***	0.099
Time trend	-0.003	0.002	-0.002	0.002
Constant	0.026 *	0.015	0.013	0.015
Number of observations	266		266	
Adjusted R2	0.327		0.233	

Notes: Observations with growth below -25 or above 50 per cent in any of the variables included in the model where not considered for estimation

Table 7. Estimation results. The 'extended model'

Factors	With labour cost included		Without labour costs included	
	Coefficient	Standard error	Coefficient	Standard error
Growth in offshoring measure	-0.164 ***	0.063	-0.173 **	0.067
Growth in market size	0.133 **	0.061	0.141 **	0.066
Growth in labour cost per employee	-0.382 ***	0.060		
Growth in exports	0.121 **	0.047	0.096 *	0.050
Growth in price index	0.266 ***	0.092	0.264 ***	0.099
Time trend NACE 30	0.005	0.003	0.008 **	0.004
Time trend NACE 32	-0.006 *	0.003	-0.006 *	0.003
Time trend NACE 72	-0.015 ***	0.003	-0.015 ***	0.004
Dummy variable NACE 30	-0.175 ***	0.026	-0.185 ***	0.028
Dummy variable NACE 32	-0.108 ***	0.026	-0.112 ***	0.028

Constant (base category: NACE 72)	0.136 ***	0.022	0.128 ***	0.023
Number of observations	266		266	
Adjusted R2	0.4386		0.3226	

Table 8. Estimation results. The 'fixed effect model'

Factors	With labour cost included		Without labour costs included	
	Coefficient	Standard error	Coefficient	Standard error
Growth in offshoring measure	-0.183 ***	0.067	-0.191 ***	0.071
Growth in market size	0.130 **	0.065	0.144 **	0.069
Growth in labour cost per employee	-0.380 ***	0.070		
Growth in exports	0.129 **	0.052	0.105 *	0.055
Growth in price index	0.325 ***	0.109	0.386 ***	0.115
Time trend NACE 30	0.003	0.003	0.006 *	0.004
Time trend NACE 32	-0.007 **	0.003	-0.008 **	0.004
Time trend NACE 72	-0.014 ***	0.003	-0.014 ***	0.004
Dummy variable NACE 30				
Dummy variable NACE 32				
Constant (base category: NACE 72)	0.042 ***	0.014	0.029 **	0.015
Number of observations	266		266	
Adjusted R2	0.37		0.28	

The basic model can explain about 30 percent of the total variation in employment growth across time and countries. Given the relatively small sample and the model's parsimony, both robustness of results and the explanatory power of the model are – in our opinion – surprisingly high.[11]

Coefficient estimates are robust to whether or not one controls for industry-country fixed effects, and to whether or not one excludes labour costs from the model. The signs of the estimates are robust to whether or not one includes outliers in the sample, but there is some variation in the

[11] Note results change only little when using the full sample with outlier observations included (all results available on request from the authors).

sizes of the estimates– as expected. However, there are no methodological based arguments for deleting specific outliers, so we will continue the interpretation of results based on the regression on the full sample – of course keeping the outlier issue in mind.

Coefficients have the expected signs, with offshoring being negatively related to employment growth; the total volume of shipments (the market size) is positively, labour costs are negatively, and export volume is positively related to employment growth. The relationship between product prices and employment is positive.

The sizes of the coefficients are of the expected order of magnitude. For example, the standard variation of the growth in offshoring measure is 0.02, which implies that a one standard deviation increase in this measure is associated with an expected decline in ICT employment growth of (0.02*0.193=0.0042) 0.4 percent, or translated into absolute numbers, (3,700,000 employees * 0.004=) 15,400 employees per year.

Step 5: Developing three scenarios

In a rapidly changing world it will most likely not suffice to base strategic decisions on simple projections of present trends into the future, because such projections are vulnerable to complexities, disruptive changes, and uncertainties. As an alternative and to broaden the scope of reflection, alternative views of the future – scenarios – are used to expand our scope of understanding of the future and to explore potential impacts on e-skills supply and demand. For the purposes of this report three scenarios are used to explore changes in global sourcing trends and their potential impact on e-skills in three distinct future environments in Europe.

Introduction to scenarios

Scenarios are plausible hypotheses about the future. Each scenario aims to provide a coherent description of the drivers, trends, and events that can influence and change the subject of analysis over a given period. However, scenarios are not predictions, and the scenario analyses and exercises do not aim to predict the future. Rather, scenarios can be considered as an early warning system or navigation tool in the present. Scenario building can also generate ideas and methods for putting into operation insights from case studies and market studies. Consequently, scenario analysis should be regarded as a tool for structured and creative thinking about the future and as a catalyst for strategic conversations and discussions, but not as an end in itself.

The three scenarios presented here represent realistic, internally consistent, and plausible pictures of alternative futures

Objectives

The objective of this study is to present a scenario analysis that can be used as a vehicle to develop long-term visions of possible opportunities, barriers and threats for the European ICT software and services sector and the sustainable development of its workforce. The task is split into the following two sub-tasks:

- To develop exploratory scenarios for the macro drivers influencing the sector. Macro drivers are understood here as trends that with very few exceptions cannot be influenced by individual companies or policy actors.

- To present plausible implications of each scenario for e-skills in Europe

Methodology

As a tool for formulating policy and for strategic planning, a scenario must fulfil the following criteria:

- It should be plausible
- It should be internally consistent to offer a plausible context for strategically exploring a distinct future in a coherent discussion.

The scenario building has been carried out in a two-phase process:

Phase 1 was devoted to developing exploratory (not normative) scenarios. During this phase, the main drivers of change identified in the synthesis report were assessed according to two criteria:

- importance (low, medium, high)
- certainty (low, medium, high)

On the basis of these assessments, we chose two drivers to form the main structure of four scenarios.

Table 9. Selected drivers

Drivers	Development
Demand for advanced ICT products and services in Europe	High vs. low
Supply of ICT practitioners outside Europe	Large vs. limited

The possible implications of these two drivers for global sourcing trends are:

- A high demand for ICT products and services makes Europe attractive to both domestic companies and foreign companies, thus stimulating the relocation of activities of activities from foreign countries to Europe or business expansion in Europe.
- A large supply of ICT practitioners outside Europe will make it attractive for companies to offshore activities if domestic supply is limited or not competitive

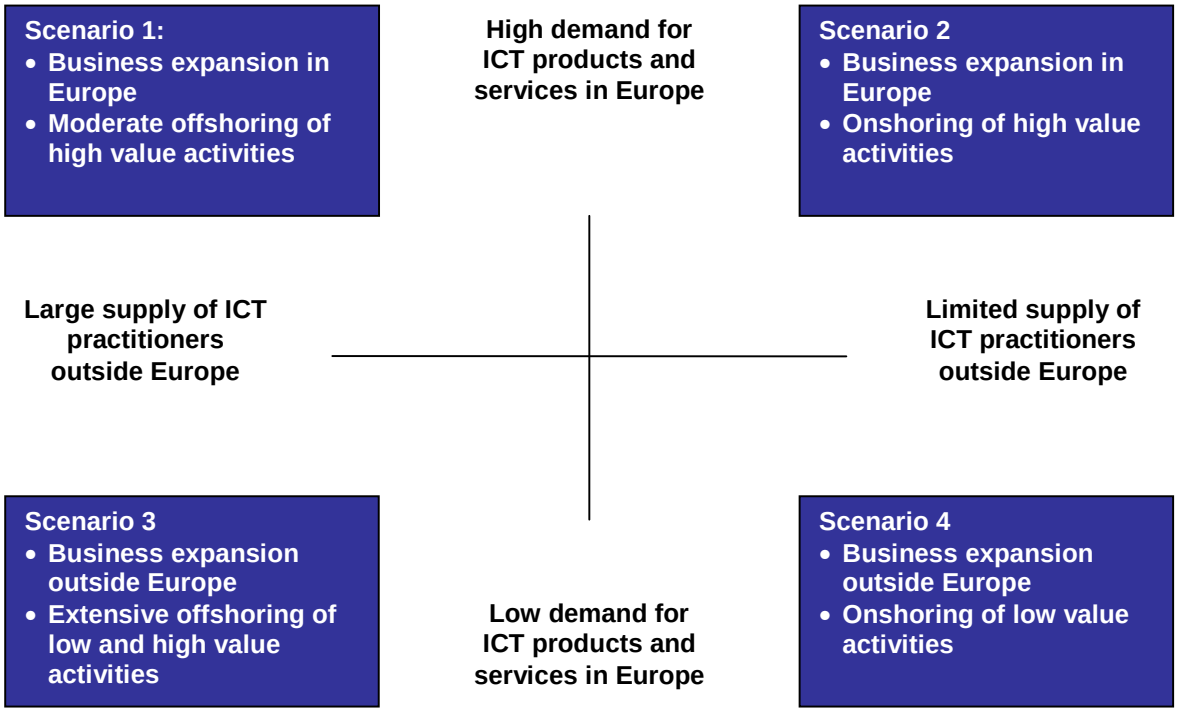
There is no direct match between the two drivers and the factors included in the global sourcing assessment model. However, the factors included in the assessment model may serve as proxies for the two drivers (see below).

In phase 2 we examined the plausible implications of the macro drivers on companies and employment of ICT practitioners.

Developing the three scenarios

The two drivers and their potential development make it possible to construct a total of 4 scenarios. The scenario structure is illustrated below:

Figure 5. Scenario structure and potential implications for sourcing of activities



The fourth scenario (Europe as a destination for low value activities) was discarded because it was not considered plausible. Therefore, a total of three scenarios are considered as providing a diverse, internally consistent and plausible view into the future.

In all the scenarios, the future domestic supply of ICT practitioners is considered to be low. However, the severity and nature of the skills gap in Europe will vary in the scenarios due to different rates of offshoring.

Scenario One: Moderate increase in offshoring

This scenario is characterised by a large supply of ICT practitioners outside Europe and a high demand for advanced ICT products and services in Europe. European companies and foreign companies are eager to be close to the European market and expand their business activities in Europe. However, companies face a limited supply of ICT practitioners in Europe and find it difficult to expand their activities in a satisfactory pace. In fact, the supply situation is keeping some foreign companies from locating activities to Europe.

In face of this shortage, companies in Europe try to recruit non-European ICT practitioners to work in Europe, while at the same time freeing up capacity in Europe by offshoring low- value activities and to an increasing extent also high value activities that are strategically important to their business.

