Information and Communications Technologies

OECD Information Technology Outlook

OECD

2004

INFORMATION AND COMMUNICATIONS TECHNOLOGIES

OECD Information Technology Outlook

2004

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Pursuant to Article 1 of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

– to achieve the highest sustainable economic growth and employment and a rising standard of living in member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;

– to contribute to sound economic expansion in member as well as non-member countries in the process of economic development; and

– to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The original member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996), Korea (12th December 1996) and the Slovak Republic (14th December 2000). The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).

Publié en français sous le titre :

Perspectives des technologies de l'information de l'OCDE 2004

FOREWORD

The OECD *Information Technology Outlook* 2004 has been prepared by the OECD under the guidance of the OECD Committee for Information, Computer and Communications Policy (ICCP), and in particular its Working Party on the Information Economy. It is the seventh in a biennial series designed to provide member countries with a broad overview of trends and near-term prospects in the information technology (IT) industry, an analysis of the growing impact of IT on the economy and society, new applications in selected areas of information technology and a description of IT policies and new policy directions. The 2004 edition builds on the 2002 edition to further extend the economic and policy analysis.

The first three chapters provide an overview of the importance of information and communication technologies (ICTs) in national economies, describe recent market dynamics and examine some of the impacts of the use of ICTs, give a detailed overview of the globalisation of the ICT sector and provide a thorough analysis of the important but relatively un-mapped development of e-business. The next three chapters describe the diffusion of ICTs and the digital divide, the growing phenomenon of digital delivery and rapidly evolving developments in the demand and supply of ICT skills. The last two chapters examine recent technological developments that will be important in the medium term and provide an overview of IT policies in OECD countries. Detailed statistical tables are provided in Annex C. Information technology policy profiles are posted separately on the OECD Web site to enable their widespread diffusion (*www.oecd.org/sti/information-economy*).

The IT *Outlook* 2004 was prepared by Graham Vickery, Pierre Montagnier, Misha Pinkhasov, Desirée van Welsum and Sacha Wunsch-Vincent of the OECD's Information, Computer and Communications Policy Division and John Houghton (Victoria University). It benefited from valuable contributions from delegates to the ICCP Committee's Working Party on the Information Economy, under the chairmanship of Richard Simpson (Canada), particularly regarding national IT policy developments and up-to-date national statistics on the production and use of IT goods and services.

The report is published on the responsibility of the Secretary-General of the OECD.

TABLE OF CONTENTS

List of boxes

Chapter 8

Annex boxes

List of tables

Chapter 1

Chapter 2

Chapter 3

Chapter 4

Chapter 5

List of figures

Chapter 1

HIGHLIGHTS

ICTs continue to play their important role in the world economy

ICTs continue to play a pivotal role in the world economy, and the outlook for ICTs has improved markedly.

Information and communication technologies (ICTs) play a pivotal role in the world economy. The ICT sector is increasing its trend share of economic activity, and ICTs are an important input for economic performance. The outlook for the ICT sector is improving, although more slowly than earlier foreseen. The slump that began in 2000 was severe in ICT manufacturing, while telecommunications services and information technology services continued to grow.

The recovery is spreading, underpinned by strong performance in the United States, China and Korea.

With ICT investment growing from the start of 2002, the United States led the way out of the downturn. As economic growth improves, the recovery in the ICT sector is spreading to Japan and Europe. Both the United States and Canada saw renewed growth of ICT goods shipments in 2002. Because semiconductors are a leading indicator of ICT hardware trends, the global upturn in semiconductors suggests that recovery is well under way, led by strong performance in China and Korea from the start of 2002. The upturn in investment has been concentrated in computers and components, but communications equipment is strengthening as the potential of high-speed broadband, WiFi, voice over Internet and video is exploited.

The top ICT and Internet firms have returned to profitability, and concentration is increasing as they gain revenue share.

Revenues of the top 250 ICT firms worldwide, which make up over half of the ICT sector, were up in 2003, and they were in profit after very large losses in 2001 and 2002. Software, IT services and telecommunications services increased revenues by over 5% a year between 2000 and 2003, while communications equipment firms suffered very steep declines. Firms headquartered in the United States have close to 40% of OECD top firm activities, and the European Union and Japan one-quarter each. Japanese electronics conglomerates have fallen in the revenue rankings, while firms in Chinese Taipei, China and Singapore have risen. Concentration is increasing, as the largest firms increase their share of revenues. Revenues of the top 50 Internet firms (firms that derive all or most revenues from Internet-related operations) grew in current terms every year through 2003; their combined incomes returned to close to breakeven in 2003 after very large losses in 2001 and 2002, with larger Internet firms performing better than smaller ones.

Long-term development of the ICT sector, which takes over half of venture capital, is strong.

The ICT sector contributed close to 10% of OECD business GDP in 2001, up from 8% in 1995. It employed over 17 million people – over 6% of business employment – with 4% annual growth. Labour productivity has risen rapidly, mirroring output growth. Expanding segments such as telecommunications services have continued to grow, but manufacturing productivity has declined from 2001. ICTs maintained their technological dynamism and leading sector role during the downturn. The sector attracted around one-half of all venture capital investment through 2003, spends one-quarter of total business R&D, and takes out close to one-fifth of all patents.

The production of ICT goods and ICT-related services are shifting towards Asia and China.

The global location of production of ICT goods has shifted, owing to the very rapid increase in output in China and other Asian countries. In 2002, the European Union, Japan and the United States accounted for less than two-thirds of global ICT goods production, compared with over four-fifths in 1990. There is evidence that IT services and ICT-enabled services are also changing their global distribution.

Global ICT trade is expected to grow strongly in 2004, driven by the global recovery. China's trade in ICT goods now exceeds Japan's.

In 2004 world trade is expected to grow at twice the rate of GDP, and trade in ICT goods and services even faster, with OECD ICT goods trade set to grow at 10% driven by higher GDP growth, particularly in Asia and the United States, rapid increases in China's trade, and trade in internationally sourced IT and ICT-enabled services. While ICT trade was severely affected by the economic slowdown, with OECD ICT goods trade dropping 13% in 2001 – compared with 3.3% for all goods – and by 4.5% in 2002. Nevertheless, ICT goods represented 14% of total trade in 2002, considerably more than in the mid-1990s. China's ICT goods trade has grown spectacularly since 1996: 28% annually compared with 4% for OECD. It is now greater and more balanced than Japan's (which is export-oriented) but still smaller than the United States (which is import-oriented).

Ireland is the leading OECD exporter of software-related goods and services, but these are difficult to measure.

Trade in software and ICT services is difficult to track satisfactorily, but, as currently measured, Ireland and the United States continue to dominate. They are the largest exporters of software goods (trade in physical supports for software). Computer and information services trade has grown very rapidly in OECD countries, with exports growing by 20% a year and imports by 15% in the 1996-2002 period. Ireland had almost USD 10.4 billion in exports in 2002 compared to USD 6.9 billion from the United States.

ICT and Internet use are increasingly ubiquitous. Firms, industries and countries are reaping the benefits of ongoing ICT investments, but impacts are not uniform and are more apparent when coupled with higher skills and improved organisation.

ICT and Internet use are increasingly ubiquitous, and firms, industries and countries are reaping the benefits of ongoing ICT investments. However, growth has been uneven across firms, sectors and countries, with ICTs' contribution to growth conditioned by overall investment and economic performance. In most OECD countries, ICTs account for a large and growing share of investment and contribute significantly to GDP growth. The ICT-producing sector has contributed to productivity growth, especially in OECD countries with relatively large R&D-intensive ICT manufacturing sectors, but there is little overall evidence that ICT-using industries, except in the United States and Australia, have experienced more rapid productivity growth. ICT use is beneficial to firm performance when part of strategies for raising skills and improving organisation; firms that invest in a range of intangible and tangible assets experience superior growth.

The ICT sector is highly and increasingly globalised

The ICT sector is a leader in the globalisation of industry.

Over the last two decades, the ICT-producing sector has become increasingly globalised. The sector's underlying structure and dynamics ensure its position at the forefront of globalisation, although the role of its different segments varies. Trade in ICT goods has grown at almost double the rate of merchandise trade and trade in ICT services even faster. The share of ICT goods in total trade has increased despite absolute declines in 2001 and 2002, and trade is growing faster than ICT spending and production.

Driven by the global rationalisation of production, countries have specialised in smaller ranges of goods and services, and in the 2001-02 downturn, countries specialised in ICT goods became more specialised, while those that were not became less so. Intra-industry trade shows that the ICT equipment-producing sector is becoming more specialised, although the picture in the recent downturn was mixed. The ICT sector is characterised by high levels of intra-firm trade as firms rationalise internal production and develop more complex systems of global production and sourcing.

Global rationalisation of production has led to greater trade specialisation and high levels of intra-firm trade.

The international expansion of ICT firms is driven by the need for market access, growth, economies of scale and access to skills and technology. Foreign direct investment (FDI) has increased significantly and investment stocks and international production by multinational enterprises (MNEs) have grown, although investment flows dropped from 2000. Detailed data on ICT FDI are limited, but show a shift towards globalising of services in the wake of deregulation and trade liberalisation. Telecommunication services are at the forefront of both investment and mergers and acquisitions (M&As), despite loss of share value and the cost of third-generation networks.

ICT firms expand internationally to gain market access and to access skills and technology.

Cross-border M&As are the most common form of ICT expansion, enabling faster build-up than greenfield investment. During the surge in worldwide M&A activity in the 1990s, activity was much higher than average in ICTs owing to very large telecommunications deals and high stock market valuations. Despite precipitous declines, cross-border ICT M&A activity remains higher than in the mid-1990s and growing again in 2003 and the first half of 2004. As the business cycle picks up, surviving firms will seize acquisition opportunities to expand and consolidate.

They expand largely through cross-border mergers and acquisitions; they led the boom and continue to be relatively active.

International sourcing of IT- and ICT-enabled business services – or offshoring – is a recent development driven by the dynamics of digital delivery, the need to fill skills shortages, increase efficiency and cut costs, in a context of increased competition and services liberalisation. Competition reinforces the trend, as other firms follow the leaders to lower-cost, high-quality locations with the available skills. There are no reliable official data on international sourcing, but most exports of computer and information services and other business services (IMF balance of payment categories) originate in OECD countries, although their share of total exports declined from 79.5% in 1995 to 77.1% in 2002. India as well as Ireland have significantly increased their shares of these exports and some developing countries are rapidly expanding their exports, albeit from very low levels.

International sourcing of IT and ICT-enabled business services has grown rapidly. Over three-quarters of exports are from OECD countries, but India is now an important exporter and other developing countries are following.

Offshoring delivers cost savings for firms, but it may also initially involve job losses in the home country and job creation in the host country. However, efficiency gains and cost savings underpin productivity growth and the creation of new employment opportunities in the home and host country. A protectionist response should be avoided in order to take advantage of the benefits of offshoring while managing the adjustment process with active adjustment policies: compensating for adjustment costs where necessary and enabling workers to seize new employment opportunities.

While offshoring can increase firms' efficiency it raises concerns about job losses which are best addressed by ensuring that adjustment costs are minimised and that workers have access to new employment opportunities.

E-business is spreading but adoption of more complex applications is slow

Computers and the Internet are now widely diffused, but integrated e-business processes are only slowly being adopted.

In OECD countries, computers and the Internet are now widely diffused among firms. However, despite good access to computers and high levels of business connectivity, including broadband, there is relatively little implementation of ICT-enabled integrated business processes and adoption of more sophisticated on-line activities (*e.g.* taking orders on line, integration with suppliers). The challenge is to increase effective use internally and externally through the use of e-business software and changes in interactions with suppliers and customers.

New trends include a shift to business-to-consumer e-commerce, greater internationalisation and a move by small firms towards more complex electronic business applications.

Many firms still use the Internet mainly for information search, supply and on-line banking. Use for e-commerce varies by firm size (large firms lead), sector and country, and many e-business applications are not suitable for all processes and sectors. However, after the initial development of e-commerce with a domestic business-to-business focus by large firms in a few sectors, new trends are appearing. There is solid growth in business-to-consumer transactions, internationalisation is continuing, the Internet is being used to support off-line transactions, and small firms are moving towards more complex electronic business process applications including ordering and logistics systems.

As the "e-readiness" divide between small and large firms closes, a new "e-business divide" may be widening for more advanced applications.

However, relatively few firms have comprehensively adapted their business concepts, value chains, organisation, and supplier and customer relations. Internal integration of electronic order systems with other functions (*e.g.* marketing) or external integration with suppliers and customers remains infrequent and is often found only in large firms. As the "e-readiness" divide between small and large firms closes, a new "e-business divide" with respect to more advanced applications may widen, although part of the apparent slow diffusion of more complex e-business process applications may be due to relatively limited attempts to measure their uptake.

The potential of ICTs can only be realised by consistently improving skills and human capital, implementing organisational and product innovations, and aligning ICT with corporate strategies.

Furthermore, the effects of using e-business methods may not be immediate. Case studies for 2000-02 show the impact of e-business to be significant but consistently lower than expected, reflecting over-optimistic expectations and measurement difficulties. Cyclical factors are also important: firms look to ICTs to rationalise and cut internal costs during downturns and to expand externally and develop markets during upturns. Tapping the potential of ICTs throughout the business cycle requires consistently raising skills and improving human capital, implementing organisational innovations (*e.g.* new business models, flatter hierarchies) and product innovations, and aligning ICT strategies with corporate strategies.

Firms with competitive advantages benefit from the use of more sophisticated forms of e-business along their value chains to improve efficiency and raise productivity.

There are clearly important differences in the intensity of e-business use among firms of different sizes and in different sectors. Measurement problems complicate the task of identifying causal relationships between increased corporate use of ICTs and their impact. However, firms that have competitive advantages, including a skilled and innovative workforce and openness to organisational change, benefit significantly from deployment of ICTs along their value chains. More sophisticated forms of e-business, involving internal and external process integration, promise efficiency and productivity payoffs.

Now that ICT access is widely available to individuals and households, the digital divide is becoming a "use" divide

Building on the installed base of PCs, the Internet and broadband have diffused rapidly to individuals and households.

Personal computers (PCs) and the Internet provide the equipment and connectivity that allow individuals and households to benefit from ICTs. PCs have diffused quite slowly in households, but, building on the installed PC base, the Internet has diffused quite rapidly and broadband technology is following at a similar pace. PCs are by far the main route for Internet access, but access via mobile devices is increasing, from a low level. While the patterns of PC and Internet uptake have been similar everywhere, levels differ significantly among countries.

Home access leads workplace access, and Internet use is diversifying and reducing time devoted to other media.

ICT uptake is affected by income, educational attainment, children in the family, age and gender. Although home Internet access has led workplace access since around 1998-99, workplace users are more likely to have access at home. Lack of need or interest and costs are the main reasons for not being equipped. Internet use is also evolving, influenced by the supply of broadband and new access devices, and by educational attainment on the demand side. The Internet's capabilities for focused information search, obtaining news, and personal banking and investment are increasingly exploited, although e-mail remains the principal activity, and browsing for information on goods and services is becoming important for off-line shopping. Time spent on line is increasing and is affecting time devoted to other media, although television still has by far the greatest share.

A "use" divide is replacing the "access" divide.

ICTs are now in daily household use in OECD countries, despite a persistent if narrowing digital divide. Socio-economic characteristics determine how people interact with ICTs. Differences are increasingly linked to unequal use, and the digital divide is progressively shifting from a simple and slowly reducing "access" divide to a more complex "use" divide. The Internet amplifies social differences as new uses emerge. This suggests that attention should increasingly be paid to "how to use" issues.

Public policy can both encourage competition and enhance diffusion and use.

Public policy focusing on a mix of connectivity, content and education and distribution issues will help maximise the benefits of ICTs. Policies need to focus on an appropriate mix of infrastructure supply-side measures (competition to reduce prices, improve quality and expand choice) to raise connectedness, with demand-side measures to enhance diffusion and encourage content provision, and related broader measures involving education, training and ICT literacy to tackle issues beyond the narrower issues of ICT supply and connectivity.

Products and information are increasingly digitised and delivered over information networks

Digital delivery is increasing rapidly across many sectors.

Digital delivery via the Internet and other computer-mediated networks is increasingly important for distributing information and commercial products. It combines greater market reach with richer interaction with customers and consumers and its level and complexity are increasing with more widespread adoption of broadband technologies. In spite of the rapid growth of digital delivery, its applications, impacts and prospects are not covered in ICT statistics; new measurement techniques may be needed to capture digital transactions.

Internet visit patterns show a very wide range of activities and large potential for digital delivery.

The potential for digital delivery is evident in the millions of Internet visits. These are most frequent in the categories computer and Internet, adult, news and media, entertainment, and shopping. Health and medical and government have relatively low shares of visits but are high among non-recreational uses, and number of visits is not necessarily a measure of utility or quality. In some categories, market shares are already very concentrated. Established business and finance firms attract a large share of visits, but new Internet firms take the top positions for shopping and classified and employment categories.

Peer-to-peer has grown rapidly to around 10 million simultaneous users.

Peer-to-peer (P2P) network use in OECD countries is a rapidly developing area of digital delivery. With approximately 10 million simultaneous users worldwide at any one time, it has a significant impact on network traffic, particularly with the current shift from audio files to larger video files. Factors determining the intensity of P2P use include availability of broadband (mainly for the size of files exchanged), student status, age (younger Internet users are the most active users), and perhaps lower incomes. File sharing applications are also rapidly being developed in business areas that benefit from the electronic distribution of information and products.

Digital delivery of business services is driven by the potential for digitising services intermediate and final products and by outsourcing.

Digital delivery in business services is driven by the potential to digitise business service inputs on the supply side and by outsourcing on the demand side. For suppliers, these factors include the need to increase richness, reach and interaction with customers, globalisation of customers, and internal cost and efficiency. For firms purchasing business services, factors include competitive pressures, cost control, access to specialist skills and demand variability. Software and IT services sectors are the current leaders, but all business services use digital delivery, particularly for document exchange and customer services. Infrastructure, including broadband availability, services standards and accreditation, and skills and employment all affect its spread. Digital delivery is more advanced in countries with well-developed network infrastructure and a strong business services sector.

Many healthcare application are trial projects but hold promise in many areas and have the potential to help transform healthcare.

ICTs and digital delivery are increasingly used in healthcare for administration and routine tasks, as well as advanced medical specialisations. Applications in the areas of patient records and smart cards, digital imaging, distance monitoring and consultation, tracking threats from diseases like SARS, research, health education/training and evaluation are being tried out and show great potential. Drivers include cost containment, quality improvement, universal access to healthcare and international co-operation. Major impediments include the structure of health institutions and specialisations, legacy ICT infrastructure, insurance and payment schemes, and poor incentives to collaborate between those who pay and those who benefit. Although digital delivery technologies can help to integrate and reorganise health systems, there is as yet too little rigorous and consistent monitoring and evaluation of the benefits and costs of applications.

ICT skills play an ever more important role in the economy

Various levels of ICT skills are increasingly and more intensively used throughout the economy.

ICT skills of different levels of complexity are widely used throughout the economy. ICT specialists (*e.g.* computer professionals, electronic engineers) represent a high share of employment in only a few sectors (office equipment and computers, precision instruments, electronic equipment, utilities and computer services). However, those who use ICTs intensively in their jobs (*e.g.* high-level technical professionals, office workers) make up a high share of employment in industries such as computer services, financial, insurance and wholesaling services, as well as the manufacturing sectors that employ ICT specialists. The importance of ICT-skilled employment at both the specialist and the user level has increased over time.

ICT-skilled employment is associated with higher levels of productivity.

The distribution of ICT skills is very similar in Europe, the United States, Japan, Korea and Australia. The distribution of ICT skills is similar to that of ICT investment, suggesting that use of ICTs in the workplace has sector-specific characteristics. At sector level, a large share of ICT-skilled employment is associated with a high level of value added per employee, a sign that use of ICT-skilled workers is associated with measurable economic benefits. The distribution of ICT skills throughout the economy is important for competitiveness, as effective use of ICTs in production and business processes is of crucial importance for countries' productivity and growth.

Full-time education is not currently the main source of ICT skills, and training and certification may be a more suitable way to develop specialist skills.

The need for ICT skills can be satisfied in part through education and training. Full-time education does not appear to be the most important path to obtaining general and advanced skills. As schools become well equipped, however, students develop at least basic ICT skills, and ICT-related degrees can be obtained through formal education. For specialist skills, however, sector-specific training and certification schemes may be more effective, given the rapid changes in skills needs and the constant introduction of new technologies.

The need for ICT skills can also be filled by outsourcing, which is increasing, or by migration, which has declined since 2001.

Skill needs can also be satisfied by domestic or international outsourcing or by migration. Outsourcing of IT services and ICT-enabled business activities is increasing, although the magnitude and geographical distribution of outsourcing depends on the reasons for doing so (skills needs, cost reductions, etc.), and no reliable official data exist. Most countries have encouraged inflows of IT migrants to some extent, although in many countries flows have diminished following the 2001 downturn. Internet recruitment is a new way of satisfying changing skills needs at firm level. It appears to be relatively more important and increasing in ICT-related fields and sectors, but it is not limited to these sectors and is increasing throughout the economy.

Emerging technology applications underpin the future contributions of ICTs to the economy

Emerging technologies can increase the contribution of ICTs to growth and employment.

Nanotechnology, grid computing, RFID, WiFi and anti-spam technologies are examples of maturing technologies that are finding increasing commercial applications. They add to the important role of ICTs in the economy through their potential contribution to growth, productivity and employment. As new applications emerge, issues such as information and system security, privacy and public safety have to be addressed.

Nanotechnology and grid computing provide new ways of enhancing the impact of ICTs by providing greater capability at lower cost.

Drawing on expertise in biology, chemistry and physics, nanotechnology can improve the performance of ICTs and find uses across a broad range of applications. Although the potential economic benefits are widespread, further R&D is necessary to ensure that health, environmental and other risks are well understood. Grid computing has moved from the first linked mainframe computers and local area networks, and now focuses on exploiting the collective computing power of interconnected machines. The shared use of computing resources requires trust, established rules, grid resources and the protections of the data within the grid.

RFID and WiFi offer new tracking and communications potential…

Radio frequency identification (RFID), first developed in the 1960s, is only now becoming practical for applications in industry, transport, security and consumer goods and services. RFID faces challenges in terms of data security and interception, and as a tracking technology it raises issues of privacy and authentication, for example for access or payment systems. WiFi is one of a group of emerging wireless ICTs that has attracted attention because of its ability to provide broadband Internet access. WiFi's flexibility and its "through-the-air" nature are its strong points, but they raise issues of encryption, access and protection of transferred data and free-rider concerns.

… but control of spam is crucial for the continued development of the capabilities of the Internet.

Spam is now estimated to account for as much as 60% of all e-mail. This has spurred discussion of its economic costs and has led to efforts by policy makers, software firms and Internet service providers (ISPs) to stem the ever-growing tide. Spam raises concerns ranging from simple inconvenience to users, to issues of economic costs and its potential as a dangerous vehicle for computer viruses and cyber-terrorism. Filtering mechanisms adopted to counteract spam run into the problem of adapting to the ever-changing characteristics of spam while still allowing legitimate e-mail to pass.

More effective policies can help enhance the contribution of ICTs to growth and employment

ICT policies are increasingly integrated into economic development strategies and co-ordinated across government.

In recent years, national ICT strategies have shown considerable continuity, integrating ICT policies more closely with economic development to mainstream ICTs' contribution to growth and employment. This is reflected in the strengthening of the links between economic development and technology agencies in the organisational structure of policy-making bodies. At the same time, efforts have been made to ensure the co-ordination of ICT policies to maximise impact and broaden the use of ICTs, and more attention is paid to the evaluation of policies. Areas such as awareness and demonstration programmes and SME-specific programmes now receive less attention. The focus is moving towards more complex e-business strategies, and specific policies for SMEs have often been absorbed into general policies for ICT diffusion and training.

They focus on a few areas…

ICT policies focus specifically on: R&D support and ICT innovation; particularly development and use of ICT skills; the impact of e-government; infrastructure, particularly broadband and areas such as authentication and digital signatures; and promoting trust, notably in the area of system and information security.

… R&D and technology diffusion, particularly the development of ICT skills.

On the supply side, there is a continuing focus on innovation, particularly ICT R&D programmes, in order to effect sectoral and structural transformations so as to more fully reap the benefits of ICT. On the demand side technology diffusion is of major importance, with increased attention to developing ICT skills and an emphasis on policies to promote professional/managerial ICT skills and to encourage ICT diffusion to businesses, individuals and households. Emphasis is also placed on providing government services on line, with governments seeking to develop streamlined, user-centred approaches that automate some aspects of public administration and also serve demonstration purposes across the economy.

Greater emphasis is also placed on the development of broadband, in terms of infrastructure build-out and provision of high-speed service, with the most advanced countries focusing on ways to increase uptake of existing capacity, including raising the quality of Internet services. There is a new and rapidly growing interest in encouraging development of content and digital delivery with added value for users, and in exploiting public sector content (*e.g.* archives, weather, maps). Enhancing trust on line receives continuing attention, particularly for system and information security; and issues of protecting data, privacy and combating spam have gained importance.

Broadband has been a new focus, accompanied by growing policy interest in digital content and digital delivery.

Awareness has increased of the fundamental importance of assessment and evaluation of ICT policies and programmes as a way to help inform government decision making and improve the effectiveness of policies and programmes. There is growing emphasis on building assessment and evaluation into programmes from the outset. International benchmarking is often a feature of evaluations, and many countries are now looking at the broader context and evaluating the contribution of these programmes to economic development.

Policy assessment and evaluation are increasing, and the contribution of ICTs to economic development is an important new focus.

Chapter 1

RECENT DEVELOPMENTS AND OUTLOOK

The outlook for the ICT sector has improved markedly, and recovery is spreading. ICT trade is growing strongly in 2004, driven by the global recovery and as the production of ICT goods and ICT-related services shifts to Asia and China. The top ICT and Internet firms have returned to profitability, and top firm concentration is increasing. Long-term development of the ICT sector, which takes over half of venture capital, is strong. This chapter outlines recent developments and the outlook for the ICT sector and summarises the impacts of ICTs on economic performance.

Introduction

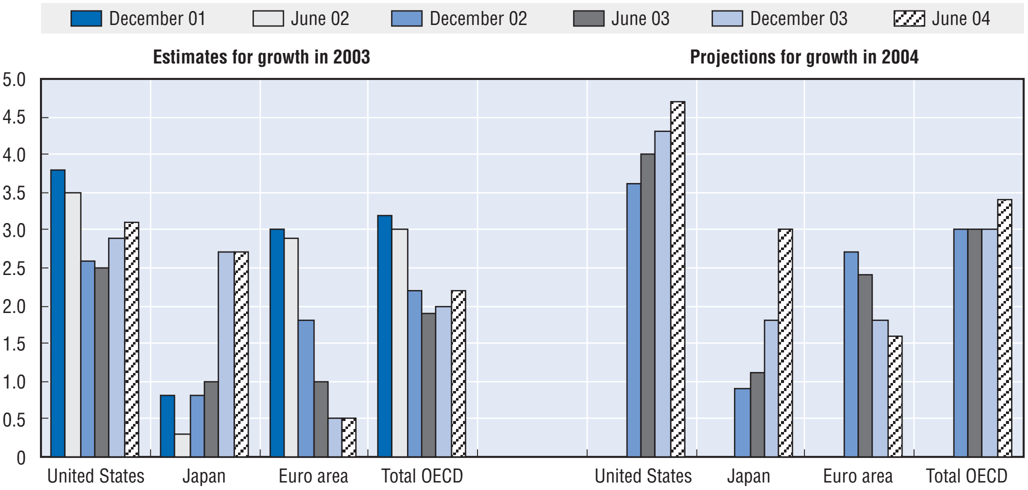
The outlook for the information and communication technology (ICT)[1] sector, ICT markets and ICT investment has improved markedly since the last *Information Technology Outlook* as prospects for OECD economies over the medium term have improved. After very low growth in 2001 (1.0% real GDP growth for total OECD, down from 3.9% in 2000), growth was stronger in 2002 (1.7% for total OECD), and rose in 2003 to 2.2%. The outlook is for growth of 3.4% in 2004 and slightly lower growth in 2005 (Figure 1.1), despite the risks from current account imbalances (large and growing deficits for the United States) and very large government budget deficits (–3.7% and –3.6% of nominal GDP for total OECD in 2003 and 2004 and –3.1% in 2005, with considerably higher deficits in Japan and the United States) (OECD, 2003c, 2004).

The improved growth outlook is already reflected in investment and consumption, including in ICT. Total gross fixed capital formation across the OECD area declined by 1.5% in 2001 and by 1.7% in 2002, but capital investment is now picking up, with growth of 2.4% in the OECD area in 2003 (although still declining in Europe) and a projected 5.1% in 2004 and 5.0% in 2005 (with Japan weakening). Gross non-residential fixed investment is growing even more strongly in Japan and the United States in 2004.[2] The pickup in investment is underpinned by strong and growing final domestic demand in all regions in 2004. The likely impacts on the ICT sector are:

- After a series of false starts since the sharp decline that began in 2000, ICT investment will continue to grow and drive the general recovery in investment, which is also sustained by domestic consumer demand.
- The recovery is likely to spread unevenly across ICT segments, with solid growth in business and consumer ICT investment goods (*e.g.* PCs, broadband, mobile communications) and continuing weakness in some investment goods (*e.g.* telecommunications investment, because of previous

Figure 1.1. **Revised estimates of GDP growth**

Annual real growth rates in percentages



Source: *OECD Economic Outlook*, Nos. 70 (Dec. 2001), 71 (June 2002), 72 (Dec. 2002), 73 (June 2003), 74 (December 2003), 75 (June 2004).

overinvestment in the United States and over-rapid expansion and purchase of third-generation (3G) licences in Europe; see OECD, 2003a). The upturn will vary among countries in line with the business cycle and consumer demand.

- There is some evidence that gross ICT investment may be slower than in earlier upturns as business and domestic demand for some ICT goods is close to saturation. In the absence of new technological breakthroughs, investment cycles are lengthening as businesses and consumers focus on making full use of their investment stock. New investment is likely to focus on complementary ICT assets such as broadband (see Chapters 3 and 4). In the business sector, demand for efficiency-raising business software and information technology (IT) services (mainly computer and software services[3]) is expected to be strong, and trends towards international sourcing and "offshoring" are expected to continue (see Chapters 2 and 6).
- Consumer ICT spending is showing strong growth in some segments, particularly for new products (*e.g.* DVDs, mobile phones with new digital imaging features, games and entertainment devices of all kinds). Many of these raise demand for semiconductors and new flat screen displays.
- Investment in ICT across the economy is likely to underpin business growth and structural change. In many respects, Solow's paradox (computers are everywhere but in the productivity numbers) is being resolved. ICT does appear to have led to productivity improvements, although these are contingent on complementary investments in skills, organisation and innovation. There are also other qualitative economic benefits, including networks between suppliers and better customer relations, notably *via* the Internet. ICTs are improving the efficiency of design and production, streamlining work organisation, making inventories and overheads more manageable, helping reduce routine transactions costs and rationalise supply chains, and more generally spurring wide-ranging changes in services. When aligned with firm strategies and combined with upgrading skills and organisational change, ICTs facilitate productivity-enhancing changes in new and traditional industries.

This chapter first describes trends in the ICT-producing sector, which has undergone a major slump and is now recovering, and then examines trade in ICT goods, software and ICT services, before turning to the overall contribution of ICTs to growth and performance

The ICT supply sector

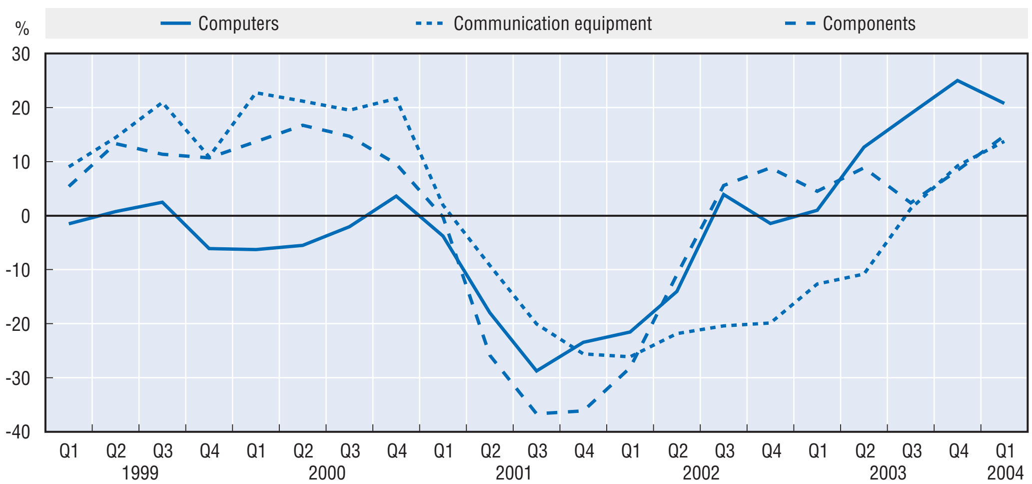
Recent developments

In 2004 there is an expanding upturn, particularly in the United States and in hard-hit hardware segments. This follows the dramatic downturn in the ICT sector that began in 2000. The slowdown that began in the United States and spread to Europe and other parts of the world was very strongly felt in the hardware side of the ICT sector, although telecommunications and IT services generally continued to grow. Excess capacity and over-investment have now been absorbed or firms have cleaned up their balance sheets, writing off liabilities particularly in telecommunications services (see OECD, 2003a). The stock market has re-evaluated technology stocks upwards, including the surviving Internet firms, and the top ICT and Internet firms increased revenues in 2003 and became profitable again after a disastrous 2002 (see Annex A). New products have boosted sales and there are signs that the ICT business investment cycle has turned up, although the replacement cycle appears to have lengthened. Finally, supply-side efficiencies are resulting in greater responsiveness among surviving firms, while on the demand side, business investment has strengthened, driven in part by continuing strong consumer demand in the United States and strengthening consumer demand in Europe and Japan.

Recent data for the United States (Figure 1.2) shows that the three main ICT equipment areas have now recovered from the slump of 2001 or begun to recover. Computers showed positive year-on-year growth throughout 2003 as demand strengthened. The fourth quarter 2003 had the fastest year-on-year growth rate in the past four years and first quarter 2004 was almost as strong. While the components sector suffered the deepest trough, it also recovered the most rapidly, although the pace has fluctuated. Finally, the communications equipment sector showed positive growth from the third quarter of 2003 although from low levels and is on an upward trend.

Figure 1.2. **Quarterly shipments of ICT goods by segment in the United States, 1999Q1-2004Q1**

Year-on-year growth, percentages

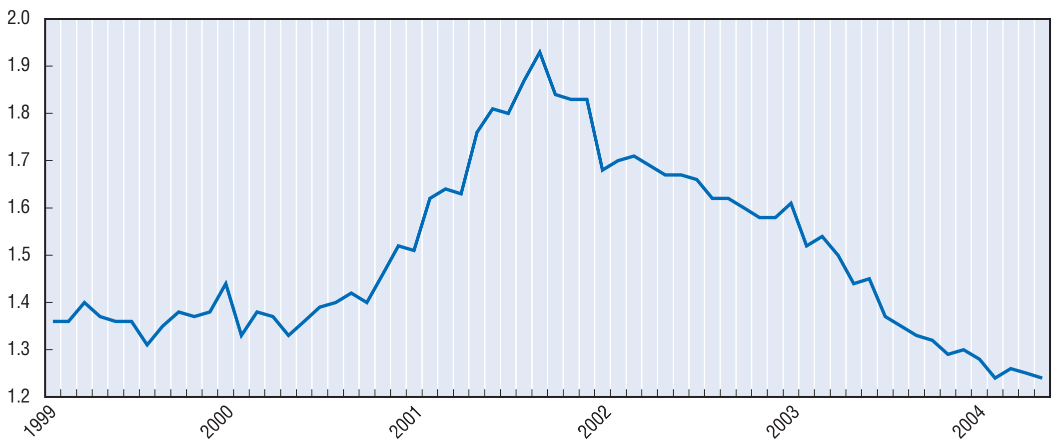


Source: OECD, based on US Bureau of the Census, Manufacturer's Shipments, Inventories and Orders (M3) survey, June 2004. *www.census.gov/indicator/www/m3/.*

The positive outlook for recovery of the ICT sector in the United States is reinforced by data on the inventories-to-shipments ratio for computer and electronic products, which show a continuing relative downward trend in inventories, suggesting that the industry continues to improve (Figure 1.3). In addition, monthly layoffs in the computer and electronic products industry, which reached a peak in 2001, continue to decline and are now back to levels of the late 1990s and 2000 (Figure 1.4).

Moreover, except in 2001 investment in the United States in information processing equipment and software has contributed positively to real private fixed investment, unlike investment in structures and non-ICT equipment, and appears to be leading the US recovery, as Figure 1.5 shows. US data show that non-farm business productivity growth remained remarkably strong throughout the recession and

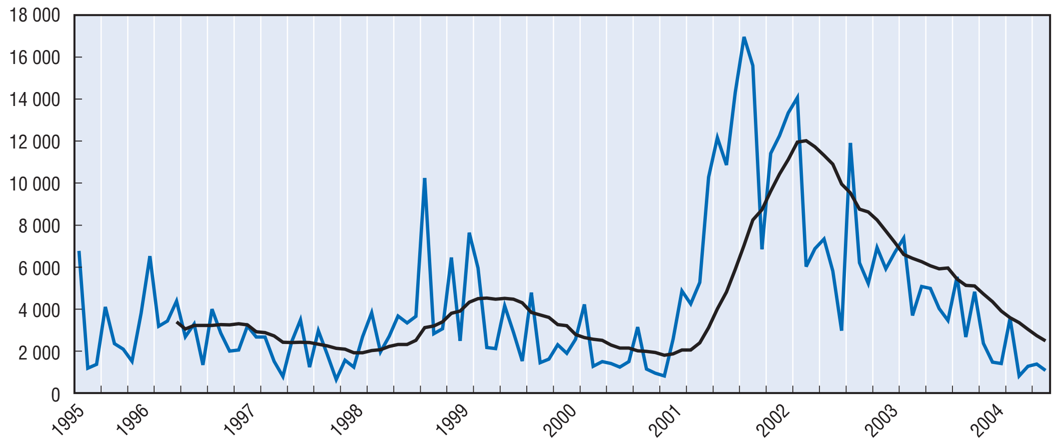
Figure 1.3. **Monthly inventories-to-shipments ratio for computer and electronic products in the United States, January 1999 to April 2004**



Source: US Bureau of the Census, M3 Survey, 2004.

Figure 1.4. **Monthly layoffs in the US computer and electronic products industry, April 1995-May 2004**

Total initial claimants and 12-month moving average

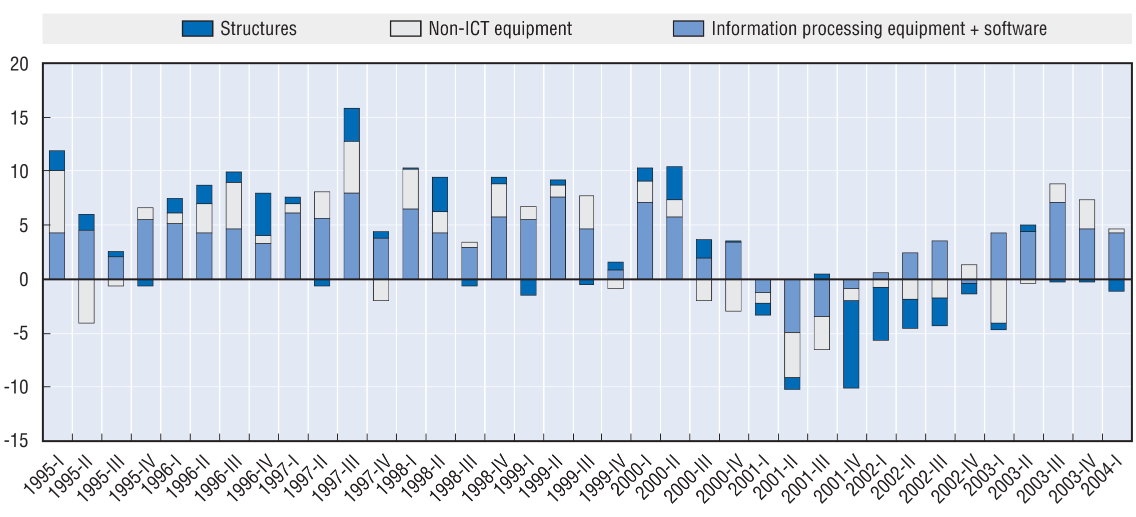


Source: US Department of Labor Statistics (BLS), Mass Layoff Statistics, March 2004, *www.bls.gov/home.htm.*

recent upturn, an indication that ICT investments along with other factors are bringing continuing economic benefits (see below and *Digital Economy* 2003).

Outside the United States, the recovery in the ICT sector has remained somewhat more muted. Figure 1.6 shows recent Canadian data on output of the ICT sector by segments. The crisis in the ICT manufacturing sectors (equipment and components) in 2001 was not shared with the ICT services sector, which increased steadily over recent years. While computers and electronic components began to recover from early 2002, albeit to levels below their peaks, communications equipment remains at low levels.

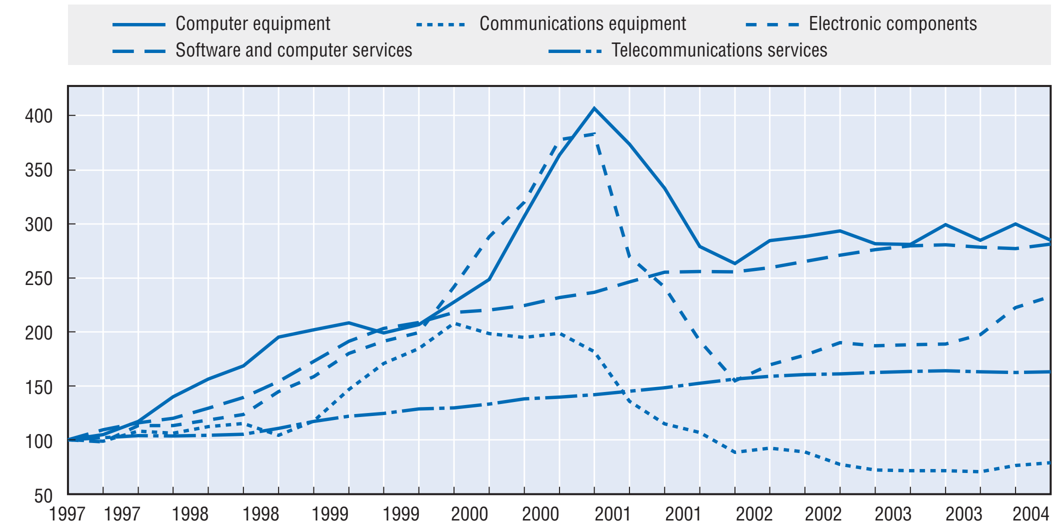
Figure 1.5. **Contributions to percentage change in quarterly real private fixed investment by type in the United States, 1995Q1-2004Q1**



Source: Bureau of Economic Analysis (BEA), National Income and Product Accounts (NIPA) tables, June 2004. *www.bea.doc.gov/bea/dn/nipaweb/index.asp.*

Figure 1.6. **Recent trends in output in the Canadian ICT sector**

Index: 1997Q1 = 100

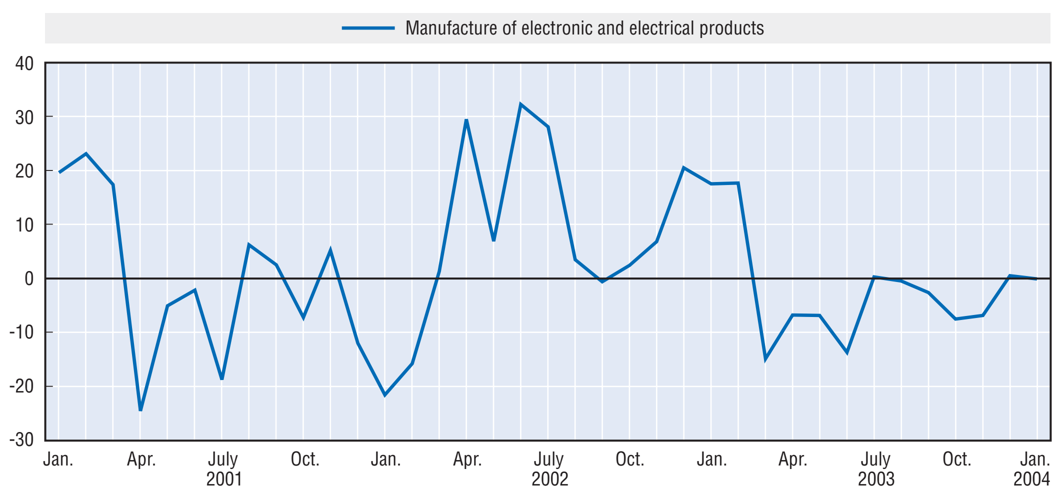


Source: Industry Canada, Quarterly Monitor of the Canadian ICT Sector, First Quarter 2004, June 2004.

According to data from two major European ICT-exporting countries, Finland and Ireland, the upturn has been slower in arriving in Europe. In Finland, manufacturing of electrical and optical equipment suffered a new decline in 2003, although not of the scale of that of 2001 (Figure 1.7). The volume index of monthly output exhibited negative year-on-year growth rates from March 2003 to November 2003, followed by two months of slightly positive growth, before a new slump in February 2004, when the volume of output was nearly 7% lower than a year earlier.

Figure 1.7. **Monthly output in the electronic and electrical products manufacturing sector in Finland, January 2001-February 2004**

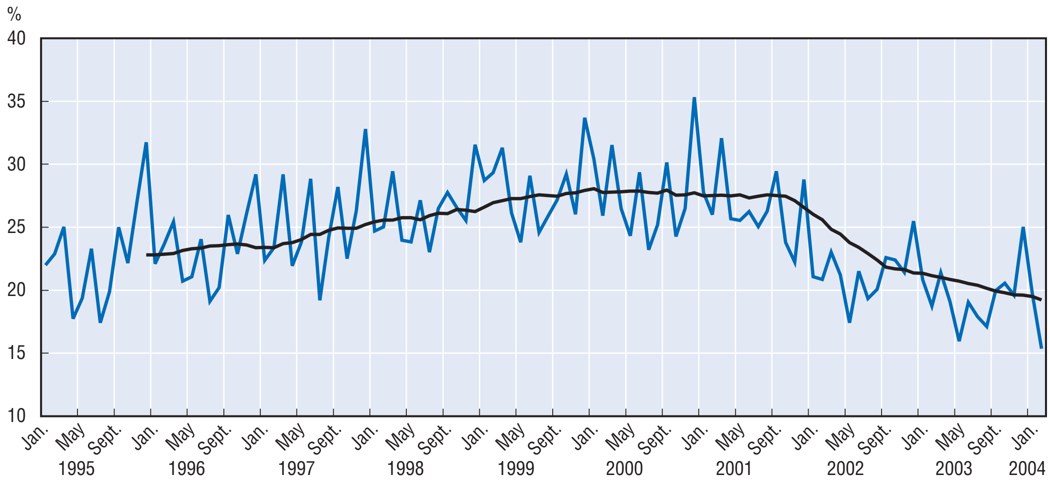
Year-on-year percentage change, seasonally adjusted series



Source: Statistics Finland, Volume Index of Industrial Output.

Figure 1.8. **Monthly exports of ICT goods (NACE 30 + 32) in Ireland, January 1995-February 2004**

As a percentage of total exports and 12-month moving average



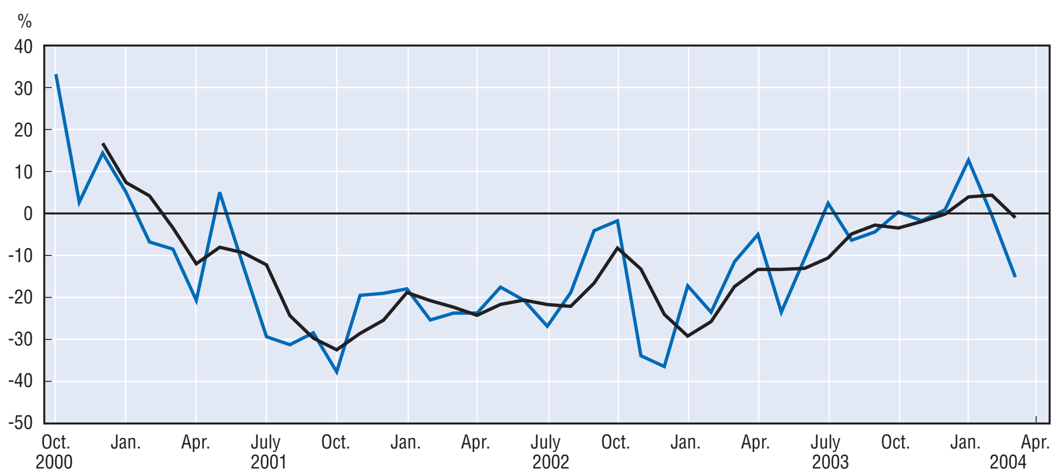
Source: Central Statistics Office (CSO) Ireland, TSAM-Trade: Imports and Exports by Section/Division (Monthly), June 2004. Available at: *www.eirestat.cso.ie/TSAMvarlist.html.*

For Ireland the share of ICT goods in total exports has not yet recovered to levels achieved prior to the beginning of the decline in 2001. It is on average at the lowest level observed since the mid-1990s (Figure 1.8), although computer and information services exports from Ireland have grown very strongly in recent years (see section on trade below).

Finally, recent data indicate that the picture has improved in Japan (Figures 1.9 and 1.10). Monthly production of computer processors is recovering slowly, with year-on-year growth positive at the end of 2003, and is on an upward trend on average. IT services show a similar picture, but without the

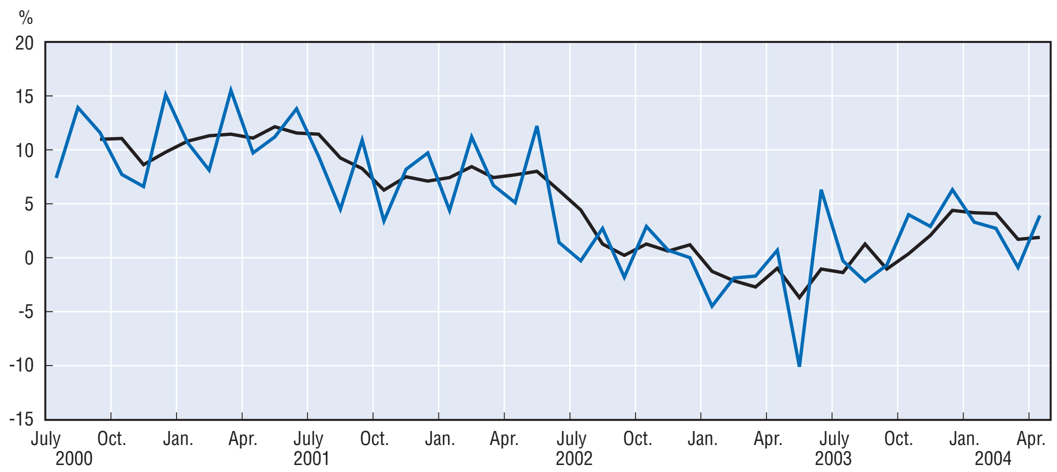
Figure 1.9. **Growth of monthly production of computer processors in Japan, October 2000-March 2004**

Year-on-year variation and three-month moving average



Source: METI, Monthly Statistics of Japan, June 2004.

Figure 1.10. **Growth of monthly sales by IT services industries in Japan, July 2000-April 2004**
Year-on-year variation and three-month moving average



Source: Japan Information Technology Services Industry Association (JISA), METI Monthly Survey on IT Services Market, June 2004. *www.jisa.or.jp.*

dramatic decline shown in hardware. By April 2004 year-on-year sales by IT services industries had been mostly positive for nine months and showed a reversal of the downward trend started in 2001.

Forecasts from private sources have also reflected the more positive outlook. At the end of 2003 they all cautiously foresaw growth in 2004 and 2005, after a return to growth in 2003 (Forrester, 2003; Gartner, 2003a; IDC, 2003). Globally in 2003, IT markets in the United States and emerging markets were growing, but declines continued in Europe, Japan and Canada. IT services and software had picked up steadily, while IT hardware revenues remained flat as price competition kept prices low. Telecommunications services continued to grow, particularly data services, and telecommunications equipment was expected to turn up in 2004. The outlook was for a more general upturn in 2004 as business confidence improved, with worldwide market growth in nominal terms of 5% for IT and 4% for telecommunications (IDC, 2003). The picture was similar for the United States, with single-digit overall IT market growth, coupled with major supply-side restructuring and shifts in skill requirements (Gartner, 2003a) and ongoing interest in security and risk-reduction systems and renewed interest in consumer-related systems (e-commerce) and support (e-business) (Forrester, 2003). Actual performance in 2004 has also been positive; previously sluggish IT hardware expenditures in Europe picked up (Gartner, 2004), software and server sales grew in the United States, and better e-commerce performance is underpinning e-business systems investment generally (*The Economist*, 2004).

Performance of major ICT firms

The recent performance of the leading ICT firms reflects the sharp downturn and the recovery affecting many ICT market segments. Fortunes are mixed, with some sectors performing better than others and some firms prospering while others have experienced difficulties. Overall, however, the revenues of the largest ICT firms have held up well over the last four years through 2003, although profitability slipped badly and is only now recovering (for more detail on the leading ICT firms, see Annex A).

The top 250 ICT firms earned total revenue of USD 2 420 billion in 2003, some USD 50 billion more than in 2000 (tracking the same panel of 250 firms over time). Average revenue among the top 250 was almost USD 9.7 billion. In 2002, the top 250 employed around 9.4 million people worldwide and

8.9 million in OECD countries, compared with just over 17 million in the entire ICT sector. The top 250 firms' revenues have been remarkably stable over the last four years, with a high of USD 2 368 billion in 2000 and a low of USD 2 302 billion in 2002, before recovering to USD 2 420 billion in 2003. Employment among the top 250 firms was some 480 000 lower in 2002 than in 2000.

The firms at the top of the revenue rankings in 2003 performed somewhat better than those lower down, suggesting an increase in industry concentration. Revenues of the top 10 firms were 3.7% a year higher in 2003 than in 2000, whereas total revenues of the top 250 ICT firms in 2003 were 0.75% higher than in 2000, the top 100 were 1.1% a year higher, and the top 50 2.0% a year higher.

Top 250 firms headquartered in the United States have close to 40% of the OECD share of activities measured by revenues and employment, and the European Union and Japan around one-quarter each. In 2003, 25 countries served as the bases (*i.e.* the country in which the firm is registered) for the top 250 ICT firms: 139 (56%) were based in the United States, 39 in Japan and 11 in Chinese Taipei. No other country had more than ten. There are some signs of a shift towards Asia, with 11 fewer US-based firms in the 2003 panel than in the 2001 panel, and five more in Chinese Taipei, three more in China, two more in India and one more in both Korea and Singapore.

Firm performance across countries has been mixed in recent years. Top 250 firm revenues declined in seven countries between 2000 and 2003 and increased in the other 18. Those based in Canada experienced an 11% revenue decline over the three years to 2003, firms based in Sweden experienced an 8% decline, and firms based in the Netherlands, Mexico and Israel experienced declines of around 3.5%. In contrast, firms based in India experienced a 34% a year increase, those based in Norway a 26% increase, those based in Singapore a 24% increase, and those based in Chinese Taipei a 17% increase.

Since the first top 250 list was compiled in 2001, the number of electronics, equipment and systems producers has declined and the number of services providers has increased. By sector in 2003, 33% were electronics and components manufacturers, 19% were IT equipment and systems producers, 15% were telecommunication services providers and 15% were IT services providers, 10% were software publishers and 8% were communication equipment and systems producers.

The software, IT services and telecommunications sectors all increased revenues by 5% a year or more between 2000 and 2003. IT equipment and systems firms have seen revenues climbing back to 2000 levels. Revenues fell by 12% a year over the same period among communications equipment firms, while those of electronic components firms fell marginally. The picture is similar for employment. Among the top 250 firms over the period 2000-02, employment grew by 4% a year in the IT services firms. Employment was steady in software and telecommunications, but other sectors shed jobs. In communications equipment firms, employment fell by almost 19% a year.

The firms that recorded R&D expenditure spent a total of around USD 125 billion, or 6.8% of revenue on R&D. Although data are incomplete, it is clear that most of the top 250 ICT firms' R&D is undertaken by electronics and components firms (44%), IT equipment and systems firms (20%) and communications equipment firms (20%). R&D expenditures by software and telecommunications services firms increased more rapidly over the period 2000-02, by 4.6% and 2.4% a year, respectively. In 2002, communication equipment firms in the top 250 reporting R&D expenditure spent almost 16% of revenue on R&D, software firms spent 15%, electronics and components firms 7.3%, IT equipment and systems firms 6.4%, IT services firms 3.0% and telecommunications services firms less than 2.0% (see Figure 1.19). No doubt R&D expenditure shares are bolstered to some extent by cyclically lower revenues, most notably among communications equipment and systems firms. Nevertheless, high levels of technological innovation continue to characterise the ICT-producing sector.

In 2003, the top 50 Internet firms earned combined revenues of USD 46.7 billion and realised a net loss of USD 2 billion. These firms employ around 200 000. The Internet top 50 are relatively top-heavy in revenue terms, with the top 25 earning 92% of the total top 50 revenues in 2003, the top 10 earning 70% and the top 5 earning 53%. The top 5 Internet firms employed 58% of all top 50 employees, the top 10, 70% and the top 25, 89%. Between 1998 and 2003, the top 50 Internet firms' revenues increased by 23% a year. Unlike the top 250 ICT firms, the larger Internet firms grew more slowly than the smaller ones. Combined Internet top 50 net income peaked in 1999 at USD 520 million, before falling to a combined net loss of USD 44 billion in 2001 and almost as much in 2002.

The listing of the largest 250 firms in 2003 captures only the winners, but the resilience of revenue performance and the relatively rapid return to profitability among the top ICT and Internet firms is striking. Nevertheless, among the top 250 ICT firms, employment fell by around 5% between 2000 and 2002, and it remains to be seen whether the return to revenue growth and profitability in 2003 will be matched in the medium term by aggregate employment growth in the highly competitive environment.

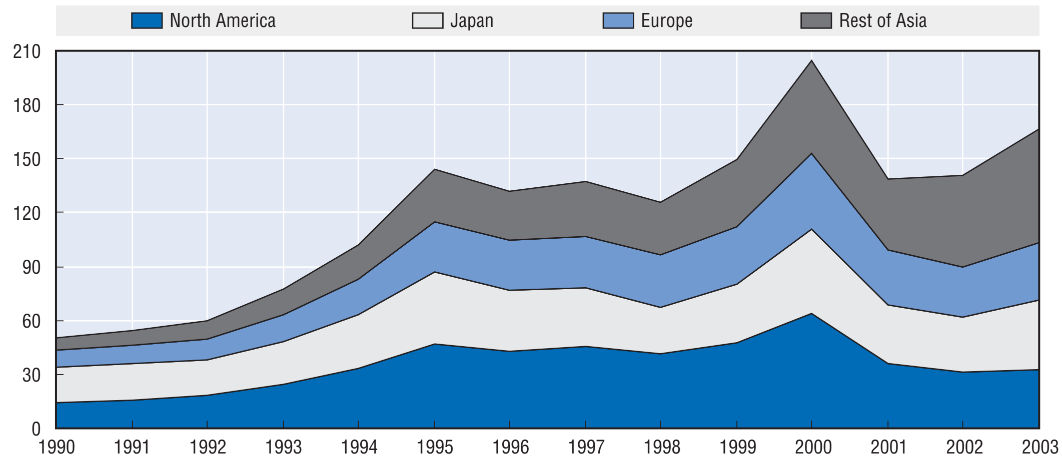
Semiconductors

Semiconductors are a key intermediate input into ICT equipment. They are a leading indicator of ICT market trends; semiconductor production suffers during a downturn and recovers quickly in an upturn (see Figures 1.2 and 1.6). The level of demand for, and the rate of adoption and incorporation of, new semiconductor products is a key driver of ICT equipment prices and productivity in the ICT manufacturing sector. The global upturn in semiconductors suggests that a recovery from the downturn is well under way.

Between 1990 and 2000 the world market for semiconductors grew from USD 50 billion to more than USD 200 billion, or by 15% a year (in current USD) (Figure 1.11). In 2000, worldwide semiconductor sales increased by 37% in current terms, but 2001 brought a dramatic collapse, with sales down by 32% to less than USD 140 billion. Since then, sales have rebounded, rising by 1.3% in 2002 and by 18.3% in 2003 to USD 166 billion. However, performance varies significantly among countries, regions and devices.

Over the period 1990-2003, worldwide semiconductor sales increased by 9.5% a year. Asia, excluding Japan, was the fastest-growing regional market (at more than 18% a year), followed by Europe (9.6% a year), North America (6.3%) and Japan (5.3%). All regions participated in the boom of 2000, with markets in Japan and the rest of Asia growing somewhat faster than those in Europe and North America. The downturn in 2001 was felt most severely in North America, with a drop of more than 44%; Japan and Europe had declines of around 30% and the rest of Asia of a little more than 20%. The rest of Asia led the recovery in 2002, growing by 28%, while all other regions continued to decline – Japan and Europe by around 8% and North America by more than 12%. Data for 2003 reveal an uneven return to growth, with

Figure 1.11. **Worldwide semiconductor market by region, 1990-2003**
USD billions



Source: OECD, based on World Semiconductor Trade Statistics (WSTS).

the Japanese market growing by 28% and the rest of Asia by 23%, while growth has been slower in Europe (16%) and North America (3.4%).

Over the period 1990-2003, sales of microprocessors, ASICS and linear devices have increased most rapidly, while sales of other devices have experienced below average growth (Figure 1.12). Both the downturn and recovery have been felt across all product groups.

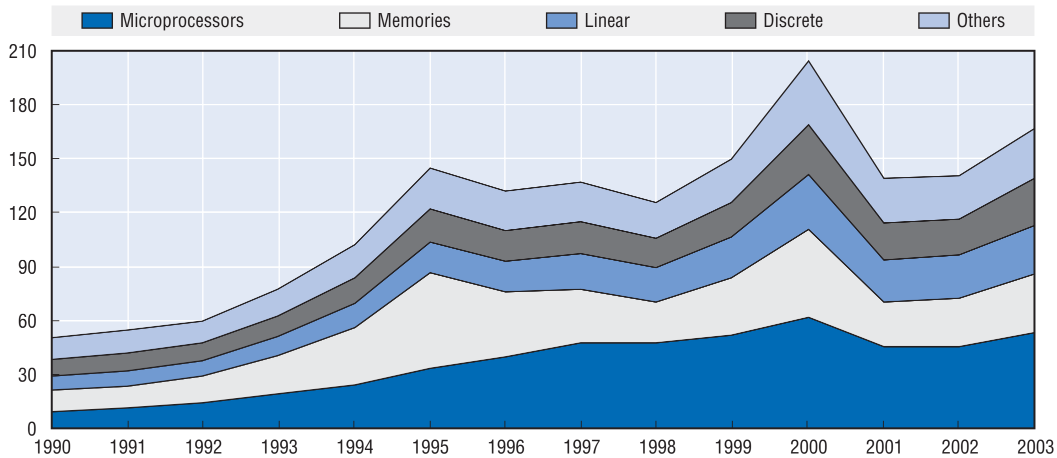
Since 1990, the computer, telecommunications and automotive semiconductor markets have increased their share of worldwide semiconductor sales, while the consumer, industrial and, perhaps surprisingly, military markets have lost share, although new consumer products (*e.g.* DVD, flat screen TV, new music devices) are now boosting consumer applications (Figure 1.13). The computer segment now accounts for 46% of worldwide semiconductor sales and telecommunications for 22%, making the ICT sector itself the major driver of semiconductor sales and those sales a leading indicator of the ICT hardware market.

Over the decade to 2000, telecommunications was the fastest-growing end market for semiconductors at 22% a year, and growth was also strong in the computer and automotive segments (at 16.4% and 15.3% a year, respectively). In 2000, the telecommunications segment increased by almost 58%. With the collapse in 2001, the computer segment (down 38%) and the telecommunications segment (down 34%) were the most severely affected; the consumer electronics segment also fell by 30%. However, the computer segment rebounded in 2002, and all product groups grew in 2003, including telecommunications by 26% and computer by 17%.

Demand for semiconductor production equipment reflects projections of semiconductor capacity utilisation and demand and is an indication of what semiconductor firms expect for future sales and the outlook for ICT hardware. Gartner (2003b) divides semiconductor capital equipment into two, wafer fabrication equipment (WFE) and packaging and assembly equipment (PAE). Capital equipment expenditure declined in 2002 by around 30% for WFE and 20% for PAE, followed by a stable 2003 for WFE and sales growth of 20% for PAE in 2003. For 2004, Gartner projects a return to growth as fabrication capacity utilisation rises above 85%, with the market for WFE and PAE expected to increase by around 30% to USD 21 billion and USD 4 billion, respectively. Such projections continued the recovery in semiconductor sales foreshadowed in 2004, leading the ICT hardware sector as a whole.

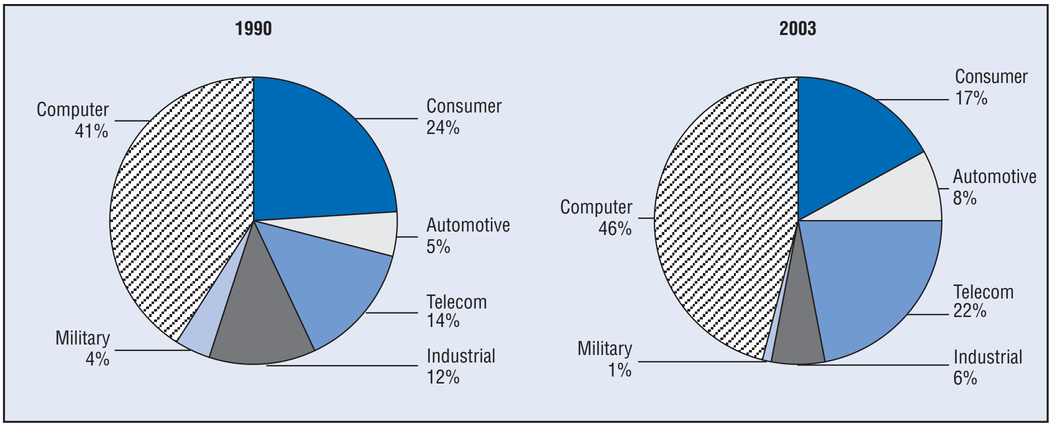
Figure 1.12. **World-wide semiconductor market by product group, 1990-2003**

USD billions



Source: OECD, based on World Semiconductor Trade Statistics (WSTS).

Figure 1.13. **Worldwide semiconductor market by application (end use) 1990-2003**
Percentages



Source: OECD, based on World Semiconductor Trade Statistics (WSTS).

Structural change in the ICT *sector*

Longer-term prospects for the ICT sector remain good despite the prolonged cyclical downturn. New goods and services will drive demand from businesses, households and governments; replacement ICT investment will help boost demand; and IT services are underpinned both by the expanding use of software and the increasing recourse to outsourcing IT services and ICT-enabled services. This section analyses the ICT supply side (value added, employment and production,) and ICT employment across the economy, relying on official data and OECD definitions of the ICT sector wherever possible (see Annex B; and OECD, 2002a).

Value added

Value added in the ICT sector has grown strongly over an extended period, with strong and sustained growth in ICT services, particularly telecommunications services and software. This has increased the sector's share in value added in all OECD countries, despite the downturn from 2000 in some manufacturing segments (*e.g.* computers, telecommunications equipment). The ICT sector (manufacturing plus services) contributed close to 10% of business sector GDP in 2001, against only 8% in 1995. The share varies from 5% to 16.4% in individual countries (Figure 1.14*a*). Finland has the largest ICT-producing sector relative to GDP, followed by Ireland.

Following the ICT manufacturing downturn of 2000, Finland is the only OECD country in which manufacturing is larger than services. Finland, along with Korea and Ireland, are the three countries with the largest ICT sector (manufacturing plus services) as a share of business sector GDP. In most countries, the relative share of the ICT manufacturing sector in total manufacturing is slightly lower than in 1995, but in Finland it increased by 13.4% in the period 1995-2001 and now represents around 8% of business sector value added, largely owing to the rapid growth of Nokia, the telecommunication equipment manufacturer.

In Ireland, the only OECD country in which ICT manufacturing activities are the most markedly oriented towards computer and related equipment (more than 45%), the ICT manufacturing sector has also grown rapidly but was significantly affected by the downturn in 2001 (Figure 1.14*b*). Almost 23% of Finnish manufacturing industry value added and more than 13% of Irish manufacturing value added came from ICT-producing industries, compared with around 13% and 11% in Japan and the United States, respectively. The Czech Republic and Mexico also had increases of about 2 percentage points in the share of ICT manufacturing in total manufacturing. Japan had a larger manufacturing sector in 1995 but strong growth in telecommunication services shifted the balance. The downturn reduced ICT

Figure 1.14*a.* **Share of ICT value added in business sector value added, 1995 and 2001**

Percentages

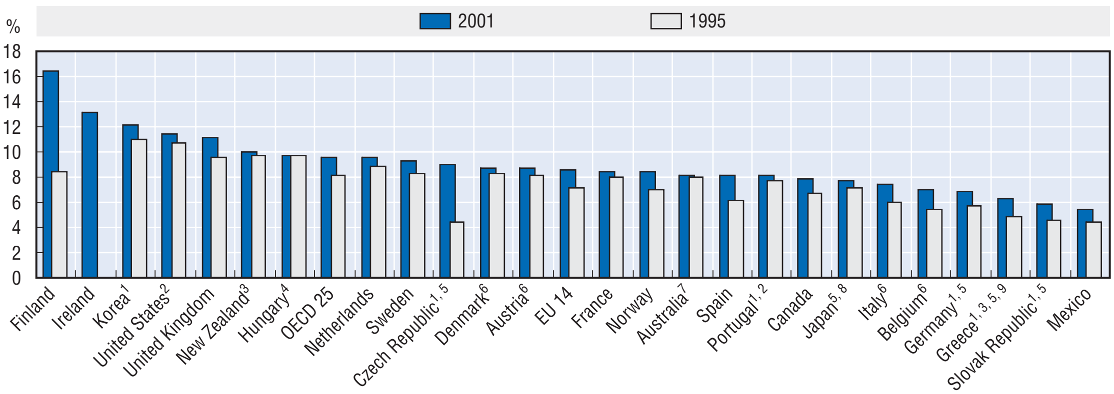


Figure 1.14*b.* **Share of ICT manufacturing in total manufacturing value added, 2001**[9]

Percentages

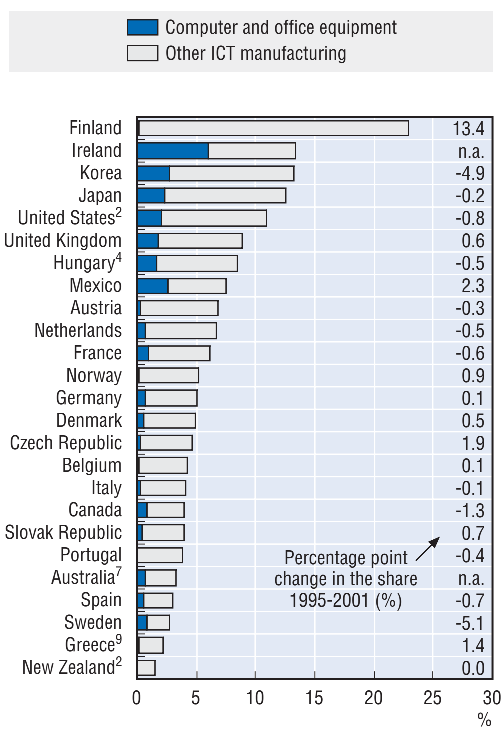
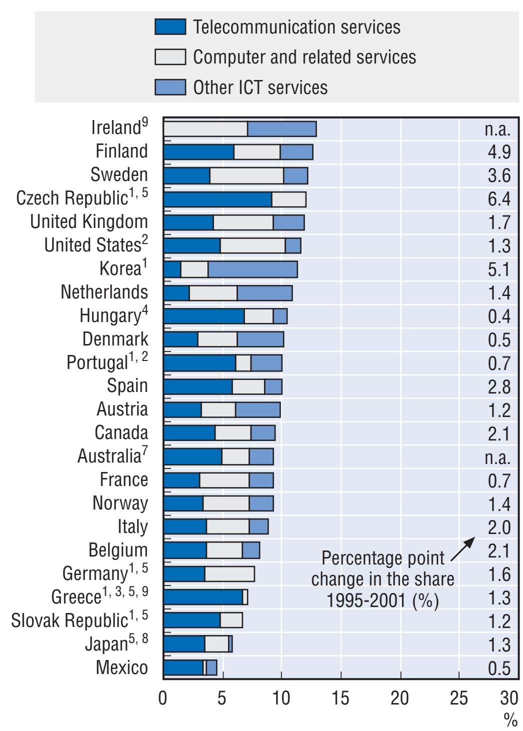


Figure 1.14*c.* **Share of ICT services in total business services value added, 2001**[9]

Percentages



1. Rental of ICT goods (7123) is not available.
2. 1996 instead of 1995.
3. Postal services included with telecommunication services.
4. 1998 instead of 1995.
5. ICT wholesale (5150) is not available.
6. 2002.
7. 1998/99 and 2000/01 instead of 1995 and 2001 respectively.
8. Includes only part of computer related activities (72).
9. “Other ICT manufacturing” includes communication equipment, insulated wire and cable and precision instruments, except for Greece, with communication equipment only. “Other ICT services” includes wholesale and rental of ICT goods, except for Ireland, where telecommunication services are also included.

Source: OECD estimates, based on national sources; STAN and National Accounts databases, March 2004.

manufacturing to around the 1995 level in half of OECD countries, whereas in 2000 the relative size of ICT manufacturing had slightly increased compared to 1995 in most OECD countries. G7 countries, Korea, the Netherlands and Sweden were notably affected by the downturn. Finland was the only country where its share increased between 2000 and 2001, by more than one percentage point.

ICT services account for more than two-thirds of the overall ICT sector in terms of value added in most OECD countries (Figure 1.14*c*). In all countries, the sector increased its share of services value added. In three-quarters of the OECD countries for which data are available, its share has increased by more than one percentage point since 1995. Its share grew strongly in Korea, Finland and G7 countries, and in more than two-thirds of countries in 2001, the ICT services industries accounted for over 9% of business services value added. Their share is highest in Ireland, where in 2001 almost 13% of business services value added originated from ICT services, mainly owing to very large foreign investment in computer and related services (software). Finland, Sweden and the United Kingdom are also highly specialised in ICT services industries and have increased the share of ICT services in total services, ahead of the United States. The Czech Republic and Hungary, with high relative shares of telecommunication services, have also seen rapid relative growth in ICT services.

Employment and labour productivity

In 2001 more than 17 million were employed in the ICT sector, or around 6.3% of total business sector employment, in the 23 OECD countries for which data are available. The United States accounted for around one-third of the total, the European Union for around 37% and Japan for 15%; the G7 countries alone accounted for more than three-quarters. Only the Czech Republic, Hungary, Japan, Mexico and Korea employed more people in ICT manufacturing than in ICT services. In more than three-fifths of countries, more than seven out of ten ICT employees worked in services activities.

The ICT sector has been a major source of employment growth, with an average annual rate of over 4% and a net addition to employment of over 3.5 million people in the 1995-2001 period. In all OECD countries except Portugal, employment in the ICT sector increased in relative terms between 1995 and 2001, most notably in Denmark, Finland, Sweden, Hungary, the Netherlands and the United Kingdom.

Employment in ICT manufacturing tended to be stable or increase slightly between 1995 and 2001 except in Germany, Japan, Portugal and the United Kingdom (Figure 1.15*a*). The share of ICT manufacturing in total manufacturing employment increased slightly in most countries owing to a decrease in overall manufacturing employment (Figure 1.15*b*). ICT manufacturing employment grew very strongly in Finland, Mexico and Hungary, and relatively dynamically in Canada and Norway.

Figure 1.15*a*. **Share of ICT employment in business sector employment, 2001**

Percentages

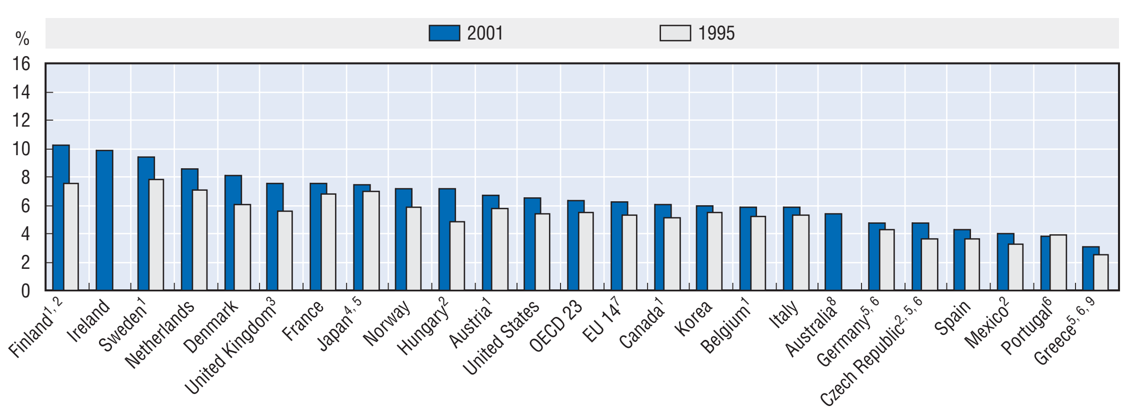


Figure 1.15*b.* **Share of ICT manufacturing in total manufacturing employment, 2001**

Percentages

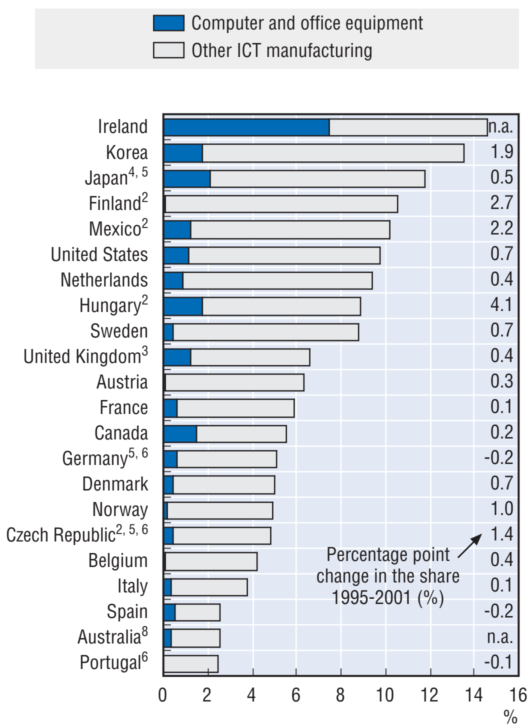
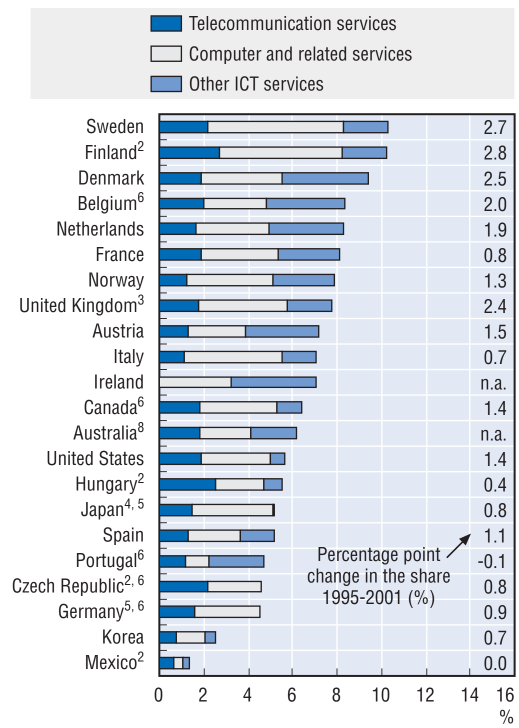


Figure 1.15*c.* **Share of ICT services in market services employment, 2001**[10]

Percentages



1. 2002.
2. Based on employees figures.
3. Excludes self-employees.
4. ICT services include market research and public opinion polling.
5. ICT wholesale (5150) is not available
6. Rental of ICT goods (7123) is not available.
7. Luxembourg not included.
8. 2000-01.
9. ICT manufacturing include ISIC 30 and 32 only, and postal services are included with telecommunication services.
10. "Other ICT manufacturing" includes communication equipment, insulated wire and cable and precision instruments. "Other ICT service" includes wholesale and rental of ICT goods, except for Ireland, where telecommunication services are also included.

Source: OECD estimates, based on national sources; STAN and National Accounts databases, March 2004.

Employment in ICT services has grown very strongly everywhere except in Mexico and the Czech Republic, at close to five times the annual rate of the overall business sector, with growth in computer and related services particularly strong. Annual employment growth in ICT services has been around 6.2% and over 16% in Finland, Korea, the Netherlands, Spain and the United Kingdom. The share of ICT services in market services employment reached almost 6% in 2001 (Figure 1.15*c*).

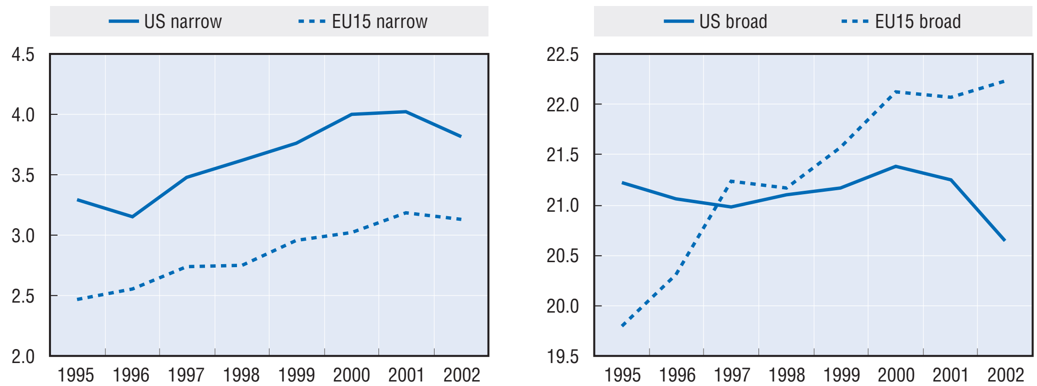
Labour productivity (value added per employee) in the ICT sector grew rapidly during the 1990s in countries for which detailed data are available, most notably in ICT manufacturing, but manufacturing labour productivity declined sharply in 2001 with the steep drop in ICT manufacturing output. Labour productivity in telecommunication services has shown a steady upward trend paralleling its regular growth.

ICT *employment across the economy*

ICT-related employment is spread widely across all sectors of the economy. The above employment data show total employment in the ICT sector only. They include occupations that are unrelated to ICT activities *per se*. In Chapter 6, two new measures of ICT employment are developed to cover workers who use ICTs intensively in their work and at various skills levels across all economic

Figure 1.16. **Share of ICT specialists and ICT users in total employment United States and EU15, 1995-2002**

Percentages



Note: See text for definitions.
Source: OECD, based on EULFS and US Current Population Survey (2003).

sectors. The first measure corresponds to a narrow definition of ICT-skilled employment: "ICT specialists", those whose jobs solely concern ICTs (programmers, software engineers, etc.). The second, broad definition comprises "ICT users" who use ICTs intensively as a tool in order to produce their own output which includes the ICT specialists but is much wider (see Chapter 6 for further details).

The share of ICT specialist employment according to the narrow definition has increased over time for European Union 15 (EU15) countries except Portugal, Spain and the United Kingdom, with an average overall increase of 0.5 percentage points between 1992 and 2002. In 1992, the share was between 1.9% (Greece) and 3.5% (Netherlands) of total employment. By 2002, it was between 2.4% (Greece) and 5% (Sweden). On the broader measure, ICT user employment also increased overall as a share of total employment for nearly all countries, except France and the United Kingdom. In 1992, the shares ranged from 10.6% (Greece) to 27.6% (United Kingdom) and in 2002 from 13.5% (Portugal) to 27.6% (United Kingdom). Most countries saw an increase of between 2 and 6 percentage points.

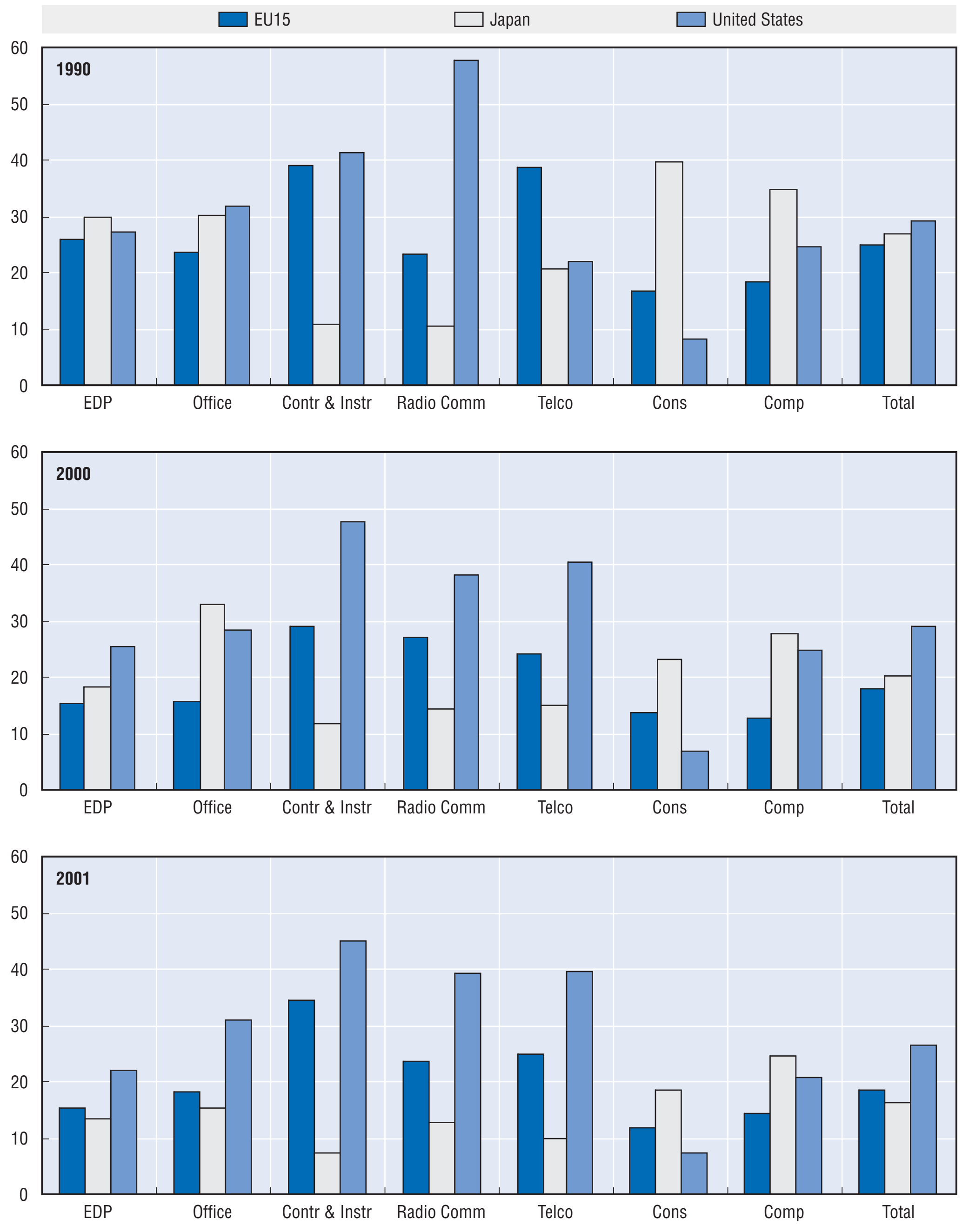
Figure 1.16 shows the evolution of the two measures for the United States and EU15, even though the definitions for narrow specialist and broad user ICT employment are not strictly comparable. The share of narrow ICT employment in the United States fluctuated over the period 1995-2002, with a minimum of 3.1% in 1996 and a maximum of 4.0% in 2000 and 2001, and accounted for 3.8% of total employment in 2002. In the EU the pattern is similar, although at a lower level.[4] The share of broad ICT employment in the United States decreased gradually over the first three years of the period, from 21.2% to 21.0%, increased to a high of 21.4% in 2000, and declined thereafter to 20.6% in 2002. Broad ICT employment in the EU15 shows a rather different picture, starting off from a lower level (19.8%), but surpassing the United States as of 1997, and resulting in 2002 in a gap of 1.6 percentage points, when the EU15 share stood at 22.2%. Overall these estimates show the importance of ICT-related occupations across the whole economy and the necessity of looking at ICT-related activities more broadly.

Production of ICT *goods*[5]

The location of ICT manufacturing has shifted markedly over time. This section examines structural changes in the ICT goods-producing sector, with particular attention to the shifts in shares of the world's producing regions. In 1990, EU15, Japan and the United States accounted for 81.1% of global ICT goods production (Figure 1.17). In 2000, their combined share had slipped to 67.5% and in 2002 to 61.2%, mainly owing to the increase in the share of China and some other Asian countries. In nominal terms, global ICT production increased from around USD 665 billion in 1990 to USD 1 262 billion in 2000, before declining to around USD 1 032 billion in 2001 and USD 968 billion in 2002 (Reed Electronics Research, 2003). In 2002, the United States and Japan accounted for the largest individual shares of total ICT production (26.5% and

Figure 1.17. **Share of world ICT production accounted for by EU15,[1] Japan and the United States, in 1990, 2000 and 2002**

Percentage of total output in current USD, by sector



Abbreviated sectors stand for: Electronic data processing, Office equipment, Control and instrumentation, Radio communications (including mobiles) and radar, Telecommunications, Consumer audio and video, Components, and Total ICT.

Note: The shares are calculated in current USD, and relative exchange rates (strong USD in 2000-01) will have a large short-term influence on calculations of relative shares of ICT production.

1. No data were available for Greece, Luxembourg and Portugal in 1990. Luxembourg is also not available for the other years.

Source: Reed Electronics Research, various years.

16.3%, respectively, compared to 29.1% and 27%, respectively, in 1990). Within the European Union, Germany had the largest share of global production (4.4%), followed by the United Kingdom (3.9%), France (2.9%) and Ireland and Italy (1.5% each). Among Asian countries other than Japan, the largest shares were held by China (12.2%), Korea (6.2%), Chinese Taipei (4.0%), Malaysia (3.9%) and Singapore (3.7%). In Latin America, Brazil had the largest share of global production (1.2%). These shares were considerably higher than in 1990 for Ireland and the Asian countries in particular (China accounted for only 1.8% in 1990).

In 2002, the largest share of total ICT production went to components (29.6%), followed by electronic data processing (29.3%) and radio communications (including mobiles) and radar (16.5%). In 1990, electronic data processing accounted for the largest share (26.8%), followed by components (25.4%) and radio communications (including mobiles) and radar (13.2%).

In 1990, EU15, Japan and the United States, together accounted for over 91% of production in radio communications (including mobiles), radar (91.4%) and control and instrumentation (91.2%). The last was also the industry in which these countries maintained their share most successfully in both 2000 and 2002 (88.3% and 86.9%, respectively). In contrast, they accounted for a much smaller share of consumer audio and video output (64.4% in 1990, 43.8% in 2000, and 37.7% in 2002).

As Figure 1.17 also shows, the overall rankings of the three geographical entities have remained more or less constant, despite some variations in individual shares, with the notable exception of the telecommunications sector, which Europe had dominated in 1990 but lost its lead to the United States by 2000-02. The importance of the United States in electronic data processing increased relative to EU15 and Japan between 1990 and 2000-02. EU15 has also declined relative to Japan and the United States in office equipment. In radio communications and radar, the United States has lessened its lead as a production source relative to Europe, while still accounting for the largest share.

Production data for 2002 show that overall production (in current USD) declined, particularly for the office equipment and telecommunications sectors (between 2001 and 2002, only production of consumer audio and video equipment increased). The evidence by country is more mixed. Production declined sharply in Japan and the United States and rather less in EU15 as a whole. The downturn is obvious in most European countries, except in Denmark and Portugal where production rose and in Finland, Greece and Norway where there was no change from 2001. Countries outside of Europe where production declined included Canada, Brazil and Hong Kong (China), but production increased in Australia, China, Korea, Singapore, Thailand, India, the Philippines and South Africa, with no change from 2001 for Chinese Taipei. Overall the data show the extent of the global downturn in 2001 and 2002 across most countries and ICT goods segments, but also the rise of non-OECD production (particularly in China) and the shifts among OECD countries.

Industry drivers

Business R&D and the early-stage financing of innovative ideas and new businesses are two major drivers of growth and structural transformation of the ICT sector. Trends in these two drivers are analysed below. Furthermore, patenting of ICT inventions continues to grow in importance and accounts for close to one-fifth of all patents, particularly now that software developments can be patented. Technological advances will allow price/performance ratios of ICT equipment to decline further in the future, thereby driving economic growth in the sector and across economies, although there are relatively slow declines in software prices, and constant or even increased prices in computer services.

Research and development

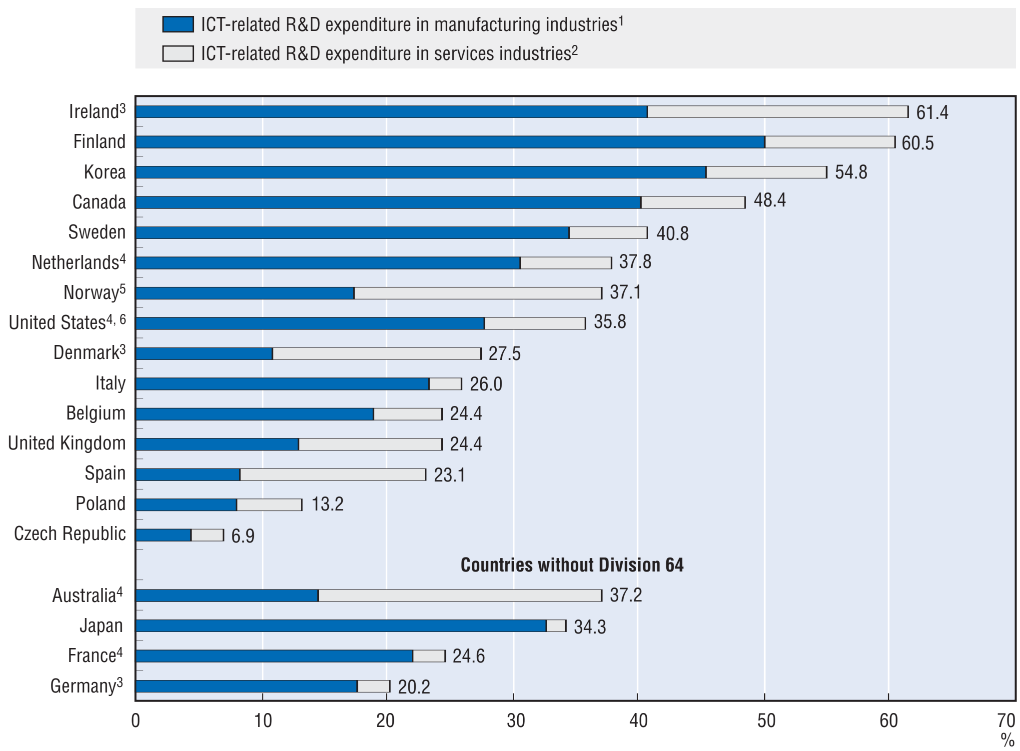
ICT industries invest heavily in R&D to create increasingly complex and efficient goods and services. The pace of innovation and competitive pressures in ICT industries drive firms to maintain their R&D efforts, and firms continue to value R&D as a necessary investment for building long-term innovative capacity and competitiveness. Firm-level evidence shows that despite the economic downturn, R&D expenditures by ICT firms did not decline significantly over the recent period (for example Cisco, Dell), and even where they did, they often rose as a share of revenue (for example Ericsson, Nortel Networks) (Lopez-Bassols, 2003; Annex A and Chapter 7).

In 2001, the ICT sector accounted for more than one-quarter of total business R&D expenditures in most OECD countries, and more than half in Ireland, Finland, and Korea (Figure 1.18). Businesses in ICT manufacturing in Finland, Korea and Sweden spent more than 0.8% of GDP on R&D. However, R&D expenditures have expanded much more rapidly in ICT services industries (14% a year) than in ICT manufacturing (6% a year) in countries for which R&D data are available for both ICT manufacturing and services industries.

R&D expenditures held up well during the downturn. A sectoral breakdown of R&D intensity (the ratio of R&D expenditure to total sales) in the world's top 250 ICT firms shows considerable variation among sectors and some change over the period 2000-02 (Figure 1.19). In 2000, R&D intensity was highest among the software firms that reported R&D expenditure (15%). Firms in the communications equipment, electronics and IT equipment sectors spent between 6% and 12% of revenue on R&D. For sectors with increasing revenues over the period 2000-02, firms typically maintained their level of R&D expenditure. Where revenues fell, most notably in the communications equipment sector, firms spent a higher percentage of revenue on R&D, although actual R&D expenditure was down a little. Nevertheless, the maintenance or expansion of R&D expenditures in both growing and declining sectors suggests that long-term commitment to R&D is a basic driver of growth in the industry and that technological innovation will continue to characterise the ICT-producing sector.