SMEs are thriving in an expanding market that is demand-intensive and on the continuous look-out for new innovative products. However, SMEs need support for recruiting ICT practitioners outside Europe or assistance in offshoring activities to destinations with access to a skilled workforce, as they do not have the internal capacity to manage such tasks.

The increase in demand for e-skills in Europe cannot be met by the domestic supply, but the apparent shortage of e-skills is to some extent offset by an increase in offshoring of activities and an increased use of migrant workers from India and China in Europe. A key challenge for policy makers in this scenario is to revise migration rules and to retain talented non-EU graduates, but also to address the cultures and mindsets of citizens to allow for easy entry and social integration of foreign ICT practitioners and graduates. Furthermore, measures must be taken at both individual and enterprise level to provide incentives for non-ICT practitioners to upgrade their skills in order to expand the pool of ICT practitioners in Europe.

The inflow of foreign ICT practitioners is affecting the European economy in several ways. For instance, foreign ICT practitioners and new graduates prefer to remain in Europe where salary levels are still higher and living conditions better than in home countries – particularly in such matters as compulsory school, the environment, and health. Because of this large pool of skilled foreign labour there is not an upward growth in salary levels as previously experienced - on the contrary. There is a growth in start-up micro companies that exploit ICT in user-friendly pervasive applications such as health, energy, and environment.

Scenario Two: Limited offshoring

This scenario is characterised by a limited supply of ICT practitioners outside Europe and a high demand for advanced ICT products and services in Europe. The high demand for products and services makes Europe an attractive market for onshoring high value activities to Europe by foreign firms – also because of an advanced level of demand in the different markets for ICT. This creates a huge demand for ICT practitioners in Europe.

However, the lack of ICT practitioners in Europe is a barrier for expanding business activities. Moreover, the shortage of ICT practitioners outside Europe means that companies cannot reduce the level of skills shortages in Europe through massive offshoring of activities or through employment of migrant ICT practitioners. As a result, the offshoring of activities is very limited and the demand for talent in Europe is intensifying. In particular SMEs find it difficult to attract enough ICT practitioners as they do not have the financial means to offer attractive wages and creative peer working environments.

In this scenario, companies face a huge shortage of ICT practitioners worldwide, and policy makers and stakeholders thus need to consider timely and comprehensive measures aimed at increasing the supply of e-skills in Europe. These measures include recruiting and retaining ICT practitioners, formal recognition of a person's prior learning in order to facilitate efficient entry into formal training systems and to stimulate labour market mobility, training of non-ICT practitioners, development of tertiary programmes and certifications in close connection with the ICT industry, as well as the promotion the automation of processes through technological and process innovations. All in all, there is a huge pressure on education and training systems.

Scenario Three: Extensive offshoring

In the third scenario, the demand for advanced ICT products and services is low due to saturated markets and a stagnating economy in Europe. The supply of ICT practitioners outside Europe is high. The limited demand for products and services means that companies look to countries outside Europe for new market opportunities and business expansion. Furthermore, due to the availability of qualified ICT practitioners close to the markets outside Europe, the demand for ICT practitioners in Europe is falling, resulting in an oversupply of ICT practitioners in Europe and rising unemployment levels among ICT practitioners in Europe. The most talented European ICT practitioners are recruited by foreign companies to work outside Europe.

A key challenge for policy makers and stakeholders in Europe is to reduce the level and length of unemployment periods through an efficient mix of guidance and training measures targeted to sectors with demand, and to stimulate innovation in potential growth areas. Also, the management of large scale restructuring processes is important to facilitate the transformation of the European economy and to avoid structural redundancies.

Step 6: Estimating the impact of offshoring on employment

On the basis of the global sourcing assessment model, we have estimated the impacts of global sourcing on ICT employment in Europe in each of the scenarios. The offshoring measure included in the global sourcing assessment model is the key to estimating the impact of global sourcing in each of the scenarios.

We have made no attempt to estimate the relationship between the two drivers of change and the offshoring measure. Instead, we present three hypothetical growth rates that differ substantially from the average growth rate in the observation period 1996-2005 (2.1%) and reflect the different developments proposed in the three scenarios. Further, we have had a look at the maximum and minimum values of the rate of offshoring in the observation period to make sure that the assumed rates of offshoring are not out of line with historical developments. According to the data, the rate of offshoring has fluctuated between 2.4% and 4.1% in the period from 1996 to 2005. On this basis, the rates of offshoring are set to 1%, 4%, and 6%, cf. table 10 below:

Table 10. Rates of offshoring in the three scenarios

Scenarios	Rate of offshoring
Scenario One: Moderate increase in offshoring	4 %
Scenario Two: Limited offshoring	1 %
Scenario Three: Extensive offshoring	6%

There is no direct match between the drivers of change and the factors included in the global sourcing assessment model. However, the two drivers that form the structure of the scenarios are related to two of the factors in the assessment model: Changes in the demand for ICT products and services may, ceteris paribus, affect product prices, while changes in the supply of ICT practitioners outside Europe may, ceteris paribus, affect relative wages.

Table 11. Drivers and key figures

Drivers	Factors (proxies)	Average growth rate	Max	Min
Demand for advanced ICT products and services in Europe	Product price	- 0.01	0.01	- 0.03
Supply of ICT practitioners outside Europe	Wages (labour costs per employee)	0.03	0.06	0.01

In scenarios one and two, the demand for ICT products and services in Europe is increasing, while demand in scenario three is decreasing. To reflect this in the estimates for the three different scenarios, we use the maximum value for product prices (0.01) in scenarios 1 and 2, while we use the minimum value for product prices (-0.03) in scenario three. Changes in the supply of ICT practitioners outside Europe will affect relative wages, but not necessarily wages in Europe in absolute terms. On this basis, we apply the average growth rate for wages in the observation period in all three scenario-specific estimates of employment effects of offshoring. Finally, for the remaining factors in the global sourcing assessment model, we apply the average growth rates.

To sum up, the rate of offshoring differs in all three scenarios, while growth in product prices differs in some of the scenarios: Scenarios one and two are characterised by a relatively large increase in prices, while scenario three is characterised by a relatively large decrease in prices.

These differences have different impacts on employment of ICT practitioners in Europe. According to the estimates based on the global sourcing assessment model, two of the three scenarios result in an increasing demand for ICT practitioners in spite of global sourcing due to an increase in the demand for ICT products and services, while the scenario characterised by

extensive offshoring and limited demand for ICT products and services will lead to a decrease in the demand for ICT practitioners in Europe:

Table 12. Overview of expected impacts in the three scenarios

	Scenario 1 – moderate increase in offshoring	Scenario 2 – limited offshoring	Scenario 3 – extensive offshoring
Offshoring rate	4 %	1 %	6 %
Change in demand for ICT practitioners in Europe (first year prediction)	+23,246	+44,700	-48,428
Change in demand for ICT practitioners in Europe (five year time horizon)	+7,946	+116,654	-337,408

The differences across the scenarios are substantial, with employment predictions diverging by more than 400,000 employees. These estimates are subject to several substantial reservations, and should be considered merely as illustrative examples of how future developments may impact employment of ICT practitioners in Europe rather than exact forecasts of employment trends as such forecasts require the development of more advanced mathematical models.

Linking scenarios and policy recommendations

Each of the scenarios presents challenges which call for a different mix of policy measures. A number of policy recommendations below are proposed to provide policy makers and stakeholders with the means to discuss and address the different challenges. The appropriate policy actions will in other words depend on which of the scenarios may unfold.

There are also a number of general policy actions relevant to all three scenarios. For instance, thorough and uniform measures to monitor the e-skills situation in Europe are essential to better understand the dynamics of change in the demand and supply of ICT practitioners both quantitatively and qualitatively. Making Europe attractive to companies and foreign direct investments is another dimension that needs attention in all the scenarios – for instance through comprehensive and coordinated innovation polices at both an EU, national and regional level as well as through further deregulations.

Table 13. Linking scenarios and policy recommendations

Scenarios	Key challenges	Policy recommendations
Scenario One: Moderate offshoring	Shortage of ICT practitioners in Europe	▪ Support for internationalisation of companies (offshoring) ▪ Attract and retain foreign ICT practitioners and ICT students in Europe ▪ Reform of migration policies to ease access to European labour markets
Scenario Two: Limited offshoring	Massive global shortage of ICT practitioners	▪ Recruitment of ICT students, including minorities and women ▪ Recruit and re-educate non-ICT practitioners ▪ Retain ICT practitioners in ICT work ▪ Recruitment and upskilling of workers ▪ Recognition of prior learning
Scenario Three: Extensive offshoring	Oversupply of ICT practitioners in Europe	▪ Mechanisms for handling redundancies ▪ Stimulate demand oriented innovation policies and deregulation
General	Ensure that supply meets demand	▪ e-skills monitoring mechanism - improvement of the statistical base ▪ Curriculum reform and use of e-learning/mobile learning
	Increase attractiveness of Europe as a location	▪ Stimulate a demand-oriented supply of training and re-training by strengthening public private partnerships
	Promoting education and training activities in SMEs	▪ Adoption of E-skills frameworks to ensure transparency in the skills base in the dialogue between key stakeholders ▪ Enabling policies that stimulate innovation ▪ Provide an attractive environment for foreign investment and location through deregulation and competitiveness policies

The scenario-specific as well as the general recommendations proposed in this report are elaborated in the next chapter.

The scenarios are sensitive to a range of uncertainties about the future. For instance, a global recession could reduce the demand for ICT products and services worldwide and also increase public perceptions of globalisation and offshoring, resulting in protectionist policy measures that reduce global trade and the globalisation of labour markets. Also, political instabilities between India and Pakistan or in Eastern Europe or China could affect the risks associated with offshoring to these sourcing destinations. Other uncertainties include technological developments or unexpected changes in consumer patterns. In effect, there is a need to continuously monitor global developments and adjust policy measures accordingly.

3. Policies: Assessment, challenges and recommendations

This chapter provides an assessment of policies related to the development of e-skills in Europe. The discussion in this section and policy pointers take a point of departure in the global assessment model and the three scenarios presented in the previous sections. The purpose of applying the scenario construct to the policy pointers is that each of the three scenarios will require a different mix of policy actions, should real life developments indicate that one of the three scenarios is in the process of unfolding. In this sense the scenarios and the assessment model are aimed to function as "an early warning system" which if used creatively by different stakeholders can be a possible space for strategic conversations about e-skills.