Figure 1.18. **Business R&D expenditure in selected ICT industries, 2001 or latest available year**

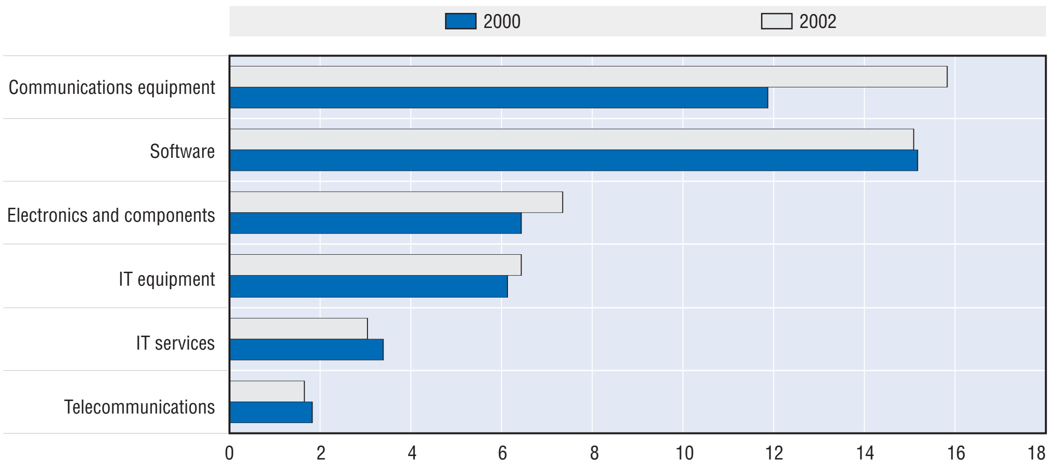
As a percentage of business enterprise sector R&D expenditure



1. ISIC, Rev. 3 divisions: 30 (manufacture of office, accounting and computing machinery); 32 (manufacture of radio, television and communication equipment and apparatus); and 33 (manufacture of medical, precision and optical instruments, watches and clocks).
2. ISIC, Rev. 3 divisions: 64 (post and telecommunications) and 72 (computer and related activities).
3. 1999 instead of 2001.
4. 2000 instead of 2001.
5. 1997 instead of 2001.
6. Due to unavailability of data for division 64, class 642 (telecommunication) is included in services ICT R&D as a proxy. Available information shows that in the United States class 642 accounts for 97-98% of division 64 total.

Source: OECD, ANBERD database, January 2004.

Figure 1.19. **Average R&D intensity in top 250 ICT firms by sector, 2000 and 2002**

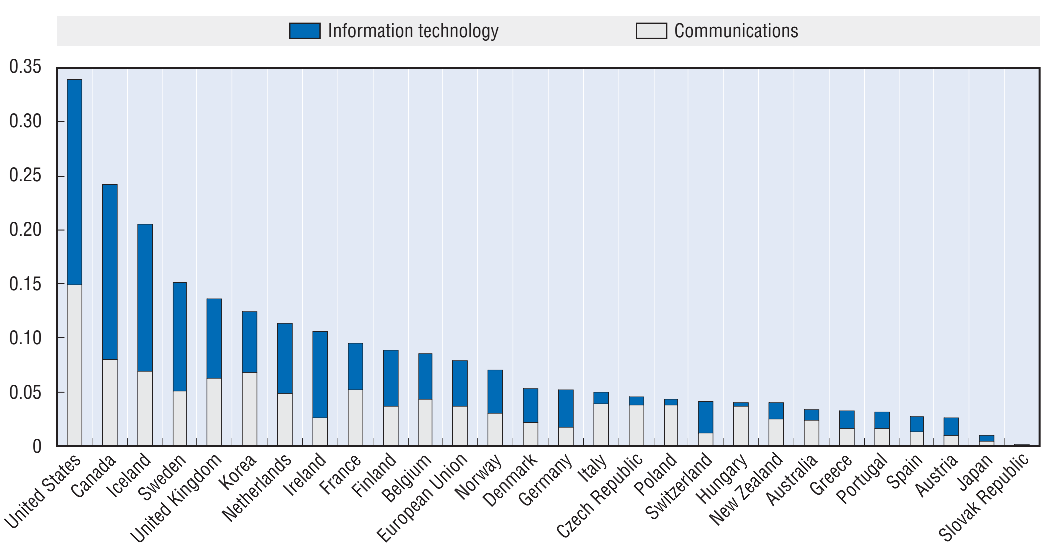


Note: R&D intensity of all firms reporting R&D. Excludes firms not undertaking or not reporting R&D expenditures.
Source: OECD, based on data drawn from the top 250 ICT firms.

Venture capital

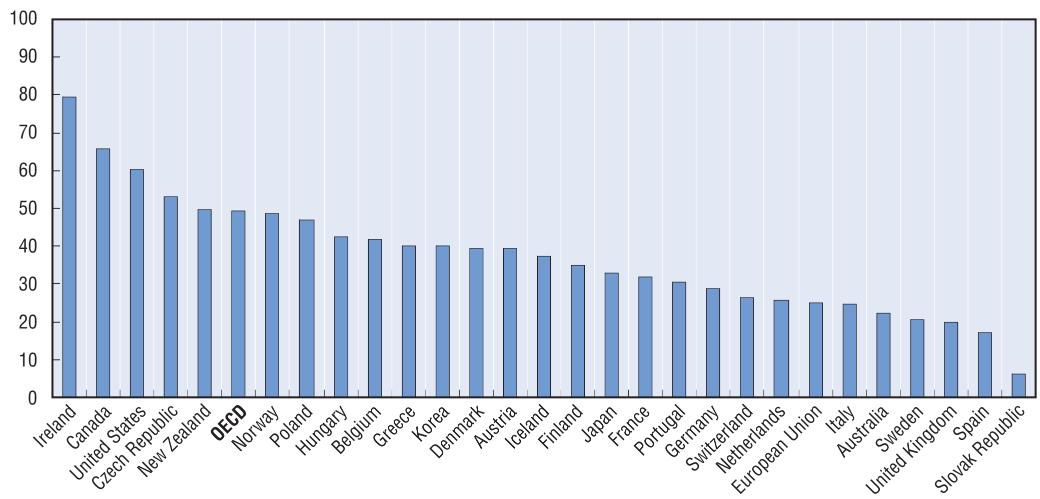
Venture capital has gone overwhelmingly to the ICT sector in recent years. While the relative amounts of venture capital and its distribution vary widely across countries, total invested venture capital represented a little more than 0.3% of GDP across OECD countries over the 1999-2002 period; one half went to ICT, distributed roughly evenly between communications and information technology (Figure 1.20).[6] At the top end of the scale, between 1999 and 2002, the equivalent of around 0.35% of GDP went to ICT in the United States. The sector attracted much interest among venture capitalists

Figure 1.20. **Venture capital investments in ICT as a percentage of GDP, 1999-2002**



Source: OECD venture capital data base, 2004.

Figure 1.21. **Venture capital investments in ICT as a percentage of all venture capital investment, 1999-2002**



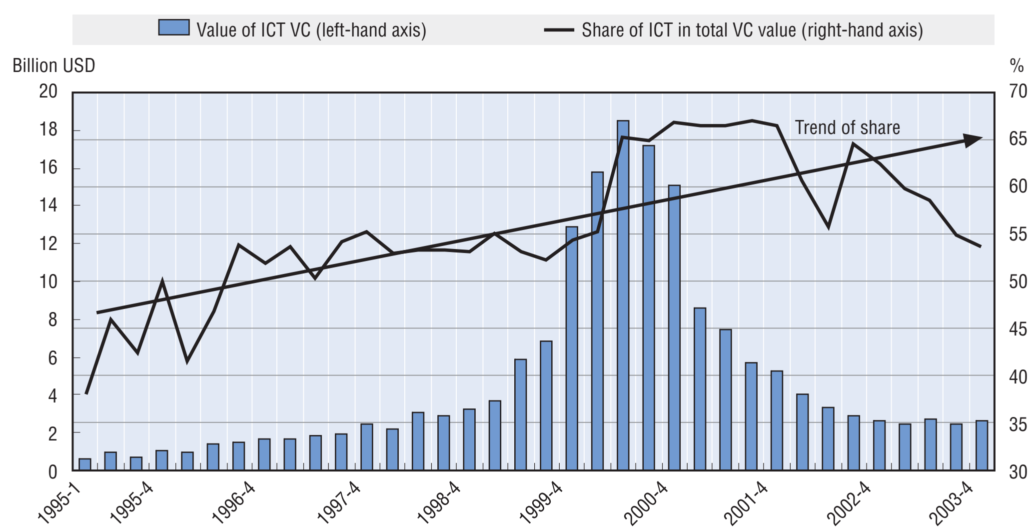
Source: OECD venture capital data base, 2004.

during the second half of the 1990s, and, as a result, funds raised increased strongly. Venture capital investments rose by a factor of 12 between 1995 and 1999; they declined almost as spectacularly from mid-2000 through 2003.

Over the period 1999-2002, in Ireland, Canada and the United States, ICT attracted well over half of total venture capital (Figure 1.21). In Korea over 40% went to ICT, a higher share than in Japan for example (around 30%), and over one-quarter of venture capital in EU countries went to ICT.

Figure 1.22. **Quarterly venture capital investments in the ICT sector in the United States, 1995-2003**

Share of venture capital investments, and value USD billions



Note: The ICT sector includes the following industries: software, telecommunications, networking and equipment, semiconductors, IT services, computers and peripherals, and electronics/instrumentation.
Source: OECD based on PricewaterhouseCoopers (2004).

A more detailed analysis of US data (with a slightly different definition of the ICT sector) shows that despite the slump in venture capital funding, the share of total venture capital going to the ICT sector has remained in the 55-65% range over the period 2000-03. This shows the vitality of the country's venture capital financing of ICT, with Internet-related firms, digital content and e-business activities receiving a significant share of the total, along with components and software ventures (Figure 1.22).

ICT markets

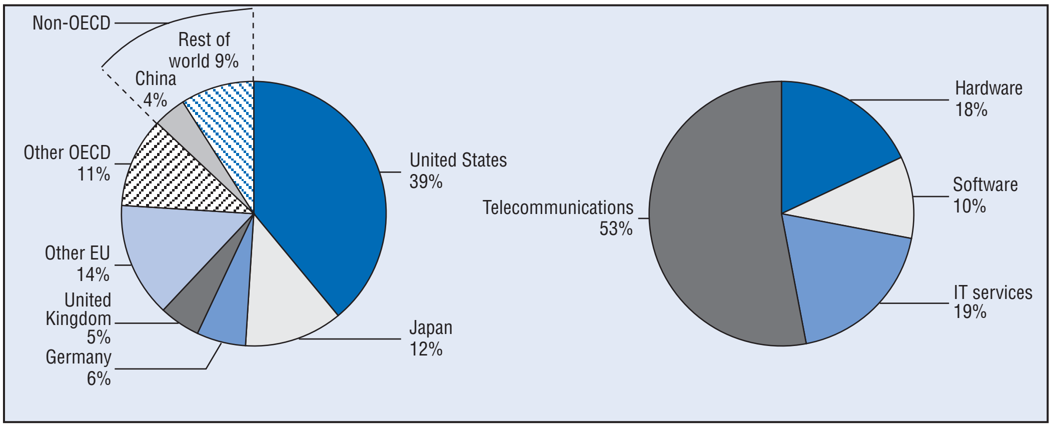
Analysis of ICT markets shows smaller changes in market shares than in production shares, a further sign of the continuing globalisation of the ICT supply sector. OECD countries are still the major markets, and much of China's rapidly increasing production has been directed at OECD markets. In 2003, OECD countries accounted for 87% of worldwide ICT markets (Figure 1.23). In terms of the various segments, telecommunications accounted for 53%, followed by IT services (19%), hardware (18%) and software (10%).[7] The relative importance of market segments varies across countries. In China, Japan, Korea, Brazil and Mexico, the telecommunications market accounted for at least 60% of the total. Conversely IT spending (defined as the sum of hardware, software and services, *i.e.* excluding telecommunications services) accounted for around two-thirds of all ICT spending in Denmark, the Netherlands, Sweden and the United Kingdom.

ICT intensity, defined as the ratio of ICT markets to GDP, is shown in Figure 1.24. The Czech Republic has the highest intensity, followed closely by New Zealand (over 7% of GDP). Ireland has the lowest intensity (less than 4%), while the overall intensity for OECD countries (excluding Luxembourg and Iceland) is just under 6% of GDP. The relative importance of the telecommunications market is clear; it is particularly important as a share of the total ICT market in Korea and in eastern European countries (particularly Hungary and Poland), and Greece, Mexico, Portugal and Turkey. This suggests that in catch-up countries more emphasis is placed on building and using the telecommunications infrastructure, and that service costs may still be relatively high owing to more recent liberalisation.

These ICT market data also clearly show the slump in all ICT segments and countries in 2001-2002, the relatively stable performance of telecommunications and services compared with hardware, and China's very high growth rates as compared to large OECD countries. Figure 1.25 shows annual growth in ICT spending, by segment, for selected countries. There is some variation among countries. For

Figure 1.23. **Worldwide ICT market,[1] 2003**

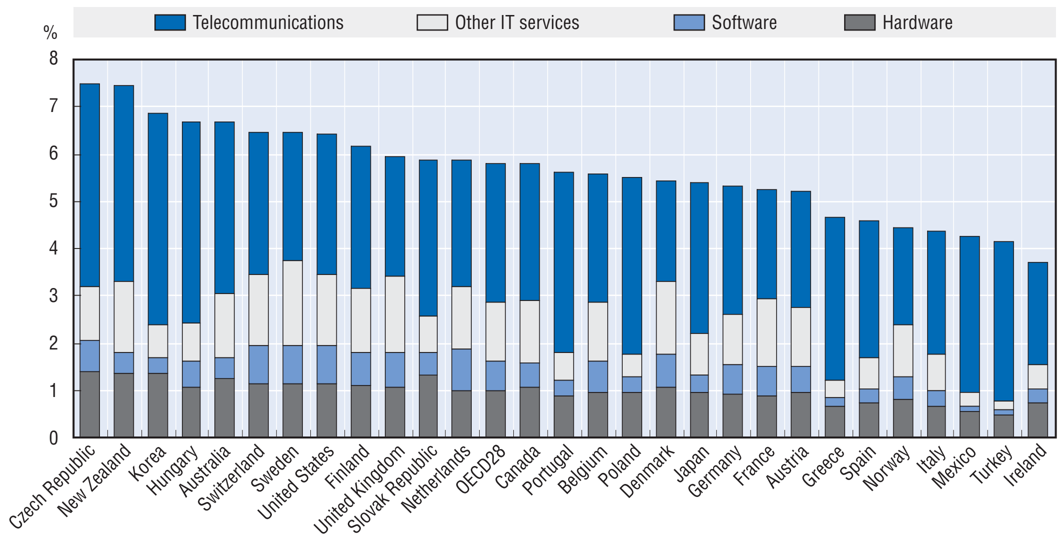
By country/region (left-hand side) and by segment (right-hand side)



1. Expressed in 2002 USD.

Source: OECD, based on International Data Corporation (IDC), 2004.

Figure 1.24. **ICT intensity[1] in OECD countries,[2] 2003**

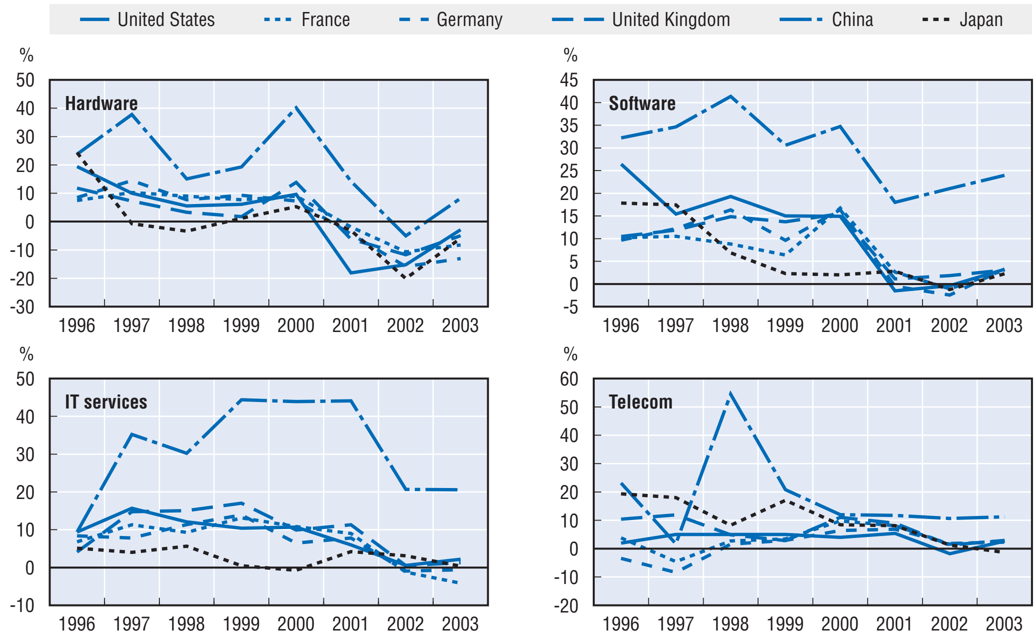


1. ICT intensity is defined as ICT markets/GDP.
2. Excluding Luxembourg and Iceland.

Source: OECD, based on International Data Corporation (IDC), 2004.

Figure 1.25. **Annual growth of ICT spending by segment, selected countries, 1996-2003**

Percentages



Source: OECD, based on International Data Corporation (IDC), 2004.

example, growth in software spending started to slow in Japan from the beginning of the period, and growth in China easily outpaces that in other countries in all market segments. Finally, a general pick-up in spending across all four market segments can be observed from 2002-03.

Trade

Trade in ICTs was markedly affected by the recent downturn. Trade had grown very rapidly through 2000, but suffered dramatic declines in 2001 and lesser declines in 2002. ICT trade was more severely affected than trade in many other categories. However, the outlook for renewed trade in ICT goods and services is strong, driven by higher global GDP growth, the rapid increase in China's trade and increasing trade in IT and ICT-enabled services owing to international sourcing. World trade grew at around twice the rate of GDP in 2003 (4.5% real growth in world merchandise exports compared with 2.5% in real GDP) and it is expected to grow at double the rate of world GDP in 2004 (7.5% compared with 3.7%), propelled by strong growth in Asia and the United States (WTO, 2004). If past patterns are repeated, OECD ICT goods trade will grow at even higher rates than merchandise exports, over 6% in real terms in 2003 and much higher in nominal terms, and 10% in 2004.

This section first presents overall trends in ICT goods trade in OECD countries and then analyses trade in specific categories of goods: communication equipment, computer and related equipment, electronic components, audio and video equipment, other ICT-related goods, and software goods. It ends by looking at developments in trade in ICT services: communication services and computer and information services (for the methodology see Annex B). Globalisation of the ICT sector, including trade specialisation and trade performance, and the very rapid increase in China's ICT globalisation and trade are analysed in Chapter 2.

Trade in ICT *goods*

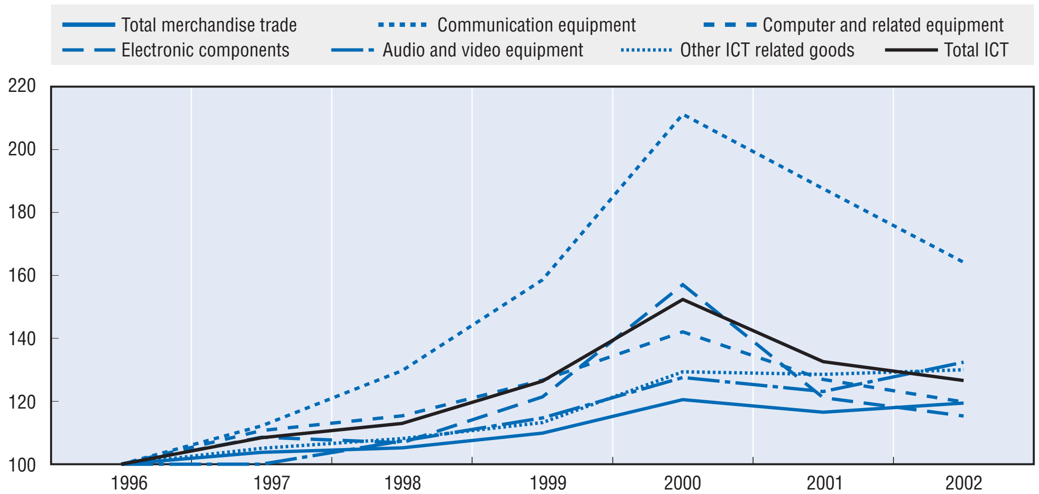
In the late 1990s, merchandise trade (the average of exports and imports) expanded rapidly, growing by 9.7% in 2000. Trade in ICT goods contributed significantly, increasing by more than 20% in 2000 and accounting for almost 17% of total OECD merchandise trade (Annex Table C.1.1). In 2001 as growth slowed in many developed economies, demand for ICT equipment was sharply reduced. This had major repercussions for global production, assembly and trade networks of components and finished products. Total OECD merchandise trade fell by 3.3% in 2001, with OECD ICT goods trade dropping by 13%, led by a 23% decline in trade in electronic components, the sector that led the ICT downturn. In 2002, although merchandise trade increased by 2.5%, ICT trade fell by 4.5%, led by a 12.5% drop in communication equipment. In current value terms, total trade in ICT goods increased from USD 502 billion in 1996 to USD 764 billion in 2000, but then decreased to USD 635 billion in 2002. Total ICT goods trade grew by 4% a year between 1996 and 2002; it grew by 11% a year from 1996 to 2000 but shrank by almost 9% a year between 2000 and 2002 (Figure 1.26).

While the recent downturn in ICT trade is evident across the board, its impacts have been uneven. The Czech Republic's ICT goods trade increased by 43% in 2000, and that of Korea, Hungary, Canada and Mexico by 30% or more (Figure 1.27). In the same year, Norway's ICT goods trade declined, and that of ten other OECD countries grew by less than 10%. In 2001, no fewer than 19 OECD countries experienced a sharp year-on-year drop: Turkey, down 38%, Sweden 36%, Iceland 29%, Canada 26%, Korea 23% and Japan 20%. Against the overall trend, the Czech Republic, Luxembourg, the Slovak Republic and Ireland enjoyed strong growth in trade in ICT goods. In 2002, six OECD countries enjoyed a double-digit increase in ICT trade (Czech Republic, Turkey, Denmark, Slovak Republic, Hungary and Korea); in the 17 countries where ICT trade slowed, Luxembourg, the Netherlands, Canada, Belgium, France and Switzerland experienced double-digit decreases.

Total *exports* of ICT goods from OECD countries rose from USD 495 billion in 1996 to USD 615 billion in 2002, with a peak of USD 741 billion in 2000, for overall growth of 3.7% a year. Total *imports* of ICT goods rose from USD 508 billion in 1996 to USD 655 billion in 2002, with a peak of USD 788 billion in 2000. Hence, the overall OECD trade deficit in ICT goods increased from USD 14 billion in 1996 to almost USD 47 billion in 2000 but decreased to USD 40 billion in 2002. The countries with a trade surplus in ICT

Figure 1.26. **OECD trade in ICT goods, 1996-2002**

Index 1996 = 100



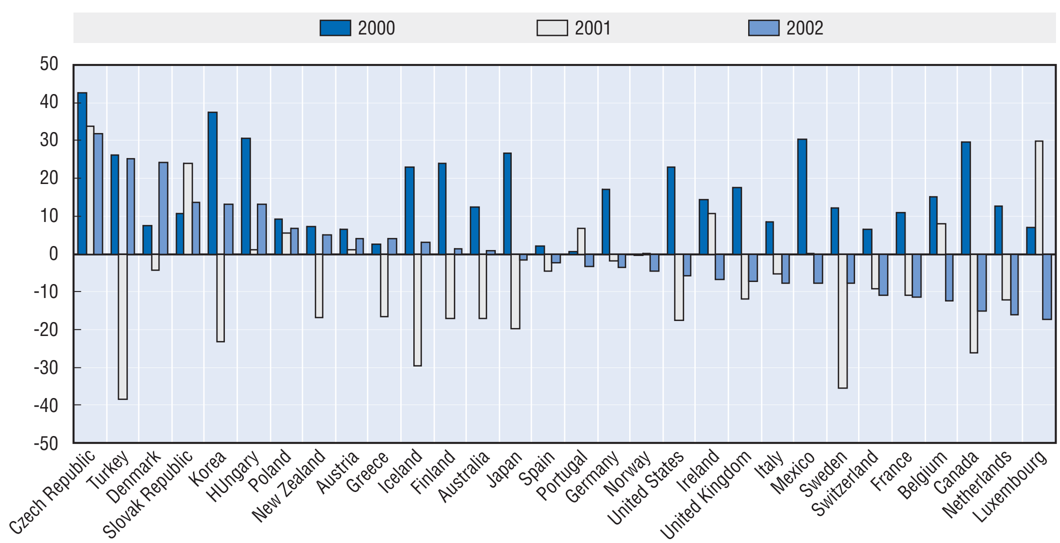
Source: OECD ITS database.

goods in 2002 were (in decreasing order of surplus) Japan, Korea, Ireland, Finland, Mexico, the United Kingdom, the Netherlands, Sweden and Hungary. Of these, the Netherlands, Korea, Finland, Ireland, and Mexico have increased their trade surplus since 1996. The countries with the largest trade deficits in ICT goods in 2002 were the United States, Canada, Italy, Australia and Spain (Annex Table C.1.2).

The United States and Japan are the OECD's largest *exporters* of ICT goods, accounting for 22% and 15%, respectively, of total ICT goods exports from OECD countries in 2002 (Figure 1.28) reflecting the

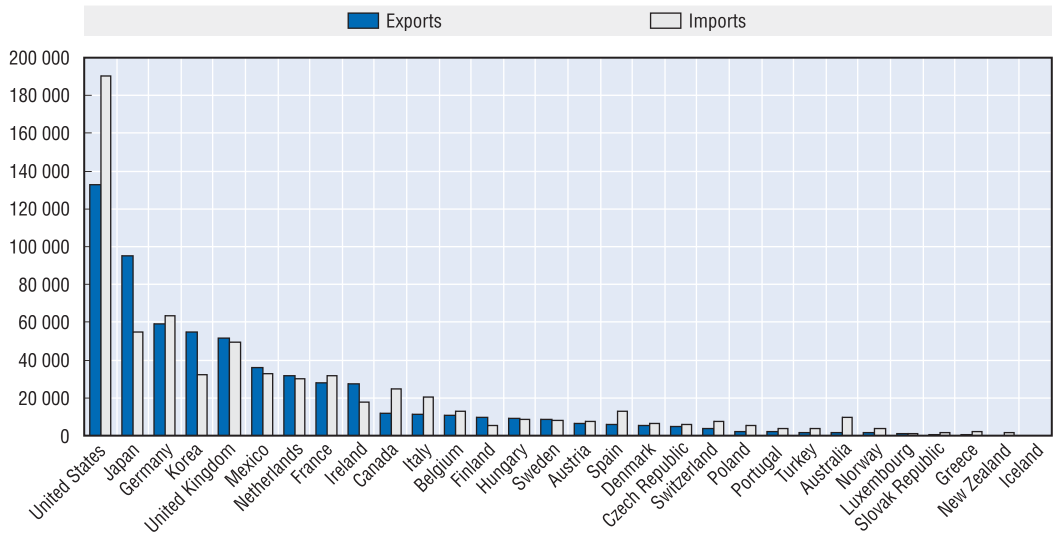
Figure 1.27. **Recent trends in ICT goods trade**

Percentage change year-on-year



Source: OECD ITS database.

Figure 1.28. **OECD area ICT goods trade, 2002**
USD millions



Source: OECD ITS database.

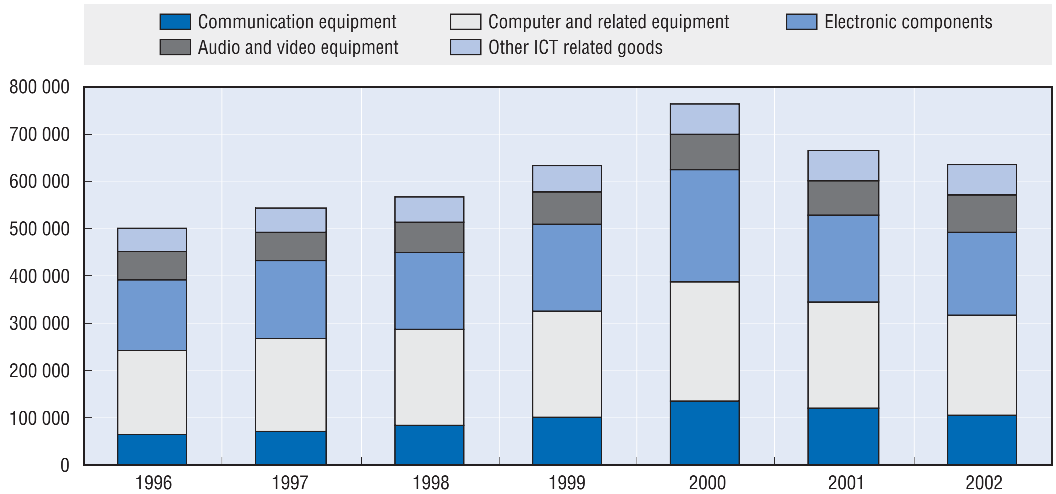
continuing major role played by their large ICT firms (see Annex A). The other large exporters, all with less than 10%, were Germany, Korea, the United Kingdom, Mexico, the Netherlands and France. The countries that have increased their ICT goods exports most rapidly since 1996 are Hungary (by 54% a year) and Iceland (by 43% a year), followed by the Czech Republic, Turkey, Poland, Greece and Mexico. In 2002, the United States accounted for 29% of all OECD ICT goods *imports* (USD 190 billion). Other notable importers of ICT goods included Germany, Japan and the United Kingdom. Reflecting their increasing roles in global production systems and as hosts for foreign direct investment (FDI), importing components and exporting finished products, the fastest growing importers of ICT goods since 1996 have been Hungary, Mexico, the Czech Republic and Ireland (Annex Table C.1.2).

Computer and related equipment is the largest component of ICT trade, accounting for 34% in 2002 (Figure 1.29 and Annex Table C.1.1). Electronic components accounted for 27%, communication equipment for 16%, audio and video equipment for 12% and other ICT-related goods for 10%. Communication equipment has been the fastest growing component of ICT goods trade and has increased its share of total trade at the expense of all other categories of ICT goods. In 2002, OECD-area computer and related equipment trade showed a *deficit* of USD 61 billion, and audio and video equipment a deficit of almost USD 26 billion. Categories of ICT goods that realised small OECD-area trade *surpluses* were electronic components (exported for assembly into finished products), communication equipment and other ICT-related goods.

Communication equipment

The Internet and the rapid expansion of mobile communications have made communication equipment the fastest-growing segment of ICT trade. Between 1996 and 2002, total OECD exports of communication equipment rose by 7.9% a year and imports rose by 9.5% a year (Annex Table C.1.3). Between 1996 and 2000, OECD exports of communication equipment increased by 19% a year, but between 2000 and 2002 they decreased by 11% a year. Nevertheless, by 2002, communication equipment accounted for more than 18% of total OECD-area exports of ICT goods, up from over 14% in 1996. Imports grew by 23% a year from 1996 to 2000 but shrank by 13% a year between 2000 and 2002.

Figure 1.29. **Composition of OECD trade in ICT goods, 1996-2002**
USD millions, current

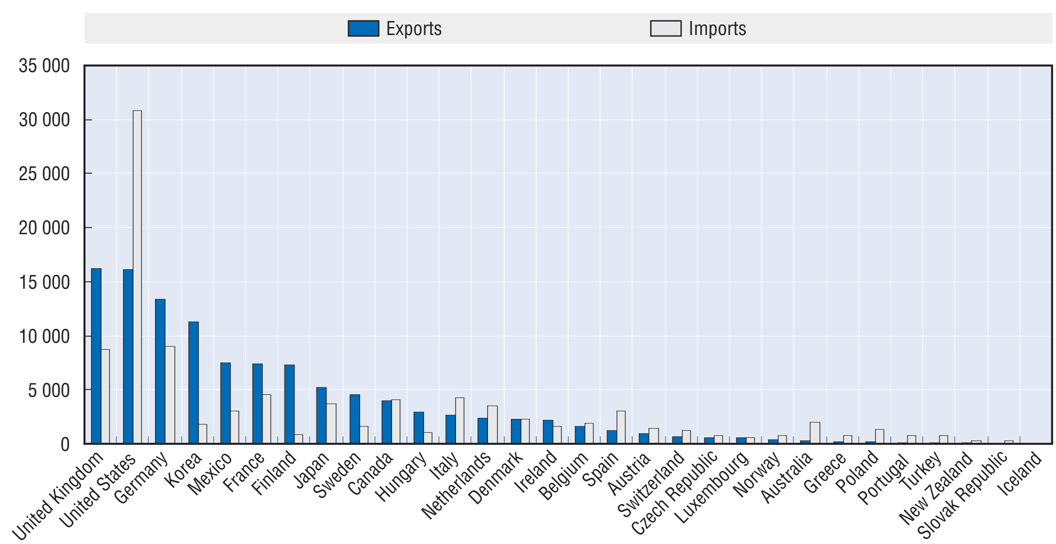


Source: OECD ITS database.

Nevertheless, communication equipment's share of total ICT goods imports into OECD countries rose from 13% in 1996 to well over 16% in 2002. The OECD trade surplus in communication equipment reached USD 16 billion in 2002.

As Figure 1.30 shows, the largest *exporters* of communication equipment in 2002 were the United Kingdom and the United States, followed by Germany, Korea and Mexico. Of these countries, exports from Korea and Mexico increased most rapidly from 1996 to 2002, by 32% and 23% a year, respectively.

Figure 1.30. **OECD communication equipment trade, 2002**
USD millions



Source: OECD ITS database.

Other countries with rapid increases were Iceland (albeit from a low base) and Hungary, as well as the Czech Republic (Annex Table C.1.3). The United States was by far the largest *importer* of communication equipment in 2002, with an average increase of 15% a year from 1996. Other major importers were Germany and the United Kingdom. Between 1996 and 2002, imports into Ireland increased most rapidly (25% a year), followed by Hungary, Denmark, the United States, Greece, Austria and Germany. Only New Zealand, Japan and Norway experienced shrinking imports over the period.

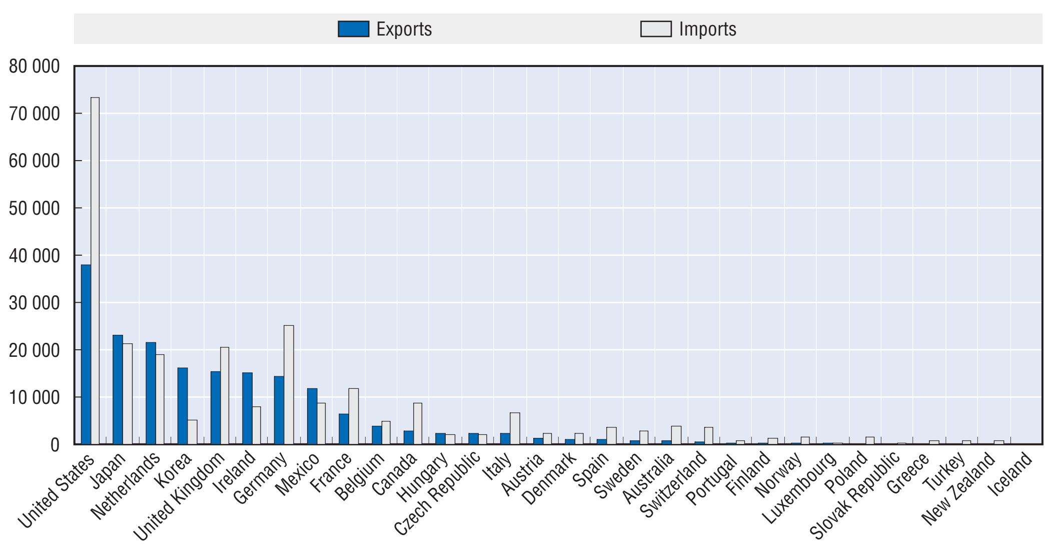
In 2002, the countries with the largest *trade surpluses* in communication equipment were Korea, the United Kingdom, Finland, Mexico and Germany. Between 1996 and 2002, Korea and the United Kingdom increased their overall surpluses by around 70% a year. In 2002, the largest *trade deficits* were in the United States, Spain, Australia, Italy, the Netherlands and Poland. The countries where the trade balance dropped fastest were the United States, which saw a surplus of USD 1.4 billion in 1996 become a deficit of USD 14.7 billion in 2002; the Czech Republic and Japan, where trade balances declined by 20% a year.

Computer and related equipment

Computer and related equipment is the largest segment of OECD-area ICT goods trade, worth USD 213 billion in 2002. OECD exports represented USD 183 billon in 2002 and imports USD 243 billion, for an overall trade deficit of USD 61 billion. The deficit has been increasing on trend since 1996, as production and assembly shift to non-OECD economies and OECD firms locate labour-intensive assembly in lower cost locations.

In 2002, the largest *exporters* of computer and related equipment were the United States, Japan, the Netherlands, Korea, the United Kingdom and Ireland (Figure 1.31 and Annex Table C.1.4). Between 1996 and 2002, the OECD countries with high average annual increases in computer equipment exports were a mixture of smaller economies and those moving into production of computer equipment, in many cases driven by inward FDI for export: Hungary, the Czech Republic, Portugal, Greece, Mexico, Korea, Austria and Turkey. Exports from 12 OECD countries declined, most notably in Finland, New Zealand and Italy. In 2002, the largest *importer* by far was the United States, followed by Germany, Japan, the

Figure 1.31. **OECD trade in computer and related equipment, 2002**
USD millions



Source: OECD ITS database.

United Kingdom and the Netherlands. Between 1996 and 2002, imports into Hungary and Mexico rose most rapidly, by 36% and 28% a year, respectively.

In 2002, the OECD countries with the largest *trade surpluses* in computer and related equipment were Korea (with the rapid rise of domestic firms), Ireland, Mexico and the Netherlands. Between 1996 and 2002, trade surpluses grew particularly rapidly in Korea (by 35% a year) and strongly in Ireland and Mexico. In 2002, the countries with large *trade deficits* in computer and related equipment were the United States, with more than half of the OECD total deficit, and Germany, Canada and France. Between 1996 and 2002, the trade deficit grew most rapidly in the United Kingdom, by 33% a year.

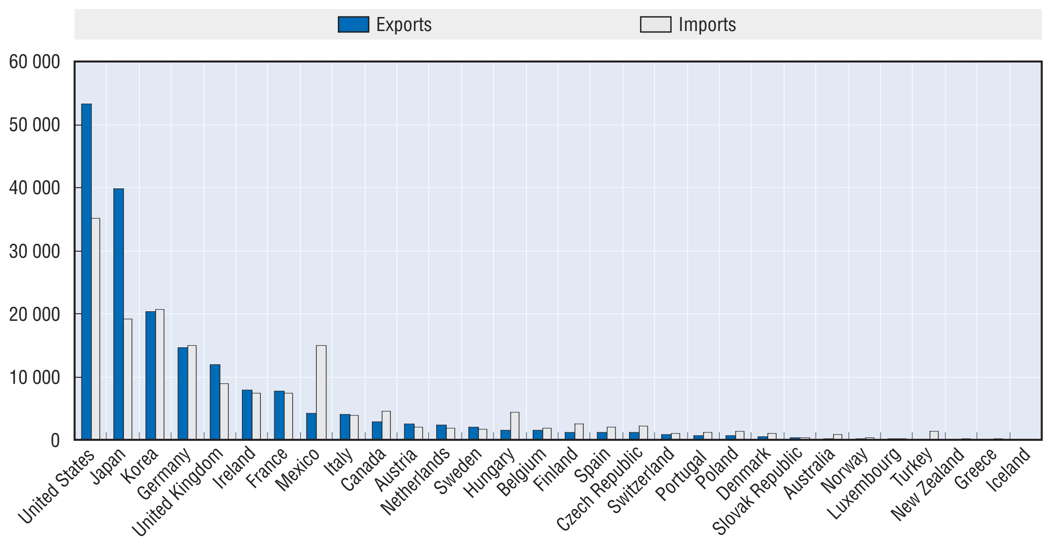
Electronic components

Trade in electronic components, at USD 174 billion in 2002, accounted for 27% of all OECD ICT goods trade, with growth of 2.4% a year between 1996 and 2002. With exports of electronic components worth USD 184 billion in 2002 and imports worth USD 163 billion, OECD countries realised an overall surplus on trade in electronic components in 2002 of USD 21 billion reflecting the leading role of OECD firms in developing and producing components for assembly into finished products.

Among OECD countries, the leading *exporters* of electronic components in 2002 were the United States, Japan, Korea, Germany and the United Kingdom (Figure 1.32 and Annex Table C.1.5). Between 1996 and 2002, US exports increased by 3% a year as US firms maintained their strong position in semiconductors. Hungary, Ireland, the Czech Republic and Poland enjoyed relatively strong growth in exports, while exports from the Netherlands, Sweden, Canada, and Japan fell. In 2002, the major *importers* of electronic components were the United States, Korea, Japan, Mexico and Germany, with Korea and Mexico registering growth of 12% and 10% a year, respectively, between 1996 and 2002. Imports into Hungary, the Czech Republic and Ireland also grew strongly reflecting the role of FDI in assembly for export; while they decreased into the Netherlands, Canada, Sweden, Australia, the United Kingdom, the United States, Italy, Norway and Switzerland.

In 2002, nine OECD countries had a *trade surplus* in electronic components: Japan, the United States, the United Kingdom, Austria, Ireland, Netherlands, France, Sweden and Italy. The countries with large

Figure 1.32. **OECD trade in electronic components, 2002**
USD millions



Source: OECD ITS database.

trade deficits were Mexico, Hungary and Canada. The combination of a large trade surplus in IT equipment and a trade deficit in electronic components indicates extensive assembly activities (*e.g.* Mexico), while a surplus in electronic components combined with a deficit in IT equipment indicates a central role in key technologies (*e.g.* the United States). ICT trade does not, therefore, paint a simple picture in which hardware manufacturing moves to lower-wage locations, but rather one in which relatively labour-intensive assembly investment moves to lower-wage locations, while relatively capital-intensive and intellectual-property-intensive manufacturing of electronic components remains in higher-wage locations.

Audio and video equipment

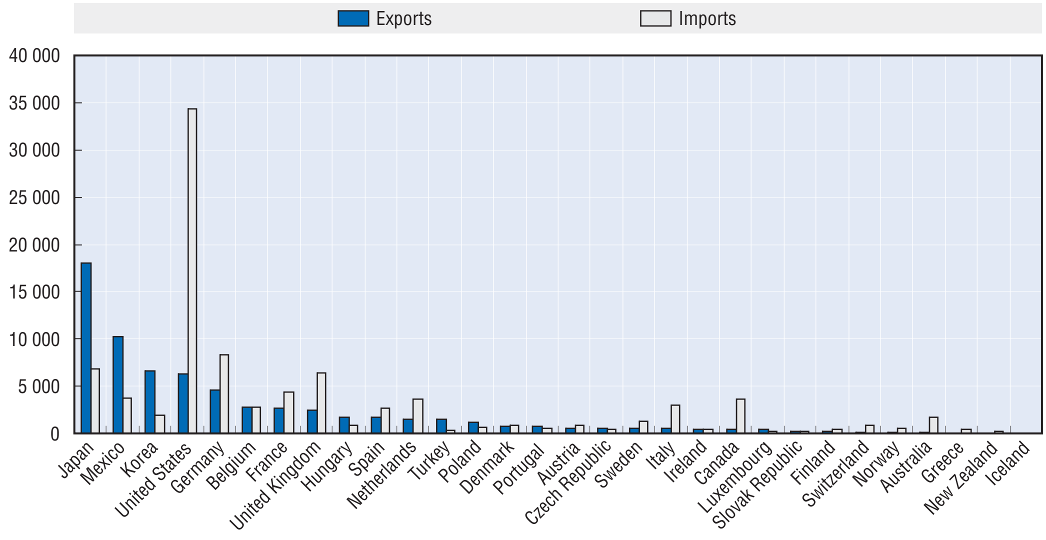
OECD trade in audio and video equipment, at USD 79 billion in 2002, accounted for over 12% of total trade in ICT goods. OECD exports were worth USD 67 billion in 2002, up from USD 55 billion in 1996 or by 3.3% a year. OECD imports of audio and video equipment amounted to USD 92 billion in 2002, up from USD 65 billion in 1996 or by 5.9% a year. The substantial and growing overall OECD trade deficit in audio and video equipment reached USD 26 billion in 2002.

In 2002, Japan remained clearly the leading OECD *exporter* (Figure 1.33 and Annex Table C.1.6) although China was almost as important (see Chapter 2). Other significant exporters were Mexico, Korea, the United States and Germany. Between 1996 and 2002, exports from the Czech Republic, Hungary and Poland increased strongly from a low base as they benefited from inward investment in assembly, while they declined from eight OECD countries. The United States was by far the largest *importer*, followed by Germany, Japan and the United Kingdom. Between 1996 and 2002, imports into Hungary and Mexico grew most rapidly, while those into Ireland, Austria, Denmark and New Zealand declined.

In 2002, Japan, Mexico and Korea realised significant *trade surpluses* in audio and video equipment, but Turkey, Hungary, Poland and the Czech Republic have also increased their surpluses rapidly as they benefited from inward investment in assembly. The United States had the largest *trade deficit* by far, although the United Kingdom, Germany and Canada also had notable deficits.

Figure 1.33. **OECD trade in audio and video equipment, 2002**

USD millions



Source: OECD ITS database.

Other ICT-related goods

Other ICT-related goods (including a wide range of medical, scientific and measuring equipment) accounted for little more than 10% of total OECD ICT goods trade in 2002. With exports of USD 69 billion and imports of USD 60 billion, the overall OECD-area surplus was USD 9 billion (Annex Table C.1.7).

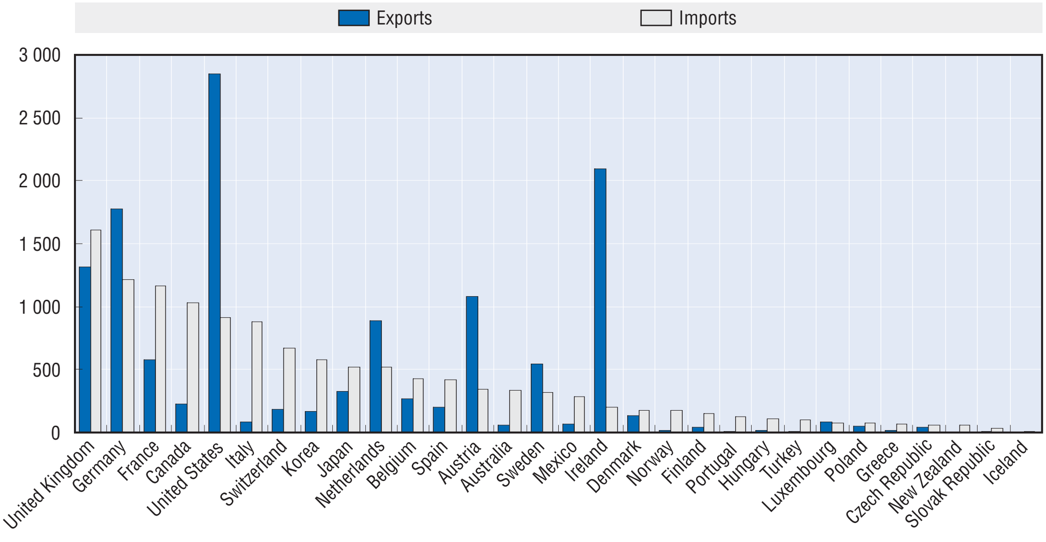
The United States, Germany, Japan and the United Kingdom were the leading *exporters* and *importers* of ICT-related equipment in 2002. Between 1996 and 2002, exports from Ireland, Hungary and Mexico increased most rapidly. They were also among those countries experiencing the fastest rise in imports, an indication of their increasing role in global production of this equipment. In 2002, Germany, Japan, the United States, the Netherlands and Ireland had the largest ICT-related *trade surpluses*, and Korea and Canada had the largest *deficits*.

Software goods

The software sector has been among the most dynamic ICT sectors, but trade in software is surprisingly low as measured in trade statistics. There are many problems associated with tracking software imports and exports in trade statistics. The approach used here is to track trade in the physical supports (*e.g.* magnetic discs, tapes and other recorded media), but it has limitations. First, as border valuations are based on physical media, the value of the software traded is likely to be significantly understated. Second, the bundling of software with hardware leads to significant mismeasurement (overstating of equipment trade and understating of software trade). Third, trade statistics do not measure the value of copyright works sold in foreign markets (*i.e.* the "gold master" problem, when only the original software product is transferred internationally and copied multiple times for sale or export in the importing country). Fourth, trade statistics do not measure the value of software transmitted electronically across borders, which accounts for a rapidly increasing share of sales, or the rise of application service providers of software (ASPs). Nevertheless, trade statistics do give some indication of the relative size and geographical distribution of cross-border sales of software goods (software goods are not included in the ICT goods totals above, Annex B describes the methodology for

Figure 1.34. **OECD trade in software goods, 2002**

USD millions



Source: OECD ITS database.

measuring software goods). This description of trade in software goods should be seen alongside that of trade in computer and information services (discussed below).

Software goods as measured in goods trade statistics account for a relatively small share of ICT trade. Total OECD trade in software goods was worth USD 12.9 billion in 2002, with exports worth USD 13.1 billion and imports worth USD 12.6 billion. Between 1996 and 2002, exports increased by 2.3% a year, while imports increased by 4.1% a year. OECD countries had an overall trade surplus of USD 500 million in 2002.

The leading *exporters* of software are the United States and Ireland, accounting for 22% and 16% of total 2002 exports, respectively (Figure 1.34 and Annex Table C.1.8). Germany, the United Kingdom and Austria were also significant exporters. Between 1996 and 2002, exports from Ireland and the United States shrank, while exports from Austria, Germany and the United Kingdom expanded. In 2002, the United Kingdom and Germany were the OECD's leading *importers* of software goods, followed by France, Canada, the United States and Italy; their imports increased between 1996 and 2002.

Trade in ICT *services*

The impact of the recent downturn on ICT-related services trade has been uneven, as it has been for ICT goods.[8] Services trade appears to have slowed somewhat earlier than goods trade. While data are incomplete, OECD trade in communications services appears to have grown by 2% a year in 1999 before falling to 1% during 2000. Similarly, trade in computer and information services grew by more than 20% a year in 1999, before slowing to 7.7% growth in 2000 and a little over 8% in 2001.

Overall, between 1996 and 2002, OECD-area communications services exports increased by 5.7% a year, while imports increased by 2.6%; computer and information services exports increased by almost 20% a year, while imports increased by 15%. In 2002, partial data indicate an OECD-area trade deficit in communication services of some USD 2.1 billion and a trade surplus in computer and information services of around USD 15 billion. ICT services trade grew strongly in some countries during what was for other countries a time of contracting trade. For example, communications services trade rose by 20% or more in 2001 in France, Iceland, Italy, Netherlands and Spain, while it declined by 20% or more in Australia, Mexico, New Zealand and Poland. Similarly, trade in computer and information services grew by 20% or more in the Czech Republic, Finland, France, Germany, Hungary, Ireland Poland and the Slovak Republic while Australia, Greece, Japan and Portugal experienced declines of 10% or more.

Communications services

The United States was the OECD's leading *exporter* and *importer* of communications services in 2002 (Table 1.1). Other leading *exporters* were the United Kingdom, France, Belgium-Luxembourg, the Netherlands, Germany, Canada and Ireland; significant *importers* included Germany, the United Kingdom, Italy, France, the Netherlands and Canada. In 2002, the top ten exporters accounted for 74% of all OECD exports of communications services, and the top ten importers for 77% of imports.

Communications services exports from OECD countries increased by 6.9% a year between 1996 and 2002, with significant variations among countries. France increased its exports of communications services most rapidly, by 25% a year; from a surplus of USD 165 million in 1996 it achieved a surplus of USD 537 million in 2002. Other countries to enjoy strong growth in exports of communications services were Sweden, Hungary, Greece and the Slovak Republic (20%), the Netherlands (15%), and the Czech Republic (14%). Exports declined over the period in Iceland, Poland, Japan, Korea, Mexico, Germany, Australia and Portugal.

In 2002, the largest *surpluses* in communications services were recorded by Belgium-Luxembourg, Ireland, France, Mexico and Austria, while significant *deficits* were recorded by Germany and Italy. Over the period 1996-2002, France had the fastest growth in overall trade in communications services (26% a year), followed by Hungary (24%), Sweden (22%), Greece and the Czech Republic (21%).

Table 1.1. **Trade in ICT services, 1996-2002**
USD millions

	Communications		Computer and information		Communications		Computer and information	
	Exports 1996	Imports 1996	Exports 1996	Imports 1996	Exports 2002	Imports 2002	Exports 2002	Imports 2002
Australia	752	843	167	173	570	810	596	519
Austria	338	361	83	172	633	431	139	280
Belgium-Luxembourg	1 274	448	1 320	680	2 238	1 311	1 918	1 558
Canada	1 282	1 243	788	529	1 356	1 313	1 960	883
Czech Republic	77	64	28	22	172	262	142	121
Denmark	. .	. .	. .	. .	. .	. .	. .	. .
Finland	155	194	888	615	232	255	503	372
France	582	417	509	482	2 262	1 725	1 190	1 153
Germany	2 025	2 692	1 602	2 379	1 409	3 381	5 162	6 096
Greece	71	78	362	55	207	264	80	183
Hungary	42	24	93	58	124	118	194	155
Iceland	23	24	17	2	8	37	39	3
Ireland	. .	. .	. .	. .	1 162	468	10 377	545
Italy	536	944	207	590	983	2 569	383	1 055
Japan	1 378	1 869	1 223	2 443	745	914	1 140	2 149
Korea	643	706	6	76	422	774	20	124
Mexico	846	. .	. .	. .	557	197	. .	. .
Netherlands	648	668	638	651	1 494	1 540	1 416	1 580
New Zealand	. .	. .	29	58	175	147	96	101
Norway	216	172	122	149	330	220	298	589
Poland	315	203	28	135	164	188	99	272
Portugal	281	172	41	112	248	217	76	185
Slovak Republic	20	19	8	16	58	43	71	80
Spain	642	443	1 279	976	922	1 022	2 483	1 570
Sweden	211	161	153	152	623	576	1 469	865
Switzerland	516	727	. .	. .	823	870	. .	. .
Turkey	. .	74	. .	. .	. .	72	. .	. .
United Kingdom	1 649	2 091	1 701	520	2 912	3 035	4 463	1 664
United States	3 543	8 792	2 775	422	4 372	4 546	6 930	4 193
Total	. .	. .	. .	. .	25 729	27 835	. .	.

Note: Communication services includes postal and telecommunications. Partial totals from available data.
Source: OECD/Eurostat Statistics on International Trade in Services.

Computer and information services

In 2002, Ireland, with its large software industry, was the OECD's leading *exporter* of computer and information services (Table 1.1), followed by the United States, Germany, the United Kingdom, Spain, Canada and Belgium-Luxembourg. Germany was the leading *importer*, followed by the United States, Japan, the United Kingdom, the Netherlands, Spain, Belgium-Luxembourg, France and Italy. Between 1996 and 2002, exports increased by almost 20% a year. Of those countries for which data are available, Sweden increased its exports the most rapidly at 46% a year. Other countries with strong growth in exports were the Slovak Republic (43%), the Czech Republic (31%), Australia and Poland (24%). Only Greece, Finland and Japan recorded declining computer and information services exports over the period.

In 2002, 13 OECD countries recorded a *trade surplus* in computer and information services. Ireland's was the largest, followed by the United Kingdom and the United States. Japan and Germany recorded significant *deficits*. Sweden had the fastest growth in computer and information services trade over the period 1996-2002 (40% a year) followed by the Slovak Republic (35%), the Czech Republic (32%) and United States (23%).

Overall, ICT trade has been very dynamic. The share of ICT goods trade is large in comparison with the size of the industry, and trade in ICT services, particularly computer and information services, has been equally dynamic, giving a measure of the global organisation of the ICT sector.

ICTs and economic performance

The ICT supply side provides the equipment, software and services that are used productively in investments across the economy as well as in consumption. This section reviews recent evidence on the economy-wide diffusion and use of ICTs and examines three ways in which ICTs contribute to economic performance: *i*) their role in aggregate investment; *ii*) their contribution to productivity growth in ICT-producing and ICT-using sectors; and *iii*) their role at firm level. There is evidence that the effective use of ICTs contributes to growth at sectoral level (OECD, 2003d; O'Mahony and van Ark, 2004, who also examine differences in productivity performance between EU countries and the United States). Increasingly, firm-level evidence also suggests that effective diffusion and use of ICTs are key factors in broad-based growth when combined with effective human resource strategies involving education and training and organisational change.[9]

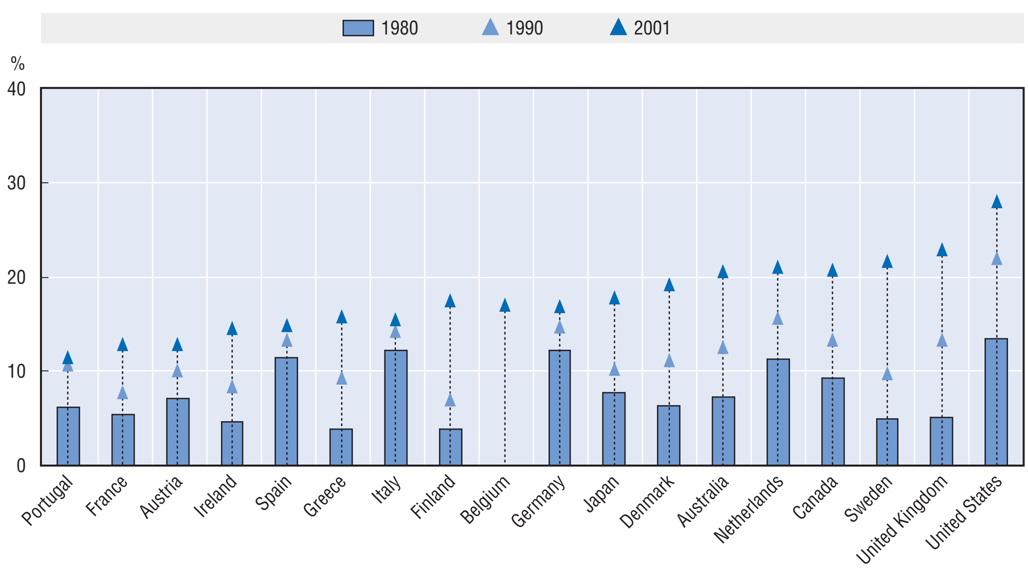
Investment in ICTs

ICTs account for an increasing share of investment because of growing demand for ICT applications and rapid price declines. Between 1980 and 2001, the share of ICT investment in total non-residential gross fixed capital formation at least doubled and in some cases grew by a factor of four (Figure 1.35). In a group of 18 countries for which comparable and harmonised OECD data are available, the overall share rose from 3-5% to 15% in 1980 to over 10% in all countries and close to 30% in the United States in 2001.[10]

Thus growth in total private investment has been increasingly driven by ICT investment, particularly in countries with a high share of ICTs in total investment. However, the pace of and impact on GDP growth ranged between 0.3 and 0.8 percentage points of growth in GDP in the 1995-2001 period (see OECD, 2003d, for a detailed discussion). Furthermore software has been a major source of ICT's rising share of investment in GDP.[11] Software investment accounted for at least one-fifth of the overall contribution of ICT capital investment to output growth and was the major contributor in Denmark, Sweden and Finland in the 1995-2001 period. On the other hand, countries where non-ICT capital

Figure 1.35. **Share of ICT investment in total non-residential gross fixed capital formation, 1980-2001**

Percentages



Source: OECD, Database on capital services, May 2003 from *Science, Technology and Industry Scoreboard* (2003).

investment remained the major contributor to growth include Ireland, Spain and Portugal, countries that are growing rapidly, transforming their economies and making modernisation investments in non-ICT infrastructure and structural change.

ICT *supply sector*

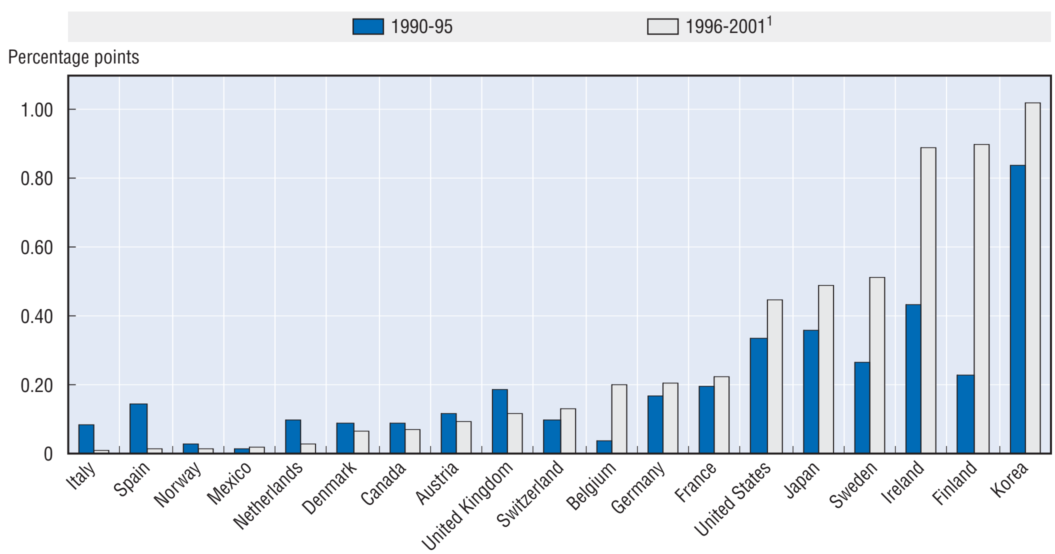
There has been continuing debate regarding the relative importance of production of ICTs *versus* their diffusion and use for economic performance. ICT production has seen rapid technological progress and very strong demand, and the sector has grown rapidly over the long term, making a large contribution to economic growth, employment and exports (see above and OECD, 2003d). Moreover, a strong ICT sector may help firms that use ICTs, since the presence of producing firms may be an advantage when developing ICT applications (OECD, 2001a). The IT O*utlook* 2002 reviewed the evidence and concluded that overall, ICT-producing and ICT-using industries contributed to the growth of total labour productivity across the economy during the 1990s For the period 1995-99, for all ten countries examined, labour productivity growth was substantially higher in the ICT-producing sector than in the rest of the economy.

More recent analysis shows that in Finland, Ireland and Korea, close to 1 percentage point of aggregate labour productivity growth over the 1995-2001 period was due to strong performance by the ICT manufacturing sector (Figure 1.36). In the United States, Japan and Sweden, ICT manufacturing also contributed significantly to productivity growth. This is partly attributable to technological progress in the production of certain ICT goods, such as semiconductors, which has contributed to rapid price declines and thus to higher growth in real volumes. However, the types of ICT goods that are produced in different OECD countries vary significantly, and variations in the distribution of these goods and in the calculation and application of price indices have large effects on productivity comparisons.

The ICT services sector (telecommunications and computer services) plays a smaller role in aggregate productivity growth, but it has also been characterised by rapid progress, owing, in part, to

Figure 1.36. **The contribution of ICT manufacturing to aggregate labour productivity growth**

Contribution to annual average labour productivity growth, percentage points



1. 1991-95 for Germany; 1992-95 for France and Italy; 1993-95 for Korea; 1996-98 for Sweden, 1996-99 for Korea and Spain; 1996-2000 for Belgium, France, Germany, Ireland, Japan, Mexico, Norway and Switzerland.

Source: OECD (2003d), *ICT and Economic Growth: Evidence from OECD Countries, Industries and Firms.*

liberalisation of telecommunications markets and the rate of technological change. This sector's contribution to overall productivity growth increased over the 1990s, notably in Canada, Finland, France, Germany and the Netherlands. Some of the growth in ICT-producing services is due to the emergence of the computer services industry, which offers key advisory and training services and the software that is used in combination with ICT hardware.

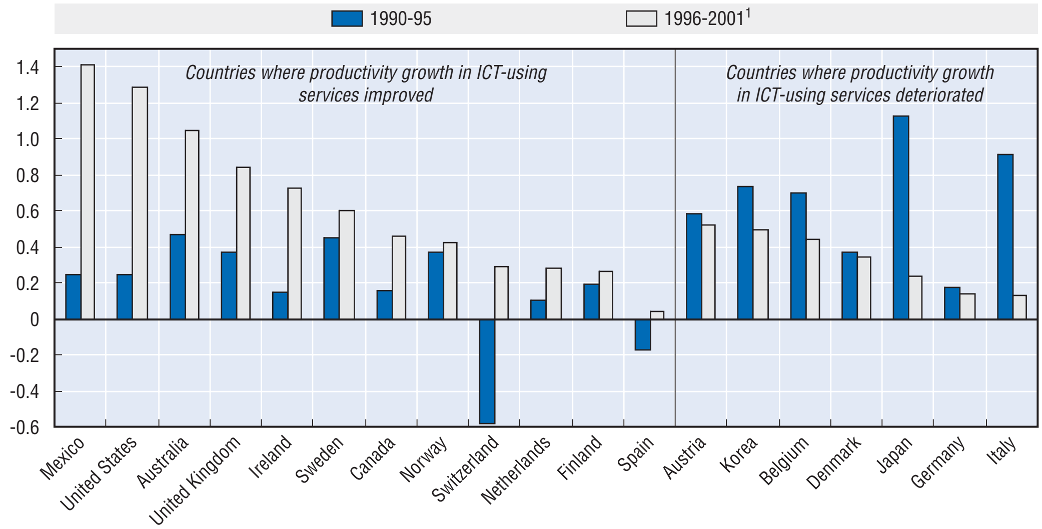
The ICT-producing sector is thus an important driver of productivity growth in countries such as Finland, Ireland, Japan, Korea, Sweden and the United States. However, because only a small number of OECD countries are specialised in the parts of the ICT sector with very rapid technological progress, notably the production of semiconductors and electronic components, the more general impact of ICTs on growth in OECD countries will be associated with investment and use in other sectors.

ICT-*using sectors*

A large part of the economy uses ICTs in production processes. Aside from the ICT-producing sectors and the non-ICT high-technology manufacturing sectors, intensive users of ICTs are largely found in the services sector (industries such as finance, business services and distribution) (OECD, 2003d). It is true that some other non high-technology sectors are also ICT-intensive (for example in the United States, petroleum and coal products, oil and gas extraction, chemicals and metal mining; US Department of Commerce, 2003). Figure 1.37 shows the contribution of the key ICT-using services (wholesale and retail trade, finance, insurance and business services) to aggregate labour productivity growth through 2001. The figure suggests small improvements in the contribution of ICT-using services in Finland, the Netherlands, Norway and Sweden, and substantial increases in Australia, Canada, Ireland, Mexico, the United Kingdom and the United States. The strong increase in the United States is due to more rapid productivity growth in wholesale and retail trade and in financial services (securities), as is the strong increase in Australia (see OECD 2003d, for more detail). While US infrastructure industries (utilities, transport, communications) are very IT-intensive, they were not associated with higher labour productivity (US Department of Commerce, 2003). In some other

Figure 1.37. **The contribution of ICT-using services to aggregate labour productivity growth**

Contribution to annual average labour productivity growth, percentage points



1. 1991-95 for Germany; 1992-95 for France and Italy; 1993-95 for Korea; 1996-98 for Sweden, 1996-99 for Korea and Spain; 1996-2000 for Belgium, France, Germany, Ireland, Japan, Mexico, Norway and Switzerland.

Source: OECD (2003d), *ICT and Economic Growth: Evidence from OECD Countries, Industries and Firms.*

countries, ICT-using services made a negative contribution to aggregate productivity growth. This is particularly true for Switzerland in the first half of the 1990s, because of poor productivity growth in the banking sector.

Stronger labour productivity growth in ICT-using industries might simply be due to greater use of capital. Estimates of growth in multi-factor productivity (MFP) adjust for growth in the capital stock and can help show whether ICT-using sectors have indeed improved their overall efficiency in use of capital and labour. OECD estimates of MFP growth at sector level point to the growing contribution of ICT-using services to aggregate productivity in Denmark and Finland. In several other countries, MFP growth in the ICT-using services was negative over the 1990s. In countries for which no OECD MFP estimates at sector level are available, notably the United States and Australia, there is evidence that sectors that have invested most in ICT, such as wholesale and retail trade, have experienced an increase in MFP growth.

For the United States, the evidence for strong MFP growth in ICT-using services is found first in retail trade, where firms such as Wal-Mart have used innovative practices to gain market share and increase pressures on competitors to improve performance (McKinsey, 2001). Securities also account for a large part of the pick-up in productivity growth in the 1990s, with strong performance attributed to a combination of buoyant financial markets (*i.e.* large trading volumes), effective use of ICTs (mainly in automating trading processes) and stronger competition (McKinsey, 2001). These impacts are primarily due to efficient use of labour and capital combined with use of ICT. In Australia, structural reforms have been important in driving the strong uptake of ICTs and have enabled these investments to be used in ways that generate productivity gains. This is particularly evident in wholesale and retail trade and in financial intermediation, where most Australian productivity gains in the second half of the 1990s occurred.

ICT services and ICT-producing industries are clearly major contributors to labour productivity growth. Sectors with high levels of ICT use (financial services, wholesale trade and other high- and medium-technology industries) also contribute significantly. However, relative contributions vary widely across countries, depending on their industry structure and, more importantly, on relative output growth in different sectors. For example, Finland has a major contribution from ICT-producing sectors, and the United States from ICT-using sectors, notably wholesale and retail trade. As the preceding discussion suggests, ICTs make a contribution on both supply and use sides, and the structure of industry as well as the growth trajectory of different sectors determine where and how ICTs will contribute to overall productivity growth. Countries can reap benefits (in terms of economic growth and greater labour productivity) from different ICT-related strategies: fostering a strong ICT-producing sector or successfully harnessing the benefits of ICT usage in other sectors of the economy to underpin growth.

The above analysis of the sectoral economic impact of ICTs is largely based on patterns and intensities of ICT capital. Analysis of the distribution of ICT-using occupations across sectors is another way to identify where ICTs are used in the economy. Chapter 6 shows in some detail that ICT-using occupations are widespread in all economic sectors but are much more important in some (ICT manufacturing, ICT services, financial and business services). It also shows that productivity performance (labour productivity measured as output per employee) is positively correlated with the intensity of ICT occupations as a share of total employment across sectors and for all countries examined, although some of this may be due to labour displacement in some sectors as well as to better growth performance.

ICT *use at firm level*

The strongest evidence for the economic impact of ICT use emerges from firm-level studies. For example, the role of ICTs in helping firms gain market share and the role of organisational change can only be examined at firm-level. Recent studies (OECD, 2003d; O'Mahony and van Ark, 2004) show that:

- ICT use has a positive impact on firm performance, productivity and wages, and is associated with plant expansion. However, the use of ICTs does not guarantee success; many firms that improved performance were already experiencing better performance than the average firm. Moreover, the benefits of ICTs depend on sector-specific effects.

- Computer networks may be particularly important, as they allow firms to outsource activities, to work more closely with customers and suppliers, and to better integrate activities throughout value and supply chains, with positive effects on productivity.
- Impacts on services are also becoming more apparent, although not all sectors use the same technologies. For example, financial intermediation is the sector most likely to use network technologies. Impacts on distribution are also significant in some countries.
- Skills are essential for effective ICT use, and firm-level studies confirm that the combination improves productivity performance.
- Organisational change is a key to benefiting from ICT investment and is closely linked to the need for skilled human resources. The greatest benefits are realised when ICT investment is combined with organisational change and changes in business processes and practices, organisational structures and human resource practices (greater voice in decision making, profit-sharing mechanisms and new industrial relations practices), including such practices as total quality management, lean administration, flatter hierarchies and delegation of authority. Organisational change tends to be firm-specific, and returns to ICT investment vary widely.
- Adoption of advanced ICTs increases with the size of firms and plants. For example, large firms are more likely to use a combination of network technologies and broadband and to use the technologies to redesign and integrate information and communication flows within the firm, whereas small firms tend only to use the Internet for marketing purposes.
- The benefits of ICTs may only emerge over time, as firms need to adapt skills and organisation.
- Cross-country studies on the impact of ICTs at firm level are still relatively scarce, since many of the original data sources are of an *ad hoc* nature and not comparable.

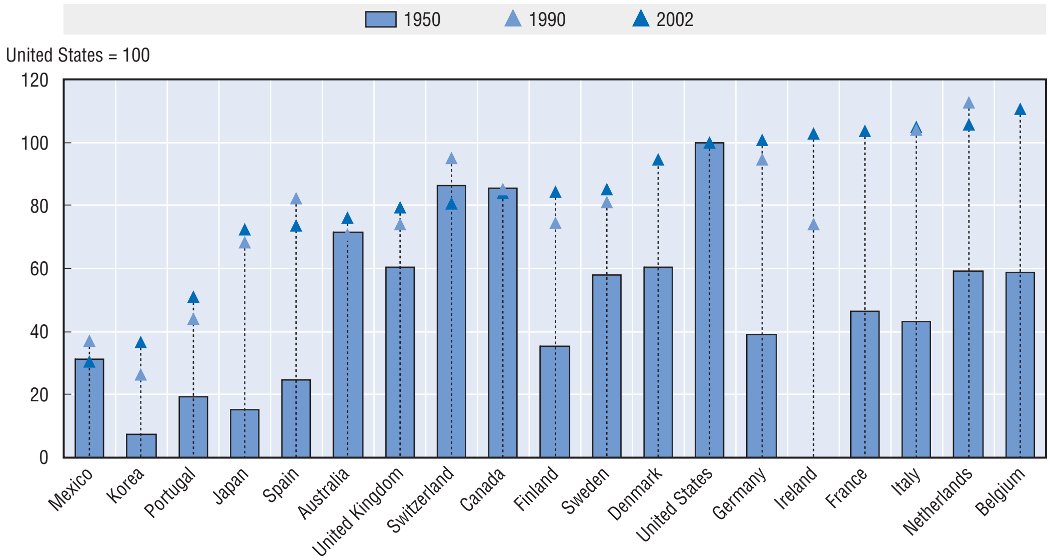
Firm-level analysis by O'Mahony and van Ark (2004) indicates that smaller companies (both less than 250 employees and 250-1 000 employees) enjoy stronger productivity growth than larger companies, while the latter benefit from higher returns to R&D investment.

Overall, firm-level evidence suggests that ICT use is beneficial – under certain conditions – to firm performance in all countries in which micro-level studies have been conducted. However, aggregate and sectoral evidence is less conclusive. It shows that investment in ICT has contributed to growth in most OECD countries, and that the ICT-producing sector has contributed to productivity growth in some. There is, however, little evidence, except in the United States and Australia, that ICT-using industries have experienced more rapid productivity growth.

In spite of the varied and positive contributions of ICTs to economic growth at various levels, the outcomes of input factors still differ widely across countries. Productivity levels (as measured by GDP per hour worked) are high in most European countries, Canada and the United States. They lag in Japan and Korea, and in catch-up countries such as Portugal and Mexico (Figure 1.38). The medium and longer-term challenge facing individual countries and regions in terms of ICT production, diffusion and applications is to improve aggregate performance. However, the challenge is not the same in different regions and countries:

- In Europe the challenge is to increase labour participation rates, while maintaining the current high rates of labour productivity per hour worked. In many European countries (except Nordic countries, the Netherlands and the United Kingdom) participation rates are low (unemployment is high, older workers often retire early, female participation is low) and the challenge is to increase use of labour at high levels of productivity. This would raise aggregate GDP and GDP per capita closer to US levels.
- In Japan and Korea, the challenge is to increase GDP per hour worked to levels closer to those in Europe and the United States, particularly by increasing efficiency in the services sectors.

Figure 1.38. **GDP per hour worked in the OECD area, 1950, 1990 and 2002**
United States = 100



Source: OECD from STI Scoreboard 2003.

- The United States has high levels of productivity and high labour participation rates as well as relatively long hours worked per worker. The challenges in the medium term are to address structural imbalances, particularly in the current account, where consumer behaviour, global ICT firm strategies and ICT trade play an important part in maintaining large current account imbalances (see the section on trade above, and Chapter 2).

Conclusions

Information and communication technologies play a pivotal role in the economy. The ICT sector is increasing its trend share of economic activity, and ICT is important for economic performance. The outlook for the ICT sector is improving from the slump which started in 2000, although the return to growth across the sector as a whole is slower than foreseen in the *Information Technology Outlook* 2002. Telecommunications services and IT services have grown steadily over the last few years, and the slump was particularly marked in ICT manufacturing. The United States led the way out of the downturn in 2002, and recovery in the ICT sector is slowly spreading to Japan and Europe as economic conditions improve, business investment strengthens and new and improved products replace earlier investments. Semiconductors are a leading indicator of ICT hardware trends, and the global upturn in semiconductors suggests that a recovery is well under way, led by strong performance in China and Korea from the start of 2002. The global top 250 ICT firms experienced difficult conditions and have returned to profit after massive losses in 2002 even though total revenues only declined 3% in 2002 from 2000 and in 2003 were above 2000 levels (current USD). Nevertheless, software, IT services and telecommunications services increased revenues by over 5% a year between 2000 and 2003. The top 50 Internet firms' revenues (firms deriving all or most of their revenue from Internet-related operations) grew in nominal USD terms through 2002 and 2003, with very large losses in 2001 and 2002.

Long-term prospects for the ICT sector are good. In 2001 the ICT sector contributed close to 10% of OECD business GDP, down a little from 2000, but up from 8% in 1995. In that year the sector employed over 17 million people, *i.e.* over 6% of business employment, and employment has grown at over 4% annually since 1995. The sector spends around one-quarter of total business R&D, attracted around half of all venture capital investment through 2003, and takes out close to one-fifth of all patents. In this overall picture, the global location of production of ICT goods has shifted, with the very rapid increase in output in China and other Asian countries, often linked with OECD investment for assembly and export. In 2002, the European Union, Japan and the United States accounted for less than two-thirds of global ICT goods production, compared with over four-fifths in 1990, and there is evidence that IT services and ICT-enabled services are also changing their global distribution.

The outlook for trade in ICT goods and services is strong, driven by higher global GDP growth, the rapid increase in China's trade, and increasing trade in IT and ICT-enabled services due to international sourcing, continuing ICT globalisation and FDI-driven organisation of production. In 2004 the volume of world trade is expected to grow at around twice the rate of GDP, as it did in 2003, and if past patterns are repeated in 2004 ICT trade should grow even faster at around 10% in real terms and more in nominal terms. However, total OECD ICT goods trade declined 13% in 2001 (after 20.5% growth in 2000), and in 2002 ICT goods trade declined another 4.5%. China's ICT goods trade has grown by a spectacular 28% annually since 1996, compared with OECD-area growth of 4.0%. Trade in software and ICT services is difficult to track satisfactorily. The two largest software goods exporters are the United States and Ireland. On the services side, communications services trade has grown steadily, and computer and information services trade have grown very rapidly, with exports growing by 20% a year and imports by 15% a year over the 1996-2002 period, with Ireland having almost USD 10.4 billion exports in 2002 compared with USD 6.9 billion from the United States, linked with their large software industries, driven by foreign investment in the case of Ireland.

In terms of wider diffusion across the economy, ICT and Internet use are increasingly ubiquitous. and firms, industries and countries are reaping benefits from ongoing ICT investments. However, growth has been uneven, and the contribution of ICTs to growth is conditioned by overall investment and economic performance, and consumer demand for new products. ICTs accounted for a large and growing share of investment, thereby contributing significantly to GDP growth in most OECD countries. The ICT-producing sector has contributed to productivity growth especially in countries with relatively large R&D-intensive manufacturing ICT sectors. There is, however, little overall evidence that ICT-using industries, except principally in the United States and Australia, have experienced more rapid productivity growth. Firm-level evidence suggests that ICT use is beneficial to firm performance when aligned with firm strategies and, most importantly, combined with improved skills and appropriate organisation and innovation. Firms that invest in a range of intangible and tangible assets experience superior growth (see Chapter 3).

A range of policies affect the development and use of ICTs. The general economic policy environment is a key factor in encouraging growth and investment both in the ICT sector and more widely in the ICT-using environment. Policies for R&D and innovation have a major impact on the ICT sector because of its reliance on innovation and new products. Venture capital is of major importance in the development of the supply side, and the supply of ICT skills both within the sector and across the economy is crucial for long-term growth. In terms of diffusion and widespread impacts, analysis shows that ICTs need to be combined with complementary skills, organisational change and innovation over considerable periods before firms reap the benefits of applications, suggesting that ICT diffusion policies need to be broadly-based and consistent over long periods. Recent trends in OECD policies are outlined in Chapter 8.

NOTES

1. The term "information and communication technology" (ICT) is used throughout the Outlook to refer generically to the family of related technologies that process, store and transmit information by electronic means. The term "information technology" (IT) is narrower and is used to denote computer, software and related technologies not including communications and network technologies, but the boundary between the two is increasingly blurred. See also OECD (2003a).
2. Gross non-residential fixed investment was up by 9.7% in Japan in 2003 and is projected to grow by 9.1% in the United States in 2004.
3. See note 1.
4. This may be due, in part, to the data for EU15 being less detailed than the US data, so that some occupations, *e.g.* electronic engineers, cannot be distinguished, resulting in an underestimation of ICT-skilled employment aggregates.
5. The data in this section are in nominal terms; data in volume terms might show a somewhat different picture, reflecting the particularly rapid price declines in hardware.
6. Averages for the period 1999-2001 are used because venture capital investments have strong annual fluctuations and shares can change significantly from year to year.
7. Market data from IDC are different from its data in the previous issue of the *Information Technology Outlook*. They do not include own-account software and the list of products has been modified and expanded to allow for changes in the composition of ICT markets. Furthermore, the definition of the ICT market is not congruent with the OECD ICT supply sector, for example, telecommunications includes hardware as well as services.
8. The intangible nature of services and the increasing number and complexity of delivery mechanisms make trade in services more difficult to quantify than trade in goods. Moreover, there is greater variation among countries in terms both of the definitions used and of the quality and coverage of the data collected.
9. This section draws extensively on the ICT and economic growth project, see OECD (2003d).
10. Data presented are calculated on a comparable basis across countries. Individual national data may vary. For example, more recent data for the United States shows higher shares of investment in information processing equipment and software as a share of total non-residential investment: 1980 19%, 1990 29%, 2001 37%, US Bureau of Economic Analysis, *Survey of Current Business*, Table 5.3.5.
11. Owing to measurement problems, some countries do not measure software investment comprehensively and their GDP therefore tends to be understated (Ahmad, 2003).

REFERENCES

Ahmad, N. (2003), "Measuring Investment in Software", STI Working Paper 2003/6, OECD.

The Economist (2004), "A Perfect Market. A Survey of E-commerce", 15 May.

Forrester Research (2003), "Despite Signs of Economic Recovery, Caution Chokes 2004 IT Spending Plans", 12 November, *www.forrester.com*.

Gartner (2003a), "Technology Demand Index Shows IT Spending Remained Soft in October, Although Increases Point to Optimism for 2004", 14 November, *www.gartner.com*.

Gartner (2003b), "Forecast Analysis: 4Q03 Update – Semiconductor Capital Equipment Spending", *Gartner*, 19 November.

Gartner (2004), "European PC Sales Continue to Soar", reported in *Financial Times*, 16 April.

International Data Corporation (IDC) (2003), "Long-awaited Turnaround in IT and Telecom Spending", Press Release, 3 November, *www.idcresearch.com*.

Lopez-Bassols, V. (2003), "Recent Developments in the ICT Sector", OECD, DSTI/ICCP/IE(2002)17/FINAL.

McKinsey (2001), *US Productivity Growth 1995-2000: Understanding the Contribution of Information Technology Relative to Other Factors*, McKinsey Global Institute, Washington DC, October.

OECD (2001a), *The New Economy: Beyond the Hype – The OECD Growth Project*, OECD, Paris.

OECD (2002a), *Information Technology Outlook 2002*, OECD, Paris.

OECD (2003a), *OECD Communications Outlook*, OECD, Paris.

OECD (2003b), *OECD Science, Technology and Industry Scoreboard*, OECD, Paris.

OECD (2003c), *OECD Economic Outlook*, No. 74, OECD, Paris.

OECD (2003d), *ICT and Economic Growth: Evidence from OECD Countries, Industries and Firms*, OECD, Paris.

OECD (2004), *OECD Economic Outlook*, No. 75, OECD, Paris.

O'Mahony, M., and B. van Ark (eds.) (2004), "EU Productivity and Competitiveness: An Industry Perspective", *http://europa.eu.int/comm/enterprise/enterprise_policy/competitiveness/doc/eu_competitiveness_a_sectoral_perspective.pdf*.

PricewaterhouseCoopers (2004), "MoneyTree Survey – Full Year and Q4 2003 Results", March 2004, *www.pwcmoneytree.com*.

Reed Electronics Research (2003), *Yearbook of World Electronics Data 2003*, Vol. 1-2, Sutton, United Kingdom, advance issue for 2004 and previous issues.

United States Department of Commerce (2003), *Digital Economy 2003*, Economics and Statistics Administration, December.

World Trade Organisation (2004), "World Trade 2003, Prospects for 2004. Stronger than Expected Growth Spurs Modest Trade Recovery", Press/373, 5 April.

Chapter 2

GLOBALISATION OF THE ICT SECTOR AND INTERNATIONAL SOURCING OF ICT-ENABLED SERVICES

The ICT *sector is a leader in globalisation. Rationalisation of global production has led to greater trade specialisation and high levels of intra-firm trade, while* ICT *cross-border mergers and acquisitions continue relatively high. China has emerged as a major global actor in the* ICT *sector. International sourcing (offshoring) of* IT *and* ICT*-enabled business services is growing rapidly, India is an important exporter and some other developing economies are following. Globalisation and international sourcing are analysed in depth and implications are drawn.*

Introduction

Globalisation is fundamentally driven by firms. Underlying the international expansion of firms, and in part driven by it, are technological advances especially in information and communication technologies (ICTs), market liberalisation and increased mobility of capital and other production factors. In the past, international strategies were based on exports or multi-domestic operations (with wholly-owned foreign subsidiaries in host countries producing for local markets). These have increasingly given way to strategies based on a mix of cross-border operations, including exports and international sourcing, foreign investment, mergers, acquisitions and alliances. Consequently, globalisation now has three main routes: international trade, foreign direct investment (FDI) and various kinds of international alliances, collaboration, co-operation and sourcing.

On any measure, the world economy is globalising rapidly. In 2002, there were an estimated 63 834 multinational enterprises (MNEs) with some 866 119 foreign affiliates operating around the world. Those foreign affiliates employed around 53 million people worldwide, up from 24 million in 1990. At almost USD 18 trillion, affiliates' sales were worth twice as much as world trade. Worldwide, FDI inflows amounted to USD 651 billion and accounted for 10% of global gross fixed capital formation, compared with 2% two decades earlier. FDI inflows increased 10% a year between 1990 and 2002, the assets of foreign affiliates increased 13% a year, their sales by 10% a year, their gross product by 7.4% a year and their exports by 6.7% a year (UNCTAD, 2003).

This chapter studies the globalisation of the ICT-producing sector. Drawing on official industry and various trade sources, it looks at a variety of quantitative indicators in order to highlight major trends and developments.[1] It demonstrates that the ICT sector has been, and remains, at the forefront of industrial globalisation.

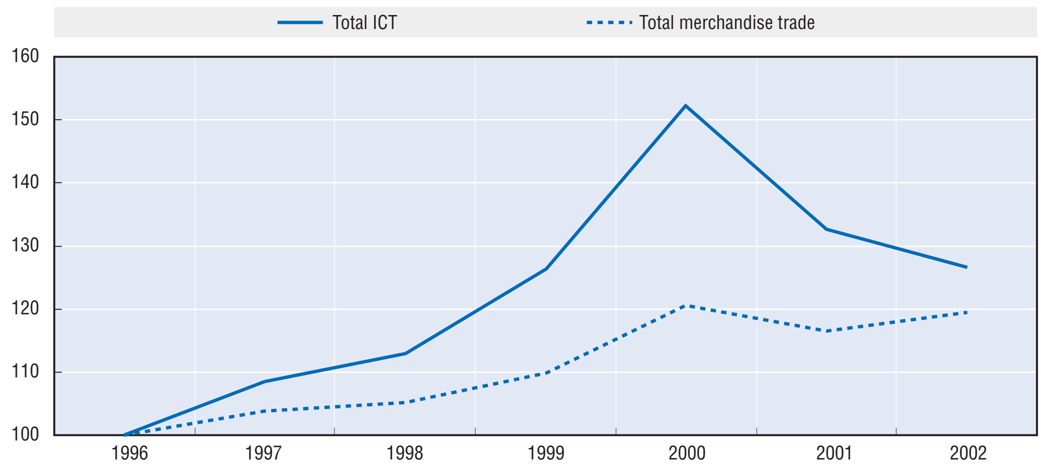
Globalisation and trade

Over the past quarter of a century, the overall pattern of world trade has changed owing to the rapid growth of exporting economies, notably in East Asia, and to the spread of high-technology industries across developed economies. In addition to the increasing intensity of trade, a key feature of this transformation has been the development of international sourcing (*i.e.* international purchasing of intermediate product and service inputs) both within firms and between firms in the same industry (*i.e.* intra-firm and intra-industry trade). This section explores these features of globalisation. It begins by examining the level of internationalisation of the ICT-producing sector.

ICT *trade is growing faster than total trade*, ICT *sales and* ICT *production*

Over the past 20 years, trade in high-technology products has accelerated, and their share in total trade has increased (Figure 2.1 and Annex Table C.2.1). ICT trade (the average of exports and imports) continues to outpace total trade, despite being affected more severely by the recent downturn than trade in many other sectors. In 1996, ICT goods (including communication equipment, IT and related equipment, electronic components, audio and video equipment and other ICT related goods, see Annex B for definitions) accounted for 13% of OECD merchandise trade. By 2002 they accounted for 14%, having peaked at 16.6% in 2000. Trade in ICT goods grew at a compound annual rate of 4% over the period 1996-2002, compared with 3% a year growth in total merchandise trade. Trade in ICT services also appears to be growing faster than total trade in services. OECD trade in communications services increased over 4% a year between 1996 and 2002 and trade in computer and information services increased by almost 18% a year. By contrast, total services trade increased by 3.4% a year over the same

Figure 2.1. **OECD trade: ICT goods and total merchandise trade, 1996-2002**
Index 1996 = 100 current USD



Source: OECD ITS database.

period. ICT goods thus account for an increasing share of OECD merchandise trade and, despite limited data, trade in ICT-related services seems to represent an increasing share of total services trade. In these terms, the ICT sector is globalising faster than many other sectors.

A comparison of national data on ICT spending and ICT-related trade data suggests that ICT trade is growing faster than ICT spending. As noted, OECD trade in ICT goods increased by 4% a year between 1996 and 2002. By contrast, spending on ICT hardware decreased by 1% a year. Spending on IT services in OECD countries increased from USD 237 billion in 1996 to USD 335 billion in 2002, or by 5.9% a year. By comparison, OECD trade in computer and information services increased from USD 13 billion in 1996 to USD 34 billion in 2002, or by almost 18% a year. Consequently, ICT-related trade is growing faster than ICT spending, a further indication that the ICT-producing sector is becoming increasingly globalised.

ICT trade is also growing faster than production (Table 2.1). Between 1992 and 2001, European production of electronics goods increased 1.9% a year, while trade in those goods increased 7.7% a year. Similarly, the production of electronics goods in other regions increased 4.1% a year, while trade increased 8.9% a year.

Table 2.1. **Annual growth in electronics goods trade and production, 1992-2001**
Percentages

	Electronic data processing	Radio communications	Telecommunications	Other	Total
Europe					
Imports	6.7	18.7	16.5	4.5	6.9
Exports	8.2	17.9	13.8	6.2	8.6
Trade	7.3	18.2	15.1	5.3	7.7
Production	1.5	6.4	– 0.9	1.6	1.9
Other regions					
Imports	11.3	18.2	13.4	8.9	10.4
Exports	7.7	13.4	9.8	6.9	7.7
Trade	9.3	15.6	11.5	7.8	8.9
Production	4.7	6.2	6.7	2.7	4.1

Note: Based on current USD values.
Source: Reed Electronics Research, *Yearbook of World Electronics Data*, 1994 and 2003.

Prior to the liberalisation of telecommunications, many national carriers practised local purchasing policies, such that communications equipment manufacturing operated multi-domestically (*i.e.* manufacturing was based in many countries to serve local markets). With liberalisation, purchasing practices changed and communications equipment manufacturing evolved towards a transnational model. Hence, the difference between production and trade is larger, and growth of trade is faster, in radio and telecommunications equipment categories owing to their more rapid globalisation over the last decade.

Specialisation in ICT *production*

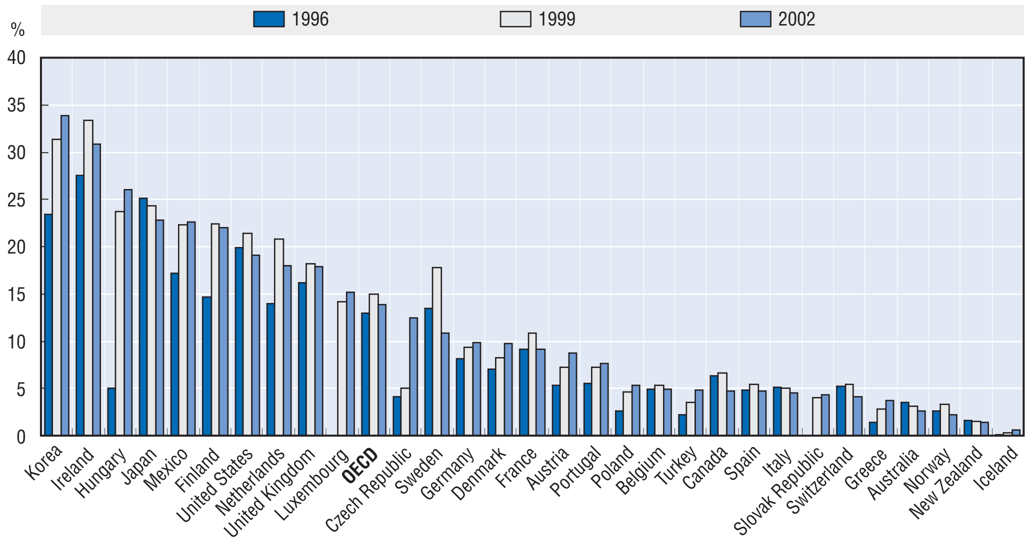
The global rationalisation of production might be expected to lead countries to become more specialised in the production of a smaller and more defined range of products and services (*i.e.* globalisation and specialisation would go hand in hand). The share of a country's manufactured exports accounted for by ICTs is one indicator of the level of specialisation in ICT production.

The share of ICT goods in merchandise exports varies significantly from country to country (Figure 2.2). In 2002, it was highest in Korea, with ICTs accounting for 34% of total merchandise exports, up from 23% in 1996. Ireland was the only other OECD country in which ICT goods accounted for more than 30% of merchandise exports, although they accounted for between 20% and 25% in Hungary, Japan, Mexico and Finland. By contrast, ICT goods accounted for less than 4% of merchandise exports from Iceland, New Zealand, Norway, Australia and Greece.

While production specialisations endure, there have been changes in rankings and levels of specialisation. Countries whose level of specialisation in ICT production has increased since the mid-1990s include: Hungary, Korea, the Czech Republic, Finland, Mexico, the Netherlands, Austria, Ireland and Denmark. Those experiencing a decline include: Sweden, Japan, Canada, Switzerland and Australia. In some of the smaller, but relatively specialised ICT-producing countries the recent poor fortunes of leading firms are evident (*e.g.* Sweden). Nevertheless, there is evidence of increasing specialisation in ICT production in some countries, with concomitant declines in others.

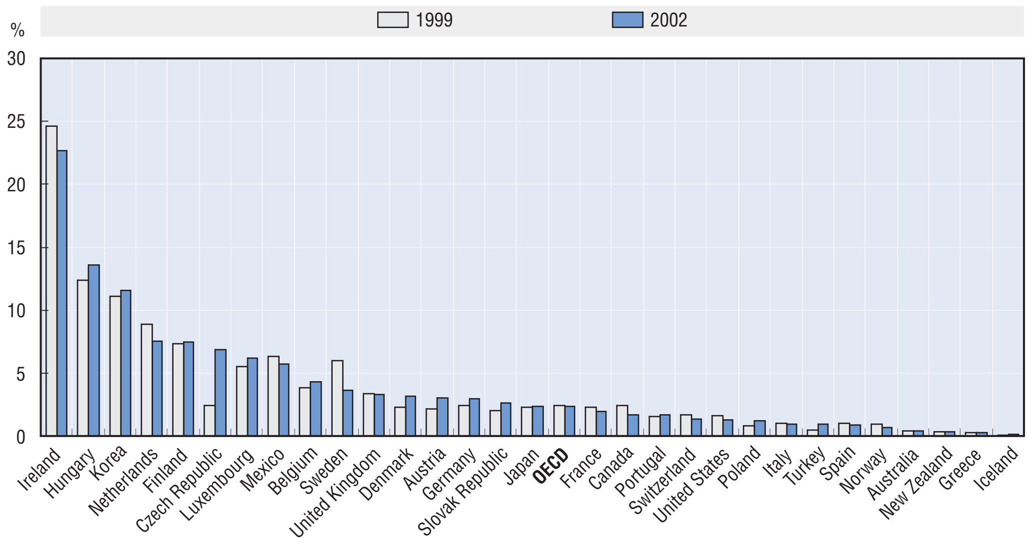
Perhaps a more direct indicator of specialisation in ICT production and the globalisation of the ICT manufacturing sector is the ratio of a country's ICT goods exports to GDP, which indicates how important ICT goods exports are in the industrial structure of the economy (Figure 2.3). Again, it is evident that

Figure 2.2. **Share of ICT goods in total merchandise exports, 1996-2002**



Source: OECD ITS database.