Furthermore the scenarios and the policy pointers have explicitly been formulated to stimulate policy coordination and policy discussions across policy realms. To ease the reading, different themes and associated policy options are as far as possible linked to the outcomes of a particular scenario. However, there are a number of policy themes that are transversal in nature regardless of developments relevant to the e-skills agenda. These cross-cutting themes are presented at the end of this chapter. Some readers may also choose to rank policy priorities, given that framework conditions and the specific pressure regarding supply and demand vary across member states. By ranking the policy options in time and with regard to level of urgency, the scenarios, the assessment model, and the policy pointers can combined be used as a platform for strategy development.

Shortage of ICT practitioners

Recruitment of ICT students, including minorities and women

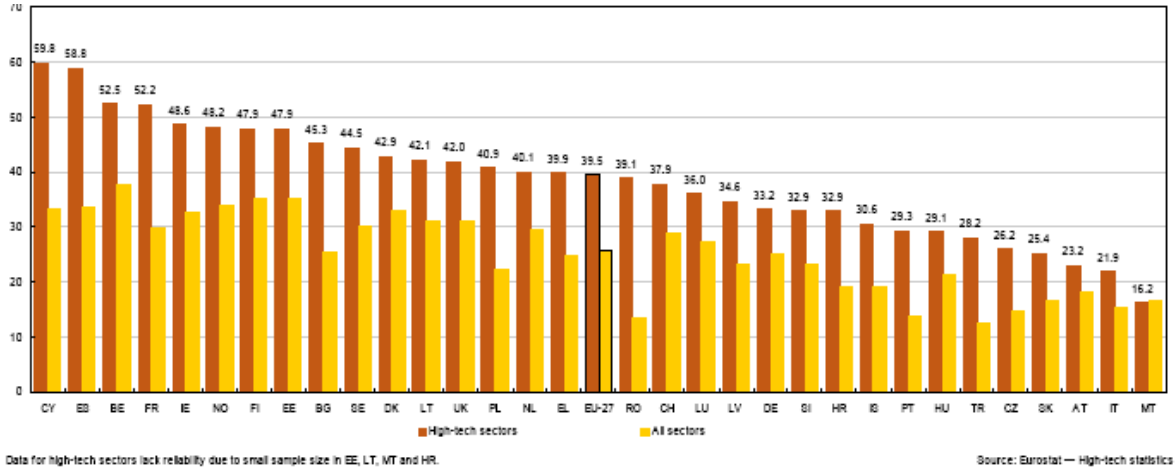
The ICT sector and ICT-intensive enterprises in Europe have at several instances voiced their concern about the supply of ICT practitioners in Europe both in quantitative and qualitative terms. There is some evidence that the lack of skilled labour with appropriate e-skills could be an explanatory factor for offshoring labour to non-EU countries (British Computer Society 2004, Løcke 2007, Gardel 2007, Larsen 2007, Kolb 2005).[12]

[12] The shortage of ICT practitioners has also been expressed by interviews with the British ICT company ARM and Stephan Pfisterer from BITKOM and the British business angel Jack Lang.

A shortage of ICT practitioners could medium-term lead to welfare losses because enterprises cannot respond efficiently to market demands due to the lack of employees with the right mix of e-skills, which subsequently could result in upward pressures on wages (e-skills UK 2008, ITPS 2006). The latter is a challenge for the competitive base and business platform for European ICT companies, whereas the first could be a challenge to medium-term employability for ICT practitioners. Should ICT business in Europe relocate a majority of value-added business activities to non-EU countries, the demand for high skilled persons with e-skills could be substantially reduced.

The relative importance of high-tech sectors to the overall economy is rapidly growing, though with marked differences across Europe, cf. figure 7 below:

Figure 6. Relative importance of high tech sectors for the European economy

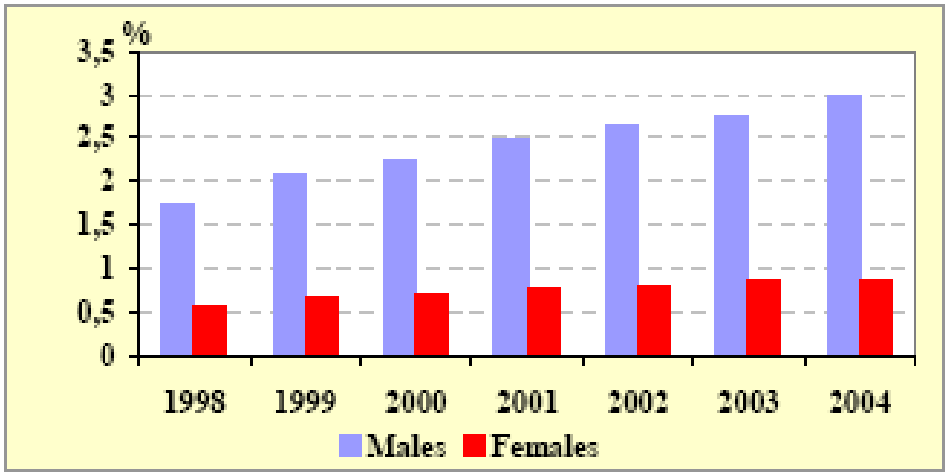


Source: Eurostat (2008)

Measures to expand the recruitment base for ICT education programmes have been launched in many European countries to reduce the shortage of ICT practitioners. These include recruiting new ICT students from segments that are underrepresented in the pool of ICT practitioners, such as minorities and women.

For instance, there are currently huge gender imbalances in terms of the number of graduates in computer science, cf. figure 8 below:

Figure 7. Percentage of male and female computer science graduates (ISCED 5/6) as a proportion of all graduates



Source: European Commission (2008)

The significant imbalance among male and female tertiary education graduates is also underlined by other indicators. A UNESCO study (UNESCO 2007) shows that the percentage of female graduates in science and technology in Europe varies from 44% in Estonia to merely 20% in the Netherlands. It is worth noting that in most of the Eastern European countries considered by the UNESCO study (Estonia, Bulgaria, Romania, Poland, Latvia) the percentage of women graduates in science and technology is situated above the EU average, while Austria (23%), Germany (24%) and France (28%) are situated below the EU average of 33%.

Several gendering initiatives have been implemented so as to attract more women to ICT studies and ICT occupations, but given the stagnating participation of women in ICT related studies (Hornung-Prähauser 2006, European Commission 2008) there is sufficient evidence to believe that the actual effects of such single measures are too limited in scope. A report from the UK Department for Business, Enterprise and Regulatory Reform examines possible causes of the tendency for men and women to work in particular occupations and links this to skills shortages in the UK labour market. The authors conclude that whilst gender stereotypes and identities still impact occupational perceptions and choices, young peoples' expectations, whether men or women, depend a great deal on the information they get about work, pay and lifestyles. The authors conclude that providing information, advice, and counselling which focus on the realities of the job and the benefits of particular career choices, could help avoid gender segregation and get more young people to choose a career in science and technology (Millard, Lynne et al. 2006).

In line with this, measures should be taken to develop more comprehensive and specific outreach mechanisms towards specific target groups. Measures could also be taken at an EU level and complementary to national and sector initiatives so as to provide a comparative view and assessment of the impact and efficiency of new initiatives aimed at recruiting more ICT students, measures to facilitate transition into ICT Labour markets, and measures to create attractive career

pathways for specific target populations. A better overview could improve the knowledge base of which types of measures work for whom, and this could form a basis for evidence-based policy making. As data seem to indicate, a 'one-size-fits' all model would most likely not work. A check list of factors developed on the basis of actual practice that are likely to influence up-take and impact among different target groups could be a useful tool for a range of actors concerned with the supply of and demand for e-skills.

Assessment models that only include quantitative measures may not adequately capture outcomes such as which type of measures work for whom or the cost-benefit of a particular initiative. A comparative analysis at a European level could also strengthen outreach measures initiated by different stakeholders. A study from 2008 published by the European Commission shows that in eight countries (Bulgaria, the Czech Republic, Germany, Greece, Austria, Slovenia, Finland, and Iceland) there has even been a decrease in the number of men who have studied at a level corresponding to tertiary education (European Commission 2008b).

Policy recommendation

- At national levels, counselling measures targeting lower- and upper secondary students should specifically include measures so as to show more females to the diversity in job- and career opportunities in ICT occupations as a basis for expanding the recruitment base of ICT students. Such measures could include the use of female role models in study and career guidance and appealing guidance material that "talks the language of youth".
- Measures at national and institutional levels could also include the offer of courses and curriculum designed to demonstrate to students that e-skills and ICT careers are not just about programming.
- Through national ICT associations, more firms within different occupations fields in the ICT sector should be encouraged to form partnerships with local educational institutions, offering short term placements integrated in the curriculum and other measures that can expose young individuals to ICT occupations in a creative way.
- At national and European levels and in collaboration with the ICT sector, measures should be taken to document the effects of different measures for recruitment of ICT students so as to disseminate promising practices through a mix of channels and as the basis for developing good practice and as a source for evidence based policy making in the field of e-skills.

Curriculum reform and use of e-Learning

Compulsory schooling contributes to the general level of digital literacy and user skills in society, and more importantly also to attitudes towards ICT and ICT occupations. It is thus influential in terms of the magnitude of a future pool of ICT students (ITPS 2006). If children and young people do not learn the manifold opportunities derived from the use of computers in school and do not learn that e-skills also encompass creativity, design, and communication, there is an imminent risk that computer science is perceived as irrelevant and distant.

In this respect data from the European Commission are quite promising. Building on data from PISA (OECD 2006), the EU study concludes that there are no overall differences in males' and

females' inclination to use science in future studies or jobs (European Commission 2008b). Overall, according to the OECD PISA 2006 study, at age 15 males and females place equal value on science. However, the data for all students from all countries combined reveal a number of gender-specific differences. In general, male students use computers more often than girls to play games, but also to look up information (these differences are significant in all cases except Hungary, Austria and Liechtenstein). As regards the use of the computer for communication, however, differences between females and males are less obvious.

Although in the OECD countries slightly higher percentages of males are more likely to have reported a high general value of science, these differences are only significant in a minority of countries (in Iceland, France, the United Kingdom, Denmark and Sweden). The Czech Republic is the only participating country where females reported higher levels of motivation to learn science.