Figure 2.3. **ICT goods exports as a share of GDP, 1999-2002**

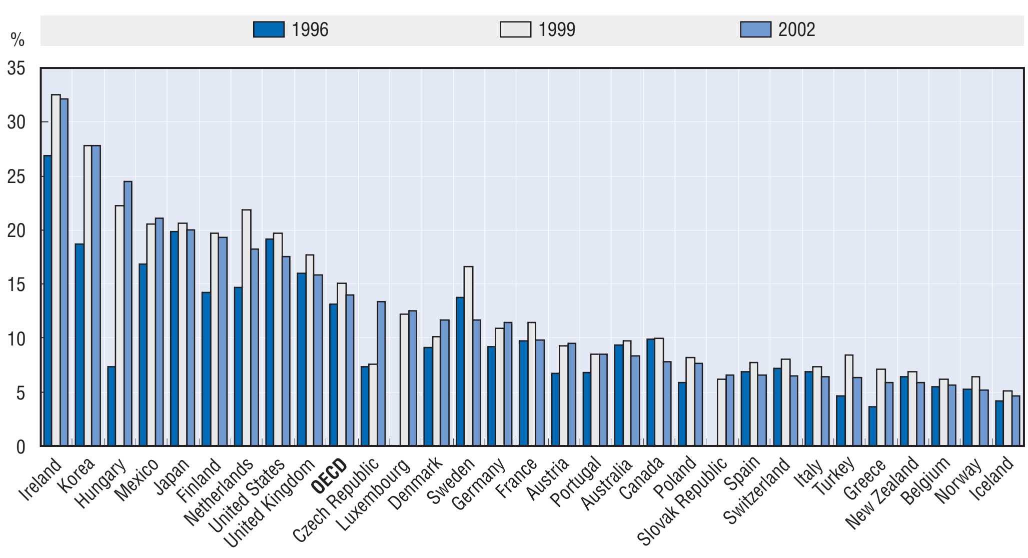


Source: OECD ITS database.

Ireland's economy is strongly oriented to ICT production for export, with ICT goods exports equivalent to 23% of GDP in 2002. Other countries with relatively high levels of specialisation in ICT manufacturing include: Hungary (with ICT goods exports equivalent to 14% of GDP), Korea (11.5%), the Netherlands (7.6%) and Finland (7.5%).

In general, countries with a high share of ICT goods exports also have high ratios of ICT goods trade (defined as the average of ICT goods imports and exports) to total trade (Figure 2.4). In 2002, ICT goods trade accounted for 20% or more of total merchandise trade for Ireland, Korea, Hungary and Mexico.

Figure 2.4. **ICT goods trade as a share of total merchandise trade, 1996-2002**



Source: OECD ITS database.

This reflects relatively high levels of intra-industry trade, with countries often exporting components for assembly elsewhere (*e.g.* the United States) or importing components and exporting assembled products (*e.g.* Ireland and Mexico).

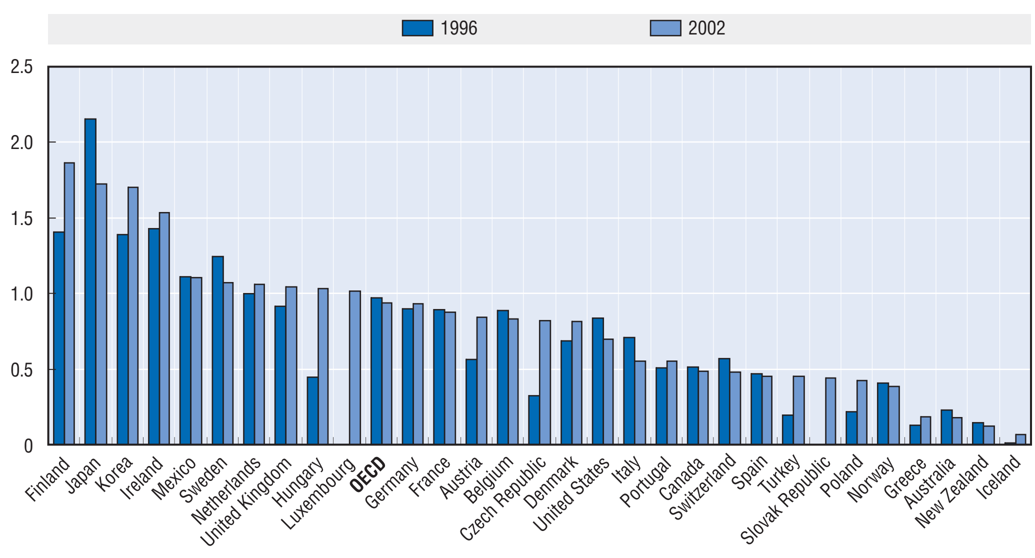
Indicators of ICT *trade performance*

The ratio of exports to imports is an indicator of specialisation – *i.e.* of how well a country is performing as producer and exporter (Figure 2.5 and Annex Table C.2.2). A ratio of more than one indicates a surplus of exports over imports, and a ratio of less than one a deficit. In 2002, Finland, Japan, Korea, Ireland, Mexico, Sweden, the Netherlands, the United Kingdom, Hungary and Luxembourg had surpluses of ICT goods exports over imports. All other OECD countries had an export/import ratio of less than one. In the cases of Finland, Korea, Ireland, the Netherlands, the United Kingdom and Hungary their level of specialisation in ICT goods increased over the six years to 2002, while the specialisation levels of Japan and Sweden decreased. Notable increases in ICT specialisation have been experienced by Hungary and the Czech Republic.

Another way to look at specialisation in ICT goods manufacture for trade is to calculate an index of "revealed comparative advantage" to see whether the ICT manufacturing industry performs better or worse in a given country than the average of its performance throughout the OECD area (Figure 2.6 and Annex Table C.2.3).[2] In 2002, ten OECD countries had a comparative advantage in ICT manufacturing: Korea, Ireland, Hungary, Japan, Mexico, Finland, the United States, the Netherlands, the United Kingdom and Luxembourg. Korea (2.44) and Ireland (2.22) had the greatest comparative advantage in ICT manufacturing, and the other eight had indexes ranging from 1.09 (Luxembourg) to 1.87 (Hungary).

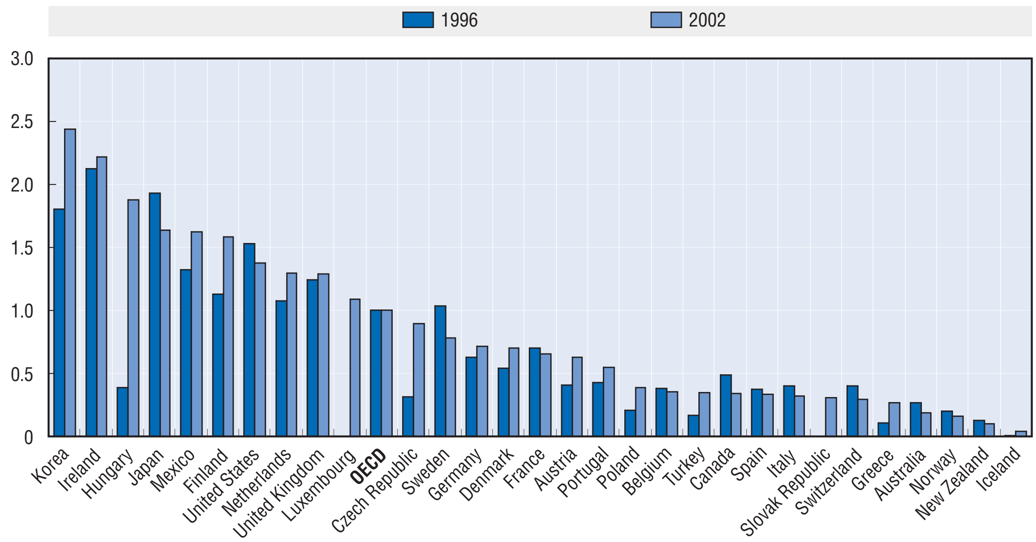
The last six years have seen a number of marked changes. Eight of the ten countries with a comparative advantage in 2002 increased their comparative advantage over the period from 1996, most notably Hungary and Korea. Japan, the United States, Sweden, France, Belgium, Canada, Spain, Italy, Switzerland, Australia, Norway and New Zealand have all experienced declining comparative advantage in ICT manufacturing. Again this suggests that the ICT manufacturing sector is becoming increasingly concentrated in some countries, while gradually exiting others.

Figure 2.5. **Export/import ratio for ICT goods, 1996-2002**



Source: OECD ITS database.

Figure 2.6. **Revealed comparative advantage in ICT goods, 1996-2002**



Source: OECD ITS database.

Intra-industry trade

Traditional economic theory suggests that trade patterns reflect factor endowments and comparative advantage. Based on their relative factor endowments, countries specialise in producing those goods and services in which they have a comparative advantage and trade them for products of different industries in which other countries have a comparative advantage. However, developed countries are increasingly trading the products of the same industries. This intra-industry trade tends to enhance the gains from trade through increasing specialisation in a limited number of products within particular industries. Intra-industry trade is a consequence of the global rationalisation of production (*i.e.* globalisation).

The Grubel-Lloyd Index is the most widely used measure of intra-industry trade. It represents the fraction of total trade in an industry accounted for by intra-industry trade, expressed as a percentage.[3] The closer the values of imports and exports the higher the index. Because the ICT goods trade categories used here include both equipment and components, they approximate the inputs and outputs of the ICT-producing sector. Although they are at a relatively high level of aggregation, they can be used to construct a Grubel-Lloyd Index. The index has a number of limitations, however, which are especially noticeable where trade is either very large (*e.g.* United States) or very small (*e.g.* Iceland). Nevertheless, it does reveal aspects of globalisation of the ICT sector.

The overall picture is somewhat clouded by the recent downturn in ICT trade. Nevertheless, the ICT goods-producing sector appears to be becoming more specialised. Fourteen of the 28 OECD countries for which data are available recorded higher levels of intra-industry trade in 2002 than in 1996 and there was a 2.6% a year increase in the average intra-industry trade index for the 28 countries for which data are available (see Annex Table C.2.4).

Intra-firm trade

Intra-firm trade consists of cross-border transactions between affiliated units of MNEs. The level and growth of intra-firm trade as a share of total trade reflects MNEs' search for greater efficiency and the consequent rationalisation of production at the global level. High and increasing levels of intra-firm trade are an indicator of the globalisation of production and of the development of ever more complex systems of global production and sourcing.

The United States is one of the few countries to report intra-firm trade in detail. In 2002, intra-firm trade accounted for 42% of total US merchandise trade (USD 770 billion): 48% of the total value of merchandise imports (USD 549 billion) and 32% of the value of merchandise exports (USD 221 billion). The shares of intra-firm trade in both imports and exports are higher than in 2000. The ratio of goods traded by related parties varies from country to country, from highs of 76% for US imports from Japan and 43% of exports to Mexico, to lows of 13% for imports from Hong Kong, China, and 12% for exports to China (Department of Commerce, 2002). These differences reflect differences in the relative levels of integration of national and international production systems.

US data on trade in ICT products and services show that the ICT sector is characterised by relatively high levels of intra-firm trade. Intra-firm trade accounted for 68% of ICT goods imports into the United States in 2002 and 40% of exports, compared with 48% of all imports, and 32% of all exports (Table 2.2). Despite the downturn, the shares of both intra-firm ICT imports and exports were higher in 2002 than in 2000. These relatively high levels of intra-firm trade mean that ICT goods accounted for almost 23% of all intra-firm goods imports into the United States in 2002.

Table 2.2. **US intra-firm trade in ICT goods, 2002**

USD millions and percentage shares

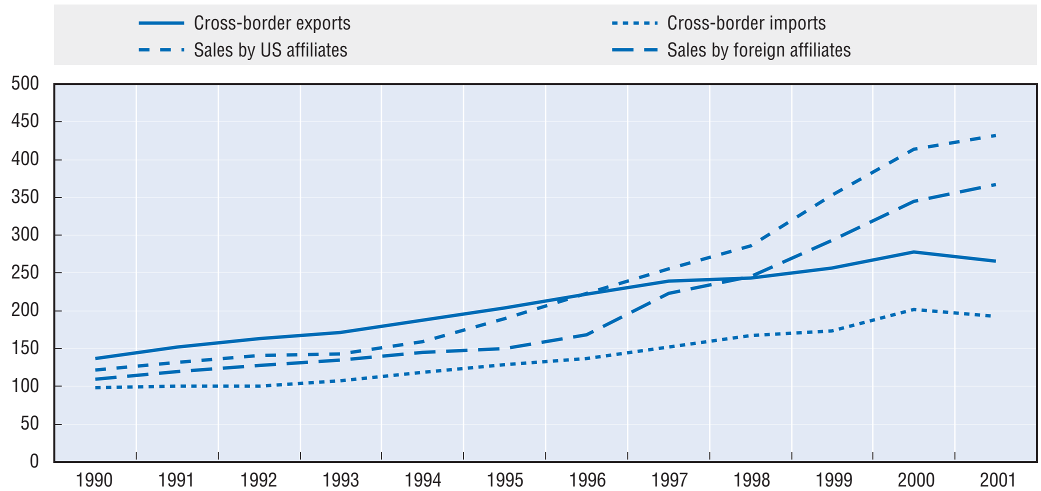
	US imports			US exports		
	Total imports	Related party trade	Share	Total exports	Related party trade	Share
All industries	1 154 811	549 402	47.6	693 257	220 967	31.9
Computer equipment	62 284	43 699	70.2	29 060	11 666	40.1
Communication equipment	27 937	20 606	73.8	12 262	2 878	23.5
Audio and video equipment	30 825	19 956	35.3	3 986	1 498	37.6
Electronic components	58 382	38 072	65.2	44 720	20 169	45.1
Magnetic and optical media	3 022	1 614	53.4	1 226	547	44.6
ICT products	182 450	123 947	67.9	91 254	36 758	40.3
ICT share of total	15.8	22.6		13.2	16.6	

Note: ICT sector based on 4 digit NAICS.
Source: US Department of Commerce, 2003.

Intra-firm trade is also increasingly important in services. US cross-border and intra-firm services sales both increased during the 1990s, but intra-firm sales increased faster than cross-border sales, by 12% a year, compared with 7% a year (Figure 2.7). US sales of computer-related services through foreign affiliates are reported to have exceeded cross-border exports in 2000 (Borga and Mann, 2002, p. 76), and in 2002, 22% of US cross-border exports and 69% of cross-border imports of computer and related services were with affiliates (Department of Commerce, 2002).

Moreover, because of the increasing role of non-US firms in ICT production and trade, US data may understate recent trends in the level of intra-firm trade in ICTs. In the past, global ICT goods production was dominated by US-based firms, it is now more and more due to non-US Asian-based firms, with the result that ICT goods trade increasingly bypasses the United States. For example, the United States was the largest supplier of ICT goods imports into Australia until 2002-03 when, for the first time, China (including Hong Kong) became the largest supplier (Houghton, 2003). Hence, trends in US intra-firm trade may no longer fully and accurately reflect overall trends in the globalisation of ICT production.

Figure 2.7. **US cross-border and intra-firm services sales, 1990-2001**
Current USD billions



Source: Department of Commerce, 2003.

Foreign direct investment

Trade is becoming a somewhat less important avenue for globalisation as new patterns of cross-border business activity emerge (see Box 2.1). FDI has played a fundamental role in furthering global economic integration and has been a driving force behind world economic restructuring over the past 20 years. FDI has increased significantly over that time, although the recent world slow down and ending of the stock market bubble meant that the level of flows of direct investment reached in 2000 has not been maintained. Direct investment activity is affected by cyclical fluctuations in income and growth. On the supply side, FDI is affected by the availability of investment funds. Recent declines in profitability and reduced stock market valuations mean that there is a reduced availability of funds for investment and expansion. On the demand side, growing overseas markets lead MNEs to invest, while depressed markets inhibit them (UNCTAD, 2002). Recent slower growth, especially in markets for many ICT products and services, reduced the attractiveness of international expansion. Consequently, FDI flows were lower in 2001 and 2002 than they had been in 2000.

Between 1990 and 2000, worldwide FDI inflows increased 20% a year, from USD 209 billion to USD 1.4 trillion. In 1990, FDI accounted for just 4% of world gross fixed capital formation. By 2000, it accounted for 22%. In 2001, worldwide FDI inflows amounted to only USD 824 billion, little more than half their value in 2000, and in 2002 they fell again to USD 651 billion. At the same time, while investment flows slowed, stocks continued to increase. From USD 1.9 trillion in 1990, worldwide FDI inward stocks increased to USD 6.1 trillion in 2000, USD 6.6 trillion in 2001 and USD 7.1 trillion in 2002. In terms of the ongoing process of globalisation, it is important to note that despite the recent slowing of direct investment flows, stocks continue to grow (see Annex Table C.2.5).

FDI *in* OECD *member countries*

FDI inflows to OECD countries grew from USD 138 billion in 1988 to USD 490 billion in 2002, and outflows from USD 175 billion to USD 606 billion. Over the last decade, FDI inflows to OECD countries increased 15% a year and outflows by 13% a year, while combined OECD-area GDP increased by around 3% a year. Hence, for the OECD as a whole, FDI has been growing more quickly than GDP, furthering industrial globalisation.

Box 2.1. Non-trade modes of industrial globalisation

Greenfield investments establish new productive facilities in the host country and are a traditional (entry) mode for globalisation. To establish business in a particular foreign market, greenfield investment requires more time than acquiring existing firms (M&A mode). However, it can be designed and implemented to incorporate the parent company's global strategy from the outset, thereby avoiding the challenging integration process involved in M&As. Traditionally, foreign investment policies favour greenfield investments over M&As, on the assumption that they have more immediate positive effects on capital accumulation and job creation in the host country.

Mergers and acquisitions (M&As) take place when operating enterprises merge with (merger) or acquire control of (acquisition) the whole or a part of the business of other enterprises. Cross-border M&As are those undertaken between firms of different national origin or home countries. A merger is the combination of two or more businesses to achieve common objectives. Once the business is combined, the merged company may cease to exist, with the acquiring company assuming the assets and liabilities of the merged company (statutory merger), or the acquired company may become a 100% subsidiary of the parent company (subsidiary merger). Also, two or more companies may join to form an entirely new company, in which case all companies involved in the merger cease to exist and their shareholders become shareholders of the new company (consolidation). Alternatively, the acquiring company may purchase a part of the stocks or assets of the target company and combine it with its own business. M&As allow firms quick entry into a specific market through the acquisition of production facilities and intangible assets.

Strategic alliances: take a variety of forms, ranging from arm's-length contract to joint venture. The core of a strategic alliance is an inter-firm co-operative relationship that enhances the effectiveness of the competitive strategies of the participating firms through the trading of mutually beneficial resources such as technologies, skills, etc. Strategic alliances encompass a wide range of inter-firm linkages, including joint ventures, minority equity investments, equity swaps, joint R&D, joint manufacturing, joint marketing, long-term sourcing agreements, shared distribution/services and standards setting. The advantage of strategic alliances over other modes of entry is their flexibility, which allows firms to respond to changing market conditions effectively, without changes in the ownership structure of participating firms.

Source: OECD (2001), p. 14.

Although in 2000 FDI inflows increased by almost 43% (USD 380 billion) and outflows increased by 26% (USD 267 billion), flows have since fallen dramatically. FDI inflows halved in 2001 and fell a further 20% in 2002, while outflows also almost halved in 2001 and fell a further 12% in 2002. In 2000, FDI flows were equivalent to around 5% of combined OECD area GDP, but in 2001 they were equivalent to less than 2.5% and by 2002 they had fallen to around 2%.

There are a number of notable features within these overall trends. Perhaps most notable is that, excluding the United States and the United Kingdom, OECD countries recorded an increase of USD 14 billion (3%) in FDI inflows in 2002. Indeed, there is significant country-by-country variation in recent FDI trends. For example, large declines in FDI inflows into the United States and United Kingdom occurred in parallel with increased inflows into Australia, Germany, Finland and Japan. It is also apparent that FDI outflows from OECD member countries have held up somewhat better than inflows, because of the continued growth potential of developing country markets such as China, which has become the world's foremost recipient of FDI. Net FDI flows to non-member economies reached USD 117 billion in 2002, up markedly from just USD 4 billion in 2000 and USD 76 billion in 2001.

FDI *in the* ICT *sector*

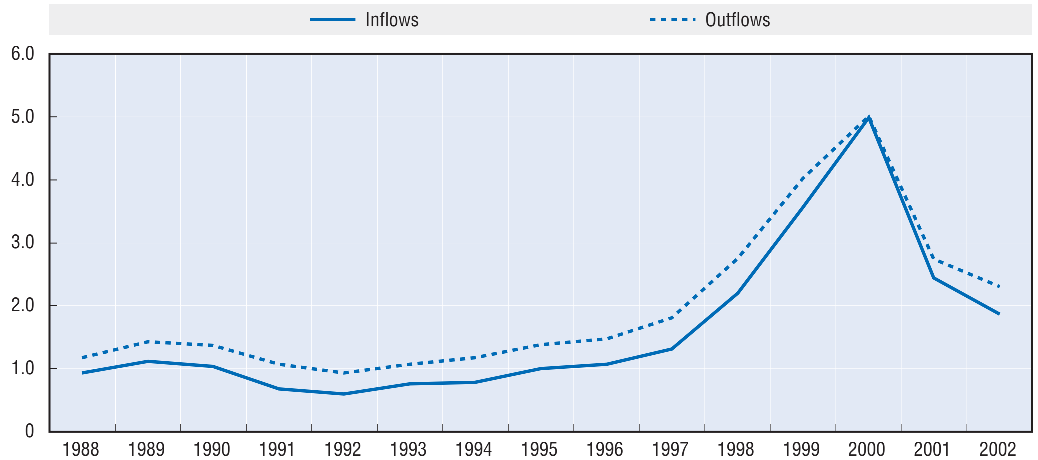
Data available on FDI by industry are limited. However, over the period 1988-97, worldwide FDI stocks in ICT goods manufacturing grew at an annual average rate of 15.3%, and computer and related services stocks at an annual average of 30%. Individual country FDI flows for a single industry sector are subject to wide variations. Nevertheless, a general pattern of growth in both inward and outward direct investment in computer and office machinery manufacturing was evident during the 1990s (Figure 2.8). In the United States, for example, inward direct investment in the sector grew from USD 271 million in 1990 to USD 16 billion in 1999, and outward direct investment from USD 1.2 billion to USD 6.2 billion. More recently, worldwide FDI inflows to electrical and electronic goods manufacturing have fallen from an annual average USD 49 billion in 1999-2000 to USD 17.3 billion in 2001. Similarly, FDI inflows to transport, storage and communications fell from an annual average USD 143 billion in 1999-2000 to USD 74 billion in 2001 (UNCTAD, 2003).

OECD countries that were major recipients of FDI inflows into machinery, computers, radio and television and communications equipment manufacturing in 2001 included: the Netherlands (USD 2.8 billion), the United Kingdom (USD 2 billion) and France (USD 1.2 billion). Major recipients of FDI inflows into telecommunication services included: Japan (USD 6.8 billion), the United Kingdom (USD 4.2 billion), the Netherlands (USD 3.9 billion), France (USD 3.8 billion) and Belgium-Luxembourg (USD 3 billion). As a share of total national FDI inflows, the countries that received the most significant inflows into machinery, computers, radio, television and communications equipment manufacturing in 2001 were: Korea (23% of the total), the Netherlands (5.5%) and Poland (5.1%). Those that received the most significant inflows into telecommunication services were: Japan (38% of total), Poland (19%), Czech Republic (17%) and Mexico (11%).

OECD countries from which major outflows of FDI in machinery, computers, radio, television and communications equipment manufacturing originated in 2001 were: the United States (USD 12 billion), the Netherlands (USD 2.5 billion) and Finland (USD 2.2 billion). Major sources of FDI into telecommunication services included: Germany (USD 34 billion), Spain (USD 5.8 billion), Italy (USD 2.8 billion), Norway (USD 2.7 billion) and Denmark (USD 2.4 billion). As a share of total FDI outflows, the countries that sent the most significant flows into machinery, computers, radio, television and communications equipment manufacturing in 2001 were: Korea (45%), Finland (26%) and the United States (10%). Those that sent the most significant flows into telecommunication services were: Norway, Germany, Denmark and Spain. Both FDI inflows and outflows relating to telecommunication services reflect major acquisitions (see below).

Figure 2.8. **Inward and outward FDI flows: OECD total, 1988-2002**

Percentage of GDP



Source: OECD International Direct Investment database.

Mergers and acquisitions

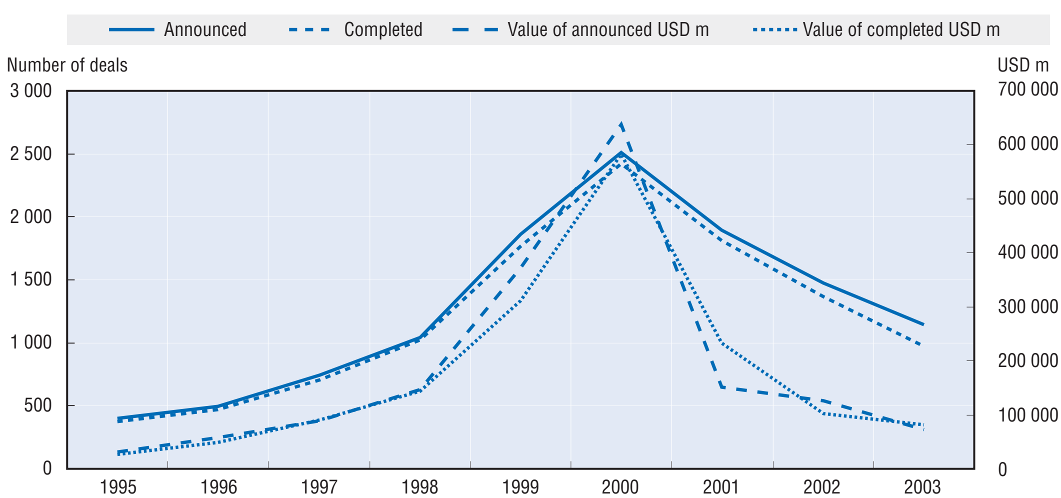
Cross-border mergers and acquisitions have become the most common form of FDI, and ICT-sector M&A activity has played a major role in overall cross-border M&A trends. They are driven by the same factors as FDI (*e.g.* scale, technology and market access). M&As allow faster build-up than greenfield investment and give the acquirer immediate access to existing business relationships. M&A trends reflect those in FDI, with a rapid increase in M&A activity during the late 1990s, a collapse of activity after 2000 and signs of a return to increasing levels of M&A activity in 2003 and the first half of 2004.[4] The rapid increase in M&A deal values during the boom years of 1999 and 2000 was the result not only of increased deal making, but also of a few very large deals in telecommunications, following the sector's liberalisation and privatisation, and of the increased stock market valuations that made targets more expensive. Both the level of cross-border M&A deal making and the value of the deals were affected by the sharp downturn in the ICT sector from 2000 (see Annex Table C.2.6).

Over the 1990s, the value of total cross-border M&As increased by more than 22% a year and the number of deals increased by around 12% a year. In 2000, the value of cross-border M&As accounted for more than 90% of total world FDI inflows (UNCTAD, 2003). The upsurge in both deal value and number of deals was especially significant during the late 1990s, and large-scale cross-border M&As accounted for the bulk of the increase in the value during that period. In 2000, the recorded deal value of completed cross-border M&As was USD 1 539 billion with some 9 295 deals, up from USD 194 billion and 2 660 deals in 1995 (OECD, 2002b; OECD, 2003a).[5] Since 2000, both the number and value of deals have fallen dramatically. In 2001, deal value fell by 50% and the number of deals fell by 17%, with just over 7 750 deals worth a total of USD 763 billion completed during the year. The slide continued in 2002, with 6 300 deals completed worldwide at a value of USD 517 billion, while 5 180 deals were completed in 2003 at a value of USD 449 billion.

During the 1990s, worldwide cross-border M&A activity in the ICT sector increased more than the all-industry average. The number of completed cross-border M&As in which ICT industries were the target increased from 376 in 1995 to 2 422 in 2000, or by 45% a year. The value of those deals increased from USD 27 billion to USD 582 billion, or by 85% a year (Figure 2.9). By comparison, the total number of completed M&A deals across all industries increased by 28% a year and M&A deal values increased by 51% a year. In 1995, deals in which ICT industries were the target accounted for 14% of total M&A deal

Figure 2.9. **ICT-sector worldwide cross-border M&As, 1995-2003**

Value in current USD millions and number of deals



Source: OECD, based on data provided by Dealogic.

value. In 2000, deals in which ICT industries were the target accounted for 38% of total M&A deal value. Since the peak in 2000, ICT M&A activity has collapsed. In 2001, the value of completed cross-border M&A deals in which ICT industries were the target amounted to USD 234 billion, fully 60% less than the previous year. Similarly, the number of completed ICT M&A deals fell to 1 810, a 25% drop from the previous year. In 2002 and 2003, the decline continued, with the value of ICT M&A deals amounting to USD 102 billion in 2002 and USD 81 billion in 2003, a further 56% and 21% lower year on year. In 2003, deals in which ICT industries were the target accounted for 18% of total M&A deal value.

The decline in cross-border M&As reflects slower economic growth and reduced profitability, particularly in developed countries. The fall in stock market values also played an important role, because it meant both a fall in the value of the assets being acquired and reduced ability to use shares to finance acquisitions. For example, the value of completed cross-border M&As in the ICT sector fell 60% in 2001, while the number of deals fell by just 25%. In 2002, M&A deal values fell a further 56% while the number of deals fell 25%. The average deal value in 2002 was USD 75 million, down from the 2000 peak of USD 240 million.[6] In 2003, the rate of decline slowed, with the average value of completed M&A deals increasing to USD 84 million, based on a 29% decline in the number of deals and a 21% decline in deal values. Just as the collapse of deal values in 2001-02 reflected the decline in stock market valuations, the recovery of average deal value reflects increasing valuations.

M&As by industry

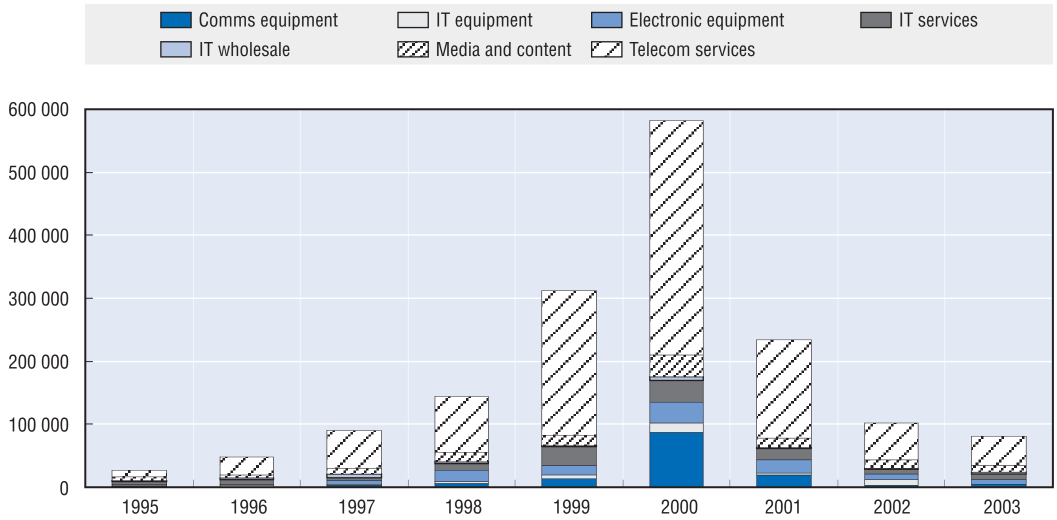
By industry, the largest number of completed cross-border M&A deals in the ICT sector over the period 1995-2003 were in IT services (4 053) and communication services (2 666).[7] Indeed, there were around three times the number of M&A deals in the ICT services industries (6 719) as in the ICT equipment manufacturing industries (2 252). There were a further 1 936 deals in IT wholesaling and media and content industries (see Annex Table C.2.7). Between 1995 and 2003, the number of completed ICT M&A deals increased by 12.6% a year. However, there was significant variation between industry sectors, with the number of deals in ICT services increasing faster (18.3% a year) than the number in ICT and related equipment manufacturing (7.9% a year). In 1996, ICT manufacturing accounted for 52% of cross-border ICT-sector M&A deals and ICT services for 34%, with the remainder in wholesale and media. By 2003, ICT manufacturing accounted for 21% of deals and ICT services for 63%.

Trends in deal values are similar. Over the period 1995-2003, cross-border M&A deals in ICT services were worth USD 1 175 billion and those in ICT equipment manufacturing USD 293 billion (see Annex Table C.2.8). Between 1995 and 2003, the value of completed cross-border ICT-sector M&A deals increased by 14.7% a year. The value of deals in ICT services rose faster (18.1% a year) than the value of those in ICT and related equipment manufacturing (12.5% a year). In 1995, ICT manufacturing accounted for 18% of ICT-sector cross-border M&A deal value and ICT services for 54%, with the remainder in wholesale and media. By 2003, ICT manufacturing accounted for 15% and ICT services for 68%. In value, communication services deals dominated, with deals worth USD 1 051 billion between 1995 and 2003, or 65% of the value of all ICT-sector cross-border M&As.

Because the value of some M&A deals reported by Dealogic is not recorded, average values are understated. Nevertheless, they are indicative of the relative size of deals in each sector. Average deal values have been higher in communication services (USD 394 million) and communication equipment manufacturing (USD 234 million) than in other sectors. As might be expected, average reported deal values were significantly smaller in IT services (USD 31 million) and IT wholesaling (USD 36 million). Of the 21 ICT-sector cross-border M&A deals recorded between 1995 and 2003 that were worth more than USD 10 billion, 19 were in communication services. Average reported deal values were highest in 2000, at USD 240 million across all ICT industries, reflecting valuation rises during the dot.com bubble (Figure 2.10). Between 1995 and 2000, average reported deal values in communication equipment manufacturing increased by 76% a year. They have since fallen by 54% a year.

M&A deals between firms in different industries ("vertical deals") are more common than deals between firms in the same industry ("horizontal deals").[8] At the peak of activity in 2000, 621 (25%) of the completed cross-border ICT-sector M&A deals recorded were horizontal deals and the remaining 1 801

Figure 2.10. **Completed ICT-sector cross-border M&As by industry, 1995-2003**
Value of deals in current USD millions



Source: OECD, based on data provided by Dealogic.

(75%) were vertical deals. At that time, horizontal deal value was USD 148 billion and vertical deal value USD 434 billion. In 2003, horizontal deals accounted for 28% of all completed deals and 21% of deal value. Of the 621 horizontal cross-border M&As completed in the ICT sector in 2000, 240 were between IT services providers, 102 between telecommunication services providers, 88 between ICT equipment manufacturers, 54 between Internet service providers (ISPs), 25 between software publishers and a further 25 between television broadcasters. In 2003, there were 272 deals: 99 between IT services providers, 57 between ICT equipment manufacturers, 41 between telecommunication services providers and 23 between software publishers. In the wake of the collapse of the dot.com bubble, just 1.8% of the horizontal cross-border ICT-sector M&A deals in 2003 were between ISPs, compared with 8.7% in 2000.

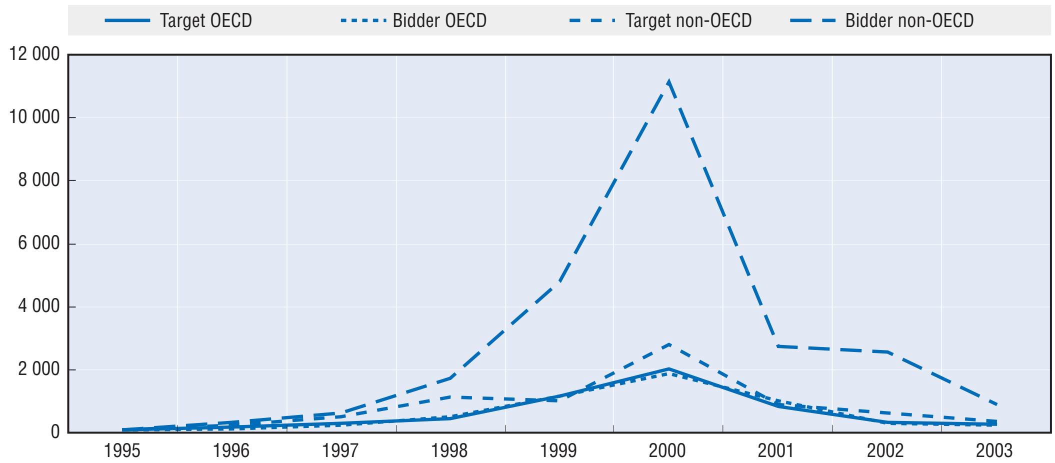
Even though data are incomplete, it is clear that some firms have engaged in cross-border M&As in support of rapid international expansion. Among those reporting the highest combined deal values over the period 1995-2003 are: Vodafone, Telefonica, China Mobile (Hong Kong, China), News Corp, Nortel, NTL, Alcatel, Global Crossing and Vivendi. However, because of incomplete data, this list is by not means complete.

M&As by country

The globalisation of the ICT sector can also be explored by looking at the expansion of the indigenous ICT industry through cross-border M&As and the expansion of MNEs into domestic industry.[9] Between 1995 and 2003, reported worldwide completed cross-border ICT-sector M&A deal values increased by 15% a year, while those in which OECD countries were the bidders increased by 12% a year. Deal values of M&As in which OECD countries were targets grew by 14% per year over the period, close to worldwide growth of deal values (15%). The dot.com peak in deal values appears to have been somewhat more accentuated in non-member economies than in member countries (Figure 2.11). This may reflect relative growth rates in North America and Europe on the one hand, and Asia on the other, as well as a small number of very large deals in 2000 (*e.g.* Hong Kong-based China Mobile's USD 38 billion acquisitions in China).

Figure 2.11. **Completed ICT-sector cross-border M&As deal values, 1995-2003**

Current USD, Index 1995 = 100



Note: Excludes M&A deals in which no individual country is specified as bidder or target.
Source: OECD, based on data provided by Dealogic.

OECD countries accounted for 89% of country-specific worldwide reported cross-border ICT-sector M&A outflows between 1995 and 2003, ranging from a high of 97% in 1995 to a low of 81% in 2002.[10] From 1995 to the peak of M&A activity in 2000, OECD country M&A outflows increased from USD 18 billion to USD 348 billion, or by 80% a year. Since then, completed M&A deal values in which OECD countries are the bidder nation have fallen to USD 45 billion, or by 50% a year. The boom years of the late 1990s saw rapid increases in ICT-sector cross-border M&A expenditures from OECD countries. Year-on-year increases climbed from 23% in 1996, to 132% in 1999. In 2000, OECD M&A deal outflows increased by 61%, before falling by 47% in 2001, 69% in 2002 and by a further 22% in 2003.

Over the period 1995-2003, the United States and the United Kingdom each accounted for around 20% of total OECD-reported ICT-sector cross-border M&A purchases by value. Other major players in ICT-sector M&A outflows included: Germany (13.3%), France (12.8%), Canada (6.5%), Spain (5.0%) and the Netherlands (4.9%). Major deals created some notable fluctuations in country shares. For example, Vodafone's acquisition of Airtouch in 1999 saw the United Kingdom's share of OECD-area M&A outflows reach 35%, whereas it was just 8% in 1998.

OECD countries accounted for an average of 85% of country-specific worldwide ICT-sector cross-border M&A inflows between 1995 and 2003, ranging from highs of 90% in 1999, to a low of 76% in 1998.[11] ICT-sector M&A deal inflows into OECD countries increased from USD 24 billion in 1995 to USD 490 billion in 2000, or by 83% a year. Since then M&A deal inflows have fallen by 48% a year to USD 68 billion in 2003. The boom years of the late 1990s saw rapid increases in ICT-sector cross-border M&A expenditures in OECD countries, and year-on-year increases reached 157% in 1999. In 2000, OECD ICT-sector M&A deal inflows increased by 76%, before falling by 59% in 2001, 61% in 2002 and by a further 15% in 2003.

ICT-sector cross-border M&A deal inflows are more evenly distributed across OECD countries than are outflows. This reflects the increasing globalisation of indigenous industries, with leading MNEs from a relatively few countries acquiring firms in many countries. Over the period 1995-2003, the United States was the target of 23% of total OECD ICT-sector cross-border M&A purchases by value. Other major target countries include the United Kingdom (16.6%), Germany (12.2%), Canada (7.6%), Japan (5.4%), the Netherlands (5.0%) and France (4.3%). Again, major deals can be seen in country shares. For example, KPN's acquisition of control of Germany's E-Plus Mobile contributed to Germany's 20% share of total OECD M&A deal value inflows in 2000, up from just 2.4% in 1999. The role of various countries in global ICT production can also be seen in their relative positions as bidders and targets. For example, Hungary's share of deal value as a bidder nation is negligible, Ireland has accounted for 0.1% of OECD bidder deal value over the period 1995-2003 and Mexico for 0.2%. Hungary has been the target of 0.6% of total ICT-sector cross-border M&A deals by value, Ireland the target of 1.3% and Mexico the target of 1.8% (see Annex Tables C.2.9 and C.2.10)

Non-member economies were the targets of almost 15% of country-specific completed ICT-sector M&A value between 1995 and 2003. China was the target of USD 58 billion worth of recorded completed ICT sector deals; Brazil, USD 44 billion; Argentina, USD 15 billion; Israel, USD 13 billion; Chinese Taipei, USD 6.6 billion; Singapore, USD 5.9 billion; Peru, USD 5.3 billion; and South Africa, USD 5.1 billion. M&A deal value targeting non-member economies increased by almost 17% a year between 1995 and 2003, compared with a 14% a year increase in deal value targeting OECD member countries. Non-member economies initiated 8% of country-specific completed ICT-sector M&A value between 1995 and 2003. Over that period, Hong Kong, China was the bidder accounting for USD 69 billion of ICT-sector M&A recorded deal value; Bermuda and Singapore accounted for USD 18 billion; South Africa, USD 4.1 billion; Israel, USD 3.5 billion; Cayman Islands, USD 2.8 billion; Chinese Taipei, USD 2.7 billion; and China, USD 2.7 billion. ICT-sector M&A deal value for which non-member economies were the bidder host increased by 31% a year between 1995 and 2003, compared with a 12% a year increase across OECD member countries.

Role of the **ICT** *sector in recent* **M&A** *trends*

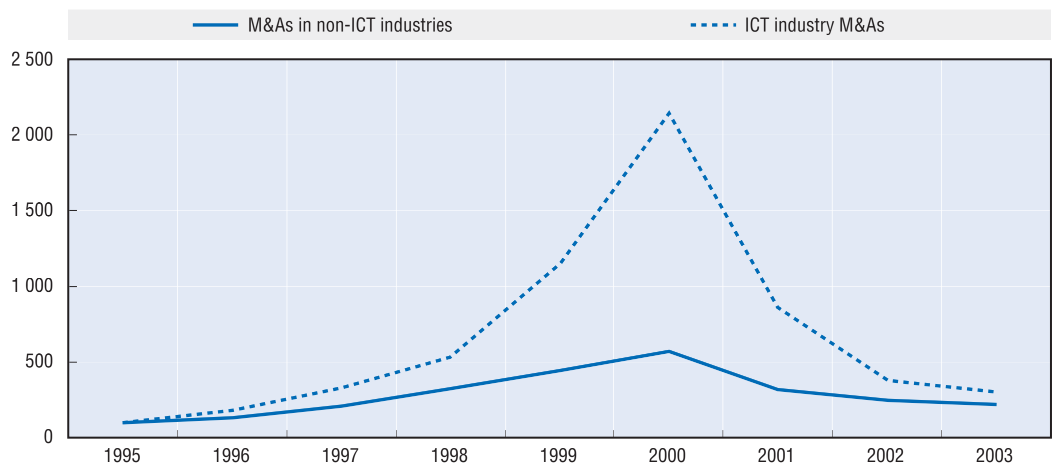
The spike in ICT-sector cross-border M&A deal values in 1999 and 2000 was accentuated by a small number of very large deals, particularly in telecommunications. Major deals in 1999 and 2000 included: Vodafone's acquisitions of AirTouch for USD 60 billion and Airtel for USD 6.4 billion; France Telecom's acquisition of Orange for USD 46 billion; Mannesmann AG's acquisition of Orange for USD 35 billion and Omnitel Sistemi Radiocellulari Italiani for USD 8.4 billion; Hong Kong-based China Mobile's acquisitions in China for USD 33 billion; KPN's acquisition of E-Plus Mobilfunk; and Deutsche Telekom's acquisition of One 2 One for USD 14 billion. Cross-border M&As in IT services also developed strongly in the late 1990s, with cross-border M&A inflows targeting IT services estimated to have climbed from just USD 4.2 billion in 1995 to more than USD 34 billion in 2000.

These deals were both based upon, and made possible by, the inflation of "new economy" and ICT-sector stock prices in 1999-2000, which contributed to the surge in ICT-sector M&A deal values, just as the subsequent correction to "new economy" stock prices contributed to the precipitous decline in deal values. At their peak in 2000, ICT-sector cross-border M&As accounted for 38% of worldwide cross-border M&A deal value, up from just 14% in 1995. By 2003, ICT-sector M&As had fallen back to 18% of worldwide total M&A deal value. The ICT sector has thus played a leading role in recent M&A trends (Figure 2.12).

Despite the recent downturn, there have been a number of significant M&A deals during the last three years, particularly in the telecommunications sector. In fact, some 4 146 cross-border M&A deals with a combined value of more than USD 417 billion have targeted the ICT sector. Large deals have included:

- In 2001, Deutsche Telekom's USD 29 billion acquisition of VoiceStream, BT's USD 10.4 billion acquisition of Viag, NTT DoCoMo's USD 9.8 billion acquisition of AT&T Wireless, SingTel's USD 8.5 billion acquisition of Australia's C&W Optus, Vodafone's takeover of Japan Telecom for USD 7.6 billion, Schlumberger's acquisition of the United Kingdom's Sema IT services for USD 5.2 billion and Vodafone's USD 4 billion acquisition of Ireland's Eircell.
- In 2002, Telia's acquisition of Sonera (Finland) for USD 8.3 billion, Vivendi's USD 4.9 billion acquisition of USA Networks' entertainment assets, KPN's acquisition of Germany's E-Plus Mobilfunk for USD 2.3 billion and Hitachi's acquisition of IBM's disk drive business for USD 2 billion.

Figure 2.12. **Completed cross-border M&A values in ICT and non-ICT industries, 1995-2003**
Current USD, Index 1995 = 100



Source: OECD, based on data provided by Dealogic.

- In 2003, France Telecom's acquisition of Germany's MobilCom AG's UMTS assets for USD 7 billion, News Corps acquisition of a stake in Hughes Electronics for USD 6.8 billion and Vodafone's acquisition of stakes in France's Cegtel for USD 2.2 billion and in Spain's Airtel Movil for USD 2.1 billion.

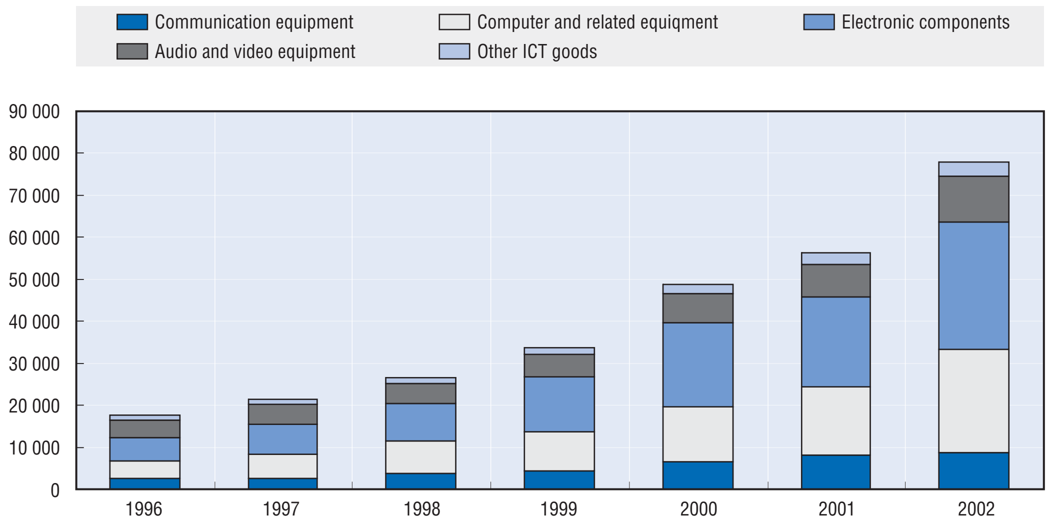
Despite recent precipitous declines in M&As by value, there nevertheless remains a significant level of cross-border M&A activity in the ICT sector, indicative of the continuing globalisation of ICT production. Indeed, there are early indications of an upturn in M&A activity, with fourth quarter 2003 and early 2004 showing an increase in cross-border M&A deal announcements. M&As will continue to provide ICT-sector firms with immediate access to skills, technology and markets, and those firms surviving a difficult period in relatively good shape are likely to seize the opportunity to acquire firms that have fared less well while their stock market valuations are relatively low.

China and globalisation: trade, FDI and M&As

ICT *trade*: While OECD-area trade in ICT goods increased 4% a year between 1996 and 2002, with a substantial decline after 2000, China's trade in ICT goods continued to grow (Figure 2.13 and Annex Table C.2.11). Worth less than USD 18 billion in 1996, China's ICT goods trade reached almost USD 78 billion in 2002, growing 28% a year. Imports have been growing faster than exports. Nevertheless, China realised a surplus on trade in ICT goods of almost USD 3 billion in 2002. China's trade in ICT goods in 2002 was equivalent to 12.3% of total OECD ICT goods trade, slightly larger than Japan (11.8%) and smaller than the United States alone.

Computer and related equipment accounted for 42% of China's total ICT exports in 2002 – worth USD 33 billion, up from USD 5.3 billion in 1996 and increasing 36% per annum. It was also the fastest growing category of ICT goods exports. Audio and video equipment exports increased from USD 6.3 to almost USD 18 billion over that period, or by 19% per annum. Electronic components exports (USD 15.5 billion), communication equipment exports (USD 10.8 billion) and other ICT related goods exports (USD 1.9 billion) made up the total USD 79.4 billion in ICT goods exports from China in 2002.

Figure 2.13. **China's trade in ICT goods, 1996-2002**
Current USD millions



Source: OECD ITS database.

Reflecting a substantial role in assembly, electronic components is the largest category of ICT good imports into China – costing USD 45 billion in 2002, up from USD 7.4 billion in 1996 or by 35% per annum. They accounted for 59% of all ICT goods exports into China in 2002. Computer and related equipment imports cost USD 16 billion in 2002, and have increased 33% a year since 1996. Other ICT goods import categories were relatively small – communication equipment USD 6.8 billion, other ICT related goods USD 4.9 billion, and audio and video equipment USD 4 billion.

The most notable feature of China's ICT goods trade was a deficit on trade in electronic components of USD 29 billion in 2002. In addition to supplying the local market, these components imports contribute to trade surpluses of over USD 17 billion in computer and related equipment, USD 14 billion in audio and video equipment and USD 4 billion in communication equipment. The other notable feature is robust growth, with year-on-year growth in ICT goods trade 1996 to 2002 equivalent to 21%, 24%, 27%, 45%, 15% and 38%, respectively.

***Foreign direct investment*:** China and Hong Kong, accounted for around 10% of worldwide FDI inflows in 2002 and became the world's largest host country for FDI inflows at USD 53 billion. Despite the marked slowdown in FDI flows worldwide since 2000, inflows into China grew by 15% in 2001 and 13% in 2002 (Table 2.3). Hong Kong, on the other hand, has been severely affected by the slowdown and it may be that the FDI to China now increasingly bypasses Hong Kong. China as well as Hong Kong appear to support a relatively high rate of return on FDI, with an apparent return of 5.8% on FDI in China and 11.5% on FDI in Hong Kong in 2001, compared with a world average return of 5.5%.

According to I*nvest in China* (*www.fdi.gov.cn/main/indexen.htm*), the top five sources of FDI into (mainland) China in 2002 were: Hong Kong, China, USD 17.9 billion (34%); the Virgin Islands, USD 6.2 billion (12%); the United States, USD 5.4 billion (10.3%); Japan, USD 4.2 billion (8%); and Chinese Taipei, USD 4 billion (7.5%), although part of the investment from Hong Kong, China, and all from the Virgin Islands originated elsewhere. China's FDI inflows are primarily sourced from Asia, with the ten major Asian investors accounting for USD 32.4 billion or more than 60% of total 2002 inflows, compared with North

Table 2.3. **FDI inflows into China and Hong Kong, China, 1991 2002**
Current USD millions

FDI Inflows (USD millions)	1991-96	1997	1998	1999	2000	2001	2002
China	25 476	44 237	43 751	40 319	40 772	46 846	52 743
Hong Kong	6 057	11 368	14 766	24 580	61 939	23 775	13 718
World	254 236	481 911	686 028	1 079 083	1 392 957	823 825	651 188

Source: UNCTAD, 2003.

America's USD 6 billion (11.4%) and the EU's USD 3.7 billion (7.2%). The largest FDI stocks in China in 2002 originated from Hong Kong (USD 205 billion), the United States (USD 40 billion), Japan (USD 36 billion), Chinese Taipei (USD 33 billion), the Virgin Islands (USD 24 billion), Singapore (USD 21 billion), Korea (USD 15 billion), the United Kingdom (USD 11 billion), Germany (USD 8 billion) and France (USD 5.5 billion).

The number of FDI projects in China increased by 30% between 2001 and 2002, from 26 140 to 34 171. ICT manufacturing featured strongly, with a 13% increase in the number of FDI projects in communication equipment manufacturing, a 37% increase in the number of projects in computer equipment manufacturing, and a 55% increase in projects in electronic components manufacturing. Combined, these projects raised contractual FDI value in ICT manufacturing to USD 14.6 billion in 2002, almost 18% of total contractual FDI value in China that year. In the first half of 2003, contracted FDI in China reached USD 51 billion, a growth of 40% over the same period in 2002; and the actual use of FDI (FDI inflows) amounted to USD 30.3 billion, a growth of 34% over the same period in 2002.

***Mergers and acquisitions*:** Multinational corporate activities in China are extensive and increasing. Cross-border M&As in which entities in China were the seller were worth just USD 8 million in 1990 and rose to USD 2.2 billion in 2000 (Table 2.4). Over the same period, the value of M&As in which entities in China were the purchaser rose from USD 60 million to USD 470 million. In 2002, the value of M&As in which entities in China were the seller was USD 2.1 billion while those in which entities in China were the purchaser were worth USD 1.05 billion. China and Hong Kong, received around 1% of worldwide M&A deal value inflows.

Table 2.4. **Mergers and acquisitions involving China and Hong Kong, China, 1990 2002**
Current USD millions

M&As (USD millions)	1990	1992	1994	1996	1998	2000	2002
World	150 576	79 280	127 110	227 023	531 648	1 143 816	369 789
				Seller			
China	8	221	715	1 906	798	2 247	2 072
Hong Kong	2 620	1 674	1 602	3 267	938	4 793	1 865
				Purchaser			
China	60	573	307	451	1 276	470	1 047
Hong Kong	1 198	1 263	2 267	2 912	2 201	5 768	5 062

Source: UNCTAD.

***Globalisation of the* ICT *sector*:** Activities of US-owned companies in mainland China increased rapidly during the 1990s, and the ICT-producing sector played a major role. The cumulative investments of US MNEs in China more than quadrupled, from USD 2.6 billion in 1994 to USD 10.5 billion in 2001. These investments have targeted the ICT sector, with China representing 7.6% of global US FDI investments in electronic and electrical equipment manufacturing but only 0.9% of global investments in all industries. These investments are not simply for manufacturing, as US affiliates in China are among the most R&D-intensive of all US overseas affiliates. In 2000, majority-owned US affiliates in China spent more than USD 500 million on R&D, up from just USD 7 million in 1994. R&D spending among US affiliates in China was equivalent to 9.2% of gross product in 2000, compared with 3.3% for the aggregate of US affiliates in all countries (National Science Foundation, 2004).

Overall, China has grown very rapidly in importance as a source and destination of ICT trade and now is second to the United States. ICT trade is driven in part by rapidly expanding global ICT investment in China to access the Chinese market and by China's rapidly expanding exports. ICT investment represented 18% of contractual FDI in China in 2002, China received 7.6% of US global FDI in electronic and electrical equipment manufacturing by 2001 and US investment is becoming increasingly R&D-intensive to underpin production for the host market and for export.

Activities of affiliates

International production by MNEs now spans virtually all countries, sectors and economic activities. By 2002, there were an estimated 63 834 parent firms with some 866 119 foreign affiliates operating worldwide. World sales of foreign affiliates amounted to almost USD 18 trillion, they employed some 53 million people worldwide, exported goods and services worth USD 2.6 trillion and held assets worth USD 26.5 trillion. Moreover, global sales and gross product associated with international production have increased faster than global exports and GDP. Worldwide GDP increased by around 3.4% a year over the period 1990-2002, while employment by foreign affiliates and foreign affiliate exports increased 6.7% a year. Sales by foreign affiliates increased by 10% a year over that period, gross product by more than 7% a year and total assets held by foreign affiliates by 13% a year. In 2002, the worldwide FDI stock was ten times higher than it had been in 1980 (UNCTAD, 2003, p. 23).

The importance of affiliate activities varies significantly from country to country. In some, affiliates account for a significant share of employment, output and exports. For example, foreign affiliates account for around 37% of manufacturing employment in Ireland and 30% in Austria and Sweden, but only around 16% in the United States and 2% in Japan. Similarly, foreign affiliates account for around 43% of GDP in Belgium-Luxembourg, 40% in Ireland, 24% in Hungary and 22% in New Zealand, but only around 5% in the United States, 4% in the United Kingdom and France, and 0.4% in Japan. FDI inflows are significant in some countries but less so in others, for example, FDI inflows during the late 1990s accounted for 70% of gross domestic capital formation in Sweden, 48% in Ireland and 38% in the Netherlands, but just 2% in Italy and Greece and 1% in Japan (UNCTAD, 2002).

ICT-sector affiliates play a significant part. In 2002, 21 of the top 100 MNEs (ranked by foreign assets) were in the ICT sector – eight in electronics and related manufacturing and 13 in telecommunications. They held foreign assets worth almost USD 800 billion, recorded foreign affiliate sales of USD 380 billion and employed 2.9 million people worldwide, more than 1.3 million of whom were employed by their foreign affiliates. Among this top group of ICT MNEs, foreign assets, foreign sales and overseas employees account for almost 50% of their total activities. Despite the overall high ranking of telecommunications in the top 100 MNEs, affiliates under foreign control play a minor role in telecommunications in all OECD countries except Hungary and Portugal. This partly reflects the degree of liberalisation of telecommunications markets (*e.g.* the limits that were, until recently, imposed by many countries on foreign investment), and the fact that until now foreign activity has involved building second or third players to compete against established national leaders. In computer services, affiliates under foreign control play a more substantial role. Their share is relatively high in Belgium, Norway and the United Kingdom, but very low in Turkey and the United States (OECD, 2003b).

The United States is one of the few countries to provide detailed data on the activities of foreign affiliates. The next two sections explore these data in order to develop a picture of the extent and nature of ICT-sector affiliate activities in a large OECD economy and US affiliates abroad. The following section explores similar data relating to Sweden, a relatively small OECD economy. Together, they are indicative of the level and nature of ICT-sector affiliate activities across OECD countries.

Affiliate activities in the United States

In 2001, foreign affiliates operating in the United States (in all industries) accounted for 22.4% of all merchandise exports (USD 164 billion) and 32.4% of all imports (USD 369 billion). ICT-sector foreign affiliates operating in the United States accounted for 7% of all foreign affiliate employment in the United States (450 000), 7% of affiliate sales (USD 154 billion), 6% of affiliate gross product (USD 30 billion) and 11% of affiliate exports (USD 17.5 billion) (Zeile, 2003).

Reflecting the slowdown, the gross product of foreign affiliates operating in the United States fell by 5.8% in 2001, the first decline since records began to be kept in 1977, and the ICT sector played a major part. In the information services sector, the gross product of foreign affiliates dropped from USD 39 billion to USD 18 billion in 2001. Significant falls in gross product were also experienced in computer and electronic product manufacturing, down 24% in 2001 from USD 28 billion to USD 21 billion. Employment trends were similar. Total employment in foreign affiliates in the United States declined overall by 2% in 2001 to 6.4 million and by 6% in manufacturing. Three-quarters of the reduction in affiliate employment in manufacturing occurred in three industries: computers and electronic products (down 20%); electrical equipment, appliances and components (down 16%); and transport equipment (down 9%). These declines reflect both production cuts and sell-offs, with the latter accounting for most of the 20% decrease in affiliate employment in the information services sector, most notably in broadcasting and telecommunications (Zeile, 2003).

In 2002, new outlays by foreign direct investors to acquire or establish US businesses fell by more than half to USD 52.6 billion, 84% below the record level of USD 335.6 billion set in 2000 (based on preliminary estimates for 2002). New affiliate investment outlays in computer and electronic products manufacturing in the United States declined from USD 42.6 billion in 2000 to just USD 488 million in 2002, while new outlays in the information services sector declined from USD 91 billion to USD 14.2 billion (US Bureau of Economic Analysis, 2003). Over the period 1997-2001, the gross product

Table 2.5. **ICT sector foreign affiliates operating in the United States, 2001**

USD millions and thousands of employees

	Employees ('000)	Compensation to employees	Total assets	Sales	Gross product	Exports of affiliates	Imports by affiliates
All industries	6 372	350 575	5 466 000	2 354 136	486 553	163 641	369 488
Manufacturing	2 570	160 926	1 151 660	952 003	225 483	99 394	144 995
Computers and electronic products	257	19 407	111 804	98 870	21 566	17 421	24 184
Computers and peripheral equipment	27	1 707	6 237	13 545	1 492	2 386	6 033
Communications equipment	73	8 083	42 961	31 583	5 309	4 682	5 909
Audio and video equipment	13	915	. .	6 057	1 141	. .	. .
Semiconductors and other electronics	83	5 102	38 059	36 490	8 160	6 224	6 569
Magnetic and optical media	11	425	. .	2 140	695	27	. .
ICT share of manufacturing	10.0	12.1	9.7	10.4	9.6	17.5	16.7
ICT *services*	193	13 619	204 032	55 597	8 856	56	6
Telecommunications	76	5 020	146 661	34 539	2 068	. .	2
Information services and processing	74	5 112	42 569	12 727	4 338	. .	4
Computer systems design services	43	3 487	14 802	8 331	2 450	56	. .
Total ICT sector	450	33 026	315 836	154 467	30 422	17 477	24 190
ICT *share of total*	7.1	9.4	5.8	6.6	6.3	10.7	6.5

Note: Blanks imply no data were available or that they were suppressed for reasons of confidentiality.
Source: US Department of Commerce, 2003.

of foreign affiliates in computer and electronic products manufacturing increased from USD 18.2 billion to USD 21.6 billion (at 4.4% a year), while that of foreign affiliates in information services increased from USD 27.8 billion to USD 39 billion in 2000, before falling to USD 18.4 billion in 2001.

In spite of the recent downturn, activities of affiliates in the ICT sector remain significant. In 2001, foreign affiliates operating in the computer and electronic products industry in the United States employed 257 000 people and earned USD 99 billion from sales and USD 17.4 billion from exports, while those operating in ICT-related services employed a further 193 000 and earned almost USD 56 billion from sales but only USD 56 million from exports (Table 2.5) showing the almost exclusive focus of ICT-related services firms on accessing the US host market.

Activities of US affiliates abroad

Majority-owned affiliates of US firms operating abroad employed more than 8 million people and realised gross product of USD 606 billion in 2000. Affiliates of US firms in the ICT sector operating abroad employed more than 1.3 million people and realised USD 72 billion in gross product (Table 2.6). Within the ICT sector, affiliates in computer and electronic products manufacturing employed around 777 100 and realised USD 42 billion, affiliates in electrical equipment and appliances manufacturing employed 232 000 and realised USD 7.4 billion, and affiliates in information services employed

Table 2.6. **US foreign affiliates operating overseas, 2000**

USD millions and thousands of employees

	All Industries		Computer and electronic products		Electrical equipment appliances and components		Information services	
	Employees	Gross product	Employees	Gross product	Employees	Gross product	Employees	Gross product
Australia	257.4	18 646	4.3	248	0.9	41	13.9	813
Austria	33.5	3 290	2.3	235	0.7	25	1.0	114
Belgium	120.9	13 150	0.6	57	3.7	242	3.8	445
Canada	1 038.7	72 398	43.9	3 169	16.3	918	32.6	1 357
Czech Republic	47.8	1 203	10.5	90	0.3	7	0.9	10
Denmark	37.1	5 673	2.6	142	0.4	17	1.3	94
Finland	16.1	1 893	2.8	294	. .	2	0.4	24
France	544.0	35 754	34.1	2 763	12.1	665	10.9	695
Germany	605.2	54 819	64.3	6 235	25.0	1 650	24.1	2 209
Greece	12.4	879	0.2	7	0.0	0	. .	1
Hungary	47.7	1 143	3.9	–279	12.4	306	1.3	18
Ireland	91.9	16 689	31.8	2 410	2.3	137	4.3	1 524
Italy	199.1	20 502	21.1	1 722	10.0	259	7.1	469
Japan	233.7	36 277	21.4	2 964	1.0	116	10.8	1 546
Korea	56.4	4 134	8.1	472	. .	–1	1.7	170
Luxembourg	9.6	199	0.0	0	0.1	2	. .	1
Mexico	804.4	20 180	109.1	1 025	38.9	568	16.2	249
Netherlands	169.0	23 371	14.3	1 027	1.7	117	10.8	651
New Zealand	34.9	1 605	0.1	–1	. .	2	2.8	81
Norway	27.1	10 140	0.5	58	0.3	17	1.1	23
Poland	67.6	1 758	0.2	4	0.3	. .	4.4	–201
Portugal	39.8	2 040	0.5	18	0.3	13	. .	. .
Slovak Republic	. .	. .	. .	. .	. .	. .	. .	. .
Spain	179.7	9 939	6.0	401	7.4	290	8.5	341
Sweden	81.8	6 222	4.3	328	. .	. .	4.5	324
Switzerland	53.3	9 387	4.3	705	2.0	150	2.3	379
Turkey	30.1	1 505	0.0	–2	0.2	7	0.1	8
United Kingdom	1 185.7	110 643	47.7	3 385	. .	. .	. .	. .
Other countries	2 039.8	122 449	338.2	14 409	95.7	1 800	168.2	11 019
Total	8 064.7	605 888	777.1	41 886	232.0	7 350	333.0	22 364

Note: Includes majority owned non bank foreign affiliates of US parents operating abroad. Blanks imply no data were available or that they were suppressed for reasons of confidentiality.
Source: US Department of Commerce, 2002.

333 000 and realised USD 22 billion. Those operating in OECD countries employed 6 million people and realised USD 483 billion in gross product. Of these, affiliates in computer and electronic products manufacturing employed around 439 000 and realised USD 27 billion, affiliates in electrical equipment and appliances manufacturing employed 136 000 and realised USD 5.6 billion, and affiliates in information services employed 165 000 and realised more than USD 11 billion.

Overall, majority-owned affiliates of US firms in the ICT sector operating abroad have relatively larger shares of employment and gross product in non-OECD economies as compared with the distribution for affiliates in all sectors combined. In computer and electronic products, only 57% of employment and 65% of gross product are in OECD countries. In information services, around half are in OECD countries, compared with three-quarters of employment and almost 80% of gross product for all affiliates. This shows the importance of non-OECD economies as markets and production locations in the globalisation of the ICT sector, which is also reflected in the rise of non-OECD economies in ICT manufacturing (see Chapter 1) and the growing integration of China in global ICT production and investment (see above).

In 2001, US parent firms acquired or established 468 new majority-owned affiliates (slightly up on 2000) with a combined gross product of USD 7 billion and combined employment of 149 000. Of these, 13 were in computer and electronic products manufacturing with a gross product of USD 172 million and employed 5 400, and 12 were in information services with a combined gross product of USD 186 million and employed 5 200 (Mataloni, 2002; 2003). In recent years, there has also been significant divestment by US MNEs operating overseas. In 2001, worldwide divestment (all industries) amounted to USD 18 billion in Germany, USD 19 billion in France and fully USD 36 billion in the United Kingdom, although some of this divestment has been due to write-downs in the value of acquisitions and previous investments.

While US firms invest around the world, their impact varies from country to country. As a share of GDP, the gross product of majority-owned foreign affiliates of US parents was highest in Ireland, at 18% of GDP in 2000. Canada was the only other OECD country in which US foreign affiliates accounted for more than 10% of GDP, although US affiliates were also significant in the United Kingdom (7.8% of GDP), the Netherlands (6.4%), Norway (6.3%) and Belgium (5.8%). In the ICT sector, US affiliates were significant employers in Mexico (164 200 jobs in 2000), Germany (113 400), Canada (92 800), France (57 100) and the United Kingdom (47 700).

Affiliate activities in Sweden and the activities of Swedish affiliates abroad

Table 2.7 shows the number of affiliates of foreign-owned enterprises operating in Sweden in 2001 (see Annex Table C.2.12).[12] The ICT sector represented 19% of such enterprises and employed 14% of all those employed by foreign-owned affiliates in 2001. Of the 1 456 foreign-owned enterprises operating in Sweden's ICT sector in 2001, 813 were wholesalers, 487 computer and related services providers and

Table 2.7. **Foreign-owned enterprises in Sweden's ICT sector, 2001**

Numbers and percentage shares

	Enterprises	Employees	Sector employment	Share of total employees
Electronic equipment manufacturing	82	16 341	71 609	23
Wholesale	813	24 331	60 941	40
Computer and related services	487	25 092	88 265	28
Renting office machinery	14	169	349	48
Telecommunication services	60	4 863	26 126	19
Total ICT sector	1 456	70 796	247 290	29
ICT sector share	19	14		
All industries	7 821	520 081		

Source: ITPS, 2002.

more than 80 were in electronic equipment manufacturing. Of the total of 70 800 people employed by foreign-owned affiliates in the ICT sector, some 25 100 were in computer and related services and 24 300 were in wholesale services. The largest employers among foreign affiliates operating in Sweden in 2001 were in software consultancy, while the highest levels of foreign affiliate activity in employment terms were in instrument manufacturing (83% of total industry employees were employed in foreign affiliates), maintenance services (66%) and electrical wholesaling (52%).

In 2001, there was a 34% increase in the number of foreign-affiliated enterprises operating in Sweden's ICT sector and a 13% increase in employment (up from 1 086 and 62 800, respectively). The largest employment increases occurred in telecommunications services (up 47%), computer and related services (up 38%) and office machine rental services (up 27%). Although the number of people employed by foreign affiliates in ICT equipment manufacturing only increased by 3% in 2001, the number of equipment manufacturing enterprises increased by 55%, suggesting the extension of foreign affiliate activities into smaller enterprises and downsizing.

Table 2.8 shows the countries of origin of foreign-owned enterprises in Sweden's ICT sector. The top ten countries' affiliates accounted for a combined 89% of affiliate employment in the ICT sector in Sweden in 2001, or 25% of total ICT-sector employment. Affiliates of US parent firms employed more than 20 000 people in Sweden's ICT sector in 2001, 30% of the total of all foreign affiliates. The United Kingdom and France were the only other countries to account for 10% or more of total affiliate employment in the sector.

Table 2.8. **Country of origin of foreign-owned enterprises in Sweden's ICT sector, 2001**

Numbers and percentage shares

	Enterprises	Employment	Enterprises	Share of employment
United States	321	21 160	22	30
United Kingdom	151	7 600	10	11
France	66	6 975	5	10
Finland	134	5 060	9	7
Switzerland	51	5 045	4	7
Netherlands	120	4 949	8	7
Germany	140	4 185	10	6
Norway	145	3 667	10	5
Japan	40	2 186	3	3
Denmark	108	1 990	7	3
Top 10	1 276	62 817	88	89
Other countries	180	7 979	12	11
Total	1 456	70 796	100	100

Source: ITPS, 2002.

Swedish-owned enterprises in the ICT sector with affiliates operating abroad employed a total of 442 100 people in 2001, of whom 163 000 were abroad and 279 100 in Sweden (see Annex Table C.2.13).[13] Those employed by ICT-sector Swedish affiliates abroad accounted for almost 17% of those employed abroad by Swedish affiliates in all industries. Not surprisingly, communication equipment manufacturing was a major activity of Swedish affiliates abroad, employing almost 60 000 in 2001. Equipment manufacturing enterprises employed fewer at home (43 600). Swedish-owned computer and related services enterprises employed 15 000 abroad and 30 500 at home.

These US and Swedish data on the activities of affiliates in the ICT-producing sector highlight both the extent of globalisation and its continuing development both within and beyond OECD countries. Despite the recent downturn, affiliate activities are extensive and play an increasingly important role in the ICT sector in most countries.

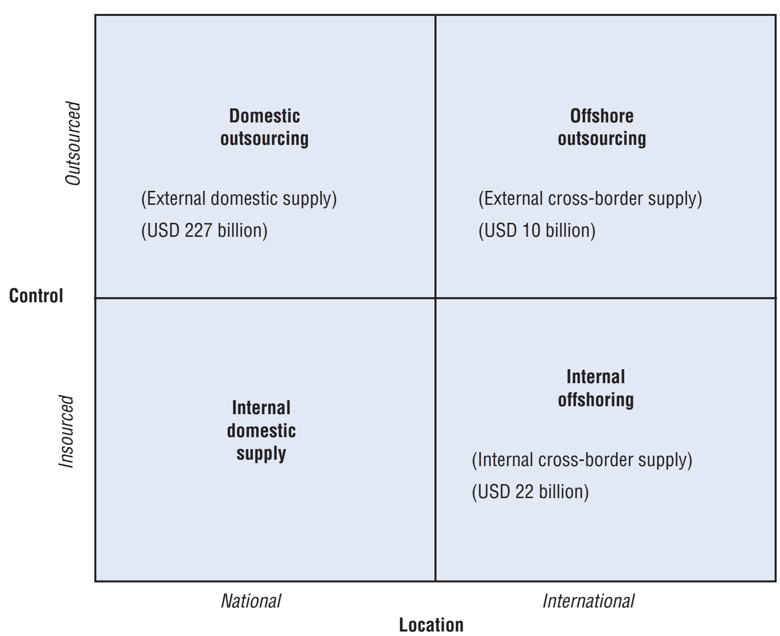
International sourcing of IT and ICT-enabled business services

In the current context of rapid technological development, globalisation and market deregulation, firms increasingly resort to new organisational forms to face competitive pressures (Pain and van Welsum, 2003). They can reorganise through mergers and acquisitions, joint ventures and strategic alliances, and by outsourcing internal activities to external suppliers or sourcing more efficiently in their own structures. By focusing on core comparative advantages and outsourcing other activities, firms may increase their competitiveness through specialisation and more efficient organisation, economies of scale, cost cutting and spreading risk. Rapid developments in ICT provide increasing opportunities for international sourcing. In particular, "knowledge work", such as data entry and information processing (IT services), and research and consultancy services (ICT-enabled business services) can be carried out remotely via the Internet and tele- and video-conferencing. The characteristics, drivers and impediments to outsourcing of business services are discussed in Chapter 5, the dynamics of business process restructuring in Chapter 3, and the skills dimension of international sourcing in Chapter 6.

Services offshoring is a recent development in the globalisation of the ICT sector. It is defined as the international sourcing of IT and ICT-enabled business services, such as customer services, back-office services and professional services. It involves both international outsourcing (*i.e.* unaffiliated trade in services) and the distribution of internal business support activities through international corporate networks (*i.e.* FDI and intra-firm sourcing). Figure 2.14 illustrates the nature and scope of offshoring, outsourcing and insourcing in terms of a matrix of location and control. Within such a framework, services can be supplied internally (*i.e.* insourced) or by an external supplier (*i.e.* outsourced), and they can be supplied from within the country or from another country. International sourcing or offshoring, therefore, can involve:

- Internal offshoring (international insourcing): internal cross-border supply, with internal business support services activities located in another country.
- Offshore outsourcing (international outsourcing): external cross-border supply, with business support services supplied by an external supplier, or suppliers, located in other countries.

Figure 2.14. **Offshoring, outsourcing and insourcing IT and business process services**
Approximate value of worldwide activity in 2001, USD



Source: Based on McKinsey and Company (2003).

Manufacturers have sourced components from other countries for many years, but the international sourcing of business support services (Table 2.9) is a relatively recent phenomenon. It has been enabled by developments in IT systems and broadband communications and by the liberalisation of trade in services, which are making services more easily tradable. As a result, service activities are now less constrained in their choice of location than they have been traditionally. As services account for a larger share of production costs, there is increasing pressure to seek lower-cost solutions for the provision of business process services. Offshoring is one response to these ongoing cost pressures and to the ICT and related skills shortages experienced in many developed countries during the late 1990s.[14]

There are many challenges involved in tracking offshoring activities, because of definitional and data collection difficulties and because there are a number of modes of offshoring. There are no official data measuring the extent of the offshoring and outsourcing phenomenon. Trade in services provides one possibly proxy, but other possibilities include employment data or input-output tables. Another way to examine the extent of offshoring using trade data would be to look at countries' imports of services. For example, van Welsum (2004) examines the relationship between US imports of services and international relocation of production and outsourcing. What can be learned about offshoring from cross-border trade in services is discussed below, in the context of an exploration of official sources of information.

The offshoring phenomenon

India has been the leading location for the offshoring of IT and related business process services activities according to widely cited industry sources.[15] McKinsey and Company (2003) suggest that *offshore* outsourcing of IT and related business process services accounts for around 4% of total outsourcing in those areas. They also suggest that internal offshoring was more than double the value of offshore outsourcing. India is said to account for around 25% of global IT and business process offshoring (McKinsey and Company, 2003). NASSCOM/McKinsey (2002) estimated India's IT-enabled services exports at USD 1.5 billion in 2001-02 (Roach, 2003).[16]

Widely cited figures from Forrester Research suggest that by 2015 around 3.3 million US business processing jobs will have moved offshore, accounting for USD 136 billion in wages (McCarthy *et al.*, 2002). Of the 3.3 million jobs, 473 000 are expected to be in the IT industry. Gartner recently projected a 40% growth in the European offshore outsourcing market, and Ovum Holway forecast that by 2006 some

Table 2.9. **Indicative list of IT and business process services involved in offshoring**

	IT services
IT services	Software development and implementation services, data processing and database services, IT support services, application development and maintenance, business intelligence and data warehousing, content management, e-procurement and B2B marketplaces, enterprise security, package implementation, system integration, SCM, enterprise application integration, total infrastructure outsourcing, Web services (internet content preparation, etc.), Web-hosting and application service providers (ASPs).
	Business process services
Customer interaction services	Sales support, membership management, claims, reservations for airlines and hotels, subscription renewal, customer services helpline, handling credit and billing problems, etc. telemarketing and marketing research services.
Back-office operations services	Data entry and handling, data processing and database services, medical transcription, payment services, financial processing (financial information and data processing and handling), human resource processing services, payroll services, warehousing, logistics, inventory, supply chain services, ticketing, insurance claims adjudication, mortgage processing.
Other professional and business services	Human resource services (hiring, benefit planning and payroll, etc.), finance and accounting services (including auditing, bookkeeping, taxation services, etc.), marketing services, product design and development.

Source: Mattoo and Wunsch (2004), p. 4.

20 000-25 000 IT jobs would be lost offshore from the United Kingdom (Moran, 2003). Miller and Codling (2003) reported that the offshore part of the United Kingdom's services market grew by 27% in 2002, to more than USD 800 million, of which 95% went to Indian IT firms. The leading Indian firms (Tata Consultancy Services with UK sales of USD 137 million in 2002, Wipro with UK sales of USD 98 million and Infosys with UK sales of USD 64 million), are significant players in the United Kingdom's IT services market (Hunt, 2003).

To date, offshoring has been dominated by American and British companies offshoring their internal operations and outsourcing to third parties, notably in Ireland, Canada and India. Relatively liberal employment laws have been one factor. Language and cultural affinity are also important. For MNEs that operate in Europe, Central and Eastern European countries offer cultural and linguistic similarities, greater ease of ensuring compliance with European regulations and high levels of technical ability. General Electric (GE) has become one of the largest investors in Hungary, moving a number of business processes to that country in support of GE units across western Europe. In late 2003, DHL announced its intention to shift its data centre from the United Kingdom and parts of its IT operations from Switzerland to a new services centre in Prague, from which it will oversee all the company's European IT operations (*The Economist*, 2003). For global firms, multi-location offshore sourcing is becoming increasingly common. For example, Siemens recently announced its intention to move 15 000 software programming jobs from offices in the United States and western Europe to India, China and Eastern Europe (Associated Press, 2004).

Many factors influence a firm's choice of location for offshore operations (Mattoo and Wunsch, 2004). For example, for US companies with a Spanish-speaking customer base, Latin American countries offer low labour costs, proximity to the United States, the same time zone and Spanish language. Since March 2002, AOL Time Warner has served its Spanish-speaking customers from a call centre in Mexico. The Philippines is also an attractive location, owing to cultural affinities with the United States and language skills in English and Spanish. To take advantage of the large number of Filipino accountants trained to US accounting standards, Procter and Gamble moved the accounting services for its global operations to the Philippines. Other companies that have located in the Philippines include: AIG, American Express and Citibank. Finally, Russia has a large pool of technical talent, and Boeing has involved Russian aeronautics specialists in designing parts of its 777 aircraft.

Growth in IT and business process services outsourcing and offshoring related direct investments in countries such as India suggests the potential for significant growth, although estimates of size and growth vary. Outsourcing of goods and services is said to have been worth USD 3 783 billion worldwide in 2001 and to be growing by around 16% a year. IT and business process services are among the largest and fastest-growing market segments, with ICT-enabled services outsourcing worth an estimated USD 490 billion in 2003 and growing 20% a year. Even higher rates of growth are expected in finance and accounting, market research, human resources, administrative and corporate services (Corbett, 2002). Between 1991 and 1996, FDI inflows into India ran at an annual average of USD 1 085 million. Since 1997, inflows have increased rapidly to USD 3 449 million in 2002, at which time inward FDI stocks in India amounted to almost USD 26 billion. Indian cross-border M&A sales were worth USD 1 698 million in 2002, up from just USD 35 million a decade earlier, and India's cross-border M&A purchases were worth USD 2 195 million in 2001, up from just USD 1 million in 1991 (UNCTAD, 2003). McKinsey and Company (2003) estimated that USD 400 million of the FDI inflow into India in 2002 was invested in offshoring activities, up from USD 300 million in 2001 and from an annual average of around USD 100 million between 1996 and 2000.

There is little doubt that labour cost savings has been a major factor in offshoring decisions. Dossani and Kenney (2003) suggested that a trained certified public accountant (CPA) in the United States earns USD 75 000 a year, while a generally accepted accounting principles (GAAP) certified accountant resident in India typically earns around USD 15 000 a year. The differential for less skilled workers is even greater, with the Indian wage rate for entry-level call centre employees in metro areas around USD 2 400 a year. NASSCOM statistics suggest that in India direct costs per employee in call centres are USD 10 354 compared with an estimated USD 55 598 per employee in the United States.

PricewaterhouseCoopers put the cost of operations in India 37% lower than in China and 17% lower than in Malaysia (*The Economist*, 2003). These numbers suggest that firms can achieve substantial cost savings through offshoring. However, it is important to note that Indian IT wage rates are now increasing, while comparable rates in the United States and Europe are relatively stable. Moreover, the experience of Fortune 500 firms in India over two years suggests that total cost savings are typically less than expected, and in fact no more than 10-15% (Biswas, 2003). Other analyses shows that only certain kinds of codified tasks can be successfully outsourced (OECD, 2003c) and that the dynamic may be self-adjusting owing to lower than expected productivity gains (Porter, 2004).

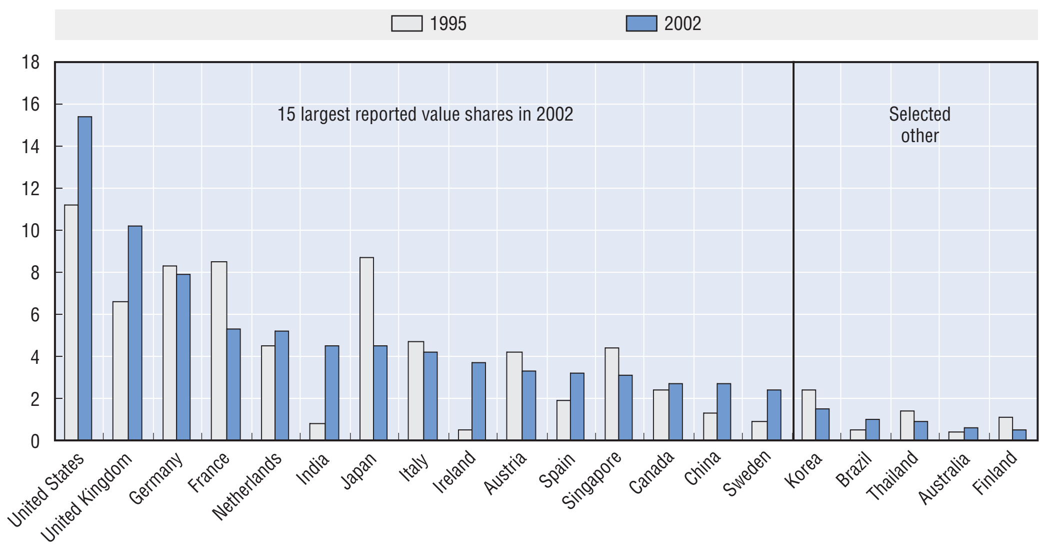
Measuring the extent of offshoring

In the absence of any official statistics measuring the extent of offshoring, this section analyses exports of services. In particular, offshoring of services activities should result in a return flow of exports of services. Indian exports of ICT-enabled services have grown rapidly since the mid-1990s. It is, however, difficult to measure the extent of international trade in IT and ICT-enabled business process services in international statistics. To provide an aggregate overview, the IMF Balance of Payments categories "computer and information services" and "other business services" (see Annex Table C.2.14 for a detailed description) are summed. These data contain information on international outsourcing and internal offshoring combined (see also van Welsum, 2004). However, data on computer and information services is not available for all countries. For some, such as India, they are included under "other business services", along with other services.[17]

Most exports of other business services and computer and information services still originate in OECD countries (77.1% of total reported exports of other business services and computer and information services in 2002, down from 79.5% in 1995).[18] Figure 2.15 shows the 15 countries that

Figure 2.15. **Share of the value of reported total[1] exports of other business services and computer and information services, selected countries, 1995 and 2002**

Decreasing order of the total reported value share in 2002, percentages



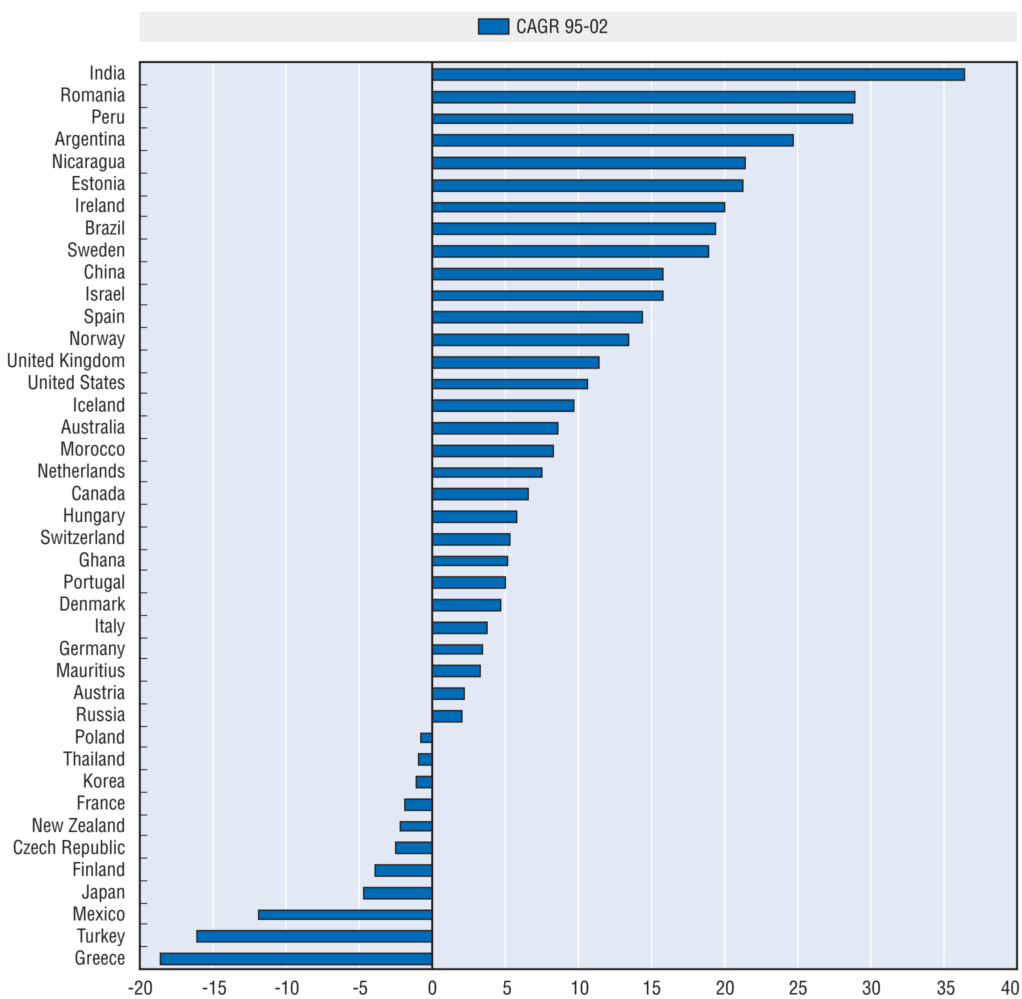
1. The reported total for all countries does not necessarily correspond to a world total. For some countries, such as India, it is not possible to break down the data to isolate other business services and computer and information services. As a consequence, for India, the category includes total services, minus travel, transport and government services (*i.e.* including construction, insurance and financial services as well as other business services and computer and information services).

Source: OECD, based on IMF Balance of Payments Database (November 2003).

accounted for the largest value shares in 2002, as well as some selected other economies. OECD countries have the top five shares of these services exports with India in sixth position. Nevertheless, some non-member developing economies are experiencing rapid growth in exports, although they are starting from very low levels (Figure 2.16). Thus while some of these economies are experiencing very high growth rates, they still account for a small proportion of total exports, although poor data collection in some means that their actual shares are likely to be understated. The "other business services" category may have variable shares of IT and ICT-enabled services in different countries. Moreover, the data are reported in current USD and will be affected by currency movements. Exports of other business services and computer and information services are also sensitive to the overall business cycle. The global downturn affected total reported values (in current USD) of exports, with annual growth rates averaging 6.9% over the period 1995-2000, and 3.9% for 2000-02. For some countries, the difference was more marked. India, for example, experienced very strong average growth of its exports over the period 1995-2000 with a compound annual growth rate (CAGR) of 43.8%, but this slowed to 19.6% for 2000-02.

Figure 2.16. **Growth of the value of exports of other business services and computer and information services for selected countries, 1995-2002**

Compound annual growth rate, percentages



Source: OECD, based on IMF Balance of Payments Database (November 2003).

Discrepancies in reported data: a challenge for statisticians

Offshoring can include cross-border trade in services (*i.e.* international outsourcing), trade related to FDI (*i.e.* internal offshoring) and also temporary migration. Both international outsourcing and internal offshoring might be expected to appear in international trade in services statistics, as unaffiliated trade and affiliated trade respectively. Table 2.10 shows data from various sources and highlights some of the discrepancies in exports reported by India (Reserve Bank of India) and imports reported by other countries. While information is not available for all importers, the magnitude of the discrepancies points to the existence of a major statistical challenge.

The discrepancies in the reported data raise a number of questions and present a challenge for statisticians, especially since their magnitude has increased over time. There are many possible reasons for the discrepancies including:

- Firms are encountering reporting difficulties related to the definition of services and modes of delivery. The definitions of the various sources are also likely to differ, with more restricted

Table 2.10. **Difference in exports reported by India and imports reported by various importers**
USD millions

	1997	1998	1999	2000	2001	2002
Total services						
Exports to all countries reported by India	9 111	11 691	14 509	19 175	20 886	24 859
Imports from India reported by						
US[1]	1 224	1 541	1 520	1 896	1 810	1 667
EU	2 241	2 425	2 518	2 268	2 418	2 275
of which: UK	702	803	958	865	1 030	1 007
Japan			455	423	357	326
Canada	117	118	102	107	155	
Sum of reported imports	3 582	4 084	4 595	4 694	4 740	4 268
Discrepancy	5 529	7 607	9 914	14 481	16 146	20 591
***i.e.* Percentage of Indian exports unaccounted for by the above countries**	**61**	**65**	**68**	**76**	**77**	**83**
All commerical services, excl. travel and transport						
Exports to all countries reported by India	3 852	6 096	8 892	13 018	15 126	18 630
Imports from India reported by						
US	422	614	568	832	803	670
EU	722	800	905	689	957	800
of which: UK						
Japan			232	237	201	180
Canada	26	27	16	24	33	
Sum of reported imports	1 170	1 441	1 721	1 782	1 994	1 650
Discrepancy	2 682	4 655	7 170	11 235	13 131	16 980
***i.e.* Percentage of Indian exports unaccounted for by the above countries**	**70**	**76**	**81**	**86**	**87**	**91**
Computer and information services						
Exports to all countries reported by India				6 341	7 556	9 600
Imports from India reported by						
US				135	104	80
EU				114	336	177
of which: UK						
Japan				13	45	37
Canada						
Sum of reported imports				262	485	294
Discrepancy in total				6 079	7 071	9 306
***i.e.* Percentage of Indian exports unaccounted for by the above countries**				**96**	**94**	**97**

1. Imports of US private services only. Note that disaggregated US data comprises unaffiliated transactions only.
Source: OECD, based on Reserve Bank of India, US Bureau of Economic Analysis, Eurostat, UK Office of National Statistics, Bank of Japan, and Statistics Canada.

definitions focusing on computer and information services in some cases and a much broader definition of ICT-enabled services often used in India and elsewhere, where for example Indian data may also include royalties and licence fees.

- Most countries implemented the revised Balance of Payments (BPM5) methodology in the late 1990s, sometimes incrementally. As a result, International Monetary Fund (IMF) figures may conceal significant methodological breaks in time series.
- To the extent that data on trade in services are collected from surveys, data on exports are likely to be collected from fewer specialised firms and provide better coverage than data on imports that are drawn from a much larger number of firms. Moreover, the existing surveys used to collect data on trade in services may not cover new importers of computer and information services, for example, and small firms and individuals may not be covered. It is also possible that the Indian data are not collected solely on the Balance of Payments criterion of a transaction having taken place between residents and non-residents.
- There may also be differences in the treatment of certain categories, such as the movement of temporary workers. OECD standards do not count the remuneration of temporary workers as trade, but for non-resident employees of firms in the host country working for periods of less than a year, their remuneration is counted as compensation of employees in that country's balance of payments. However, this type of remuneration may be counted as exports in the Indian data. Similarly, there are likely to be differences in coverage. For example, US services trade data do not include packaged software recorded on media (*i.e.* software products), nor software embedded in hardware, while Indian sources may do so.
- Another part of the challenge may be understanding the structures and operations of global firms, which often no longer organise along national lines and may find it difficult to report along national lines to statistical agencies.[19] The existence of triangular arrangements, for example, between a firm's global headquarters, regional headquarters and local offices, may make it difficult to establish where and between whom transactions have actually taken place.

Globalisation and offshoring

Offshoring involves both international insourcing and outsourcing of services. It takes a number of forms, and mutually reinforcing trends have created a dynamic that leads to further offshoring (Table 2.11). Internal offshoring provided the confidence to begin offshore outsourcing. To compete with the cost savings achieved through internal offshoring and offshore joint ventures, multinational service suppliers (*i.e.* providers of services to others) moved part of their activities offshore through FDI and subcontracting. With multinational service suppliers accessing the same cost base, indigenous offshore-

Table 2.11. **The dynamics of offshoring in the offshore location**

	MNE subsidiaries supplying internal services	Local joint ventures and spin-offs	MNE subsidiaries providing outsourcing services to others	Local independents
Offshore activity	Supply insourcing services	Supply related party sourcing services	Supply outsourcing services	Supply independent outsourcing services
Initial stage	Driven by internal cost cutting at home	Build on local knowledge to win share of international sourcing	Compete to win outsourcing business	Compete for local subcontracting
Subsequent stage	Cut internal costs further to compete with rivals that are outsourcing		Compete with developing local independents to win outsourcing business	Establish subsidiary in country of origin of outsourcing to compete for outsourced business

based service supplying firms responded by opening front-office operations in developed country markets in order to compete in the country of origin of outsourcing with the MNE suppliers of outsourced services. This, in turn, has compelled MNE suppliers of outsourced services to extend their offshoring activity.

Early experience in India was built via the establishment of MNE operations in India, often triggered by senior executives of Indian origin (Tschang, 2001). This led to in-house offshoring, involving the operation of internal business support activities offshore following FDI (*i.e.* internal offshoring through FDI). American Express established business process services operations in India in 1993, British Airways established a business process support services operation in India in 1996, and General Electric did so in 1998. GE is now one of the largest business process services employers in India and intends to increase staff to 20 000 by the middle of 2004. An increasing number of Fortune 500 firms have established operations in India, including AOL, Citigroup, Dell, Hewlett-Packard, HSBC and JP Morgan Chase (Dossani and Kenney, 2003). Many of their facilities are growing rapidly. For example, one computer manufacturer's Indian facility grew from 200 employees to 3 200 within two years. As experience is gained, higher value activities are being offshored. For example, GE's Indian operations have added employees to undertake actuarial support, data modelling and portfolio risk management, and GE is reported to employ 40 doctors in its healthcare insurance operations (Dossani and Kenney, 2003).

Multinational providers of services have followed, moving an increasing share of their work to low-cost offshore facilities (*i.e.* providing offshore outsourcing services through FDI and affiliated trade in services). Convergys, Hewlett-Packard, IBM, EDS, Computer Sciences Corporation (CSC) and Accenture are among the firms making extensive use of their global networks to source both external and internal support services. Convergys opened its first Indian operation in New Delhi in late 2001. By April 2003, it had more than 3 000 employees, and was building a second facility in Bangalore that was expected to grow to 3 000 employees (Dossani and Kenney, 2003). In India, Hewlett-Packard employs around 8 000 people in software development, call centre, helpdesk and R&D activities. CSC is opening two new software development centres in India, adding to the three centres it already has there. Cap Gemini Ernst and Young has also been increasing staff in India, aiming for around 3 000 by 2005 (Moran, 2003). IBM recently announced its intention to move nearly 5 000 programming jobs from the United States to India (Lyman, 2003), and in early 2004 IBM (Australia) announced that it was moving software development jobs from its contract with Telstra in Australia to facilities in India (Crowe and Connors, 2004). The Australian case provides an illustration of the dynamic at work. It began with Telstra's cost cutting, and then, following IBM's loss of another Telstra contract to the Indian firm Infosys, IBM needed to match Infosys's cost structure which is based on an offshoring component. The process of international sourcing, as this case illustrates, will continue to adjust to skill and cost factors.[20]

Some smaller IT and related services providers are now making international sourcing a key element of their business models. For example, Covansys claims to have been one of the first US-based IT services companies to establish offshore facilities in India and to be a pioneer in seamlessly integrating offshore capabilities. Covansys earned revenue of around USD 380 million in 2002. It operates in 27 locations around the world, including six development centres in India and the United States. Cognizant has around 70% of its workers in India and had expanded its Indian workforce to 6 700 by the end of 2003. Harvey Nash Software Development, based in the United Kingdom, chose to locate its activities in Vietnam, which it claims undercuts UK costs by 50-60%, and those of India by as much as 15%. Harvey Nash recently won a large contract from Honda (Moran, 2003).

Independent Indian firms are also providing outsourced services (Table 2.12). In the year ending March 2003, Tata Consultancy Services earned revenues of USD 1 billion, of which USD 944 million from exports. Over the period 1997-2003, TCS's revenue increased 31% a year, with export revenues increasing 33% a year. TCS employed 9 500 people in 1997 and 24 000 by early 2003 (according to the company's annual report). Wipro earned USD 886 million in 2003, up from USD 525 million in 2000 or by 19% a year. Wipro's IT services and business process outsourcing exports amounted to USD 618 million in 2003, up from USD 234 million in 2000, an increase of 38% a year (according to the company's annual report). Infosys Technologies also offers IT services to clients worldwide. In 2002-03, it earned

Table 2.12. **India's offshore IT and business process outsourcing services players**

	MNE subsidiaries supplying internal services	Local joint ventures and spin-offs	MNE subsidiaries providing outsourcing services to others	Local independents
Information technology	Microsoft	MBT	Deloitte	Infosys
	Oracle	Syntel	PricewaterhouseCoopers	Wipro
	Adobe	Cognizant	Accenture	NIIT
	SAP	Covansys	IBM	Satyam
	Cadence		EDC	TCS
			CSC	
Business process	General Electric	WNS	Convergys	Daksh
	HSBC	Stream Trac Mail	Sitel	Spectramind
	American Express	EXL	EFund	MsourcE
	Standard Chartered	Health Scribe	Sykes	Intellinet
	Ford	eServe	First Data	TransWorks
	McKinsey			Progeon
	JP Morgan			ICICI OneSource
	Flour Daniel			

Source: Derived from McKinsey and Company, 2003.

USD 754 million, up from USD 203 million in 2000, an increase of 55% a year. At USD 740 million, exports accounted for around 98% of 2002-03 revenues. Infosys has around 17 000 employees. Other Indian firms developing along similar lines include: Satyam Computer Services, which earned around USD 460 million in 2002-03 and employed 9 750; HCL Technologies, which earned USD 332 million and employed 9 500; and Patni Computer Systems, which earned USD 188 million and employed 5 600 (Hunt, 2003).

Indian services providers are now expanding their operations and investing abroad as a result of the development of their service provision capabilities. TCS operates branches in 32 countries worldwide and has development centres in India, the United States, Canada, United Kingdom, Australia, Japan, China, Hungary and Uruguay (see the company Web site). Wipro has 30 offices worldwide, 21 000 employees and more than 300 customers across the United States, Europe and Japan (see the company Web site). Infosys now operates in 16 countries, including Mauritius, where it established a USD 25 million disaster recovery centre in 2002 (Hunt, 2003).

International sourcing arose as a response to skills shortages and the need to cut costs, and competition has created a self-reinforcing dynamic that is propelling its further development. Once one or two firms accessed lower-cost locations and moved the cost/quality frontier, others had to follow. How much longer this dynamic continues to operate will depend on the availability of skills and relative wage and other costs.

Impacts, issues and responses

While offshoring may deliver cost savings, it may also involve initial job losses in the home country and job creation in the host country. However, over time, cost savings and efficiency gains provide the foundation for productivity growth and the creation of new employment opportunities in the home country. They enable firms to compete, win new business, gain market share and grow.

Because of the rapid rise of international sourcing of services and the fact that it increasingly involves relocation of high-quality service jobs, there is considerable controversy surrounding the issue. However, even if one takes the most widely cited consultancy projections at face value, it may be less significant than some suggest. For example, the widely cited figure of 3.3 million jobs moving offshore from the United States between 2000 and 2015 is not a large one for an economy with around 130 million employed workers and in which an average of 7-8 million jobs were lost every quarter during the boom years of the 1990s, while even more were created (Agrawal and Farrell, 2003; Lohr, 2003;

Kirkegaard, 2004).[21] To date, the scale of offshoring is relatively modest and, if history is a guide, growing open economies should be able to adjust and prosper.

Reduced costs for businesses with offshore operations or that make use of international outsourcing operations should make them more competitive. In the first instance, they should gain market share and profitability should improve. Over time, competition should ensure that the benefits flow through to consumers in the form of lower prices. Thus, offshoring should enable firms based in developed economies to gain market share in the global economy, grow and expand employment opportunities both at home and abroad. In addition, jobs created offshore generate demand for developed country goods and services exports – for ICT equipment and communications services immediately and, over time, for a wide range of consumer goods. At the same time, wages and prices in offshore locations are likely to rise, creating wealthier developing-country consumers and reducing the wage cost differential and arbitrage opportunity. Such a scenario would make offshoring a win-win.

However, there are adjustment costs and there may be longer-term challenges. Personal adjustment costs for those who lose jobs are high, but can be lessened through job search support, retraining opportunities and, perhaps, insurance schemes.[22] Many of the activities going offshore may have previously located in lower-cost rural locations in the home economy (*e.g.* call centres). This may limit the opportunities available to displaced workers and require special mechanisms to assist regional adjustment, although some of these jobs may have been vulnerable to automation in any case. Similarly, there may be particular adjustment difficulties for smaller countries which are neither low-cost locations nor the home base of MNEs, with jobs losses and benefits accruing in the first instance to US and European MNEs and their shareholders, and a greater time lag between job losses and realising the benefits of lower-cost structures through lower world prices.

In the longer term, there may also be a need to adjust education and training, not only to account for the types of jobs being lost and created, but also for the possible erosion of traditional career paths. For example, as programming activities move offshore there may be fewer career path opportunities for learning about systems design. All of these adjustments are made more challenging by the potential speed of relocation of IT and business process services activities, which are typically less capital-intensive and more footloose than manufacturing activities. A measured response to international sourcing would be to take advantage of the benefits while managing the adjustment process. One of the keys to maximising the benefits will be to ensure that they flow to the consumer as quickly as possible through continued attention to competition policy, and compensating for adjustment costs where necessary with active adjustment policies and enabling workers to seize new employment opportunities and increase employment security, *e.g.* through lifelong learning mechanisms and incentives (Dossani and Kenney, 2003).

Conclusion

The ICT sector is highly and increasingly globalised. In many respects, it offers a leading example of industrial globalisation. While different segments of the ICT sector vary, owing to different regulatory and market imperatives, the ICT sector as a whole reveals some of the key drivers and core characteristics of industrial globalisation. The underlying structure and dynamics of the ICT sector are likely to ensure that it remains at the forefront of globalisation.

ICT trade is dynamic, with trade in ICT goods growing at almost double the rate of merchandise trade and trade in ICT services growing faster still. In terms of investment, there has been a shift of focus away from globalised manufacturing activities towards globalising services activities. As services become the focus of deregulation and trade liberalisation, and marketed services become a larger part of economic activity in most economies, the trend seems likely to continue. In recent years, telecommunication services were at the forefront of investment and M&A activities as liberalisation opened new markets and will probably continue to be, despite the recent loss of share value and the cost of rolling out third-generation mobile networks.

The impact of the business cycle on the level of FDI and M&A activity is clear. The boom years of the 1990s were a period of rapid globalisation. The recent "tech wreck" and the international economic downturn have had a significant impact on these forms of globalising activity in the ICT sector. However, there are signs of a resurgence of FDI and M&A activity, and one can expect to see consolidation in all parts of the industry as the firms that emerge from a difficult period relatively unscathed seize the opportunity to consolidate their position through takeovers of firms that encountered more serious difficulties. Thus, despite the recent downturn, which the ICT-producing sector felt particularly harshly, ICTs will remain at the forefront of developments in globalisation.

Services offshoring, defined as the international sourcing of IT- and ICT-enabled business support services, is a recent development. It arose from the potential for digital delivery of IT and ICT-enabled services, in response to skills shortages and the need to cut costs, and competition has created a self-reinforcing dynamic that is propelling its further development. However, while offshoring may deliver cost savings, it may also involve initial job losses in the home country, while creating jobs in the host country. Over time, cost savings and efficiency gains should enhance productivity growth and create new employment opportunities in the home as well as the host country.

Rather than a protectionist response, it would be better to take advantage of the benefits while managing the adjustment process with active adjustment policies, compensating for adjustment costs where necessary and enabling workers to seize new employment opportunities, for example by adjusting education and training programmes. Although there are concerns that some of the jobs lost may be difficult to replace and that labour conditions may be eroded in the home country, international sourcing is an important strategic factor in the continuing competitive adjustments of firms and labour markets, and it is important to couple these adjustments with appropriate good labour and social welfare provisions everywhere, and with lifelong learning strategies. Furthermore, international sourcing has self-adjusting mechanisms, and most firms are currently beginning to work out what can be successfully sourced internationally (codified tasks) and what cannot (more context-specific tasks which require greater interaction). At present, the formal analysis of international sourcing and its implications is complicated by the absence of reliable statistics measuring its extent, and in particular its net employment impacts.

NOTES

1. All values are expressed in current USD at annual average exchange rates, unless otherwise indicated.
2. Revealed comparative advantage is calculated as the ratio of the share of ICT goods exports in total merchandise exports for each country to the share of OECD ICT exports in total OECD merchandise exports, *i.e.* (country ICT exports/Country total exports)/(OECD ICT exports/OECD total exports). A value of greater than 1 indicates a comparative advantage in ICTs, and a value of less than 1 a comparative disadvantage.
3. For an industry "i" with exports "Xi" and imports "Mi", the index is GLI = [1 – |Mi – Xi|/(Mi + Xi)].
4. Press reports show that global M&A deal values increased strongly in the first half of 2004, up by 38% in current USD terms over the first half of 2003, which was only slightly ahead of first half 2002, with the US leading with its best year since 2000 for M&A activity (*Financial Times*, 2004).
5. Detailed analysis of cross-border M&As is based on Dealogic data (*www.dealogic.com*). Data from Dealogic were used initially for the analysis of investment trends in OECD, 2002b, see Box 2, p. 17, for description, and in OECD, 2003a. The data include deals that are between entities based in different economies (cross-border) and have been announced and declared completed. They are recorded as occurring in the year of announcement when reference is to deals announced and in the year of completion when reference is to deals completed. Country data refer to country of bidder and country of target – reflecting M&A deal outflows and inflows, respectively. Not all deal values are recorded, and not all deals are reported. Consequently, these data only provide a guide to M&A activity. ICT-sector M&As are those in which ICT industry entities, defined by primary NAICS (North American Industry Classification System), are the target (see note 7).
6. Average deal values are understated because not all deals report a value. Hence they are only indicative of the relative levels of deal value year to year.
7. The ICT industries include the following NAICS groups:

   Manufacturing. *Communications equipment manufacturing*: 33421: Telephone apparatus manufacturing; 33422: Radio and television broadcasting and wireless communications equipment manufacturing; 33429: Other communications equipment manufacturing; 33431: Audio and video equipment manufacturing; *Computer and office equipment manufacturing*: 33411: Computer and peripheral equipment manufacturing; *Electronics equipment manufacturing*: 33441: Semiconductor and other electronic component manufacturing; 33451: Navigational, measuring, electromedical, and control instruments manufacturing; 33461: Manufacturing and reproducing magnetic and optical media.

   IT Services. 51121: Software publishers; 54151: Computer systems design and related services.

   IT Wholesale. 42342: Office equipment merchant wholesalers; 42343: Computer and computer peripheral equipment and software merchant wholesalers; 42362: Electrical and electronic appliance, television, and radio set merchant wholesalers; 42369: Other electronic parts and equipment merchant wholesalers.

   Media and content. 51211: Motion picture and video production; 51212: motion picture and video distribution; 51213: Motion picture and video exhibition; 51219: Postproduction services and other motion picture and video industries; 51221: Record production; 51222: Integrated record production/distribution; 51223: Music publishers; 51224: Sound recording studios; 51229: Other sound recording industries; 51511: Radio broadcasting; 51512: Television broadcasting; 51521: Cable and other subscription programming; 51611: Internet publishing and broadcasting.

   Communication services. 51711: Wired telecommunications carriers; 51721: Wireless telecommunications carriers (except satellite); 51731: Telecommunications resellers; 51741: Satellite telecommunications; 51751: Cable and other program distribution; 51791: Other telecommunications; 51811: Internet service providers and Web search portals; 51821: Data processing, hosting, and related services.
8. ICT industries are defined at the 5-digit NAICS level, such that "horizontal deals" are those in which both target and bidder report the same primary 5-digit NAICS.
9. The former can be seen in M&A deals by "bidder nation" and the latter in deals by "target nation". Because of reporting limitations, however, data are incomplete and should be treated as no more than indicative. For example, while just 1.2% of all reported completed ICT-sector M&A deal value over the period 1995-2003 has

no individually specified target nation, fully 29% of reported deal value has no individually specified bidder nation. Because of this difference between bidder and target data, no inferences can be drawn as to trends in regional ownership (*e.g.* non-member country acquisition of member country assets).

10. Owing to reporting limitations, data are incomplete and should be treated as indicative. For example, fully 29% of reported deal value has no individually specified bidder nation.
11. Owing to reporting limitations, data are incomplete and should be treated as indicative. For example, 1.2% of all reported completed ICT-sector M&A deal value over the period 1995-2003 has no individually specified target nation.
12. Including enterprises controlled by a foreign owner in which more than 50% of voting rights are foreign-owned.
13. Including Swedish-owned groups of enterprises that have at least one subsidiary company abroad and, in addition, have at least one person employed abroad. A group of enterprises is defined as Swedish-owned if a Swedish juridical person is at the top of the enterprise.
14. A recent survey of European firms by the UNCTAD and Roland Berger Strategy Consultants found cost savings are still the main driver for services offshoring. Relative costs as well as local skills and infrastructure were important factors in choosing the offshore location (UNCTAD, 2004).
15. OECD (2000a) provides an extensive review of the Indian software industry.
16. NASSCOM consolidates IT and IT Enabled Services (ITES) into a single category. See NASSCOM/McKinsey (2002), cited by Roach (2003). It should be noted that NASSCOM does not follow the revised Balance of Payments (BPM5) methodology.
17. For India, the category "other business services" includes all services except travel, transport and government services. However, Indian firms are now extensively exporting ICT-enabled services and business process services and the remaining services included in the category are likely to be small in comparison. Furthermore, data on overseas revenues from annual reports of top Indian export firms show patterns similar to the IMF data.
18. However the share of some services exporting countries may be understated as they may not have very good data on trade in services to report to the IMF, which will bias their actual share downwards. Furthermore, other countries that export services may not be members and report to the IMF.
19. For example, a regionally organised firm may trade between its regional entities globally and its national entities regionally, such that US offshoring to India might appear to be conducted between the United States and an Asia-Pacific regional entity based in Japan, Singapore or Australia in US trade data. Moreover, when organising its internal office functions globally, a firm may not even record activities as transactions between profit/cost centres. It may see itself as simply operating an accounts department on the other side of the world, rather than the other side of the corridor.
20. It was reported that: "Telstra has struck a deal to send 450 software jobs to India in the biggest example yet of sending skilled Australian jobs to low-wage countries […] IBM will send much of the work currently done in Australia to its services operations in India, helping the computer giant meet Telstra's demands for lower costs […] IBM lost a key part of its business with Telstra to Indian outsourcing company Infosys, which won a five-year $75 million project that put at risk 180 local software jobs. The contract announced is understood to be the first time IBM Australia has been forced to send work to India to meet cost targets in Australia, demonstrating the pressure it is under to match the cost structure of rivals like Infosys" Crowe and Connors (2004).
21. One concern is that low-cost countries enter on the supply side of global commerce, but their demand response lags and domestic demand remains weak, creating asymmetrical globalisation that leads to jobless growth in higher wage economies as they provide the demand side (without the supply side, which has moved offshore). See Roach (2003).
22. McKinsey Global Institute (2003), p. 15, citing L. Kletzer and R. Litan (2001).

REFERENCES

Agrawal, V. and D. Farrell (2003), "Who Wins From Offshoring?", *McKinsey Quarterly*, No. 4.

Associated Press (2004), "Most Siemens Software Jobs Moving East", *The New York Times*, 16 February, Available at *www.nytimes.com/aponline/technology/AP-India-Siemens.html?ex=107801465*.

Business and Industry Advisory Committee to the OECD (BIAC) (2004), "BIAC Statement on Trade, Global Sourcing and Structural Adjustment: Policies to Promote Growth and Employment", submitted to the 2004 OECD Council Meeting at Ministerial Level.

Biswas, D. (2003), "Offshore Outsourcing: Is it the TCO the slasher it promised to be?", *Information Age*, October/November 2003, p. 21. Available at *www.acs.org.au/infoage.html*, accessed December 2003.

Borga, M. and M. Mann (2002), *US International Services: Cross-border Trade in 2001 and Sales Through Affiliates in 2000*, US Department of Commerce, Washington DC.

Bureau of Economic Analysis (United States) (2003), "Foreign Direct Investors' Outlays to Acquire or Establish US Businesses Fell Sharply in 2002 for the Second Year", *BEA News* 03(19), June.

Corbett, M.F. (2002), *The Global Outsourcing Market 2002*, Corbett & Associates, New York. Available at *www.corbettassociates.com*, accessed January 2004.

Crowe, D. and E. Connors (2004), "Telstra Sends 450 Jobs to India", *The Australian Financial Review*, 14 January 2004, p. 3. Available at: *www.afr.com.au*, accessed January 2004.

Department of Commerce (United States) (2002), *Digital Economy 2002*, Department of Commerce, Washington DC.

Dossani, R. and M. Kenney (2003), "Went for Cost, Stayed for Quality? Moving the Back Office to India", *Berkeley Roundtable on the International Economy* (BRIE) Working Paper 156, University of California at Berkeley, August 2003. Available at: *http://repositories.cdlib.org/brie/BRIEWP156* accessed January 2004.

The Economist (2003), "Relocating the Back Office – Offshoring – The Benefits of Offshoring", 13 December.

Financial Times (2004), "Global M&A Activity Continues to Grow", 28 June.

Houghton, J.W. (2003), *Australian ICT Trade Update 2003*, Centre for Strategic Economic Studies, Victoria University, Melbourne.

Hunt, B. (2003), "Offshore Role is Growing Fast", *Financial Times*, 5 February.

Kirkegaard, J. F. (2004), *Outsourcing – Stains on the White Collar?*, IIE Working Paper, Institute for International Economics, Washington DC, available at *www.iie.com/publications/papers/kirkegaard0204.pdf*, accessed June 2004.

Kletzer, L. and R. Litan (2001), "A Prescription to Relieve Worker Anxiety", Institute for International Economics, Policy Brief 01-2, February 2001.

Lohr, S. (2003), "Offshoring: Opportunity or Threat?"*The New York Times*, 23 December.

Lyman, J. (2003), "IBM Offshoring Nearly 5 000 Software Jobs", *TechNewsWorld*, December 15. Available at: *www.technewsworld.com/perl/story/32396.html*, accessed January 2004.

Mataloni, R.J. (2002), *US Multinational Companies: Operations in 2000*, Department of Commerce, Washington DC.

Mataloni, R.J. (2003), *US Multinational Companies: Operations in 2001*, Department of Commerce, Washington DC.

Mattoo, A. and S. Wunsch (2004), "Securing Openness of Cross-Border Trade in Services: A Possible Approach", World Bank Policy Research Paper 3237, March 2004, World Bank, Washington DC, forthcoming in the *Journal of International Economic Law* (Vol. 7, Issue 4, December), available at *www.cid.harvard.edu/cidtrade/Papers/mattoo-wunsch.pdf*, accessed June 2004.

McCarthy, J.C. *et al.* (2002), "3.3 Million US Services Jobs to Go Offshore", *Forrester TechStrategy Brief*, Forrester Research, 11 November.

McKinsey and Company (2003), "India Information Technology/Business Process Offshoring: Case Summary", McKinsey Global Institute, San Francisco. Available at *www.mckinsey.com* accessed January 2004.

McKinsey Global Institute (2003), *Offshoring: Is It a Win-Win Game?* McKinsey Global Institute, San Francisco, August. Available at *www.mckinsey.com/knowledge/mgi* accessed January 2004.

Miller, A., and P. Codling (2003), *The Offshore Services Report* 2003, Ovum Holway, February. Available at *www.ovum.com/go/content/HAE.htm*.

Moran, N. (2003), "Global Outsourcing: Looking for Savings on Distant Horizons", *Financial Times*, 2 July.

NASSCOM/McKinsey (2002), *The IT Industry in India: Strategic Review* 2002, NASSCOM. Available at: *www.nasscom.org/Default.asp*.

National Science Foundation (2004), "US-China R&D Linkages: Direct Investment and Industrial Alliances in the 1990s", *InfoBrief* NSF 04-306, National Science Foundation, Arlington, VA. Available at: *www.nsf.gov/sbe/srs* Accessed February 2004.

OECD (2001), *New Patterns of Industrial Globalisation*, OECD, Paris.

OECD (2002a), *The Manual on Statistics of International Trade in Services*, joint publication of the United Nations, the International Monetary Fund, the OECD, the European Commission, the United Nations Conference on Trade and Development and the World Trade Organization. Available at *www.oecd.org/std/trade-services*.

OECD (2002b), *International Investment Perspectives*, No. 1, 2002 Edition, OECD, Paris.

OECD (2003a), *International Investment Perspectives*, 2003 Edition, Chapter I, "Trends and Recent Developments in Foreign Direct Investment", OECD, Paris.

OECD (2003b), *Indicators of Economic Globalisation*, OECD, Paris, DSTI/IND(2003)4/FINAL.

OECD (2003c), *Digital Delivery of Business Services*, OECD, Paris, DSTI/ICCP/IE(2003)2/FINAL.

Pain, N. and D. van Welsum (2003), "Financial Liberalisation, Alliance Capitalism and the Changing Structure of Financial Markets", in *Alliance Capitalism and Corporate Management: Entrepreneurial Cooperation in Knowledge Based Economies* (ed. J. H. Dunning and G. Boyd), Edward Elgar, Cheltenham, UK.

Porter, E. (2004), "Send Jobs to India? Some Find It's Not Always Best", *New York Times*, 28 April.

Roach, S. (2003), *The Global Labor Arbitrage*, Morgan Stanley Global Economic Forum, 6 October. Available at *www.morganstanley.com/GEFdata/digests/20031006-mon.html*, accessed January 2004.

Trade Union Advisory Committee to OECD (TUAC) (2004), Submission to the OECD Trade Committee Consultations with Civil Society Organisations, 19 October.

Tschang, T. (2001), "The Basic Characteristics of Skills and Organizational Capabilities in the Indian Software Industry", Asian Development Bank Working Paper 13, Manila.

UNCTAD (2002), *World Investment Report: Transnational Corporations and Export Competitiveness*, UNCTAD, Geneva.

UNCTAD (2003), *World Investment Report* 2003: FDI *Policies for Development*, UNCTAD, Geneva.

UNCTAD and Roland Berger Strategy Consultants (2004), "Services Offshoring Takes Off in Europe – In Search of Improved Competitiveness", Summary Report, UNCTAD, Geneva.

van Welsum, D. (2004), "In Search of 'Offshoring': Evidence from US Imports of Services", Birkbeck Economics Working Paper 2004 No. 2, Birkbeck College, London. Available at: *www.econ.bbk.ac.uk/wp/eco/ecoup.htm*

Zeile, W.J. (2003), US *Affiliates of Foreign Companies: Operations in* 2001, Department of Commerce, Washington DC.

Chapter 3

E-BUSINESS DEVELOPMENTS

In OECD countries, computers and the Internet are now widely diffused among firms. However, despite good access to computers and high levels of business connectivity, including broadband, there is relatively little implementation of ICT-enabled integrated business processes or adoption of more sophisticated online activities (e.g. taking orders on line, integration with suppliers). The challenge is to increase effective use internally and externally through the use of e-business software and changes in interactions with suppliers and customers.

Introduction

Internet-based and other ICT technologies that allow e-business (defined here as ICT-enabled intra- and inter-firm business processes over computer-mediated networks[1]) are ever more present in the firm environment. The dot.com bubble – with its fixation on e-commerce and its disproportionate ICT budgets often not aligned on broader business strategy and exaggerated expectations – has only temporarily affected e-business implementation. The general economic downturn that began in 2000 resulted in falling investment in software and ICTs and stretched out replacement cycles; this has widened the gap between the latest available technologies and those now used in many companies (Board of Governors of the Federal Reserve System, 2003). However, this publication suggests that ICT spending is recovering, with growth of investment in computers and software as of the second quarter of 2003, and – after two year of record declines – a rise in ICT spending in 2004. Companies continue to invest in e-business solutions. To meet increased competition, they adopt various ICT-enabled changes: more sophisticated and rapid use of information; a streamlining of business processes, often accompanied by a transformation of the value chain (outsourcing, use of ICTs in manufacturing, global sourcing, new network organisational structures, etc.); the use of e-business software (such as customer relationship management – CRM); and a change in the ways in which firms interact with suppliers and customers.

At present, the issue for firms is not whether but how to deploy Internet technology in their business processes, *i.e.* how to move from a satisfactory deployment of ICT infrastructure to effective use of ICTs.[2] Learning from earlier experience with ICT spending, the focus has changed from the presentation of the firm to the outside world via an Internet page to a focus on how the firm operates and integrates ICTs in its overall business strategy. For some firms, the integration of internal ICT systems is most important, while others also work towards integrating their ICT systems with those of suppliers (especially for ordering, production and logistics).

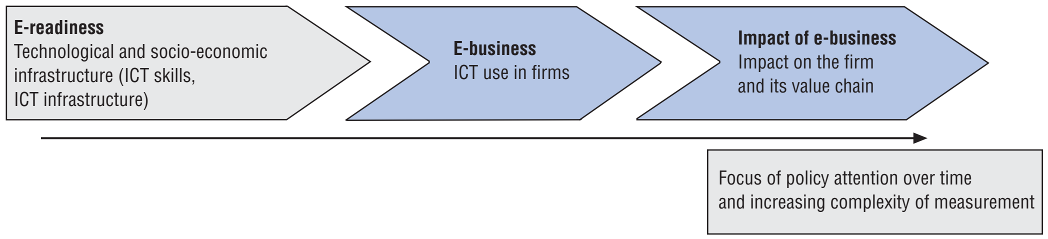
Firms have been looking to use ICTs more to drive supply chain efficiencies and thus to cut costs than to boost revenues. Now, however, as the business cycle is again trending upwards, firms will start looking for new products and ways to increase customer reach. They will seek to maximise the impact of existing ICT investments and to get IT spending right this time with a view to specific goals, rather than engage in massive ICT expenditures with uncertain payoffs (*The Economist*, 2003) and revenue performance (McKinsey, 2003).

Following a brief presentation of recent developments and methodology and measurement issues, the chapter addresses four e-business phases ranging from early to more sophisticated e-business applications in order to analyse the uptake of e-business in OECD countries. To conclude, some light is shed on the impact of e-business. In Chapter 6, industrial sectors are discussed in terms of their share of ICT-skilled employment and different ways in which ICT skills essential for e-business can be satisfied are considered.

Recent trends and shift of policy attention

In discussing firms' adoption of e-business processes and their impact, this chapter continues the analyses of previous issues of the *Information Technology Outlook* (OECD, 2000, Chapter 3, on e-commerce readiness; OECD, 2002, Chapter 4, on e-commerce intensity). Figure 3.1 describes the conceptual framework that underpins the present analysis. It shows that initially, policy makers need information on enabling factors and barriers to e-business (*e-readiness* indicators). Access to computers, the Internet

Figure 3.1. **Changing focus of policy attention and increased complexity of measurement over time**



Source: OECD.

and a Web page are seen as part of this first stage. Next, policy makers need information on intensity of business use of ICTs in order to address imbalances (*e-business* indicators). At a still later stage, they need information that makes it possible to measure the impact of e-commerce on the economy and society (*e-impact* indicators). As the graph also shows, measurement problems increase as one moves from one set of indicators to another.

Today, computers and the Internet are widely diffused in enterprises of all sizes and in all sectors in OECD countries (OECD, 2002, 2003c; Sessi, 2003; DTI, 2003). Although differences between larger enterprises and the smallest are still substantial, a large percentage of small firms now have access to the Internet and e-mail. In terms of ICT adoption, business and financial services generally lead and retail generally lags behind. As a result, ICT infrastructure and access to the Internet are no longer the only focus of policy makers in OECD countries. These results are shown for Australia, Canada, the Netherlands and Norway in Annex Figure C.3.1.

It has also been shown that an exclusive focus on e-commerce (purchasing or selling over computer-mediated networks) and e-procurement excludes much of the Internet-based activity of manufacturing plants (US Bureau of the Census, 1999, 2001a, 2001b, 2002). Instead, e-business covers all business applications that use Internet technology to improve the firm's efficiency. Hence, the policy focus is shifting from promoting e-commerce to a more holistic view of e-business, which includes not only buying and selling over the Internet but also the productive integration of ICTs in business processes (European Commission, 2003a; Sessi, 2003).

Therefore, the chapter focuses on the use of ICTs in business processes (e-business) and, to some extent, on the impact of ICTs on firms. Electronic business processes are here defined as "ICT-enabled business processes (both intra-and inter-firm) over computer-mediated networks". E-business itself is wider in scope than ICT-enabled processes as it also includes the creation and delivery of new products (databases, new financial services or digital products).

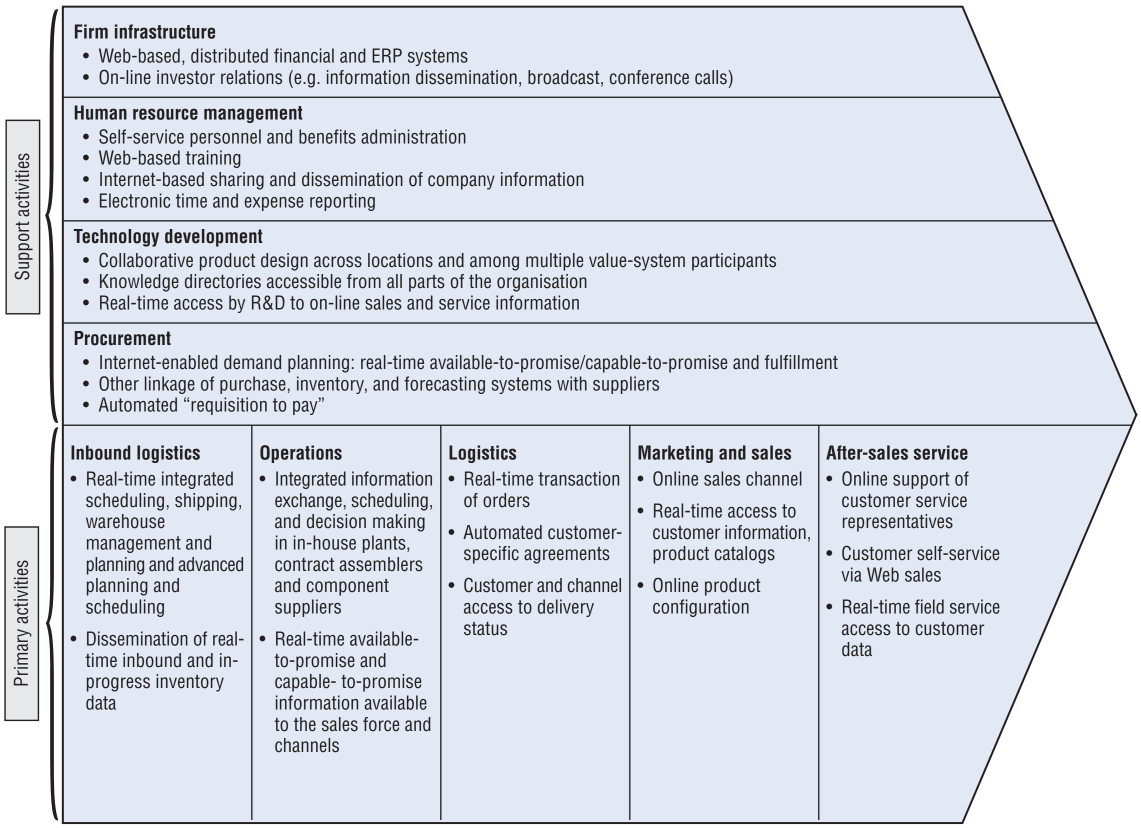
To study e-business processes, the Porter value chain/supply chain approach is used to examine the impact of computer-mediated networks on internal firm functions and external firm relations. The management literature has provided many arguments for the use of ICTs as a strategy enabler to change how firms compete (McFarlan, 1984).

Figure 3.2 shows how ICTs can be employed for different business processes along the value chain. Within the various functions of the Porter value chain, specific e-business processes which automate existing processes or change companies' existing processes can be identified.

***Production-focused processes*:** the use of ICTs to design and test new products (blueprints), electronic procurement, automated stock replenishment, payment processing and other electronic links with suppliers, as well as production control and processes more directly related to the production process.

- ***Internal processes*:** knowledge management platforms, automated employee services and training, internal recruitment.

Figure 3.2. **The use of ICTs in the Porter value chain**



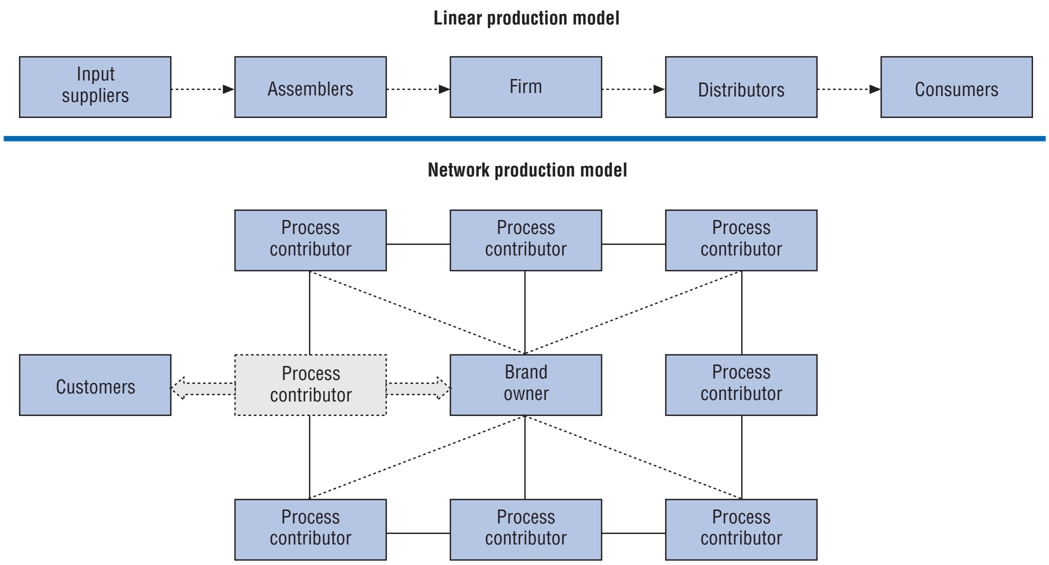
ERP: enterprise resource planning.
Source: Porter (2001).

- ***On-line purchasing processes*****:** access to vendors' products/catalogues, ordering from vendors, electronic payment to vendors, vendor managed inventory, use of electronic marketplaces.
- ***Customer-focused processes*****:** marketing, processing of customers' orders and payments, customer management and support. E-commerce is part of this category and essential for selling products. New revenue-generating streams can result in enhanced access and sales to customers (potentially with an extended geographic reach) and the possibility to deliver electronically (digital products like software, music, etc., and digital services).

The value activities depicted in Figure 3.2 are not only internal to the firm. They are related by linkages that exist not only in a firm's value chain but also between a firm's chain and the value chains of suppliers and channels (vertical linkages). These provide further opportunities to enhance competitive advantage (Porter, 1985).

Globalisation and increased market pressures force firms to concentrate on their core competence, and ICTs can serve as a catalyst for making possible hitherto unavailable strategic choices (outsourcing, application service providers, etc.). The availability of ICTs makes it easier for firms to outsource non-core competencies to partner networks (Atrostic and Gates, 2001; Atrostic *et al.*, 2002). ICTs make it possible to reduce transaction costs, improve businesses processes, facilitate co-ordination with suppliers, fragment processes along the value chain (both horizontally and vertically) and across different geographical locations, increase diversification and even lead to a decrease in firm size (Motohashi, 2001; Porter, 2001; Brynjolfsson *et al.*, 1994; Brynjolfsson and Hitt,

Figure 3.3. **Linear vs. network production model**



Source: OECD, based on Chung *et al.*, 2004; Jagdev and Thoben, 2001; and Bitran *et al.*, 2003.

1998; McCarthy and Anagnostou, 2004). In manufacturing, for example, many large firms have moved to global ICT-enabled sourcing and decentralised management of global production networks (Chung *et al.*, 2004). The outsourcing of business processes related to interaction with customers (sales support, membership management, etc.), back-office operations such as accounting, and more independent business/professional services is increasingly frequent (see Table 2.9 in Chapter 2; McCarthy and Anagnostou, 2004).

ICTs and integration have also made boundaries more permeable and increased the need for collaborative relations and automated exchange of information. Competitiveness in this new environment depends on a cluster of firms' capacity to develop sophisticated but flexible value network strategies to deliver the highest value (Quinn, 1992). The notion of the "extended enterprise" or of the evolution of supply chains into "value networks" (Jagdev and Thoben, 2001; Bitran *et al.*, 2003; A.T. Kearney, 2002) reflects this trend towards networks of interlocking businesses in which the firm functions as an information hub for process contributors (other firms) and customers.

Figure 3.3 turns from Porter's linear production model to an ICT-enabled network production model in which firms, suppliers and often customers become contributors to the production process. Instead of merely supplying raw materials or intermediate inputs to an end producer, contributing firms participate in two-way information flows and a dynamic production process. In services industries (*i.e.* banks, telecommunications) in particular the creation of value has always been less sequential and intra-firm than in a traditional, product-centred manufacturing firm (Stabell and Fjeldstad, 1999). Service firms mediate interactions and exchanges across a network of suppliers and customers, and each specialises in one part of the value chain, a situation that increases the potential for ICT-enabled co-ordination.

Measurement issues

In spite of the growing level of business adoption and public debate concerning e-business (e-commerce), very little data on the use and impacts of e-business have been available to policy

Box 3.1. Defining and measuring electronic business at the OECD

Only a few years ago, there were no internationally comparable official statistics measuring e-business. Following a recommendation made by Ministers at the 1998 Ottawa conference on e-commerce, the OECD agreed definitions for e-commerce transactions which are now widely used by OECD and non-OECD countries and international organisations that cover developing countries (for example, UNCTAD 2003a, 2003b). Work on broader e-business processes is also being undertaken.

In 2001 and 2002, in addition to statistical work, the OECD carried out the Electronic Commerce Business Impacts Project (EBIP) to develop in-depth, internationally comparable case studies that would provide new insight into the dynamics and impact of electronic commerce and electronic business strategies and adoption (OECD, 2003d).

Further work has explored definitions and led to the inclusion of questions relating to e-business in OECD model surveys of ICT use in business. The following definition of e-business processes is under consideration for the purpose of statistical surveys: "(automated) business processes (both intra- and inter-firm) over computer-mediated networks." In addition, it is suggested that "electronic businesses processes should integrate tasks and extend beyond a stand-alone or individual application".

Source: OECD (2003a).

makers, and indeed the measurement of sophisticated ICTs is a serious challenge. Most internationally comparable official data at OECD level concentrate on access, connectivity and some aspects of ICT use (mainly e-commerce). Little information is as yet available on more advanced e-business processes or impacts. Aside from the OECD Electronic Business Impact Project (EBIP), large-scale e-business impact assessments are rare even at the level of the firm or case study.

The following discussion thus relies on statistical surveys conducted by national statistical offices (or government collection agencies) or by private bodies that address newer e-business phenomena (Box 3.1 describes OECD efforts to improve e-business metrics). The two types of survey are described in more detail in Annex Box C.3.1 and their validity, advantages and drawbacks are compared. In general, all survey results may have relevant standard errors and should be used with care.

Adoption of ICTs for business processes

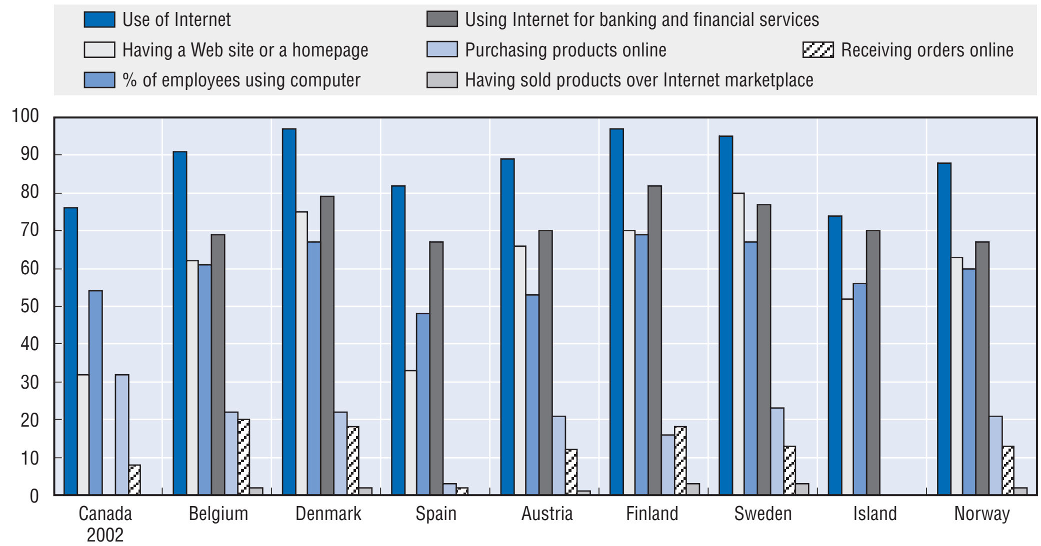
In spite of the problems of measurement, all studies and measurement efforts to date clearly show that there is substantial scope for firms to make use of e-business (DTI, 2002; E-business Nordic.com 2003; e-Business W@tch, 2003). This is because access to ICTs does not directly translate into efficient use, so that even with good access to computers and high levels of business connectivity, adoption rates of simple (*e.g.* e-commerce) and advanced on-line activities (*e.g.* integration with supplier) continue to be low (Charles and Leduc, 2002).

Figure 3.4 shows that despite high Internet access and a large percentage of employees using computers, the share of firms that receive orders on line or that sell over the Internet is still very low (Leek *et al.*, 2003, find similar result for the United Kingdom). More businesses are ordering and paying on line than accepting orders and payments, an indication that many firms that fulfil the technical preconditions for doing e-business stick to straightforward e-business processes (DTI, 2002, 2003). More sophisticated forms of e-business that involve the internal or external integration of ICT systems are less present.

Both the uptake of e-business and the use of more sophisticated e-business processes vary markedly by sector and firm size (Preissl, 2003; e-Business W@tch, 2003). E-business has meant real

Figure 3.4. **High levels of business connectivity but low rates of e-commerce adoption in selected EC countries, Norway, Iceland and Canada, 2003 or latest available year**

As a percentage of all firms



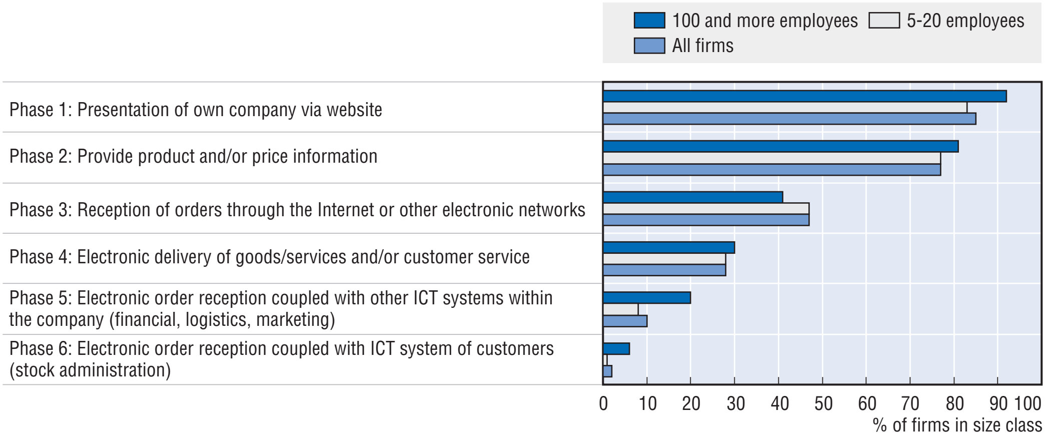
Source: OECD, based on Eurostat, European Community Survey on ICT Usage in Enterprises, 2003, firms of all sizes in seven sectors; and Industry Canada, Survey of Electronic Commerce and Technology, April 2003 (figures for Canada are for 2002).

changes to their business concept, value chain, organisation and relationships with suppliers and customers only in a few enterprises. There is little integration of electronic order systems with other functions (marketing, logistics, etc.) or with suppliers and customers (external integration), except in some large firms. As the divide between small and large firms with respect to "e-readiness" closes, a new "e-business gap" with respect to more advanced e-business applications may widen. It has in fact been argued that firms move progressively from one step on the e-business value ladder to the next (CBI, 2002).

The steps involved appear to involve two distinct phases. Early use: *step* 1: ICTs provide and help search for information (sharing of documents, price information, product availability, etc.); and *step* 2: ICTs are used to conduct on-line transactions (banking, reception and placing of orders, e-commerce). Next, more sophisticated e-business applications are adopted: *step* 3: ICTs are integrated in internal processes (sharing of information internally, integration of ICT systems for marketing with order reception system, integration of e-commerce with back-end system, production planning, enterprise resource planning); and *step* 4: ICTs are used to integrate external and internal processes and ICT systems (system integration with suppliers of customers), also referred to as the "extended enterprise" in the literature.[3]

Each step is understood to increase business benefits, but also requires greater organisational change and sophistication. Some surveys show that the number of firms active in particular e-business activities decreases as the e-business activity involved becomes more sophisticated (*i.e.* moves from step 1 to step 4). This is the case for Dutch firms in nearly all analysed sectors (Figure 3.5). However, although it is appealing to think in terms of a sequential e-business ladder which firms steadily mount, the reality may be more complex. It is not necessarily true that some activities (*e.g.* e-commerce) are a precondition for adopting more sophisticated e-business processes (*e.g.* internal ICT-enabled processes or ICT-enabled external integration). Again, the lack of evidence on more sophisticated uses of ICTs may also be due to measurement problems.

Figure 3.5. **Different phases of e-business in the Netherlands, 2001**
Percentage of firms[1] that offer services over electronic networks



1. Firms with more than five employees.
Source: OECD, based on CBS (2003).

Early use of e-business

Use of ICTs to provide and search for information

Businesses still use ICTs and the Internet mainly to search for information (mostly technical) and for e-mail and as a communication and publishing medium (Table 3.1). For instance, 92% of Australian firms with Internet access use it for e-mail (ABS, 2003a), and more than 90% of Spanish firms use it to search for information (INE, 2003).

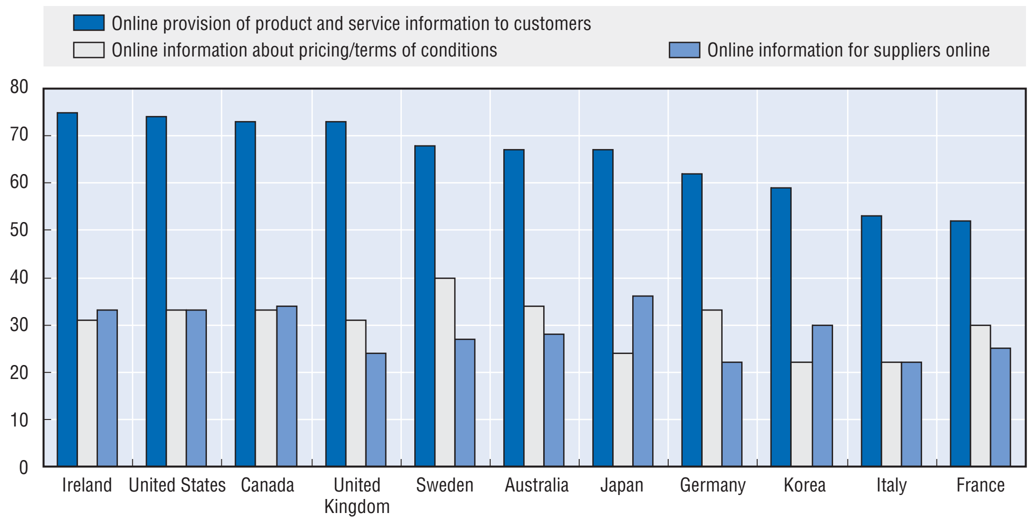
Many firms do not move beyond using the Internet as an electronic brochure for the firm Dutta and Segev, 1999; Protogeros, 2002; Nordic e-Business.com, 2003). Yet, while more firms use ICTs to obtain information than to provide it, the second most popular Internet function seems to be the use of the Internet as a marketing channel. Some types of information are more likely to be provided than others. Most firms provide information about products or services (around 70% of businesses in most countries), but information on other topics is scarcer (in decreasing order: product availability; pricing, terms and conditions; delivery schedules). Information provided to suppliers on line is mainly a description of products, information about product and service development and business

Table 3.1. **Use of the Internet to search for or provide information, 2002 or latest available year**
Percentage of enterprises with Internet access

	AUS	ESP	NLD	KOR[1]	DEU	GBR[2]	DNK[1]	FIN[1]	ISL[1]	NOR[1]	SWE[1]
Information search	88	93.2	n.a.	88.5	n.a.	96	90	91	n.a.	83	95
Information provision	n.a.	n.a.	85	49.9	70-96	n.a.	96	87	82	93	98

1. Data for 2001.
2. Data for 2000.
Source: OECD, based on GBR (Great Britain): Leek *et al.* (2003); KOR (Korea): NCA (2002), refers to information search by general management and customer marketing by sales management; AUS (Australia): ABS (2003b) for 2001-02; NLD (Netherlands): CBS (2003), percentage of firms that use electronic networks with more than five employees; DNK (Denmark), FIN (Finland), ISL (Iceland), NOR (Norway), SWE (Sweden): Nordic Council of Ministers (2002), proportion of firms with at least 10 employees having Internet access and for Internet as marketing tool; ESP (Spain): INE (2003); DEU (Germany): 70% (firms with 1-19 employees) and 96% (firms with 250 and more employees).

Figure 3.6. **Businesses that provide information on line, 2002-03**
Percentage of all surveyed firms



Note: Results are weighted to reflect employee distribution, *i.e.* 30% of businesses stands for businesses accounting for 30% of employment.
Source: OECD, based on DTI (2003).

processes (Figure 3.6). However, provision of information to suppliers – the first step towards process integration with external sources – is much less widespread than the provision of information to customers (DTI, 2002, 2003).

Use of ICTs to conduct on-line transactions

A large majority of firms use the Internet for banking and financial services (Table 3.2). On-line banking and other financial services is one of the most popular business activities on the Internet and certainly one of the greatest drivers of Internet use (Nordic Council of Ministers, 2002; Statistisches Bundesamt, 2003).

Low levels of ordering and selling on line

Official statistics for 2001 for most OECD member countries show the number of firms that engage in purchasing or receiving orders (e-commerce) on line (Figure 3.7).[4] A large share of Internet access does not automatically translate into strong e-commerce activity. Japanese firms, for instance, scores high in terms of Internet access but relatively low in terms of ordering on line. In most countries (except the Netherlands with a share of around 35%), only between 10% and 25% of firms take orders on line.

As Figure 3.7 also shows, the Internet is used much more frequently to purchase/order goods and services than to receive orders (see also Statistisches Bundesamt, 2003; Charles and Leduc, 2002). As many as two-thirds of enterprises with 250 or more employees in Australia, Canada, Denmark, Sweden

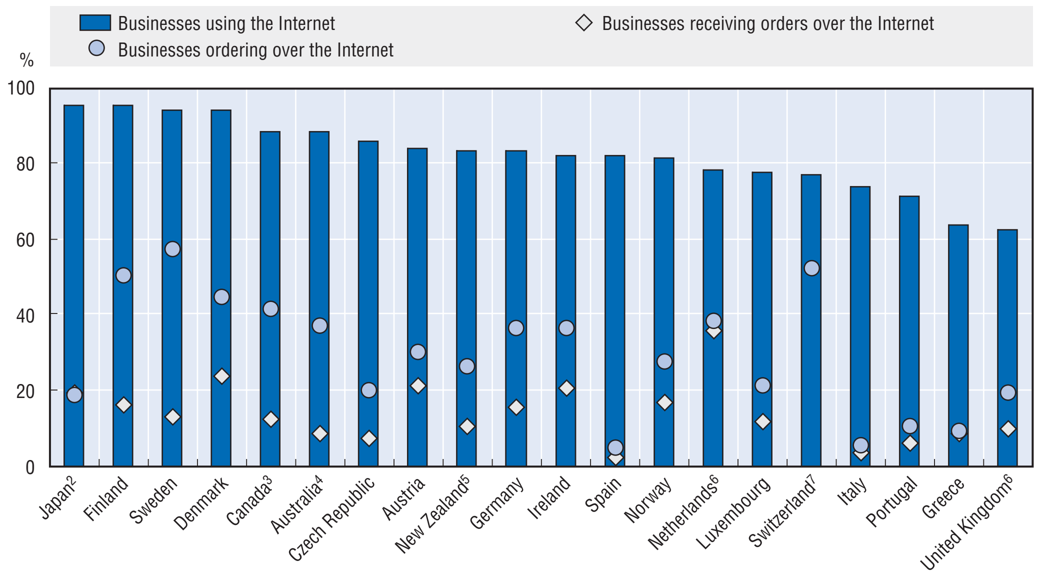
Table 3.2. **Percentage of firms using Internet for banking and financial services, 2003 or latest available year**

Australia	Belgium	Denmark	Spain	Austria	Finland	Sweden	Iceland	Norway
69	69	79	67	70	82	77	70	67

Source: OECD, based on Eurostat, EC Survey on ICT Usage in Enterprises 2003; ABS (2003b).

Figure 3.7. **Businesses using the Internet for purchasing and selling, 2001 or latest available year**[1]

Percentage of businesses with ten or more employees



1. In European countries, except the Netherlands, Portugal and the United Kingdom, figures refer to orders received and placed over the Internet in 2001, while use of the Internet refers to the beginning of 2002. Only enterprises with ten or more employees in the business sector, excluding NACE activity E (electricity, gas and water supply), NACE activity F (construction) and NACE activity J (financial intermediation), are included. The source for these data is the Eurostat Community Survey on enterprise use of ICT. All other countries, unless otherwise noted, refer to enterprises at the beginning of 2001 for Internet use and to 2000 for purchases and sales.
2. Data refer to 2002 and to enterprises with 100 or more employees (excluding small firms). Agriculture, forestry fisheries and mining are excluded.
3. Data refer to 2002 and include the industrial sector.
4. Data for Internet use refer to 2002 while data for sales and purchases refer to 2001-02. All employing businesses are included, except businesses in: general government, agriculture, forestry and fishing, government administration and defence, education, private households employing staff and religious organisations.
5. Data refer to 2001 and include enterprises with more than ten employees in all industries except electricity, gas and water; government administration and defence; and personal and other services.
6. Orders received and placed refer to Internet and other computer-mediated networks.
7. Data refer to 2000 and include industry, construction and services.

Source: OECD, ICT database and Eurostat, Community Survey on ICT usage in enterprises 2002, May 2003

and Finland buy goods or services via the Internet. In the United States, on-line purchases accounted for 11% of all costs of materials at manufacturing plants in 1999 (US Bureau of the Census, 2003a, 2003b).

Significantly fewer firms sell on line. Data for 2001 show that in most countries fewer than 20% of firms receive orders over the Internet. Exceptions are Denmark, Austria, Ireland and the Netherlands. For 2002 in Canada, 7.5% of private sector firms received orders over the Internet whereas almost 32% used the Internet to make purchases (Statistics Canada, 2003). During 2002-03, 13% of Australian businesses received orders on line while 28% placed orders over the Internet (ABS, 2004). In Korea, 7.1% of firms received orders on line in 2003 whereas 26.2% ordered online (Korean Ministry of Information and Communication). In the available official data for 2002, only the Czech Republic experienced a slightly smaller gap between the share of enterprises purchasing and selling on line (Czech Statistical Office, 2004).

In many countries, private electronic data interchange (EDI) networks dating from the 1970s (often referred to as legacy systems) are still used for e-commerce and these often coexist with Web-based applications (CRITO, 2004, for Japan; MINEFI, 2004, for France). In France in 2002, for example, the percentage of firms conducting on-line sales over the Internet (9% of manufacturing firms) was for the first time higher than that of firms selling over EDI systems (6%) (Sessi, 2003). In the Czech Republic, as in other OECD countries, EDI is used mostly by large enterprises in the manufacturing and trade sectors

(Czech Statistical Office, 2004). As suppliers, small and medium-sized enterprises (SMEs) find Web-based systems based on XML less expensive and less cumbersome to implement.

Most general business-to-business (B2B) e-marketplaces of the late 1990s have now disappeared (*Financial Times*, 2004). Instead, economic activity is concentrated in a few sector-specific marketplaces in which some of the biggest companies participate (*e.g.* SupplyOn for automotive, Transora for the food and beverages, Global Healthcare Exchange for healthcare and pharmaceutical). There are also specific marketplaces with large trading volumes, low-cost items and relatively homogenous products for aviation, building and construction, chemicals, energy and fuels, metal and mining) (European Commission, 2003b; eMarket services, 2003).

Low levels of on-line payment

Few firms accept on-line payment (Table 3.3).[5] Although significantly fewer firms accept on-line payment than on-line orders, there is a positive relationship between those that accept on-line orders and those that accept on-line payment (DTI, 2002).

Table 3.3. **Percentage of enterprises with more than ten employees having received on-line payments for Internet sales, 2002**

Canada	Sweden	Ireland	Denmark	Finland	Luxembourg	Germany	Spain	Italy
9	4	5.6	4	2.6	2.1	2	1.6	0.6

Source: OECD ICT database (rounded).

Among Australian businesses placing orders *via* the Internet in 2002-03, more than three-quarters also made payments on line for ordered goods and services (26% of businesses with Internet access). In contrast, approximately one-sixth of businesses receiving orders on line received payments on line (ABS, 2004). Among businesses that allow on-line payment, the average share of the total value of sales paid for on line increased in France, Germany, Italy, Sweden, the United States and slightly in Canada between 2001 and 2002. The most common reasons for not paying on line are concerns about security and fraud. Investment in security technology, credit card penetration and limited liability laws for credit card use (in the case of business-to-consumer transactions) play a major role in facilitating on-line payment (DTI, 2002, 2003).

E-commerce: mainly B2B and mainly to national destinations

The OECD EBIP project has shown that while e-commerce is an integral part of a global restructuring strategy for some firms, most still focus on local (e-commerce) operations. In some cases, the risks of marketing abroad may be too high; trade in a more geographically distributed market can involve substantially increased administrative, marketing, logistics and sometimes regulatory costs (OECD, 2003d). As Table 3.4 shows, the large majority of e-commerce is still national in scope. In addition, to an overwhelming extent, on-line sales continue to take place between businesses (although in Iceland most sales are to households). In Korea, buyer-centric B2B (suppliers bid on contracts of conglomerates) dominate the picture with 72.7% of all B2B transactions (Ministry of Commerce, Industry and Energy, 2003). Very little Korean B2B commerce is organised by middlemen (3.5%).

Nevertheless, e-commerce is becoming more international. In Canada, for instance, on-line sales for export more than doubled from CAD 1.2 billion to CAD 2.7 billion between 2000 and 2001 and then rose to CAD 2.9 billion in 2002. These sales accounted for slightly more than one-quarter of total e-commerce sales. In 2002, retail trade had 33% of the electronic export market, followed by manufacturing (17%) and information and cultural industries (13%); 56% of all on-line sales in the retail sector were for exports.

Table 3.4. **Type and geographical destination of e-commerce, 2002 or latest available year**

	Percentage of e-commerce that is B2B	Percentage of e-commerce to national destination
Canada	73	Less than 75
Denmark[1]	80	82
Finland[1]	81	87
Germany[1]	n.a.	90
Iceland	37	83
Korea	93	83.5[2]
Netherlands	88[2]	70 (95 to EU)
Norway[1]	84	97
Spain	88	92 (98 to EU)
Sweden[1]	78	78
United States[1]	93	n.a.

1. Data are for 2001.
2. Data are for 2003.

Source: OECD, based on INE (2003), Nordic Council of Ministers (2002), Ministry of Commerce, Industry and Energy (2003), NCA/MIC 2003, Statistics Canada (2003), CBS (2003), US Bureau of the Census (*www.census.gov/eos/www/papers/2001/2001estatstext.pdf*); The figures for Denmark, Finland, Iceland, Norway, Sweden include business to government (B2G).

There is also some indication that business-to-consumer (B2C) e-commerce is growing fast, indicating that the long-expected take-off of e-commerce is materialising. This trend reflects the maturation of the on-line market (improved product comparison features, more off-line merchants adding on-line components, more trust) and increased broadband penetration. The DTI's International Benchmarking Study shows that the percentage of on-line orders placed by households rose between 2001 and 2002 (DTI, 2002), with the United States, Canada, France and the United Kingdom in the lead. In Asia, the growth of B2C e-commerce is quite significant. In Korea, B2B grew by 54.1% from 2001 to 2002, B2G by 172% and B2C by 110% (NCA/MIC, 2003). In Japan, the B2C market increased by 90.1% to JPY 1 587 billion over the same period, mainly for home appliances and household consumables (MPHPT, 2003a).

Data for Canada also illustrate the growing importance of B2C (Industry Canada, 2003). In previous years the ratio of B2B to B2C was 80:20 and is still that today in other countries, but the most recent Canadian data point to a shift towards a ratio of 70:30 in 2002. B2C sales in Canada are particularly important in the arts, entertainment and recreation, and retail trade sectors, where they accounted for 97% and 85% of Internet sales, respectively. Available figures for e-commerce in France in 2003 demonstrate that for a given panel of firms that sell on line to consumers, e-commerce revenues grew by 56% from 2002 to 2003 and the number of transactions grew by 69% (ACSEL, 2004; FEVAD, 2004).

It has also been noted for Canada that smaller firms are more specialised in B2C than larger ones; B2C sales of SMEs accounted for 25% of their total Internet sales, compared with 18% for large firms (Charles and Leduc, 2002). Data for Japan confirm a similar trend (CRITO, 2004).

E-commerce revenue as a share of total revenue: very low but growing

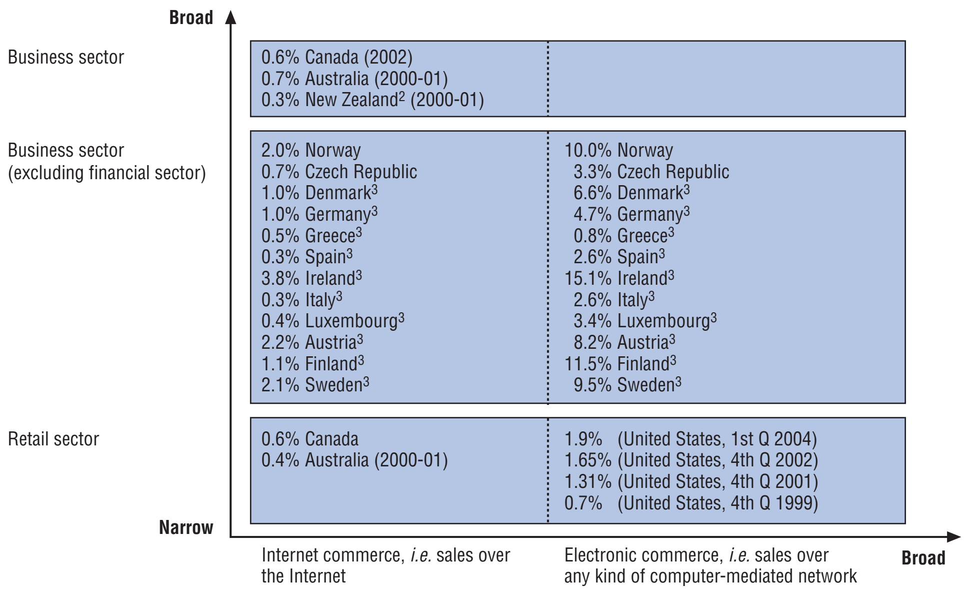
There are no official statistics on the global value of e-commerce. Efforts to compile information from private sources (*i.e.* Forrester Research) put the value of global e-commerce in 2003 between USD 1 408 billion and USD 3 878 billion and project a global volume of e-commerce of USD 12 837 billion by 2006 (UNCTAD, 2003b). However, such figures must be viewed with caution.

In support of findings that only a small share of firms sell on line, there is general agreement that electronic transactions represent a very small share of overall economic activity for most firms in OECD countries. Internet sales represent between 0.3% and 3.8% of total sales (Figure 3.8).[6] In official surveys electronic sales, *i.e.* sales over any kind of computer-mediated network, reach 10% or more of sales in Austria, Sweden, Finland and Ireland.

A look at more recent data and comparisons over time reveal that e-commerce – in terms of share of revenue and of volume – is increasing steadily despite some setbacks. There was an obvious setback

Figure 3.8. **Official estimates of Internet and electronic commerce transactions,[1] 2001 or latest available year**

Percentage of total sales or revenues



Note: In April 2000, OECD member countries endorsed two definitions of electronic transactions (electronic orders), based on narrower and broader definitions of the communications infrastructure. According to the OECD definitions, the method used to place or receive the order, not the payment or the channel of delivery, determines whether the transaction falls under "narrow": an Internet transaction (conducted over the Internet) or "broad": an electronic transaction (conducted over computer-mediated networks). See: *www1.oecd.org/publications/e-book/92-2003-04-1-7294/GB-04-5A.htm*

1. For more information, see Measuring the Information Economy (*www.oecd.org/sti/measuring-infoeconomy*).
2. Data for New Zealand exclude electricity, gas and water supply and only cover enterprises with six or more full-time equivalent employees and NZD 30 000 or more in turnover.
3. Enterprises with ten or more employees. Data exclude NACE activity E (electricity, gas and water supply), NACE activity F (construction) and NACE activity J (financial intermediation).

Source: OECD (2003c), ICT database and Eurostat, European Community Survey on ICT usage in enterprises 2002, May 2003, US Bureau of the Census (2004), Statistics Canada (2003).

to e-commerce in 1999, 2000 and/or 2001 in most OECD members countries, when a large share of pure Internet firms went out of business. The decline is thus clearer among firms that sell on line than among those that buy on line. However, the fall in the proportion of businesses that sell on line can be accompanied by a significant increase in the value of on-line sales (Charles and Leduc, 2002).

In Canada, for instance, the proportion of businesses selling on line declined from 1999 to 2000, as Internet selling became more concentrated among fewer, larger businesses. Since 2001, however the share of firms selling and buying on line has grown in Canada (Table 3.5). In Australia, the share of

Table 3.5. **Placing and receiving orders over the Internet in Australia and Canada, 1999-2002**

Percentage of enterprises that use the Internet to buy goods or services

	2000		2001		2002		2003
	AUS[1]	CAN	AUS	CAN	AUS	CAN	AUS
Placed orders via Internet or Web	6	18.2	20	22.4	25	31.7	39
Received orders via Internet or Web	6	n.a.	9	6.7	6	7.5	19

1. For Australia, the 2000 data are for 1999-2000, for 2001, for 2000-01, etc.

Source: OECD, based on ABS (2003a, 2004) and Statistics Canada (2003).

businesses placing orders on line grew regularly, while those receiving orders experienced a decline followed by a sharp rise. The proportion of businesses ordering on line fell in 2001 in France, Germany, Italy, Sweden and United Kingdom but picked up again in 2002 (DTI, 2002).

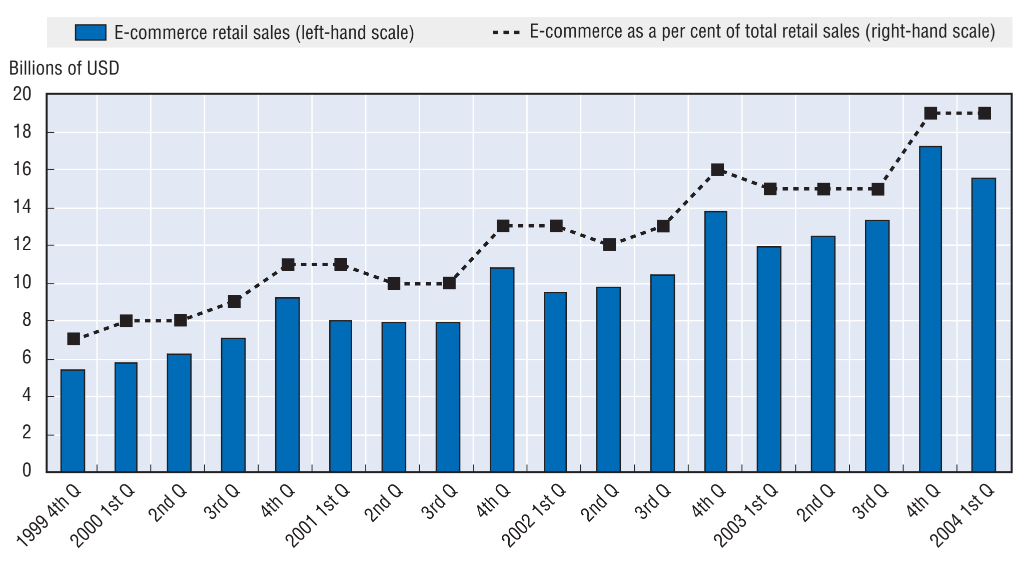
Of the 91 000 Australian businesses estimated to have received income via the Internet in 2002-03, 43% generated 5% or more their total income in this manner, a significant increase over previous periods. Internet income earned by Australian businesses rose from AUD 9.4 billion in 2000-01 to AUD 24.3 billion in 2002-03. In Canada Internet-based orders rose from 0.2% of total economic activity in 1999 to 0.6% of total economic activity in 2002 (Statistics Canada, 2003). Figures for the Czech Republic, Denmark, Finland, France, Germany, Iceland, Italy, Norway and the United Kingdom also confirm an increase of the share of e-commerce in total sales from 2002 to 2003 (Nordic Council of Ministers, 2002; e-Business W@tch, 2003; Czech Statistical Office, 2004). In France, on-line sales are said to represent a 2.2% share of all revenue of manufacturing firms in 2002 (Sessi, 2003). In France, Germany, Italy and the United Kingdom, tourism, media and printing, insurance, ICT services and retail lead the way in terms of share of on-line to total revenues (e-Business W@tch, 2003).

Data for US retail e-commerce sales (US Bureau of the Census, 2004) show that e-commerce retail sales represent a steadily increasing share of total retail sales, in terms both of value and of volume (Figure 3.9). Projections from Forrester Research predict that US on-line retail sales will reach nearly USD 230 billion and account for 10% of total US retail sales by 2008, but should be used with caution.[7]

In 2002 and 2003, the percentage of firms in some OECD countries that order and sell on line has risen to significantly higher levels than in 2001 (DTI, 2002, 2003; Statistics Canada, 2003). In France in 2002, for example, 45% of manufacturing firms purchased over the Internet as compared to 15% in 1999 (Sessi, 2003). According to e-Business W@tch (2003), EU firms made about 6% of their total purchases on line in 2003 (including maintenance, repair and operations and direct production goods). The leading sectors for on-line purchases were ICT services, the electrical machinery/electronics industry and business services. In 2002, about 32% of Canadian firms bought over the Internet, up from 18% in 2000 (Statistics Canada, 2003).

In the United States, a survey of 294 supply management executives from both manufacturing and non-manufacturing organisations indicated that firms increasingly use the Internet to purchase direct

Figure 3.9. **Estimated quarterly US retail e-commerce sales,[1] 4th quarter 1999 to 1st quarter 2004**



1. Data in billions of USD, not adjusted for seasonal, holiday and trading-day differences, or price changes
Source: OECD, based on US Bureau of the Census (2004).

and indirect goods and services (an average of 13% of their total direct materials were purchased over the Internet in the second and third quarters of 2003) and that the percentage of direct materials purchased over the Internet surpassed that of indirect materials (goods/services that do not go into final manufactured product) (Institute for Supply Management, 2003). In Canada, the value of on-line orders rose by 28.4% from 2001 to 2002 in spite of the slow rise in the proportion of Canadian firms selling on line. Nonetheless, the e-commerce market has been very volatile. In Canada in 2002, seven firms stopped selling over the Internet for every ten that started. Moreover, 43% of those that sold on line in 2001 exited the on-line market in 2002 (Statistics Canada, 2003).

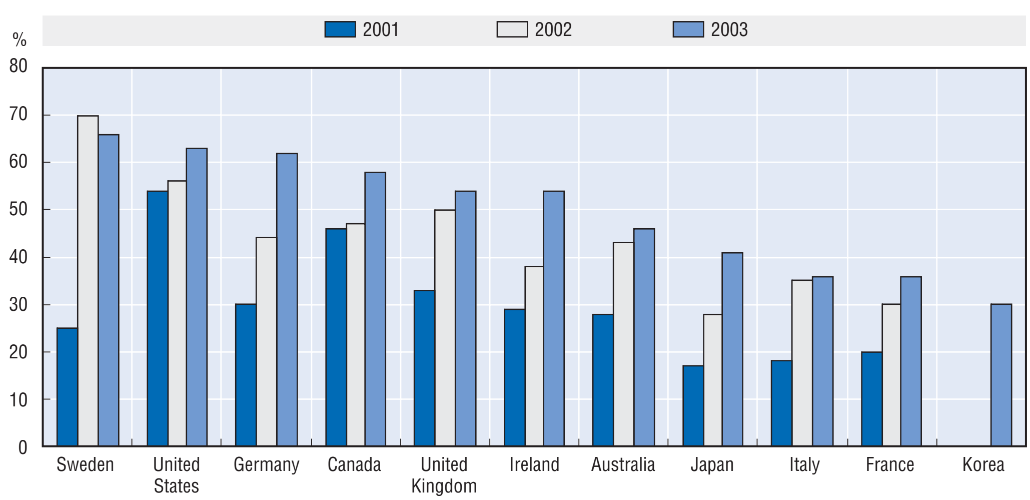
There are now a critical mass of suppliers to buy from, more mature software systems and better integration of front-end and backend systems. Although most on-line purchases still involve catalogue-based buying of indirect materials such as office supplies, there are also increasing purchases of direct materials and various services, such as consulting or auditing services. The most common reason given by UK businesses for not ordering goods or services on line was that the products required were not suitable for on-line purchase or a preference for dealing with suppliers face to face (DTI, 2002).

Figures 3.10 and 3.11 present the latest trends. Although both ordering and selling on line are growing, the number of firms allowing on-line orders from 2001 onwards has risen less than that of firms that order on line (DTI, 2003).

Effect of firm size on ordering and selling over the Internet

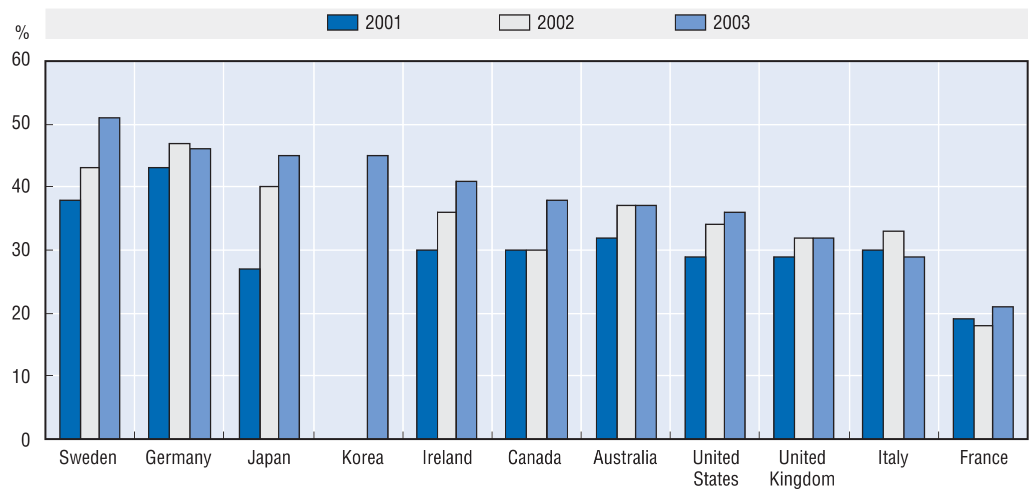
The Internet is far from playing the equaliser between large and small firms, as initially expected in the literature (Evans and Wurster, 1997). All in all, firm size is a more important determinant in this respect than the sector of e-business (Statistisches Bundesamt, 2003). OECD data show that large firms use the Internet more frequently than small ones to sell goods and services (OECD, 2003c; Nordic Council of Ministers, 2002; DTI, 2003). At the same time, it has been noted, for example for Canadian firms, that the gap in e-commerce adoption rates is smaller than that for adopting Internet use and setting up a Web site (Statistics Canada, 2003). Size also plays an important role in the uptake of more sophisticated e-business applications.

Figure 3.10. **Businesses placing orders on line, 2001-03**
Percentage of all firms



Note: Figures are employment-weighted.
Source: OECD, based on DTI (2003).

Figure 3.11. **Businesses that allow customers to place order on line, 2001-03**
Percentage of all firms



Note: Figures are employment-weighted.
Source: OECD, based on DTI (2003).

In 2002, Canadian firms with more than 500 employees were responsible for more than 41% of sales over the Internet, up slightly from 40% in 2001. The 7.5% of businesses that reported selling goods and services on line in 2002 accounted for nearly 30% of gross business income in Canada (Statistics Canada, 2003). In 2001, the proportion of enterprises with at least 100 employees selling over the Internet in Denmark, Finland, Norway and Sweden ranged between 11% and 18%; among small enterprises with 10-19 employees the share ranged between 8% and 12% in all countries (Nordic Council of Ministers, 2002). Small firms use the Internet more to communicate with vendors on inventory levels of finished goods, to communicate with customers and check their credit status, and get price quotes. Surveys of Australian SMEs in 2001 show that most viewed e-commerce as a way to improve the efficiency of their business operations rather than a way to increase sales to new or existing markets (NOIE, 2002).

Effect of the industry sector on ordering and selling over the Internet

OECD data show that there is a trend towards the concentration of e-commerce activity in certain sectors (OECD, 2003b). The propensity to purchase over the Internet is higher in services than in manufacturing, and the real estate and wholesale sectors make the most use of the Internet as a purchase and sales channel. Among possible reasons is the fact that services companies usually do not have EDI and lack alternate channels for electronic purchases. Also they source and purchase more additional services (advertising, legal, consulting, etc.) as direct inputs to their operations (ISM, 2003). In terms of sales, however, other sectors take the lead.

For on-line purchasing, available data for Australia and the United Kingdom show that the financial sector is the lead user. In the United Kingdom, it also has a significant role in Internet sales. The business services sector also has high rates of e-commerce (OECD, 2002), notably in the Nordic countries (Nordic Council of Ministers, 2002). In Canada, the share of businesses purchasing over the Internet was highest in the information and cultural services industry for the fourth straight year (about 60% for 2002). This sector includes enterprises involved in publishing, broadcasting, telecommunications, information services and data processing. Private sector educational services also had a high share of about 46% (Statistics Canada, 2003). Professional, scientific and technical services is also a leading sector for Internet purchasing, as is the utilities sector. For Europe, e-Business W@tch

(2003) found that in 2002 and 2003 e-procurement leaders are ICT services, the electrical machinery and electronics industry and business services. In France, the manufacturing sectors that ordered the most on line in 2002 are energy, automobile and consumer goods (Sessi, 2003).

In Canada, manufacturing industries, transport, warehousing and retail trade remain the big players in Internet sales (70% of all Internet sales in 2002), while wholesalers reported the biggest increases. Canada's laggards are utilities, transportation and warehousing and accommodation and food services (Statistics Canada, 2003). In Austria, Denmark, Finland and Japan, more than one-fifth of enterprises in the wholesale sector use the Internet for sales purposes (see also ABS, 2004).

US data indicating the share of e-commerce shipments as a share of total value of industry shipments show the manufacturing sector leading e-commerce. In 2001, the US manufacturing sector (especially transport equipment) led all industry sectors in e-commerce shipments, with shipments accounting for 18.3% (USD 725 billion) of the total value of manufacturing shipments (US Bureau of the Census, 2003a). Next in e-commerce intensity were wholesalers and retail trade. The services sectors with the highest e-commerce revenues were, in order of importance: information (on-line information services, broadcasting and telecommunications, publishing industries); administrative and support services, waste management and remediation services; travel arrangements and reservation services; selected professional, scientific, and technical services (computer systems design and related services).

For Europe, e-Business W@tch (2003) found that in 2002 and 2003, out of 15 sectors analysed, on-line sales were important in tourism, media and printing, insurance, ICT services and retail.

More mature e-business applications: internal and external ICT-enabled process integration

ICT-enabled integration of business functions (*e.g.* logistics, production processes, the supply chain) with a cross-operational ICT system is one of the main challenges for companies that seek to reap the benefits of ICTs in terms of time and cost savings (MPHPT, 2003b; DTI, 2002). Internal ICT-enabled integration allows a company's various departments to interact in the course of key business processes, for example by linking an electronic ordering system with the various internal functions necessary to process an order. The firm can then manage its different business processes with one well-organised database (single data model). External ICT-enabled integration takes the further step of forming linkages between firms involved in a transaction.

In spite of the large potential payoff of such e-business processes, existing studies unanimously conclude that they are largely unexploited. E-business has only meant a real change to a relatively small number of enterprises' business concept, organisation and relationships with suppliers and customers. It takes considerable effort and changes in management to make ICT-based supply chains operational (Naude *et al.*, 2000), and some countries have succeeded better than others (see Box 3.2). ICT-enabled integration of the value chain, integration of electronic order system with ICT systems of other functions (marketing, logistics, etc.) and the use of e-business software solutions all remain quite rare, and only large firms have integrated their ICT systems with suppliers and customers (external integration). Reasons proposed for the low uptake of e-business include inadequate hiring of technology knowledge workers, unsystematic and inadequate supplementary and further training for e-business, and inadequate resources devoted to devising and implementing an e-business strategy (E-business Nordic.com, 2003).

Larger firms are more likely to capitalise on digital options and shift to on-line business processes because they have the resources, capabilities or relationships that support and facilitate the digitisation of business processes (BarNir *et al.*, 2003; e-Business W@tch, 2003). They also generally have more experience in managing the deployment of the necessary technologies. Established or large firms may also be more motivated to digitise processes because of the benefits they hope to gain (BarNir *et al.*, 2003). They are also better able to sustain higher rates of technological change (Statistics Canada, 2004).

The transition from e-commerce to e-business seems to be more difficult for smaller firms. It is true that e-pioneers include a substantial number of SMEs. Studies have shown that in Finland enterprises

Box 3.2. OECD business usage of ICTs in the Networked Readiness Index

The *Global Information Technology Report* 2003-2004 of the World Economic Forum produces indicators on the degree of business usage of ICTs in 102 countries. Business usage is determined by factors such as the level of B2B and B2C e-commerce, the use of ICTs for activities like marketing, and levels of on-line transactions. The table below shows the ranking of the 30 OECD member countries in the business usage sub-index of the Networked Readiness Index 2003-04.

Country	Rank	Country	Rank	Country	Rank
United States	1	New Zealand	13	Italy	28
Australia	3	Netherlands	15	Czech Republic	30
Sweden	4	Germany	16	Mexico	32
Denmark	5	Ireland	17	Spain	34
Switzerland	6	Korea	18	Portugal	38
Norway	8	Luxembourg	18	Poland	41
Iceland	9	United Kingdom	20	Greece	43
Japan	10	France	23	Slovak Republic	45
Finland	11	Austria	25	Turkey	49
Canada	12	Belgium	26	Hungary	51

The 30 OECD member countries are spread evenly throughout the top 50 countries of the index. The top five OECD performers are the United States, Australia, Sweden, Denmark and Switzerland. Singapore (2), Israel (7), Hong Kong, China (14), Chinese Taipei (21), Malaysia (22), South Africa (24), Chile (27), Malta (29), Brazil (31), Thailand (33), Costa Rica (36), Croatia (37), Estonia (39) and other non-OECD members are also among the top 50.

Source: Adapted from WEF (2003).

with 21-50 employees focus on e-business slightly more than other enterprises with fewer than 250 employees, while in Norway, a slightly larger share of very small enterprises focus on e-business than enterprises with 21-50 employees (E-business Nordic.com, 2003). Overall, however, only a small share of mostly large firms has fully tapped the e-business potential. Indeed, certain small businesses have in some cases be led to give up their Web sites or Internet access altogether ("clicking off") (DTI, 2003).

At a time when the gap between small and large firms in terms of technology adoption (readiness, access to Internet) has narrowed, the main policy challenge is thus no longer to get SMEs connected to the Internet but to ensure more generally the effective and productive integration of ICTs into business processes (European Commission, 2003a).

Lower rates of e-business among SMEs are not necessarily a problem. Firms with fewer than 50 employees may find it easier to retain an overview and handle relations with customers and suppliers on an individual basis, so that ICT integration may not be a priority. Small firms may simply find that – from a cost-benefit point of view – their Internet projects are not satisfactory (DTI, 2003). At the same time, however, they may not have the scale to employ ICT specialists in-house or they may allocate inadequate resources to planned e-business activities (E-business Nordic.com, 2003). Costs associated with training, such as time loss and administrative fees, may also deter them (Sussman, 2002). Moreover, they often use e-business for promotion and marketing, customer support and communication but give less attention to areas where e-business works particularly well (procurement, human resource management, inbound logistics or production).

For all firm sizes and most sectors, studies of e-business for 2002 and 2003 point to progress in the integration of ICTs in businesses' internal and external processes. US firms' use of technology in supply management, for example, increases every quarter (ISM, 2003), and the 2003 DTI International Benchmarking Study indicates that businesses are increasingly looking to more sophisticated forms of ICT deployment to unlock value (DTI, 2003). SMEs also show clear signs of a pick-up in e-business, which is reflected in an increase in products tailored to SMEs by e-business solution providers (such as Oracle and IBM[8]). The development of low-cost, "off-the-shelf" tools has greatly expanded the use of e-business applications among smaller organisations (US Department of Commerce, 2003).

As e-business integration increases, there is a renewed focus on the use of new technologies to improve processes and cut costs and thus on supply-side applications (DTI, 2003; Rahmann, 2003). UK companies that had expected the Internet to expand markets and create sales and new market opportunities, for instance, are now applying e-business technologies to improve efficiency (CBI, 2002). All in all, businesses appear to be taking more time to develop a more strategic approach to their ICT use, considering how they can integrate new applications into their business processes, drive supply chain efficiencies, and thus meet their overall business objectives (DTI, 2002).

Use of ICTs to integrate internal processes and ICT systems

Internal integration is measured here by the integration of ordering systems with other internal systems and the use of ICTs in certain processes.[9] Available official figures on the intensity of this e-business application are generally low.

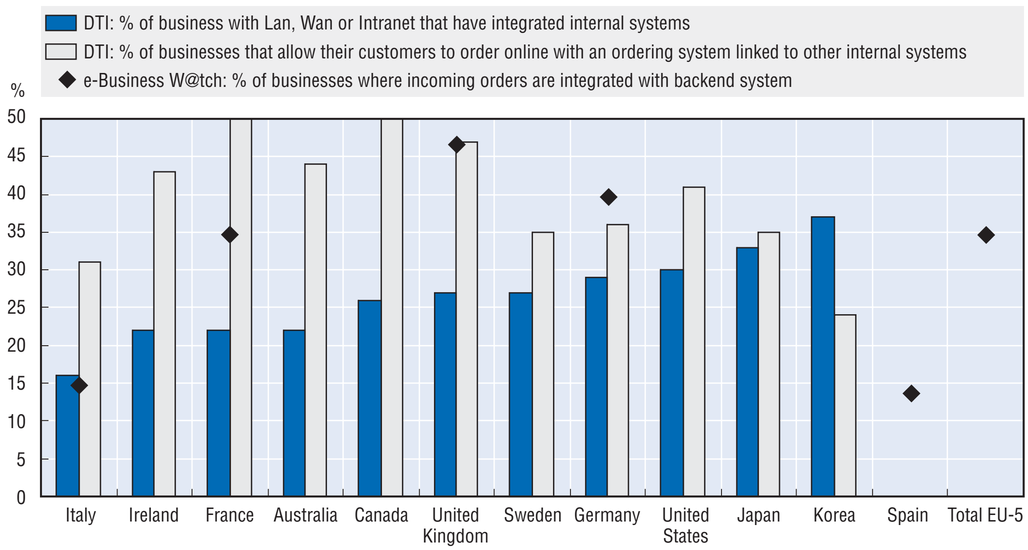
For instance, 6% of Australian firms with a Web presence had integrated on-line orders with their backend system in 2002 (2001: 3%) (ABS, 2003a). In 2003, 84% of Australian firms indicated that their systems for receiving orders did not have automated links to any other business system (ABS, 2004). The most common automated links were to invoicing and payment systems and to systems used for marketing operations (6% each).[10] In 2002, just 3% of all UK businesses had electronic ordering systems that linked automatically to electronic systems either within or outside their business, although 11% of all businesses with ten or more employees had such linked systems; however, 51% of businesses with 1 000 or more employees had adopted them (ONS, 2003).

Figure 3.12 draws on smaller-scale surveys to shed more light on internal integration. The first column shows the percentage of businesses with local area network (LAN), wide area network (WAN) or intranet that have integrated internal systems (*e.g.* links between sales forecasting and production scheduling). This metric is interesting as it does not simply cover linkages to an ordering (e-commerce) process. With respect to internal integration, Korea, Japan, the United States and Germany score best. The second column and the rectangles describe the level of integration between ordering and internal systems among businesses that accept on-line orders as yielded by two separate studies. There are slight variations between DTI and e-Business W@tch data for similar questions related to internal integration (second column *versus* rectangle) demonstrating that the measurement of e-business is complex. Both the DTI study and the e-Business W@tch study show that some countries have experienced significant growth in integration since 2002.

Table 3.6 shows which sectors have most integrated their on-line orders with the backend system.

Compared to OECD figures on the percentage of firms accepting orders on line (Figures 3.7 and 3.11), these results look high for four main reasons: *i*) the surveys often cover businesses with more than ten employees; *ii*) the OECD data is business-weighted rather than employment-weighted; *iii*) in this case the data are shown as the percentage of firms that have on-line access conduct business on line (and not as percentage of the much greater volume of all firms) which automatically pushes up the percentage value; *iv*) the data are for 2003 rather than 2001 and implementation of e-business may have grown substantially in the last two years. Medium-sized companies reporting that their e-commerce system and their backend system are integrated rose from 18% for 2002 to 26% in 2003. Surveys asking about full business integration of the whole supply chain find much lower results (4-7% of all firms for the Scandinavian countries) (E-business Nordic.com, 2003).

Figure 3.12. **Businesses that accept orders on line with an ordering system linked to other internal systems, 2003**



Note: 7 sectors. First DTI bar: All businesses with LAN, WAN or intranet, Second DTI bar and e-Business W@tch data: All businesses selling on line. As the basis of comparison is different in all cases, the percentages cannot be compared across columns. Figures are employment-weighted.
Source: DTI (2003) and e-Business W@tch (2003).

The increasing role played by ICT-enabled process integration varies according to countries, sectors and business practices. A survey of selected large Japanese and US firms, for example, demonstrates that firms rely heavily on ICT systems for operational co-ordination between sales/ marketing, inventory management, manufacturing, procurement, customer services, finance and accounting and – to a somewhat lesser extent – payroll, accounting and human resource management (HRM) (MPHPT, 2003a; 2003b). In general, US firms rely more on functional integration than the Japanese firms (CRITO, 2004, suggests only modest company-wide co-ordination of ICT use across different Japanese business units). In Japan, use by the manufacturing sector (25%) is above the national and global averages, but the wholesale and retail sector (11%) and the bank and finance sector (7%) lag behind.

Figure 3.13 sheds more light on ICT supply chain integration (specific systems linked to ordering: stock control; invoicing, production/service operations; marketing) for different OECD countries. It

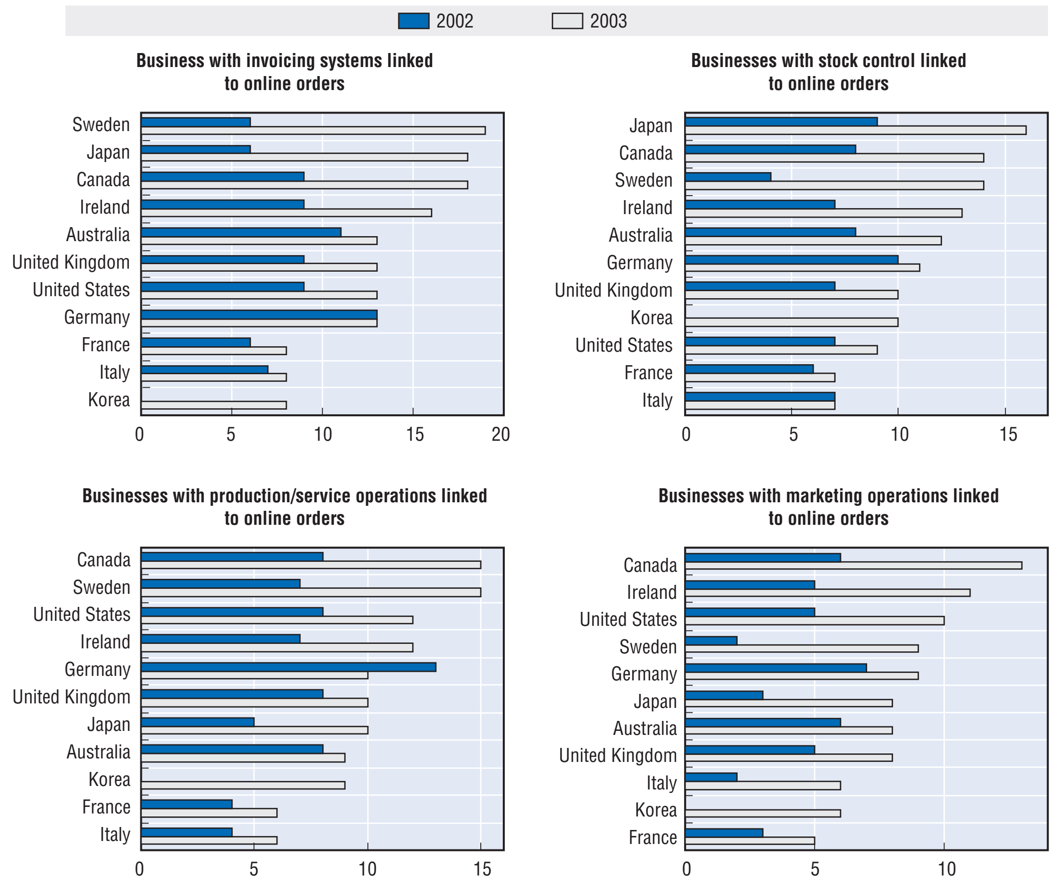
Table 3.6. **Integration of orders with backend system by sector, EU5, 2003**
As a percentage of firms that sell on line

EU5 (France, Germany, Italy, Spain, United Kingdom)	Incoming on-line orders integrated with backend system
Transport equipment	78
Electrical machinery and electronics	60
Retail	41
ICT services	39
The chemical industries	37
Food, beverages and tobacco	24
Tourism	18

Figures are employment-weighted. Base: enterprises selling on line. N = 542 for EU5.
Source: OECD, based on e-Business W@tch (2003).