The advantages of e-learning methodologies in relation to the development of potential ICT students, particularly through the application of ICT in different subjects, have not yet been fully harvested (Shapiro 2007). The long term e-skills agenda of the European Commission addresses this topic under the headline of increasing the attractiveness of developing e-skills by:

"Promoting science, maths, ICT, e-skills, job profiles, role models, and career perspectives with a particular focus on young people, especially girls, and providing parents, teachers and pupils, with an accurate matter, but in innovative teaching and learning environments, *understanding of opportunities arising from an ICT education and an ICT career to counter the alarming decline in young people's interest for science and technology careers in Europe"* (European Commission 2007).

Most European countries have launched e-learning initiatives and some of the current trends include: 1) New Learning Environments integrating ICT in other subjects, which is particularly important so that students understand ICT also as a means for collaborative work, design, creativity, and content creation and 2) Learning Management Systems such as Open Source tools to manage and personalise learning in various user contexts (Miller, R et al 2007).[13]

Policy recommendation

- At the member state level, national programmes should encourage collaboration between educational providers and multimedia producers and publishers to develop innovative and interactive educational materials that use ICT technologies and which can be adapted to different learning contexts.
- European educational programmes and existing measures such as European School net could put priority to proposals that include creative measures – integrating counselling and curriculum to attract a wider target group of students to e-skills careers.
- At an EU level the European Commission should across existing programmes and initiatives take a leading role in encouraging National Ministries of Education take an interest in Open Educational Resources (OER), also in the context of compulsory school, building on the experiences and the developments which have already occurred in the University Sector. OER can be used to stimulate

[13] See for example European Commission website on digital literacy, http://ec.europa.eu/information_society/tl/edutra/skills/index_en.htm

active self learners and creativity in curricular design. OER is also a means to promote high quality materials (OECD-CERI 2007)

Attracting foreign ICT practitioners and retaining foreign ICT students

With an imbalance in the supply of and demand for ICT students, countries and firms will need to pursue different strategies so as to remain competitive. One way to ensure a European ICT labour pool could be to increase the number of non-European ICT employees in Europe. The number of non-EU ICT practitioners in EU can be increased by:

- Attracting foreign ICT practitioners to EU, and
- Retaining foreign ICT students in the EU after graduation.

Both sources of increasing the European ICT labour pool are regulated through migration policies. Migration of skilled ICT workers is increasingly being intertwined with debates and policies on offshoring and technological and economic development (Millar & Salt 2007; Valiani 2007). During the last couple of years countries such as France, Denmark, Germany, the Netherlands, and the United Kingdom, and also OECD countries such as the USA, Canada, and Australia, have implemented different forms of green card schemes to expand the pool of labour for selected high skilled occupations such as ICT practitioners (Millar & Salt 2007). In the UK, the Migration Advisory Committee has been set up to provide transparent, independent and evidence-based advice to the UK Government on where skilled labour market shortages exist that can sensibly be filled by migration, given that employment of migrant labour may only be one of a number of possible responses to labour shortage. This includes producing shortage occupation lists for the UK and Scotland for use alongside the launch of Tier 2 of a new points-based system for migration (Migration Advisory Committee 2008). The EU has proposed a legal framework *"on the conditions of entry and residence of third-country nationals for the purposes of highly qualified employment"* with the overall aim of increasing the supply of high-skilled labour in the EU (European Commission 2007b).

Currently it is too early to assess most of these initiatives, but existing experiences from Germany show that attracting already employed ICT specialists from other countries is not the most efficient way to expand the pool of high skilled labour (Valiani 2007; Work Foundation 2008). All things equal it will be more difficult for skilled ICT practitioners to move to another country, as they often will have to move both their spouse and their children.

The Work Foundation concludes that global knowledge-intensive firms need a global recruitment strategy so as to tap into the pool of highly qualified people around the world (Work Foundation 2008). The author's message is that this is not only to fill shortages, but for the sake of enabling firms to innovate. To this end, issues of social and cultural openness in a society need to be addressed if it is to be an attractive place for highly skilled people to want to move to.

As the Work Foundation report shows, it is not only migration regulations that determine location of ICT practitioners and other types of high-skilled labour. Other factors in various combinations are: jobless growth in home countries, infrastructure, standard of living, employment options for

the accompanying spouse, language, fiscal and health policies, but most importantly the general openness in the cultural climate and the stock and quality of social capital.

To that end the World Trade Organization, certain governments, the private sector, the International Organization for Migration (IOM), and the World Bank, are developing the International Migration and Development Initiative (IMDI) - a set of measures to liberalise and integrate labour markets around the world taking into account both the needs of individuals and enterprises. The IOM proposal for an International Migration and Development Initiative ("IMDI") is envisioned as a collaborative effort by relevant international organisations to work together with interested governments and other stakeholders, particularly from the private sector, to facilitate matching labour supply with labour demand in safe, legal and orderly ways that maximise the societal and human development potential of global labour mobility.[14]

A more sustainable approach to attracting a potential pool of high skilled ICT labour would be to expand the intake of talented non-native students at both MA and PhD levels. Some English-speaking countries have seen multi-stakeholder partnerships between Higher Education Institutions and enterprises on attracting foreign students in ICT with the promise of getting an internship during education – some even include the opportunity of placement upon graduation (Expert Group on Future Skills Needs 2008). Such initiatives could solve some of the integration challenges that foreigners often face.[15]

Lessons could be learned from US approaches prior to 9/11, but examples also include measures taken by the Australia government to attract talented students, particularly from South East Asia. The rationale for expanding the composition of the student population to encompass more international students has been that having access to a worldwide pool of talent leads to a higher-quality science and engineering (S&E) workforce than if the country had access only to domestic talent. The flow of international students and scholars has according to a study allowed the United States to conduct research and education at lower cost than if the country had to rely exclusively on domestic talent. In addition, international students and scholars can help to form international research collaborations and to foster international understanding (Committee of Science, Engineering and Public policy 2005). For instance, a recent initiative taken by the State of Massachusetts in The United States aims at raising the public awareness of the needs to expand the pool of international students and expand strategic collaboration - particularly with universities in China and India - by using existing public-private partnerships between industry and universities in the state (Mass Insight Corporation 2007).

[14] IMO website, http://www.un.int/iom/IMDIevent.html

[15] Work Foundation website, http://www.theworkfoundation.com/pressmedia/news/newsarticle.aspx?oItemId=52

Policy recommendations

- Drawing on lessons from United States and Australia, EU member states should take measures to expand the pool of high-skilled students through migration schemes; through grant measures targeting priority student groups; through MOU with selected countries and in priority fields so as to strengthen the formal level of collaboration; and through encouragement of strategic collaboration between national and international TIER I universities
- Financial incentives to universities that demonstrate high performance in attracting high skilled students. Furthermore, through counselling measures and collaboration with industry partners offer a smooth transition to the ICT labour market, which could expand globalisation efforts of universities.
- Member States and policy makers within the EU should follow the IMDI initiative with a view to informing national and European policies in the field of migration of high-skilled labour.

Recruit and re-educate non-ICT practitioners

An often unrecognised source to increasing European ICT labour pool is non-ICT practitioners being retrained as ICT practitioners – in a medium term perspective such measures could expand the pool of ICT labour considerably, particularly in countries characterised by a pool of graduates with tertiary qualifications that have poor labour market perspectives. In the UK this source of intake accounted for approximately half of all new ICT practitioners (e-skills UK 2008). In Denmark the ICT University builds on a broad national access infrastructure that has gradually been expanded since its creation. The KibNet model from Germany is another interesting example of a modular approach to the ICT profession to increase the recruitment basis with a model that also builds on permeability between upper secondary and tertiary level of professional education. In the Netherlands reforms are underway to stimulate return to education through recognition of prior learning to offer an attractive and efficient way to tertiary professional qualifications in sectors with skills demands (OECD 2007b).

Retraining of non-ICT practitioners also contains a potential for increasing the share of women in ICT positions, if UK data can be extrapolated to other European countries: 35% of the non ICT workers being recruited to ICT jobs are women, whereas the female share of ICT education is only 18 in the UK (e-skills UK 2008). In the 90s a very successful initiative was CyberNova that aimed at strengthening the pool of ICT labour though the training of women with a tertiary qualification in humanities or arts. The initiative was later fully implemented in national recruitment strategies.

Monitoring the supply of and demand for e-skills in Europe

Currently it is difficult to get a coherent picture of e-skills supply and demand in Europe now and in the medium term, particularly at the micro level regarding specific occupations within the ICT sector and ICT-intensive businesses. The stock of employees, as measured by statistical offices through household survey data using occupational frameworks, provides information on the number of ICT practitioners in employment accumulated over time by inflows (hiring) and/or by outflows (retirement, replacement, job shift).

This methodology may give indications of the demand that is currently met, but it does not provide information on demands which are not satisfied or on alternative firm strategies pursued by firms in shortage of labour with the appropriate mix of e-skills. Furthermore, it is not possible from these data to get information about the potential stock of persons who with adequate measures could be persuaded to shift careers and become part of the ICT workforce. A plethora of skills initiatives in most European countries have aimed at understanding drivers of supply and demand within ICT and ICT-intensive sectors and to improve the recruitment basis of students through measures such as improving the image of ICT occupations and ICT studies and easing migration legislation (Empirica 2007, OECD 2007, CEPIS 2007). However, given the variations in methodologies and definitions applied, some form of forward looking coordinating platform for understanding drivers and changes over time and as a knowledge base for policy initiatives at the different levels - EU, sector, national, regional - is still pending.

The establishment of a European initiative to monitor and analyse global trends and e-skills issues could be a means to improve methods for early anticipation of factors which may influence supply of and demand for e-skills in Europe. This would not imply the costs of creating new institutions. The initiative should rather form an umbrella and create liaisons with existing measures at national levels, through the OECD and through European policy instruments such as CEDEFOP's Skillsnet.[16] The initiative could for example work on the basis of the assessment model developed as a part of the present study, but more data and analyses are needed, particularly longitudinal data, to understand labour market dynamics and external drivers to the ICT sector within an overall innovation and competitiveness policy realm. In particular, a more coherent approach to *European* data collection is needed, as one of the current obstacles to evidence-based e-skills policy making is the lack of comparable data across the EU. This has been identified as an obstacle both by the OECD, national statistical offices, sector bodies, and not least through the multi-directorate work of the e-skills initiative coordinated by DG Enterprise. A coordinated effort in the field could not only ensure economy of scale, but could also medium term create more transparency in existing data beneficial to a range of stakeholders concerned with e-skills developments in rapidly changing sectors in the economy.

Policy recommendation

- A European umbrella initiative for early anticipation of e-skills demand and supply, in coordination with existing measures so as to create coherence and transparency in the knowledge base relating to e-skills. Driving factors within an overall model of innovation and competitiveness will be central to understanding demand and supply.
- Encourage a convergence in methodologies for the collection and analysis of comparable longitudinal European data on e-skills, through an open method of coordination and through the existing collaboration between statistical offices in the Member States.

[16] CEDEFOP website, http://www.trainingvillage.gr/etv/Projects_Networks/skillsnet/

Retain ICT practitioners in ICT work

To avoid the risk of skills shortages, ICT-intensive enterprises have not only to attract new ICT graduates and foreign ICT workers; they must concurrently address measures to retain their workforce. Particularly women seem to be prone to leave the ICT sector (OECD 2007c). One reason is the gendering of the working climate which can best be addressed at the firm level through leadership practices as well as HRM policies. In this respect IBM for example has taken a number of measures (Webster 2005). Other factors can be addressed at a policy level, such as maternity leave and public child care provision. Another interesting example stems from a small firm in Australia now merged with a multi-location software producer.

Case study – Australia

Solution 6 Pty Ltd. won the Employer of Choice for Women in 2003. At that time the company employed less than 500 employees, of which 52 per cent were female. Solution 6 merged in 2004 with MYOB, a producer of accounting software to small businesses and multi-location operations. In September 2001, Solution 6 established the advancement of women as a strategic objective. This entailed fostering and developing the talented women in the workplace:

- Appointed a member from its HR department as the company's National EEO Coordinator to act as the champion for its strategic direction.
- Several focus groups aimed at identifying specific issues for women and strategies to resolve these were chaired by the EEO Coordinator
- Expanded the annual employee satisfaction survey to include survey questions on the advancement of women conducted informal consultation with managers and staff to identify issues for women in the workplace, and
- Put together a project team (branded the Butterfly Initiatives) charged with building a dynamic and inclusive employee culture.

Outcomes

- The gender ratio of Senior Executives and General Managers improved significantly. The percentage of females in junior development roles grew from 29 per cent to 38 per cent.
- The wage gap between males and females reduced significantly - from a variance of 20 per cent to 7 per cent.
- Females took up 51 per cent of the internal employee transfers and 62 per cent of promotions.

- Ninety-five per cent of the women who took maternity leave returned and took advantage of flexible working hours in some way.

Source: http://www.eowa.gov.au/Case_Studies.asp

Recruitment and upskilling of workers

Persons with non-academic vocational qualifications working as a skilled employee are often overlooked as a potential recruitment source for ICT practitioners. A study carried out within the EU-USA agreement on collaboration within the field of education and training has shown that there are a number of factors which cut across countries and firm size that have a negative impact on the scope and culture of recruitment practices to the ICT sector. These factors include the fact that institutions do not sufficiently flag competences a person with an upper-secondary ICT qualification possesses in terms of work processes competences understandable to a recruiting company. In fact, the 2007 IDC survey showed that the education system is constructed so as to further the recruitment of persons with a tertiary qualification rather than persons with an upper secondary qualification (IDC 2007). Therefore firms tend to favour, if at all possible, the recruitment of a person with an academic qualification as a perceived guarantee of learning to learn competences.

Furthermore, according to the study many education providers tend to exclude the integration of globally recognised certifications in their curricula even though the possession of such certifications could improve transition and employment in ICT occupations. The study found that providers of ICT qualifications at the upper-secondary level often would not have sufficient connect to the ICT industry as a basis for upgrading curriculum. Measures that need to be strengthened are continuing education and training for ICT teachers and trainers - both in broader ICT related topics as well as in more specific fields such as certifications in particular platforms, ICT security, system integration, and Green ICT - to improve the quality of continuing education and training provision.

The study from Empirica (2007) contains a number of interesting examples of promising multi-partner arrangements in the field of ICT. For reasons of economy of scale such initiatives could rightly be taken at EU sector level or within the EU Lifelong Learning Initiative, and based on principles of modularity and e-learning platforms to ensure adaptation to specific user contexts Re-skilling measures should also be a central component in collective agreements for ICT employees as well as educators and trainers.

Policy recommendations

- Member states should encourage that EU education and training programmes be used to facilitate re-training and up-skilling of non-ICT practitioners and teachers and trainers in the field of ICT
- Through the annual review processes carried out by the European Commission on the "Objectives 2010" process, member states should analyse if there are gaps in educational systems with regard to permeability and streaming between vocational education and Higher Education in the field of ICT - and if so take appropriate actions in coordination with sector representatives to maximise impact
- Sector representatives and national governments should monitor the extent to which Recognition of

Prior Learning instruments are used in the field of ICT to make visible the actual competences of the potential pool of an ICT workforce - and if used, the effects of such measures.

- Member states, sector representatives and the European Commission should jointly encourage the use of the e-skills/ EQF framework to enable efficiency and transparency in lifelong learning systems and to ensure mobility across sectors.
- National and EU-level sector representatives should encourage that ICT certifications be included in the formal curriculum to ensure relevance and efficiency in education systems and in continuing education and training measures

Adapting the supply of educational programmes and training systems

Co-operation on education and training

The long term e-skills agenda emphasises the need for longer term cooperation in developing e-skills by:

"Strengthening cooperation between public authorities and the private sector, academia, unions and associations through the promotion of multi-stakeholder partnerships and joint initiatives including monitoring supply and demand, anticipating change, adapting curricula, attracting foreign students and highly-skilled ICT workers and promoting ICT education on a long-term basis." (European Commission 2007).

A similar conclusion can be drawn from e-skills UK:

"The majority of the development need for IT professionals is for those already holding graduate level qualifications. There therefore may be a significant opportunity for and benefits from increased participation by Higher Education, with offerings specifically tailored to meet employer needs in terms of content and delivery. This may require new partnerships across the Higher Education sector, including linking with private training providers and recognising employers' own development programmes" (e-skills UK 2008).

The existence of multi-stakeholder partnerships between education institutions and the private sector, academia, unions, and associations, varies a lot across Member States. One type of partnership focuses on the education of students. Another is the use of internship programmes which facilitate students' practical learning and knowledge of future occupations. Another set of partnerships are concerned with continuing education and training measures targeting the existing workforce (Expert Group on Future Skills Needs 2008, Empirica 2007). There is a balance to be struck between a concurrent offer of entirely new programmes and the level of transparency in the educational offer of ICT education and training. It can also be argued that in sectors affected by rapid change and technological disruptions, there is likely to be a more or less permanent skills mismatch which the general provision of formal qualifications has difficulties addressing for simple time delay reasons; therefore the bridging of the formal supply and industry certifications - both vendor and non-vendor specific, is vital to a dynamic and relevant offer of ICT education and training programmes.

Incentives to study ICT

A number of countries have taken measures to increase the number of ICT students through financial incentives to study subjects like computer science and software engineering The Irish Expert Group on Future Skills Needs has proposed a pilot project giving grants to computer science students (Expert Group on Future Skills Needs 2008). There are several caveats to such proposals. Firstly, ICT is not the only sector short of high-skilled workers. Second, the time lag between the intake of students and graduation implies that demand for employment could change during the span of education. Factors such as potential dead-weight (giving grants to students who would have chosen an ICT study anyway), and risks of creating an instrumental attitude to the choice of education, which again can influence motivation, must be considered carefully in the design and mix of policy instruments to address the ICT recruitment base. Financial gains can be one of *several* factors influencing the choice of study. Other motives can be an intrinsic interest in the subject, career potentials, social environment in schools, family and friend's attitudes, quality and methods of teaching and curricula, social status, and norms (State of Victoria 2007).

Another factor which will likely have to be addressed is whether a dispersed access to ICT programmes at tertiary level could impact the level of quality in the design and supply of curriculum. Influential factors could be limitations in the number of high skilled university staff in ICT programmes, limited industry connects for educational institutions where ICT programmes only constitute a minority in the overall field of activity, thereby risking that the curriculum is out of date, and a disconnection between R&D that takes place in leading-edge universities and what is taught at colleges and universities with no or limited ICT R&D activity.

Though a number of countries have taken measures to strengthen the knowledge base of their higher education institutions through mergers and/or more emphasis on contestable funding and improved collaboration with industry, there are still major variations across and within specific institutions. Medium quality in the educational supply of ICT programmes could not only have a negative impact on the number of students wishing to enrol in an ICT programme, but could also impact the level of dropouts and potentially also the transition to ICT labour markets because the sets of skills obtained are not sufficiently relevant to industry.

The need to address issues of curricular design, including cross curricular offers to meet growing enterprise needs for graduates that have a multi-disciplinary profile, is central to attracting more students to tertiary level programmes in ICT. Wallenberg Global Network is just one example of a US/Swedish collaborative effort to stimulate innovations in design of curriculum with an embedded use of ICT and an applied research approach.[17] Other ways to raise quality and innovation in the tertiary supply of programmes targeting the ICT sector is through the growing offer of open educational resources from Global TIER I Universities.[18]

The OECD-CERI study (2007) on open educational resources (OER) has identified a number of factors which make the use of OER increasingly appealing such as:

[17] http://www.wgln.org/projects/2005-2006.html

[18] See for example OpenCourseware MIT in the US: http://ocw.mit.edu/OcwWeb/web/courses/courses/index.htm

- Easier infrastructure or software for managing open resources (such as eduCommons in the USA, Austria, the Netherlands, Japan, and China);
- Easier licenses (such as Creative Commons and GNU FDL);
- Easier production of resources, because of the possibilities to do pod casting, screen casting,
- Video casting, blogs, wikis etc.;
- Easier-to-reuse resources because of software that simplifies their assembly, contextualisation and aggregation.

Looking at the future, the study has predicted that the emergence of PLE – Personal Learning Environments – will move the power over learning from the institutions controlling the learning management systems (LMS) to individuals. This may in turn dramatically increase informal and non-formal learning, both in the form of individual learners and communities of learners, at the expense of today's institutions. If so, issues of recognition and accreditation will be of growing importance to the supply of e-skills.[19]

Higher education and curricula

Higher education aimed at a professional career as ICT practitioner has traditionally mainly concentrated on computer science (EF48 Computer Science). Education in mathematics, engineering and science are also popular sources of recruitment for the ICT-using enterprises. This type of education focuses on hardcore technological and mathematics skills, and our analysis show that these types of skills are in high demand.