Figure 3.13. **ICTs in supply-chain-related deployment, 2003**

Percentage of all businesses



Note: Base: all businesses. Question: "Which internal systems are, or will be, automatically linked to on-line orders?". All figures are employment-weighted.
Source: DTI (2003).

shows that levels of integration are modest, with Sweden, Canada and Japan ranking highest. As the DTI study found, the more prevalent forms of internal integration among businesses are between supply-side systems such as ordering and production/logistics systems, as opposed to marketing or other systems. Relatively few firms undertake supply and production integration which require more advanced use of ICTs. Moreover, businesses are using ICTs more to cut costs than to boost revenues. The data show that use of ICTs in most of the described functions grew rapidly between 2002 and 2003.

ICTs also have a major role as collaborative tool (US Department of Commerce, 2003). One example is teamwork on a design project. e-Business W@tch data for five European countries and seven sectors show that firms mostly use ICTs to share documents and to conduct collaborative work (see Annex Table C.3.1). Next in intensity of use across all sectors and countries are: on-line tracking of work hours and production time, support of human resources, e-learning and, finally, automation of travel reimbursement. A study of the Scandinavian countries notes that on-line recruitment (filling specific vacancies, finding the right qualification profiles) is only used by 12-29% of industrial enterprises (E-business Nordic.com, 2003). In terms of sectors, ICT services always score highest and electrical machinery and electronics is also among the leaders. Sectors that often lag are food, beverage and tobacco, tourism and, surprisingly, retail (see Annex Table C.3.1).

Use of on-line technologies in production and RD *processes*

Increasingly sophisticated uses of ICTs are also gaining ground in areas such as production and R&D (Table 3.7). However their level of use, especially in production, also remains modest in some countries.

Table 3.7. **Business use of ICT technology in production (2003) and of on-line technology in R&D (2002)**

	Japan	Canada	United States	Australia	Korea	Germany	Ireland	United Kingdom	Italy	Sweden	France
ICT in production	24	20	17	17	17	14	14	12	12	9	8
On-line technology in R&D	20	46	58	n.a.	n.a.	32	51	47	39	19	24

Note: Base: all businesses with on-line technology. All figures are employment-weighted.
Source: Data on production from DTI (2003) and data on R&D from DTI (2002).

Most countries have seen an increase in use of ICTs in production between 2002 and 2003. ICTs can help identify the raw materials or components required for production over a defined time period, compare this information with stock holdings, initiate reorder, etc. According to DTI (2003), an average of 12% of businesses with ICTs use on-line technology in production. However, use varies greatly across sectors. In the United Kingdom, businesses with ICTs in the finance (20%), manufacturing (15%) and services (15%) sectors use ICTs in production the most. Only 3% of retail businesses with ICTs use on-line production technology.

The share of firms in 2002 using ICTs in R&D varies greatly among countries. Less than a quarter of businesses that use ICTs in Sweden, Japan and France employ on-line technology for R&D. Firms in the United States, Ireland, the United Kingdom and Australia and larger firms in general are more likely to do so.

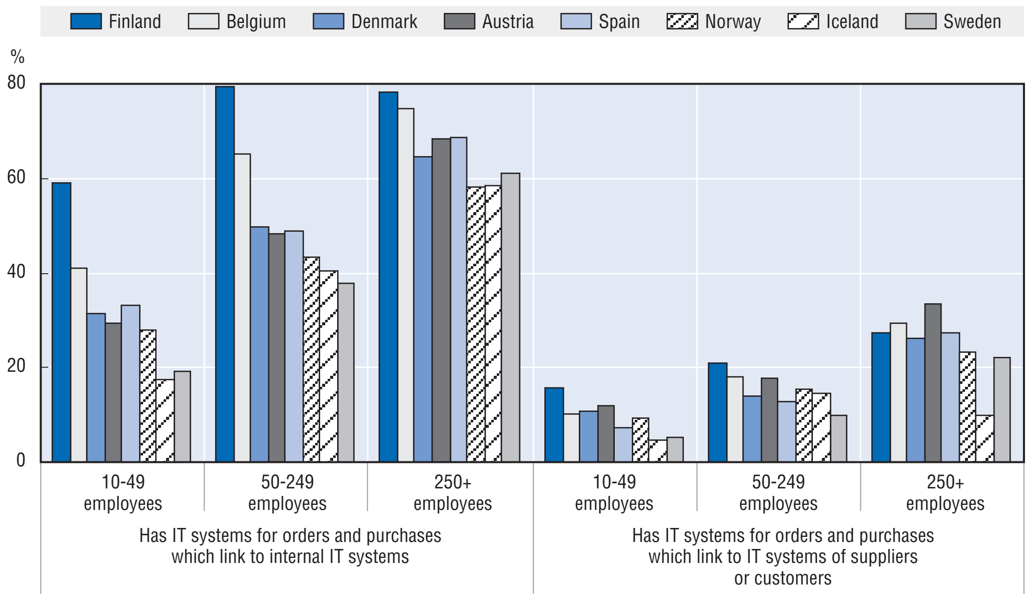
Use of ICTs *to integrate external and internal processes and* ICT *systems*

With the need for collaborative relations/automated exchange of information to make production networks more efficient, the integration of ICT systems does not stop at firm boundaries. In fact, process integration between firms, leading to the so-called "extended enterprise", is said to be the most sophisticated ICT deployment of all and to offer some of the greatest benefits. Instead of using older EDI systems, firms can now collaborate with suppliers using Internet-based supply-chain tools. The greatest benefits of this B2B e-business-relation are reaped when ICTs are used not only to replace more traditional communication means but when new ways of collaboration with partners comes about (Lee *et al.*, 2003). Examples are automatic reordering based on stock levels or producer's production planning systems linked directly to the sales and demand tracking systems of the retailer. Objectives are to cut costs, lower inventory levels, increase speed and accuracy of orders and improve cash flow (CRITO, 2004).

Although it promises the greatest efficiency payoffs, integration with suppliers is also the biggest challenge. This is reflected in the fact that internal integration is more prevalent than external integration (Figure 3.14). Again firm size plays a major role.

Businesses seem to be reluctant to give external stakeholders full access to their information (DTI, 2002). Country-specific business practices have an influence on the degree of inter-firm integration (see Box 3.3). Although businesses commonly provide information on line to their suppliers (DTI, 2002), the integration of systems with suppliers or customers is rather low, even among businesses that interact on line (MPHPT, 2003a, 2003b; DTI, 2003). In addition to reluctance to share data with other firms, a lack of "shared values", greater expected immediate benefits from using ICTs for internal processes and a lack of shared standards and technology for data exchange may be reasons for the low level of external

Figure 3.14. **Selected EU countries, Iceland and Norway, Internal vs. external integration, 2003**



Note: Seven sectors, Base: all firms.
Source: OECD, based on European Community Survey on ICT Usage in Enterprises 2003, Eurostat.

integration. Some businesses also fail to see the potential behind external integration or have difficulties implementing successfully what is a rather complex facet of e-business.

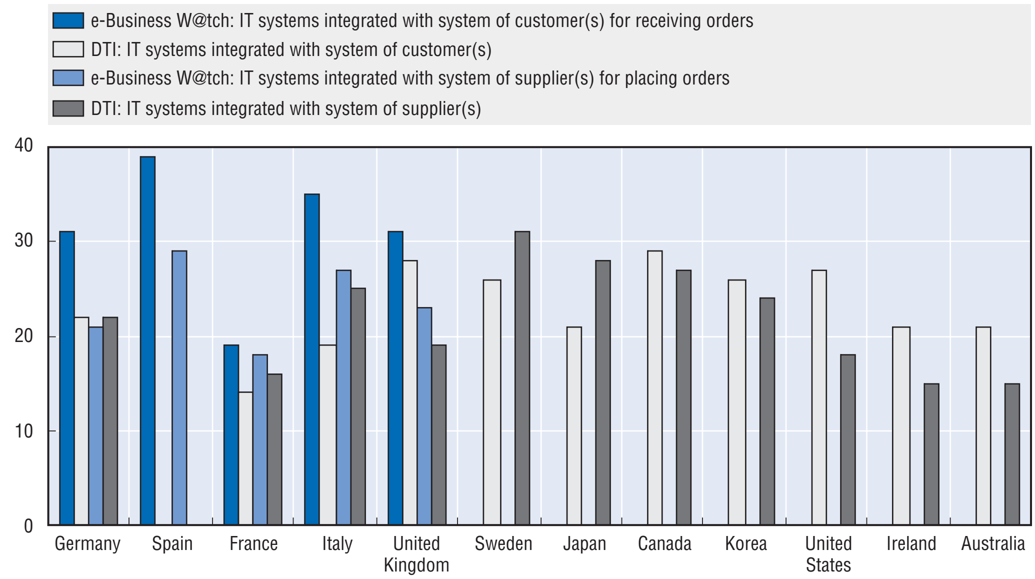
Integration with suppliers is not necessarily more widespread than integration with customers. In fact, there seems to be no clear answer as to whether firms are more integrated with their customers than with their suppliers, for example, for checking availability of goods/supplies, ordering/paying for goods/supplies, tracking progress of the order, etc.

Figure 3.15 shows for five EU countries that more of the firms that sell on line have integrated their ICT systems with their customers than with their suppliers. In 2003, enterprises representing 31% of employment integrated their ICT system with their customers' system (against 23% for their suppliers). This finding supports earlier results indicating that the provision of information to suppliers – the first

Box 3.3. **Operational ICT-based co-ordination between Japanese companies**

Japanese firms, which are more closed and hierarchically (vertically) organised, seem reluctant to use ICT systems for operational co-ordination between companies except in procurement (the *kanban*/just-in-time system) (MPHPT, 2003a; 2003b; CRITO, 2004). US companies have roughly double the co-ordination rate of Japanese companies and, in general, use of ICT systems between firms seems strong in the areas of procurement, sales marketing, customer service and manufacturing, and weak in payroll accounting and HRM (MPHPT, 2003a; 2003b). In Japan, the manufacturing sector is most likely to integrate electronically with their suppliers and business customers, followed by the financial sector. Large Japanese companies are more likely to integrate with suppliers and customers. Cultural factors help to explain this difference. In Japan, a greater wish for interpersonal relations and EDI networks and management practices which do not favour ICT-based process integration may be reasons for the low level of inter-firm electronic relations (CRITO, 2004).

Figure 3.15. **External integration: integration with consumers vs. with suppliers**



Note: All figures are employment-weighted. As the base of comparison is a different one in all cases the percentages attached to the three columns cannot be compared. 7 sectors.

Source: DTI (2003) and e-Business W@tch (2003), Base e-Business W@tch: All businesses selling on line, Base DTI: all businesses who enable their supplier/customer to interact on line.

step towards external process integration – is much less widespread than the provision of information to customers (DTI, 2002, 2003). Only a small proportion of businesses in the countries studied by the DTI share sensitive information with suppliers (such as future requirements and financial forecasts).

The DTI data also show that UK, Canadian, South Korean and US-American businesses that interact on line report the highest levels of customer systems integration; for example, 28% of UK businesses that allow their customers to interact with them on line either already have integrated their systems with those of their customers or are in the process or planning to do so. On the other hand, in France, Italy and in Sweden integration with suppliers seems greater than integration with customers.

For other, more specific forms of inter-firm collaboration, e-Business W@tch data (Annex Table C.3.2) show that on-line exchange of documents with both customers and suppliers is much more common (almost half of the surveyed EU5 firms exchange document with suppliers on line) than – in order of importance – collaborative ICT-enabled product design, on-line management of inventory/capacity and on-line collaboration to forecast demand. Again the ICT, the electrical machinery and electronics but also the transport equipment sectors score high, whereas food, beverages and tobacco and again, surprisingly, the retail sectors score low.

Table 3.8 shows that 10-25% of all firms according to e-Business W@tch and less than 10% to almost 30% of all firms using the Internet according to DTI use on-line technology for collaborative design and development co-operation with other firms. UK businesses using ICTs in the construction and manufacturing sectors appear to drive the use of ICTs in collaborative design and development with customers (30% and 21%, respectively). Retail, government and finance are the least likely to do so (7%, 8% and 6%, respectively) (DTI, 2003). For collaborative demand planning/forecasting, 10-19% of all firms use ICTs (e-Business W@tch) and 3-17% of all firms using the Internet (DTI) do so.

The IFO B2B Metrics project provides a rich, sector-specific picture on both internal and external integration for the German distribution and automotive sector (Table 3.9). It is clear that the automotive

Table 3.8. **Percentage of firms carrying out certain functional inter-firm ICT integration**

	Use of on-line technology for collaborative design and development		Use of on-line technology for collaborative demand planning/ forecasting	
	DTI for 2002[1]	e-Business W@tch for 2003	DTI for 2002	e-Business W@tch for 2003
Germany	29	20	15	10
Spain	n.a.	12	n.a.	16
France	8	21	9	18
Italy	18	18	11	12
United Kingdom	16	24	7	19
Sweden	23	n.a.	17	n.a.
Japan	7	n.a.	3	n.a.
Canada	16	n.a.	10	n.a.
United States	23	n.a.	10	n.a.
Ireland	15	n.a.	6	n.a.
Australia	17	n.a.	6	n.a.

Note: All figures are employment-weighted. As the basis of comparison is different in all cases the different percentages attached to the three columns cannot be compared.
1. Refers to on-line collaborative design with customers only
Source: DTI (2003) and e-Business W@tch (2003), 7 sectors, base e-Business W@tch: all businesses (EU5 and 7 sectors). Base DTI: businesses using the Internet-based technologies.

Table 3.9. **Internal and external integration in the German automotive and distribution sector, 2002-03**

Distribution sample: N = 120/Automotive sample: N = 224

	Automotive		Distribution	
	Yes	Planned	Yes	Planned
PURCHASING Are you using one of the following e-business instruments (Internet, EDI)?				
Procurement via e-catalogues with integrated order form	46	16.1	18.3	11.7
Automated electronic payment	45.5	15.6	41.7	13.3
E-auctions for procurement	21.4	18.3	5.8	5.8
Electronic distribution of tender specifications (not with manual e-mail)	19.6	20.1	7.5	14.2
PRODUCTION PLANNING AND LOGISTICS – SUPPLY CHAIN MANAGEMENT (SCM) Are you using one of the following e-business instruments (Internet, EDI)?				
Collaborative stock management with partners (incl. delivery request)	49.6	12.5	18.3	10
Collaborative transport control with partners?	35.7	11.6	9.2	7.5
Software-based, collaborative simulation and planning?	17.0	10.7	5	6.7
SALES, CUSTOMER RELATIONSHIP MANAGEMENT (CRM) Are you using one of the following e-business instruments (Internet, EDI) with business customers (not consumers)?				
We inform customers about our products on the Internet	87.5	2.7	57.5	10
The invoice is generated automatically	54.9	7.6	31.7	9.2
We collect customer information *via* the Internet	48.2	8.9	16.7	7.5
We search business customers on the Internet	44.6	4.5	23.3	3.3
Complaints are received and processed electronically	43.8	7.6	24.2	6.7
We participate in on-line auctions of our customers	41.1	5.4	1.7	3.3
We regularly update our information in customers databases	34.4	6.7	13.3	6.7
We offer an on-line catalogue for products with an integrated on-line ordering system	26.8	13.4	37.5	14.2
A catalogue for spare parts exists on line	24.6	12.5	14.2	6.7
The customer can configure the product on line	15.2	8	7.5	8.3
Service is organised on line	8.9	12.5	10.8	9.2
Tele-service and tele-maintenance are provided	7.1	4.9	8.3	0.8
DEVELOPMENT Are you using one of the following collaborative e-development instruments (Internet, EDI)?				
We use networked product development	30.8	8.9	3.3	0.8
We use a common project management tool together with our partners	18.3	15.6	4.2	4.2
We use networked simulation techniques with partners	13.4	14.3	2.5	2.5

Note: the summation of percentages may deviate from 100 as the option no answer was not listed. Firms with more than 100 employees.
Source: OECD based on data provided by the IFO B2B Metrics Project.

sector boasts higher current and planned internal and external integration than the distribution sector. For both sectors, some e-business processes (search and provision of information over the Internet, electronic procurement, automated electronic payment, electronic complaint processing) are more common than others (service organised on line, tele-service and tele-maintenance, networked simulation techniques, collaborative simulation and planning). High values for collaborative stock management and, for example, networked product development in the automotive sector confirm the leading role of the automotive sector with its sophisticated supply chains and dependence on contractors.

E-*business solutions*

Business solutions like enterprise resource planning (ERP), supply chain management (SCM) and customer relationship management (CRM) software (Box 3.4) often complement EDI/intranets to support ICT-enabled supply chain integration and linkages between internal functions to increase efficiency.[11]

Figure 3.16 shows the use of e-business solutions in EU4 (Germany, France, Italy, United Kingdom). Except for large firms, there has generally been an increase in the use of all three e-business solutions between 2002 and 2003. The data show that there is clearly a size issue involved in the use of e-business solutions. In 2003, less than 20% of medium-sized enterprises used CRM and less than 6% of medium-sized firms used SCM.

In France, for instance, the most intensive users of ERP in manufacturing sectors in 2002 were: the energy and water industry, electronics, pharmacies and perfume, and electronic component industries. Interestingly, some traditional sectors make above-average use of e-business solution software (metal, textile, clothing industry) (see Sessi, 2003; and Annex Table C.3.3 for more country- and sector-specific data).

Except for small firms in 2002, ERP is the main solution adopted and supply chain management software is used the least. Earlier official figures for France indicate that already in 2000 around 37% of firms were equipped with some ERP software and 23% were intensive users. In 2002, roughly 80% of large enterprises (more than 500 employees), more than 70% of medium-sized enterprises (250-499 employees) and somewhat less than 45% of smaller enterprises (20-249 employees) were using ERP software (Sessi,

Box 3.4. E-business software solutions

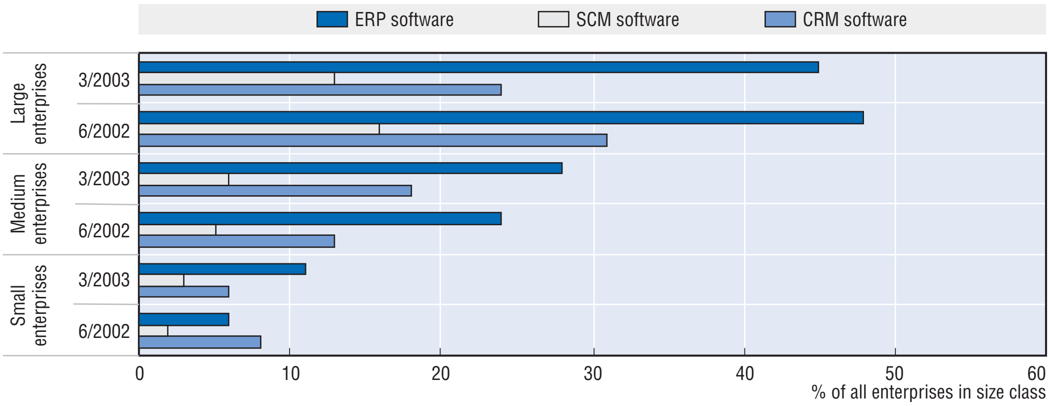
ERP: An enterprise resource planning system (SAP R/3 Enterprise or solutions by Oracle are the most common) is an integrated enterprise computing system that automates the flow of material, information and financial resources among all functions within an enterprise on a common database (Kumar *et al.*, 2002). It attempts to integrate all departments and functions across a company to create a single software programme which runs off a single database. It automates tasks such as order fulfilment, which involves taking an order, shipping and billing.

SCM: Supply chain management software improves the flow and efficiency of the supply chain and reduces inventory. Earlier, managers tried to estimate consumer demand and to manage the supply chain accordingly. Today a firm can connect its supply chain to the supply chains of customers and suppliers.*

CRM: ICT-enabled customer relationship management is a strategy to learn more about customers' needs and behaviour. Goals are to provide better customer service, track and analyse shifting customer needs, make call centres more efficient, cross-sell products more effectively, help sales staff close deals faster, simplify marketing and sales processes, discover new customers, increase customer revenues while collecting data on responses to campaigns, shipping data, account information, demographic data, etc.

* See "MySAP™ ERP Press Fact Sheet", June 2003 Internet: *www.sap.com/company/press/factsheets/solution/erp.asp*.

Figure 3.16. **Businesses that use e-business solutions, 2002 and 2003**



Note: Base: all enterprises in the respective size-class, EU4. Figures are employment-weighted.
Source: e-Business W@tch (2003).

2003). One reason for the greater prevalence of ERP is the fact that software solutions like SAP, Oracle or EDIFACT have been available for a longer time than SCM and CRM software. In addition, SCM systems often build on ERP systems as they rely on in-house information usually stored in ERP systems. Moreover, internal integration – the main goal of ERP – has been more widely adopted than external integration.

There are various reasons why e-business solutions have not been more widely adopted. The process of implementing them is very time- and resource-consuming because significant customisation and data entry are often necessary. It is necessary to spend on software, consulting, process rework, teaching users their new job processes, integration testing and a long list of other items before benefits emerge. Also, the complexity of installing and working CRM and SCM systems extends beyond the company itself as suppliers or customers need to be integrated. As with any other major ICT-driven process redesign, the effective introduction of such software solutions necessitates changes that may meet with internal resistance.

Small firms have additional reasons to refrain from the use of e-business solutions. Compared to large ones, small firms, spend – in proportion – more on ICT hardware than software. Also, they may have less need of co-ordination software. In the case of CRM for example, the more sales channels/ contacts to customers a firm has, the greater the need for such co-ordination software. Finally, small firms may be more likely to purchase off-the-shelf technologies. Tools like these software solutions that need expensive customisation are less popular with small firms (Statistics Canada, 2004). However, they may need the software to communicate with larger firms in supplier relationships.

In recent months, business interest in firms like Oracle and IBM to provide e-business solutions for SMEs has been on the rise, suggesting a significant pick-up in the months and years to come. Newer trends in e-business solutions point to Web-based, less hierarchical software that moves beyond the limitations of centralised systems for automating business operations like enterprise resource systems. Experts also points to the rapid development of "social software" like instant messaging, Weblogs (Web pages containing brief, chronologically ordered items of information), wikis (multi-user Weblogs) and peer-to-peer tools, all of which make it easier for workers to communicate and collaborate on line, almost instantaneously (Brown, 2004).

The impact of e-business

This section chapter briefly discusses lessons and measurement issues concerning e-business impacts that emerge from the preceding discussion of the use of e-business solutions.

The economic literature based on the logic of transaction costs (Bakos, 1997, Choi *et al.*, 1997),[12] as well as case and policy studies (Laube and Zammuto, 2003; A.T. Kearney, 2003a, 2003b; NOIE, 2003) suggest that firms can increase their competitiveness, business performance and productivity through the effective use of ICTs.

However, the evidence presented in this chapter suggests that the availability of computers and businesses' Internet access does not readily translate into e-commerce or more sophisticated e-business applications. Spending on ICT does not automatically lead to their effective use, nor does business use of ICTs directly translate into significant positive business benefits and positive economic impacts. The OECD Electronic Business Impact Project (EBIP) found that between 2000 and 2002 perceived e-business impacts were significant but nonetheless consistently lower than expected (OECD, 2003d). Clearly, however, the view of achieved ICT impacts also crucially hinges on initial expectations, and those regarding the use of ICTs and e-commerce were often excessive.

Although most firms understand that e-business is essential to remain competitive, detailed studies that substantiate a causal link between ICTs and concrete performance increases or specific organisational improvements are rare. Yet finding this link is important for managers who have to justify new ICT expenditures. Moreover, managers and policy makers who devise e-business policies need concrete understanding of which type of ICT deployment (hardware, software, etc.) and which applications (systems integration, specific use of e-business solutions, etc.) and complementary ingredients (skills, organisational change) lead to the significant business impact of ICTs which they seek.

Clearly, a growing economic literature demonstrates the productivity impacts of ICTs. According to studies employing growth accounting techniques, ICTs were a major source of labour productivity growth during the 1990s in many developed countries (Tuomi, 2004). In the mid-1990s, economic research also provided first cross-sectoral firm-level evidence of the impact of IT usage on firm-level productivity and output growth (Brynjolfsson and Hitt, 1996).[13] OECD sector- and firm-level studies concerning the economic impact of ICTs have also found conclusive evidence of the benefits of ICTs and demonstrated that the productivity gains from the use of e-business process are greater than those that result from the use of e-commerce. (OECD, 2003b, 2003e, 2004a). They show that the use of computer networks is associated with significantly higher total factor productivity, improved procurement, efficiency of markets as well as firms' more efficient internal operation (Atrostic and Nguyen, 2002; Clayton *et al.*, 2003; Motohashi, 2003; Maliranta and Rouvinen, 2003). ICT use is also associated with product or process innovation and improved collaboration between firms in the innovation process. Consequently, the services sectors that used ICTs most intensively (wholesale and retail trade, finance, insurance and business services) were also the sectors that contributed mostly to aggregate productivity growth over the 1990s. Other firm-level studies also find that the use of ICTs is positively correlated with productivity growth (Baldwin and Sabourin, 2002, for Canada; Gretton *et al.*, 2002, for Australia; Atrostic and Nguyen, 2002, for the United States; Atrostic *et al.*, 2002, for Japan).

Studies taking stock of the specific ICT usages throughout value chains that maximised impacts due to ICT expenditures are rare. Some concentrate on the *expected* impact of ICT use and conclude that ICT-using firms have similar priorities: cost reduction, increased operational efficiency and better customer contact seem the most important drivers (OECD, 2003d; DTI, 2003; Net Impact Study, 2002).[14] Keeping up with progress, better information access, increased service quality and development of collaboration capabilities are also important objectives. Interestingly, such aims, which point to anticipating changes and seizing opportunities, are inherent to good firms. This may also explain why ICT investment is often correlated to firm performance.

Moving beyond firms' expectations, some surveys and studies have assessed the perceived impacts of ICTs, which may not necessarily reflect actual impacts (DTI, 2003). For instance, e-Business W@tch (2003) finds that 50% of firms in the seven sectors surveyed (accounting for 60% of employment) said that e-business represented a "significant part" or "some part" of the way they operate (*cf.* Annex Table C.3.4). The impact is perceived mostly in sectors that manufacture or operate ICTs and electronics

(ICT services, electronics industry) and in sectors with a high potential for digitisation of service delivery (publishing, business services). These were also the sectors with most intensive use of ICTs. Impact was greatest in terms of the increased efficiency of internal work processes. Looking more specifically at the impact of online procurement, savings on procurement costs, better relations with suppliers, more efficient internal business processes and variations in the number of active suppliers played an important role. For instance, 60% of enterprises that made on-line purchases reported positive effects with respect to procurement costs and the efficiency of internal processes.

A cross-sector study covering many OECD countries concludes that the use of ICTs has led to improved communications, simplified processes, more sales on line and a few adverse effects from on-line technology adoption, such as disruption of services (*e.g.* system crashes). Cost reduction rather than revenue increase is the prime driving force behind ICT adoption but is not the most frequently achieved goal. Beyond the initial drivers, firms also realise additional benefits from adopting on-line technologies (DTI, 2003).

Few studies, however, have concretely estimated actual impacts in terms of money saved, reduced cycle times, increased customer satisfaction, etc. Cost-benefit analyses of Internet-based support of business processes are – because of measurement difficulties – rare in the business literature.[15] The Net Impact Study (2002) estimated that between 1998 and 2001 a sample of some 2 000 corporations in the United States achieved accumulated savings of USD 155.2 billion and revenue increases of USD 443.9 billion (Net Impact Study, 2002). For 630 corporations in France, Germany and the United Kingdom, Internet-generated savings amounted to USD 8.3 billion and additional revenue to USD 79 billion. Companies reported that the major impact on revenue came from the ability to attract new customers and from more frequent customer purchases.

Focusing on firms that lead in the use of ICT, the Net Impact Study (2003a, 2003b) found that they had greater productivity on average than their peers. Again it is hard to know whether this is due to the use of ICTs. The results, however, show that these advanced ICT-using firms experienced more than a 10% greater decrease in annual sales operating costs, a 20% increase in average revenue per sales employee, and a 30% increase in employee time spent on selling activities.[16] Measurement of the performance of these ICT-enabled efforts is often essential to realising increased productivity throughout different business functions (Net Impact Study, 2003a, 2003b). More sector-specific studies, like the IFO B2B Metrics project focused on the automotive and distribution sector and studies based on detailed firm interviews (Productivity Commission, 2003) also demonstrate more specific gains (increased turnover, customer retention, quality improvements).

As a result, despite the statistical firm-level studies and the more applied case and sector studies, the precise connection between ICT and business value (*i.e.* sales performance, efficiency, sales and net profit margin) – as well as in terms of cause and effect – remains poorly understood (MIT, 2003; Laube and Zammuto, 2003). It is clearly more difficult to measure the benefits of ICTs than to measure their costs because many of the benefits of ICT use are qualitative (quality improvements, product customisation, customer retention) or occur over significant time spans. ICTs are neither the only, nor necessarily the most important, driver of cost, quality and productivity (sector dynamics including innovation, organisational change, competition, scale, etc., are crucial), and it is difficult to identify separately the impacts of e-business strategies from other attributes of successful firms (good management, skilled employees, appropriate organisation). Factors like innovation, competition and demand are – side by side with ICTs – the important drivers of productivity (McKinsey 2002, 2003).

Furthermore, innovations such as organisational change (*i.e.* process redesign, new business models, flatter hierarchies, etc.), improvement of human capital, other transformational efforts and forms of "organisational capital"[17] are actually shown to be a necessary condition for maximising the economic impact of ICTs (Clemons and Row, 1991; Brynjolfsson and Hitt, 1996, 1998; OECD, 2003e; NOIE, 2003). Whereas ICTs are almost never the only causal factor for the reorganisation of production, or for organisational change, the gains derived from such strategic measures appear to be enhanced by ICTs and *vice versa*.

On top of measurement problems, lower than expected evidence for the business impact of ICTs is often due to the inability of firms to implement a complex set of complementary innovations. Among the reasons cited for lower than expected results are a lack of strategic clarity among top management as to how e-business can leverage existing business strategies (intersection of technology and strategy systems),[18] deficient organisational and product innovations, a lack of investment in skills, a shortage of college-educated managers to implement the required reorganisation (for these "e-business" skills, see Chapter 6 and Basu *et al.*, 2003) and a lack of metrics to assess ICT impacts (Porter, 2001; E-business Nordic.com, 2003; McKinsey, 2003). Finally, it has proven difficult for firms to view ICT planning and execution as an integrated business process built on co-operation between business and technology executives (A.T. Kearney 2003b).

Conclusion

ICTs are progressively spreading through the value chains of most firms and having an impact on costs and revenues. They affect e-business applications as well as on-line buying and selling activities, but the intensity of e-business use among firms in different sectors and of different sizes vary significantly. Often, measurement problems complicate the task of confirming causal relationships between increased use of ICTs and sustained impacts, and improved measurement of e-business processes is of key importance for better policy development. However firms with competitive advantages – a skilled and innovative workforce, openness to organisational change – benefit significantly from the deployment of ICTs along their value chains. For these firms, more complex e-business applications, including internal and external process integration, are the most promising in terms of efficiency and productivity payoffs.

This chapter raises some clear policy issues. Maintaining a competitive market for telecommunication services and broadband should remain high on the policy agenda. The recently adopted OECD Council Recommendation on Broadband Development encourages the development and uptake of broadband networks and applications. Furthermore, despite high levels of business connectivity, policies in OECD countries should continue to encourage lagging sectors and small and medium-sized enterprises to increase their adoption of ICTs and the Internet (see Chapter 8 and OECD, 2004b). However, governments need to move beyond policies for basic connectivity and ICT readiness to facilitate more widespread uptake and use of complex ICT and e-business applications. These include regulatory frameworks and technological developments (including certification, authentication, electronic signatures and online payment systems) that enable online processes and transactions and foster the necessary trust and security in them (see Chapter 8 and the OECD *Security Guidelines*).

As the "e-readiness" divide among firms closes, a new "e-business" divide may be developing. Firms are slow to adopt more complex forms of e-business and integrated ICT-enabled processes, and it is essential to understand why this is so, and what the policy role should be. Important policy recommendations on e-business and SMEs have been proposed, but are applicable to firms of all sizes (see Chapter 8 and OECD, 2004c). They include the necessary financial, legal or technological frameworks for enabling business ICT use, exchange of best practice, the development of managerial and ICT skills, and increased efforts for ICT-enabled product, process and organisational innovation. Policies to encourage and enhance the online delivery of services (both business-to-business and business-to-consumer) and the electronic distribution of digital content are necessary components. The shift towards global networked production, in addition to international sourcing (see Chapters 2 and 6), also raises new policy issues in areas such as interoperability and standards and the new forms of competition among firms.

NOTES

1. Other definitions of e-business include: "the utilisation of Internet-based applications and infrastructure, both internally and through collaborative linkages with trading partners" (A.T. Kearney, 2003); "business applications of net-based IT solutions whose purpose is to increase efficiency and improve the enterprise" (E-business Nordic.com, 2003); "The process of using Web technology to help businesses streamline processes, improve productivity and increase efficiencies. Enables companies to easily communicate with partners, vendors and customers, connect back-end data systems and transact commerce in a secure manner" (IBM: *www-3.ibm.com/e-business/doc/content/toolkit/glossary_a.html*).
2. As ICTs are increasingly "commoditised", firms need to find better ways to use ICTs to achieve their strategy objectives (Carr, 2003).
3. A similar classification is used in CBI (2002), DTI (2003) and CBS (2003).
4. The OECD has developed standard definitions of e-commerce. The nature of data collection in different surveys should be taken into consideration, however, when attempting to make international comparisons. For example, surveys may differ in terms of coverage of sectors, firms (establishment/enterprise) and timing, as well as in the size of the firms sampled (OECD, 2003c).
5. Fewer firms may accept online payment for individual purchases because they may have regular automatic payment arrangements with customers. Therefore, these figures may be low because some businesses do not need to accept such payments, not because of a lack of sophistication.
6. As many businesses can only provide an estimate of their Internet income, estimated values of Internet income for all businesses should be used with caution.
7. Forrester Forecast: US Online Retail Sales, 2003 to 2008, *www.forrester.com/ER/Research/Brief/Excerpt/0,1317,16875,00.html*.
8. See *www.oracle.com/solutions/mid/* and *www-1.ibm.com/businesscenter/smb/fr/fr/*.
9. The data in this section are not necessarily comparable to earlier OECD data (different years, only selected countries, different denominators for percentages, firm size). Moreover, different surveys have different methodologies.
10. ABS notes, however, that the figures should be used with caution as they have a relative standard error of 10-25%.
11. Based on Laube and Zammuto (2003, Section 5); "The ABCs of Supply Chain Management", Christopher Koch, Supply Chain Management Research Center, January 2002 (*www.cio.com/research/scm/edit/012202_scm.html*), Darwinmag.com, "What Is a Customer Relationship Management (CRM) System?", December 2003, (*www.darwinmag.com/read/120103/question65.html*), Enterprise Resource Planning Research Center, "The ABCs of Enterprise Resource Planning," (*www.cio.com/research/erp/edit/erpbasics.html*).
12. Based mostly on Williamson (1975, 1985).
13. Until the early 1990s, studies of the economic impact of IT investment on industries revealed that it had not significantly affected industry productivity (Brynjolfsson and Yang, 1996).
14. These goals are also confirmed by official statistics: CBS (2003), INE (2003), Nordic Council of Ministers (2002).
15. For an example in which potential ICT use and impacts are compared to actual use and impacts, see Manecke and Schoensleben (2004).
16. Customer service and support operations experienced greater productivity on average than their peers, as demonstrated by a 20% greater decrease in annual service operating costs, up to 25% more cases resolved per month, and up to a 30% decrease in average cost per case resolution (Net Impact Study, 2003).
17. Lev and Radhakrishnan (2003) emphasise that organisation capital, defined as "the knowledge used to combine human skills and physical capital into systems for producing and delivering want-satisfying products", contributes significantly to the explanation of market values of firms.
18. Leveraging a firm's strategy through IT means targeting technology investments to enhance specific strategic objectives. See Laube and Zammuto (2003), Section 1.

REFERENCES

ABS (Australian Bureau of Statistics) (2003a), *Year Book Australia* 2003: *Communications and Information Technology: Business Use of Information Technology*, Australian Bureau of Statistics, Canberra.

ABS (2003b), *Business Use of Information Technology* 2001-2002, Cat. No. 8129.0, February.

ABS (2003c), "Science and Technology Statistics Update", *Newsletters*, Bulletin No. 8, June, Australian Bureau of Statistics, Canberra.

ABS (2004), *Business Use of Information Technology*, 2002-2003, March, Australian Bureau of Statistics, Canberra.

ACSEL (2004), "Baromètre E-commerce de l'ACSEL 2003", Press conference, 3 February, available at *www.acsel.asso.fr*.

A.T. Kearney (2002), *The Extended Enterprise*, *The Evolution of e-Business Gateways*, White Paper, available at *www.atkearney.de/content/veroeffentlichungen/whitepaper_practice.php/practice/sitp/id/*48519.

A.T. Kearney (2003a), *E-Business Outlook* 2004, White Paper, available at *www.atkearney.de/content/veroeffentlichungen/whitepaper_practice.php/practice/sitp/id/*48934.

A.T. Kearney (2003b), *The Road to Business Value*, *An Integrated Approach to IT Investment*, White Paper, available at *www.atkearney.de/content/veroeffentlichungen/whitepaper_practice.php/practice/sitp/id/*48876.

Atrostic, B.K. and J. Gates (2001), "US Productivity and Electronic Business Processes in Manufacturing", presented at the IAOS Satellite Meeting on Statistics for the Information Society, Tokyo, Japan, 30-31 August.

Atrostic, B.K. and S. Nguyen (2002), "Computer Networks and US Manufacturing Plant Productivity: New Evidence from the CNUS Data", CES Working Paper 02-01, Center for Economic Studies, Washington DC.

Atrostic B.K., P. Boegh-Nielsen and K. Motohashi (2002), "The Effect of Computer Networks on Firm Performance: Japan, Denmark and the United States", Center for Economic Studies, US Department of Commerce, available from OECD as DSTI/EAS/IND/SWP/AH(2002)8.

Bakos, J.Y. (1997), "Reducing Buyer Search Costs: Implications for Electronic Marketplaces", *Management Science*, 43 (12), pp. 1676-1692.

Baldwin, J.R. and D. Sabourin (2002), "Impact of the Adoption of Advanced Information and Communication Technologies on Firm Performance in the Canadian Manufacturing Sector", STI Working Paper 2002/1, OECD, Paris.

BarNir A., J. M. Gallagher and P. Auger (2003), "Business Process Digitization, Strategy, and the Impact of Firm Age and Size: The Case of the Magazine Publishing Industry", *Journal of Business Venturing*, Vol. 18, Issue 6, November, pp. 789-814.

Basu, S., J.G. Fernald, N. Oulton and S. Srinivasan (2003), "The Case of the Missing Productivity Growth: or, Does information technology explain why productivity accelerated in the United States but not the United Kingdom?", Bank of England, July.

Bitran, G., P. Bassetti and G. Romano (2003), "Supply Chains and Value Networks, The Factors Driving Change and their Implications for Competition in the Industrial Sector", MIT Center for e-business, Research Brief No. 3, August.

Board of Governors of the Federal Reserve System (2003), *Monetary Policy Report to the Congress*, Washington DC, 15 July.

Brown, J.S. (2004), Interview, former director of Xerox Palo Alto Research Center, reprinted in "Technology and Worker Efficiency", *New York Times*, 2 February.

Brynjolfsson, E., T.W. Malone and V. Gurbaxani (1994), "Does Information Technology Lead to Smaller Firms?", *Management Science*, Vol. 40 (12), pp. 1628-1644.

Brynjolfsson, E. and S. Yang (1996), "Information Technology and Productivity: A Review of the Literature", *Advances in Computers* 43, pp. 179-214.

Brynjolfsson, E. and L.M. Hitt (1996), "Paradox Lost? Firm-level Evidence on the Returns to Information Systems Spending", *Management Science*, 42(4), pp. 541-558.

Brynjolfsson, E. and L.M. Hitt (1998), "Beyond Computation, Information Technology, Organizational Transformation and Business Performance", *Journal of Economic Perspectives*, Vol. 14, No. 4, Fall, pp. 23-48.

Carr, N. (2003), "IT Doesn't Matter", *Harvard Business Review*, 1 May.

CBI (Confederation of British Industry) (2002), *Reality Bites: The Second Annual Report on E-Business in the UK*, Confederation of British Industry.

CBS (Central Bureau of Statistics, the Netherlands) (2003), *De digitale economie* 2003, available at *www.cbs.nl/nl/publicaties/publicaties/bedrijfsleven/algemeen/p-34-03.pdf*.

Charles, S., M. Ivis and A. Leduc (2002), "Embracing e-Business, Does Size Matter?", available at *www.statcan.ca/cgi-bin/downpub/listpub.cgi?catno=56F0004MIE2002006*.

Choi, S., D.O. Stahl and A. Whinston (1997), *The Economics of Electronic Commerce: The Essential Economics of doing Business in the Electronic Marketplace*, MacMillan, Indianapolis, Indiana.

Chung, W., A. Yam and M. Chan (2004), "Networked Enterprise: A New Business Model for Global Sourcing", *International Journal of Production Economics*, 87, pp. 267-280.

Clayton, T., C. Criscuolo, P. Goodridge and K. Waldron (2003), "Enterprise E-Commerce: Measurement and Impact", UK Office for National Statistics, available at *www.statistics.gov.uk/events/caed/abstracts/downloads/clayton.pdf*.

Clemons E.K and M.C. Row (1991), "Sustaining IT Advantage: The Role of Structural Differences", *MIS Quarterly* 15(3), pp. 275-293.

CRITO (Center for Research on Information Technology and Organizations, Japan) (2004), "Diffusion and Impacts of the Internet and E-Commerce in Japan", by D. Tachiki, S. Hamaya, K. Yukawa, CRITO, Tokyo.

Czech Statistical Office (2004), "Results of a Survey on the Usage of Information and Communication Technologies and Electronic Commerce in Enterprises in 2002", 31 January, available at *www.czso.cz/eng/edicniplan.nsf/publ/9602-03-in_2002*.

Dutta, S. and A. Segev (1999), "Transforming Business in the Marketspace", *Proceedings of the Thirty-Second Annual Hawaii International Conference on System Science*, held 5-8 January, Vol. 5, p. 5025.

E-business Nordic.com (2003), study conducted by Rambøll Management.

DTI (Department of Trade and Industry, United Kingdom) (2002), "Business in the Information Age, International Benchmarking Study (IBS) 2002", UK Department of Trade and Industry, available at *www.ukonlineforbusiness.gov.uk/benchmarking2002/index.html*.

DTI (2003), "Business in the Information Age, International Benchmarking Study (IBS) 2003", UK Department of Trade and Industry, available at *www.ukonlineforbusiness.gov.uk/benchmarking2003/index.htm*.

E-business Nordic.com (2003), "Strategies and Spreading of e-business in Nordic Enterprises", Ramboll Management, November, available at *www.pls-ramboll.com/eng/sites/pubarr/bussdevandinn/ebusinessnordiccom2003.htm*, accessed 10 July 2004.

e-Business W@tch (2003), *The European e-Business Report: A Portrait of e-Business in 15 Sectors of the EU Economy*, 2nd Synthesis Report of e-Business W@tch, July, European Commission, Enterprise Directorate General.

eMarket services (2003), "Significant E-marketplaces (previously Who's Who of eMarkets)", updated November, available at *www.emarketservices.com/reports_facts/*.

European Commission (2003a), "Adapting E-Business Policies in a Changing Environment: The Lessons of the Go Digital Initiative and the Challenges Ahead", Communication from the Commission COM(2003)148 final, 27 March, Commission press release IP/03/451.

European Commission (2003b), "Report of the Expert Group on B2B Internet trading platforms, Report of the Expert Group on B2B Internet trading platforms", 7 July, available at *http://europa.eu.int/comm/enterprise/ict/policy/b2b/wshop/fin-report.pdf*.

Evans, P.B. and B.S. Wurster (1997), "Strategy and the New Economics of Information", *Harvard Business Review*, 75(5), pp. 70-83.

FEVAD (Fédération des Entreprises de Vente à Distance) (2004), "Nouveaux records sur Internet à l'occasion des fêtes de fin d'année 2003", Fédération des Entreprises de Vente à Distance, 20 January, available at *www.fevad.com/library/documents/45.pdf*, accessed 2 July 2004.

Financial Times (2004), "Net Voyagers Navigate Stormy Seas", 17 March.

Gretton, P., J. Gali and D. Parham (2002), "Uptake and Impacts of ICT in the Australian Economy: Evidence from Aggregate, Sectoral and Firm Levels", paper presented at OECD Workshop on ICT and Business Performance, Productivity Commission, Canberra, December.

Industry Canada (2003), "Key Indicators on ICT Infrastructure, Use and Content", Ottawa, September, available at *strategis.ic.gc.ca/epic/internet/inict-tic.nsf/vwapj/0106101e.pdf/$FILE/0106101e.pdf*.

INE (Instituto Nacionál de Estadística) (2003), "Encuesta sobre el uso de TIC y Comercio Electrónico en las empresas 2002, Notas de Prensa, Resultados provisionales", 6 November, available at *www.ine.es/prensa/np302.pdf*, accessed 20 May.

ISM (Institute for Supply Management) (2003), "Report on Technology in Supply Management", Institute for Supply Management, 27 October, available at *www.ism.ws/ISMReport/Forrester/FROB102003PR.cfm*.

Jagdev, H. and K.-D. Thoben (2001), "Anatomy of Enterprise Collaboration", *Production Planning and Control*, No. 12, pp. 437-452.

Kumar V., B. Maheshwari and U. Kumar (2002), "Enterprise Resource Planning Systems Adoption Process, A Survey of Canadian Organizations", *International Journal of Production Research*, No. 40, pp. 509–23.

Laube, D. and R.F. Zammuto (2003), *Business-driven Information Technology*, Stanford Business Books, Palo Alto, California.

Lee, S.C., B.Y. Pak and H.G. Lee (2003), "Business Value of B2B E-commerce: The Critical Role of Inter-firm Collaboration", *Electronic Commerce Research and Applications*, Vol. 2, Issue 4, Winter, pp. 350-361.

Leek, S., P.W. Turnbull and P. Naudé (2003), "How Is Information Technology affecting Business Relationships? Results from a UK Survey", *Industrial Marketing Management*, Vol. 32, Issue 2, February, pp. 119-126.

Lev, B. and S. Radhakrishnan (2003), "The Measurement of Firm-specific Organization Capital", NBER Working Paper 9581, March, available at *www.nber.org/papers/w9581*.

Manecke, N. and Paul Schoensleben (2004), "Cost and Benefit of Internet-based Support of Business Processes", *International Journal of Production Economics* 87, pp. 213-229.

McCarthy, I. and A. Anagnostou (2004), "The Impact of Outsourcing on the Transaction Costs and Boundaries of Manufacturing", *Journal of Production Economics*, Vol. 88, pp. 61-71.

McFarlan, E.W. (1984), "Information Technology Changes the Way You Compete", *Harvard Business Review*, May-June, pp. 98-103.

McKinsey (2002), *How IT Enables Productivity Growth*, October.

McKinsey (2003), "Getting IT Spending Right This Time", 4 October, *McKinsey Quarterly*.

Maliranta, M. and P. Rouvinen (2003), "Productivity Effects of ICT in Finnish Business, ETLA", The Research Institute of the Finnish Economy, available at *www.statistics.gov.uk/events/ caed/abstracts/downloads/maliranta*.

MINEFI (Ministry of Economics, Finance and Industry, France) (2004), "Internet et Entreprise: mirage ou opportunité ?, Pour un plan d'action", Ministry of Economics, Finance and Industry, January.

Ministry of Commerce, Industry and Energy (Korea) (2003), *Ecommerce in Korea* 2003, Korea Institute for Electronic Commerce, Seoul.

MIT (2003), "Information, Technology and Business Value", Digital Productivity Workshop, Center for E-business, 19 November.

Motohashi, K. (2001), "Economic Analysis of Information Network Use, Organizational and Productivity Impacts on Japanese Firms", Research and Statistics Department, METI, Tokyo, January.

Motohashi, K. (2003), "Firm-level Analysis of Information Network Use and Productivity in Japan", Hitotsubashi University and Research Institute of Economy, Trade and Industry, available at *www.statistics.gov.uk/events/caed/abstracts/downloads/motohashi.pdf*.

MPHPT (Ministry of Public Management, Home Affairs, Posts and Telecommunications, Japan) (2002), *Information and Communications in Japan, Stirring of the IT-prevalent Society*, White Paper, MPHPT, Tokyo.

MPHPT (2003a), "Information and Communications in Japan, Building a New Japan-based Information Society", MPHPT, available at *www.johotsusintokei.soumu.go.jp/whitepaper/eng/WP2003/2003-index.html*.

MPHPT (2003b), "Survey on the Utilization of IT in Business Management", MPHPT, available at *www.johotsusintokei.soumu.go.jp/linkdata/it_sankou_h15.pdf*.

Naude P., C. Holland and M. Sudbury (2000), "The Benefits of IT-based Supply Chains – Strategic or Operational?", *Journal of Business-to-Business Marketing*, 7(1), pp. 45-67.

NCA (National Comuterization Agency, Korea) (2002), *Informatization White Paper 2002: Global Leader E-Korea*, Korea National Computerization Agency, Seoul.

NCA/MIC (Ministry of Information and Communication) (2003), *Internet Korea: White Paper* 2003, available at *www.mic.go.kr/eng/res/res_pub_db/res_pub_kwp/kwp_2003_full.pdf*.

Net Impact Study (2002), "The Projected Economic Benefits of the Internet In the United States, United Kingdom, France and Germany", January, available at *www.netimpactstudy.com*.

Net Impact Study (2003a), "Customer Service and Support", prepared by Momentum Research, available at *www.netimpactstudy.com*.

Net Impact Study (2003b), "Sales", prepared by Momentum Research, available at *www.netimpactstudy.com*.

NOIE (National Office for the Information Economy, Australia) (2002), "The Benefits of Doing Business Electronically – E-business", *www.noie.gov.au/projects/e-business/Advancing/benefits/index.htm*.

NOIE (2003), "Productivity and Organisational Transformation – Optimising Investment in ICT", National Office for the Information Economy, February.

Nordic Council of Ministers, and Statistics Denmark, Statistics Finland, Statistics Iceland, Statistics Norway, Statistics Sweden (2002), *Nordic Information Society Statistics* 2002, December, available at *www.ssb.no/ikt/ict_nord/publ.pdf*

OECD (2000), *Science, Technology and Industry Outlook: Drivers of Growth, Information Technology, Innovation, and Entrepreneurship*, available at *www.oecd.org/bookshop*.

OECD (2002), OECD *Information Technology Outlook: ICTs and the Information Economy*, OECD, Paris.

OECD (2003a), "OECD Work on Standards for Measuring Electronic Business", prepared by Sheridan Roberts (OECD) and Ivan Bishop (Department of Trade and Industry, United Kingdom) for the 18th Meeting of the Voorburg Group on Service Statistics, Tokyo, October.

OECD (2003b), Seizing the Benefits from ICT: An International Comparison of the Impacts of ICT on Economic Performance, OECD/DSTI/IND/ICCP(2003)2, March.

OECD (2003c), OECD *Science, Technology and Industry Scoreboard*, OECD, Paris.

OECD (2003d), "Electronic Business Networks, An Assessment of the Dynamics of Business-to-business Electronic Commerce in Eleven OECD Countries, A Summary Report on the e-Commerce Business Impacts Project (EBIP)", prepared by Pascal Verhoest (TNO-STB) and Graham Vickery (OECD), May, available at *www.jrc.es/home/publications/publication.cfm?pub=1122*.

OECD (2003e), ICT *and Economic Growth – Evidence from* OECD *Countries, Industries and Firms*, OECD, Paris.

OECD (2004a), *The Economic Impact of* ICT, *Measurement, Evidence and Implications*, OECD, Paris.

OECD (2004b), "Recommendation of the Council on Broadband Development", adopted by the Council at its 1077th Session on 12 February, C(2003)259/FINAL, available at *www.oecd.org/dataoecd/31/38/29892925.pdf*.

OECD (2004c), "Promoting Entrepreneurship and Innovative SMEs in a Global Economy", Second OECD Conference of Ministers responsible for Small and Medium-sized Enterprises, Istanbul, Turkey 3-5 June, available at *www.oecd.org/dataoecd/5/24/31919590.pdf* (19 June).

ONS (Office of National Statistics, United Kingdom (2003), 2002 *e-commerce Survey of Business, Information and Communication Technologies* (ICT) *Adoption and Usage*, UK National Statistics Office, London.

Porter, M. (1985), *Competitive Advantage, Creating and Sustaining Superior Performance*, The Free Press, New York.

Porter, M. (2001), "Strategy and the Internet", *Harvard Business Review*.

Preissl, B. (2003), "E-business in Service Industries, Usage Patterns and Service Gaps", Discussion Paper 373, DIW (German Institute for Economic Research), Berlin.

Productivity Commission (2003), "ICT Use and Firm Performance in Australia Evidence from Firm Interviews", September.

Protogeros, N. (2002), "A Comparative Study Of Business Practices Of North American And European Online Companies", *Information and Management* 39, pp. 525–538.

Quinn, J.B. (1992), "The Intelligent Enterprise, A New Paradigm", *Academy of Management Executives* 6(4), pp. 48-63.

SESSI (Service des Etudes et des Statistiques Industrielles) (2003), "Mise à jour du Tableau de bord du commerce électronique", Mission pour l'Économie Numérique, Ministère délégué à l'Industrie DiGITIP, 4th edition, May.

Stabell, C.B. and O.D. Fjeldstad (1999), "Configuring Value For Competitive Advantage, On Chains, Shops, and Networks", *Strategic Management Journal*, Vol. 19, pp. 413-437.

Statistics Canada (2003), "Survey of Electronic Commerce and Technology 2002", *Daily Canada* 2 April, available at *www.statcan.ca/Daily/English/030402/d030402a.htm*.

Statistics Canada (2004), "Starting the New Century, Technological Change in the Canadian Private, Sector, 2000-2002", by L. Earl, Science, Innovation and Electronic Information Division, Working Paper, available at *www.statcan.ca/english/research/88F0006XIE/88F0006XIE2004001.pdf*.

Statistisches Bundesamt (2003), "ICT in Businesses: Results from the Pilot Study 2002" (in German), February, available at *www.destatis.de/presse/deutsch/pk/2003/iuk_unternehmen.pdf*.

Sussman, D. (2002),"Barriers to job-related training", *Perspectives on Labour and Income*, Vol. 3, pp. 3-12, Catalogue No. 75-001-XIE, Statistics Canada, Ottawa.

The Economist (2003), "Surviving Better Times: Keep Calm, Stay Focused", 15 November.

Tuomi, I. (2004), "Knowledge Society and the New Productivity Paradigm: A Critical Review of Productivity Theory and the Impacts of ICT", JRC/IPTS, IPTS Working Paper, 11 February, available at *www.jrc.es*.

UNCTAD (United Nations Conference on Trade and Development) (2003a), Measurement and impact Paper for UNCTAD workshop on Measuring Electronic Commerce, Geneva, by T. Clayton, C. Criscuolo, P. Goodridge and K. Waldron (Office for National Statistics, United Kingdom), September.

UNCTAD (2003b), *E-commerce and Development Report 2003*, Geneva.

US Bureau of the Census (1999), *Measuring Electronic Business, Definitions, Underlying Concepts, and Measurement Plans*, by T.L. Mesenbourg, Bureau of the Census, Washington DC.

US Bureau of the Census (2001a), *1999 E-business Process Use by Manufacturers Initial Report on Selected Processes*, 8 June.

US Bureau of the Census (2001b), *Measuring Electronic Business*, by T.L. Mesenbourg, Bureau of the Census, August.

US Bureau of the Census (2002), *1999 E-business Process Use by Manufacturers: Final Report on Selected Processes*, 1 March.

US Bureau of the Census (2003a), "E-commerce 2001 Highlights",available at *www.census.gov/eos/www/papers/2001/2001estatstext.pdf*, accessed 30 June 2004.

US Bureau of the Census (2003b), *2001 E-commerce Multi-sector Report*, released 19 March, available at *www.census.gov/eos/www/papers/2001/2001estatstext.pdf*, accessed 30 June 2004.

US Bureau of the Census (2003c), *Retail 3Q E-commerce Report*, released 22 August, available at *www.census.gov/mrts/www/current.html*, accessed 30 June 2004

US Bureau of the Census (2004), *Retail 1Q, 2004 E-commerce Report*, released 21 May, available at *www.census.gov/mrts/www/current.html*, accessed 30 June 2004.

US Department of Commerce (2003), *Digital Economy 2003*, Economics and Statistics Administration, *www.esa.doc.gov/DigitalEconomy2003.cfm*.

WEF (World Economic Forum) (2003), "Network Readiness Index", available at *www.weforum.org/pdf/Gcr/GITR_2003_2004/Framework_Chapter.pdf*.

Williamson, O. (1975), *Markets and Hierarchies: Analysis and Antitrust Implications*, Free Press, New York.

Williamson, O. (1985), *The Economic Institutions of Capitalism*, Free Press, New York.

Chapter 4

USE OF ICTS BY INDIVIDUALS AND HOUSEHOLDS

The Internet and broadband are diffusing rapidly to individuals and households, building on the installed base of PCs, following similar patterns in different countries but at different levels. ICT uptake and use is strongly affected by socio-economic characteristics. Internet use is diversifying and affecting time devoted to other media. A "use divide" is progressively replacing a persistent, if narrowing, "access" divide. Beyond the narrower issues of ICT supply and connectivity, public policy can encourage diffusion and use and content provision through broader measures involving education, training and literacy.

Introduction

Public authorities have increasingly concerned themselves with the diffusion of information and communication technologies (ICTs). In the early 1990s, they launched information infrastructure initiatives to accompany the development of information and communication networks to ensure access to "information highways". On the public policy agenda, the focus soon shifted from information highways to the more complex notion of the "information society". In order to look at how the information society has evolved in recent years, this chapter focuses on recent developments in ICT access, diffusion and use by individuals and households in OECD countries. It analyses trends in the adoption of personal computers (PCs) and the Internet and, to a lesser extent, mobile communications. Data on individuals and households have certain limitations with respect to type of access and the evolution of both number of households and household socio-economic characteristics, so that the indicator of household penetration rates should be interpreted with care.

Speed of diffusion

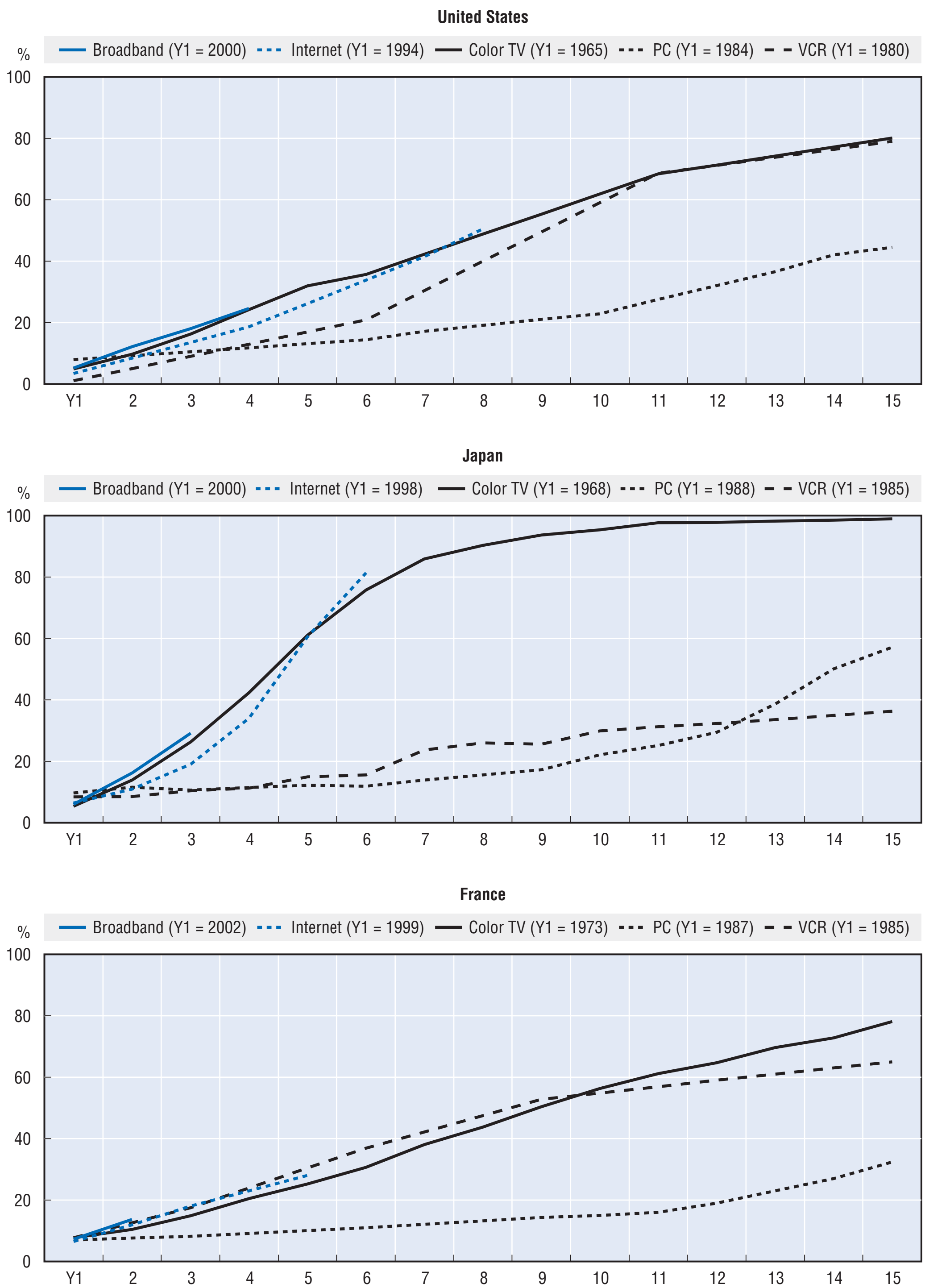
Diffusion of technologies is not homogeneous and depends upon a range of factors. Technologies that use computers rely on communication and interaction skills and differ in some ways from other types of goods. The diffusion of PCs and the Internet to households is becoming widespread in some OECD countries, but remains low or marginal in others. Within countries, there are still significant gaps among users, and socio-economic factors, such as level of income, occupation, level of educational attainment or the presence of computer or Internet access at work, play a role.

In general, the PC has diffused quite slowly in all countries and seems to require a period of a decade before it is widely adopted. For example, it took around 13 years for the PC to reach 40% of households in Japan and the United States and just over 20% in France. Both colour television (TV) and the video cassette recorder (VCR), for example, deployed more rapidly. In France and the United States, both reached 60% of households in around ten years; in Japan, 80% of households were equipped with colour TV in five years. Internet access has spread more rapidly than the PC, probably because the Internet uses an existing and already well-diffused technology.[1] It seems to be diffusing at about the same rate as colour TV. For broadband, it is too early to have a precise idea of the pace of diffusion, but the initial years suggest a pace similar to or even more rapid than the Internet (Figure 4.1, and Annex Figures C.4.1 to C.4.4).

Table 4.1 shows the number of years needed for diffusion to move from 20% to 50% of households. Compared to colour TV, VCR or mobile phones, PCs have diffused relatively slowly. Black and white television diffused very rapidly,[2] colour TV less rapidly (the technology was expensive at first), with the noticeable exception of Japan. Mobile phones are not far behind.

The diffusion of innovations may start, for instance, with a first users' group and then diffuse (trickle down) to a wider population. A recent study on four European countries (Denmark, France, Italy and the United Kingdom) suggests that the Internet has been adopted in this way in these countries. Concretely, young people (most often students) and technology enthusiasts and professionals have been the first adopters (Flacher, 2003). In Japan, the explosion of "i-mode" – use of Internet *via* mobile phones – was also ignited by the young: more than three out of four users were under 24 years old in 1999 and 45% under 19 years old.

Figure 4.1. **Evolution of PCs, Internet access (including broadband) and consumer goods after reaching 5% of households**



Source: OECD, based on data from INSEE (France), Economic Planning Agency and MPHPT (Japan); US Department of Commerce and Nielsen Media Research (United States), and OECD estimates.

Table 4.1. **Pace of diffusion for selected goods in selected OECD countries**

Goods	Estimated number of years to move from 20% to 50% of households				
	Canada	Finland	France	Japan	Netherlands
TV	2	. .	. .	. .	. .
Colour TV	. .	7	4	3	4
PC	7	5	7[1]	5	8
VCR	3	6	5	5	6
Mobile phones	4	2	2	. .	. .
Mobile phones[2]	. .	3	3	4	2

1. OECD estimates, based on current growth trends. As of May 2003, 41% of households were equipped with a PC.
2. Percentage of individuals.

Source: OECD estimates, based on data from the OECD Telecom database, Statistics Canada, Economic Planning Agency (Japan), Statistics Finland, Statistics Netherlands, INSEE and CREDOC (France).

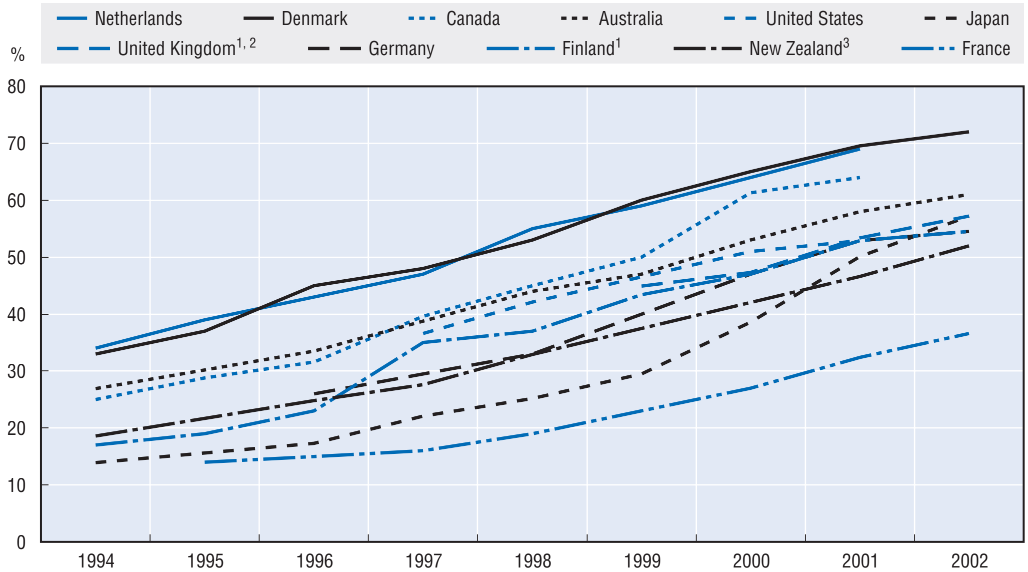
Computer and Internet penetration

During the second half of the 1990s, PCs diffused relatively regularly in most OECD countries. Over the last eight years, both the level and pace of diffusion of PCs to households has been strikingly homogeneous in Australia, Canada, Denmark, the Netherlands and the United States. Japan, the United Kingdom and, to a lesser extent, France, seem to have seen some acceleration in the latest years, in contrast to the more regular pace of other countries. While Japan and France began the period at the same level, Japan had reached the level of the more advanced countries at the end of the period, while France still lags by 20 percentage points (Figure 4.2).

In spite of very rapid growth in recent years, PC access among households varies across countries. In 2002, PCs were in two-thirds or more of homes in Sweden, Denmark and Germany and in more than half of homes in ten OECD countries out of the 21 for which data are available. In other countries, more

Figure 4.2. **Access to a home computer in selected OECD countries, 1994-2002**

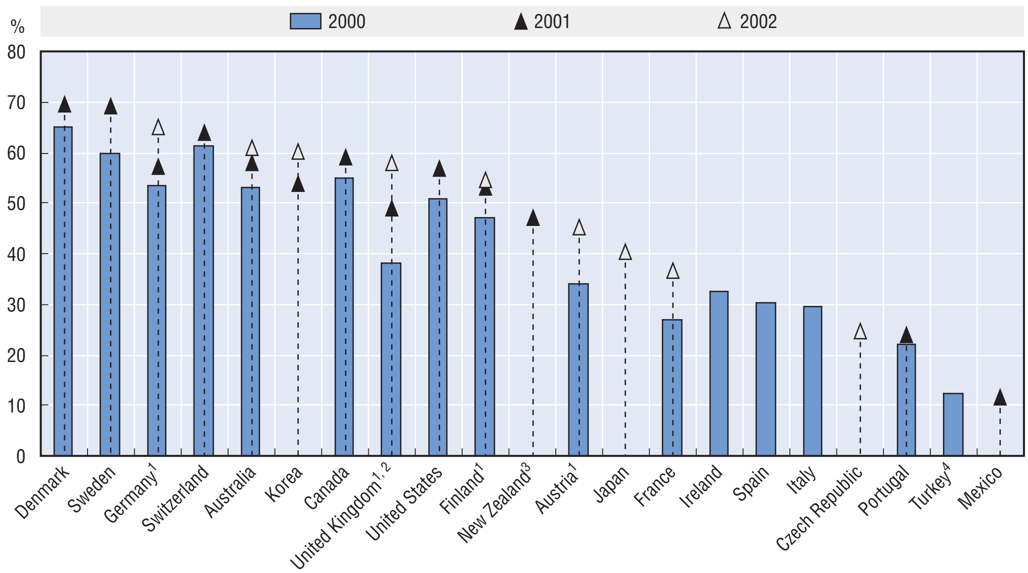
Percentage of households



1. For 2002, first quarter data from the EU Community Survey on Household Use of ICT 2002, June 2003.
2. March 2001-April 2002 (financial year) instead of 2001.
3. July 2000-June 2001.

Source: OECD, based on ICT database and national sources. For further details, see Annex Table C.4.1.

Figure 4.3. **Households with access to a home computer, 2000-02**



1. For 2002, first quarter data from the EU Community Survey on Household Use of ICT.
2. March 2001-April 2002 (financial year) instead of 2001.
3. July 2000-June 2001.
4. Households in urban areas only.

Source: OECD, ICT database and Eurostat, Community Survey on Household Use of ICT 2002, June 2003. See also Annex Table C.4.1.

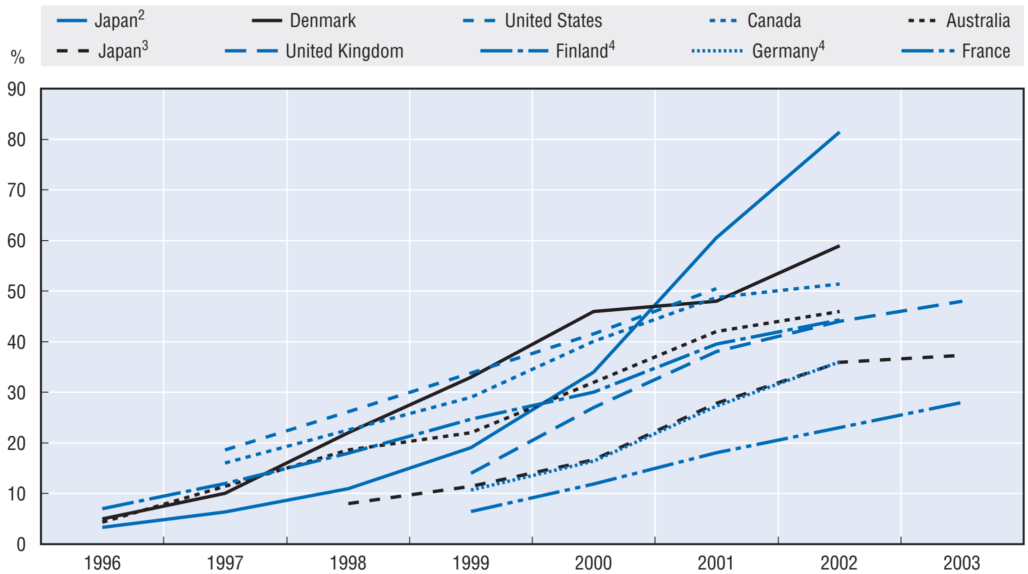
than half of households still do not have a PC at home (Figure 4.3). The growth pattern in the most advanced countries suggests that PC diffusion will continue in the less advanced countries but will not reach saturation very quickly.

Diffusion of the Internet has been more rapid than that of the PC in a number of countries, rising from less than 10% to around 50% of households within a six-year period. Between 1996 and 2003, the pace of diffusion was very similar in Australia, Canada, Finland and the United States. It has been particularly strong in Denmark and the United Kingdom, and in Korea where it reached 70% by 2002. In most countries, diffusion slowed significantly in 2002 and 2003, although it is far from saturation. In Japan, where access to the Internet via a PC has slowed, access by all means is still growing and was approaching saturation in 2002 (Figures 4.4 and 4.5).

Connection via broadband and wireless

Since 2000, the total number of subscribers to broadband and "always on" (permanent) Internet connection has increased very rapidly in OECD countries, doubling from around 15 million to 33 million between the end of 2000 and the end of 2001. Growth appears to be accelerating, as subscribers reached 43 million at the end of June 2002, 69 million in June 2003 and more than 83 million at the end of 2003. On a per capita basis, Korea takes the lead, followed by Canada. Availability and uptake vary widely across OECD countries (Figure 4.6). Korea's lead is due first to public investments in infrastructure, in particular connecting new buildings and fierce competition leading to lower prices, on the supply side, followed by demand side factors and development of content. Recent developments mirror the strength of growth in broadband subscribers in a good third of the OECD countries. Between June 2002 and December 2003, there were over 40 million new broadband subscribers at the OECD level. Broadband access per 100 inhabitants grew particularly strongly in the Netherlands, in Japan, Belgium, in the Nordic countries, and in Canada, France, the United States and the United Kingdom

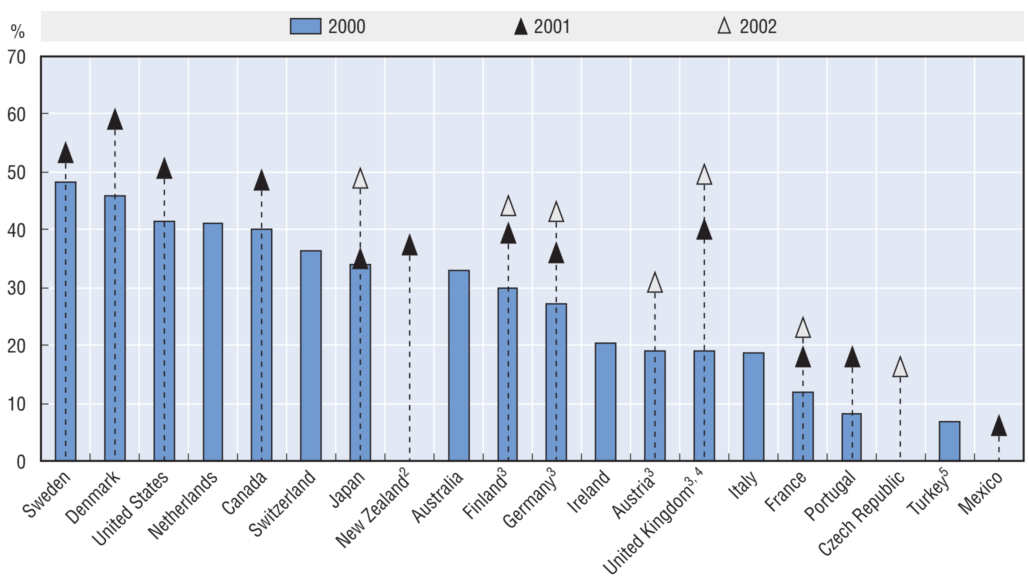
Figure 4.4. **Household access to Internet[1] in selected OECD countries, 1996-2003**



1. For 2000 and 2001, Internet access *via* any device except for Denmark, the Netherlands, Ireland, Austria, France and Turkey where Internet access is *via* a home computer.
2. Share of households using the Internet. Access devices include PCs, mobile phones, PDAs, Internet-capable video game consoles, TVs, etc.
3. September of each year, except October for 1999. Internet users only via a home PC.
4. For 2002, first quarter data from the Eurostat Community Survey on Household Use of ICT 2002, June 2003.

Source: OECD, ICT database; Eurostat, Community Survey on Household Use of ICT 2002, June 2003; MPHPT, *Communication Usage Trends Survey*; and OECD estimates, based on data from NRI, *Cyberlife Observation Survey*, various years.

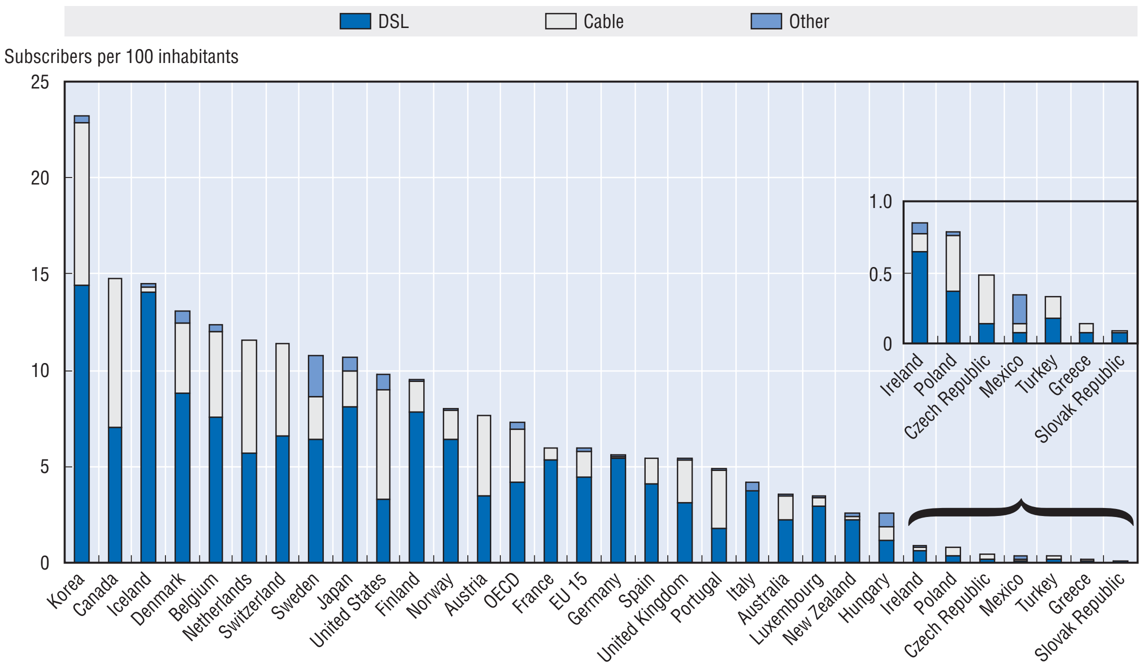
Figure 4.5. **Households with access to the Internet,[1] 2000-02**



1. For 2000 and 2001, Internet access *via* any device except for Denmark, the Netherlands, Ireland, Austria, France and Turkey where Internet access is *via* a home computer.
2. July 2000-June 2001.
3. For 2002, first quarter data from the EU Community Survey on household use of ICT.
4. March 2001-April 2002 (financial year) instead of 2001.
5. Households in urban areas only.

Source: OECD, ICT database and Eurostat, Community Survey on Households Use of ICT 2002, June 2003 – see also Annex Table C.4.2.

Figure 4.6. **Broadband access per 100 inhabitants, December 2003**

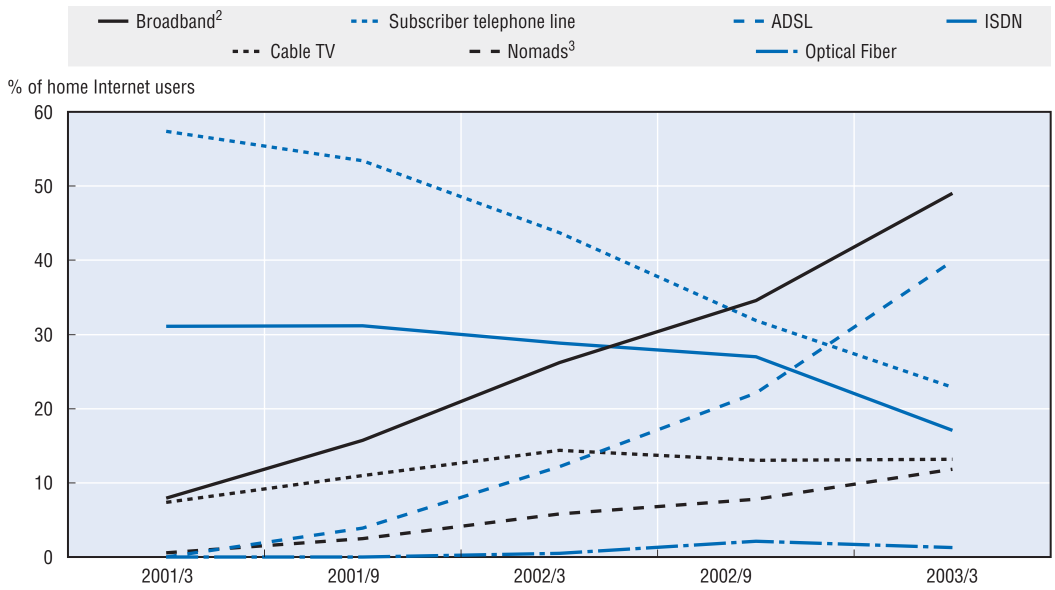


(with growth of between four and almost eight percentage points). In spite of an already high level, Korea also had growth of more than 4%.

More generally, communication network infrastructure has progressed rapidly over the past decade, with average fixed telecommunication access channels per 100 inhabitants increasing from about 40 to almost 55 in the OECD area. However, the most impressive growth in telecommunication infrastructure has been for wireless access. Substantial rollout of wireless access has been observed in all OECD countries, notably in Nordic countries; in Norway, for example, it is providing cost-effective broadband solutions for many sparsely populated areas. Across all OECD countries, in the four years between 1997 and 2001, the average number of mobile subscribers per 100 inhabitants more than tripled. Although the situation across countries is uneven, network infrastructure has increased everywhere, creating a powerful enabler of connectedness and mobility (OECD, 2003).

While the PC remains by far the main source of Internet connection, an increasingly significant share of individuals in several countries already access the Internet from home via devices other than the PC or are planning to do so in the near future. In June 2001, 13% of people in France said they were going to use their mobile phone to navigate the Internet. The share was 19% among those already equipped with a mobile phone, and 24% among those who already accessed the Internet. Two years later, in 2003, a reality check provides a much more moderate picture, as only 5% of mobile phone owners in France access the Internet using their mobile phones, and mobile phones are seen as the best tool for accessing the Internet by only 3% of the population (CREDOC, 2001, 2003). In 2002 in the United Kingdom, about 10% of individuals were using mobile phone/WAP [wireless application protocol] to connect to the Internet. In the United States in 2001, Internet-enabled mobile phones or pagers were owned by around 5% of households, and Internet-accessible personal digital assistants (PDAs) by 1.8% (US Department of Commerce, 2002). In 2002, around 9% of adult Internet users were accessing it *via* a wireless device (The UCLA Internet Report, 2003).

Figure 4.7. **Internet access line type at home in Japan, 2001-03**[1]



1. Multiple answers were possible.
2. In addition to cable TV, ADSL (asymmetric digital subscriber line), and optical fibre, includes high-speed dedicated line in aggregate housing and wireless.
3. Users who access the Internet *via* both mobile phones and broadband.

Source: OECD, based on data from NRI, *Cyberlife Observation Survey*, various years.

In Japan, use of the Internet by households has been increasingly "nomadic". Increasing use of mobile phones as stand-alone terminals for e-mail and as an alternative means of Internet access was already apparent in 2001 (Toda, 2001). In the last three years, Internet usage via a single mobile phone or by connecting mobile phones to data communications terminals, personal handy systems (PHS) or other devices has expanded rapidly in Japan. The share of Internet users who exclusively used a PC to access the Internet decreased from 54% in 2000 to 30% in spring 2003. In parallel, the mobile phone is increasingly used exclusively to access the Internet (from 7% in 2000 to 16% in March 2003) (Nomura Research Institute, various years). There is an increasing trend for people to access the Internet *via* both a mobile phone and a broadband connection at home (Figure 4.7).

In Korea, although wireless access to the Internet is still marginal (less than 1% of the connections to the Internet through a mobile device in December 2002), it is increasing regularly. In September 2002, around one-third of mobile phone users were also using wireless Internet services, an increase of five percentage points in the six months from March 2002. If most of these used mobile phones, one wireless Internet user out of ten used a laptop (Korea Network Information Centre, 2003b).

Determinants of ICT diffusion

ICT uptake by households is not uniform, and many factors explain differences among households. This section focuses on selected demand-side factors. Some of the factors linked to the supply side, such as prices, competition and market structure, were analysed in OECD (2002), and the influence of price on the use of network infrastructure is analysed extensively in OECD (2003). Use of ICTs largely depends on the perceived value added that ICTs can provide, and this perceived value added is greatly influenced by the user's social and economic status. Selected determinants are investigated below.

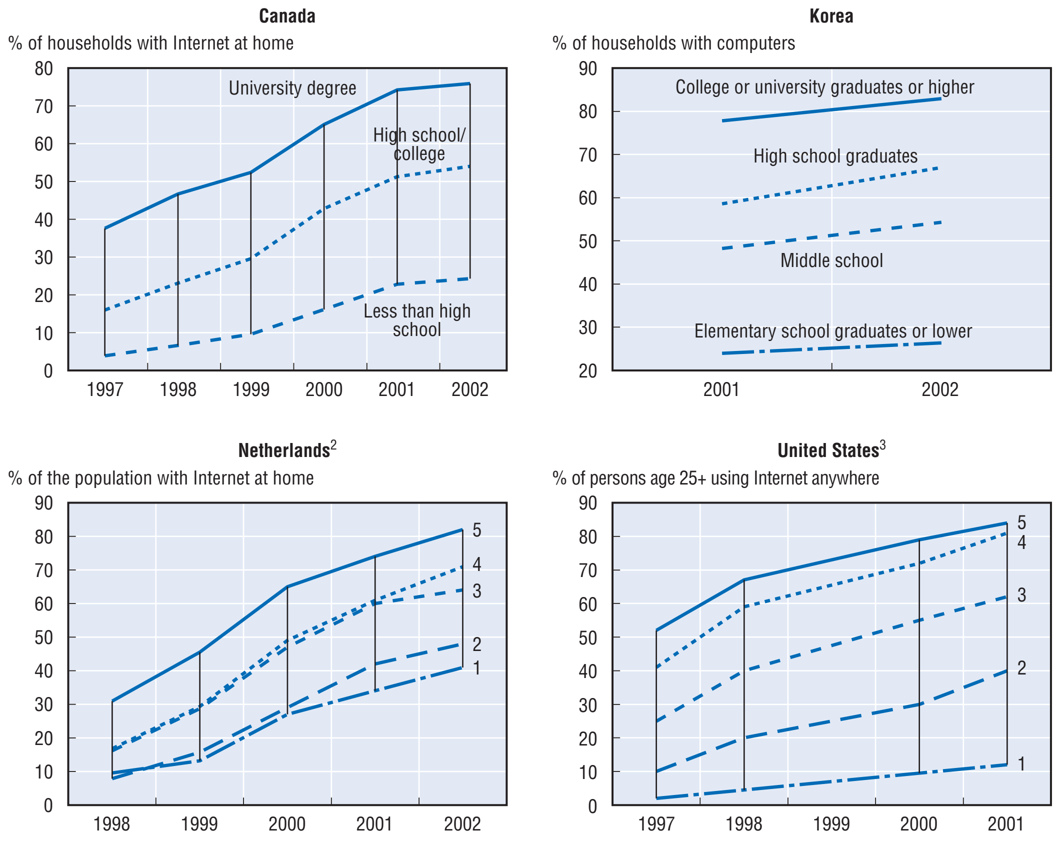
Household characteristics

Educational attainment

In all countries where this is measured, the educational attainment of the head of household – or the individual – is significantly and positively correlated with the level of connectedness (measured by access to or use of a PC or the Internet) and directly affects the dynamics of uptake (Figure 4.8). In Korea, despite the huge development of the Internet, a similar increasing gap in Internet use among adults was observed between 2000 and 2002 (Korea Network Information Centre, 2003a). In Germany, the educational attainment of the parents increases the likelihood that children will use the Internet. If the parents have primary or secondary level education, around 37% of the children use the Internet. If the parents have tertiary level education, the share rises to 52% (NFO Infratest, 2003, p. 195). The potential for a "two-class society" was also noted in a recent US study (Annie Casey Foundation, 2003).

In Nordic countries also access to the Internet at home systematically increases with level of education. The share of individuals with tertiary education accessing the Internet from home is between one-quarter and one-third higher than that for individuals with primary education level (Nordic Council of Ministers *et al.*, 2002). In addition, within income levels or age groups, the level of education is significantly

Figure 4.8. **ICT access or use by educational attainment in selected OECD countries**[1]



1. Levels of education, locations and populations (households or individuals) vary among the selected countries.
2. Levels of education: 1 = Primary education; 2 = Secondary education; 3 = Lower general secondary education; 4 = Senior, higher general secondary education/intermediate vocational education/pre-university school; 5 = Higher vocational education/university.
3. Levels of education: 1 = Less than high school; 2 = High school diploma / GED; 3 = Some college; 4 = Bachelor's degree; 5 = Beyond bachelor's degree.

Source: OECD, based on data from national statistical offices and from US Department of Commerce, 2002.

correlated with use of a computer and the Internet.. In the United States in 2001 educational attainment has a greater effect on Internet use than income levels: people with lower levels of education but living in households with high family incomes are less likely to be Internet users than those with high levels of education and living in households with low family income (US Department of Commerce, 2002). More recently, it has been found that for PC, Internet access and mobile phone use, educational level was the second most discriminating factor after occupation (CREDOC, 2002, 2003). (See also Frey, 2002 for Italy and Sciadas, 2003, and Dickinson and Sciadas, 1999 for Canada.)

Households with children

In Finland, France, the Netherlands and Canada, changes in household ICT uptake over the last decade have been significantly influenced by the presence of children. In spite of differences in the time period covered, the pattern of diffusion in families with or without children in France, the Netherlands and Australia shows that uptake is more rapid in families with children (Figure 4.9).

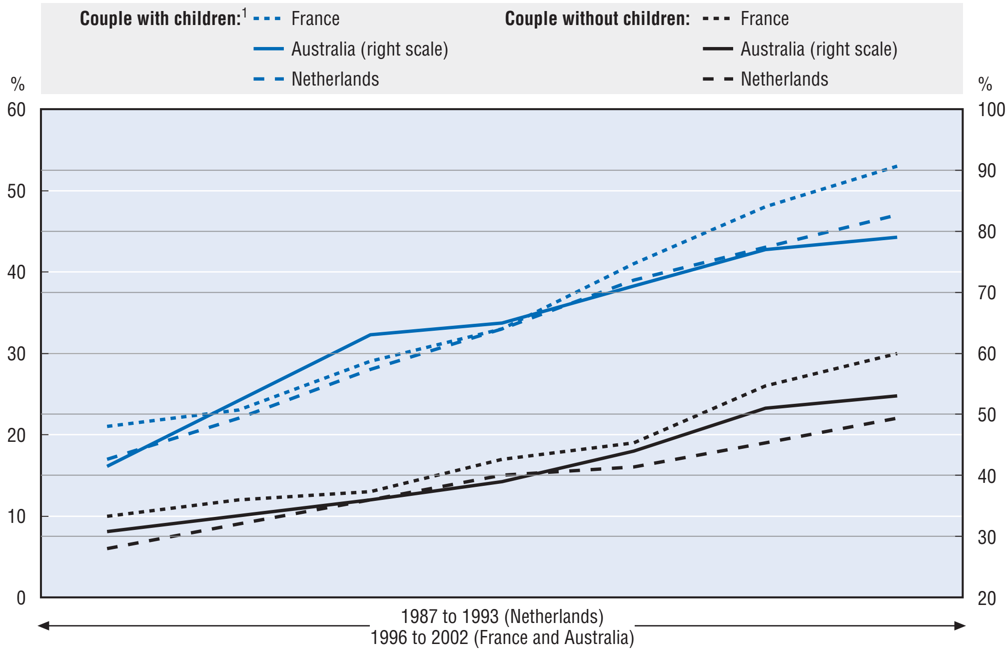
For Canada, the pattern is similar for Internet uptake, although diffusions is more rapid. The gap widens rapidly during the first five years and then stabilises and drops slightly (Figure 4.10).

In 2002, it was clear that the "child factor" systematically increased Internet access from home (Figure 4.11). However, as Dickinson and Ellison (2000) point out, the presence of children may be related to other household characteristics that are more important sources of the difference (for example, age groups).

Age

PCs and the Internet diffuse unevenly across age groups. At the outset, young people tend to be greater users than older people; while differences persist, they tend to weaken over time. Diffusion

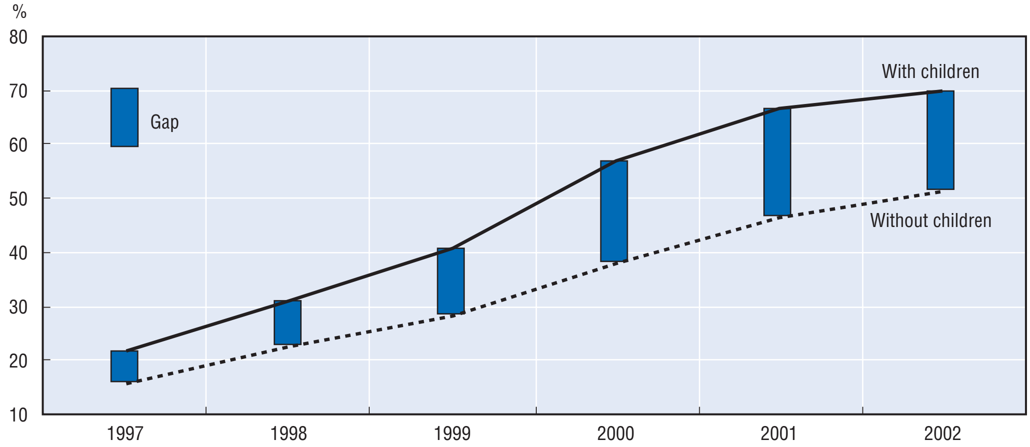
Figure 4.9. **PC uptake among individuals with or without children in Australia, France and Netherlands**



1. With one child for France.

Source: OECD, based on data from Australian Bureau of Statistics (ABS), Central Bureau of Statistics (CBS) and INSEE, October 2003.

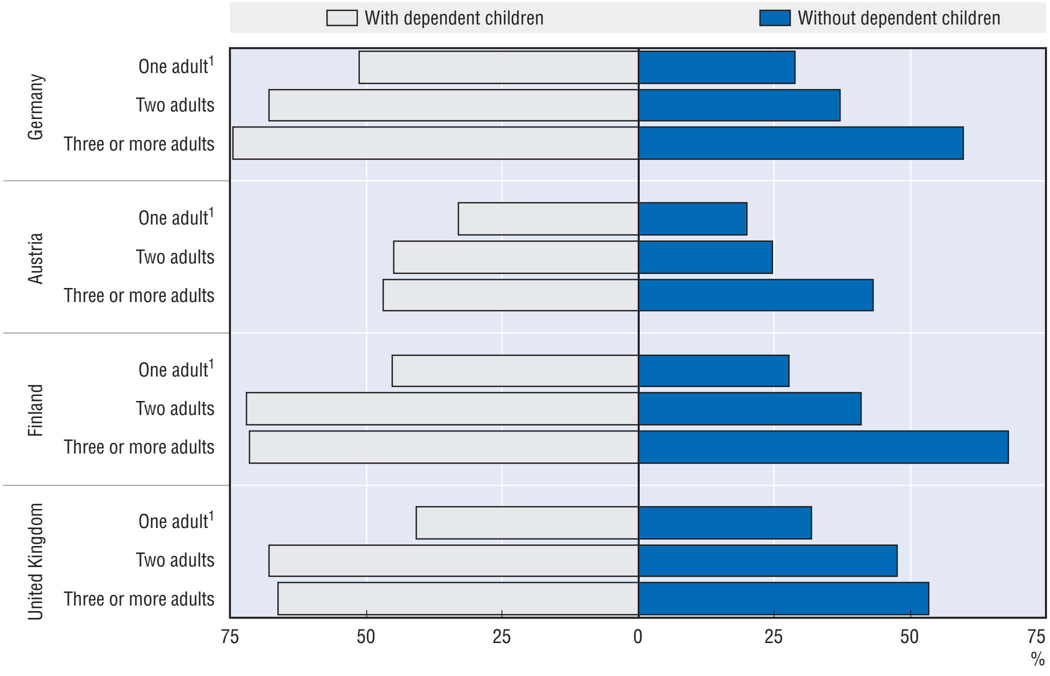
Figure 4.10. **Internet uptake in Canadian households with or without children, 1997-2002**



Source: OECD, based on Statistics Canada, October 2003.

of both PCs and the Internet has been notably more rapid among younger generations (Figure 4.12). Similar pattern are observed in Canada, France, Korea, Japan, the United Kingdom and the United States.