During the past five to six years a number of new programmes and awards have been developed to look at design aspects of ICT and at ICT and business processes, such as e-business qualifications. The data collected for the present study and several other studies have also shown that business skills and management skills are also increasingly important for ICT practitioners (cf. Expert Group on Future Skills Needs 2008; OECD 2006b; CEPIS 2007). This can be done either by creating new types of bachelor and master programmes or by offering certified re-training for ICT practitioners already in jobs, and by more targeted profiling of relevant programmes that have already been developed, where the numbers of students may still be limited or the programmes yet little known among ICT-using firms, particularly among SMEs.

Examples of initiatives combining different courses are:

- *Denmark:* The IT University of Copenhagen offers Master degrees, diplomas, and PhD's in IT subjects combining technical computer science skills with applied skills in gaming and media technology. The university also offers part-time programmes for people with two years of work experience and a tertiary degree.[20]
- *United Kingdom:* Queens Mary's College, University of London, runs a number of interdisciplinary Computer Science programmes: Computer Science and Industrial Experience, Computer Science with Business Management, Computer Science and Web

[19] See OECD- CERI (2007)
[20] http://www1.itu.dk/sw499.asp

Technologies, Computer Science and Multi-media, Computing and Biology, and Language and Linguistics and Computer Science.

- *Sweden:* Malmo Hogskola offers a range of programmes at MA level in design and ICT.
- *Canada:* Toronto University offers a programme in user interface design.

The cases above are examples of adapting education and curricula to changing market demands. The strengths of the two cases from Denmark and the UK is that they are coherent and modular, which makes them more flexible. Education programmes should not be changed constantly in name and curricula without a proper knowledge base about employment options for the graduates. Another way to develop the quality of education and the composition of curricula is to apply the open source education materials available from highly esteemed education institutions such as MIT. The OECD-CERI (2007) has recently concluded a study on the business models and approaches in open source materials. Most importantly, the development of curricula should be competence based and in line with the European Qualification Framework.

The KibNet – Kompetenzzentrum für Bildungsnetzwerke, Germany, is one of many examples of a modular and comprehensive approach to ICT qualification with permeability between educational levels of qualification.[21] Also SFIA[22] in the UK has been influential in shaping national and EU policies in developing comprehensive competence and work process based reference frameworks for e-skills, but there are a number of other national initiatives which have taken similar approaches to the development of competence and work process based qualifications (Shapiro & Rosenfeld 2006; Empirica 2007).

The OECD Information Technology Outlook 2006 nevertheless concludes that because ICT specialist skills needs are likely to change rapidly as technology changes and also as a result of technological convergence, the formal education system may offer less flexibility for adapting curricula than private-sector schemes, usually set up as multi-stakeholder partnerships (OECD 2006b). For the competitiveness of the European ICT industry it is therefore of high interest that the European Commission continues to have an enabling role in disseminating the outcomes of multi-stakeholder partnerships within a common monitoring and evaluation framework so that the ICT sector and national governments can contrast and learn from experiences across Europe-potentially also drawing on more global data sources.

Internationalisation of education

Another dimension to improving the curriculum and to making an ICT career profile more attractive is to improve its international dimension. A new study by the Institute for the Study of Labour (IZA) shows that enrolment in a student exchange programme such as the ERASMUS is associated with an increased probability of labour market mobility across borders (Parey & Waldinger 2008). Language barriers are an obstacle for further development of the international dimension of higher education. Informatics and computer science departments in Spain, Portugal, Italy and France offer cooperation with other European universities, but master level courses are only taught in the national language.[23] The IT University Copenhagen is encouraging global

[21] http://kibnet.org
[22] http://www.sfia.org.uk
[23] http://www1.itu.dk/sw53283.asp

cooperation in ICT education and research in the framework of the Global IT University, which includes universities in China, United States, and Singapore.

Policy recommendation

- Stimulate the up-take of the European e-skills reference framework, so as to enable transparency in qualifications - and the use of transcriptors that are competence- and outcome based in the development of ICT programmes. To stimulate innovation and high quality in curriculum development and design, the Commission could take the initiative to assess if there is a basis for taking a European approach to the use of OER for innovation of curricula in ICT, and what type of knowledge base is needed to assess pros and cons to the involvement in an OER philosophy at the specific institutional level.
- To kick off such an initiative, a call for tender could be launched to analyse current usage in the HE sector, the business models adopted, and the constraints and enablers to the use of OER (technical, legal, attitudinal).
- National Ministries will have to address a balance between how widely dispersed the offer of ICT programmes is versus a globally competitive quality in the educational supply of ICT programmes. Instruments such as global benchmarks, global peer evaluations, and strong connects to alumni students can be measures relevant to stimulating the attractiveness of ICT programmes in the medium term.
- European Sector representatives, including organisations such as UABME, should initiate a dialogue with Higher Education representatives to assess if there is a common industry and provider interest at an EU level to develop comprehensive EU Master programmes with specialisations targeting the ICT sector in Europe - notably SMEs - with the use of a modularised, case-based e-learning platform.
- The European Commission should continue to play en enabling role in documenting and disseminating the outcomes of multi-partnership arrangements created to respond to e-skills demands. Common methodologies applied across an analysis of specific cases are essential if countries and sector representatives are to contrast, track, and learn about the impact, the efficiency, sustainability and relevance of the different approaches taken.

Anticipation of future e-skills needs (qualitative)

The ICT industry contributes over 9% of total business value added and employs 14.5 million people directly in OECD countries. As many ICT products become commodities, rapid growth occurs in new and niche goods and services and in emerging geographical markets. Open source (the “Linux effect”), online delivery of IT services (the “Google” effect) and new digital products are also disrupting how technology is developed and delivered. Widespread restructuring is expected to continue in IT services, telecommunications and digital content as industries and firms adapt to changing technologies and markets (OECD 2006b). Traditional models for forecasting skills are due to their disruptive nature of changes in the ICT sector of little use to policy makers and educational planners.

CEDEFOP conducts a wide range of skills and qualification forecasting for the European Union, and has a specific initiative on early anticipation of skills needs. Many of the existing studies are based on the analysis of single enterprises and the work processes in forefront businesses. The

number of studies that also include analyses of external factors influencing future skills needs is more limited in scope. Such factors could include: global sourcing (on a more permanent basis than the present study), effects of disruptive technologies, automation, effects of changing global value chains, customer preferences, and migration. There have been a number of studies regarding the anticipating of future e-skills needs. Advantages and disadvantages of different analytical approaches and methodologies should be discussed among experts and analysts to ensure development of good practice and possible greater level of coherence in methods at a European level.

Given the dynamics and disruptive changes in ICT and ICT-intensive occupations, a better knowledge base about factors influencing demands of e-skills is essential in the cases of increasing demands, changing types of demands, and decrease in demands.

Policy recommendation

- A coordinated European umbrella initiative to follow factors that are likely to impact the nature of demands could methodologically be inspired from the work of the European Monitoring Centre of Change.
- A call for tender should be launched by the European Commission to analyse pros and cons in different qualitative and quantitative methods for skills projections so as to arrive to a higher level of coherence and transparency in methods and findings. It is paramount that such a measure methodologically builds on global state-of-the-art, taking into account non-EU initiatives.
- Member states, sector representatives and the EU should pilot the extent to which technology foresights can be used as an instrument in early anticipation of skills needs, particularly types of skills affected by disruptive changes or major break-through in the R&D basis.

Lifelong learning

EU's lifelong learning programme for 2007-2013 constitutes a vital contribution for the development of a knowledge based Europe. The lifelong learning programme supports and complements the actions of Member States by encouraging mobility and cooperation between European education and training systems. Efficient lifelong learning systems are also central to improving the individual's employability in dynamic economies where occupational opportunities are likely to change over time

Lifelong learning programme 2007-2013

- Contribute to the development of quality lifelong learning, and to promote high performance, innovation and the European dimension in systems and practices
- Support the realisation of a European lifelong learning area
- Help improve the quality, attractiveness and accessibility of the opportunities for lifelong learning
- Reinforce their contribution to social cohesion, active citizenship, intercultural dialogue, gender

equality and personal fulfilment

- Help promote creativity, competitiveness, employability and the growth of an entrepreneurial spirit
- Contribute to the increased participation in lifelong learning by people of all ages, including those with special needs and disadvantaged groups
- Promote language learning and linguistic diversity
- Support the development of ICT-based resources
- Reinforce their role in creating a sense of European citizenship based on respect for European values and tolerance and respect for other peoples and cultures
- Promote co-operation in quality assurance in all sectors of education and training
- Improve their quality by encouraging the best use of results, innovative products and processes and the exchange of good practice

Source: Web site of European Commission, DG Education and Culture

In line with the Lifelong Learning programme, the long term e-skills agenda has addressed the need for lifelong acquisition of e-skills implying that:

"Ensuring that workers can regularly update their e-skills and encouraging better and more user-centric ICT-enhanced learning and training approaches (e-Learning). Government should promote good practices for the training of employees using e-Learning, with a particular emphasis on SMEs, and should publicise successful solutions and business models" (European Commission 2007a).

Continuing training is one of the main components of lifelong learning. To engage in continuing training both employer and employee need to be faced with the possibility and incentives for engaging in training programmes. In sectors with high job mobility and volatility, enterprises may not have many incentives to provide training for their employees (Zysman & Schulze-Cleven 2006). In Germany, regulatory measures have been taken whereby enterprises cannot poach workers from each other to the same extent as British enterprises can. In Germany, as in other countries with a dual system, state authorities and the social partners jointly run the public vocational training system, thereby providing better access for employees in SMEs, which often otherwise may be less inclined than large enterprises to engage in workforce development, which remains a challenge given the composition of the European industry base (Stone and Bradford 2008).

The advantage of the German approach in a training perspective is that it enhances the payoff for the individual enterprises to invest in training and lifelong learning. Contrary to this, some research sources have indicated that the relatively high job mobility in the British labour market could have negative consequences on company investment in upskilling the ICT workforce (Zysman & Schulze-Cleven 2006). Data from the e-skill survey from 2006, however, show that half of the employment base in ICT has participated in some form of training.

Transparency in the skills base

The transparency of qualifications and certifications is central to efficient lifelong learning systems, the mobility of skills, and the employability of individuals as occupations change. One study on e-skills shortage found that the challenges are not solely related to quantitative shortages, but also to a qualitative skills mismatch and lack of transparency and mobility in the ICT practitioner labour market (Petersen & Wehmeyer 2003). The European Qualifications Framework is a measure for translating and increasing transparency in the qualification offered between Member States of the European Union by linking national qualifications' systems to an overall framework (European Commission 2008b). The European Qualification Framework aims to improve the mobility of labour across countries and enable citizens to participate in lifelong learning.