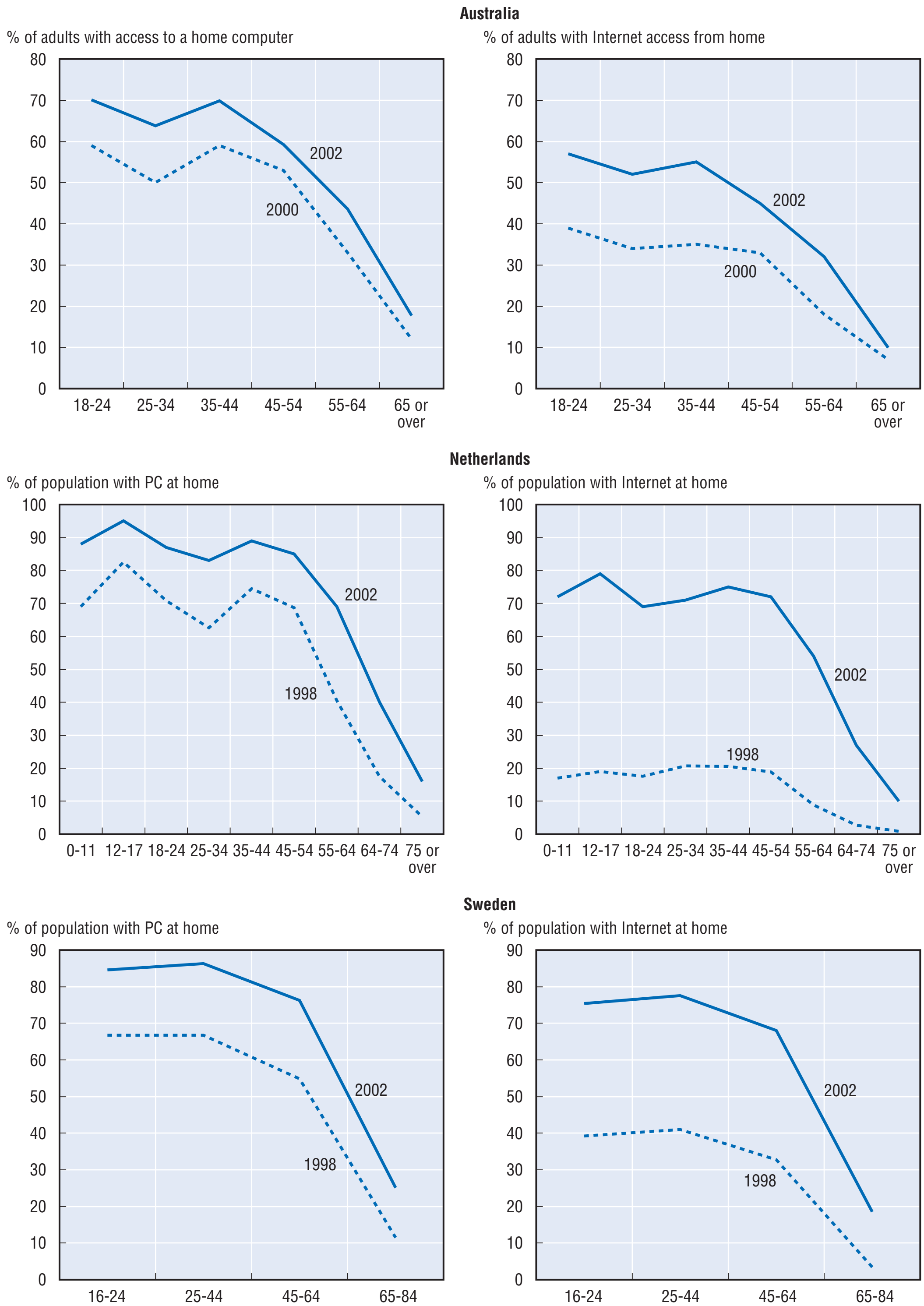
Figure 4.11. **Household Internet access by household size and dependent children, 2002**



1. Single parent with dependant children, or one adult without children.
Source: Eurostat, Community Survey on Household Use of ICT 2002, June 2003.

Figure 4.12. **ICT access by age in selected OECD countries**

As percentage of the population[1]



1. Age cut-offs vary.

Source: OECD, based on data from national statistical offices.

Box 4.1. Ageing populations and ICTs

With populations ageing in all OECD countries, the issues of how long people will be required to work and whether they will be able to cope with new technologies is of increasing importance for future growth and employment. Compared to younger generations, the rate of diffusion of computers and Internet among older people is lower. As shown in the figure below, most countries observe a marked break after the age of 60-65. While the age bracket immediately before 60-65 is close to the average, later brackets fall considerably below average.

Beyond diffusion, Internet usage patterns provide additional insight into whether there is a technological divide with respect to age. A Belgian survey in 2002 showed that the daily usage is evenly distributed across age categories of users, with those over 60 making greater than average use, possibly because of time availability (FTU, 2003). Similar results were found in a 2003 French study; among Internet users, the 65+ age group spend the most time on the Internet (7.5 hours a week on average, against 5.5 hours for those aged 15-24) (Fontaine and Pernet, 2003). This contrasts with Canadian data for 2000, where older users who had used the Internet during the previous month from any location spent an average of 5.7 hours the previous week, compared to 8.3 hours for those aged 15-59 (Silver, 2001). However as older age groups become more familiar with the Internet, they may now use it more.

The socio-economic situation of older people also plays a very strong role. In Belgium in 2002, among those aged 60 or more, the share of Internet users is twice as high among those who are still working (15% *vs.* 8%), and educational attainment is also an important determinant: 20% of the 60+ group with a secondary or tertiary education are Internet users, 8% of those with low secondary education and only 4% of those with primary or no diploma. Among older people, the computer or the Internet can be mastered with experience gained in working life or leisure activities, or with help from friends or children (FTU, 2003).

The on-line behaviour of older people suggests some similarities and some differences in use of the Internet across age groups. In Finland, for example, all age groups use e-mail, information search and surfing, as well as banking and other financial services (Nurmela and Ylitalo, 2003). In Canada in 2000, most surfing by older Internet users was for personal interest or entertainment, with a ranking by categories of content and services similar to that of younger people. Almost all older Canadians use e-mail to maintain ties with family and friends (Silver, 2001).

In the United States in 2001, people over 55 were likely to use e-mail and had a significantly higher propensity (42.7%) than any other age group to check health information on line (US Department of Commerce, 2002). However they were least likely to use the Internet to play games, search for a job, participate in chat rooms, view television or movies or listen to the radio, or to trade. Similarly, in Norway in 2003, people aged 65-74, like younger age groups, use the Internet for communication, information search and on line services but were noticeably less inclined to purchase, bank on line or interact with public authorities (Statistics Norway, 2003).

Overall the use of ICTs by older people appears to be strongly marked by age of retirement from the workforce and by educational attainment. Once on line, their patterns of use are similar to, or more intense than, those of younger age groups, except for lower propensities to purchase and use the Internet for entertainment. This suggests that older age groups will not be handicapped by a technological divide as they work longer, provided that they have the educational background to take advantage of new technologies.

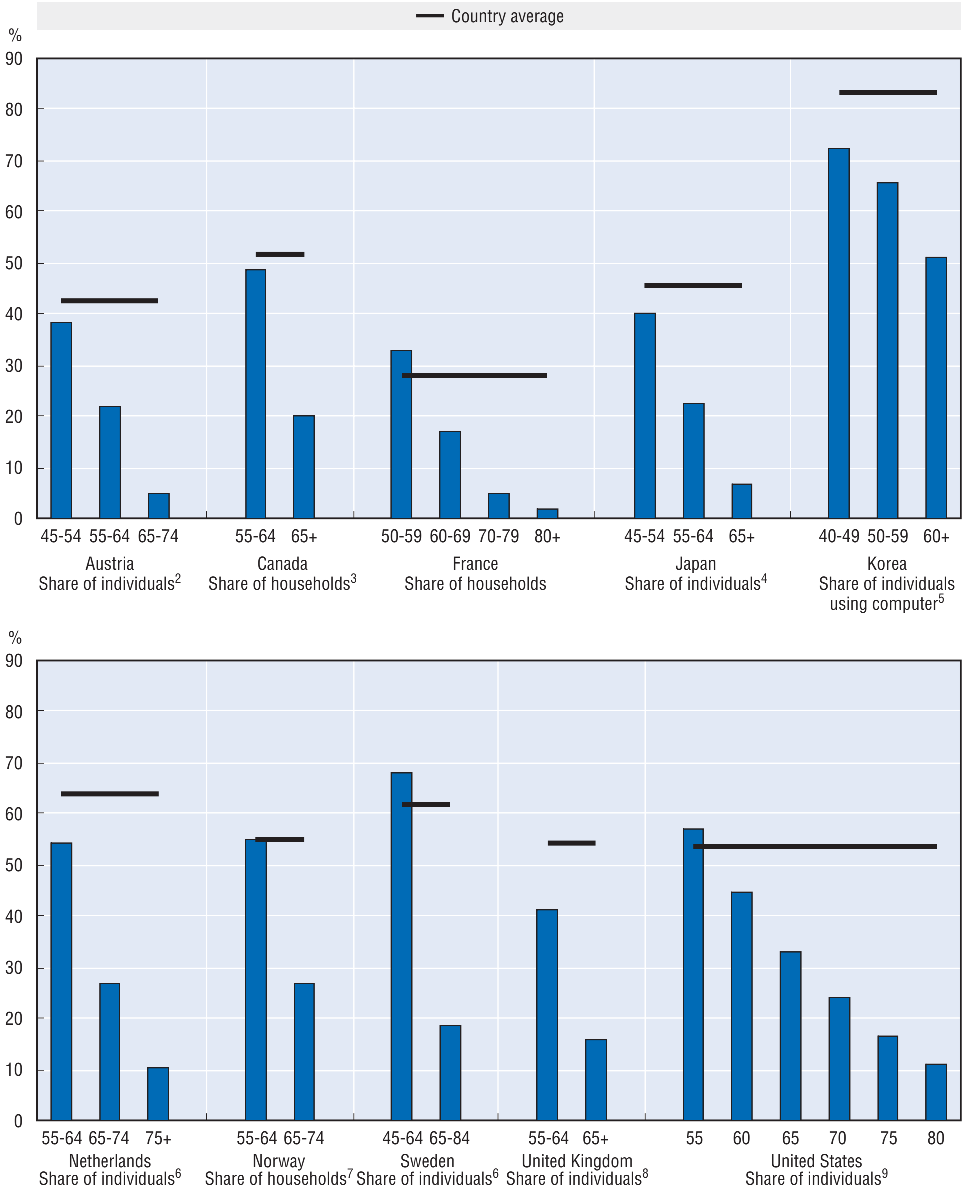
Gender

In all OECD countries for which data are available, men make greater use of the Internet than women. The gap appears to be largest in Switzerland. Male usage is higher than female in the early stages of adoption and differences seem less marked among the youngest generations. Over time, the Internet gender gap has disappeared in the United States, declined in the United Kingdom, Korea and Australia and remained stable in Sweden (Figures 4.13 and 4.14).

Box 4.1. **Ageing populations and ICTs** (*cont.*)

Figure Box 4.1. **Internet access or diffusion pattern in oldest age groups, selected OECD countries, 2003**[1]

Percentages of individuals, households or computer users

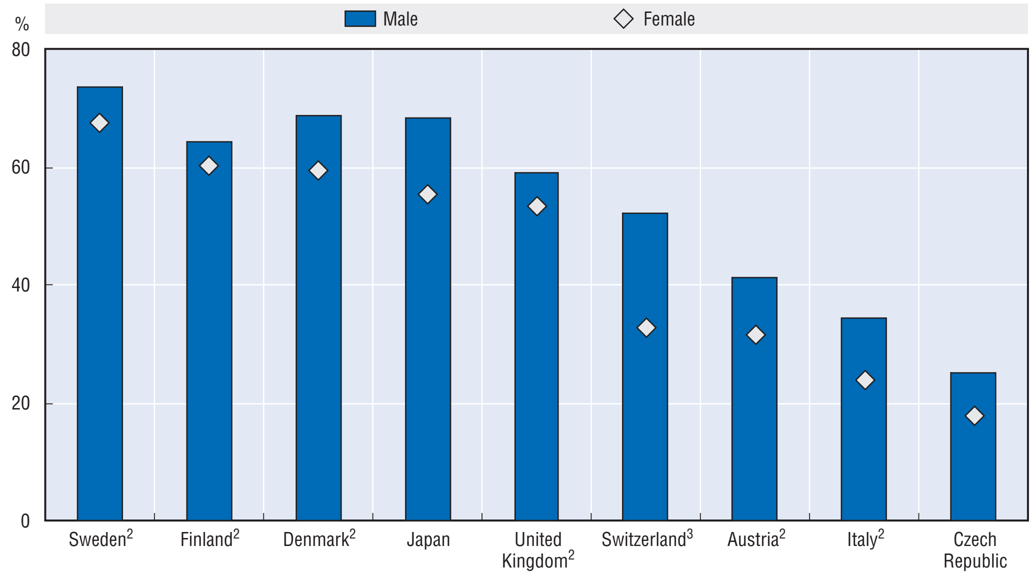


1. Or latest available year.
2. People having used the Internet between March 2002 and March 2003.
3. Percentage of households with Internet at home (regular use from home) in 2002.
4. 2001. From MPHPT, *Survey on Time Use and Leisure Activities for Japan,* 2001.
5. 2002. Persons using the Internet more than one hour a week, as a percentage of computer users.
6. 2002. Percentage of the population with Internet at home.
7. Second quarter 2003.
8. Percentage of adults who used the Internet in the three months prior to interview, April 2003.
9. Persons using the Internet for the selected ages (centred 3-year moving average).

Source: OECD, based on data from national statistical offices.

Figure 4.13. **Individuals[1] using the Internet from any location by gender, 2002**

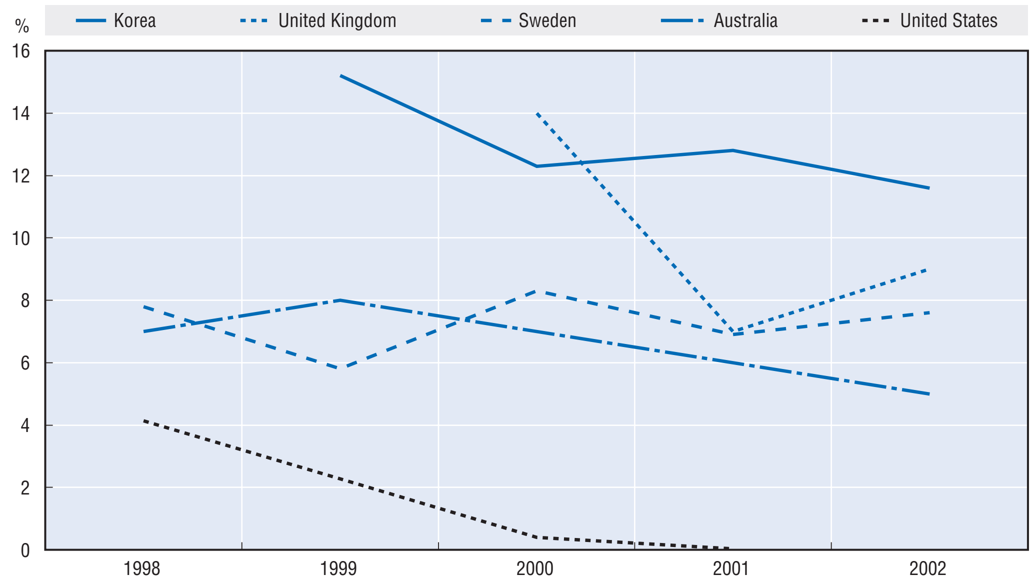
Percentage of individuals by gender



1. Age cut-off: 16 years and older except for Finland (15+), Italy (11+), and Austria (6+).
2. First quarter 2002.
3. October 2001-March 2002.

Source: OECD, ICT database and Eurostat, Community Survey on ICT usage in households 2002, June 2003.

Figure 4.14. **Evolution of Internet gender gap in selected countries, 1998-2002[1]**



1. Differences in percentage points between male and female Internet use/access; individual home access in Sweden, Internet use from any location in the other countries.

Source: OECD, from national statistical offices and the Korean Network Information Centre.

Influence of PC and Internet use at work or in the working environment on home use

Workers increasingly use PCs and the Internet in their everyday working life. Those accessing the Internet from the workplace are increasing in absolute numbers and vary from around one-third of adult Internet users (Australia, Canada) to more than 45% (United Kingdom). In France, among people who use a PC at work every day, one out of two also uses the Internet daily, and only two out of ten never use it. In Austria, around 55% of employees were using a computer at work in 2001, and around one-third had access to a computer with an Internet connection (Statistics Austria, 2003a).

Overall, the workplace has played a significant role in the diffusion of home Internet usage, and use of a PC and the Internet at the workplace remains a significant factor in being connected at home. A recent survey in France indicates that exposure in the workplace makes an individual substantially more likely to use a computer and the Internet at home. This suggests that diffusion of ICT at work, which began earlier and is now very widespread, plays a role in the learning process by which people adopt ICTs at home and know how they use them.[3] It has also been observed in France that ICT use at work reinforces both autonomy and internal and external communication tasks (Greenan *et al.*, 2003), especially among blue-collar workers (both low-and high-skill). The use of computers in the working environment depends both on the nature of tasks and professional status but also on the cultural and educational assets of users (Cézard *et al.*, 2000). In Finland as well, it has been noted that PC usage differs depending on the kind of work, the sector, and the level of digital literacy, and this can affect the use of ICTs in private life (Statistics Finland, 2001). Chapter 6 investigates in greater depth how ICT skills, at different levels of complexity, are used in the economy, and how industrial sectors can be characterised according to their share of ICT-skilled employment.

Employment thus plays a not unimportant role in household connectedness. In the United States, for example, participation in the workforce plays a significant role in the decision to go on line or not. As Table 4.2 shows, those who are employed are almost three times more likely to consider being connected in future than retired non-Internet users. In the United States, household Internet access is also significantly affected by Internet use at work by a member of the household, and this was particularly important for low-income and low-education groups (Table 4.3). Moreover, between 1997 and 2001, the gap in Internet use between employed and unemployed increased.

As of March 2003 in Austria, three-quarters of employed people had used a computer but only 38% of the unemployed. For Internet use during the previous year (March 2002-March 2003), the shares were 55% and 19%, respectively. Among older people (60+) in Canada, being unemployed has been negatively related to Internet use over time (Silver, 2001). Similarly, the diffusion of PCs in Japanese households clearly follows employment status (Figure 4.15).

Patterns of Internet use

Beyond simple access, patterns of use offer ways to understand how ICTs are adopted and integrated into society.

Table 4.2. **Workforce participation and future Internet use in the United States, March-May 2002**
Percentage of each demographic group of non-users who say they will or will not go online

	Will go on line	Will not go on line
Employed full time	54	43
Employed part time	55	40
Retired	19	76
Disabled	27	65

Note: Numbers for each demographic category may not add up to 100% because of non response.
Source: Lenhart, 2003.

Table 4.3. **Influence of levels of income and education on Internet access in the United States, 2001**

Percentage of households with Internet access

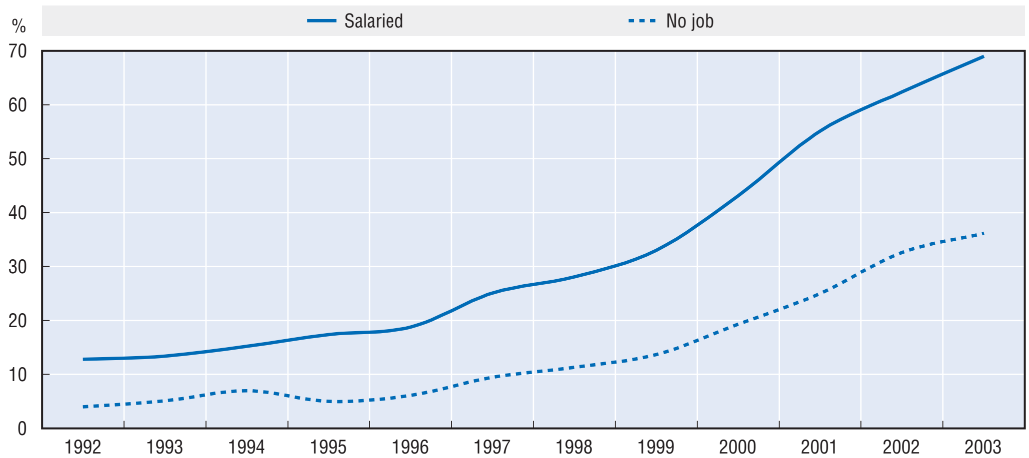
	All	Income[1]		Education level[2]	
		Lowest	Highest	Lowest	Highest
All households	50.5				
One member of the household with Internet access at work					
Yes	76.8	57.2	89.7	54.2	85.6
No	34.8	14.8	72.9	14.5	61.7
Difference	42.0	42.4	16.8	39.7	23.9

1. Lowest: yearly income under USD 15 000; highest: over USD 75 000.
2. Lowest: less than high school; highest: beyond college.

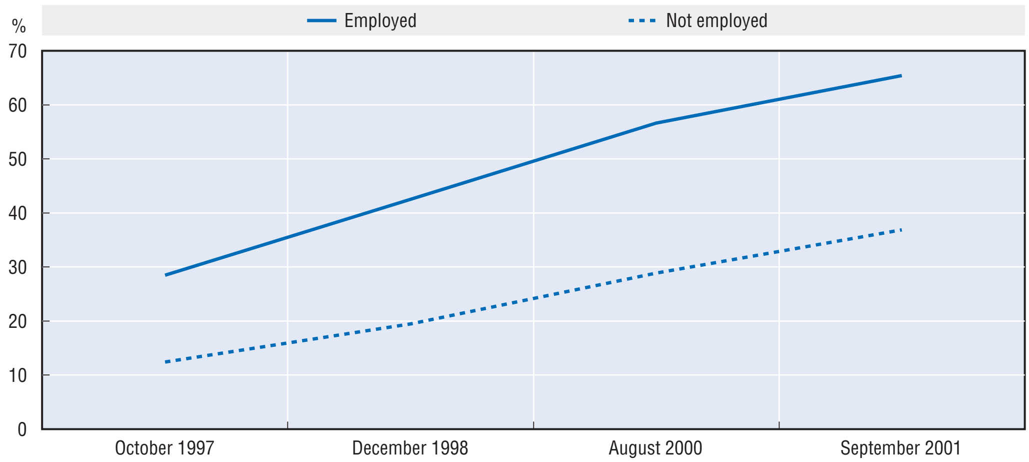
Source: OECD, based on data from A Nation Online, US Department of Commerce, 2002.

Figure 4.15. **PC and Internet diffusion and use in the United States and Japan, by employment status**

PC diffusion in Japan, 1992-2003



Internet use in United States, 1997-2001



Source: US Department of Commerce, 2002, and Economic Planning Agency (Japan).

Location and frequency

The home is now the first location for accessing the Internet, followed by the workplace. In 2001 in the United States, 43% of the population used the Internet from home and 5.8% from another person's home, 19.6% from work and 11.9% from school (US Department of Commerce, 2002). In the United Kingdom, adults increasingly access the Internet from their own home rather than another person's and work is the next location (Table 4.4). In New Zealand between 2000 and 2002, home was again the primary location, followed by friends or relatives, with the workplace in third place.[4] In Korea, eight out of ten Internet users use the Internet at home, followed by the workplace (one out of seven) (Korean Network Information Centre, 2003). In Australia Internet use among adults almost doubled between 1998 and 2002, and home is now the preferred site for access; work was the first choice at the beginning of the period (Table 4.5), a trend confirmed in Canada (Table 4.6).

Frequency of use is influenced by place of use. In the Netherlands almost one-third of the working population uses the Internet on a daily basis, and only one in ten uses it on a weekly basis (Table 4.7). If more than one-quarter of the overall population uses Internet from home on a daily basis, more than one in three does so on a weekly basis. Thus while a smaller proportion of the working population than the total population uses the Internet, they use it more regularly. Access is also more dispersed and less regular from educational institutions than from work, with regularity of access relatively stable despite a significant increase in overall Internet usage.[5]

Table 4.4. **Locations used by adults to access the Internet for personal use in the United Kingdom, 2000-03[1]**

Percentage of all adult users

	2000	2001	2002	2003
Own home	77	84	85	82
Respondent's workplace	41	40	42	45
Another person's home	33	28	34	24
Place of education[2]	21	19	28	17
Public library	. .	10	13	10
Internet café/shop	9	11	15	8

1. October of each year, except April for 2003. The questions used to derive the estimates to February 2003 asked respondents which places of access they had ever used for personal and private use. The figures presented for this time period are restricted to those who had used the Internet in the previous three months for personal and private use. Up to October 2001 data exclude adults who have never worked. From April 2003 data refer to the mode of access for adults who have used the Internet for general use in the previous three months.
2. Up to February 2003 place of education was spilt into two categories: "a school" and "a college, university or other educational or training institution". For April 2003 no distinction is made.

Source: Office of National Statistics, National Statistics Omnibus Survey.

Table 4.5. **Adults' Internet use by site[1] in Australia, 1998-2002**

Percentage of all adults

	1998	1999	2000	2001	2002
Home	13	18	29	38	43
Work	14	20	23	27	30
Other locations					
of which:	16	23	22	25	25
Neighbour, friend or relative's home	8	12	13	16	22
Public library	3	6	5	6	6
TAFE[2] or tertiary institution	6	8	7	6	8
Cybercafé	. .	. .	4	6	7
Any location	31	41	46	54	58

1. More than one site may be named.
2. Technical and further education. This is an educational institution in Australia.

Source: ABS, 2003.

Table 4.6. **Household Internet use,[1] by location of use in Canada, 1997-2002**
Percentage of all households regularly using the Internet from various locations

	1997	1998	1999	2000	2001	2002
Home	16	22.6	28.7	40.1	48.7	51.4
Work	19.9	23.3	21.9	27.5	32.6	34.2
School	9.3	12.1	14.9	19.2	22.2	22.9
Public library	3.7	4.3	4.5	6.5	7.9	8.2
Other locations	2.8	2.6	3.9	3.2	9.6	10.4
Any location[2]	29	35.9	41.8	51.3	60.2	61.6

1. Percentage of all households regularly using the Internet from various locations.
2. Any location includes use from home, school, work, public library or other and designates a household as only using once, irrespective of use from multiple locations.

Source: Statistics Canada, Household Internet Use Survey.

Table 4.7. **Frequency[1] of Internet use by location in the Netherlands, 2002**

	At home		At work		At an educational institution (like university)	
	% of population[2]		% of working population[3]		% of people who receive education	
	2001	2002	2001	2002	2001	2002
Using the Internet	47	77	36	47	28	33
of which						
Daily/every working day	35	36	67	66	18	21
Once a week	57	50	28	26	65	56
Once a month	8	14	4	9	18	24

1. During the four week period prior to the research.
2. Population 12 years or more.
3. Working population age 15 or more (to age 65 and working for at least 12 hours a week).

Source: Statistics Netherlands, POLS 2002.

At the beginning of 2003, more than four out of ten Finns used the Internet weekly from home; for almost the same share, it is now a daily activity from one location or another. People have also progressively realised the potential of the Internet, as shown by the increasing share that use it for purposes other than e-mail. Nevertheless, after an initial period of strong growth, the share of those using the Internet on a daily basis seems to level off (Table 4.8).

Table 4.8. **Frequency of Internet use in Finland, 1996-2003**

	% of population aged 15-75							
	Oct.-Nov. of each year, except for 2003 Jan.-Feb.							
	1996	1997	1998	1999	2000	2001	2002	2003
Internet use…								
Sometimes	19.6	29.0	38.5	50.6	59.1	66.5	70.4	71.5
At least once a week	10.9	18.4	28.1	38.3	47.2	54.2	57.6	58.4
Daily basis	4.5	8.1	13.2	17.4	26.5	34.8	36.6	37.6
Weekly from home	4.7	7.6	13.9	21.4	30.2	36.8	41.0	43.5
Weekly from workplace	5.3	8.1	13.2	17.4	22.7	27.0	29.4	28.8
Weekly from place of study	4.8	7.0	8.5	9.0	8.5	9.3	10.6	10.5
For purposes other than e mail	17.6	24.9	33.9	43.0	53.8	60.5	64.8	67.0

Source: Taloustutkimus Oy, Internet Tracking Survey.

Recent developments

Across a wide range of OECD countries and age groups, e-mail and information search on products and services are the most common activities (Figure 4.16). Next come in decreasing order of use: reading/downloading news sources, playing/downloading games and music, banking services (where available), and purchasing goods and services, although in Korea, for example, around 70% of people using the Internet use on-line banking services, not far behind e-mail use (85%).

The Internet is clearly becoming an information medium in everyday life and is significantly and increasingly used to search for information (not only on goods and services but also from newspapers, journals, etc.). For instance in Japan, it is among the most frequently used information sources and is in the first rank for product or health information and in the second rank for emergency information (MPHPT, 2003). In the United Kingdom in February 2003, among those who had accessed the Internet for private use, nearly eight in ten adults (compared with seven in ten in July 2000) used the Internet to find information about goods or services. In Italy in 2000, six out of ten persons using the Internet used it to get information from newspapers or journals (ISTAT, 2002). In Austria, the most recent data confirm that communication via e-mail is the favourite private activity on the Internet, followed by finding information about goods and services, and reading and downloading newspapers and news magazines (Statistics Austria, 2003b). However, after a period of strong growth, interest in the Internet as a new information medium may be waning. In Norway in 2002 people used the Internet no more than in the previous year.[6]

A comparison of Internet use in Japan between a personal computer and a mobile phone/PHS reveals some interesting differences. With the PC, use is principally for e-mail, information search and news/weather forecast. From mobile/PHS phones, e-mail is even more dominant, followed by download of music, in particular ringing melodies that are specific to mobile phones. Content purchase is in third position, at a much higher level than for PCs, suggesting that mobile phones are more frequently used than PCs for payments (Figure 4.17).

The adoption of broadband Internet access strongly affects usage patterns, in terms not only of activity (type of use) but also in terms of intensity (frequency and volume of information exchanged). In 2002, for example, for all of the most popular Internet activities, broadband users in the United States spent more time on line than telephone modem users. The increased use has the greatest relative effect on use for professional work, followed by instant messaging and e-mail. In terms of absolute time spent, broadband has the greatest effect on downloading of music (Figure 4.18). In addition, broadband users consider the Internet an important source of information to a greater extent than telephone modem users. Recent developments on specific peer-to-peer file sharing activities in various OECD countries are outlined in Chapter 5.

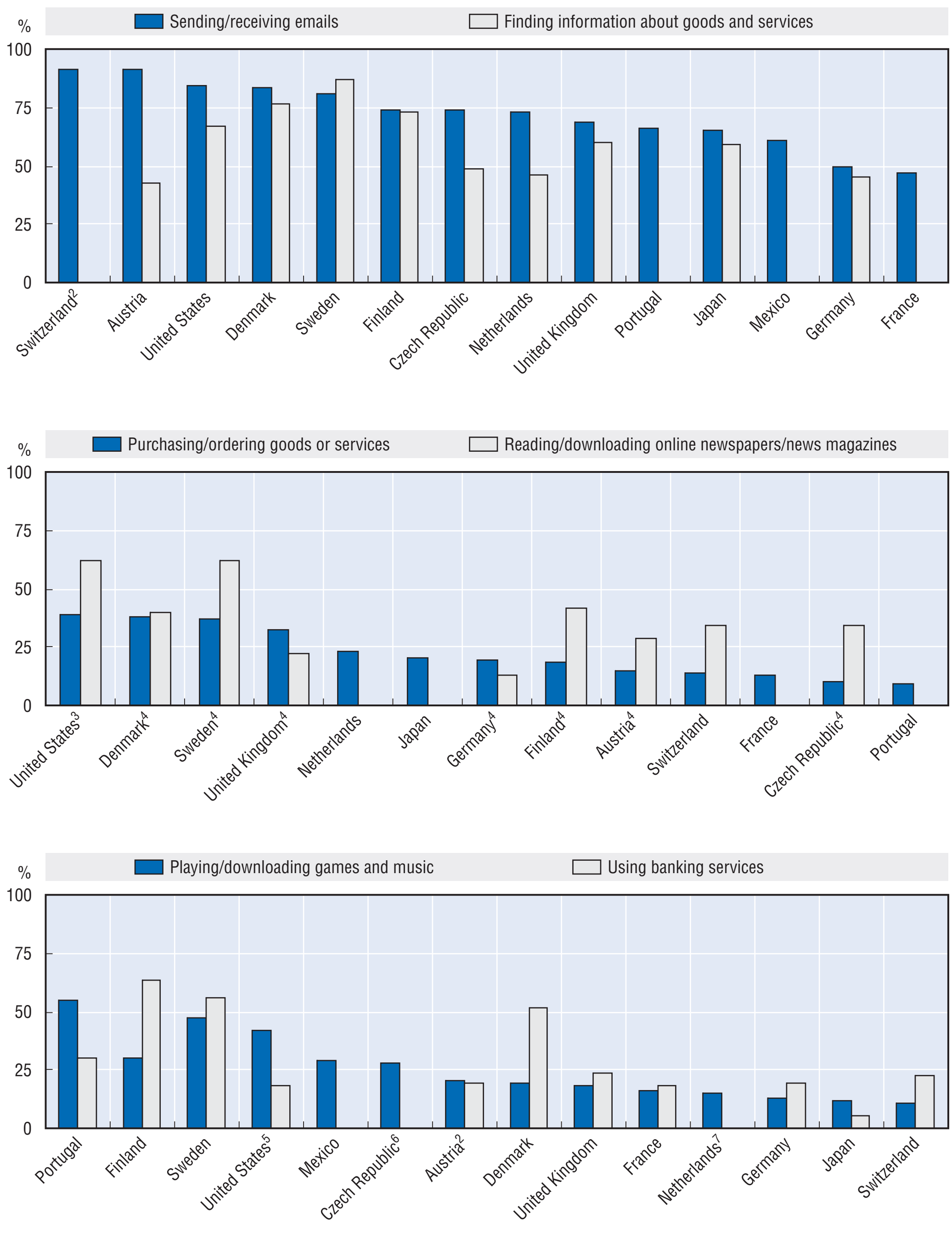
Similarly, Japanese broadband users show a higher rate of Internet use for all purposes than narrowband users. The differences are most marked for downloading and viewing/listening activities related to music, pictures and videos (Figure 4.19). In France as well, broadband users use all available services more often (Fontaine and Pernet, 2003). The greatest difference between French narrowband and broadband users concerns downloading. Use for information search on products and for relations with administrative bodies is also greater for broadband connections (Figure 4.20).

Over time, use of the Internet shifts gradually from general to more specific areas and towards greater interactivity between providers and users of information. In the United Kingdom, general browsing and surfing have diminished significantly, and activities such as "buying/ordering tickets/goods/services", "finding information about goods/services or education", or "personal banking/financial/investment activities" have proportionally increased. In Canada, as the number of broadband users rises, the most rapidly growing use of Internet by households is e-banking and government information (Figure 4.21). E-mail remains one of the main uses of the Internet in the Netherlands, after information search and surfing. E-shopping and other activities, such as chatting, have increased since 2000 (Figure 4.22).

A significant and increasing share of Internet users browse for goods or services without ordering or paying over the Internet. They gather information (check prices, compare products, etc.) in preparation

Figure 4.16. **Internet use by type of activity, 2002 or latest available year**[1]

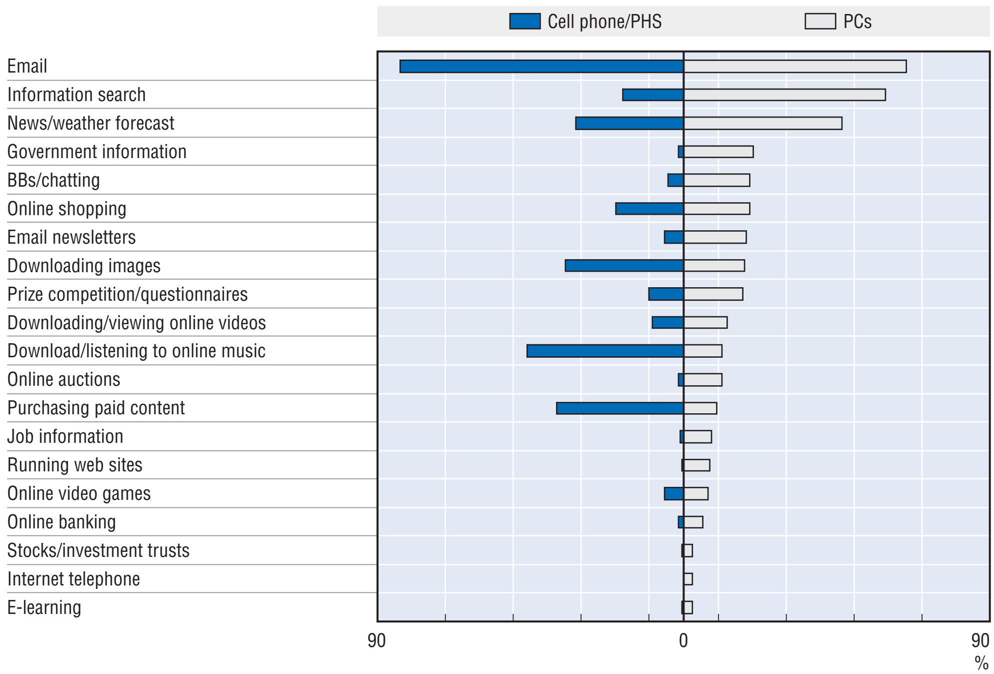
Percentage of individuals using the Internet



1. 2001 for France, Mexico, Netherlands, Portugal, Switzerland and the United States. Beginning of 2002 for Austria, Denmark, Finland, Germany, Sweden, the United Kingdom, and 2002 for Japan.
2. Only sending e-mails instead of sending and receiving e-mails.
3. Reading/downloading newspapers also includes movies.
4. Purchasing/ordering goods or services excludes shares/financial services.
5. Playing games only instead of downloading games and music.
6. Banking services relate to year 2003 (Czech Statistical Office Survey).
7. Downloading music only instead of games and music.

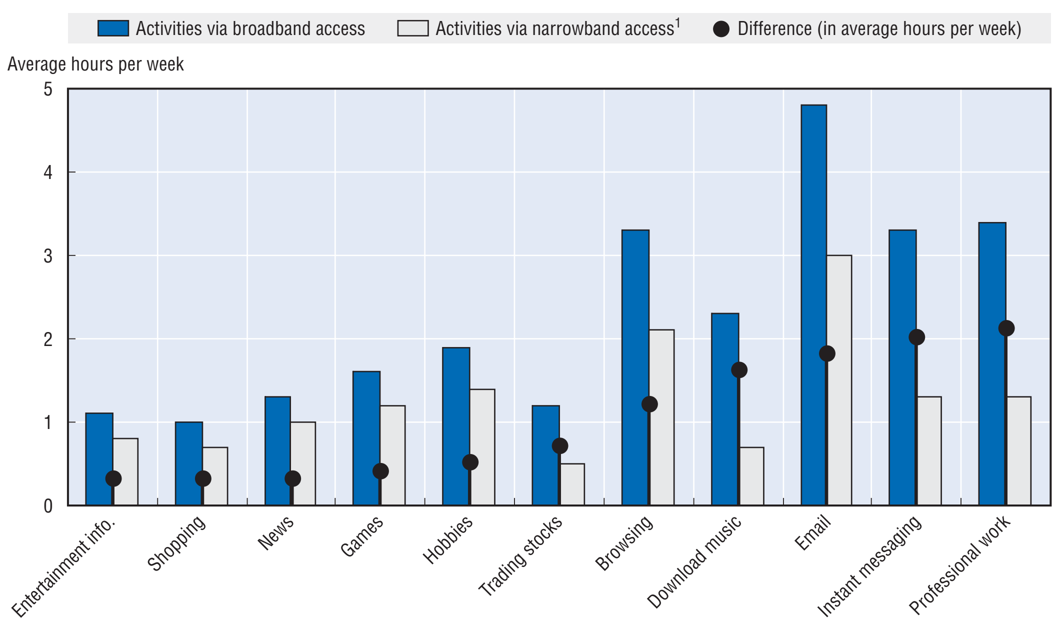
Source: OECD, ICT database and Eurostat, Community Survey on ICT usage in households 2002, June 2003.

Figure 4.17. **Purpose of Internet use from PCs and mobile phone/PHS[1] in Japan, 2002**



1. Personal handyphone system.
Source: MPHPT, Communication Usage Trend Survey in 2002.

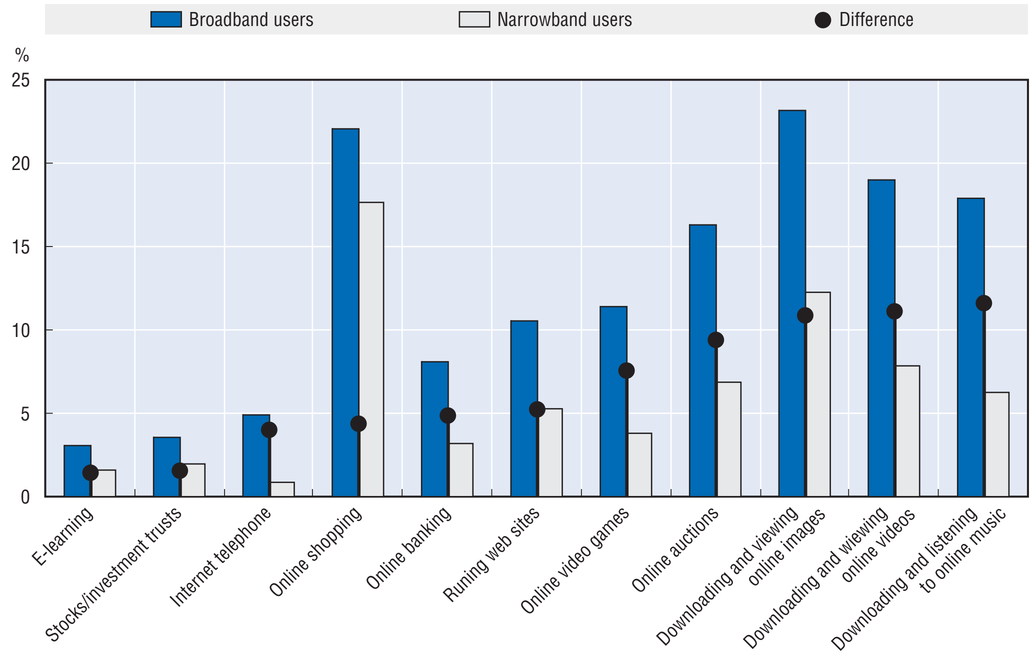
Figure 4.18. **On-line activities: narrow[1] and broadband access in United States, 2002**



1. Narrowband equals on-line activities via a telephone modem.
Source: The UCLA Internet Report, 2003.

Figure 4.19. **arrow and broadband Internet users by purpose in Japan, 2002**

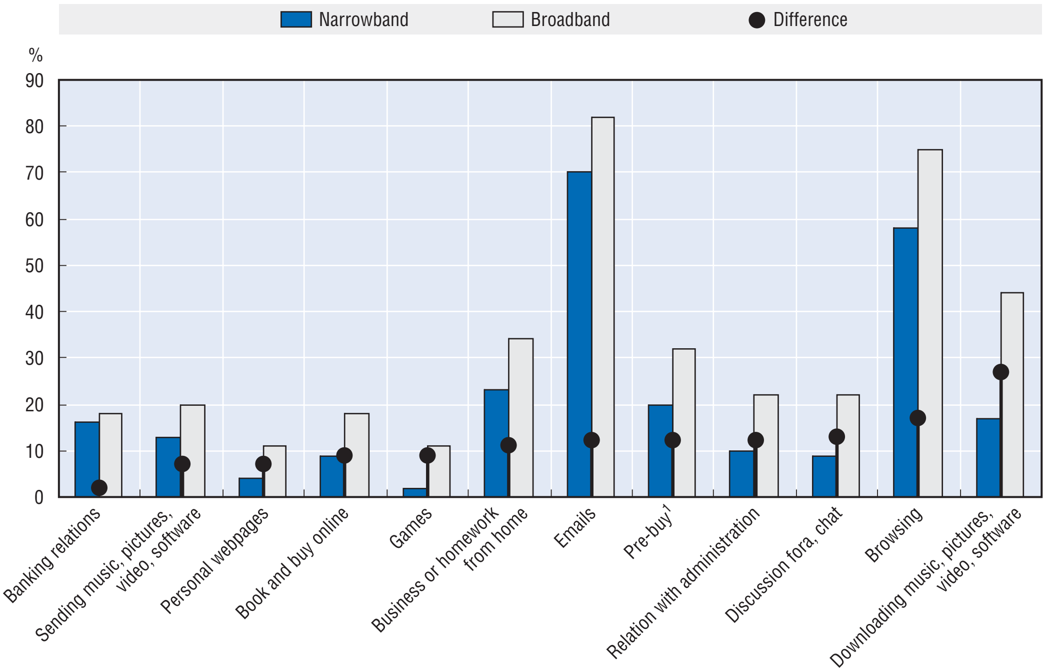
Percentage of respondents



Source: MPHPT, Communication Usage Trend Survey in 2002.

Figure 4.20. **Narrow and broadband Internet users by purpose in France, 2003**

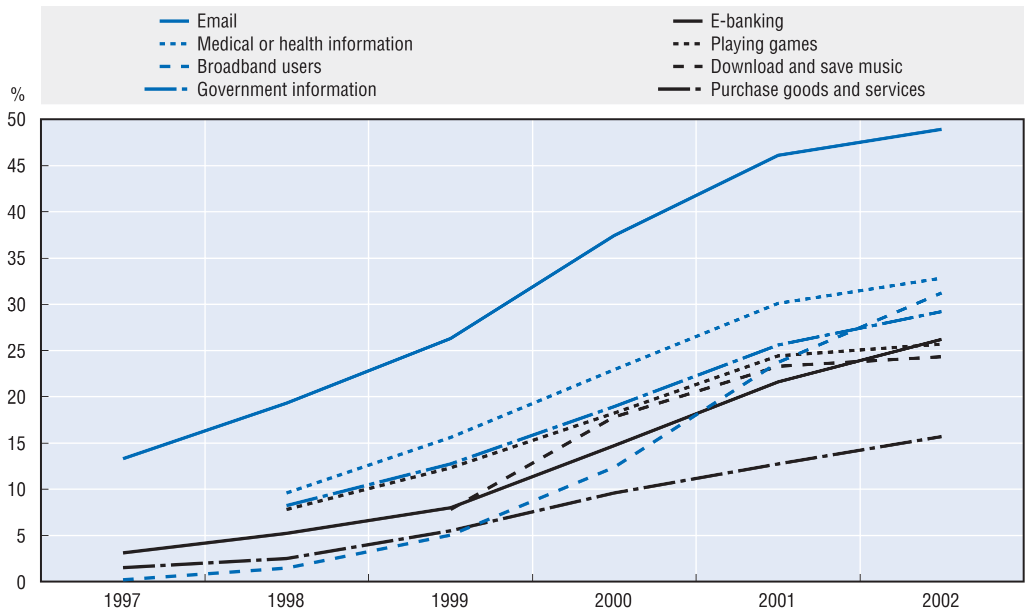
Percentage of individuals using the Internet frequently from home



1. Get information before going to a bricks-and-mortar shop.

Source: Fontaine and Pernet, 2003.

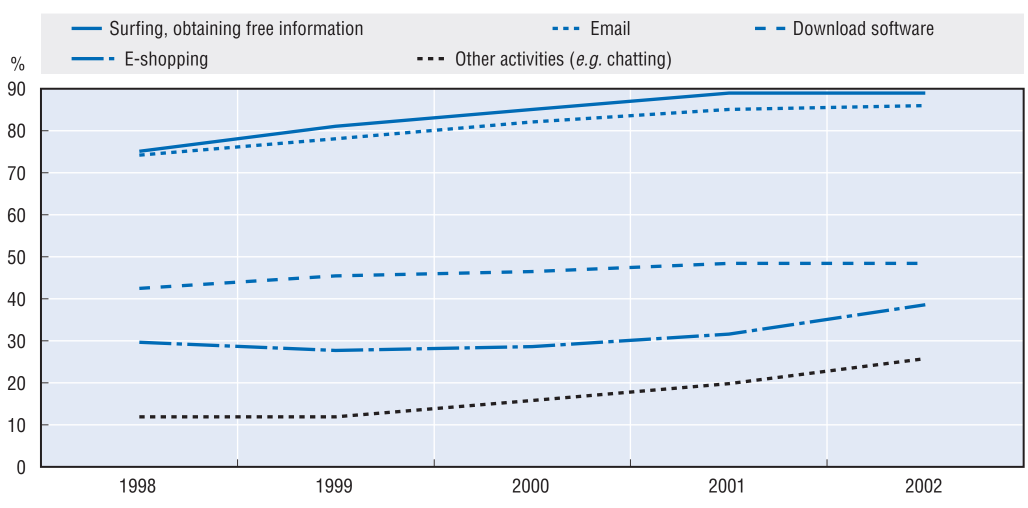
Figure 4.21. **Broadband diffusion and use of the Internet in Canadian households, 1997-2002**
Percentage of all households



Source: OECD estimates and Statistics Canada.

for an off-line purchase. In Canada in 2002, around 14% of households practised such "window shopping" (Statistics Canada, 2003a). The goods and services primarily researched were household goods (furniture and appliances), clothing, jewellery and accessories, automotive products, consumer electronics and real estate. In France, window shopping was the third most important activity of Internet users in 2003 (Fontaine and Pernet, 2003).

Figure 4.22. **Use of the Internet by households in the Netherlands, 1998-2002**
Percentage of households with the Internet



Source: CBS Statline, October 2003.

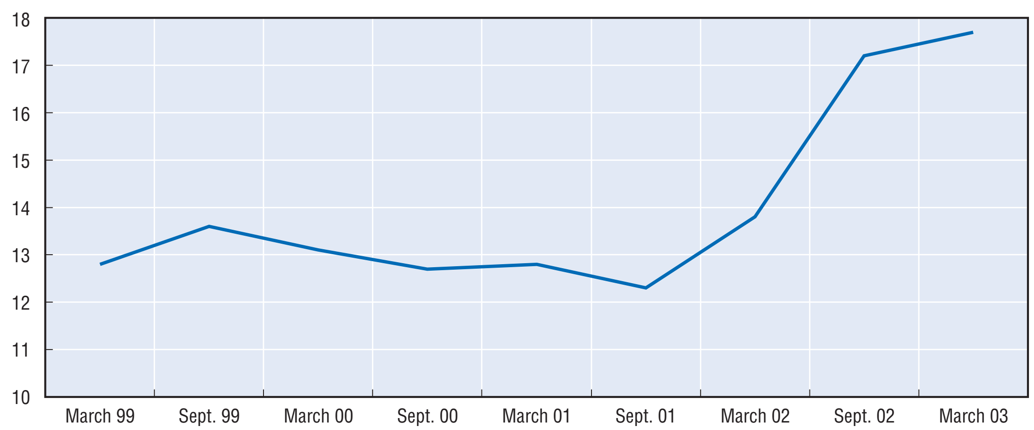
The results of a cross-country study of four European countries in 2001-02 (Denmark, France, Italy and the United Kingdom), illustrate differences in use among and within countries and over time, in terms of number of e-mails, clicks on banners and types of sites visited. Recreational and commercial uses are favoured in England, while a "practical" approach seems to be more common in Denmark (accessing public authorities, everyday life, banking and insurance), with France and Italy falling between these two. Changes over time also reveal differences that appear to be cultural in nature, such as use of auctions which has increased in England and decreased in France (Flacher, 2003). Where diffusion is less advanced (France, United Kingdom) usage seems to be less stable. Even if differences in technological infrastructures and devices are reduced, it is likely that the intensity of Internet use will differ substantially among countries and groups (Corrocher, 2002).

Internet use also depends upon existing patterns of consumption and time spent on traditional media. In Europe, Japan and the United States, television is in first place. Worldwide, television viewing increased between 2001 and 2002 by nine minutes a day on average, except in Norway, where it decreased slightly. In Japan, where the amount of time spent at home on the PC and on line significantly increased over 1999-2003 (Figure 4.23), people still devote more than four hours to TV in an average day. A recent French study notes that the time devoted to television[7] is decreasing among Internet users and that the decrease is more important among broadband users. It also points out that the consumers that are the most inclined to use ICT products and services are in a situation of "time crisis" which requires them to choose among the various services provided (Fontaine and Pernet, 2003). Similarly, a Finnish survey shows that both in 1999 and in 2002, not only was time spent on computer use at home often at the expense of time spent on other activities, but also that watching television was the activity that suffered the most (Nurmela and Ylitalo, 2003).

In the United States, adults increasingly report (one in four in 2001 and one in three in 2002) that children in their household watch less television since they began to use the Internet (UCLA, 2003). Details on use of leisure time suggest that Internet users are more active users of a variety of leisure activities than non-users except (marginally) watching TV. Between 2000 and 2002, they increased playing video or computer games and reduced their relative higher propensity to read – offline – newspapers (Table 4.9).

The use of the Internet for social networks and community use has also grown rapidly. In Korea, at the end of 2002, four Internet users out of ten are registered to community sites, mainly for personal relations and hobbies (Korea Network Information Centre, 2003a). The social importance of the Internet

Figure 4.23. **Monthly hours for using the PC at home to access the Internet in Japan, 1999-2003**



Source: NRI, Cyberlife Observation Survey, various years.

Table 4.9. **Influence of Internet use on leisure time use of media in the United States, 2000-02**
Per cent of respondents

	2000		2002		2002-2000 variation	
	Internet		Internet		Internet	
	Users	Non-users	Users	Non-users	Users	Non-users
Watching television	97.0	97.0	97.0	97.4	0.0	0.4
Listening to the radio	87.0	78.0	90.5	82.5	3.5	4.5
Reading Magazines	. .	. .	79.5	70.4	. .	. .
Reading Newspapers	89.0	83.0	81.9	81.3	–7.1	–1.7
Listening to recorded music	85.0	63.0	86.8	73.2	1.8	10.2
Playing video/computer games	23.0	8.0	35.5	12.5	12.5	4.5
Reading books	82.0	70.0	82.6	71.6	0.6	1.6

Source: OECD, based on data from *The* UCLA *Internet Report*, 2001 and 2003.

is also evident in innovative usages such as "weblog"[8] development, which is still small in scale but growing rapidly. The number of "webloggers" in the United States is estimated to have tripled to 3 million between May 2002 and May 2003 (Mayfield, 2003). The share of American adult users of the Internet who have created on-line content (publishing, responding to others, posting pictures, sharing files, etc.) has been estimated at 44% (Lenhart *et al.*, 2004)

Barriers to uptake

Factors affecting uptake include simple lack of interest (no need, no use) and barriers such as cost, skills, availability and convenience. Although lack of interest and barriers to use have declined as diffusion has increased, they remain important. In Australia, for example, the number of households stating they had no need of a computer has decreased significantly and computers are increasingly seen as useful, but one household out of five still expresses lack of interest, and the share has increased over time. An increasing share of households also state that they do not know how to use a computer. Perception of the utility of the Internet has increased very rapidly but around one-quarter of the population still lacks interest in it. The view of cost as a barrier has increased, possibly owing to price sensitivity in lower income groups. Accessing the Internet outside the home remains marginal (Table 4.10).

In Korea also, although the share of non-users of the Internet has declined (from 55.3% in December 2000 to 40.6% in December 2002), perceived barriers remain at a fairly high level. At the end

Table 4.10. **Reason why Australian households were without a PC or Internet access, 1998-2002**
Percentage of households

	1998	2000	2001	2002
Main reason why households were without a computer				
No need	37	36	30	23
Costs too high	26	24	28	26
Lack of interest in computers	20	23	24	26
Don't know how to use a computer	7	7	8	11
Access elsewhere	6	5	5	6
Main reason why households were without Internet access				
No use	. .	24	21	16
Costs too high	. .	19	24	26
Lack of interest in the Internet	. .	27	26	25
Access elsewhere	. .	6	6	7

Source: ABS, 2003.

of 2002, more than four out of ten non-users thought the Internet unnecessary and almost one out of three stated that they did not know how to use it, a share that increased from one out of four at the end of 2001. More than eight non-users out of ten were over 40 years old. The increase of "don't know how to use" may be directly linked to age (Korea Network Information Centre, 2003a). In Finland, for instance, the major factor for not having an Internet connection at home among younger households is access elsewhere, but in older households the most significant factor was lack of interest (Nurmela *et al.*, 2003, p. 56). In France in 2003, the main reasons provided by people for not buying a computer were lack of usefulness, cost and lack of competence. Again, people aged 65 or more gave lack of usefulness and competence as a reason for non-use, while cost was much less a factor. For those aged 15-24, cost was the primary factor; lack of usefulness and lack of competence were far less important (ministère de l'Économie, des Finances et de l'Industrie, 2003; CREDOC, 2003). In the United States in 2001, cost was the second reason for not being connected, but the main reason among lower-income households. Lack of knowledge or the possibility to use the Internet elsewhere were much less often mentioned (US Department of Commerce, 2002).

Finally, social acceptance and perceived utility of ICT use also play a role and varies among countries. Public policy can address this issue through measures affecting supply (price and quality) and demand (information, awareness, education). As has been pointed out (Selwyn, 2002), signs of the limitations on simple "universal access" strategies based solely on "public" ICT access sites are emerging.

Revisiting the digital divide

There are signs of a persistent albeit diminishing digital divide. The digital divide reflects economic and social factors such as infrastructure deployment ("readiness"), skills, training and knowledge, but also quality of life (Sciadas, 2003). ICT uptake in households and by individuals is due to a variety of factors which are not necessarily directly linked to ICTs. It has been noted in Finland that marginalisation due to ICT is not a phenomenon that is different from others types of marginalisation (Statistics Finland, 2003). In the United States in 2002, 52% of children and 42% of adults do not have access to the Internet at home (Annie E. Casey Foundation, 2003, p. 85; Lenhart, 2003). In Finland, in 2002, 10% of households with school childrendid not have a PC, and one-quarter of them did not have access to the Internet Nurmela *et al.*, 2003, p. 31). In Italy in 2000, almost four out of ten children aged 11-17 had never used a computer (ISTAT, 2002, Table 5.1, p. 70) and in France, in February 2003, one person out of five aged 15-24 is not interested in a PC or its use (ministère de l'Économie, des Finances et de l'Industrie, 2003, p. 5). In the Netherlands in 2001, 38% of the population had never used the Internet (De Haan, 2003, p. 35; CBS, 2003).

Many variables can be used to measure this divide. The preceding discussion has focused on educational attainment as an important factor in uptake and use, but owing to differences among educational systems and the available data, income is used for international comparisons. The analysis of Internet penetration by income raises some problems however, as income deciles or quartiles are not identical between periods, both in terms of nominal incomes, and of numbers of households or individuals (Sciadas, 2002b). Also, as Frey (2002) remarks, "to get a satisfying comparative analysis of the digital divide among different age groups of population, we need information over time on personal attitudes and behaviours, subjective evaluations of the performances of using digital tools and procedures". In other words, the divide is not only a question of being equipped or connected; attitude, usage, behaviour and perceived utility, as well as income, age and educational attainment also enter the picture.

When looking at diffusion overall, the digital divide appears to be declining regularly.[9] However, when differences in income groups are examined, the divide is still relatively wide. The gap between top and bottom quartiles or deciles has widened regularly in the six countries analysed, with the noticeable exception of Sweden, where the gap started to widen for PCs but the trend was reversed in 1997 and is now regularly declining, while for the Internet, it has decreased since 1999 (Table 4.11).

Table 4.11. **PC and Internet differences in penetration rates, top vs. bottom income quartiles and deciles**[1]

	1994	1996	1997	1998	1999	2000	2001	2002	2003
					Quartiles				
Canada									
Internet	..	..	27.0	37.8	42.6	48.9	53.2	53.3	..
Finland									
Internet	..	..	20.3	32.8	40.6	52.4	53.8	49.4	60.2
France									
PC	..	18	20	22	28	28	33	32	..
Internet	..	..	..	..	11	20	27	29	..
					Deciles				
Canada[2]									
PC	31.8	48.2	..	..	..	65.2	..	..	..
Internet	..	18.2	41.1	47.2	55.1	62.5	..	..	..
Netherlands									
PC	..	..	..	29.0	38.0	37.6	50.0	..	..
Internet	..	..	..	24.0	37.2	41.4	59.0	..	..
Sweden									
PC	9.1	12.4	17.5	15.5	13.1	7.0	7.7	..	..
Internet	..	..	..	18.8	20.3	16.3	14.8	..	..
United Kingdom[3]									
Internet	..	..	..	29.0	42.0	66.4	69.0	74.0	..

1. Difference in penetration rates between high- and low-income quartiles or deciles.
2. 1990 instead of 1994.
3. 1998/99 instead of 1998, and similarly for other years.

Source: OECD, based on data from national statistical offices.

If gaps are large, they need not remain large, and once they decrease, they need not stay small. Small disparities in fixed phone rates in France and Canada, for instance, are starting to become larger.

The digital divide: the outlook

The question is whether the divide among OECD countries will close, and if so, when. Possible scenarios for ICT diffusion in households have been offered by a number of authors (Sciadas, 2002a; CREDOC, 2003; Ironmonger *et al.*, 2000; Martin, 2003). Time estimated to reach saturation (*i.e.* including the lowest revenue categories), varies from a decade to more than 56 years. On the other hand, current analysis suggests that a significant part of the population may never be equipped with a PC or access the Internet (CREDOC, 2002). Most US non-Internet users have friends or family who use it or know of public access locations in their communities, but 56% of them said they probably or definitely will not ever go on line (Lenhart, 2003). In Japan and France, it is clear that while the PC is reaching saturation in households with the highest incomes, the lowest income categories are far from equipped (Figure 4.24). Although it is premature to conclude that past patterns will persist (Martin, 2003), the current slope of the curves suggest a lower rate of uptake and use for the lowest income groups in the long term.

Beyond connectedness

Access (haves *vs.* have nots) is not the only issue. Technology use and learning also play a vital role, and people's background and their membership in a particular socio-economic group have a direct bearing on how they use PCs and the Internet. A recent study suggests indeed that it is more a "use" divide than an "access" divide (Jackson *et al.*, 2003).

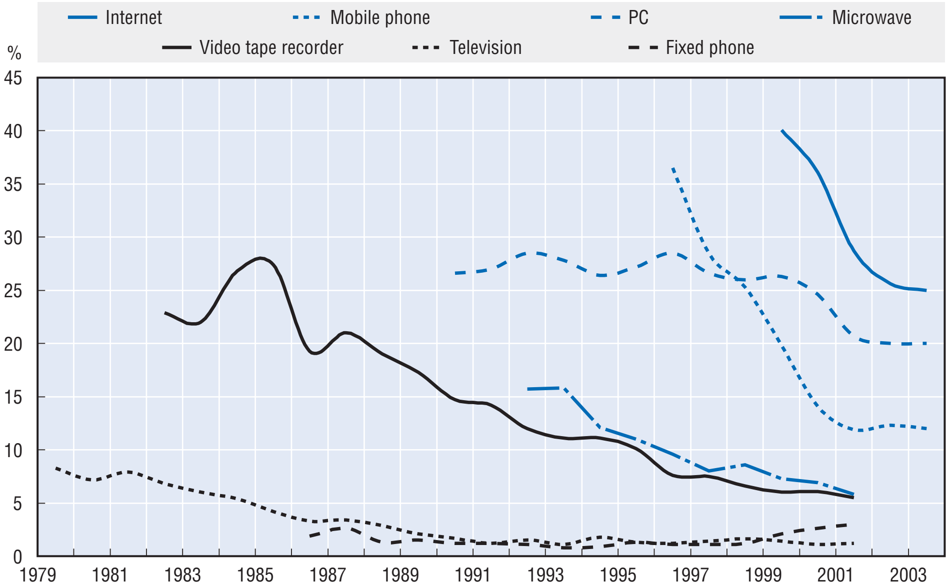
In France, for example, computers are used for more "functional" purposes by executives than by lower-level employees. In the Netherlands, use of PCs during leisure time reveals differences among groups, and differences in use appear to be augmenting differences in possession (De Haan, 2003). In the

Box 4.2. France: a specific diffusion pattern of ICT compared to other technologies

In France, penetration rates differ among products. Moreover, for a given diffusion rate, the disparities (measured through a set of socio-economic variables) are greater for the Internet or the PC than for the mobile phone, *i.e.* some products are intrinsically more "democratic" than others. Compared with "old" goods, new ICTs seem to have higher but – except for PC- more rapidly decreasing rates of disparity.

Figure Box 4.2. **Evolution of inequalities in possession of selected products in France**

Average value[1] of the Gini coefficient in percentage



1. Gini coefficient average calculated from values for each category (age, income, diploma, profession, and size of agglomeration).
Source: CREDOC, 2002 and 2003.

Results based on econometric simulations suggest the likelihood that some parts of the population will never have a mobile phone or a PC. For similar penetration rates, colour TV, fixed phone or VCRs had much lower disparity levels.

Table Box 4.2. **Gini coefficients according to product diffusion rate[1] for selected goods in France**

Gini coefficient expressed in percentages

	Penetration rate of the product in percentage			
	0	15	30	60
PC	30	26	22	16[2]
Internet	45	29	17[2]	. .
Mobile phone	24	19	16	10
Color TV	30	18	11	4
Video tape recorder	27	20	14	8
Microwave	33	22	15	7

1. Projections are based on econometric estimates.
2. Based on extrapolation of the observed trend.
Source: CREDOC (2002).

Box 4.2. **France: a specific diffusion pattern of ICT compared to other technologies** (*cont.*)

Diffusion of the PC has been slow and large disparities remain. The Internet shows even larger initial disparities; however, the heterogeneity of social groups (location, occupation, educational or income level) has been significantly reduced in the last three years. ICTs thus seem to have a specific diffusion pattern whereby the level of disparities in diffusion, for a given penetration rate, is systematically higher compared with other products. Within ICTs, mobile phones and the Internet are diffusing rapidly and the Internet ranks second of all technologies in terms of diffusion speed.

Source: OECD, based on CREDOC (2002).

United States, the digital divide tends to concern less the issue of hardware than the types of computer and telecommunication solutions used (Rob Kling, former Director of the Center for Social Informatics, Indiana University). US studies show that students (kindergarten through 12th grades) from high socio-economic backgrounds frequently use computers for experimentation, research and critical enquiry, while students from les advantaged backgrounds engage in less challenging drills and exercises that do not take full advantage of computer technology (Warshauer, 2003). The issue of use as the basis of the digital divide is an essential element of information and communication policies to reduce socio-economic barriers to ICT diffusion and to transform the digital divide into a digital opportunity.

Overall, many dimensions of the digital divide need to be addressed. First, efforts to minimise the size and duration of the divide should continue. There are high social opportunity costs when individuals and economies are not part of network connectedness. Second, for those who are currently considering remaining unconnected, what can be done to reduce barriers to uptake and use of the Internet? Public policy can play a key role in improving the articulation between use and demand, in particular in the areas of education and learning.

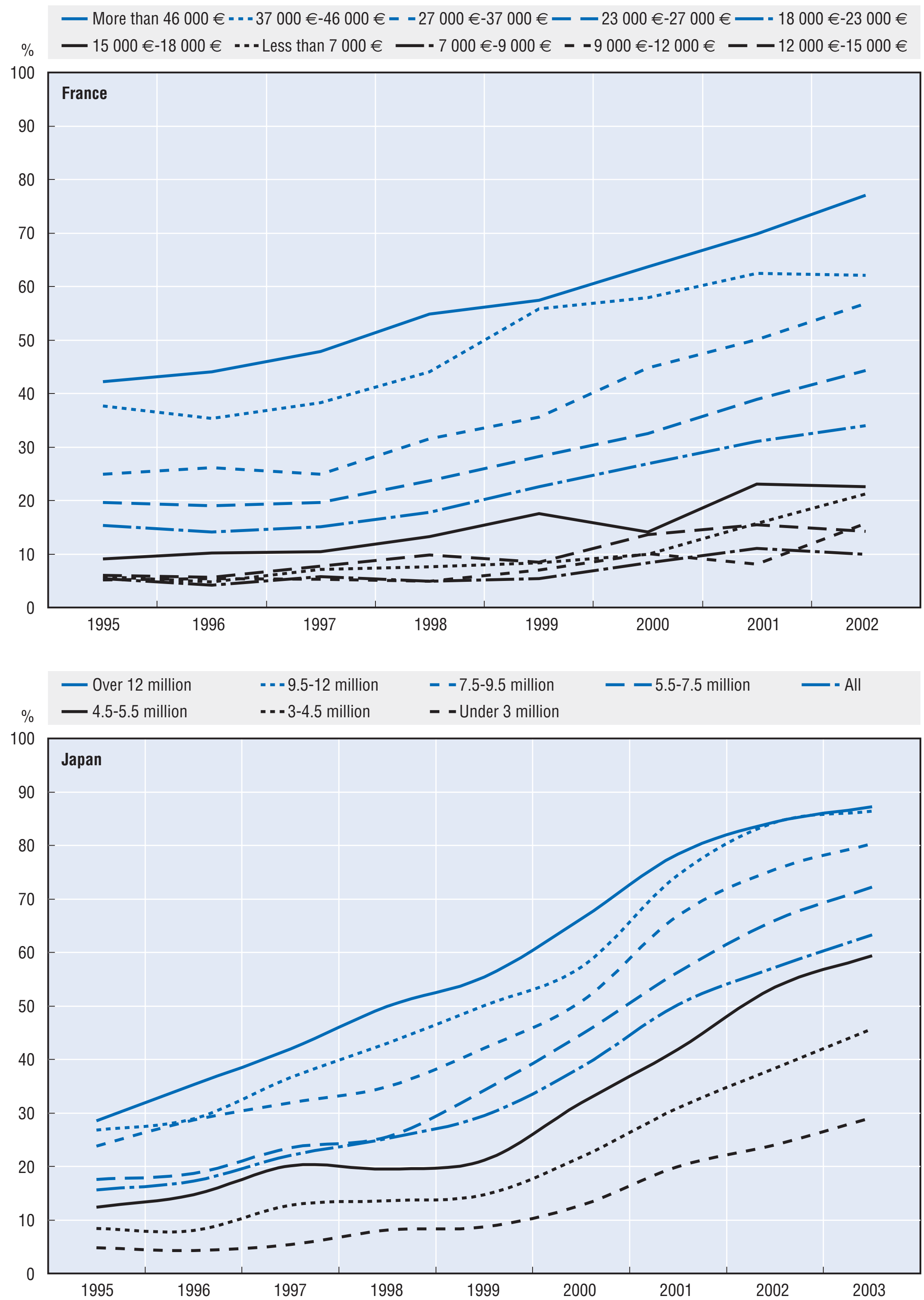
Conclusion

In the leading OECD countries, within a decade ICTs have become an integral part of everyday household use, despite signs of a persistent if narrowing digital divide. In other countries ICTs are still diffusing at a pace that excludes most of the population, despite progress. To avoid leaving a significant part of the population behind, it is necessary to address issues relating to connectedness and use. Because the Internet amplifies social differences as new uses emerge, policy needs to address the broader issues of education, training, and ICT literacy, not only the narrower issue of ICT supply. ICT policies may need to focus on an appropriate mix of supply-side measures (competition to reduce prices, improve quality and expand choice) to raise connectedness, with demand-side measures to enhance diffusion and encourage content provision, and related education and social development measures.

Diffusion of ICTs across the economy, including to individuals and households, receives considerable policy attention in OECD countries. Recent ICT policy actions follow one or a combination of models and mixes. These include encouraging the rollout of broadband infrastructure, government development projects focusing on e-government with a government online portal for citizens to access the full range of government services available electronically, and initiatives in areas such as digital signatures and privacy measures to help drive development of ICT use among citizens. Focused measures for individuals and households include integration of ICT literacy into education, development or encouragement of community access points, specific targeting of certain socio-economic groups, enabling legal or financial measures to encourage uptake of ICTs, and the creation of experimental model wired communities. All of these measures are common recent trends in OECD policies, as outlined in Chapter 8.

Figure 4.24. **PC uptake in households by income brackets[1] in France and Japan, 1995-2003**

Percentage of households



1. In current euros for France and million current yen for Japan.

Source: OECD, based on data from the Economic Planning Agency, and INSEE.

NOTES

1. In countries for which data are available, the PC seems to be the predominant mode for accessing the Internet: 95% in Italy in 2000 (ISTAT) and 99% (and mobile phone/WAP 9%) in the United Kingdom in 2003 (Office of National Statistics – ONS). In the United States in 2002, around 6.4% of adults users accessed the Internet via a cell phone or a personal digital assistant (PDA) and 3% via a wireless computer (University of California at Los Angeles – UCLA).
2. In the United States, black and white TV went from 20% to 50% of households in three years and from 20% to 75% in five. In England and Wales, this took four and seven years, respectively (Bowden and Offer, 1994).
3. According to the Taylor Nelson Sofres-Interactive 2002 survey conduced in 37 countries, the share of population using Internet at work is higher than the share using it from home in only a few countries where general diffusion of Internet is still at an early stage (Czech Republic, Estonia, Hungary, Latvia, Lithuania, Slovak Republic and Ukraine).
4. See Ministry of Economic Development New Zealand, Statistics on Information Technology in New Zealand, Personal Use of Information Technology, Figure 5.2.3: Access to the Internet by location, at: *www.med.govt.nz/pbt/infotech/it-stats/it-stats-2003/it-stats-2003-06.html#P339_18576*, accessed September 2003.
5. Although they are not strictly comparable, 2001 POLS (Permanent Onderzoek Leefsituatie [*Integrated Survey on Living Conditions*]) survey results provide similar orders of magnitude for frequency of use according to location.
6. Norwegian media barometer, 2002, *www.ssb.no/english/subjects/07/02/30/medie_en/*, accessed 25 September 2003.
7. However, cable and satellite television are not affected.
8. A weblog, or blog, is a frequent publication of personal thoughts on the Web, usually with Web links. This "online diary" often combines personal and Web-related events.
9. Gini coefficients for PC and Internet dispersion by income level show a continuous and regularly declining trend (see OECD [2002), Annex Tables 6.5 and 6.6).

REFERENCES

Annie Casey Foundation (2003), "Kids Count 2003 Databook Online", available at *www.aecf.org/kidscount/databook/pdfs.htm*.

Bowden, S. and A. Offer (1994), *Household Appliances and the Use of Time: The United States and Britain Since the 1920s, The Economic History Review*, New Series, Vol. 47, No. 4, November, pp. 725-748, available at *www.jstor.org/view/00130117/di011849/01p0370s/0?config=jstor&frame=noframe&userID=c1334125@oecd.org/018dd553400050dcb7c6&dpi=3*.

CBS (Central Bureau of Statistics) (2003), *De digitale economie* 2003, available at *www.cbs.nl/nl/publicaties/publicaties/bedrijfsleven/algemeen/p-34-03.pdf*

Cézard, M., M. Gollac and C. Rougerie (2000), "L'ordinateur, outil de travail et bien culturel, diffusion de l'informatique et selection des utilisateurs", *Actes de la Recherche en Sciences Sociales*, September.

Corrocher, N. (2002), "Internet Diffusion Dynamics in Europe: Demand Scenarios and the Digital Divide", Issue Report No. 29, Socio-economic Trends Assessment for the Digital Revolution (STAR), July, available at *www.databank.it/star/list_issue/f.html*.

CREDOC (Centre de Recherche pour l'Étude et l'Observation des Conditions de Vie) (2001), *Baromètre de la diffusion des nouvelles technologies en France*, Report No. 220, November.

CREDOC (2002), *Le fossé numérique en France*, Cahier de Recherche, No. 177, November.

CREDOC (2003), "La diffusion des technologies de l'information dans la société française", study commissioned by the Conseil Général des Technologies de l'Information et de l'Autorité de Régulation des Télécommunications, November, available at *www.art-telecom.fr/publications/etudes/et-credoc-2003.zip*.

Dickinson, P. and J. Ellison (2000), "Plugging In: The Increase of Households Internet Use Continues into 1999", Connectedness Series, Statistics Canada, November, available at: *www.statcan.ca/english/research/56F0004MIE/56F0004MIE2000001.pdf*.

Dickinson, P. and G. Sciadas (1999), "Canadian Connected", *Canadian Economic Observer*, Statistics Canada.

Flacher, D. (2003), "A European Panel Approach to Web Users and E-consumers", Issue Report No. 39, Socio-economic Trends Assessment for the Digital Revolution (STAR), September, available at *www.databank.it/star/list_issue/f.html*.

FTU (Fondation Travail – Université ASBL) (2003), *La Lettre* EMERIT, Trimestriel d'information sur l'évaluation des choix technologiques, Fondation Travail-Université ASBL, 4th quarter, available at *www.ftu-namur.org*.

Fontaine, G. and S. Pernet (2003), *Use-IT, Usage des produits et services de communication électronique grand public*, IDATE.

Frey, L. (2002), "The "Digital Divide' by Age Groups in the Countries Involved in NESIS„, paper presented at the New Economy Statistical Information System (NESIS) conference held in Olympia, Greece, 9-14 June, available at *http://nesis.jrc.cec.eu.int/downld/event/doc/260_Frey*.DOC

Greenan, N., S. Hamon-Cholet and E.Walkowiak (2003), "Autonomie et communication dans le travail : les effets des nouvelles technologies", Direction de l'animation de la recherche des études et des statistiques (DARES), ministère des Affaires Sociales, du Travail et de la Solidarité, May, available at *www.travail.gouv.fr/publications/picts/titres/titre1917/integral/2003.05-20.1.pdf*.

De Haan, J. (2003), "IT and Social Inequality in the Netherlands", *IT & Society*, Vol. 1, No. 4, Spring, pp. 27-45, available at *www.stanford.edu/group/siqss/itandsociety/v01i04/v01i04a04.pdf*.

Ironmonger, D.S., C.W. Lloyd-Smith and F. Soupourmas (2000), "New Products of the 1980s and 1990s: The Diffusion of Household Technology in the Decade 1985-1995", *Prometheus* 18(4): 403-415.

ISTAT (2002), *I cittadini e le tecnologie della comunicazione, Indagine Multiscopo sulle famiglie " I cittadini e il tempo libero " Anno* 2000, Settore Famiglia e Societa-cultura.

Jackson, Linda, G. Barbatsis, A. von Eye, F. Biocca, Y. Zhao and H. Fitzgerald (2003), "Internet Use in Low-income Families: Implications for the Digital Divide", *IT&Society*, Vol. 1, No. 5, Summer, pp. 141-165, available at *www.ITandSociety.org*.

Korea Network Information Centre (2003a), "A Survey on the Number of Internet Users and Internet Behavior in Korea (Summary)", January, available at *http://isis.nic.or.kr/admin/eng_report/upload/summary200212eng.ppt*.

Korea Network Information Centre (2003b), "2002 Survey on the Usage of Wireless Internet Summary Report", available at *http://isis.nic.or.kr/english/sub04/sub04_index.html*.

Lenhart, A. (2003), "The Ever-shifting Internet Population", The PEW Internet and American Life Project, April, available at *www.pewInternet.org/reports/pdfs/PIP_Shifting_Net_Pop_Report.pdf*.

Lenhart, A., J. Horrigan and D. Fallows (2004), "Content Creation Online", The PEW Internet and American Life Project, February, available at *www.pewinternet.org/reports/pdfs/PIP_Content_Creation_Report.pdf*.

Martin, S.P. (2003), "Is the Digital Divide Really Closing? A Critique of Inequality Measurement in a Nation Online", IT & Society, Vol. 1, No. 4, Spring, pp. 1-13, available at *www.stanford.edu/group/siqss/itandsociety/v01i04/v01i04a01.pdf*.

Mayfield, R. (2003), CEO of Socialtext, and Pew Center, quoted by Francis Pisani, "Internet saisi par la folie des weblogs", *Le Monde Diplomatique*, August.

Ministère de l'Économie, des Finances et de l'Industrie/ Baromètre CSA opinion (2003), *Les Français et l'utilisation des micro-ordinateurs*, February.

MPHPT (Ministry of Public Management and Home Affairs), Japan (2002), *Communication Usage Trend Survey, 2001 Survey Results*, available at *www.johotsusintokei.soumu.go.jp/tsusin_riyou/data/eng_tsusin_riyou02.pdf*.

MPHPT (2003), *Survey on Utilization of IT in National Life*, quoted in *Communication White Paper 2003*, Section 3, Chapter 1.

MPHPT (2003), *Information and Communications in Japan 2003*, available at *www.soumu.go.jp/joho_tsusin/eng/Resources/WhitePaper/WP2003/Chapter-1.pdf; /Chapter-2.pdf; /Chapter-3.pdf*.

NFO Infratest (2003), "Monitoring Informationswirtschaft – 6. Faktenbericht 2003", for the Bunsdesministerium für Wirtschaft und Arbeit, Munich, March.

Nomura Research Institute (various years), "CyberLife Observations, Study on the Japanese Consumer's Use of Information and Telecommunication Equipment and Services", Overview of the results of the 11th, 12th, and 13th Surveys, available at *www.nri.co.jp/english/news/2002/021120.html* and *www.nri.co.jp/english/news/2002/020507.html*.

Nordic Council of Ministers, and Statistics Denmark, Statistics Finland, Statistics Iceland, Statistics Norway, Statistics Sweden (2002), *Nordic Information Society Statistics 2002*, December, available at *www.ssb.no/ikt/ict_nord/publ.pdf*.

Nurmela, J., L. Parjo and M. Ylitalo (2003), "A Great Migration to the Information Society", *Reviews 2003/1*, Statistics Finland, available at *http://tilastokeskus.fi/tk/yr/tietoyhteiskunta/suomalaiset_linkit_muutto_en.html*.

Nurmela, J. and M. Ylitalo (2003), "The Evolution of the Information Society", *Reviews 2003/4*, Statistics Finland.

OECD (2002), *OECD Information Technology Outlook: ICTs and the Information Economy*, OECD, Paris.

OECD (2003), *OECD Communications Outlook*, OECD, Paris.

Sciadas, G. (2002a), "Unveiling the Digital Divide", paper presented at the conference on Statistical Information System for Good Governance within the New Economy held in Olympia, Greece, 9-14 June, available at *http://nesis.jrc.cec.eu.int/downld/event/doc/305_SciadasFinal.zip*.

Sciadas, G. (2002b), *Unveiling the Digital Divide*, Research Paper, Connectedness Series, Statistics Canada, October, available at *www.statcan.ca/english/research/56F0004MIE/56F0004MIE2002007.pdf*.

Sciadas, G. (ed.) (2003), *Monitoring the Digital Divide… and beyond*, Orbicom, available at *www.orbicom.uqam.ca/projects/ddi2002/2003_dd_pdf_en.pdf*.

Silver, C. (2001), "Internet Use Among Older Canadians", Research Paper, Connectedness Series, Statistics Canada , August, available at *www.statcan.ca/english/research/56F0004MIE/56F0004MIE2001004.pdf*.

Statistics Austria (2003a), *Result of the European Survey on E-commerce 2001/2002* (in German), available at: *www.statistik.at/fachbereich_forschung/commerce_txt.shtml*.

Statistics Austria (2003b), *Main Results of the European Survey on ICT Diffusion in Households 2003 in Austria* (in German), available at *www.statistik.at/fachbereich_forschung/ikt_txt.shtml*.

Statistics Canada (2003a), "Type of Products and Services for which Electronic Commerce Households Shopped", data table, available at *www.statcan.ca/english/freepub/56F0003XIE/tables/prodserv.htm*.

Statistics Finland (2001), *On the Road to the Finnish Information Society III*, Helsinki.

Statistics Finland (2003), *A Great Migration to the Information Society*, Helsinki.

Statistics Norway (2003), "ICT in the Households, 2003", available at *www.ssb.no/ikthus_en/*.

Selwyn, N. (2003), "Widening Access to ICT via Public Sites", available at *www.becta.org.uk/page_documents/research/digidiv_selwyn.pdf*.

Toda, J.(2001), "Consumers and Consumer Industries in the Ubiquitous Network Era", Nomura Research Institute Papers No. 36, November, available at *www.nri.co.jp/english/opinion/papers/2001/np200136.html*.

UCLA (2003), The UCLA Internet Report: Surveying the Digital Future Year Three, February, available at *http://ccp.ucla.edu/pdf/UCLA-Internet-Report-Year-Three.pdf*.

US Department of Commerce (2002), A *Nation Online: How Americans are Expanding their Use of the Internet*, Washington DC, available at *www.esa.doc.gov/nationonline.cfm*.

Warshauer, M. (2003), "Demystifying the Digital Divide", *Scientific American*, August.

Chapter 5

DIGITAL DELIVERY

Digital delivery is increasing rapidly across many sectors, for both private and business purposes. Its potential is evident in the millions of Internet visits, which are most frequent in the categories computer and Internet, adult, news and media, entertainment and shopping. Furthermore, file sharing of audio and video material and other uses of peer-to-peer networks are on the rise. As evidenced by the sections on business and healthcare services, electronic networks are also an increasingly frequent means of delivery in service sectors.

Introduction

Digital delivery of information and products via the Internet and other computer-mediated networks is increasingly important for the distribution of information and commercial products. It combines greater market reach with the capacity to engage in richer interaction with customers and consumers and has grown rapidly, aided by the widespread adoption of broadband technologies. However, its dimensions, its impact on various sectors and its future prospects remain – despite increasing policy-interest – largely unmapped within ICT statistics.

Understanding digital delivery is complicated by the fact that it takes a variety of forms, which Table 5.1 attempts to map. An effort is also needed to move beyond a focus on on-line transactions (e-commerce) to understand the socio-economic impact of the Internet on commerce and consumer habits (Star, 2003). In addition, the heterogeneity of digital delivery may require the adoption of new measurement techniques.

Digital delivery processes may be internal or between organisations and the transactions may be commercial or non-commercial in nature. This chapter seeks to shed light on the extent of the shift to digital delivery, its characteristics and suitability, its drivers and impediments and its impact. It draws attention to policy issues and policy initiatives to enhance digital delivery.

The following discussion first presents the available statistics on the magnitude of digital delivery of products and services in OECD member countries. Then, on the basis of new data, it analyses Internet use patterns to shed light on the magnitude of the sector-specific potential for digital delivery. Businesses and consumers often access the Internet to download information (*e.g.* product information and prices) or products (*e.g.* software, music, films, etc.) or to use services (entertainment, news and

Table 5.1. **Examples of digital delivery**

	Internal to organisation	Between firms, governments and individuals			
	Digital delivery as part of internal business processes	Business to business (B2B)/business to government (B2G)	Business to consumer (B2C)	Consumer to consumer (C2C)	Government to consumer (G2C)
Non commercial transactions	Customer information in different departments Software from headquarters to affiliate Digital x-rays in hospital	Price information Exchange of standardised protocols for production Other large files	Most internet pages Free on-line newspaper On-line advertising	Sharing of files and information (peer to peer – P2P) Chat rooms Digital pictures	Tax forms, other administrative documents Government services
Commercial transactions	Internal exchange of digital products (software, blueprint) where transfer pricing is involved	Digital products (software, etc.) Electronically delivered services	Paid information services Paid software, music, films	Upcoming C2C services Online auctions	Paid government services

information, business services). Data for selected OECD countries indicate which areas are most often accessed for digital delivery.

Subsequent sections discuss first the spread of peer-to-peer (P2P) networks in OECD countries to focus on one form of management and digital delivery of content. In terms of Internet traffic, this new digital delivery technology (file sharing) seems to account for a significant share of contemporary network use. As file sharing is currently mostly used for the non-commercial delivery of digitised products (music, video, software), P2P has important implications for the entertainment industry. Although the technology is currently associated with the non-commercial downloading of music, it will soon find much wider application in standard business areas (*e.g.* business and financial services) for the electronic distribution of information and products.

Next, digital delivery of business services is addressed: software and information, R&D and technical testing, marketing and advertising, consulting, human resource development and labour supply. Factors shaping digital delivery of business services and drivers and impediments shaping digital delivery in different business services segments are analysed.

The final section looks at the health sector's use of digital delivery in care, research, health education and evaluation. Particular attention is paid to the extent of shifts to digital delivery as well as impediments and areas where policy co-ordination and convergence across different government agencies could be pursued.

Digital delivery over the Internet: Internet usage patterns

The Internet is increasingly used as a communication medium by both the public and private sectors. Internet traffic is the result of interaction among millions of users, hundreds of applications and dozens of sophisticated protocols. The amount of digitally available services and content on the Internet has grown exponentially over recent years, and the number of transactions either initiated or concluded over the Internet has also increased substantially. Here the delivery of information over the Internet is treated as an important but perhaps underestimated phenomenon (Star, 2003). Even if it does not result in a purchase (music sites, online newspapers, search engines), it may be of great value to users and thus have significant impact. Use of the Internet often prepares the ground for subsequent digital delivery of products and services or for off-line transactions (see Chapter 4). Nevertheless, the creation and persistence of Internet information resources and the habits of on-line consumers are not well known, especially since official statistical agencies provide only some of the relevant data (Steinmueller, 2003; Star, 2003). Official data on digital delivery by businesses is also scarce.

The lack of more comprehensive data on digital delivery is unfortunate at a time when policy makers attach increasing importance to locally created content (national e-content, local language) and to e-government initiatives and e-business. To address the lack of publicly available data on use of Internet content, Hitwise, an organisation that tracks Internet use, has made available to the OECD detailed statistics on country-specific Internet use (for the methodology, see Box 5.1 below), but only for four English-speaking countries (the United Kingdom, the United States, Australia and New Zealand).[1]

Hitwise data show trends in Internet consumption and activity in these countries as a basis for the analysis of Internet usage. It covers the following categories as grouped by Hitwise: business and finance, education, entertainment, health and medical, lifestyle, music, news and media, shopping and classifieds, sports, travel, government and adult. It also has a computers and Internet category. Hitwise information is complemented by studies by Technopolis (2003) and Star (2003) on indicators of European digital content for global networks. Unfortunately, information on Internet content in Japan or Korea was not available for this study. In future, it would be highly desirable to conduct work with a broader set of (especially non-English speaking) countries.

Box 5.1. **Data on Internet usage**

***Hitwise*:** The Hitwise data sample provides a good indication of the relative popularity of Web usage in each country measured. It collects data from two sources. One is anonymous usage data collected from multiple Internet Service Providers (ISPs) in each market. The ISPs include some of the main ISPs as well as a geographically diverse range of middle-tier and small ISPs, representing both home and work usage. Sample sizes are very large, with around 10 million Internet users included in the United States and over 8 million in the United Kingdom, for example. Most net rating agencies collect usage information for far smaller numbers of local users. The privacy of users is protected by the ISPs at all times. The second source of data in the United States, Australia, United Kingdom and New Zealand is a supplementary sample of the usage of opt-in panellists. This supplementary data is used to provide demographic data.

The data are aggregated by country and offered for review through *www.hitwise.com*. In addition to sectoral analysis, this site provides comparative information on over 500 000 Web sites. Before the data appear in the database, Web sites are categorised and descriptions and titles are written for each site. The categories used (over 160) are business- and market-oriented. A Web site is classified on the basis of subject matter and content, but also on its market orientation and competitive context.

Number of visits is the key metric used to calculate the percentages provided by Hitwise. A "visit" is defined as a series of page requests by a visitor without 30 consecutive minutes of inactivity identified by a collection of page requests from an IP address or a specific unique identifier grouped to form a visit. Most IP addresses analysed by Hitwise are unique to an individual and do not serve more than one visitor. The data does not take account of time spent on individual sites, quality of the Internet visit or whether consumers have engaged in on-line commercial transactions.

Market shares presented for individual countries represent the share of all visits secured by a given category in that country on the basis of the Hitwise sample of Internet usage. This metric does not take into consideration how long each visitor stayed on an individual site (intensity or quality of time spent). The ranking of top sites includes domestic (in the United Kingdom, for example, *www.ecommerce.co.uk*), localised (in the United Kingdom, for example, *www.amazon.co.uk*) and international/foreign Web sites that are not tailored to local use. Here, the term "localised site" is used for foreign firms/institutions/Internet content providers that tailor their digital content to local tastes by establishing a specific national sub-site. D*ot.com* sites are not automatically classified as international/foreign Web sites. Hitwise simply checks whether the content is aimed at a particular national audience.

***Technopolis*:** The Technopolis study analyses the top 50 Web sites (Web sites that receive the most visits) for all EU15 member states (plus Norway) and the United States to measure use of digital Internet content by the European population. The data analysis is done at the domain level, as opposed to the property or Web page level, because domains are the main level of analysis of the major rating agencies. The main indicator for measuring the popularity of Web sites is "unique audience". Unique audience refers to the estimated number of *different* individuals that access any Internet entity analysed during the course of a given reporting period. Most of the data sets were therefore obtained from a major commercial net-research agency, Nielsen NetRatings. The analysis of the top 50 Web sites is based on data obtained for November 2001 and October 2002. Sites are qualified as indigenous (local or localised) when domains from organisations are located or headquartered in the country analysed and/or if they are aimed at the local market. Sites are qualified as foreign when the domains are those of organisations located or headquartered outside the EU and when the content has not been tailored to local markets. The study does not provide the sector-specific breakdown (and level of specificity) and does not include Internet use at work, which are provided by Hitwise.

***Star Report*:** the study relies on the data of the Netvalue European domestic panel. It includes four countries (England, Denmark, France and Italy) and two one-month periods (April 2001 and April 2002).

Sector-specific rankings

Hitwise monitors 500 000 Web sites broken down into over 160 vertical sectors on the basis of subject matter and context, as well as market orientation. Market shares represent the share of all visits secured by a given category on the basis of the sample of Internet usage. Average annual market shares are presented in Table 5.2. For the United Kingdom, the United States and Australia, the categories are ranked according to their average market share over one year (and ten months in the case of the United States).[2]

Table 5.2. **Rankings of Internet activity for the United Kingdom, the United States and Australia**
Average of October 2002-October 2003 (January 2003 to October 2003 for the United States)

United Kingdom	United States	Australia
1. Computers and Internet 35.8%	1. Computers and Internet 34.8%	1. Computers and Internet 37.9%
2. Adult 20.6%	2. Adult 18.6%	2. Adult 18.3%
3. News and media 8.9%	3. Entertainment 7.4%	3. Entertainment 11%
4. Entertainment 7.3%	4. News and media 7%	4. News and media 7.7%
5. Shopping and classifieds 6.9%	5. Business and finance 5.9%	5. Business and finance 7.3%
6. Business and finance 5.9%	6. Shopping and classifieds 5.4%	6. Shopping and classifieds 3.9%
7. Travel 3%	7. Lifestyle 2.8%	7. Education 3.1%
8. Lifestyle 2.4%	8. Education 2.4%	8. Lifestyle 2.6%
9. Sports 1.9%	9. Sports 2.2%	9. Sports 2.2%
10. Education 1.7%	10. Travel 1.6%	10. Travel 1.5%
11. Music 1%	11. Music 0.8%	11. Government 1.5%
12. Government 0.7%	12. Government 0.8%	12. Music 1.3%
13. Health and medical 0.4%	13. Health and medical 0.5%	13. Health and medical 0.4%

Note: A 35.8% market share for computers and Internet in the United Kingdom means that of all Web visits by UK users in Hitwise's sample, 35.8% go to sites in this category.
Source: OECD, based on averaging of Hitwise monthly data.

The fact that these data are collected from national Internet service providers (ISPs) means that there is no overlap in terms of the users monitored, *i.e.* users must be based in the markets monitored in order to be in the sample. Still, there are striking similarities among the different English-speaking countries with respect to both the categories that draw users and the size of the shares. The results also largely confirm the results of Chapter 4 which found that mail, information search on products, reading news sources, downloading games and music, banking services and purchasing goods and services are the largest purposes of Internet use.

The computers and Internet category[3] has nearly twice the share of the second largest category in each market. This may be due to the fact that it includes not only the sites of computer manufacturers (hardware or services like Web development), but also widely used search engines (*e.g.* Google), popular e-mail providers (*e.g.* MSN Hotmail, Yahoo!) and Net Communities/Chats, etc. It is said that in the United States, 26.7% of traffic to shopping sites originated from search engines and directories.[4]

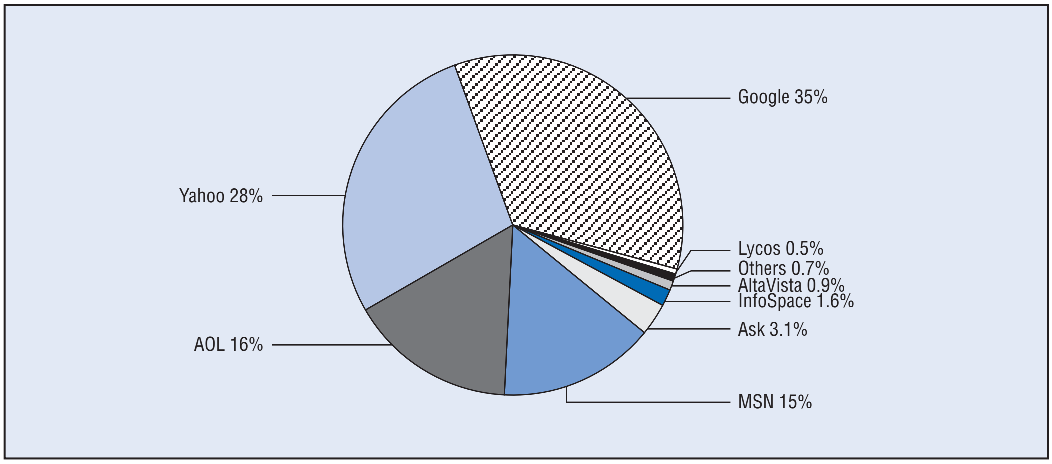
Sites in this category are often used as "gateways to content", *i.e.* sites the Internet user passes through quickly to reach the desired goal, where they spend more time. Table 5.3 shows the top five UK and US computer and Internet sites, and Figure 5.1 shows the market shares of search engines used by US Web surfers in November 2003. These sites often also include content, such as news items, weather, product sales, etc., to increase "stickiness", *i.e.* to encourage users to spend more time there or to return more often. Major portals such as AOL, Yahoo! and MSN offer a wide range of information services, games, on-line chat rooms, etc. (Technopolis, 2003).

Table 5.3. **Top five Computer and Internet sites in the United Kingdom and the United States, January 2004**

Rank	United Kingdom		United States	
	Name	Market share	Name	Market share
1	MSN UK	10.6%	Yahoo! Mail	14.4%
2	MSN Hotmail	7.3%	Yahoo!	13.7%
3	Google	7.1%	MSN Hotmail	8.3%
4	Google UK	5.8%	Google	6.7%
5	Freeserve	4.7%	Yahoo! Search	5.1%

Source: OECD, based on Hitwise.

Figure 5.1. **Searches by US Web surfers, market share of search engines, November 2003**



Source: www.searchenginewatch.com, November 2003.

The second biggest category – and the first content-specific one – is adult entertainment with a market share of around 19%. This supports anecdotal evidence indicating that this business has succeeded better than other content categories in exploiting the Internet; it is also the lead developer and user of new Internet technologies (streaming, etc.). Third, in terms of market share, news and media and entertainment follow, a good indication that the Internet is an increasingly popular source of news and entertainment content (*New York Times*, 2004a). Fourth, shopping and access to sites relating to business and finance also score quite high.

The data for music do not include commercial or non-commercial downloading of music. In the Hitwise data, sites like KaZaA, which are used for sharing music and other content, are mostly classified with computers and Internet. The relative share of e-government/e-health sites is low but growing rapidly. Moreover, the data do not show how much time is spent on individual sites, how quality is judged or whether consumers have engaged in on-line commercial transactions. As will be seen, Internet users state that visits to health sites are top non-recreational reasons for going on line.

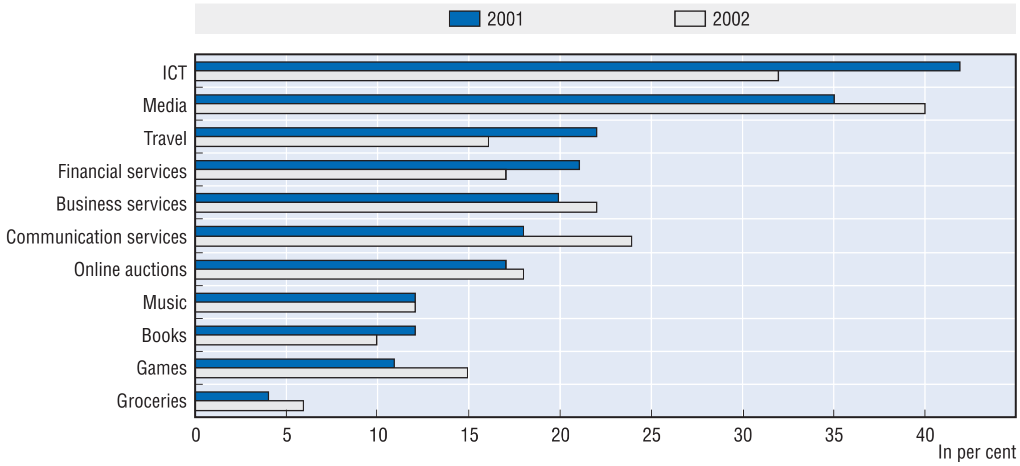
The study carried out for Europe (Technopolis, 2003) yields some similarities and some differences with the Hitwise data, although computer and Internet sites also attract the most traffic. Figure 5.2 shows the relative importance of different categories in the top 50 Web sites for the EU15.

The Technopolis study can be complemented by results of the Star research project on Internet behaviour of English, French, Danish and Italian consumers. Portals, ISPs and, to a lesser extent, search engines are favourite sites. These are followed by adult sites, gambling and financial services. TV, telecommunications and information and entertainment are also among the 15 favourite sites (Star, 2003).

Table 5.4 shows the categories of Internet pages most used in certain EU countries. The differences reflect both cultural differences and differences relating to the structure of the population of Internet users. In England, users favour the recreational and commercial dimensions, in Denmark (where the Internet was adopted very early), users emphasise the "practical" dimension, while French and Italian users, often young, fall between but give more importance to technology (software and hardware) and communication tools (Chat/Internet Relay Chat, IRC and message boards). As noted in Chapter 4, use of the Internet shifts gradually from general to more action-related items (purchases, downloads, etc.).

Figure 5.2. **EU sites by category, 2001 and 2002**

As a percentage of the top 50 Web sites, excluding portals and ISPs



In this survey, ICT stands for ICT hardware and service firms (part of the computer and Internet category in the Hitwise data). Adult entertainment is not included in this survey.
Source: Technopolis (2003), Nielsen Rating.

Evolution of sector-specific market shares

According to Hitwise data, the relative ranking of categories remains fairly constant over the period October 2002-October 2003 for the United Kingdom and Australia and January 2003-October 2003 for the United States. However, market shares have evolved, with some categories growing rapidly in terms of market share, while others have shrunk or remained stable. In this case, the starting and end points are compared, rather than average use over the period (as in Table 5.2). In the United Kingdom, the fastest-growing category is shopping and classified which overtook entertainment before October 2003. Health and medical and other categories (education, sports, travel, government, etc.) are taking relative market share from the leaders (adult and computer/Internet sites). In the United States, business and finance

Table 5.4. **Use of the Internet in selected EU countries, April 2002**

England	France	Denmark	Italy
Auctions	ISP	Directories	Portals
Shopping malls	Free SAP	Bank, credit and insurance	Education and learning
Automotive	Cyber media	Personal ads	Telecom
Meetings and contacts	Radio	Organisations and associations	Public authorities
Television	Gambling	Public authorities	Knowledge/other
Leisure	Stock market and finance	Television	IT/other
Travel and tourism	Jobs and careers	Food and drink	Forum/mess boards
Bank, credit and insurance	Personal ads	Everyday life	Instant messaging
Search engines	Everyday life	Real estate	News
Cinema	Chat/IRC	Instant messaging	Print press
Games	Organisations and associations	Adult	Software
Television	Directories	Personal	
Personal transportation	Hardware	Transportation	
Food and drink	Print press		
Music and literature	Games		
Messaging	News		
Real estate	Cinema		
Adult			

Source: Star (2003), "A European Panel Approach to the Web Users and E commerce", *Issue Report* No. 39, September.

Table 5.5. **Categories gaining in importance in England, Denmark and France, April 2001 April 2002**

England	Denmark	France
Maps	Bank and credit and insurance	Maps
Meeting and contacts	Shopping malls	Search engines
ISP	Food and drink	ISP
Search engines	Search engines, portals	Cyber media
Auctions	Software	Portals
Shopping malls	Television	Software
Travel and tourism	Consulting and hosting	Bank and credit and insurance
Real estate	Public authorities	Travel and tourism
Cinema	Maps	Hardware
Chat/IRC	Print press	Games
Forums	Transport	Music and literature
Adult	Telecom	Chat/IRC
	Communication	Radio
		Cinema
		Adult
		Shopping malls

Source: Star (2003), "A European Panel Approach to the Web Users and E commerce", *Issue Report* No. 39, September.

has overtaken shopping and classifieds and government has overtaken music. Health and medical, lifestyle and education have grown somewhat at the expense of computer and Internet, albeit from very low levels. Australia has seen greater changes in relative positions. Business and education have overtaken news and media, education has overtaken lifestyle, and government has overtaken travel. The fastest growth has been in government and education, both of which have almost doubled their market share at the expense of music and adult (but not computers and Internet). Table 5.5 sheds some light on sectors that have gained in importance in selected European countries over an earlier period.

Main destinations for Internet visitors

Detailed rankings and individual market shares confirm that very few Internet sites capture most of the visits. For both the United Kingdom and the United States, the top ten sites computer and Internet categories and for business information (a sub-category of the business and finance grouping) capture around half of all Internet visits (see Annex Tables C.5.1 and C.5.3). Because the computer and Internet category is also the most popular category, the top ten sites attract most Internet visits overall.

In the shopping and classified category, more than 35% of all visits are to eBay and Amazon (Table 5.6). There is less concentration in the top ten sites in business and finance and health and

Table 5.6. **Top ten UK and US shopping and classifieds sites, January 2004**
Percentages

Rank	United Kingdom		United States	
	Name	Market share	Name	Market share
1	eBay UK	24.4	eBay	29.8
2	Amazon UK	6.6	Amazon.com	3.9
3	eBay	3.8	Dell Computer	1.8
4	eBay Shops UK	2.1	eBay Motors	1.6
5	Kelkoo UK	1.6	Yahoo! Shopping	1.5
6	Argos	1.3	Walmart.com	1.2
7	Amazon.com	1.2	Half.com	1.1
8	Tesco.com	1.2	Lower My Bills	1.1
9	Play.com	1	eBay Stores	1.1
10	Dell Europe	0.7	Target	1.1

Source: OECD, based on Hitwise data.

medical (see Annex Tables C.5.2 and C.5.4, respectively) than in other categories (less than 20% of visits go to the top ten business and finance sites in both the United Kingdom and the United States). In the health and medical category, some drugstores, health insurance, medical libraries, government institutions and diet-related sites capture much of the traffic but visits are still dispersed.

Many bricks-and-mortar companies have successfully used their off-line market position to take leading positions in the on-line environment (and become so-called "click and mortar" firms). Examples are Lloyds, HSBC and Barclays in the top five positions for UK business and finance sites and Bank of America and Wells Fargo in the top five US business and finance sites. Other examples for health and medical are: Walgreens.com in the United States and Boots in the United Kingdom; for shopping and classifieds: Tesco Superstore and Marks & Spencer in the United Kingdom and Wal-Mart, Target and BestBuy in the United States. Overall, US traditional retail and banking firms have been successful in integrating the Internet and capturing user attention. The consultancy category is still dominated by traditional firms such as KPMG, PricewaterhouseCoopers and McKinsey.

However, firms that were created on the Internet, such as eBay, Amazon, Kelkoo and Yahoo Shopping, capture a large share of visits in the shopping and classified category. The top business information sites also have many Internet newcomers (United Kingdom: Yell.com, Yahoo!UK and Ireland Finance and MX Moneyextra; United States: Yahoo! Finance, MSN MoneyCentral, Netscape White Pages). Internet firms are also present in other categories (see the top 50 Internet firms listed in Chapter 1 and Annex A). In business and finance, there are Egg and O2*.co.uk* in the United Kingdom and MSN MoneyCentral in the United States. In health and medical there are N*et*D*octor.co.uk* in the United Kingdom and *drugstore.com* in the United States. Indeed, sale of prescription drugs over the Internet has been particularly popular, and Jupiter Research estimates that US pharmaceuticals will experience faster growth than other health categories in on-line sales, increasing from USD 3.2 billion in 2003 to USD 13.8 billion in 2007.[5] Job-market sites also do well (see Chapter 6).

Local vs. international Web content

Policy makers are increasingly interested in the availability of local Internet content in the local – often non-English – language. Data on Internet visits and rankings of the top Internet sites can be used to assess the degree to which Internet users are attracted by local or localised[6] *vs.* non-local Web content. Unfortunately, detailed data are only available for English-speaking countries. They are supplemented here by a study on European Internet content.

The local competitiveness index (LCI) shows the share of visits in each market to sites designated as local/localised as percentage of all visits. Table 5.7 presents the LCI for Australia, New Zealand, the United States and the United Kingdom. The 71.11% for business and finance in Australia, for instance,

Table 5.7. **Local competitiveness index (LCI), yearly averages, 2003**

Category	Australia	New Zealand	United States[1]	United Kingdom
Adult	0.5	0.5	63.7	2.1
Business and finance	71.1	53	82.9	74
Computers and internet	16.2	14.6	91.2	35.9
Education	64.4	52.6	93.1	62.4
Entertainment	39.3	15.4	91.3	43.4
Health and medical	42.7	23.7	92.4	63.5
Lifestyle	35.7	39.7	89.1	57.5
Music	19	12.0	82.5	32.2
News and media	52.8	44.5	87.4	81.5
Shopping and classifieds	50.2	42.8	95.3	77.6
Sports	50.1	35.9	93.7	74.6
Travel	64.7	50.6	93.8	77.2
Government	86.4	69.2	95.4	82.3

1. Ten month average for the United States.
Source: OECD, based on Hitwise.

means that this share of Australian Internet visits goes to local/localised sites. In general, these English-speaking countries all have a very large share of local or localised content. The United Kingdom and the United States rely particularly on local or localised Web content. New Zealand has the greatest share of visits to foreign Web pages, followed by Australia, the United Kingdom and the United States suggesting that domestic market size is important.

International brands often tailor their Web presence to the local market with a Web site in the respective country domain (*i.e.* Ikea: *www.ikea.co.uk*, KPMG: *www.kpmg.co.uk*, Monster job site: *www.monster.co.uk*). Other businesses have Web pages for certain regions (*i.e.* Dell for Europe: *www.euro.dell.com*). While many non-local Web sites are localised for UK users, few foreign sites are localised to fit the US market.

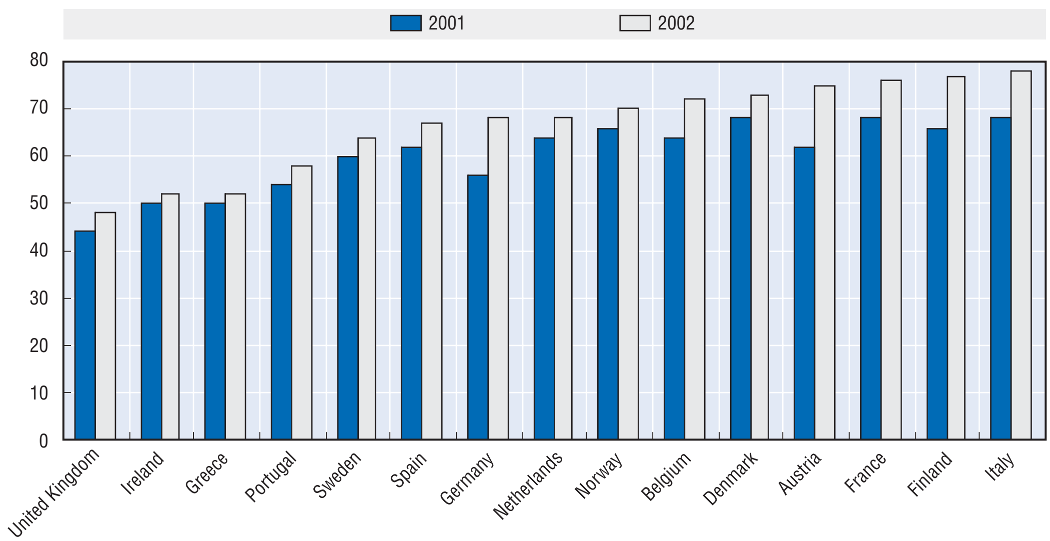
Internet users tend to access local content in the categories government, business and finance and education. Categories for which Internet users rely mostly on content from international sites are adult entertainment, and, for Australia, New Zealand and the United Kingdom, entertainment, lifestyle and music. In Australia, New Zealand and the United Kingdom, Internet users also rely heavily on international computer and Internet sites whereas in the United States – often the home of these sites – few Internet users access non-local sites. It is clear that US Internet firms (especially for shopping, e-mail, search engines and other Internet services) are particularly successful internationally (eBay, Amazon, Yahoo!, MSN, Monster.com, Netscape, etc.). In Japan, the most popular Web sites are also Yahoo! Japan and Amazon.co.jp; however, for linguistic reasons in particular, few pure Internet companies have been able to achieve similar success (CRITO, 2004).

The Technopolis study (2003) for the EU15+Norway assesses which of the top 50 sites are local ("indigenous"), localised or global. It found that "indigenous offerings" constitute a small share of the home market in most European countries. The adaptation of globally available information to specific, largely geographically defined markets is said to be crucial. Language, and even more importantly, culture play a significant role in the availability and access of local content.

Figure 5.3 shows how local (indigenous or localised) the top European sites are. All EU15 countries and Norway experienced a rise in indigenously created Web sites. A majority of sites visited by

Figure 5.3. **Indigenous national and localised sites in Europe**

As a percentage of the top 50 sites, including portals and ISPs



Note: The sample size in this study (50 top sites) is more limited than for the United States, Australia, New Zealand and the United Kingdom. However, given that the top 50 sites are likely to capture most of the Internet traffic, the results may be as representative.

Source: OECD, based on Technopolis (2003), "Indicators for European Digital Content for the Global Networks", Final Report for the Second Measurement for DG Information Society, Technopolis Group, Vienna, April.

EU15 users (up to nearly 80% in Italy, Finland and France in 2002) are either national or localised sites, and the use of national/localised sites has – in relative terms – been on the rise.

Usage patterns vary across EU15 countries. Those with a particularly high share of local and localised content are Italy, the Nordic countries, Austria and France. Use of indigenous content has grown substantially in Germany, Austria, Italy and the Nordic countries (Technopolis, 2003). In the latter countries the use of local and localised content is certainly related to language. The United Kingdom and Ireland, which share cultural similarities, economic closeness and a common language with the United States access the least local/localised content.

Further confirmation of the importance of language can be found in the fact that intra-European use of content (*i.e.* a French person using a Dutch Web page) is very limited. EU Internet users rely on a mixture of local/localised and US content. Europe accesses more US content than the United States accesses content from EU15 countries. Among the 50 most popular Web sites in the United States, none originates in an EU country. This appears to be due to the fact that US firms localise content to a greater extent than European firms and that, as noted, US computer and Internet sites are very popular in Europe.

Peer-to-peer digital delivery

Though still relatively new, the P2P file-sharing marketplace is evolving rapidly. It may be one of the most important factors in changing how digital delivery is done. Together with new compression technologies and formats like MP3 and more widely shared and faster broadband access, this technology has also greatly influenced how traditional entertainment industries operate. It also raises specific challenges in the area of copyright protection.

This section focuses on measuring the use of P2P networks for the non-commercial downloading of music, video and software files in OECD countries. Free downloading of music, films, or other files does not generate revenue for copyright holders (artists, music publishers) and may negatively affect the development of new legitimate services that deliver music, films, etc., to customers. Some argue that downloading supplements regular purchases of music or serves as way to sample new music (Pew, 2003). However, the recording industry has also warned that free downloading poses a severe threat to the music industry in terms of diminishing sales.[7] There are currently a significant number of lawsuits in OECD countries to prevent infringement of copyright when P2P networks are used to share commercial music and films. This section analyses the current impact of this new technology for digital delivery as a way to shed light on the potential for the commercial use of P2P technologies and policy issues.

Peer-to-peer file sharing

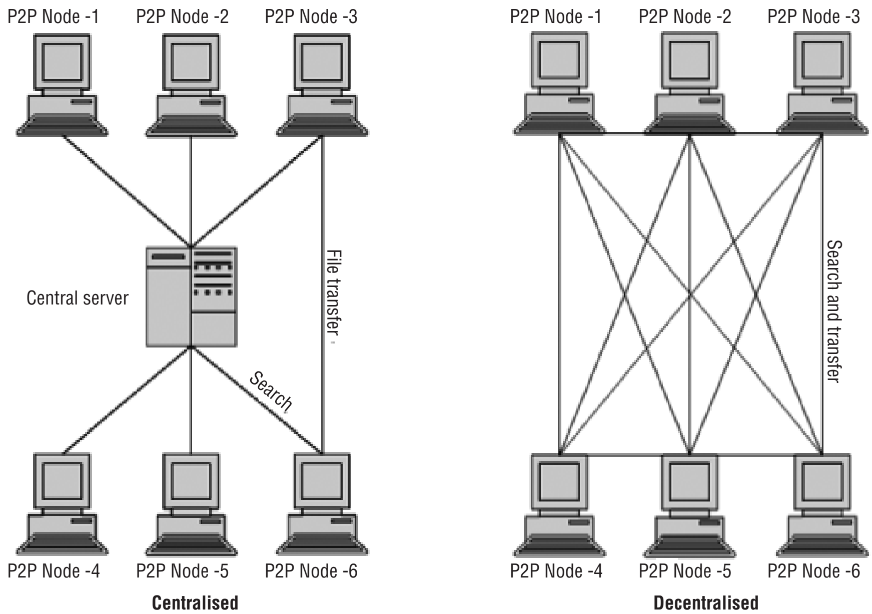
Peer-to-peer is essentially a communication structure in which individuals interact directly, without going through a centralised system or hierarchy. Users can share information, contribute to shared projects or transfer files (OECD, 2002; Minar and Hedlund, 2001).

In the past, systems for sharing files and information between computers were limited. The picture changed radically when in 2001, Napster had a daily average of 1.57 million simultaneous users and 60 million daily users worldwide. Napster was the first file-sharing service that allowed the non-commercial trade of music. In mid-2001 Napster was closed down owing to increasing lawsuits by the music industry accusing Napster of violating copyright and related rights.

Since Napster has been restricted, imitators such as Audiogalaxy, Morpheus, Gnutella and KaZaA have become more widely used. P2P thus emerged as the dominant use of bandwidth by residential Internet subscribers; it can consume 30% of network bandwidth of some broadband providers (Blue Coat, 2004). Today, most current P2P applications are not 100% P2P, but hybrid versions that make some use of central servers, which can ensure accountability and/or quality. Unlike Napster, for example, Gnutella does not have a central directory server; users connect directly to other nodes within the immediate vicinity and request a file (see Box 5.2 for an explanation of centralised vs. decentralised P2P systems).

Box 5.2. **Forms of P2P file sharing**

The dominant forms of P2P file-sharing systems are:



***Centralised system*:** First generation P2P (*e.g.* Napster) utilises a server-client network structure. This one-to-many relationship enables a single host to communicate and share files with multiple nodes. The central server acts as a sort of "traffic cop". It maintains directories of shared files stored on each node. Each time a client logs on or off the network, the directory is updated. The centralised P2P framework provides the best performance in terms of locating files. Every individual in the network must register; this ensures that all searches are comprehensive and are executed quickly and efficiently.

***Decentralised system*:** The many-to-many relationship used by Gnutella protocol clients like BearShare enables highly automated resource sharing among multiple nodes. A decentralised framework does not rely on a central server and is therefore more robust than a centralised system.

***Third generation* P2P** (*e.g.* FastTrack, KaZaA, Grokster, Groove, and current Gnutella clients) employs a hybrid of the central-server and fully decentralised frameworks (controlled decentralised framework).

Source: Sandvine (2003); OECD (2002); Minar and Hedlund (2001).

Although file sharing consumes large amounts of bandwidth, broadband access does not seem to be a precondition for file sharing. P2P use actually outpaces broadband adoption. New subscribers begin sharing files earlier and existing subscribers share files more often. The evolution from Napster to Gnutella to KaZaA and BitTorrent, and now eDonkey and WinMX (in Europe), has radically increased the amount of data transferred across broadband networks (Sandvine, 2003). Over KaZaA, for instance, almost 5 000 terabytes of information, including over 600 million files, are shared by an average of 3 million users at any given time (Lyman and Varian, 2003). More recent systems like BitTorrent and eDonkey make it easier to distribute large files to a large numbers of people, because users who want a file are sharing with each another, simultaneously uploading and downloading pieces of the same file or different files, rather than downloading from a central source. In essence, the BitTorrent system makes it easy to distribute very large files to many people while placing minimal bandwidth requirements on the original uploader of the file. Other improvements are making new P2P technologies more efficient at finding what is available in all distributed networks and helping ISPs by significantly reducing Internet traffic caused by P2P search queries (so-called NEOnet technology) (Technewsworld, 2004).

P2P *use in* OECD *countries*

BigChampagne provides data on country-specific use of P2P networks, their evolution and determinants of use.[8] It does so by indexing and searching shared folders on P2P networks and tracks some 50 million search queries a day to determine the activity and origin of P2P users. The data show the activity and origin of P2P users that are logged on to the given P2P network, thereby providing a reliable indicator of the number of individuals using file-sharing networks to upload or download files. BigChampagne began monitoring Napster in 2000 and now covers the most popular networks, including FastTrack (KaZaA, Kaza Lite, iMesh, Grokster, etc.), eDonkey, Direct Connect. Gnutella-based clients like ScourExchange, AudioGalaxy and Morpheus are also covered. However, it does not track less popular P2P sites, such as Soribada in Korea or FileRogue in Japan, or smaller ones in other OECD countries.

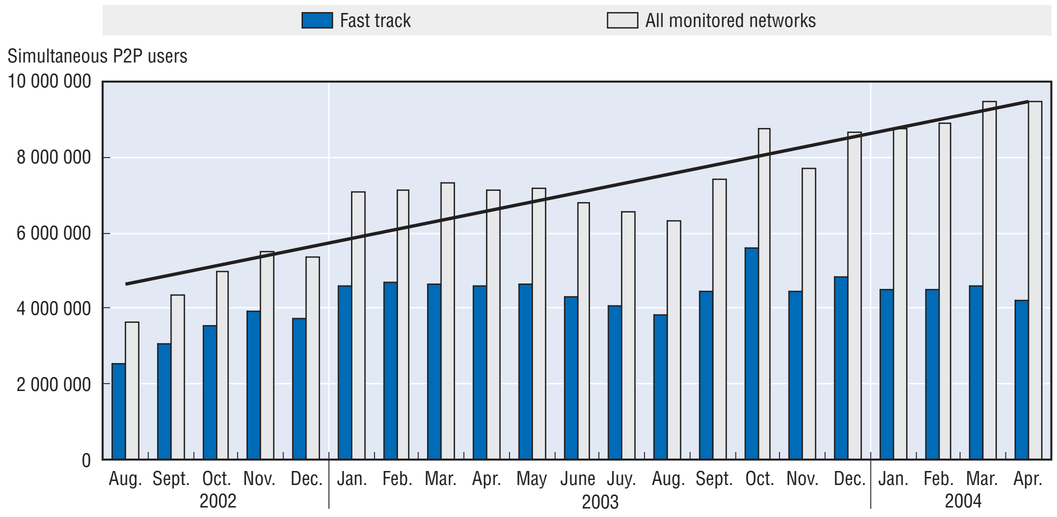
Today more than 60 million US consumers appear to see file sharing as a convenient, efficient and enjoyable way to obtain digital content (PC M*agazine*, 2003). As Figure 5.4 shows, global P2P use of the popular fast-track networks (*e.g.* KaZaA) increased by roughly 2.3 million simultaneous users (*i.e.* users who are jointly connected at any given moment rather than total users who are far more numerous) on FastTrack file sharing networks from August 2002 to April 2004. A peak of more than 5.4 million simultaneous users was reached in October 2003 but the number has since dropped back to around 4.2 million.

On the one hand, this decline is attributed to an increase in lawsuits against users of P2P networks and the rise of successful commercial music downloading services (*e.g.* Apple's iTunes, an online music store). Recent Pew surveys suggest that, owing to the increase in lawsuits by the record industry[9] and the rapid adoption of commercial online music sales, the number of people in the United States swapping music files on line has dropped by half, while the number of people downloading files on any given day has dropped by 75% since mid-2003 (Pew and comScore, 2004; N*ew York* T*imes*, 2004b). In a survey of 1 358 Internet users conducted from 1 March to 20 May 2003, 29% of Internet users admitted to downloading free music. The percentage dropped to 14% in a survey conducted from 18 November to 14 December 2003. In November 2003, for example, 3.2 million Americans visited Napster.com, which was re-launched as a paid online music service in late October, while Apple's iTunes, an online music store, drew 2.7 million visitors in November 2003.[10]

On the other hand, it is argued that the fall only represents a return to normal, as sharing levels are again back to the four months preceding October 2003. The Pew figures may overstate the drop in file sharing because survey respondents are now more reluctant to admit to engaging in downloading activity. It is also pointed out that the Pew studies do not take into account the fast growth of P2P use outside the United States and that the lawsuits may not achieve the desired effect (N*ew York* T*imes*, 2004b; California Senate, 2003). As Figure 5.4 shows, the figures for all P2P networks (fast-track plus other networks) show a trend increase from August 2002 to April 2004 that bring the simultaneous P2P users close to the 10 million mark. The rather flat trend of the fast-track networks since November 2003 and the parallel rise of simultaneous use of other networks may hint at a migration of P2P users to networks that attract less attention from the music industry and thus fewer lawsuits.

In terms of the distribution of P2P users, 55.4% originate from the United States. Germany accounts for 10.2%, Canada for 8%, France for 7.8%, United Kingdom for 5.4%, Italy for 1.7%, Spain for 1.1% and the Netherlands for 1% (see Table 5.8). No other OECD country accounts for more than 1%, although it must be recalled that BigChampagne does not cover Japanese and Korean sites. When weighted by population, Canadians seem to be the most intensive users (1.2% of total population). In no other country does the number of users, as a share of total population, exceed 1%. On average 0.24% of the OECD population is simultaneously logged on to a P2P network. If the data were weighted by number of Internet users rather than by the general population, average use of P2P would be much higher. When

Figure 5.4. **Growth in global FastTrack and other P2P networks, simultaneous audience, August 2002-April 2004**



* The black line is the trend line for "all monitored networks (FastTrack plus other networks)".
Source: OECD, based on BigChampagne data.

Table 5.8. **Distribution of simultaneous P2P users in OECD countries, 2003**
Percentage of all users and percentage of the total population logged on simultaneously

	Percentage of all users		P2P users as a percentage of total population, Sept.-Oct. 2003
1. United States	55.4	1. Canada	1.2
2. Germany	10.2	2. United States	0.9
3. Canada	8.0	3. France	0.6
4. France	7.8	4. Germany	0.6
5. United Kingdom	5.4	5. Luxembourg	0.4
6. Italy	1.7	6. United Kingdom	0.4
7. Spain	1.1	7. Sweden	0.4
8. Netherlands	1	8. Belgium	0.4
9. Australia	0.91	9. Switzerland	0.4
10. Belgium	0.8	10. Austria	0.3
11. Sweden	0.7	11. Netherlands	0.3
12. Japan	0.7	12. Norway	0.3
13. Switzerland	0.6	13. Australia	0.2
14. Austria	0.5	14. Finland	0.2
15. Mexico	0.3	15. Denmark	0.2
16. Norway	0.3	16. New Zealand	0.2
17. Korea	0.2	17. Italy	0.1
18. Portugal	0.2	18. Spain	0.1
19. Poland	0.2	19. Iceland	0.1
20. Finland	0.2	20. Portugal	0.1
21. Denmark	0.2	21. Ireland	0.1
22. New Zealand	0.1	22. Japan	0.1
23. Ireland	0.1	23. Hungary	0.02
24. Hungary	0.1	24. Poland	0.02
25. Greece	0.1	25. Greece	0.02
26. Luxembourg	0.04	26. Korea	0.02
27. Czech Republic	0.04	27. Czech Republic	0.01
28. Turkey	0.03	28. Mexico	0.01
29. Slovak Republic	0.01	29. Slovak Republic	0.01
30. Iceland	0.01	30. Turkey	0.00
OECD countries	96.9	OECD average	0.24

Source: OECD, based on BigChampagne data.

the technology was taken up by Internet users, cultural factors and others that are discussed below (*e.g.* the level of broadband access) may help to explain the level of P2P activity in some countries.

The studies conducted on US P2P users show that music downloading has been one of the fastest-growing Internet activities. A survey by Pew (2003) conducted between March and May of 2003 found that 29% of Internet users have downloaded music files to their computer and that about 4% do so on an average day. The proportion was the same as in the previous survey of 2001 (Pew, 2001) but the absolute number was larger owing to overall growth of the on-line population. More than three-quarters (79%) of adult US Internet users who download music indicated that they do not pay for the files the download, and some two-thirds do not care whether the files are copyrighted or not. A study for France has shown that 30% of Internet users (from age 12) have downloaded music or other files over P2P networks (CREDOC, 2003) and that 15% of French Internet users who had not yet used P2P networks planned to do so in the next 12 months. Another study of May 2004 (CNC, 2004) found that in France more than 31 million films a month are downloaded via non-commercial means. It appears that around 19% of French Internet users have already downloaded and watched movies at home. Only 4% have paid to view films on line.

For other OECD countries, music downloading does not necessarily, but is likely to, take place over P2P networks. In Finland, for example, the number of Internet users aged 10-30 who have downloaded an MP3 file to their PC[11] rose from 33% in 1999 to 46% in 2002 (Statistics Finland, 2003). In Canada, 24.3% of all households (up from 7.8% in 1999) obtain and save music over the Internet (Statistics Canada, 2003). In Japan, in 2002, 17.9% of broadband users (6.2% of narrowband users) downloaded music and 19% of broadband users (3.8% of narrowband users) downloaded videos (MPHPT, 2003). This demonstrates the importance of broadband for downloading large files.

The Pew studies for the United States also show considerable overlap between downloading and sharing populations (Pew, 2003), as 42% of those who download files say they also share files with others. Out of all Internet users, 17% download music but do not share files on line, 9% share files on line but do not download music, 12% both download music and share files, and 62% do not download music or share files at all.

The evolution of country-specific shares in P2P use from 2002 to 2003 (not weighted by population) indicates that French, German, Japanese and Italian shares have grown fastest, while those of the United States, Belgium and the United Kingdom are decreasing (significantly in the United States which started with a very large share) (see Annex Figure C.5.1). The strong growth rates in European countries, for instance, can be explained by the fact that P2P has become popular later than in countries like the United States. Other OECD calculations based on BigChampagne data show that countries with an initially very low share of P2P users (like Turkey, Czech Republic, Luxembourg, Greece, Mexico, Japan, New Zealand, Poland, Hungary and Portugal) have seen strong growth in their market share.

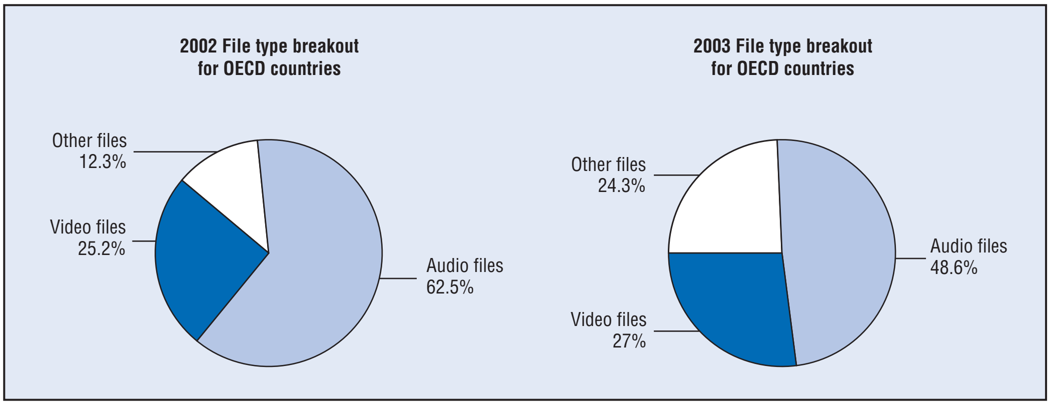
The ongoing increase in European P2P usage and the decrease of the share of the United States are also mirrored in the evolution of country-specific shares in P2P use from 2003 to 2004 (Table 5.9).

Table 5.9. **Change in share of global P2P user base, January 2003 to January 2004**

Canada	+4.5%
France	+4.4%
United Kingdom	+3.7%
Germany	+3.6%
Spain	+1.2%
Japan	+1.1%
Austria	+0.8%
Netherlands	+0.7%
Belgium	+0.6%
United States	–23.53%

Source: OECD, based on BigChampagne data.

Figure 5.5. **Breakdown of file sharing for OECD countries, 2002 and 2003**



Note: Other files include software, documents, images and other files not included in the video and audio categories. The numbers indicate the files available for upload on P2P networks. Owing to the close correlation of uploaded and downloaded files, the figures are representative for downloaded files.
Source: OECD, based on BigChampagne data.

Some interesting points can be made concerning the type of files shared. Napster only allowed users to share music files in the popular MP3 format. Today, however, video and other files (*i.e.* software) make up more than 35% of total files offered over file-sharing networks. Indeed, the share of video and software files traded increased significantly between 2002 and 2003, while the share of audio files decreased from 62.5% to 48.6% (Figure 5.5). The increased downloading of video files is mainly due to higher available bandwidth and improved file sharing systems as well as new DVD and CD burning technologies. A 2003 study concluded that using current art compression techniques and commonly available broadband speeds, one could almost download a typical half-hour TV programme in real time (Williams, 2003). It also states that in one year, it will take less time to download a standard-definition film than to watch it. Today, with KaZaA it can – depending on factors such as whether other users are uploading or downloading the same movie – take a few hours to download a recent Hollywood movie.

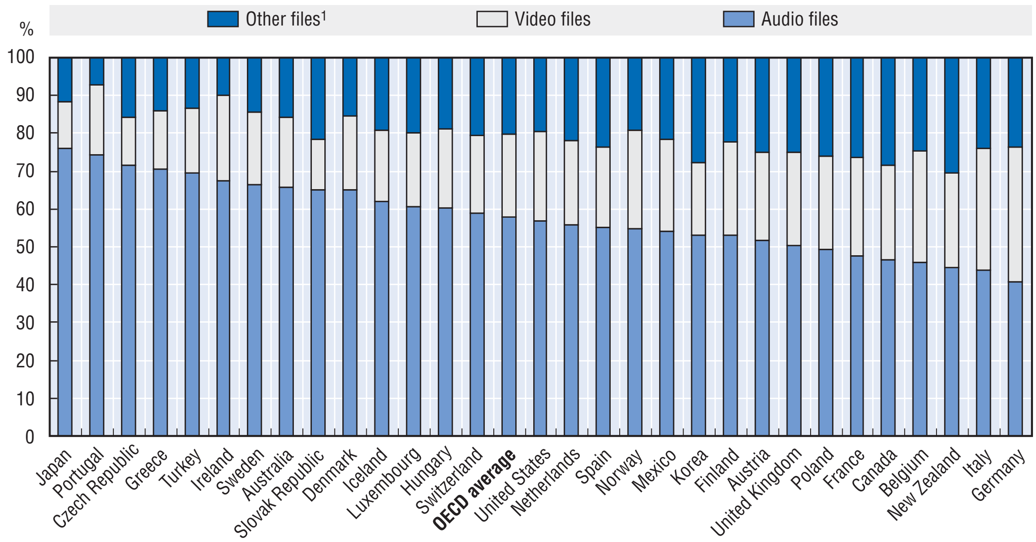
Some sources see increased non-commercial downloading as a threat to the sale of hard media (CDs, videos, etc.). In the United States, one in five young file sharers has downloaded a movie. By 2008, revenues from DVDs and tapes are expected to drop by 8%, while various forms of video on-demand will gross USD 4.2 billion (Forrester Research, 2003).

Figure 5.6 shows the breakdown of file use for individual OECD countries on KaZaA, a popular P2P network.

To access video and software files, Germany, Italy and New Zealand use P2P networks the most and Japan, Portugal and the Czech Republic the least. Other studies indicate that video content is more popular in Europe than in other OECD countries. This is partly due to the fact that the P2P technology most used in Europe (eDonkey) is particularly useful for sharing large files (600 MB or more), whereas most US users rely on FastTrack, which is a better resource for sharing smaller music and software files (3-7 MB) (Sandvine, 2003).

Lyman and Varian (2003) have found that the total size of video files being shared is greater than that of audio files (Table 5.10). The average size of an ".avi" file (a common video format) is 162 MB, while the average size of an ".mp3" (the most common audio format) is about 4 MB). In terms of the total number of individual files (as opposed to their cumulative size), audio is the most shared format by far. The files most commonly shared by P2P users are MP3 files, music files encoded using MP3 technology and .kpl files (KaZaA play list files). Lyman and Varian (2003) find that MP3 files use up to 30% of file users' hard disks. Image files (.jpg, .bmp) are also popular.

Figure 5.6. **File breakdown for OECD countries based on peak simultaneous KaZaA users, September-October 2003**



Note: Other files include software, documents, images and other files not included in the video and audio categories. The data are not representative of other P2P networks.
Source: OECD, based on BigChampagne data.

Table 5.10. **Size of traded files, 2003**

Type	Sum of size (GB)	Number of files	Percentage of total size
Video	8 661.6	126 217	58.7
Audio	4 929.4	1 253 308	33.4
Software	648.3	85 072	4.4

Source: Lyman, P. and H.R. Varian (2003), "How much Information 2003", *www.sims.berkeley.edu/research/projects/how much info* 2003/.

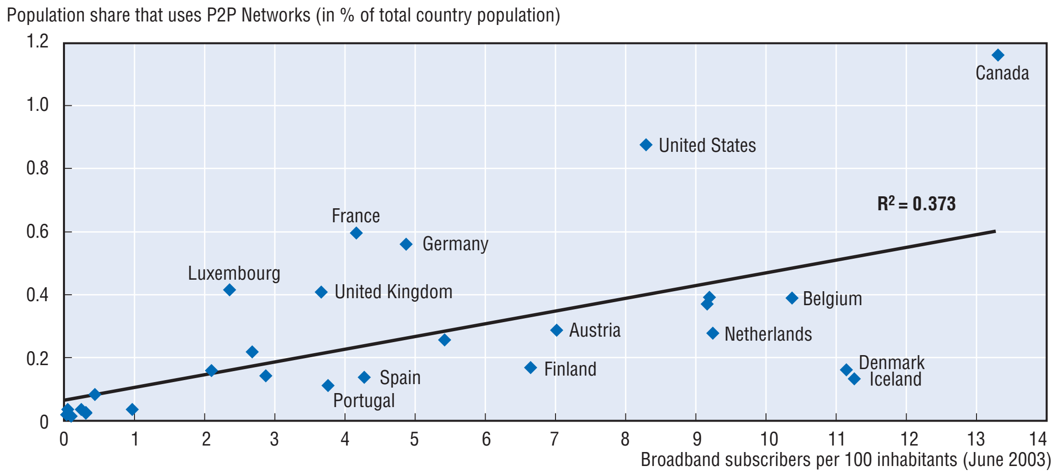
The ever-increasing amount and diversity of copyright-protected content circulating over P2P networks clearly present a challenge to governments and to firms. First, businesses are confronted with degraded network availability, reduced bandwidth, potentially lost worker productivity and the threat posed by the presence of copyrighted material on their networks (Blue Coat, 2004). Second, copyright owners fear the immediate non-commercial distribution of their work. Governments and courts have to determine what part of such activity is illegal and how intellectual property right frameworks have to be adjusted and enforced to reduce illegal file sharing.

Determinants of **P2P** *use*

Plotting the availability of broadband against P2P use (Figure 5.7) shows a positive relationship between P2P use and broadband availability. Studies for the United States indicate that availability of broadband increases downloading of music, films and other copyrighted works. According to Pew (2003), 41% of US Internet users with a broadband connection at home have downloaded music *versus* a quarter of dial-up users.

However, the availability of broadband alone does not explain P2P use (R-square: 0.37). According to BigChampagne, more people use P2P sites in OECD countries than have a broadband connection.

Figure 5.7. **Relationship between broadband access and P2P use in selected OECD countries, 2003**



Source: OECD, based on BigChampagne data and OECD ICT database.

Broadband certainly has a positive effect on the spread and intensity of P2P use (especially on the size of exchanged files). However, low bandwidth did not deter P2P users before the advent of broadband. For some Internet users (especially students), the desire to use P2P networks more efficiently may have influenced their decision to upgrade to broadband. In this case, it is the availability of content that drives broadband uptake and not the other way around.In any case, the relationship between technology uptake and the availability of content is a difficult one that deserves further study. Other important explanatory variables include factors such as age, educational attainment, income and whether or not the Internet user is a student.

Younger US Internet users are the most active P2P downloaders (Pew 2001, 2003). In 2001, 53% of users aged 12-17 downloaded music files via P2P networks. In a related finding, students are also more likely to download music, with 56% of full-time students and 40% of part-time students reporting downloading music files to their computer. Only a quarter of non-students report downloading files.

In the United States Internet users' household income and educational level appear to be negatively correlated with downloading behaviour. For example, 38% of Internet users in households earning less than USD 30 000 a year download music files, as opposed to 26% of those earning more than USD 75 000 (Pew, 2003), and more highly educated Internet users seem less prone to download music. Specifically, 23% of Internet-using college graduates download music files as compared to 34% of Internet users with lower levels of education (Pew, 2003). However, it is important to recall that students, who are usually counted as low-income and who have not yet completed their degree, are the most active file-sharing users. This and following student generations that have grown up with file sharing and free music are likely to continue using P2P networks and will be the hardest to convince to return to legitimate commercial services.

For France, for instance, the negative relationship between P2P use and income cannot be confirmed (Table 5.11). French students and managers (*cadres*) are most likely to download. French Internet users aged 18-24 are the most active P2P users, followed by users under 18 years and those aged 25-39. As the current generation of P2P users moves into older age brackets, file sharing is likely to become widespread at all ages. With respect to income, blue-collar workers earning less than EUR 900 a month are as likely to download music as persons earning more than EUR 3 100 a month. In addition, Internet users with a university diploma are more likely to download music than those with a high school or no diploma. In general, men are more likely to download music than women.

Table 5.11. **French Internet users having downloaded free music, movie or software files over P2P networks, June 2003**

Percentage of all Internet users

		Yes	No
Gender	Male	37	60
	Female	23	72
Age	12-17 years	31	66
	18-24 years	47	52
	25-39 years	31	65
	40-59 years	22	74
	60-69 years	(11)	82
Education	No degree	(21)	75
	High school diploma	33	62
	University diploma	35	61
	Individuals between 12 and 17 years	31	66
Profession	Self-employed	(28)	70
	Manager or posts of high responsibility	37	58
	Employee	26	69
	Blue-collar worker	31	67
	Retired	(14)	72
	Student	36	61
Monthly household income	Below EUR 900	36	60
	EUR 900 to EUR 1 500	28	67
	EUR 1 500 to EUR 2 300	31	64
	EUR 2 300 to EUR 3 100	27	69
	Above EUR 3 100	35	60

Figures in brackets may not be statistically meaningful and should be interpreted with caution.

Source: CREDOC (2003), "La diffusion des technologies de l'information dans la société française", Document réalisé à la demande du Conseil Général des Technologies de l'Information et de l'Autorité de Régulation des Télécommunications, Novembre, *www.art-telecom.fr/publications/etudes/et-credoc-2003.zip*.

New applications of P2P networks in research and business

P2P is not simply downloading of MP3 files. In fact, file sharing has already moved to the next level and will be applied to all types of online information – data distribution, grid computing and distributed file systems (USA *Today*, 2003; see also OECD, 2002). For example:

- In applying the P2P technology to Skype, a free, high-quality Voice over the Internet (VoiP) service that has diffused rapidly, another important driver of change in traditional telephone markets may have been kicked off.[12]
- Furthermore, banks already use file-sharing technology to transfer data to branches; in future, P2P platforms will be used for sharing proprietary information and distributing data for banking, insurance and other industries.
- Contiki, a travel service group, and Akamai, which provides e-business infrastructures, use P2P technology to help companies deliver sales presentations and multimedia content.
- The Linux company Lindows is continuing its experiment to offer software *via* P2P networks at half the normal price from its Web site, passing on lower networking costs to customers and increasing the number of simultaneous downloads.[13]
- P2P file sharing is also used in academia and government. Recently Penn State and MIT in the United States and British Columbia's Simon Fraser University in Canada started developing a P2P network to share academic materials faster and more reliably.
- The US government is using decentralised networks to exchange data,[14] and US federal agencies are reported have begun using P2P technology to get statistics and information from computers in over 100 different government agencies.

Digital delivery of business services

This section discusses digital delivery for a particular economic sector, business services (knowledge-intensive producer services). In this case, digital delivery is mainly part of on-line commercial transactions between businesses (outsourcing, digital product delivery) or of business processes along the value chain (on-line design collaboration, exchange of documents with customers, exchange of inventory information or outsourcing business processes such as IT, human resource or market research functions).

Characteristics and suitability of digital delivery for business services

The business services examined here include software and information services, R&D and technical services, advertising and marketing, business consulting, recruitment and human resource development services (based on OECD, 2003a, 1999). These activities are a significant and growing part of all OECD economies.

EU estimates put the European business services sector's turnover at around EUR 863 billion in 1999 (USD 918 billion) and employment at more than 11.6 million. Legal, accounting, market research and consulting was the largest segment, at around EUR 317 billion (USD 337 billion) or 38% of the total sector turnover. Architectural and engineering services accounted for around EUR 160 billion (USD 170 billion) or 18%, advertising services for EUR 115 billion (USD 122 billion) or 13%, and labour recruitment and personnel services for EUR 62 billion (USD 66 billion) or 7%. Partial data suggest that the telecommunications services sector's turnover was around EUR 287 billion (USD 256 billion) in 2001, and turnover in computer services around EUR 258 billion (USD 230 billion). Employment by these ICT services sectors was around 1 million and 2.1 million, respectively (E-business Watch, 2002, 2003). In the United States, professional, scientific and technical services revenues reached USD 937 billion in 2001, of which IT-related services accounted for USD 184 billion, management consulting services for USD 116 billion, advertising and related services for USD 72 billion, and scientific research and development services for USD 57 billion (US Bureau of the Census, 2003a).

While business services are very diverse, they do share some common characteristics. Many sectors have a few large multinational players and a large number of small specialist, niche, locally focused contractors. There is both consolidation at the top and churning, driven by technology, demand and supply below. Many business services have low barriers to entry with relatively low levels of capital intensity; exceptions are areas such as telecommunications services, which require significant investment in infrastructure. Economies of scale are typically linked to branding, reputation and experience. Price competition is strong in many areas, but is moderated to some extent in knowledge-intensive business services by the limited supply of highly skilled personnel and firm and niche specialisation. Demand for services and the performance of many business services providers are strongly (pro)cyclical, because they are linked to the fortunes of their customers. Moreover, because they often provide non-core functions, they may be among the early casualties in the event of a business downturn. Finally, because many business services firms operate in national and small local markets, e-business developments have opened these markets to increased competition, creating both an opportunity and a threat. In particular, the globalisation of clients in customer industries is driving international expansion of management consulting, human resource management and recruitment, computer and information services, marketing and advertising. Services firms seek to "own" customers by locating with them. This encourages them to establish offices in all major cities worldwide (Taylor *et al.*, 2002).

Most business services activities are information- and knowledge-intensive. Business services invest heavily in ICTs and content and, along with skilled personnel, these are their most important direct inputs and assets. However, given the amount of information and knowledge now easily, and often freely, available on the Internet, the core competence of services such as management consultancy is shifting from ownership of or access to knowledge towards an ability to organise and manage available knowledge and deliver tailored solutions to clients efficiently and effectively. As scale, regulation and internationalisation increase, many business services are becoming more complex. This drives the growth of services firms, as they try to encompass all the expertise required for the more challenging and multifaceted tasks before them.

The suitability of digital delivery for business services is mainly affected by the centrality of information exchange, level of standardisation, complexity of the task, nature of the problem addressed and the knowledge involved, and the context of delivery. Business services have elements of both codified and tacit knowledge and various levels of complexity and context. Business service problems which require high levels of tacit knowledge and are highly contextual are better co-located with customers unless they have extremely sophisticated technologies to overcome distance effects. Those working with clear problem specification, more codified knowledge and standard routines are able to handle distance effects more easily and such problem solving is more readily outsourced locally or internationally (Morris, 2000).

There is thus more scope for digital delivery where the exchange of information is a central part of the business model, where there is more scope for standardisation, where the complexity of the tasks involved can be managed, where the knowledge involved either is or can be codified, where the nature of the problem addressed by the service can be specified and defined, and where the context of the work involved is relatively low.

The importance of such issues is apparent in the development of the Indian software industry (Heeks *et al.*, 2000). Flecker and Kirschenhofer (2002) have examined the relocation of work and digital delivery in Europe and call attention to the fact that this generally creates or intensifies co-operation and triggers organisational and technological changes. Information and communication become more formalised as tacit knowledge is transformed into explicit or codified knowledge and there is a shift towards more comprehensive documentation and the digitisation of information.

Drivers and impediments to digital delivery

Drivers of digital delivery of business services are a combination of demand and supply factors, increasing technological opportunities and increasing availability of high-quality broadband networks.[15] On the demand side, the key drivers are a combination of those that drive outsourcing (purchase of business service inputs formerly produced internally, see Chapter 2) and e-business (see Chapter 3).[16] These include access to specialist skills, competitive pressures and cost control, and demand variability, all of which increase demand for digitally delivered business services. On the supply side, the key drivers relate to increasing demand and the need for greater richness and reach in customer relationships; the increasing size and complexity of projects that require more frequent and efficient interaction between suppliers and customers; the globalisation of suppliers in parallel with globalisation of client businesses; increasing internal cost and efficiency considerations; and competition among suppliers and downward pressure on prices.

Although e-commerce is a more limited concept than digital delivery, some aspects of the pervasiveness and complexity of digital delivery of business services can be identified in available e-commerce data. In a survey of e-commerce activities in Europe, the United States, Japan, South Africa and India, conducted in June-July 2001, supply-side services innovation and enhancement were a major driver of e-commerce adoption, with 77% of firms using e-commerce reporting doing so to offer new services to existing customers (Accenture, 2001). In the United States, the United Kingdom, France and Germany it was found that firms adopted customer-facing applications first, an indication that improved customer relations and enhanced market reach are major drivers of the adoption of Internet business solutions (Varian *et al.*, 2002, pp. 20 and 40).

On the demand side, a comprehensive survey of European establishments showed that major factors influencing the choice of an ICT-enabled services supplier were technical expertise (cited by 23%), cost (cited by 13%), supplier reputation (cited by 12%), and quality, reliability and creativity (cited by 12%). The importance of particular factors varies from service to service; for example, access to technical expertise is more often cited in software development, creativity more often cited in marketing, reputation more often cited in accounting and financial services, and cost more often cited in routine data processing and data entry services (Huws and O'Regan, 2001, p. 71). On the supply side, more emphasis is placed on reputation, quality and reliability than on cost or expertise. The survey found that reputation was cited as the reason for winning business by 21% of the supplying services companies surveyed, while reliability, quality and creativity were cited by 18%. By comparison, cost was cited by 10% and skills and technical expertise by 9.7% (Huws and O'Regan, 2001, p. 56).

Among the impediments to the digital delivery of business services, suitability of the particular services to digital delivery, concerns over security and privacy, internal and external skills availability, infrastructure and implementation costs, and regulatory barriers are some of the more important. In terms of digital delivery "readiness", lack of necessary skills, both internally and externally, is a widely cited barrier which can be addressed through better education and training as well as through increased adoption and thereby learning. A number of the other widely cited barriers are also likely to benefit from increased levels of adoption and consequent scale and learning opportunities. Cost- and skills-related barriers are felt more acutely by the many small firms in the business services sector. However, as digital delivery options develop, more solutions are likely to be better tailored to their needs. There are also barriers relating to standards, privacy, security and trust. The potential barrier of communications costs can be addressed through telecommunications reform and enhanced competition. Finally, there are a number of barriers that may be loosely described as cultural (*e.g.* management of remote work and international outsourcing contracts).

Extent and levels of adoption of digital delivery

Surveys of business services suggest that use of digital delivery and related e-business support are already extensive when looked at in terms of the proportion of firms offering digital delivery options, but do not yet account for a very large share of business services revenue (see Chapter 3). Digital delivery is more often supplementary and supportive than the main form of delivery. Nevertheless, an increasing number of business services firms have adopted, substantially and sometimes exclusively, on-line business models. Hence, the level of digital delivery of business services varies from country to country, from firm to firm, from service to service, between small, medium-sized and large firms, among metropolitan, regional and rural locations, among different business and cultural milieux, and among provider business models. Digital delivery is relatively mature in some services (*e.g.* software development and IT services) while still emergent in others (*e.g.* R&D and technical testing and business consulting).

Demand side

Businesses and organisations that outsource some of their activities and purchase goods and services on line are ready customers for digitally delivered business services. A European survey of establishments with more than 50 employees, found that in 2000 43% of establishments digitally outsourced at least one business service, 41% engaged in B2B digital delivery (ICT-enabled sourcing), 11% engaged freelancers using digital delivery, 35% outsourced within their own region, 18% outsourced to other regions within their own countries and 5.3% outsourced to companies in other countries (Huws and O'Regan, 2001, p. 16). Outsourcing was more prevalent in the Czech Republic, Hungary and Poland than in EU15, although this may be due to sample and respondent bias (the surveyed firms are more likely to outsource) (Mako and Keszi, 2003), and it appeared to be more widely adopted in Mediterranean Europe (Italy, Spain, Portugal and Greece) than in central Europe (Altieri *et al.*, 2003). In Australia, where a similar survey included small firms, 19% of establishments engaged in outsourcing, 16% to other businesses and 6% to individual freelancers using digital delivery. If small firms are excluded, ICT-enabled outsourcing levels are closer to European averages, with around 25% of establishments engaged in ICT-enabled outsourcing (24% used contractors and 7% freelancers) (Emergence, 2002, p. 15, 2003).

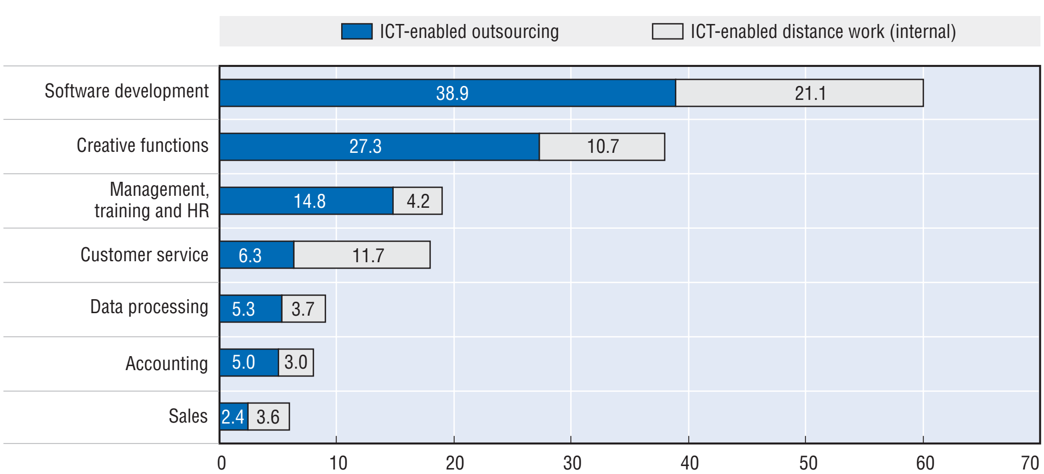
The European study also gives some indication of adoption and use of digital delivery in relative terms. Digital delivery of outsourced business services appears widespread; more than 75% of establishments that outsource receive digital delivery. Among these, almost 77% outsource to other establishments, while 66% outsource to individual freelancers that use digital delivery. Not surprisingly, digital delivery is more popular where services are delivered from a distance and internationally. No fewer than 88% of establishments that outsourced business services to a supplier in a different country received digital delivery, compared with 76% of those outsourcing to another region within the same country or within their own region (Huws and O'Regan, 2001).

Software development and creative functions (including marketing, advertising and R&D) are among the most common digitally delivered outsourced business services (Figure 5.8). Among European establishments surveyed, 39% reported using ICT-enabled outsourcing for software development, 27% for creative functions and 15% for management, training and human resources. When digitally delivered outsourcing of services is compared with the use of digital delivery in general (outsourcing plus internal ICT-enabled distance working) in the same sectors, ICT-enabled outsourcing is relatively more common in software development, creative functions and management, training and human resources (which used digital delivery outsourcing relatively frequently, although digital delivery was low overall), than in customer services (which used it relatively little and had little digital delivery overall) (Huws and O'Regan, 2001). In Australia too, software development and support is the most commonly ICT-enabled outsourced business function, followed by creative functions (editorial, design and R&D). However, firm size makes a significant difference to the functions outsourced, with larger establishments more likely to outsource customer services, data processing/typing and software development and support functions, and less likely to outsource creative, accounting and human resources functions (Emergence, 2002, p. 16).

Supply side

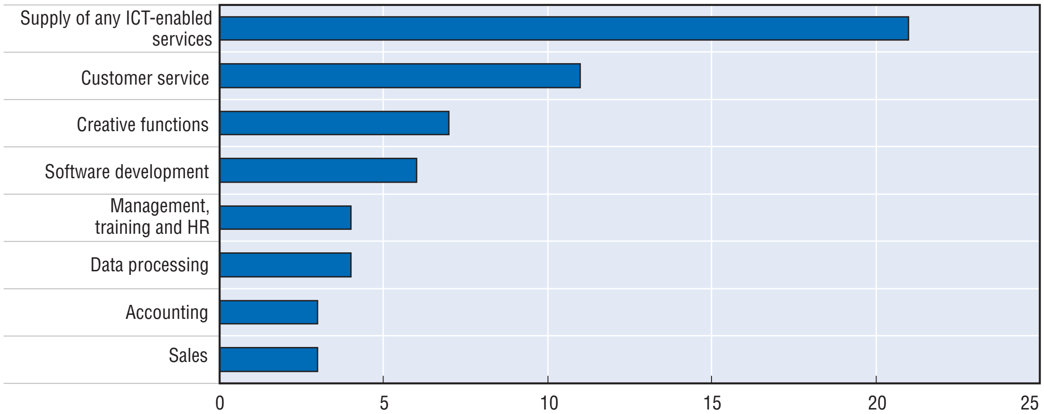
Data on e-commerce transactions in services (selling and buying on line) give some indications of the extent of digital delivery. In the United States, e-commerce revenues for selected services industries amounted to USD 37.3 billion in 2002, or approximately 0.8% of total revenues. Of this total, computer systems design and related services realised USD 3.5 billion in e-commerce revenues (2.1% of total) and other information services realised USD 2 billion (5.7% of total) (US Bureau of the Census, 2003b). The Boston Consulting Group (2000) reports that in Australia and New Zealand, B2B e-commerce transactions were worth USD 10 billion in 2000, or around 2% of all business purchasing. It estimates that 3.1% of B2B e-commerce (worth approximately USD 300 million) was in the business services sector.

Figure 5.8. **Outsourcing and digital delivery in Europe by function (demand side), 2000**
Percentage of establishments



Source: Huws, U. and S. O'Regan (2001), *E–work in Europe: Results from the 18-Country Employer Survey*, Institute for Employment Studies, IES Report 380.

Figure 5.9. **Supply of ICT-enabled services in Europe, 2000**
Percentage of establishments surveyed



Source: Based on Huws, U. and S. O'Regan (2001) *E-work in Europe: Results from the 18-Country Employer Survey*, Institute for Employment Studies, IES Report 380, p. 39.

In the European survey, 21% of establishments with more than 50 employees supplied business services electronically *i.e.* used digital delivery for the supply of business services (Huws and O'Regan, 2001, p. 40). However there were marked national differences, with high levels of supply in Poland, Hungary, Finland and the Netherlands and lower levels in Italy, France and Greece. In Australia, 15.4% of establishments surveyed in early 2002 delivered services digitally, with the inclusion of small firms in the sample making relatively little difference to the overall level of services supply reported (Emergence, 2002, p. 30). This suggests that digital delivery of business services in Australia is slightly below the European average, but on a par with such countries as Sweden and Germany.

In Europe, the services most commonly supplied were: customer services; design, editorial and creative functions (including advertising, marketing and R&D; and software development and support services (Figure 5.9). In Australia, the most common business services delivered digitally in early 2002 were customer services and creative functions (including editorial, design, marketing and R&D). Among medium and large establishments, human resources, software development and support, and accounting and financial services were the most common digitally delivered services, but among smaller establishments, human resources services were less commonly supplied (Emergence, 2002, p. 30). ICT-enabled outsourcing of human resources management and training functions is much less common in Australia than in Europe; outsourced call centres are also less common (Emergence, 2002, p. 45).

ICT *services*

ICT services should be major suppliers of services to other businesses via digital delivery, but surprising little is known about the level of digital delivery in ICT industries. In the United States, data on the adoption of various Internet-based business solutions in the group of industries "Service providers and telecommunications" (SIC 4812, 4813 and 4841) show that 50% of enterprises had adopted sales-force automation by late 2001, 69% had adopted e-commerce, 74% had adopted Internet-based marketing and 86% had adopted Internet-based customer service and support. In Canada, the rates were 26% for sales force automation, 46% for e-commerce, 64% for Internet-based marketing and 54% for Internet-based customer service and support. For the United Kingdom, France and Germany the rates were 27% for sales-force automation, 39% for e-commerce, 47% for Internet-based marketing and 74% for Internet-based customer service and support (Varian *et al.*, 2002, pp. 22 and 41) (see Annex Table C.5.5).

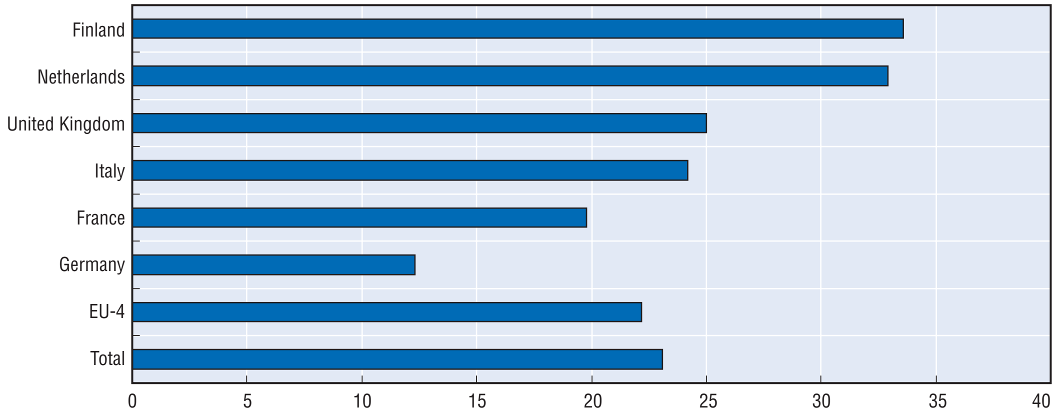
Available data suggest that a significant share of ICT services firms are selling on line but that sales volumes are low (Figure 5.10 and Chapter 3). In Europe in mid-2002 just over 22% of enterprises surveyed in the telecommunications and computer (ICT) services sector in Germany, France, Italy and the United Kingdom (EU4) were selling on line, although in 33% of cases on-line sales accounted for less than 5% of total sales.

Levels of on-line collaboration and services vary from country to country, with somewhat higher levels of digital delivery in Finland and somewhat lower levels in Italy. Levels of on-line collaboration and services are higher in Finland and somewhat lower in Italy. For example, 75% of ICT services enterprises in the United Kingdom and 67% in Finland exchanged documents with customers on-line in mid-2002, compared with 53% in Germany and 41% in Italy. In terms of *internal* support processes, more than 20% of ICT services enterprises in the United Kingdom and Finland used knowledge management systems to support digital delivery in mid-2002, compared with just 7% in Italy. Similarly, the use of on-line technologies to support human resources management varied from 13% of ICT services enterprises in Italy to more than 40% in Finland, and the use of on-line technologies in core project management functions (*e.g.* to track working hours and production time) varied from 9% in Italy to more than 50% in Finland (E-business Watch, 2002) (see Chapter 3).

Other business services

Other business services sell their services on line less than ICT services, and sales values remain low despite some evidence of increasing activity. In mid-2002, an average of 47% of business services enterprises in Europe were procuring on line, with 46% of them procuring direct inputs and 69% procuring maintenance, repair and operations supplies (MRO goods). Recruitment and standardised and digitised goods (*e.g.* media advertising space, images for advertising and marketing, etc.) were the most widely procured. Because of the tacit and face-to-face nature of many services, on-line sales are still quite uncommon in some areas of business services. In the EU4 countries, only around 10% of other business services[17] enterprises were reported to be selling on line in mid-2002, and in almost 60% of cases on-line sales accounted for less than 5% of total sales by value. Among business services

Figure 5.10. **European ICT services enterprises selling on line, mid-2002**
Percentage of all ICT services enterprises



Source: E-business Watch (2002) *ICT and e-business in the Telecommunications and Computer Services Sector*, European Commission, Sector Report No. 6, July. Data Annex: Enterprise weighted.

enterprises selling on line, just over 30% took customer payments on line, but around 67% provided after-sales service on line (E-business Watch, 2002).

Countries differ markedly in terms of the levels of on-line sales and related support activities reported by business services enterprises. Enterprises selling on line in mid-2002 varied from 21.5% in Ireland to just 3.5% in France, and while 67% of the business services enterprises selling on line in Italy accepted payment on line, none did in Germany. There appears to be major variations in the level of trust in on-line payments systems. The variation in the share of enterprises providing after-sales service on line varied significantly but somewhat less; almost all business services enterprises selling on line in France offered on-line after-sales services, while only around half of those in Germany and the Netherlands did so.

At mid-2002, 15% of enterprises in the European business services sector used on-line technologies to post job vacancies, and 13% used them to support human resources functions. At that time, 16% used on-line technologies to track working hours and billable time and 5.2% used automated travel reimbursement systems. Some 45% of employees in the business services sector in Europe worked in firms that allowed remote access to the firm's computer systems, and almost 42% of enterprises in the sector used on-line technologies to share documents and support collaborative work. Knowledge management systems were used by 7% of the small and 23% of the large firms in the sector, and almost 13% of all of the sector's employees worked in firms that used knowledge management systems. Around 20% of employees in the sector worked in firms that had extranets that supported collaboration with third parties (E-business Watch, 2002) (see Chapter 3).

In mid-2002, almost 58% of business services enterprises with Internet access in the EU4 countries used on-line technologies to exchange documents with customers, 51% used them to exchange documents with suppliers, 16% used them to collaborate with partners for designing products, 16% negotiated contracts on line, 9.4% collaborated on line with partners to forecast demand, and 7% used on-line technologies for management of capacity and inventory (E-business Watch, 2002). As in the case of digital delivery, digital delivery support activities varied among countries. In Denmark, 73% of business services enterprises with Internet access exchanged documents with customers on line in mid-2002, compared with just 37% in the Netherlands. On-line collaboration with business partners in the business services sector varied from more than 27% of enterprises with Internet access in Denmark to 5% in the Netherlands (E-business Watch, 2002) (see Chapter 3).

Impact of digital delivery

The impact of digital delivery is felt somewhat differently from country to country, from service to service and from firm to firm. The impact of digital delivery varies among countries, services and firms. At national level, the difference can be summarised in terms of readiness, diffusion and the impact environment (see Chapters 3 and 4). The economy must be digital-delivery "ready" before digital delivery of business services can take off. This involves, *inter alia*, access to affordable bandwidth, skills and services. Diffusion will depend upon convergence of the adoption of outsourcing and e-business on the demand side and the development of sustainable digital delivery business models on the supply side. The scope and scale of the impact will depend upon the capacity of management and government to realise potential benefits and on such factors as industry structure and competition to ensure the diffusion of benefits. Where these come together, the take-up of digital delivery of business services will be faster, the diffusion of digital delivery more rapid and extensive, and the impact of digital delivery greater and more widely felt.

At industry level, the impact of digital delivery is different for industries with strong economies of scale (*e.g.* packaged software) and those without (*e.g.* consulting). Distribution via digital delivery enables firms to grow and achieve lower average costs and may lead to some concentration. The effect will be greater if there are network effects (*e.g.* standardised packaged software). Conversely, in such areas as management consulting, owing to the enhanced availability and accessibility of information on the Internet, small firms may be able to compete more equally in some areas (*e.g.* market research) and deliver certain types of services worldwide (*e.g.* research reports). There is potential in some areas for new or adapted business models based on digital delivery and entry of new firms, which will tend to increase competition and put downward pressure on prices.

At firm level, the financial and organisational impacts of digital delivery can be significant. Substantial cost savings and revenue increases are widely reported owing to increased sales, access to more customers and improved customer relationships. Internally, efficiency of business processes and reduction of costs are also widely observed. Scattered evidence suggests overall that business services firms that adopt digital delivery and Internet business solutions, where applicable, increase revenues and decrease costs, thereby raising productivity. Impacts on employment were not measured to any extent in the studies examined, nor were impacts on international trade, although earlier OECD work (OECD, 2002) suggests that business-to-business e-commerce is somewhat less international than conventional commerce. The need for tacit information and face-to-face contacts in many areas of business services suggests that this could also be the case for business services.

Challenges to be addressed

Government policy challenges relate to: strengthening the framework for the digital delivery of business services and enhancing its diffusion, and ensuring that the business environment allows positive impacts to diffuse (Table 5.12). Key policy areas include: network infrastructure (*e.g.* broadband availability, network latency, communications costs); standards (*e.g.* formal and informal messaging standards); quality certification and accreditation (*e.g.* recognition of professional qualifications and service provider quality accreditation); intellectual property (*e.g.* R&D, design, software development and technical testing); privacy, security and authentication (*e.g.* handling customer information, accounting and financial records); commercialisation of public sector activities (*e.g.* R&D and technical testing); public contracting for services and serving as a demanding user (*e.g.* outsourcing leading-edge activities); leading the way (*e.g.* e-government, e-procurement); education and training (*e.g.* equipping workers for change at both entry level and through lifelong learning); labour market flexibility (*e.g.* enabling contract and agency staffing); competition policy (*e.g.* ensuring that business services industries remain competitive); and harmonising and simplifying international regulations (*e.g.* investment, legal, reporting and physical presence requirements). A key to reaping the full benefits of digital delivery lies in integrating it into full e-business processes and solutions: business value chains, front and back office, and internal and external processes. Technical, organisational and business skills are crucial to success in gaining benefits from digital delivery (see Chapters 3 and 6).

Table 5.12. **Digital delivery of business services**

Current status, potential and major policy issues

Service type	Potential	Current status	Major policy issues
Software development	High	Mature	IPRs, bandwidth, congruence
IT services	Moderate	Mature	Trade regulation, congruence
Information retrieval services	High	Mature	IPRs, bandwidth, security/authentication
R&D services	Moderate	Emergent/developing	Congruence, bandwidth, IPRs, security
Design services	High	Emergent/developing	Congruence, bandwidth, IPRs, security
Technical testing services	High	Developing	Bandwidth, IPRs, security
Advertising	High	Developing/mature	Bandwidth, privacy, security
Marketing	Moderate	Emergent/developing	Congruence
Business consulting	Low	Emergent	Congruence
Human resources (VET)	Moderate	Emergent/developing	Congruence, bandwidth, privacy
Labour supply	High	Mature	Labour market regulation, congruence
Recruitment	High	Developing/mature	Congruence, privacy, security

Note: Congruence refers to the fit between client and provider in areas such as co ordination and control systems, objectives and values, capabilities, processes and information technology.

Digital delivery of healthcare

This section discusses the application of digital delivery in healthcare, drawing on OECD (2003b). Although various healthcare activities and functions make intensive use of ICTs (*e.g.* advanced imaging technologies, data processing, record tracking), there is wide potential for integrating various technologies and for digital delivery as part of the process.

Characteristics and suitability of digital delivery for healthcare

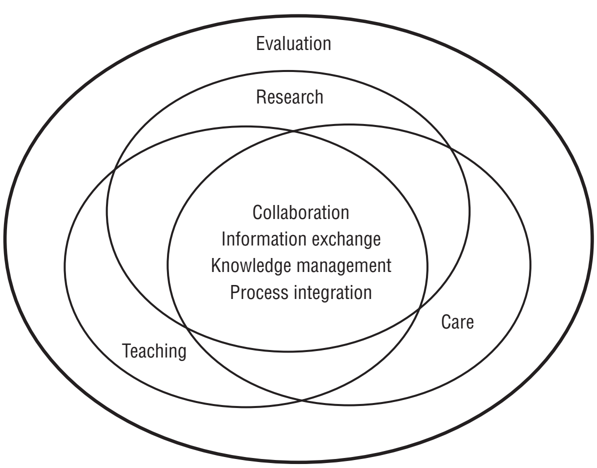
Digital delivery of health services is defined as the (direct or indirect) ICT-enabled movement of health-related goods, services and knowledge. These can take many forms and offer great potential for digital delivery as they involve content that can be stored, transmitted and manipulated in digital form This section looks at applications in four domains:

- ***Care***: consumer-oriented health Web sites, electronic exchange between patients and providers, on-line health records, patient monitoring and home care, remote consultation, digital medical image exchange, clinical transactions.
- ***Research***: biomedical databases, research collaboration, networks of clinical research centres of excellence in specific fields.
- ***Teaching***: distance learning, continuing medical education and self-care education courses.
- ***Evaluation***: peer review publication and data gathering for evaluation of the impact of digital delivery on health outcomes and the effectiveness of ICT policy in maintaining and accessing evidence-based databases on the effects of healthcare interventions.

A report by the US Institute of Medicine (2001) maintained that "automation and standardisation of clinical, financial and administrative transactions in the healthcare industry are essential to improving quality, preventing medical errors, enhancing consumer confidence, and improving efficiency". A wide range of studies have focused on specific scenarios and argue strongly that digital delivery can have significant clinical and economic benefits.

Figure 5.11 illustrates the role of digital delivery in health. In most studies, health ICT systems are examined in terms of the "care" domain, but it is too narrow to reveal the full potential impact of digital delivery. A "holistic" perspective on the "complex adaptive systems" (Institute of Medicine, 2001) in each domain is essential in order to analyse the dynamic and complex forms that digital delivery can take.

Figure 5.11. **Digital delivery domains in the healthcare sector**



Drivers of digital delivery

Digital delivery applications in the health sector are examined below in terms of readiness, diffusion and impact. Once the basic infrastructure is in place, the diverse systems are interoperable and privacy and security concerns have been addressed, digital delivery is likely to diffuse rapidly if unevenly and have widespread effects on healthcare. Important drivers include cost containment, quality improvement, universal access to care and realisation of the benefits of international co-operation. Other significant drivers include the rapidly increasing availability of inexpensive broadband Internet access and "Web-enabled" consumers who take greater control of their own well-being. Recently, global issues such as SARS and the threat of bio-terrorism have emerged as very significant drivers at both national and international levels.

Readiness

Broadband and WiFi. The rapidly increasing availability of inexpensive broadband infrastructure is a significant driver, and always-on, high-speed Internet connections are essential for many digital delivery applications. Many OECD countries are investing to increase broadband penetration; the United Kingdom, for example, has committed GBP 1 billion for establishing high-speed links to every hospital and doctor's office. WiFi is emerging as an increasingly attractive solution for providing low-cost, ubiquitous broadband access for providers and consumers of health services, despite the current limited range of signal capture (approximately 100 metres).

Open software standards and reusability. Increased reusability of software components through greater availability of open source applications and improved software development methods is another significant emerging driver. Standardised, component-based software reduces or eliminates impediments to interoperability of applications and data sharing due to incompatible data standards and high implementation costs. Such software makes digital delivery infrastructure and solutions more affordable and feasible on a global scale.[18]

Reimbursement. Reimbursement schemes that allow payment for electronic delivery of services is another driver for the adoption of digital delivery solutions, as are the presence of financing mechanisms and clear business models.

Diffusion

Extending geographical coverage of universal care. Countries such as Australia, Canada, Finland and Sweden with large areas of very low population density face significant challenges for meeting health policy goals such as universal access to quality care. Digital delivery via distance medicine applications is an important tool for overcoming the constraints of distance, time and availability of expertise.

National security and international co-operation. The transmission of infectious diseases across political and organisational boundaries is an important new driver. The SARS crisis and the threat of bio-terrorism are accelerating investment in bio-surveillance networks, collaborative medical research networks and disease management decision support systems.

Impacts

Cost containment. All healthcare systems face increasing financing challenges, and cost reduction is a major driver for implementing digital delivery solutions. As in other industries, digital information exchange makes possible more efficient movement and warehousing of supplies and facilitates the reorganisation of supply chains and physical infrastructure. Health enterprises see digital delivery as a way to reduce overhead through just-in-time warehousing and supply of drugs and other consumables and as an enabler of group purchasing. Thanks to digital delivery, capital-intensive infrastructure such as medical image archiving systems can be shared or outsourced, reducing duplication.

Quality. Digital exchange of knowledge and information improves care quality by eliminating sources of error. Prime examples of avoidable errors include the misinterpretation of handwritten medication orders and prescriptions and incorrect dispensing and administration of drugs. Error reduction is one of the most quickly realised, easily measured and dramatic benefits of digital delivery.

Integrated disease management. Management of chronic illnesses such as diabetes requires the integration of many areas of health expertise. Each actor in the "value chain" may specialise in different parts of the care protocol, *e.g.* diet, exercise, blood sampling and analysis. Digital integration is a very cost-effective tool for supporting complex and often *ad hoc* care paths and workflow.

On-line consumers. Motivated Internet-literate consumers are major drivers for on-line health information and services. More people will seek to take responsibility for and manage their health as the "baby boomer" generation develops more chronic illnesses and traditional health delivery channels become more overburdened. Consumer interest in health sites is confirmed by data presented earlier in this chapter and in Chapter 4. Despite the dot.com crash and the collapse of many health portals, surveys show that health is a prime goal of Internet information search (OECD, 2003b). Health consumers represent a large share of non-recreational US Internet consumers. Most on-line health consumers search for information on drugs and diseases. They are more likely to search for additional information after seeing an off-line advertisement for a prescription medication and are much more likely to take action off line (*e.g.* visit a doctor, request a prescription drug by name, consult a pharmacist, call a toll-free number). According to the Cybercitizen® Health Study (Manhattan Research LLC, 2003), on-line consumers of health information and products rose from 13.4 million or about one-third of on-line consumers in mid-1997 to 63.3 million or some 65% of total on-line consumers in the third quarter of 2002. By 2007, they are expected to increase by about another 50% to close to 100 million out of a total of about 132 million.

Impediments

As digital delivery enters its diffusion phase, the impediments are primarily human and organisational. Issues such as security and trust, driven by the need for confidence in the quality of information as well as the need for privacy and confidentiality slow the diffusion and implementation of digital delivery systems in the health sector. Reimbursement rules that do not allow claims for services delivered electronically are another. Rigorous evidence-based case studies that would convince decision makers of the value of digital delivery applications for health are not available. Finally, because benefits often accrue downstream from where investments must be made to ensure readiness, political or competitive boundaries can hamper investment in the necessary infrastructure.

A significant barrier to investment in digital delivery infrastructure and systems has been the paradox that "revenues/benefits often appear at one site and in one budget, while a large share of the costs/resource commitments appear at another site and in another budget" (Federation of Swedish County Councils, 2001). In addition, benefits such as better health outcomes and improved population health are difficult to demonstrate and quantify unequivocally. The digital delivery infrastructure for health is part of an "e-health commons", and it is often difficult for any single organisation to commit to funding the depth and breadth of components necessary for its successful establishment.

Basic infrastructure: broadband networks, security and trust. In many cases some of the prerequisite infrastructure components are missing or inadequate. Network infrastructure limitations such as bandwidth and accessibility are still common in many countries. The lack of private- or public-sector financing mechanisms for building infrastructure for digital delivery systems that span many organisations is also a major impediment. The legal infrastructure, including privacy and confidentiality legislation, often predates the advent of the Internet and does not facilitate digital delivery. Data relating to individual patients and visitors to a medical/health Web site, including their identity, are highly confidential. The consumer's involvement with on-line health systems depends both on his/her confidence in the quality and reliability of information and certainty that confidentiality is maintained.

Financing and reimbursement infrastructure. Administrative infrastructure such as purchasing and payment systems as well as reimbursement methods must be adapted to digital delivery. While the existence of payment schemes that reimburse digitally based delivery of services is an important driver for adoption, non-reimbursement of digitally delivered services is a common and significant impediment. Many health insurance systems require a physical meeting between physician and patient before payment for service is approved.

Awareness of and evidence on the case for digital delivery. Lack of awareness and understanding of the organisational and personal case for digital delivery is a major impediment. Very few studies contain clinical evidence on consumer-focused digital delivery. There is also a lack of evidence to support investment at the organisational level. Most digital delivery applications (remote consultation, patient monitoring) are stand-alone products and services that are only partially integrated into the mainstream health system. There is also a need for a clear business case before consumers make the investment necessary to benefit from digital delivery. Consumers are more likely to adopt digital delivery solutions when they are an integral part of self-care protocols that address their health problems and make use of their personal health records.

Skills and competence. As is the case when introducing any new technology, a significant investment of time and money in training is needed by both healthcare providers and consumers to establish the required competence for effectively employing digital delivery systems.

Technical and clinical standards. The lack and inconsistent implementation of technical and clinical standards also pose significant obstacles. Health systems still suffer from an incompatible variety of ICT technologies as a result of competition based on proprietary architecture strategies. ICT data standards such HL7 have not been implemented consistently, resulting in poor software integration and interoperability. This situation is exacerbated by budget cuts and the reluctance of healthcare organisations to replace legacy systems because of sunk costs. From a clinical perspective, reliable and consistent methods of data collection are lacking. Definitions and meanings of medical terms vary across countries, and coding schemes such as ICD9 are often subject to individual interpretation. It is difficult to compare or measure performance in health systems because coding at the point of care often distorts data (Bridges-Webb, 1986; OECD, 2003b).

Adoption and use of digital delivery

Table 5.13 outlines a range of goods and services amenable to digital delivery in each of the four domains discussed.

Table 5.13. **Digital delivery of goods and services by domain: current status and potential**

Domain/ type of service	Current status	Potential
A. Care		
General health information	Mature examples exist	Low – medium
Patient – provider e-mail	Some examples, no success yet	Medium
Personal health records	Emergent	Medium – high
Interactive personalised care plans	Emergent	High
Evidence based information	Emergent	High
Disease/population health management	Difficult to implement	High
Telemedicine applications	Emergent to advanced	High
Remote consultation	Emergent	High
B. Research/innovation		
Biomedical databases	Some examples exist	High
Remote control of experiments	Emergent	Medium – high
Publication on the Internet	Relatively mature	High for bandwidth intensive media
Researcher collaboration	Emergent	High
C. Teaching/learning		
Graduate education	Many examples	High for outreach
Continuing medical education	Many examples	Very high when linked to decision support
Patient education	Emergent	Very high
D. Evaluation		
Resource optimisation, utilisation, *e.g.* best use of medication, error correction, protocol adherence	Difficult to implement because of fragmented systems and lack of integrated measurement of outcomes	High
Resource allocation, *e.g.* best use of laboratories, emergency services, specialty care	Examples for specific areas, *e.g.* emergency bed availability	High
Health policy outcomes measurement	Difficult to implement because of lack of standards implementation and data capture at point of care	Very high

The range of possibilities for digital delivery to suppliers of health and healthcare-related goods and services is very broad. However, compared to what is possible the core business of healthcare delivery, research, teaching and evaluation remains virtually unaffected. Most digital delivery applications in these areas are project- or pilot-based and not permanent self-sustaining implementations. The most significant opportunities will be created when there is a critical mass of permanent implementations with attendant connections, interoperability and applications capabilities.

The most common permanent applications involve fairly simple, non-clinical transactions, such as electronic data interchange (EDI) applications for claims processing, or continuous medical education. The most mature applications are in the financial and administrative domains, including processing of health insurance claims and drug benefits and reporting of laboratory results, all of which are common and well established in many countries. The rapidly increasing adoption of ICTs and increased integration and standardisation suggest that suppliers have only exploited the tip of the iceberg. In Europe, for example, significant opportunities for managing drug delivery exist. A survey by Deloitte & Touche (European Commission, 2002) showed that nine out of ten hospitals managed stocks using computers, but that the supply of drugs was much less automated with only one hospital in two using IT applications.

The consumer is emerging as perhaps the most important strategic driver for digital delivery. It has been observed that "from the point of view of the consumer, the Internet has already become a critical resource when researching health information, making decisions about treatment options, and interacting with health professionals and organisations" (Basch, 2000). Consumers with chronic diseases (allergies, migraine, asthma, overweight, high cholesterol, diabetes) are highly motivated to use digital delivery systems to improve their quality of life. This will eventually lead to embedding digital delivery in care to enable electronic patient management, with resources devoted to quality and workflow enhancements to meet expanded definitions of care.

Table 5.14 summarises the routes for digital delivery in the care and teaching/learning domains that represent the largest number of users and are representative of the full range of routes that support health applications. These applications provide an ideal test bed for innovations in digital delivery because of their nature and complexity.

Table 5.14. **Digital delivery routes and infrastructure requirements**

Domain/service	Technology	Individual	Small institution	Large institution
		10 Mbps	100 Mbps	1 Gbps
A. Care				
High quality non-real-time video-imaging for diagnosis	File transfer	High quality	High quality	High quality
Cardiology neurology and emergency room consultations	H.323 video	High quality	High quality	High quality
Cineo-angiography and echocardiograms	H.323 video	High quality	High quality	High quality
3D Interactive brain imaging	SGI Vizserver	Unsupportable	Medium quality	High quality
Clinical decision-support systems	Web browsing	High quality	High quality	High quality
Advanced decision support systems	Image transfer		High quality	High quality
Home monitoring	Telemetry	Medium quality always on		
Home tele-visits	H.323 video	Medium quality		
Public health information	Web browsing	High quality		
C. Teaching/learning				
Professional tele-education	MPEG 1 video	High quality	High quality	High quality
Effective learning	Multimedia			
Browsing	High quality	High quality	High quality	
Comprehensive learning environment	H.323 video conferencing T.120 applications Sharing	Medium quality	High quality	High quality

Source: OECD, based on CANARIE (2001).

Impacts of digital delivery

Digital delivery may foster the simplification, differentiation and transformation of the health supply side. The creation of new, more complex supply networks and more rapid and dynamic restructuring of distribution channels will enable the transfer of care to more cost-effective locations and unbundling of services into the community.

Specialisation and differentiation. Customisation of services and product/service bundling is made possible because of the ability to establish electronic connections easily and facilitate the delivery of goods, knowledge and services to address the specific health needs of an individual or group. Broader access to and availability of more diverse and detailed economic data on health allow custom tailoring of reports, etc., to more specific and varied audiences. Demand for value-added, non-product-related services, creates opportunities for differentiation in areas such as clinical guidelines, disease management, decision support and on-line support communities.

Consolidation and integration. Digital delivery will drive the commoditisation of some services because it can facilitate consolidation into more cost-efficient and effective distribution channels. This can help contain or reduce health costs by increasing competition and reducing the possibility of market domination. In Canada for example, consolidation of the provincial drug formularies into a common national formulary could increase the provinces' buying power and thus reduce the total cost of drugs to Medicare.

Transformation. In some cases digital delivery will spark a radical transformation of the structure of the supply side of health. Elimination of distance and time barriers as well as the ability to link components of health systems in more dynamic and complex ways will create the conditions for important innovations.

Economic impact on healthcare, research, education and evaluation

There is a range of anecdotal evidence about the benefits of digital delivery for healthcare, but it has been difficult to measure benefits at the broader level of national or regional health systems. Overall, there is little published evidence showing whether telemedicine is a cost-effective alternative to standard healthcare delivery. A search of more than 600 cost-related articles on telemedicine found that only 9% contained any cost-benefit data, and only 4% of the articles met quality criteria (Whitten *et al.*, 2002). Most were small-scale, short-term, pragmatic evaluations with few general conclusions. An earlier study came to similar conclusions: "There are still few data on the effectiveness and cost-effectiveness of telemedicine. Of the more than 1 000 articles surveyed, most were reports about the feasibility of various applications, and only a few of the studies reported a controlled comparison of a telemedicine application with conventional means of providing services" (Roine *et al.*, 2001). There is some evidence on the efficiency of applications in clinical care and administration in a report by the US General Accounting Office (2003); it indicates improvements mainly in administrative savings, reduced errors and shorter waiting and processing times. Another US example showed that implementation of the barcode medication delivery and management system facility resulted in a 64% reduction in the medication error rate between 1993 and 1999 (Baldwin, 2002).

Care. The impact of digital delivery systems on care has often been described in terms of potential. It has been considered likely to change competition and accelerate the creation of new businesses in care services. Business processes related to delivery of care may be streamlined, resulting in increased output and productivity. New employment opportunities may arise that will require training and education of care services personnel. Data standardisation, a foundation for digital delivery, and use of high-speed broadband networks will help facilitate and drive increased international trade in care services.

Research. Research is the leading health domain in terms of applying and experiencing the impact of the Internet, digital information and digital delivery. International collaboration and competition in health research increased with the advent of the Internet. Genome research output, for example, has accelerated dramatically via Web-based collaborative tools and knowledge bases. Digital delivery enables unbundling and outsourcing of research services to lower costs and increase output in the same way as the software industry has employed talent in countries with skilled resources and lower costs such as India. This will both increase and shift employment in the field of health research. The need for reliable sources of trusted information will lead to greater research output, as well as customisation and repackaging of peer-reviewed research and evidence-based evaluation into marketable products and services.

Education. Health-related teaching and education services have adopted Internet and on-line strategies and used digital content extensively to improve and extend the availability of health-related teaching and information. New businesses have developed and adapted content for consumer and professional education. Medical schools are reducing the cost of training doctors and nurses and increasing their enrolment via Web-based courses. International trade in health education services is also increasing across the range of services trade modes. Digital delivery enables highly distributed teams of subject and media experts to work together to develop new, more broadly accessible education tools. New approaches to encoding, reformatting and localising information make possible cost-effective customisation of health education services for international markets.

Evaluation. Digital delivery will transform traditional evaluation methods for health, such as peer review of research and evidence-based evaluation, into marketable products and services. Web-based delivery and development of evidence-based "health knowledge" for healthcare professionals has existed for some time. Digital delivery will make this knowledge more available for international markets and packaged in ways that consumers can use. New businesses will emerge to satisfy the demand for reliable sources of trusted "evidence-based" health information for both consumer and professional.

Emerging issues and new challenges

Top-down ICT policy implementation regarding health has often been unsuccessful because of the complex characteristics and behaviour of health systems. It is difficult to impose top-down change and/or the adoption of single solutions. It may be much more effective to take a broader approach and to focus on shaping the environment that influences both group and individual behaviour through bottom-up strategies. However, these need to take into account obstacles due to insufficient and inconsistent implementation of technical and clinical standards. Effective application and reference implementations need to focus initially on interoperability and avoid greater incompatibility. Standards development and implementation need to be user-driven, simplified and more pragmatic so that a minimum critical mass of international standards is agreed for data exchange. It is essential that financing mechanisms and payment models encourage rather than impede the adoption and establishment of digital delivery (PricewaterhouseCoopers, 2001).

Care. Priority needs to be given to implementation of digital delivery of services, logistics and organisational innovation in areas such as diabetes, hypertension and obesity. These problem areas are well understood, affect large numbers of people and provide a very large return on investment. Digital delivery of knowledge and services has the potential to increase patients' understanding, commitment and compliance with care plans. The rapid emergence of the consumer and the community as strategic drivers for digital delivery should be more widely recognised. Suggested areas to be targeted include programmes to stimulate and support self-care and prevention and active involvement and responsibility for chronic disease management, home care and end-of-life care.

Research. Collaborative research needs to identify optimum interfaces between digital delivery technology and users, including development of open collaborative standards, knowledge sharing and applications. The field of bioinformatics has had notable success with open collaborative methods, software and tools and provides a good example.

Education and training. Education programmes on clinical and administrative management need to take greater account of both the individual and organisational cases for digital delivery. Significant investment of time and money in training and changes in management are required to establish the required competencies if consumers and healthcare providers are to employ digital delivery systems effectively.

Evaluation. The healthcare benefits and costs of digital delivery need to be measured consistently and rigorously. It would be useful to: *i*) embed evaluation processes, methods and criteria in the digital delivery infrastructure, using evidence-based, critical peer-review methods where appropriate; *ii*) integrate multi-participant measurement of the effectiveness of digital delivery solutions in areas such as early hospital discharge and home care; *iii*) collect longitudinal data from representative samples of health systems to measure the benefits and effectiveness of digital delivery of healthcare services. Digital delivery infrastructure and systems are also important for capturing and reporting the effectiveness of other health interventions and investments.

Policy dialogue and convergence. Many government actors are involved in technological development, the technical infrastructure and the economic environment that provide opportunities and incentives for the development and application of healthcare digital delivery. Government can help to ensure that their involvement is subject to the same kinds of economic scrutiny and evaluation as other areas of the economy where governments have a major financial and operational role. There is a further need to encourage dialogue on all aspects of digital delivery for health among different parts of government, as digital delivery touches all aspects of care, actors and organisations in the health sector.

Conclusion

Digital delivery of information and content via the Internet and computer-mediated networks is taking place in an expanding number of applications and sectors, and its level and complexity are increasing with the widespread diffusion of broadband. Its potential is evident in the millions of Internet visits, most frequent in the categories computer and Internet, adult, news and media, entertainment and shopping. Health and government have smaller shares but are important non-recreational uses and are growing relatively rapidly. Market share is concentrated in certain categories, with established business and finance firms attracting large shares of visits; new firms take top positions for Internet portals, shopping and classified, and employment. Important avenues for future study are factors that drive Internet visit patterns (*e.g.* search engine functioning, Web site linkages) and impacts on competition.

Peer-to-peer (P2P) digital delivery networks are developing rapidly. Analysis shows that digital delivery of increasingly large files is expanding. With approximately 10 million simultaneous users and a shift from audio to larger video files, non-commercial content downloads and other file-sharing applications continue to grow, along with related intellectual property issues. Factors currently influencing P2P use include broadband availability (for the size of files exchanged), student status and age (younger Internet users are more active). File-sharing applications are also developing in business areas that benefit from the electronic distribution of information and products.

The opportunities and challenges for development and delivery of digital content are well illustrated by business services, although lack of comparable data makes it difficult to measure their extent and impact. Within business services, software and IT services are current leaders in digital delivery, but all business services increasingly use it, particularly for document exchange and customer services. Digital delivery is driven by the potential to digitise business service inputs on the supply side and by outsourcing factors on the demand side and it is more advanced in countries with a well-developed network infrastructure and a strong business services sector. Technological factors, including the availability of broadband, play an important role, as do readiness for digital delivery, industry structure and competition, economies of scale and scope, and firm-level ability to capture the efficiency and productivity benefits on both demand and supply sides. Issues that require particular attention include services standards, accreditation and skills.

Healthcare is an intensive user of ICTs and digital delivery in administration, records and routine tasks, and advanced medical specialisations. There is large potential in care delivery (patient databases, ID cards, digital imaging, distance monitoring and consultation), administration (information exchange and interoperability), and training. Major impediments include the vertical structure of health institutions and specialisations; legacy ICT infrastructure that requires significant investment and co-operation to integrate; the need to reform insurance and payment schemes; and lack of collaboration between those who pay for and those who benefit from investments in new digital technology. However, there is very little rigorous monitoring and evaluation of the benefits and costs of applications to guide effective investment.

The increasing ubiquity of digital content and delivery is generating increasing policy attention. Policies ranging from R&D support to promoting trust on line (summarised in Chapter 8) influence the development and delivery of digital content, as does the presence of low-price, high-capacity broadband. Policies that further broadband availability, encourage investment in new content and applications, and balance the interests of suppliers and users in the protection of intellectual property will accelerate development and access to digital content (see the OECD Recommendation on Broadband Development). National and international frameworks for systems and payment security are necessary conditions, and the control of spam is crucial to reduce network congestion and enhance legitimate delivery of digital content (see Chapter 7). To the extent that there are market failures, measures may be needed to enhance content creation and supply, for example for the public sector.