The National Qualifications' Systems shall be linked to the European Qualifications Framework by 2010 to ensure that by 2012 all European certifications and qualifications obtained in the EU will refer to one of the eight reference levels of the European Qualifications Framework. The eight reference levels range from basic general knowledge obtained through compulsory education to higher education. The four highest reference levels are in line with the Bologna Process and are defined within the European Higher Education Area.

The strength of the European Qualifications Framework is that qualifications are described on the basis of learning outcomes rather than the length of a study and curriculum contents, the latter not necessarily linked to the knowledge of the individual. This should also facilitate the linkage between non-formal learning, informal learning, and the formal qualification system, because it provides a tool for assessing whether non-formal learning is equivalent to the learning outcomes described in the European Qualifications Framework (European Commission 2008b). The success of this will depend on national implementation and methods of prior learning assessment.[24]

The implementation of measures for the recognition of prior learning differs considerably between member state countries and between sectors. A number of pilots are under implementation for different purposes. However, little is still known about the long-term effects of such measures, even in countries where the use of recognition of prior learning has been in place for a long period; this includes a lack of knowledge on the effect on efficiencies of lifelong learning systems; return to education and permeability between education sectors; the effects on firm flexibility and retention of staff, and; the effect on personal life and career trajectories. The final outcomes of a comprehensive OECD study involving more than 20 countries are still pending, expected at the end of 2008.

Meanwhile, the OECD study so far shows that evidence is still anecdotal.[25] Nevertheless, for ICT practitioners, recognition of prior learning could constitute a vital measure to make transparent the actual competences of many ICT practitioners who do not have formal qualifications, but are autodidact and/or have developed their competence base through job assignments, and it could also be a major incentive to return to education for both firms and individuals.

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[24] See also OECD study on Recognition of informal and non-formal learning, http://www.oecd.org/document/25/0,3343,en_2649_39263238_37136921_1_1_1_37455,00.html

[25] OECD- Mexico meeting 2008

The European Qualifications Framework was initiated as a result of a request from Member States and stakeholders (including the Social Partners) and both have been involved in the development of the framework. This enhances the chance that implementation will be based on the actual needs of enterprises and ICT practitioners. In conclusion the European Qualifications Framework is a contribution to the long term e-skills agenda objective of *"…facilitating mobility, transparency of qualifications, and promoting recognition and credit transfer between formal, non-formal and industry ICT education and certifications"* (European Commission 2007a). However, the European Qualifications Framework is a framework for cross-border recognition of qualifications, and in order to increase the human capital of ICT enterprises and the skills level of ICT practitioners it needs to be combined with funding, incentives, and comprehensive measures for lifelong learning including recognition of prior learning.

European e-Competence Framework

The e-Competence Framework facilitates links between ICT core competences and the European Qualification Framework.[26] The e-Competence Framework aims to provide a common framework for ICT practitioners, ICT users, Social Partners, ICT-using and supplying enterprises, and education and training institutions. Since the e-Competence Framework is developed with a focus on competences (applied skills) rather than qualifications, different descriptors have been used for the two frameworks (European e-Competence Framework 2007). The initiative is still under implementation, but could be central to enabling mobility within the ICT sector, and could also be a reference framework in the development of European ICT Master programmes.

National skills frameworks

Skills frameworks are already implemented or are under development in many EU countries (IRL, DK, NL, DE, and also within the OECD (AUS). The differences between such frameworks illustrate the importance of distinctive traditions for the organisation of work, skills management and education (CEN 2006). It is important to distinguish between qualification and competence frameworks: the latter refers to *the application of learning outcomes* and the former to *learning outcomes.* The major e-skills frameworks have until now been structured along a 3-tier hierarchical model, and the CEN Workshop Agreement on e-skills meta-frameworks has recommended that future frameworks are structured in a similar way in order to facilitate future cross-country comparison (CEN 2006).

Cases on major national e-skills frameworks

- **Netherlands:** Generic Referential ICT Profiles (GRIP) is a method for characterising and analysing e-skills profiles.
- **United Kingdom:** Skills Framework for the Information Age (SFIA).
- **France:** Référentiel du CIGREF
- **Germany:** Advanced IT Training System (AITTS/APO-IT)

Source: CEN 2006

[26] http://www.ecompetences.eu/

Policy recommendation

- In line with existing measures at EU level, sector level, and national level, all concerned stakeholders within the field of ICT should encourage that efficient lifelong learning systems are continuously a key priority to the benefit of both industry and individuals – regardless how the demand and supply situation related to e-skills may develop.
- To that end sector bodies and the social partners can play a central role in disseminating good practice and in identifying gaps in existing measures where concerted actions could be needed.
- Public-private partnerships of the types already developed can be an excellent arena for addressing issues relating to skills mismatches and skills needs in ICT.

Restructuring and business development

Mechanisms for handling redundancies

There are potential adverse effects of offshoring – mainly employees who may be at risk of redundancy. This is particularly acute in countries with low levels of job mobility and labour market flexibility in Continental and Southern Europe (Danish Technological Institute 2008). The composition of labour market institutions is vital for the ability to anticipate and manage labour market changes in a manner which respects workers' rights, increase their future employability, and respect the decisions of enterprises and their needs to remain competitive.

One critical aspect of strict employment policy legislation (EPL) is that it might constitute an impediment to innovation and the adoption of new technologies when this is related to labour adjustment (OECD 2003; Danish Technological Institute 2008). Whereas collective bargaining structures in the ICT software and services sector are not yet fully developed, there are policies and practices also at the firm level concerning pro-active restructuring that can reduce the impact of restructuring on individuals. If documented, such examples inform policy and practice across Europe.

A number of models have developed across Europe to meet changing dynamics in labour markets. One of the measures is a growth in temporary contracts which can be of benefit to both enterprises and individuals, but new forms of employment may also have unintended consequences. Various studies have found that temporary contracts could constitute an impediment to further skills development, as enterprises will have less incentive to invest in training and up-skilling of temporary employees (OECD 2006d, OECD 2007, Danish Technological Institute 2008). Countries with a high share of temporary workers in the workforce are for instance Spain (31.9%), Poland (26.2%) and Italy (12.9%), and such countries are also typically characterised by strict Employment Policy Legislation (Danish Technological Institute 2008).

A comparative study of four European countries (Sweden, the Netherlands, the United Kingdom and Spain) funded by the European Commission (The NUEWO project)[27] dealt with contingent employment in the above mentioned countries, contrasting the findings with the situation in the USA. The study has particularly focused on the use of limited duration contracts and temporary agency work in the healthcare, food manufacturing, financial services, and information and communication technology.

According to the study, temporary agency work can provide both security and flexibility. Security can be achieved through an employment contract at the agency, and flexibility through assignments at various user firms. The regulation of the assignment itself does not serve the job security interests of the agency worker. Rather, it is the regulation of the contract at the temporary work agency that should be the focus of attention. The presumption should be that employment is on an open-ended contract unless there are objective grounds for contracting otherwise.

Despite the various efforts to regulate the use of limited duration contracts, problems for employees still exist. The characteristics of contingent employment make it difficult for the regulatory framework to limit potential undesirable effects.

Policy recommendation
▪ Governments should take a pro-active role in recognising how temporary work agency (TWA) industry may contribute to labour market policy goals ▪ In this context, governments must consider how to strike a balance between the private TWA industry and the public employment services. A first step could be to consider revisions of the governance structure of temporary agency work.

Sustainable regional specialisation and development of hubs through integrated innovation and R&D policies

Policies to enable cluster development and hubs as part of regional policies have at times built on imitating successful regions rather than a strategic exploitation of regional strengths and comparative advantages (Danish Technological Institute 2005). Nevertheless, Ireland is a prominent example of how the structural funds have been used strategically not only in the traditional sense of regional development, but also as a measure to create favourable framework conditions for incoming ICT companies. The cross-border Oresund region and the KISTA in Sweden, and the region of Catalonia (BDIGITAL)[28] are examples of regional policy measures that have had as their prime aim to strengthen regional specialisation and inward investment. Also Malta is a prime example how a small country with an open economy has prioritised a specialisation strategy to become a hub for inward investment by ICT firms. As the EU has expanded, a crucial element will be the way in which the structural funds are used to enable

[27] NUEWO project website, http://cordis.europa.eu/data/PROJ_FP5/ACTIONeqDndSESSIONeq112302005919ndDOCeq3272ndTBLeqEN_PROJ.htm

[28] http://www.cesca.es/promocio/congressos/tac08/VicencGasulla.pdf

regional specialisation and competitiveness, also in the medium term to attract inwards investment, particularly when low salaries are no longer a location factor.

Another potentially limiting factor is that technology foresights both at EU and member state levels are primarily used to inform R&D and technology policies, but are seldom used across policy realms for example to inform business innovation and education and training policies. As boundaries between mode I and mode II forms of innovation are blurring (science based versus user and employee driven innovations), the need to use the knowledge base from Technological Outlooks across a range of often disconnected policy realms becomes more acute (TEKES 2008). Previously, the Commission's advisory group ISTAG has played a prominent role in ICT research priority setting, but also a number of other measures are concurrently taken to ensure multi-partnership engagement.

As policy makers pay greater attention to innovation, more countries are developing formal plans and strategies for science, technology and innovation, combined with funding increases and changing institutional structures. The Finnish government has strengthened its Science and Technology Policy Council and boosted funding for its innovation agency (TEKES) through the creation of centres of excellence with a strong involvement of industry and with the use of competitive bids.[29] France not only boosted funding for public sector research by EUR 1 billion, but also established a new National Research Agency to provide selective funding to public research and public/private partnerships.[30] The German government has announced its intention to invest an additional EUR 6 billion in R&D through 2009.[31] The Slovak Republic published an Action Plan for Science, Research and Innovation to increase R&D funding, and established a new Government Council for Science and Technology to facilitate implementation (OECD 2006b). In the United States, the American Competitiveness Initiative set a target in 2006 to strengthen investments in science, technology and education.[32] A cross-ministerial initiative in Denmark is under preparation to spur innovation mechanisms with a particular focus on ICT and services from the outset.

A growing number of economies have established quantitative targets for R&D. Many countries – for example Finland, Iceland and Ireland - are moving to more competitive funding models for public research. Germany has strengthened institutional funding for non-university research to diversify research portfolios. In addition, many countries are establishing evaluation systems to ensure the quality of public research. Austria, Finland, Germany, and the Netherlands have streamlined and consolidated their innovation support programmes to make them simpler to use. Support to small firms has also increased and is channelled through a broadening array of programmes. Some aim at fostering spin-offs from public research – as in Austria's Academy plus Business (AplusB) programme and Germany's EXIST programme.

Substantial funding has been invested in ICT and diffusion of knowledge through the EU Framework programmes over the years, and a number of impact studies have been conducted, though seldom with instruments that make it possible in detail to track different types of impacts

29 http://www.tekes.fi/eng/news/uutis_tiedot.asp?id=5246
30 http://ec.europa.eu/research/headlines/news/article_04_07_16_en.html
31 http://www.wissenschaftsrat.de/texte/7854-07.pdf
32 http://www.whitehouse.gov/stateoftheunion/2006/aci/

in a substantial manner. Different consultation measures have also been used throughout the shaping of the different framework program periods. However, it is arguable whose voices are heard - particularly when it comes to the voices of the innovative and knowledge-intensive SMEs within the ICT sector - and if the programmes in spite of numerous forms of adaptation are sufficiently flexible and targeted to genuinely contributing to a global competitiveness of the European ICT industry.

Though some member states have taken measures to concentrate research efforts both in scope and in areas of research excellence at an international level, there is concern if measures and instruments at national levels and EU levels are sufficiently coordinated and targeted so as to stimulate global alliance in the field of ICT research and innovation. A recent publication from TEKES (2008) in Finland addresses the particular challenges of governance of R&D and innovation for small countries in Europe. Funding models are also evolving.

The OECD Science and Technology Outlook 2006 concludes that as yet few countries have determined how best to adapt national policy frameworks to a more global innovation system, but small open economies such as Finland and Ireland are mentioned as countries that appear to be leading the way (OECD 2006c). Therefore it is of vital importance that the European Commission takes an enabling role in creating a discourse space regarding how the ICT sector engages in innovation, and if there are specific models of innovation that seem to work better under different framework conditions. Influential factors could be firm size, geographical location and role within value chains, and internal capacities and level of connectedness to knowledge environments. A broader discourse can lead to a better comprehension of firm-specific innovation strategies, and thereby also provide a basis for strategically targeted policy measures.

Given the level of uncertainty concerning how companies, sectors, and regions best can position and re-position themselves within a more globalised innovation system, open strategic dialogues and real-time evaluation measures can contribute to policy learning and a strengthened competitive basis for the European ICT sector. Evaluation measures - whether of individual policy instruments or overall national or EU innovation performance - are central to the effective management and governance of publicly funded research, as properly designed evaluation methodologies can inform public policy measures and can increase an understanding of the effectiveness of different types of policy instruments and tune them to specific needs.

Policy recommendations

- Governments should together with industry assess if R&D and innovation policies are sufficiently dynamic in governance methods to enable a better connect between policy realms and different modes of innovation. This could be done as a global benchmark exercise building on findings from the EU innovation score board, research of OECD, and the recent study carried out by TEKES. The EU could play a coordinating role in initiating such an initiative and in formulating relevant policy pointers.

- Given that ICT R&D and innovation initiatives are likely to increasingly need a multidisciplinary approach due to the complexity of innovation processes, all relevant actors should address whether current evaluation and monitoring methods and indicators are sufficiently well targeted to measure outcomes and impacts. An indicator of impact is not only an increase in firm spending on R&D and innovation. Other indicators could be the level, the type, and the intensity of collaboration firms

pursue, post- programme investment, or the internal capabilities they obtain to initiate and manage and commercially exploit R&D and innovation measures.

- Member states and sectors should pilot the use of technology outlooks, particularly in ICT and related matters, to examine to which degree they can inform dynamic policies in areas such as regional development, education and training, and industry policies.

- The European Commission should launch a tender to assess opportunities and potential impacts of open innovation models specific to the ICT industry in Europe, the ICT industry's competitiveness, and R&D and innovation models of operation

Facilitative cooperation between ICT enterprises and key industrial/service sectors

A key feature of ICT is its pervasiveness and generic character. Therefore ICT does not only hold a productivity and innovation potential for the ICT sector but also for other sectors such as health, finance & banking, insurance, and automotive, with regard to products, services, business models and processes. Indeed, the EU ICT Task Force attributes the lack of ICT uptake in non-ICT sectors as a vital reason for the European decline in labour productivity (EU ICT Task Force 2006; Aslesen et al 2008).

Support innovative and growth start-ups

Europe is not short of entrepreneurship and start-ups, but Europe is short of start-ups and SME which grow and innovate at international competitive levels (Aslesen et al 2008). The European ICT sector is experiencing impressive multi-stakeholder partnerships and strong industry involvement, but most of these initiatives and projects are run by large corporations like Microsoft, Cisco, IBM and SAP. This is indisputably positive, but there is a need to also assess how SME can become more integrated in such initiatives or create their own innovation environments through networks and different models of innovation.

The recent establishment of a pan-European business association for ICT SME could prove to be a step in the right direction. This organisation is more likely to take the needs of start-ups and SMEs into consideration than larger enterprises. In general there is a need for a better knowledge base to understand modes of innovation in the knowledge-intensive ICT and services sector, and which forms of framework policy measures, including measures for policy coordination, favour innovation in SMEs in the ICT and services sector in the most efficient and sustainable way.

One of the most pressing challenges for start-ups in Europe in general is the lack of access to venture capital and business angels (Library House 2007, Aslesen et al 2008). There are several government and EU funds and policies aimed at helping start-ups – known as *Gazelles programmes* - but outcomes and effects of these programmes are not widely known. A European-wide analysis and impact evaluation on the effects of gazelle programmes and different models of incubators for knowledge intensive start-ups such as ICT companies could inform European and national policies in the field.

Currently there are a number of interesting programs and initiatives which combine business incubation with business development and market penetration, and programmes which also build

on generating learning between the participating companies (Stockholm School of Entrepreneurship, The Accelerace program, Symbion DK). These are in different stages of implementation, but it is yet too early to conclude about effects.

Policy recommendation

- Member States should use the annual GEM surveys as a framework for understanding which type of framework conditions and framework policy measures are most central to foster innovation and growth in ICT firms - including policy coordination between agencies.
- Member States should be encouraged to collect longitudinal data on business start-up programmes in ICT to document and analyse promising practice programmes so as to support policy learning at member state and EU level. The Commission could play an enabling role in disseminating promising practices across Member Sates

Ensuring that Europe is an attractive place to do business

Enterprises have to consider and re-consider location factors on a more or less constant basis (Expert Group on Future Skills Needs 2008). This implies that policy makers also need to consider factors which attract inward investment, as discussed previously in terms of design and innovation of regional policies which favour regional specialisation. With regard to attraction of highly skilled labour, and thus also of favourable framework conditions for knowledge-intensive firms, the recent report on Globalising Labour Market from The Work Foundation (2008) deserves proper policy attention, with the type of findings it brings forward and in light of the current stage of play concerning immigration of highly skilled labour.

Fiscal policies and regulation are the responsibility of the Member States and vary a lot depending on the institutional characteristics of the country in question. It is not possible to deploy a one-fits-all model when it comes to fiscal policies and regulation since such measures are intertwined with the surrounding institutional environment such as labour market policies, welfare regimes, employment patterns, and enterprise structures. The low corporate tax in Ireland has been mentioned as a vital contributor to the success of attracting Foreign Direct Investment and Multinational Enterprises to the country. Nonetheless, several critics have pointed to the unique situation of Ireland which made this policy feasible, while other countries would probably be unlikely to benefit from (solely) pursuing low tax policies.

Over the last couple of years, Northern European countries have shown a remarkable ability to attract inward investment by global players in the ICT and services industry despite the relatively high levels of both corporate tax and income tax. One of the reasons for this is probably that other factors offset the negative effects of high taxes. Such factors are: a good technological and physical infrastructure, high standard of living, access to highly skilled labour, and reliable public institutions. With the word of warning from Katerina Rüdinger (Work Foundation 2008), favourable conditions increasingly, and not least for highly globalised and highly skilled employees, also include a multi-cultural and open environment in the country of destination.

Some countries have deployed tax exemptions for ICT-related investments such as individuals or schools buying ICT equipment. In Sweden the government has launched an initiative giving tax

exemptions for citizens' purchase of computers. Tax policy is the domain of Member States and thus policy recommendations in this regard should be limited. However, experiences of single tax initiatives could be exchanged to enable mutual learning and policy innovation.

Policy recommendation
▪ Collection and dissemination of good practise cases on tax policies favouring the development of digital literacy and e-skills

Conclusion

The knowledge base about global sourcing of ICT software and services is still fragmented. It is however recognised that global sourcing may offer both opportunities and challenges for the competitive base of the ICT software and services sectors in Europe as well as impacting labour markets for ICT practitioners. This is very important in the context of the future of the Internet and the evolution of the software business as a service industry. Different sourcing strategies that firms may pursue will at the aggregated level call for different policy measures to ensure a dynamic match between the demand and supply of e-skills in Europe.

It can be argued that in dynamic sectors characterised by disruptive change such as in the ICT software and services sectors there are bound to be serious challenges concerning the right match between supply and demand of e-skills. Both at an EU level, at sector and national levels numerous technological foresights have been carried out in the field of ICT typically to inform policy making. Within the emerging initiatives to further early anticipation of e-skills needs - measures are still pending to explore if technological foresights also are suited to give an external and broad perspective on sector dynamics that can inform e-skills - and lifelong learning policies.

Efficient and comprehensive lifelong learning policies are central to ensure sector dynamism. Lifelong learning policies, however, should not be seen in isolation, but must be in tune with broader innovation policies so that ICT companies have access to a skills base capable of spotting and exploiting windows of opportunities as a basis for the future competitiveness of European ICT software and services sectors. In many countries there are increased pressures to strengthen the knowledge base for policy making- this also includes education and training policies. However, for accountability purposes targets should not be defined so strictly, so they unintendedly impede systemic reform of both content and modes of organising ICT programmes. Innovative approaches to curriculum reform are not at odds with accountability, but may call for evaluation measures that genuinely support policy learning and policy coordination across traditional policy realms and stakeholder constituencies.

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