NOTES

1. Other firms that measure Internet use are ComScore Networks and Nielsen/NetRatings.
2. A ranking on the basis of an annual average may be different from a ranking at the end of a period (*e.g.* October 2003).
3. The Hitwise category covers specifically: e-greetings, electronics, e-mail services, graphics and clip art, hardware, hosting and domain registration, Internet advertising, net communities and chat, paid to surf, search engines and directories, software, Web development and Webcams.
4. "What Sells Well", in Ecommerce News, *ecommerce.internet.com/news/news/print/*0,,10375_3112401,00.*html*, accessed 12 May 2004.
5. "Web Swallows Chunk of Prescription Sales", in Internetnews.com, 19 November 2003, *www.internetnews.com/stats/print.php/*3111481, accessed 12 May 2004.
6. These are foreign contents providers/firms that tailor their sites to the local market.
7. Record Industry Association of America (RIAA), *www.riaa.com/issues/default.asp*, accessed 12 May 2004.
8. "BigChampagne is Watching You", *Wired*, Issue 11.10, October 2003, *http://wired.com/wired/archive/*11.10/*fileshare.html?pg*=1, accessed 12 May 2004.
9. "Music Industry Commences New Wave of Legal Action against Illegal File Sharers", RIAA Press Statement, 3 December 2003, *www.riaa.com/news/newsletter/*120303.*asp*, accessed 12 May 2004.
10. "Apple Unveils Music Store", CNET News.Com, 28 April 2003; "Napster: 5 Million Songs Sold", CNET News.com, 23 February 2004; "Microsoft Considering Music Store", CNET News.Com, 25 July 2003.
11. Not all music downloaded over the Internet is non-commercial in nature or over P2P networks. It can be assumed however that non-commercial downloading over file-sharing networks is a large share.
12. "Janus Friis, cofondateur de KaZaA: Nous adaptons le peer-to-peer au téléphone pour secouer l'ordre établi", CENT News.com, French Edition, 18 Septembre 2003.
13. "Lindows Routes OS over File-sharing Networks", CNET News.com, 4 March 2004.
14. "US Government to Isolate Itself from P2P Risks", CNET News.com, 10 September 2003.
15. Boundaries between supply and demand are not limited to the business activity classifications of various services. Business services suppliers are major outsourcers (purchasers) of business services, and organisations such as government and non-profit entities also play a significant role on both the demand and supply sides.
16. Here digital delivery is a term much broader than e-commerce, involving interactions and exchange of digitised information and data along e-business value chains, which does not necessarily include formal buying and selling transactions.
17. The E-business Watch survey of business services covers: professional services (*e.g.* legal and tax consultancies as well as business consultancies); technical services (*e.g.* architectural and engineering activities as well as technical testing and analysis); marketing services (*e.g.* advertising and public relations); labour recruitment (including provision of personnel); operational services (*e.g.* investigation and security activities, industrial cleaning); and other services (*e.g.* photographers, packaging and direct mailing services, fairs and exhibitions). This grouping covers most services not included in ICT services. See E-business Watch, 2002.
18. Open Source Health Care Alliance, *www.oshca.org*, an EC funded SPIRIT initiative, *www.euspirit.org*.

REFERENCES

Accenture (2001), "The Unexpected eEurope: The Surprising Success of European eCommerce", Accenture, *www.accenture.com/eEurope2001*, accessed 12 January 2003.

Altieri G., L. Birindelli, P. Bracaglia, C. Tartaglione, D. Albarracín, J. Vaquero and V. Fissamber (2003), "eWork in Southern Europe", Institute for Employment Studies, Brighton, IES Report 395, *www.employment-studies.co.uk*, accessed 12 April 2003.

Baldwin, F.D. (2002), "It's All in the Wrist, Bedside Bar-code Scanning and Unit-dose Drug Packaging are Keys to Patient Safety, and More", *Healthcare Informatics*, October.

Basch, P. (2000), "Electronic Patient Management, The Expanding Concept of Quality Redefines the Electronic Medical Record", MedStar Health, eHealth Developers Conference, November.

Blue Coat (2004), "Establishing an Internet Use Policy to Address Peer-to-Peer (P2P) Use", Sunnyvale: Blue Coat, *www.bluecoat.com/downloads/whitepapers/BCS_Controlling_P2P_survey.pdf*, accessed 7 July 2004.

Boston Consulting Group (2000) "After the Land Grab: B2B e-commerce in Australia and New Zealand", December 2000, *www.bcg.com/publications/files/B2B_Paper_Final_Summary.pdf*, accessed 12 February 2003.

Bridges-Webb, C.J. (1986), "Classifying and Coding Morbidity in General Practice: Validity and Reliability in an International Trial", *Family Practice*, August, 23(2), pp. 147-150.

California Senate (2003), "Embracing the Digital Age of Entertainment", Hearing before the California Senate Select Committee on the Entertainment Industry on Peer to Peer File Sharing, 27 March 2003, *www.bigchampagne.com/BigChampagne_Senate_Testimony.pdf*, accessed 4 July 2004.

CANARIE (2001), The Next Internet: Broadband Infrastructure and Transformative Applications, Canada; Background Studies Commissioned for the National Broadband Task Force.

CNC (Centre National de la Cinématographie) (2004), La piraterie de films : Motivations et pratiques des internautes ; Analyse qualitative, Service des études, des statistiques et de la prospective, Paris, May, *www.cnc.fr/a_presen/r4/pirateriemotivprat.pdf*, accessed 8 July 2004.

CREDOC (Centre de Recherche pour l'Étude et l'Observation des Conditions de Vie) (2003), "La diffusion des technologies de l'information dans la société française", Report commissioned by the Conseil Général des Technologies de l'Information et de l'Autorité de Régulation des Télécommunications, November, *www.art-telecom.fr/publications/etudes/et-credoc-2003.zip*, accessed 8 July 2004.

CRITO (Center for Research on Information Technology and Organizations) (2004), "Diffusion and Impacts of the Internet and E-Commerce in Japan", by D. Tachiki, S. Hamaya and K. Yukawa, Center for Research on Information Technology and Organizations, Tokyo.

E-business Watch (2002), ICT & *E-business in the Business Services Sector*, European Commission, Sector Report No. 15, October.

E-business Watch (2003), ICT & *E-business in the Telecommunications and Computer Services Sector*, European Commission, Sector Report No. 6/III, July, www.ebusiness-watch.org/marketwatch/, accessed 30 October 2003.

Emergence (2002), *eWork in Australia: The Employer Survey*, Edith Cowan University, Perth.

Emergence (2003), *Cities are main eWork magnets in Australia*, *www.emergence.nu/news/ausreport.html*, accessed 12 July 2004.

European Commission Directorate General Information Society (2002), *The Emerging European Health Telematics Industry*, Market Analysis, February, Reference C13.25533.

Federation of Swedish County Councils (2001), "Telemedicine From a Management Perspective – From Trials to Standard Practice: Report from the Project 'Telemedicine – Regional and National Collaboration'", March.

Flecker, J. and S. Kirschenhofer (2002), *Jobs on the Move: European Case Studies in Relocating eWork*, Emergence & Institute of Employment Studies Report 386, Brighton.

Forrester Research (2003), "From Discs To Downloads", Forrester Research Report, August, *www.forrester.com/ER/Research/Report/Summary/0,1338,16076,FF.html*, accessed 6 July 2004.

General Accounting Office (2003), *Information Technology Benefits Realized for Selected Health Care Functions*, GAO Report to the Ranking Minority Member, Committee on Health, Education, Labor and Pensions, US Senate, Washington DC.

Heeks, R., S. Krishna, B. Nicholson and S. Sahay (2000), "Synching or Sinking?", Development Informatics Working Paper, Institute for Development Policy and Management, Manchester. *www.man.ac.uk/idpm*, accessed 30 June 2004.

Huws, U. and S. O'Regan (2001), *E-work in Europe: The Emergence 18-Country Employer Survey*, Institute for Employment Studies, IES Report 380, Brighton, *www.emergence.nu*, accessed 6 July 2004.

Lyman, P. and H.R. Varian (2003), "How Much Information 2003", *www.sims.berkeley.edu/research/projects/how-much-info-2003/*, accessed 6 July 2004.

Minar, N. and M. Hedlund (2001), "Peer-to-Peer Models Through the History of the Internet", Chapter 1 in *Peer-to-Peer: Harnessing the Power of Disruptive Technologies*, Oreilly Press.

Mako, C. and R. Keszi (2003), *eWork in EU Candidate Countries*, Institute for Employment Studies, Brighton, IES Report 396, *www.employment-studies.co.uk*, accessed 6 July 2004.

Morris, P. (2000) "World Wide Work: Globally Distributed Expert Business Services", Emerging Industries Occasional Paper 4, Department of Industry, Science and Resources, Canberra.

MPHPT (2003), *Information and Communications in Japan, Building a New Japan-based Information Society*, Japan Ministry of Public Management, Home Affairs, Posts and Telecommunications. *www.johotsusintokei.soumu.go.jp/whitepaper/eng/WP2003/2003-index.html*, accessed 6 July 2004.

New York Times (2004a), "Internet Said to Gain as Source for News", 12 January.

New York Times (2004b),"In Survey, Fewer Are Sharing Files (or Admitting It)", 5 January.

OECD (1999), *Strategic Business Services*, OECD, Paris.

OECD (2002), *Information Technology Outlook: ICTs and the Information Economy*, OECD, Paris.

OECD (2003a), *Digital Delivery of Business Services*, DSTI/ICCP/IE(2003)2/FINAL, *www.oecd.org/dataoecd/40/5/31818723.pdf*, accessed 7 July 2004.

OECD (2003b), *Digital Delivery of Health Care*, DSTI/ICCP/IE(2002)13/FINAL.

PEW (2001), "The Music Downloading Deluge", Pew Internet Tracking Report, 24 April, *www.pewinternet.org/reports/pdfs/PIP_More_Music_Report.pdf*, accessed 3 July 2004.

PEW (2003), Music Downloading, File-sharing and Copyright: A Pew Internet Project Data Memo, Pew Internet Tracking Report, 31 July, *www.pewinternet.org/reports/toc.asp?Report=96*, accessed 4 July 2004.

PEW and comScore (2004), "The Impact of Recording Industry Suits against Music File Swappers", Pew Internet Project and comScore Media Metrix Data Memo, January, *www.pewinternet.org/reports/pdfs/PIP_File_Swapping_Memo_0104.pdf*, accessed 4 July 2004.

PC Magazine (2003), "The Changing Face of Online Music", 24 September, *www.pcmag.com/article2/0,1759,1298685,00.asp*, accessed 4 July 2004.

PricewaterhouseCoopers (2001), "Care for ICT, An International Comparative Research Project of ICT Use in Healthcare in 8 Countries: Executive Summary, Country Profiles and Examples", February.

Roine, R., A. Ohinmaa and D. Hailey (2001), "Assessing Telemedicine: A Systematic Review of the Literature, CMAJ, 165(6), pp. 765-771.

Sandvine (2003), "Regional Characteristics of P2P: File Sharing as a Multi-application, Multi-national Phenomenon", An Industry White Paper, October, Sandvine Incorporated, *www.sandvine.com/solutions/pdfs/Euro_Filesharing_DiffUnique.pdf*, accessed 7 July 2004.

Star (2003), "A European Panel Approach to the Web Users and E-commerce", Issue Report No. 39, September, *www.databank.it/star/list_issue/f_3.html*, accessed 7 July 2004.

Statistics Canada (2003), High-speed on the Information Highway: Broadband in Canada, September, *www.statcan.ca/english/research/56F0004MIE/56F0004MIE2003010.pdf*, accessed 7 July 2004.

Statistics Finland (2003), *The Evolution of the Information Society: How Information Society Skills and Attitudes Have Changed in Finland in 1996-2002*, Statistics Finland, Helsinki.

Steinmueller, E.W. (2003), "New Directions for Social Science Research on IST; STAR Issue Report No. 33, September, Science and Technology Policy Research, Sussex.

Taylor, P.J., D.R.F. Walker and J.V. Beaverstock (2002), "Firms and their Global Service Networks", in Sassen, S. (ed.), *Global Networks, Linked Cities*, Routledge, London and New York, pp. 93-115, *www.lboro.ac.uk/gawc*, accessed 21 February 2003.

Technewsworld (2004), "P2P Networks Evolve: An Interview with StreamCast CEO Micheal Weiss", 26 January.

Technopolis (2003), "Indicators for European Digital Content for the Global Networks", Final Report for the Second Measurement for DG Information Society, Technopolis Group, Vienna, April.

US Bureau of the Census (2003a), *Professional, Scientific and Technical Services*: 1998-2001, Washington DC, *www.census.gov/econ/www/servmenu.html*, accessed 6 July 2004.

US Bureau of the Census (2003b), *E-Stats*, 19 March, *www.census.gov/estats*, accessed 6 July 2004.

US Institute of Medicine (2001), *Crossing the Quality Chasm: A New Health System for the 21st Century*, March, Committee on Quality of Health Care in America.

USA Today (2003), "File-sharing Goes to the Next Level", 16 November.

Varian, H., R.E. Litan, A. Elder and J. Shutter (2002), *The Net Impact Study*, January 2002, V2.0, *www.netimpactstudy.com*, accessed 7 July 2004.

Whitten, P.S., F.S. Mair, A. Haycox, C.R. May, T.L. Williams and S. Hellmich (2002), "Systematic Review of Cost Effectiveness Studies of Telemedicine Interventions", *British Medical Journal*, 324, pp. 1434-1437.

Williams, J.C. (2003), "Trends – Download an HD Movie in 5 Minutes!", Television and Video Systems Standards, study commissioned by the Motion Picture Association of America (MPAA), June.

Chapter 6

ICT SKILLS AND EMPLOYMENT

Two measures of ICT-skilled employment are developed in this chapter, one covering ICT specialists only and one that also includes basic and advanced intensive users of ICTs. The share of these two measures in total employment is calculated by industry. Many services industries have a very large share of such broadly defined ICT-skilled employment, as do certain manufacturing industries. The ICT-skilled employment share is also associated with higher levels of productivity. Four ways in which ICT skills needs can be satisfied, namely through education, training, outsourcing and immigration are examined, and the role of Internet recruitment is also considered.

Introduction

This chapter examines the diffusion of ICTs from the perspective of skills and employment.[1] It first builds up a picture of the demand for ICT skills across economic sectors, particularly those that employ people with ICT skills relatively intensively. In changing ways in which business is carried out, ICTs have led to productivity gains and new employment opportunities, with new demands in terms of workers' skills. In the past, the use of ICTs has often been measured in terms of ICT investment. Here it is investigated through actual use, *i.e.* by measuring the share of each sector's workforce that is likely to use ICTs directly to produce output. The chapter then addresses the supply of ICT skills, in particular the ways in which ICT skills needs can be satisfied: education and training, but also outsourcing and immigration. Finally it draws attention to Internet recruitment, which brings together ICT skills, use of ICTs and finding employment and filling jobs.

ICT skills: where in the economy are they found?

The following discussion takes a new approach to capturing the diffusion of ICTs throughout the economy by examining the level of their use and identifying the sectors that employ people with ICT skills relatively intensively. Two definitions of ICT skills are used, approximated by occupational data. One is narrow and corresponds to the first category of ICT skills described in Box 6.1, and one is broad and attempts to capture all three of the competency levels (*i.e.* ICT specialists as well as basic and advanced ICT users). These measures are then used to classify industrial sectors according to their share of ICT-skilled employment. The section concludes with a brief examination of these sectors' performance, relating the ICT-skilled employment measure to a productivity measure.

ICT-*skilled employment*

Methodology and classification

ICT-using sectors are identified here by their employment of ICT-skilled personnel, *i.e.* by the level of their actual ICT usage, rather than by investment in ICT capital. Industries are then grouped according to the ICT-skills specialisation of their workforce, or the industry's share of ICT-skilled employment (see van Welsum and Vickery, 2004).

The term "ICT employment" can be interpreted in two ways: *i*) employment in industries traditionally identified as belonging to the ICT sector (all occupations, even those with no use of ICTs); and *ii*) employment in occupations that use ICTs to various degrees across all industries. The focus here is on the latter.

The standard list of ICT occupations used to date in OECD publications[2] (previous editions of the *Information Technology Outlook*, the STI *Scoreboard* and *Measuring the Information Economy*), roughly refer to the first category (ICT specialists). The approach taken here in the broad definition is a first attempt to identify the sum of the three levels of ICT skills, *i.e.* both ICT specialists and advanced and basic ICT users. However, in the absence of formal guidance as to ICT content in the various occupational classifications used by countries, which are used to approximate skills,[3] occupations were chosen on the basis of an assessment of the degree to which workers are expected to use ICTs for their own output/production.[4]

The way in which ICT and/or IT occupations have been defined in other studies is illustrated in Annex Tables C.6.9 and C.6.17-to C.6.21. To be consistent with previous OECD publications, the

Box 6.1. Defining ICT skills

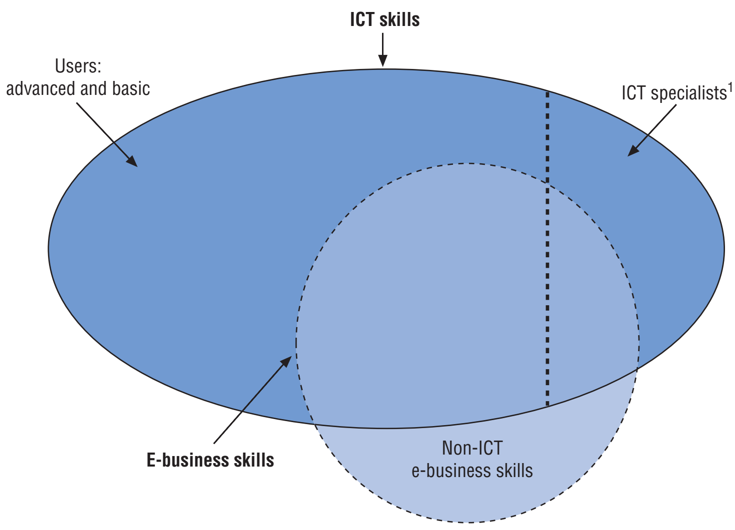
There is currently no commonly adopted definition of ICT skills, but efforts are ongoing to characterise the various types of ICT skills, for example through the European e-Skills Forum (2004). It is important to bear in mind that while the term "skills" refers to a set of capabilities, it may have different meanings for an employer or a jobseeker. We propose to distinguish three categories of ICT competencies:

1. ICT *specialists*, who have the ability to develop, operate and maintain ICT systems. ICTs constitute the main part of their job.
2. *Advanced users*: competent users of advanced, and often sector-specific, software tools. ICTs are not the main job but a tool.
3. *Basic users*: competent users of generic tools (*e.g.* Word, Excel, Outlook, PowerPoint) needed for the information society, e-government and working life. Here too, ICTs are a tool, not the main job.

Thus, the first category covers those who supply the tools, and the second and third categories those who use them. This chapter uses the first category for the narrow measure of ICT-skilled employment, and the sum of all three categories for the broad measure of ICT-skilled employment.

Finally, the term "*e-business skills*" is increasingly used. It refers to skills that are needed to exploit the business opportunities provided by ICTs, and in particular the Internet, to explore possibilities for new ways of conducting business, to enhance the efficiency of various types of organisations, and perhaps even to establish businesses (European e-Skills Forum, 2004). These skills play an increasingly important role in a company's competitiveness (see Chapter 3) and include both ICT specialist and ICT user skills, as well as non-ICT e-business skills (*e.g.* managerial and organisational skills).

The image below synthesises and combines the above descriptions of ICT skills:



1. Includes programmers, but also equipment and cable fitters, for example.

standard list of ICT occupations is used here for Europe and the United States for the narrow definition of ICT-skilled workers (similar to the ICT specialists group of Box 6.1) with some minor changes to the US list. The broad definition adds those who can be considered as advanced and generic users (see the tables in Annex C for details).

- Europe

The section on ICT employment across the economy and Figure 1.16 in Chapter 1 show that ICT-skilled employment has generally increased in EU15 countries under both the narrow and broad definitions (see Annex Table C.6.1 for a list of occupations included in these two measures). In 2002, the narrow share of ICT-skilled employment was comprised between 2.4% (Greece) and 5.0% (Sweden), and the share of broad ICT-skilled employment between 13.5% (Portugal) and 27.6% (United Kingdom).

Data from the European Labour Force Survey for 2002 are used to calculate the intensity of ICT-skilled employment by industry (using the three-digit ISCO88 classification and the two-digit Classification of Economic Activities in the European Community – NACE). The intensity of ICT-skilled employment is defined as the ratio of those employed under the narrow or broad definitions in an industry to total employment in the industry.[5]

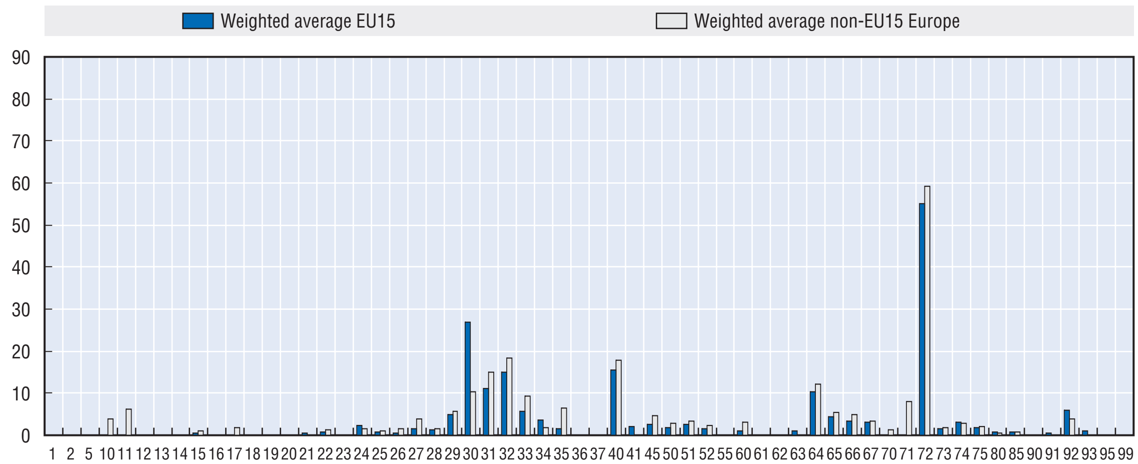
The use of ISCO88 presents some drawbacks. First, it is less detailed than the classifications available for countries such as the United States, Korea and Australia. As a result, electronic engineers cannot be included in the narrow definition, even though they may be heavily involved with jobs relating to ICT hardware, because ISCO88 does not distinguish this category separately. As a result, the narrow intensity ratios are likely to be somewhat lower than they otherwise would be. Furthermore, because it is an old classification, it may pose a problem for new occupations. While most countries are able to incorporate new job categories in their national classifications, it may not be possible to take them into account when recoding into ISCO88. For example, desktop publishers would be placed in ISCO88 category "3471 Decorators and designers", whereas some of the more detailed lists of occupations for other countries distinguish this as a separate category which can be included in the broad definition. Nevertheless, ISCO88 provides (more or less) comparable data for most European countries, and some of the involuntary exclusions or inclusions that result from the relatively higher level of aggregation may even out.

Figures 6.1 and 6.2 show the sectoral distribution of the weighted average across countries of the share of ICT-skilled employment in total employment, where the weights are calculated as the ratio of employment in industry *i* in country *j* divided by total employment in industry *i* across all countries.

In both figures, two sectors have a very high share of ICT-skilled employment in total employment. The first, 30:Manufacture of office machinery and computers, is also where the difference between

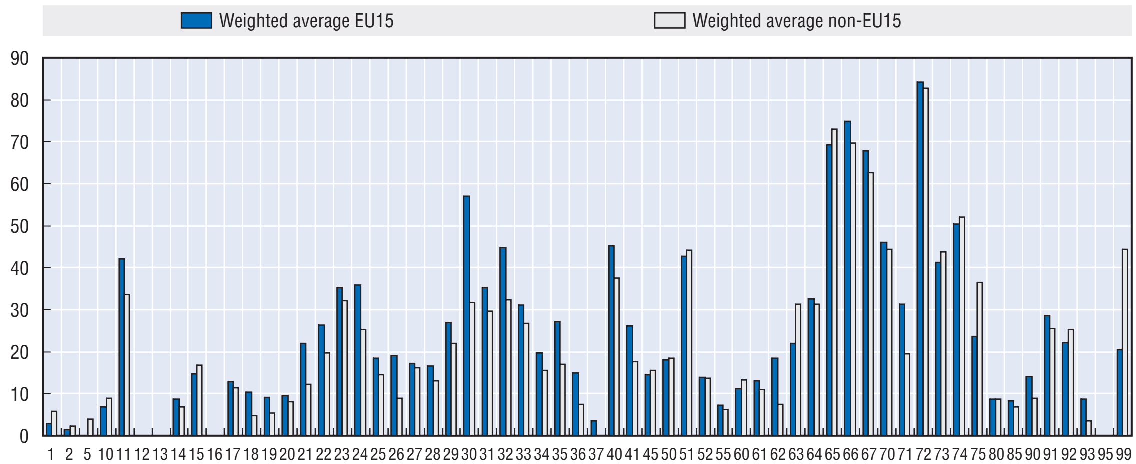
Figure 6.1. **Europe: share of ICT-skilled employment in total employment, narrow definition, by sector, 2002**

Percentages



Note: Data refer to 2002. Non-EU15 data refer to non-EU15 Europe: Iceland, Norway, Switzerland, Czech Republic, Hungary, Slovak Republic. As fewer data were available to calculate the ratios for non-EU15 Europe, outliers may have a relatively larger effect than in the EU15 distribution.
Source: OECD, based on EULFS (2003).

Figure 6.2. **Europe: share of ICT-skilled employment in total employment, broad definition, by sector, 2002**
Percentages



Note: Data refer to 2002. Non-EU15 data refer to non-EU15 Europe: Iceland, Norway, Switzerland, Czech Republic, Hungary, Slovak Republic. As fewer data were available to calculate the ratios for non-EU15 Europe, outliers may have a relatively larger effect than in the EU15 distribution.
Source: OECD, based on EULFS (2003).

EU15 and the rest of Europe is greatest. The other is 72:Computer and related activities. Non-EU15 Europe has a relatively larger share than EU15 countries of broad ICT employment in 99:Extra-territorial organisations and bodies.

The next step is to divide the distribution into industries with low, medium and high intensity of ICT-skilled employment. The classification obtained by ranking the weighted average of the intensity of ICT-skilled employment for EU15 countries is shown in Table 6.1. Sectors with an intensity of 30% and above are considered as high-intensity, those between 10% and 30% as medium-intensity, and those below 10% as low-intensity.[6]

A striking number of services sectors are included in the high-intensity group, mainly at or near the top of the ranking, along with some manufacturing sectors and wholesale trade. The medium-intensity group is dominated by manufacturing industries, but also includes retail trade and printing and publishing. The low-intensity group is dominated by primary industries and personal services industries (as opposed to business services industries which tend to be in the high-intensity group).

- United States

Data for the United States are taken from the Current Population Survey (CPS). The occupations included in the narrow definition are very similar to those used in previous OECD publications. For the broad definition, the same method was applied as for the European countries, and efforts were made to maximise comparability across countries, but without harmonising the classifications. See Annex Table C.6.2 for detailed information on occupations included in these aggregates.

Figure 1.16 in Chapter 1 shows the evolution of the ratio of these two measures to total employment. By 2002, narrow ICT-skilled employment accounted for 3.8% of total employment in the United States and the broad measure for 20.6%. The narrow measure was flat in 2000 and 2001 and declined in 2002; the broad measure started its decline in 2000.

Table 6.1. **Europe: classification of industries according to their intensity of broad ICT-skilled employment, 2002**

Decreasing order, percentages

NACE 2 digit	Industry	Intensity (%)
High-intensity		
72	Computer and related activities	84.2
66	Insurance and pension funding, except compulsary social security	74.8
65	Financial intermediation, except insurance and pension funding	69.2
67	Activities auxiliary to financial intermediation	67.9
30	Manufacture of office machinery and computers	57.1
74	Other business activities	50.4
70	Real estate activities	46.1
40	Electricity, gas, steam and hot water supply	45.1
32	Manufacture of radio, television and communication equipment and apparatus	44.8
51	Wholesale trade and commission trade, except of motor vehicles and motorcycles	42.7
11	Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction excluding surveying	42.0
73	Research and development	41.3
24	Manufacture of chemicals and chemical products	35.9
31	Manufacture of electrical machinery and apparatus, n.e.c.	35.3
23	Manufacture of coke, refined petroleum products and nuclear fuel	35.2
64	Post and telecommunications	32.6
71	Renting of machinery and equipment without operator and of personal and household goods	31.4
33	Manufacture of medical, precision and optical instruments, watches and clocks	31.0
Medium intensity		
91	Activities of membership organisation, n.e.c.	28.6
35	Manufacture of other transport equipment	27.2
29	Manufacture of machinery and equipment, n.e.c.	26.9
22	Publishing, printing and reproduction of recorded media	26.4
41	Collection, purification and distribution of water	26.2
75	Public administration and defence; compulsary social security	23.6
92	Recreational, cultural and sporting activities	22.3
63	Supporting and auxiliary transport activities; activities of travel agencies	22.1
21	Manufacture of pulp, paper and paper products	21.9
99	Extra territorial organisations and bodies	20.5
34	Manufacture of motor vehicles, trailers and semi trailers	19.7
26	Manufacture of other non-metallic mineral products	19.0
62	Air transport	18.5
25	Manufacture of rubber abd plastic products	18.4
50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel	18.1
27	Manufacture of basic metals	17.1
28	Manufacture of fabricated metal products, except machinery and equipment	16.7
36	Manufacture of furniture; manufacturing n.e.c.	14.9
15	Manufacture of food products and beverages	14.7
45	Construction	14.5
90	Sewage and refuse disposal, sanitation and similar activities	14.0
52	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	14.0
61	Water transport	13.0
17	Manufacture of textiles	12.9
60	Land transport; transport via pipelines	11.2
18	Manufacture of wearing apparel; dressing and dyeing of fur	10.4
Low intensity		
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	9.5
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	9.2
80	Education	8.8
14	Other mining and quarrying	8.8
93	Other service activities	8.6
85	Health and social work	8.3
55	Hotels and restaurants	7.2
10	Mining of coal and lignite; extraction of peat	6.8
37	Recycling	3.6
1	Agriculature, hunting and related service activities	2.9
2	Forestry, logging and related activities	1.5
95	Private households with employed persons	0.4
5	Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing	0.0
12	Mining of uranium and thorium ores	0.0
13	Mining of metal ores	0.0
16	Manufacture of tobacco products	0.0

Source: OECD, based on EULFS (2003).

Figures 6.3 and 6.4 show the distribution of industries for the United States based on the intensity of ICT-skilled employment according to the narrow and broad definitions, respectively. The ICT-producing sectors have a high intensity, as do some of the services and retail sectors. Details of the distribution are given in Annex Table C.6.3.

Table 6.2 shows the 70 industries (out of 236) classified as high-intensity under the broad definition, *i.e.* with a ratio of ICT-skilled employment to total employment of over 30%, and the first 70 industries under the narrow definition (35 of the first 70 industries in the broad classification are also among the first 70 in the narrow classification). Many services sectors appear at the top of the list, as in the European classification. An interesting difference with the latter is the presence of quite a few retail sectors in the high-intensity group, whereas retail is classified as medium-intensity in the European distribution. Although this may be due simply to the difference in aggregation, for example, it is consistent with the idea that retail trade is more ICT-intensive in the United States than in Europe. The complete classification obtained on the basis of the broad definition is given in Annex Table C.6.3.

- Japan

Although the data provided by the Statistics Bureau of the Japanese Ministry of Public Management, Home Affairs, Post and Telecommunications is much less detailed (only 15 different occupations distinguished[7]), an attempt was made to repeat the same exercise as for Europe and the United States. Figure 6.5 gives the ratio of ICT-skilled employment to total employment by sector.

Annex Table C.6.4 classifies industries by ICT-skilled employment shares. Again, most services sectors have a high intensity of ICT-skilled employment. Some manufacturing industries seem to have somewhat lower intensities than in Europe and the United States, but this is probably due to the high level of aggregation in the occupational data, and the different aggregation of industries.

- Korea

Data on employment by occupation (three-digit KECO: Korean Employment Classification of Occupations) and industry (two-digit KSIC: Korean Standard Industrial Classification) were provided by the Work Information Center, Human Resource Development Service of Korea. Occupations to be included under the narrow and broad definitions of ICT-skilled employment were chosen on the same basis as for the other countries and efforts were made to maximise comparability, but without harmonising the classifications (see Annex Table C.6.5 for details).

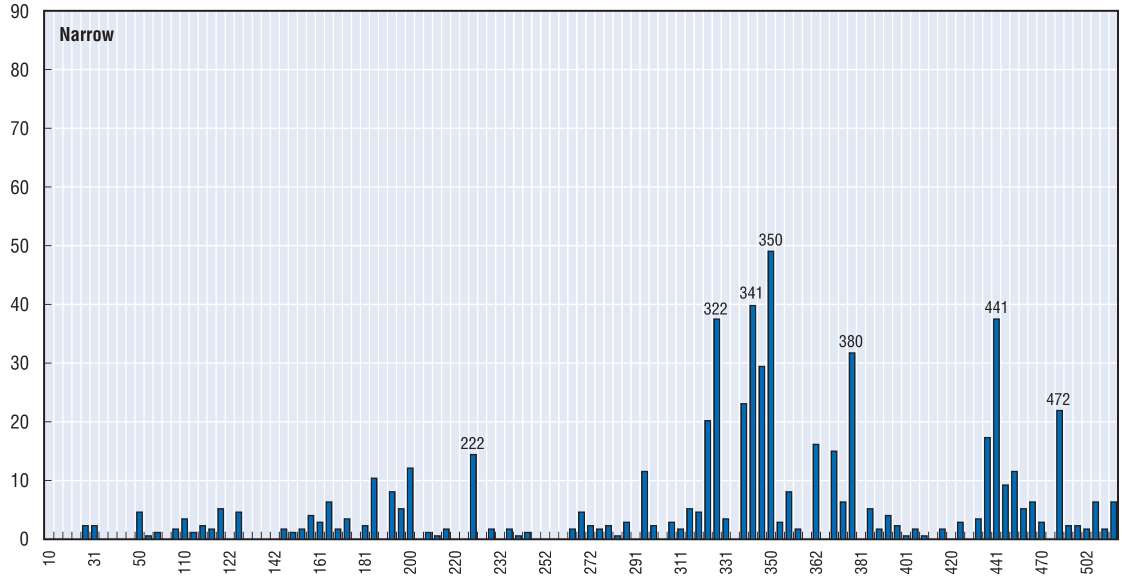
Annex Table C.6.6 classifies industries on the basis of their ICT-skilled employment intensity. As in other countries, most services industries and manufacturing of computers and office machinery are in the high-intensity category (over 30%). However, the distribution of industries across high-, medium- and low-intensity categories is more uneven than for other countries. In particular, relatively fewer industries are classified as having high intensity of ICT-skilled employment.

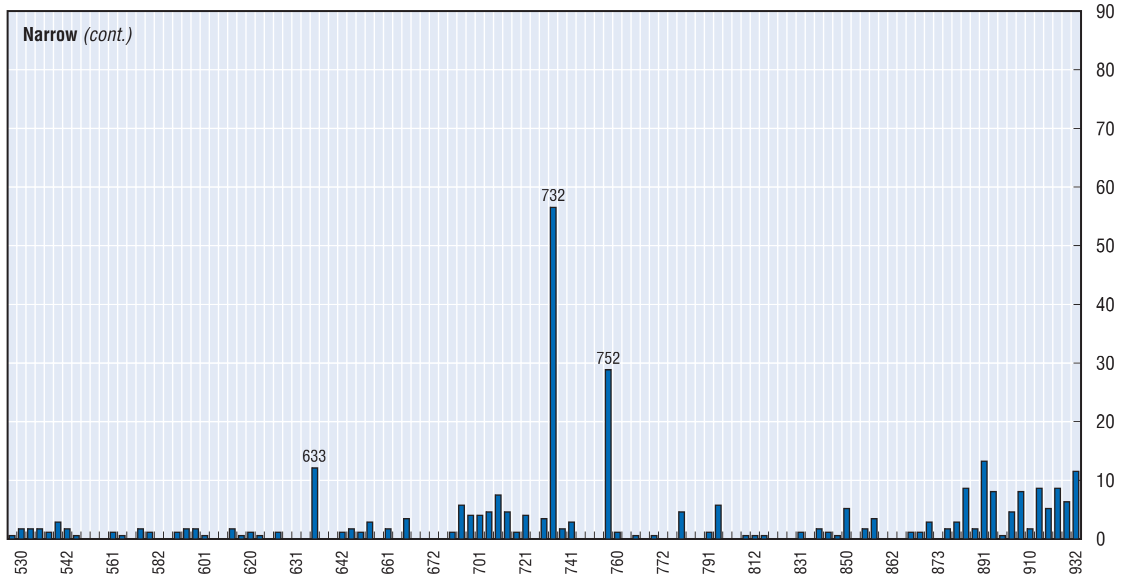
- Australia

The Australian Bureau of Statistics (ABS) provided aggregated data on employment by occupation by industry, based on four-digit ASCO (Australian Standard Classification of Occupations) and two-digit ANZSIC (Australian and New Zealand Standard Industrial Classification). The ABS collects labour force data on a quarterly basis and uses the ASCO (second edition) to classify occupations according to skills level and skills specialisation. Occupations were included in the narrow and broad definitions (see Annex Table C.6.7) on the same basis as for other countries and efforts were made to maximise comparability across countries, but without harmonising the classifications.

Annex Table C.6.8 classifies industries according to their intensity of ICT-skilled employment. As for most countries, services sectors dominate the top of the ranking. Some mining and extraction industries and related services are also classified as high intensity, *i.e.* with at least 30% of ICT-skilled employment. In contrast to most other countries, no manufacturing industries are ranked as high-intensity (although

Figure 6.3. **United States: share of ICT-skilled employment in total employment, narrow definition, by sector, 2002**

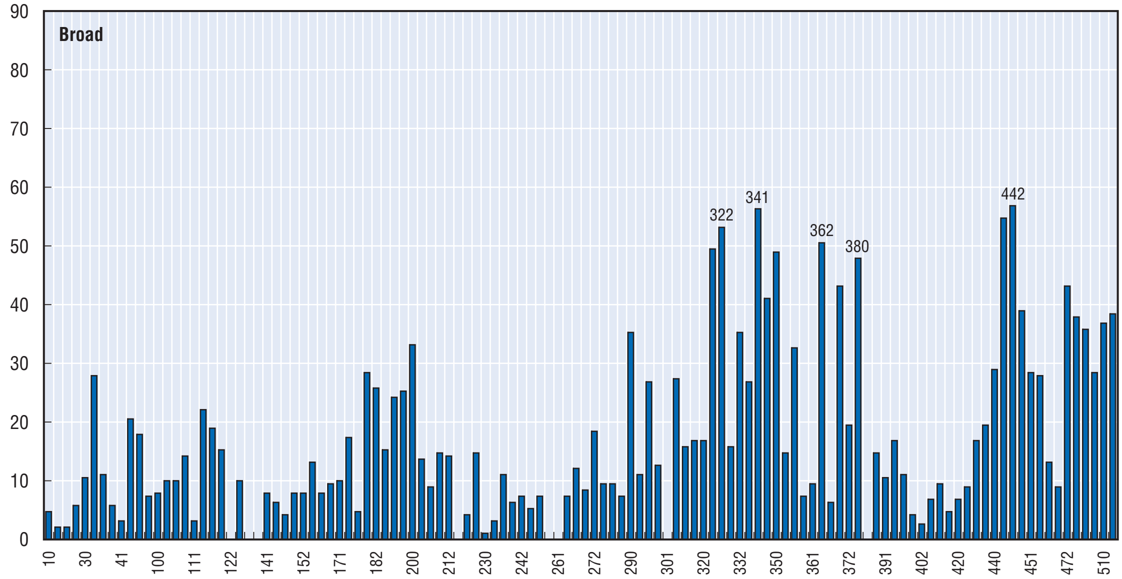


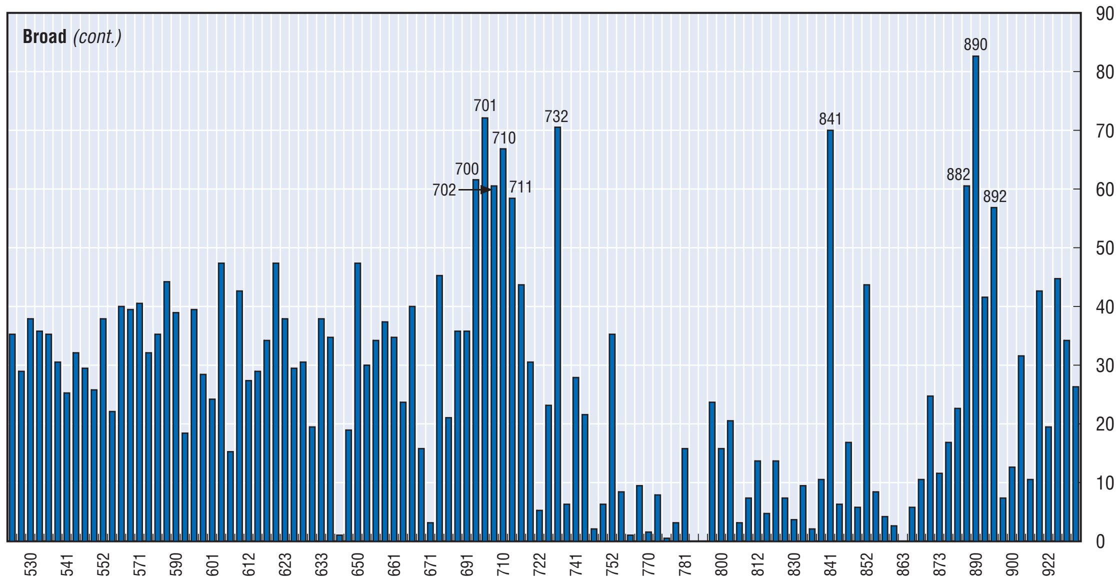


Note: 222: Leather products except footwear; 322: Computers and related equipment; 341: Radio, TV and communication equipment; 350: Not specified electrical machinery, equipment, and supplies; 362: Guided missiles, space vehicles, and parts; 380: Photographic equipment and supplies; 441: Telephone communications; 442: Telegraph and miscellaneous communications services; 472: Not specified utilities; 582: Stores, retail nurseries and garden; 602: Stores, dairy products; 633: Stores, radio, TV, and computer; 700: Banking; 701: Savings institutions, including credit unions; 702: Credit agencies (n.e.c.); 710: Security, commodity brokerage, and investment companies; 711: Insurance; 732: Computer and data processing services; 752: Electrical repair shops; 841: Legal services; 882: Engineering, architectural and surveying services; 890: Accounting, auditing, and bookkeeping services; and 892: Management and public relations services.

Source: OECD, based on Current Population Survey (CPS) (2003).

Figure 6.4. **United States: share of ICT-skilled employment in total employment, broad definition, by sector, 2002**





Note: 222: Leather products except footwear; 322: Computers and related equipment; 341: Radio, TV and communication equipment; 350: Not specified electrical machinery, equipment, and supplies; 362: Guided missiles, space vehicles, and parts; 380: Photographic equipment and supplies; 441: Telephone communications; 442: Telegraph and miscellaneous communications services; 472: Not specified utilities; 582: Stores, retail nurseries and garden; 602: Stores, dairy products; 633: Stores, radio, TV, and computer; 700: Banking; 701: Savings institutions, including credit unions; 702: Credit agencies (n.e.c.); 710: Security, commodity brokerage, and investment companies; 711: Insurance; 732: Computer and data processing services; 752: Electrical repair shops; 841: Legal services; 882: Engineering, architectural and surveying services; 890: Accounting, auditing, and bookkeeping services; and 892: Management and public relations services.

Source: OECD, based on Current Population Survey (CPS) (2003).

Table 6.2. **Top 70 high-intensity industries in the US classification under the broad and narrow definitions of ICT-skilled employment, 2002**

Descending order of intensity in percentages

Broad					Narrow				
	Industry		Broad	Rank		Industry		Narrow	Rank
	Accounting, auditing, and bookkeeping services	890	82.7	1	✓	Computer and data processing services	732	56.8	1
✓	Savings institutions, including credit unions	701	72.3	2	✓	Not specified electrical machinery, equipment, and supplies	350	48.8	2
✓	Computer and data processing services	732	70.6	3	✓	Radio, TV, and communication equipment	341	39.7	3
	Legal services	841	70.1	4	✓	Computers and rel. equipment	322	37.3	4
✓	Security, commodity brokerage, and investment companies	710	66.8	5	✓	Telephone communications	441	37.2	5
✓	Banking	700	61.3	6	✓	Photographic equipment and supplies	380	31.5	6
✓	Credit agencies, n.e.c.	702	60.5	7	✓	Electrical machinery, equipment, and supplies, n.e.c.	342	29.6	7
✓	Engineering, architectural, and surveying services	882	60.3	8	✓	Electrical repair shops	752	28.6	8
✓	Insurance	711	58.4	9		Household appliances	340	23.1	9
✓	Management and public relations services	892	57.0	10	✓	Not specified utilities	472	22.0	10
✓	Telegraph and miscellaneous communications services	442	57.0	11	✓	Office and accounting machines	321	20.2	11
✓	Radio, TV, and communication equipment	341	56.4	12		Radio and television broadcasting and cable	440	17.4	12
✓	Telephone communications	441	54.9	13	✓	Guided missiles, space vehicles, and parts	362	16.0	13
✓	Computers and rel. equipment	322	53.0	14	✓	Scientific and controlling instruments	371	15.3	14
✓	Guided missiles, space vehicles, and parts	362	50.5	15		Leather products, except footwear	222	14.5	15
✓	Office and accounting machines	321	49.6	16	✓	Research, development, and testing services	891	13.5	16
✓	Not specified electrical machinery, equipment, and supplies	350	48.8	17	✓	Stores, radio, TV, and computer	633	12.0	17
✓	Photographic equipment and supplies	380	48.1	18	✓	Petroleum refining	200	11.9	18
	Liquor stores	650	47.6	19		National security and international affairs	932	11.8	19
	Miscellaneous vehicle dealers	622	47.5	20		Ordnance	292	11.8	20
	Stores, dairy products	602	47.5	21	✓	Electric light and power	450	11.3	21
	Fuel dealers	672	45.3	22		Soaps and cosmetics	182	10.2	22
✓	Environmental quality and housing programs administration	930	44.6	23	✓	Telegraph and miscellaneous communications services	442	9.4	23
	Stores, retail nurseries and garden	582	44.2	24	✓	Engineering, architectural, and surveying services	882	8.6	24
	Libraries	852	43.6	25	✓	Public finance, taxation, and monetary policy	921	8.6	25
	Real estate, including real estate-insurance offices	712	43.6	26	✓	Environmental quality and housing programs administration	930	8.4	26
✓	Scientific and controlling instruments	371	43.1	27	✓	Aircraft and parts	352	8.3	27
✓	Not specified utilities	472	43.0	28		Agricultural chemicals	191	8.2	28
	Food stores, n.e.c.	611	42.5	29	✓	General government, n.e.c.	901	8.1	29
✓	Public finance, taxation, and monetary policy	921	42.4	30	✓	Management and public relations services	892	7.8	30
✓	Research, development, and testing services	891	41.6	31	✓	Security, commodity brokerage, and investment companies	710	7.2	31
✓	Electrical machinery, equipment, and supplies, n.e.c.	342	41.1	32		Medical, dental, and optical instruments and supplies	372	6.6	32
	Not specified wholesale trade	571	40.4	33	✓	Professional and commercial equipment and supplies	510	6.4	33
✓	Catalog and mail order houses	663	40.0	34	✓	Economic programs administration	931	6.4	34
	Farm supplies	561	39.9	35		Electric and gas, and other combinations	452	6.3	35
	Misc wholesale, nondurable goods	562	39.7	36	✓	Electrical goods	512	6.1	36
	Variety stores	592	39.4	37		Paperboard containers and boxes	162	6.1	37
✓	Electric light and power	450	39.0	38		Theaters and motion pictures	800	5.8	38
	Mobile home dealers	590	38.9	39	✓	Not specified retail trade	691	5.6	39
	Metals and minerals, except petroleum	511	38.3	40		Miscellaneous food preparations and kindred products	121	5.5	40
	Motor vehicles and equipment	500	37.9	41		Gas and steam supply systems	451	5.4	41
✓	Stores, radio, TV, and computer	633	37.9	42		Construction and material handling machines	312	5.3	42
	Stores, apparel and accessory, except shoe	623	37.9	43		Industrial and miscellaneous chemicals	192	5.1	43
	Petroleum products	552	37.8	44		Toys, amusement, and sporting goods	390	5.1	44
	Machinery, equipment, and supplies	530	37.7	45		Colleges and universities	850	5.1	45
	Jewelry stores	660	37.3	46		Human resources programs administration	922	4.9	46

Table 6.2. **Top 70 high intensity industries in the US classification under the broad and narrow definitions of ICT skilled employment, 2002** (*cont.*)

Descending order of intensity in percentages

Broad				Narrow			
Industry		Broad	Rank	Industry		Narrow	Rank
✓ Professional and commercial equipment and supplies	510	36.9	47	Metalworking machinery	320	4.8	47
✓ Not specified retail trade	691	35.9	48	Funeral service and crematories	781	4.6	48
Stores, Miscellaneous retail	682	35.9	49	Tobacco manufactures	130	4.6	49
Scrap and waste materials	531	35.9	50	Iron and steel foundries	271	4.6	50
Furniture and home furnishings	501	35.7	51	✓ Insurance	711	4.6	51
✓ Electrical goods	512	35.5	52	Nonmetallic mining and quarrying, except fuel	50	4.5	52
Miscellaneous wholesale, durable goods	532	35.3	53	Executive and legislative offices	900	4.5	53
✓ Screw machine products	290	35.3	54	✓ Credit agencies, n.e.c.	702	4.4	54
✓ Electrical repair shops	752	35.3	55	✓ Banking	700	4.2	55
Not specified machinery	332	35.3	56	✓ Advertising	721	4.2	56
Hardware stores	581	35.3	57	Not spec manufacturing industries	392	4.2	57
Gift, novelty, and souvenir shops	661	34.9	58	Pulp, paper, and paperboard mills	160	4.1	58
Music stores	640	34.8	59	✓ Savings institutions, including credit unions	701	3.9	59
✓ Economic programs administration	931	34.2	60	Educational services, n.e.c.	860	3.7	60
Gasoline service stations	621	34.1	61	Services incidental to transportation	432	3.5	61
Stores, Book and stationery	652	34.0	62	✓ Catalog and mail order houses	663	3.5	62
✓ Petroleum refining	200	33.2	63	Grain mill products	110	3.5	63
✓ Aircraft and parts	352	32.5	64	Machinery, except electrical, n.e.c.	331	3.4	64
Lumber and building material retailing	580	32.2	65	Printing, publishing, and allied industries, except newspapers	172	3.3	65
Apparel, fabrics, and notions	542	32.1	66	Personnel supply services	731	3.2	66
✓ General government, n.e.c.	901	31.5	67	Engines and turbines	310	3.2	67
Paper and paper products	540	30.5	68	Miscellaneous paper and pulp products	161	3.1	68
✓ Advertising	721	30.4	69	Water supply and irrigation	470	3.0	69
Stores, furniture and home furnishings	631	30.3	70	✓ Screw machine products	290	3.0	70

Note: Industry sectors that appear in both groups are indicated by a tick mark.
Source: OECD, based on Current Population Survey (2003).

this may be due to differences in industry breakdown and the fact that manufacturing of computers and office machinery, for example, is not identified separately).

- Canada

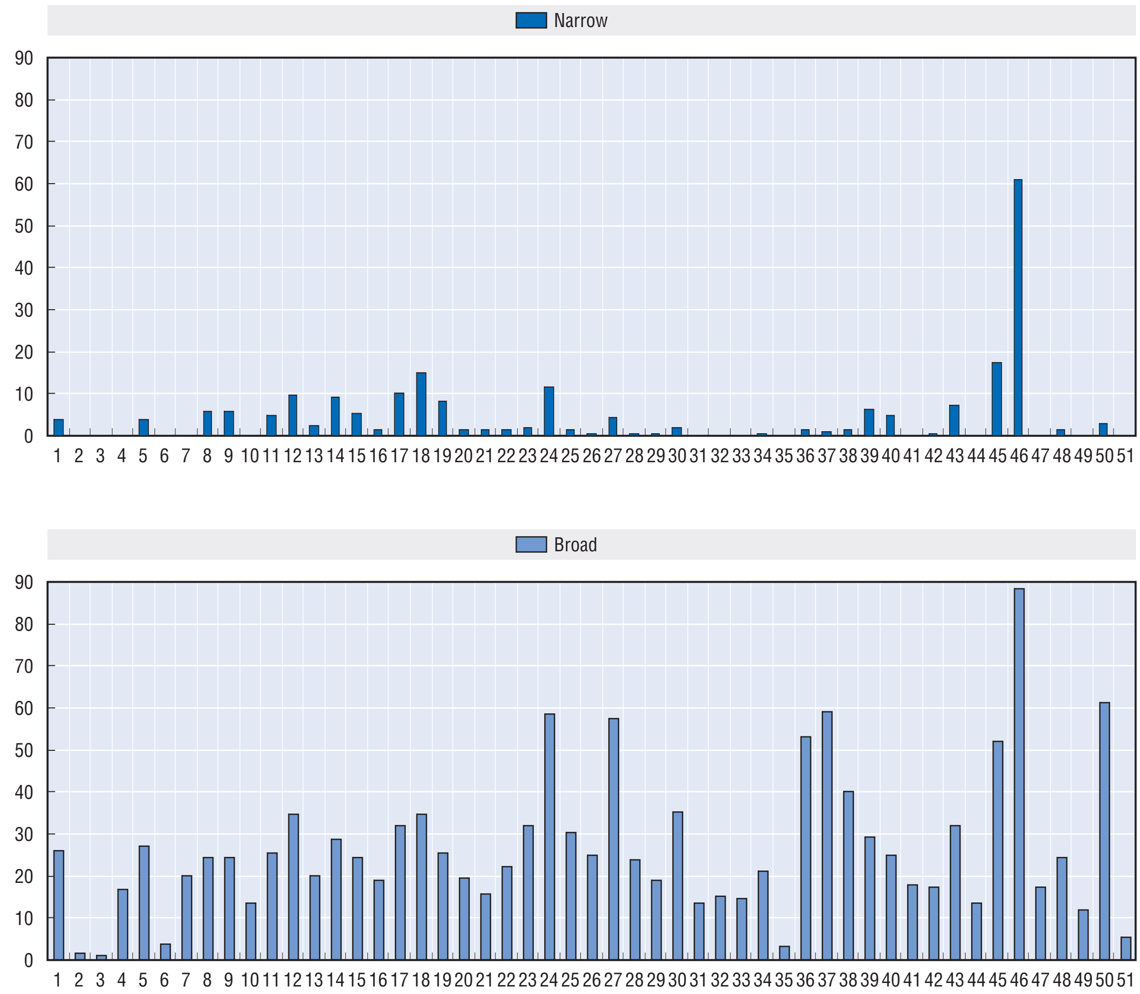
Habtu (2003), using results from Census Canada 2001 on the experienced labour force,[8] reports that in Canada in 2001, IT occupations represented 2.6% of total employment (see Annex Table C.6.9 for the definition of IT occupations) and was quite concentrated. The two largest groups, Systems analysts and consultants (26.6%) and Computer programmers and interactive media developers (24.9%) accounted for over 50% of total employment in IT occupations. Furthermore, IT workers tended to be: *i*) relatively young (36 years old on average, against an average of 39 for all employed workers); *ii*) highly educated (44% held at least a bachelor's degree against only 19.6% for all employed workers), with 72% having specialised in applied sciences, engineering and mathematics; and *iii*) earning relatively higher wages (mean earnings of CAD 45 500 in 2001 compared to CAD 28 000 for all employees). Finally, immigrant workers have come to play a larger and more rapidly increasing role in IT occupations than in total employment, accounting for 31.5%, compared to almost 20% overall. Just under half of the immigrants with IT qualifications arrived in the 1990s (and around one-third after 1996 during the high-technology boom), compared to only 30% of the overall immigrant population. However, these summary results hide sometimes large differences between occupations.

ICT-skilled employment and productivity in Europe

There has been considerable debate about productivity gains in ICT sectors and ICT-induced productivity gains in other sectors. For example, new-economy sceptics argue that productivity gains

Figure 6.5. **Japan: share of ICT-skilled employment in total employment, narrow and broad definition, by sector, 2002**

Percentages



Note: Industries with a high share include: 12: Chemical products, oil products, coal products, 18: Electronic machinery and instruments, 24: Electricity, gas, heat provision, water, 27: Communication, 30: Wholesale, 36: Finance, insurance, real estate, of which: 37: Finance, insurance and 38: Real estate, 45: Business services, of which 46: Information and research services, and 50: Public services. Annex Table C.6.4 provides the complete list of industries.

Source: OECD, based on data provided by the Japanese Ministry of Public Management, Home Affairs, Post and Telecommunications, Statistics Bureau, Labour Force Survey (2003).

over the past decade were due to very concentrated gains in manufacturing durables (especially industries producing computers and semiconductors) but not to sectors that invested in the use of ICT (US Department of Commerce [DoC], 2002). However, research on micro data tends to point to a positive link between IT and productivity even when the official aggregated statistics still point to a productivity paradox (US DoC, 2003a, p. 63), although the strength of the link differs widely in the available studies. Moreover, the mechanism by which IT positively affects productivity is difficult to pin down.

It is also important to examine the issue of productivity in the context of ICT skills. As DiNardo and Pischke (1997) note, computers are only productive when used in combination with certain types of

Figure 6.6. **Korea: share of ICT-skilled employment, narrow and broad definition, by sector, 2002**

Percentages

Note: Industries with a high share include: 21: Manufacturing of other machinery and equipment; 23: Manufacturing of electronic components, radio, television and communication equipment and apparatus; 29: Electricity, gas, steam and hot water supply; 41: Post and telecommunications; 42: Financial institutions, except insurance and pension funding; 43: Insurance and pension funding; 44: Activities auxiliary to financial intermediation; 45: Real estate activities; 47: Computer and related activities; 48: Research and development; and 49: Professional, scientific and technical services. See Annex Table C.6.6 for the complete list of industries.

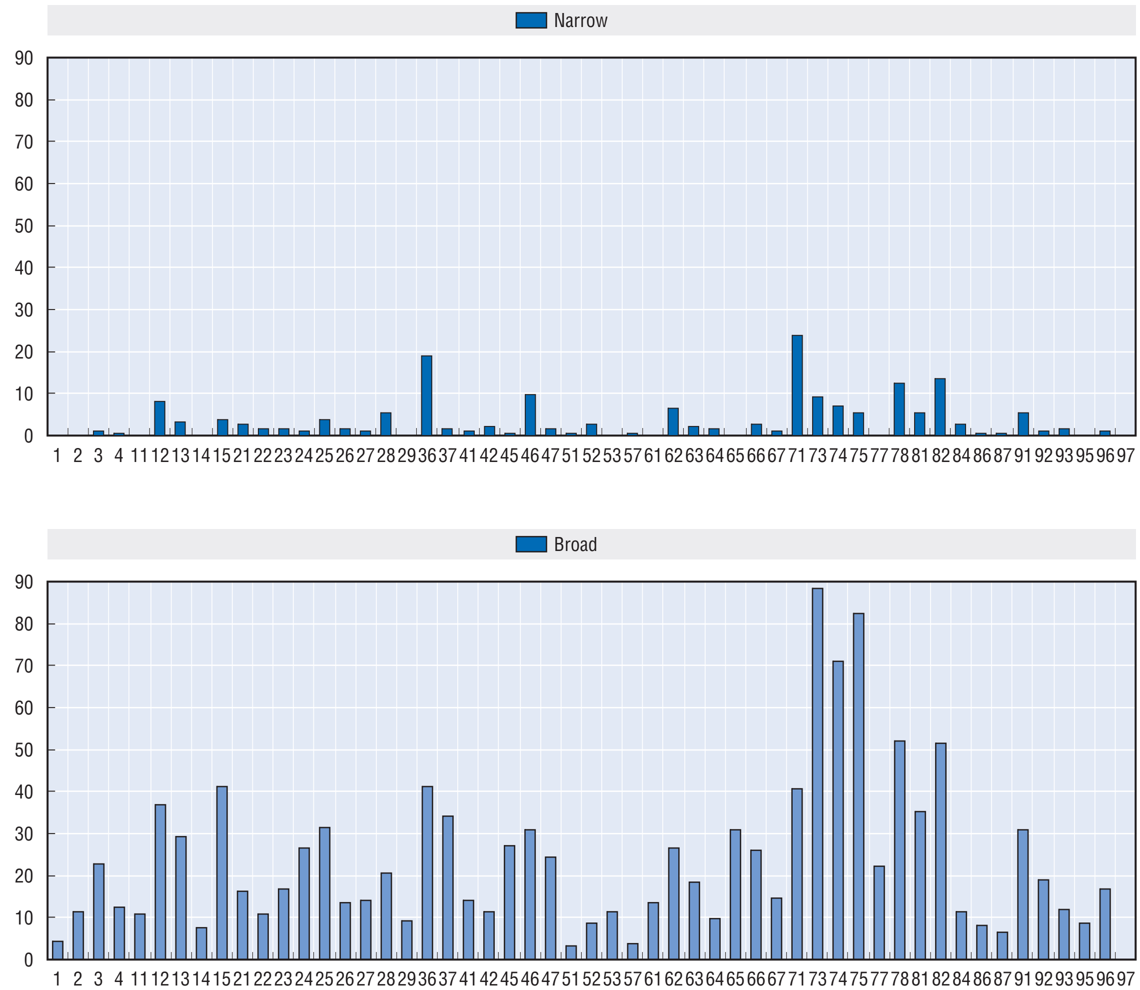
Source: OECD, based on data provided by the Korean Work Information Center, Human Resource Development Service (2003).

skills (*e.g.* programming) and only have value for certain types of workers (*e.g.* empirical economists but not ballet dancers).

Furthermore, as Mann (2003) argues for the United States, more integrated use of ICTs is likely to lead to a second wave of productivity growth not only because of the increased adoption of ICTs owing to reductions in costs, but also because of changes in existing production and business processes. However, integration of ICTs will require the presence of an appropriate skills base. This is likely to be relevant outside the United States too. For example, van Ark *et al.* (2002) suggest that industry patterns of ICT diffusion in Europe are following a similar pattern to that observed in the United States, but at a slower pace. They also note that the greatest differences between Europe and the United States are in

Figure 6.7. **Australia: share of ICT-skilled employment, narrow and broad definition, by sector, November 2003**

Percentages



Note: Some of the industries with a high share are: 12: Oil and gas extraction; 15: Services to mining; 36: Electricity and gas supply; 46: Machinery and motor vehicle wholesaling; 71: Communication services; 73: Finance; 74: Insurance; 75: Services to finance and insurance; 78: Business services; 81: Government administration; 82: Defence; and 91: Motion picture, radio and television services. See Annex Table C.6.8 for the complete list of industries.
Source: OECD, based on data provided by ABS (2004).

the intensive ICT-using services industries. It is important for Europe to look very closely at these sectors in particular in order to advance the catching-up process.[9]

To study the question, data on gross value added per employee (Eurostat, NewCronos) are plotted against the measure of broad ICT-skilled employment (Figure 6.8). Data are available only for some European countries and some industries. Overall, there appears to be a positive, but relatively weak, relationship between productivity and the intensity of broad ICT-skilled employment. In most countries, NACE sector 72:Computer and related activities stands out, as it tends to combine a relatively high share of broad ICT employment in total employment with low gross value added per employee (although this may be due to output measurement problems in this sector).

Box 6.2. Women, minorities and older workers in the IT workforce

The Information Technology Association of America (ITAA) (2003b), using data from US Current Population Survey from 1996 to 2002, finds evidence of important differences in the presence of minorities in the IT workforce.* In 2002, women made up 46.6% of the US workforce but only 34.9% of the IT workforce (in 1996, they accounted for 41%). In addition, women obtained only 22% of the total degrees in computer science and engineering awarded in 2000. Similarly, African Americans accounted for 10.9% of the total US workforce in 2002 but only 8.2% of the IT workforce (down from 9.1% in 1996). Hispanic Americans are also under-represented in the IT workforce. They made up 12.2% of the total workforce in 2002 but only 6.3% of the IT workforce. Native Americans accounted for 0.9% of the total workforce and 0.6% of the IT workforce. See US DoC (1999), for example, for complementary analysis of these issues.

In Germany, the *Statistisches Bundesamt* (2002) compiled similar data on the distribution of men and women in the IT workforce. In 2001, women accounted for 44% of the overall workforce and 25.9% of the ICT workforce. There were differences within ICT occupations, with women accounting for 46.2% of telecommunications occupations, 15.4% of IT occupations and 39.2% of media occupations.

Habtu (2003) reports that in Canada in 2001, women accounted for 46.9% for all occupations but only 27% of total IT workers. Again there are differences within specific categories: women account for only 17.7% of software engineers, for example. Women also earned lower median earnings, CAD 41 100 against median earnings of CAD 45 500 for all IT workers.

Finally, it is generally thought that the position of older workers in the labour force as a whole is likely to deteriorate as a result of the increasing use of ICTs. First, it is believed that they have less ability and fewer incentives to acquire ICT skills and that there will be a growing mismatch between their skills and those that are in demand (which would reduce the value of their existing skills). Second, it is feared that the resulting lack of skills may cause a slowdown in the introduction of ICTs in jobs filled by older workers and slow a company's productivity growth and competitiveness. However, there has been no firm empirical evidence to confirm the alleged increasing competitive disadvantage of older workers in the labour market. In fact, Borghans and ter Weel (2002), using UK data and controlling for wage costs and the tasks to be performed, show that computer use does not depend on age. Still, they do find that older workers tend to have fewer computer skills than younger workers, but that the relevant age groups are 20-29 years old *versus* 30 years and older. It also appears that there are no specific labour market returns to having computer skills, so older workers' wages are unlikely to suffer. As for the position of older workers in the IT workforce, the ITAA (2003a), for example, reported that Americans aged 45 years and older accounted for 37.6% of the total workforce in 2002, but for only 29.4% of the IT workforce. Thus, while concerns about older workers have not, as yet, been confirmed by empirical studies, there may be cause for concern about their position in ICT occupations specifically.

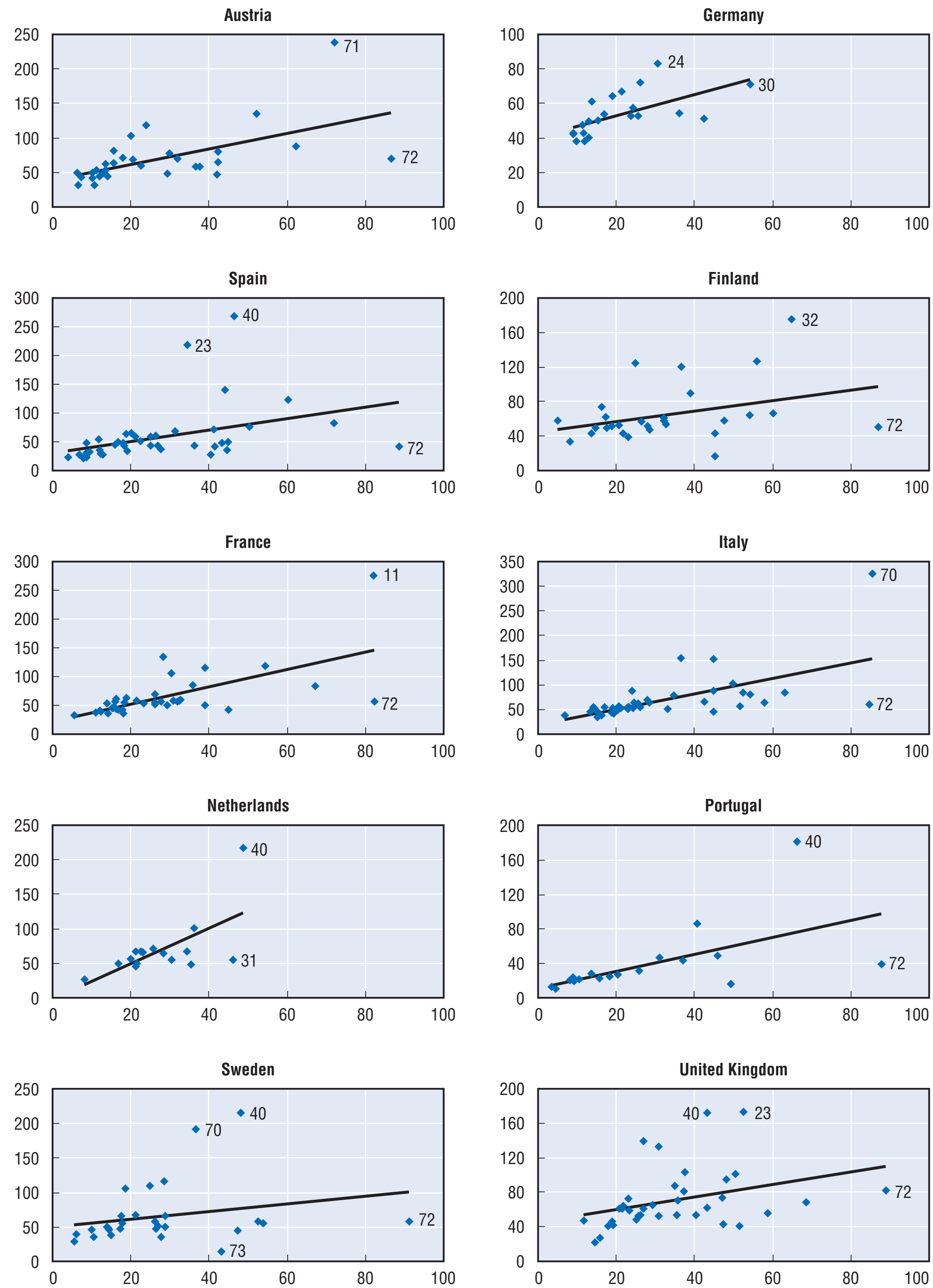
* The definition of the IT workforce used by the ITAA includes: programming/software engineering, technical support personnel, other, enterprise systems specialists, database development/administration, Web development / administration, network design/administration, digital media, technical writing.

However, the measure of ICT-skilled employment by sector does not necessarily provide an indicator of the amount of ICT work carried out in that sector. To the extent that sectors outsource such work, the relationship between the measure of ICT-skilled employment and productivity will be distorted. Sector 72 is likely to carry out such activities, with the (possible) productivity gains accruing to the sector that outsources them. Thus, sectors with low intensity of ICT-skilled employment may benefit from large ICT-induced productivity gains if they outsource ICT activities.

The following calculation was carried out. Gross value added per employee was regressed on the measure of broad ICT-skilled employment (and a constant). The results show that the coefficient on ICT-skilled employment is always positive and significant at least at the 5% level (except for Sweden), but the adjusted R^2 tends to be quite low. There thus appears to be a positive correlation between sectors with high value-added per employee and sectors with a high share of ICT-skilled employment (for details, see Annex Table C.6.10).

Figure 6.8. **Gross value added per employee and the share of ICT-skilled employment, broad definition, in total employment, selected EU countries**

Vertical axis in thousands of EUR per head, horizontal axis in percentages



Note: Some outliers have been removed: Germany NACE 23, Italy NACE 11, Sweden NACE 32 and United Kingdom NACE 11.
Source: OECD, based on EULFS and NewCronos, 2003.

ICT skills: how to get them and put them to work

This section examines first how individuals, firms and countries can acquire ICT skills, at various levels of complexity, and then looks at e-recruitment: a new method of using ICTs to match employers and jobseekers. The definitions of IT and ICT occupations used in this section are mostly based on those from the different national sources and may not match the definitions in the first part of this chapter.

Figure 6.9, based on the 2001 UK Skills Survey, shows the various means by which ICT skills of various levels of complexity are acquired. Respondents could choose from nine sources of learning.

For individuals, the main channels for acquiring ICT skills are: education, training (both on and off the job) and self-learning and practice at home. Almost 59% of respondents said they had a computer at home, and over 64% had used a PC at home for at least three years (Chapter 4 discusses diffusion of ICTs in households).

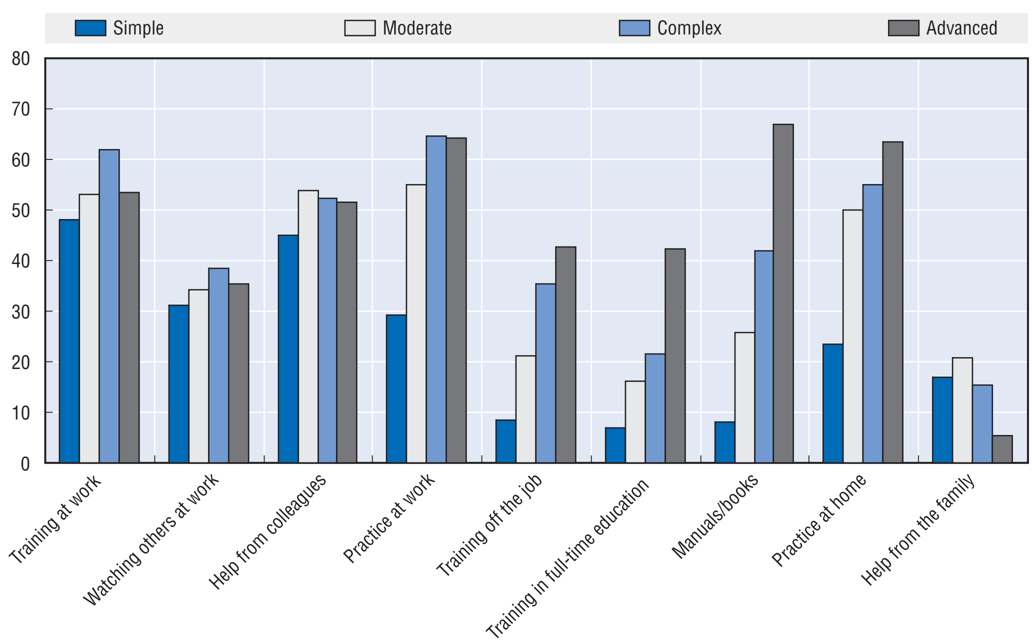
Firms can hire staff with sought-after skills directly (either on the domestic labour market, or from abroad, making use of visa arrangements where available), train and/or retrain existing staff, or outsource certain activities to those possessing the appropriate skills, either domestically or internationally.

Countries can satisfy the need for ICT skills, both in the narrow sense (ICT specialist skills) and the broad sense (including basic and advanced user skills), through education policies, training and lifelong learning incentives, and by allowing (often temporary) immigration of persons with skills that are in demand.

Although there is much debate surrounding the alleged existence of shortages in computer skills, there is currently little tangible evidence. The issue is complicated by the use of often unclear terminology (see Box 6.3). Furthermore, shortages and mismatches are also likely to depend on the

Figure 6.9. **Relative importance of various means of acquiring computing skills in the United Kingdom, by complexity of computing skills, 2001**

Percentages



Note: Respondents could give more than one answer.
Source: Felstead *et al.*, 2002.

Box 6.3. Shortages: what are they/how can they be measured?

While the existence of ICT skills shortages is often discussed, the nature of the alleged shortages is not always clear. In particular, the terminology employed tends to be quite loose. Partly as a result, there is little evidence demonstrating the existence or importance of such shortages. In addition, a distinction should be made between quantitative and qualitative shortages or mismatches. To structure the debate, the European e-Skills Forum (2004) proposes to define the various types of deficiencies as follows:

- **Shortage:** a quantitative lack of skilled people in the labour market.
- **Gap:** a competence shortfall between current and needed competence levels of personnel in companies or other organisations.
- **Mismatch:** a difference between the competence of the trainee or graduating student/learner and employers' expected competence needs. Mismatches are assumed to arise from inappropriate training and/or inappropriate course curricula.

Several variables can be used as possible indicators of skills shortages or tightness in the (IT) labour market, although none is very satisfactory: changes in wages, employment/unemployment rates, information from employers' surveys, information on vacancies (notably, the time it may take to fill them), even though the latter may be ill-adapted to rapidly growing and changing sectors such as the IT sector.

general economic climate, that of the ICT sector, and the stage of the business cycle, as well as the cycle of innovation and adoption of new technologies. The latter is likely to affect demand for different types of skills, particularly at the ICT specialist level. It is also probable that the way to satisfy the need for ICT skills depends on the skills levels in question. For example, while the diffusion of ICTs to households, schools and firms, aided by appropriate educational and training policies, is likely eventually to take care of at least basic ICT skills, changing needs for ICT specialist skills which depend, in part, on the introduction of new technologies, may be more likely to require industry- and/or technology-specific training and certification schemes (see OECD, 2002, Chapter 5).

Satisfying ICT *skills needs*

Education

Countries can use education policies to ensure that skills needs are satisfied in the long run. However, precisely because they are effective in the long term, they may not be appropriate for supplying specific (and advanced) ICT skills needs, which may change rapidly and considerably as a result of technological advances. While it can be argued that education can satisfy at least basic needs, Borghans and ter Weel (2003a, 2003b) argue that large investments in computer skills and educational programmes in order to teach pupils how to use computers are likely to be ineffective. They find no indication that computer skills are becoming a new basic skill and question whether they should be taught in schools at all. The survey results reported in Felstead *et al.* (2002) tend to support this, as relatively few respondents mentioned full-time education as a source of their computing skills (Figure 6.9). However, this may be due to the relatively recent introduction of ICTs in schools and their gradual integration into the classroom. As time goes by, more people are likely to use ICTs in school and may, as a result, indicate this as a source of at least their basic ICT skills.

While schools from primary level to universities are gradually being equipped with ICTs, the focus here is on upper secondary schools as the last stage between school and further education or work. Even when pupils' primary schools are not equipped with ICTs, they may enrol in secondary schools that are equipped and still acquire a certain level of ICT skills before entering higher education or employment.

This section looks at some of the new, detailed data on the integration of ICT equipment in the instruction of students at upper secondary schools collected in the OECD's International Survey of Upper

Secondary Schools (ISUSS) (OECD, 2004).[10] Table 6.3 shows, for the participating countries, various indicators of the extent to which students are likely to be familiar with ICTs and are likely to have at least basic ICT skills. The first three columns indicate the accessibility of ICTs for students and the next three indicate the timing and availability of certain ICT applications (standard software, Internet, e-mail). The average numbers of students per computer and the percentage of computers linked to the Internet and to local networks, respectively, can be taken as indicators of accessibility of ICTs. In 2001, Denmark, Sweden, Norway and Finland had a ratio of five students or fewer per computer and, on average, more than 90% of computers were connected to the Internet. Portugal, Spain and Mexico had the highest number of students per computer (over 14), and among the lowest percentages of computers connected to the Internet (53%, 61% and 27%, respectively). France and Italy also had low connectivity, both at 47%.

The latter part of the table shows that by 2001, in all of the countries participating in the survey, at least 90% of upper secondary students were attending schools where standard word processing and spreadsheet applications had been introduced. In 1995 this was the case in only three countries. In addition, at least 90% of upper secondary students in 2001 attended schools where the Internet had been introduced in all participating countries except Mexico. In 1995, the percentage of students exceeded 30% in only four of the sample countries (Finland, 57%; Denmark, 52%; Sweden, 43%; and Norway, 39%). The use of e-mail is somewhat less widespread (at least 90% of students in only nine of the sample countries) and also started from lower numbers in 1995 (less than 10% in over half of the sample countries).

Table 6.4 indicates the types of ICT skills students are likely to acquire in the schools that participated in the 2001 survey. In most countries, at least 90% of students attending schools in which students perform computer-related activities at least once a month operated a computer and used a word processor as part of their assignments. At least 75% of students sent, searched for and used electronic forms of information in 11 out of the 15 sample countries; in ten out of 15, at least 70% of the students used spreadsheet applications. The use of email varies from 79% in Finland to only 23% in Spain. Finally, the use of graphical applications and programme writing were less common in most countries.

It is important to bear in mind, however, that these averages may hide large differences according to type of school and geographical area. Furthermore, as only 15 countries participated in the survey, it cannot be regarded as representative of the OECD as a whole (in particular, the sample includes only one Anglo-Saxon country as the United Kingdom and the United States did not participate).

The introduction of ICT equipment in schools is not sufficient to incorporate ICTs into the learning process if teachers do not possess the appropriate skills. Indeed, use of ICTs in schools is disappointing, particularly when compared with the diffusion of ICTs in other parts of society (OECD, 2004; see also Chapter 4). The most frequently cited reasons were: *i*) problems in integrating the use of ICTs into classroom instruction; *ii*) finding enough time to schedule computer classes; and *iii*) recruiting ICT teachers. Nevertheless, the survey results show at least some evidence that students attending upper secondary schools in the participating countries are likely to acquire at least basic ICT skills.

- ICTs in schools in the United States

The US Department of Education (2003a) reports that in 2002, the ratio of students to instructional computers with Internet access in public schools was 4.8 to 1 (significantly down from a 12 to 1 ratio in 1998 when first measured). Moreover, 53% of schools with Internet access reported that students were allowed to use the computers outside of regular hours. Efforts to integrate the use of computers into classroom instruction are actively encouraged, and 87% of public schools with Internet access reported that either the school or the school district had offered teachers professional development to help them integrate use of the Internet into the curriculum in the 12 months prior to the survey. According to the US Department of Education (2003b), in 2001, 44% of children used computers and 42% the Internet to complete assignments. Finally, the "No Child Left Behind Act" supports the students who need it most, with USD 700 million earmarked for educational technology programmes in 2002-03.

Table 6.3. **ICT equipment in upper secondary schools, 2001**

	Average ratio of students to computers for students' use	Average percentage of computers connected to the Internet	Average percentage of computers connected to local area networks	Percentage of upper secondary students attending schools where…					
				… standard word processing and spreadsheet applications were introduced by 2001	by 1995	… Internet was introduced by 2001	by 1995	… an e-mail system accessible for teachers and students was introduced by 2001	by 1995
Belgium (Fl.)	7.5	68	59	100	83	100	9	66	3
Denmark	2.8	91	84	98	88	100	52	100	32
Finland	5.0	90	70	100	90	100	57	99	36
France	5.8	47	35	100	88	99	12	88	4
Hungary	10.2	68	49	100	80	100	18	99	14
Ireland	13.1	58	m	100	82	100	14	96	8
Italy	11.7	47	38	98	75	100	16	94	8
Korea	6.4	92	89	98	49	100	7	99	6
Mexico	16.5	27	25	99	65	76	9	66	5
Netherlands[1]	13.5	73	72	100	65	100	16	78	n
Norway	3.7	91	74	100	93	100	39	99	22
Portugal	14.4	53	41	94	85	95	22	89	11
Spain	15.5	61	46	93	73	98	14	66	2
Sweden	3.4	95	88	90	80	91	43	90	20
Switzerland	9.0	82	73	99	93	99	20	94	6

Note: The reported data are unweighted. m = data not available, n = near-zero number.
1. Country did not meet the national sampling requirements.
Source: OECD International Survey of Upper Secondary Schools Database, 2003.

Table 6.4. **Use of ICT equipment in upper secondary schools, 2001**

Average percentage of upper secondary students attending schools where principals reported that various computer-related activities form part of students' assignments at least once a month

	Operating a computer (saving files, printing, etc.)	Writing documents with a word processor	Making illustrations with graphical programmes	Calculating with spreadsheet programmes	Writing programmes	Communicating via e-mail with teachers and other students	Sending, searching for, and using electronic forms of information
Belgium (Fl.)	99	95	42	75	27	38	85
Denmark	99	99	68	88	14	74	96
Finland	97	96	64	61	19	79	96
France	94	91	58	88	13	44	86
Hungary	97	96	70	86	44	53	92
Ireland	87	87	66	62	13	34	67
Italy	90	89	56	78	47	39	68
Korea	90	92	46	68	14	86	91
Mexico	93	93	84	84	60	44	49
Netherlands[1]	99	99	39	63	9	48	82
Norway	99	99	66	82	21	67	88
Portugal	94	94	82	81	38	48	75
Spain	86	87	60	60	18	23	61
Sweden	96	97	61	73	30	87	91
Switzerland	93	91	57	70	14	52	82

Note: The data are unweighted.

1. Country did not meet international sampling requirements.

Source: OECD International Survey of Upper Secondary Schools Database, 2003.

• ICT in schools in Japan

By the end of March 2003, over 1.4 million computers were in use in Japanese schools for educational purposes (88.8% of the total number of computers in schools), resulting in an average ratio of 9.7 students per computer, an improvement over the 11.1 students per computer in the previous fiscal year. Nevertheless, these numbers mask differences by type of school. Table 6.5 shows the average number of students per computer by type of school for fiscal year (FY) 2001 and FY 2002. Furthermore, by the end of March 2003, over 98% of computers used for educational purposes were equipped with either a Windows or Mac operating system, and around 85% were connected to the Internet.

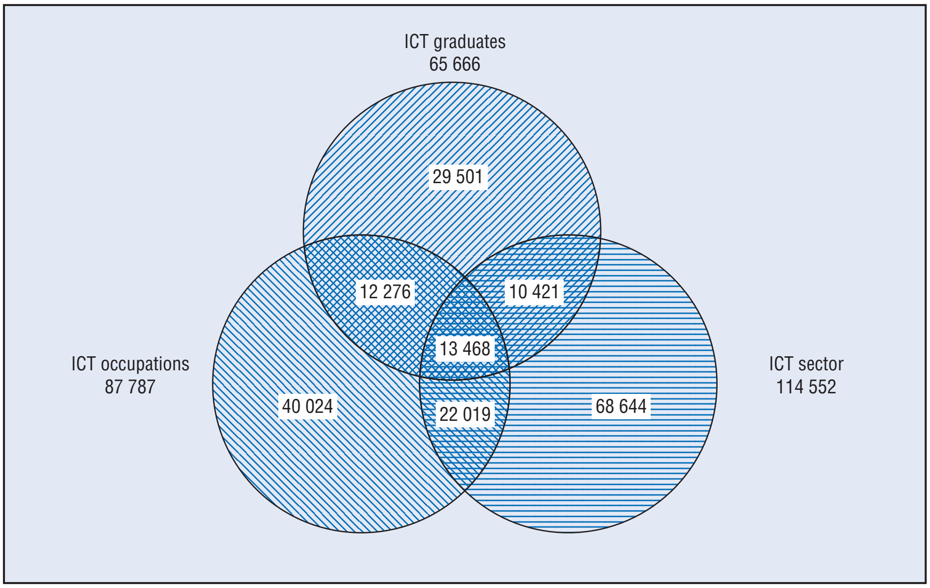
Table 6.5. **Average number of students per computer by type of school in Japan, FY 2001 and 2002**

	Total	Elementary school	Junior/lower secondary	High/upper secondary	Total special education	Schools for blind students	Schools for deaf students	Schools for handicapped students
03/02	11.1	15.0	9.3	8.4	5.1	2.2	2.0	6.2
03/03	9.7	12.6	8.4	7.4	4.0	1.1	1.5	4.8

Source: Japanese Ministry of Education, Culture, Sports, Science and Technology (2003).

When integration of ICTs into school instruction is combined with the general diffusion of ICTs among households, most people are likely eventually to acquire some basic ICT skills but not ICT specialist skills. It is questionable whether formal education is the appropriate vehicle for supplying these skills (OECD, 2002, Chapter 5). The Alliance for Information Systems Skills and the Information Technology National Training Organisation (AISS and ITNTO, 1999), for example, reported that formal education provided only some of the needed IT specialist skills (many graduates working as IT specialists had a non-IT-related degree, and many of those with an IT-related degree worked in jobs other than IT specialist jobs). Figure 6.10 illustrates the relationship between ICT degrees, ICT occupations and employment in the ICT sector in Denmark in 2002. It shows that only one in five ICT

Figure 6.10. **The Danish ICT labour market in 2002**



Source: Statistics Denmark (2003).

graduates was employed in an ICT occupation in the ICT sector. Just over 39% of ICT graduates had an ICT occupation and over 36% of ICT graduates were employed in the ICT sector.

The AISS/ITNTO report also indicated that the importance of industry certification schemes was increasing. It may be that tertiary education is ill-adapted to providing the often rapidly changing skills needed by ICT specialists and that multi-stakeholder partnerships (such as the Cisco Academic Networking Programme [CNAP], Career-Space and the GENIUS consortium[11]), industry certification schemes and various other forms of training may be more appropriate.

Training

Skills needs can also be satisfied through training. Felstead *et al.* (2002) (see above) found that in the United Kingdom training at work was an important source of learning. Employers can use on-the-job training to ensure that their workforce is equipped with the right skills for the company, and in particular to re-train personnel that lack the right skills, especially since rapid technological advances continually change skills requirements. Such training is likely to correspond to companies' needs, especially in cases where the employer provides the training directly or pays for it. Nevertheless, market failures may lead firms to underinvest in skills. OECD (2003b) discusses the policies aimed at overcoming these market failures.

Dickson *et al.* (2002) asked firms about internal skill gaps, defined as the difference between an establishment's current skills levels and what it thinks it needs to meet its business objectives. Both basic computing (30%) and advanced IT skills (30%) were mentioned by employers as occupational skill gaps (in particular for associate professionals and administrative/secretarial staff). Failure to train and develop figured prominently among the reasons for the existence of internal skill gaps (after lack of experience and *ex æquo* with lack of motivation). Employers' principal responses to internal skill gaps were to provide further training (89%) and to increase and/or expand trainee programmes (59%). Finally, firms also used training as a means to deal with 41% of hard-to-fill vacancies.

Training can also be used off the job to improve job opportunities for the unemployed. For example, many unemployment agencies run free or subsidised courses for jobseekers, often to ensure basic IT literacy skills and sometimes more advanced ICT skills.

- Computer skills in continuing vocational training in Eurostat countries

Results from the second Eurostat survey on continuing vocational training (CVTS2, 2003), defined as training measures or activities which are fully or partly financed by the enterprise for employees with a work contract, are summarised in Annex Table C.6.11. The data are relative numbers so that it is not possible to compare absolute numbers of hours spent on each type of training or across industries or countries. It appears that computer training is ranked relatively highly in Germany, France, Finland and Sweden. It is relatively less important in Italy, Bulgaria, Estonia and Lithuania. In terms of sectors, it is relatively most important in services sectors such as real estate, renting and business activities, and other community social and personal services, as it is ranked first or second in 18 out of 25 countries, and in financial intermediation (17 out of 25 countries). The relative importance of computer training in real estate, renting and business activities is also striking in EU15 countries, where it was the most important type of training in 12 of the 15 countries. Moreover, it appears that computer training is, overall, relatively more important in the EU15 and Norway than in the other European countries (where computer training tends to be relatively more important in other community, social, personal service activities).

- Computer skills training in Australia

A survey conducted by the Australian Bureau of Statistics (2002) found that 54.3% of all those who completed training courses in computer skills were female and 45.7% male. Those aged 35-44 represented around 29%, followed closely by those aged 25-34 (27.3%). There is relatively little difference between men and women by age group in completed computer training courses (plus or minus 0.4 or 0.5 percentage points) for each of the age groups, except for the group aged 45-54 where the difference is 1.1 percentage points.

A breakdown by employment status shows that around 83% of those who completed training courses in computer skills were wage or salary earners, just under 11% worked in their own business, and fewer than 6% were not working (a small residual percentage worked under other arrangements). Moreover, while for both wage and salary earners and those who work in their own business, computer skills were the fourth most important field of training (after management and professional, health and safety, and technical and para-professional), it was third for those who do not work (after management and professional and health and safety). Finally, 88.5% of wage and salary earners who completed training courses in computing skills found that the skills were transferable (*i.e.* could be used in a similar job for a different employer) but did not tend to induce a pay rise (90.8%).

Computer training varies substantially in importance among all fields of training across industries and across occupations, but it is never the most important field of training. Education, property and business services, government administration and defence, and finance and insurance account for the four largest shares of total computer training and together account for over 57% of total. These are also industries, along with wholesale trade, in which computer training is the second most important field of training (see Annex Table C.6.12 for details). By occupation, the concentration is somewhat greater. The two occupations with the largest individual shares of total computer training (professionals, and intermediate clerical, sales and service workers) account for almost 62% of the total, but computer training is only the third and fourth most important field of training, respectively (see Annex Table C.6.13 for details).

- IT training in Japan

Japan has two types of government-supported IT training programmes. Local governments support basic IT training courses (basic computer operations, e-mail, Word, etc.). In FY 2000 (ending March 2001) just over 100 000 people had enrolled in over 6 000 classes. By the end of FY 2001, the number had increased to just over 5 million and over 300 000 classes. The government also supports training for professional IT skills (Information and Communications Personnel Training Support System) which is organised by non-private organisations and public corporations. In FY 2001, 1 299 people enrolled in these courses and in FY 2002, 5 065.

Outsourcing

Skill deficiencies can also be met through outsourcing, either domestically or internationally. Although there are no official data measuring the extent to which outsourcing takes place (see Chapter 2), anecdotal evidence suggests that firms' inclination to outsource depends on the reasons for outsourcing: saving on costs, improving quality or filling a skill deficiency.

In a context of globalisation, market deregulation and rapid technological developments, firms increasingly resort to new organisational forms in order to face competitive pressures. Firms can reorganise through mergers and acquisitions, joint ventures and strategic alliances (see Pain and van Welsum, 2003, for example), but also by outsourcing. By concentrating on their core comparative advantage activities and outsourcing others, firms may increase their competitiveness through cuts in labour and capital investment costs and the exploitation of economies of scale. Outsourcing may also lead to more efficient organisation of firms and allow them to share and spread risk. Furthermore, rapid developments in ICTs provide increasing opportunities for outsourcing. In particular, "knowledge work' such as data entry and information processing services and research and consultancy services can easily be carried out via the Internet and e-mail, as well as tele- and video- conferencing (ICT-enabled services). Increasingly, activities such as call centres have also started to be outsourced. For example, when phoning to a call centre on a local telephone number in the United Kingdom, the person answering may well be located in Bangalore.

In light of the increasing interconnectedness of both people and countries, as well as the omnipresence of affordable and powerful ICTs, Millar (2002a) examined outsourcing practices in Europe, using the know-how of industry experts from leading international consultancies, in order to identify outsourcing trends and their implications for employment and the accumulation and distribution of skills. She reports mixed evidence regarding the degree of geographic flexibility. On the one hand, outsourcing contracts may involve short-term arrangements that are determined by the demand for particular technologies and the supply of specific skills. On the other hand, some geographical patterns emerged. For example, software development and support work tended to be contracted out to firms in Poland, the Czech Republic and clusters around capital cities with important services sectors such as Brussels, London and Madrid. The outsourcing of creative services[12] tended to concentrate in regions in southern Europe (Madrid again, Athens, Milan, the south of France), along with Germany and the United Kingdom. However, labour-intensive, low value-added processing work tended to be outsourced to cheap-labour peripheral regions. Outside Europe, India has emerged as a major outsourcing centre. It initially attracted outsourcing activities because of its low-skilled cheap labour (in particular for call centres), but it is now becoming a location for the outsourcing of more sophisticated, higher value-added business processes or IT consulting. Over the next few years, other locations in the region are likely to compete as low-cost locations (*The Economist*, 2003a, 2003b).

Most outsourcing involves routine tasks and is driven by a desire to lower costs, but some is for specialist activities. Millar (2002a) found that European firms tended to outsource within Europe, with low-skill tasks mainly going to low-cost locations. Thus, while the use of ICTs makes possible the redistribution of ICT-skilled employment, it appears to do so in ways that result in increased regional polarisation. This could have lasting consequences for both the distribution of ICT-skilled employment and the accumulation of skills across countries.

Geographical and cultural diversity may also create barriers to the internationalisation of organisational relationships. Asymmetric information between clients and suppliers, which is particularly common for electronic goods and services, and differences in (corporate) cultures and national rules and regulations impede the globalisation of activities. Nevertheless, these can be overcome by adopting special practices, by implementing various types of outsourcing arrangements, and, increasingly, by entering into alliances and joint ventures.

Differences in geographical developments are also driven by differences in employment regulations, industrial organisation and institutional structures, and attitudes towards international investment and outsourcing practices. It appears that, in Europe, the outsourcing market is growing relatively more quickly in the United Kingdom than in Germany or France, for example. Morgan Chambers (2001), in a study of outsourcing in the FTSE100 firms, found that 56% had engaged in the outsourcing of internal services.[13] The banking sector alone accounted for 22% of business processes (*e.g.* finance and procurement) and ICT outsourcing contracts, followed by aerospace and defence (16%), oil and gas (14%), and telecommunications (13%). ICT-only contracts account for almost 75% of total business processing and ICT outsourcing contracts (while business processes outsourcing will often also include an ICT component). For such contracts, aerospace and defence account for the largest share (21%), followed by banks (18%), telecommunications services (12%) and oil and gas (8%). The study also notes that while there are many ICT services providers among the FTSE100 firms, often with divisions offering outsourcing services for their clients, these firms do not tend to outsource activities themselves. The study also found that the average ICT outsourcing contract is for 5.3 years, against 6.4 years on average for business processes outsourcing contracts.

Finally, outsourcing practices may change over time (Millar 2002a, 2002b). In the late 1990s, in the presence of skills shortages and rising costs, outsourcing in Europe was mainly for low-value, low-skill work on fixed contracts. Firms that dominated this part of the outsourcing market at that time (India in particular) are believed to benefit now from first-mover advantages. Moreover, there appears to be a trend towards the outsourcing of high-value, high-skilled work to countries where the outsourcing market is relatively mature. Firms in these countries now require staff to have more diverse skills, *i.e.* to combine technical skills with communication, management and business skills. While the first type of outsourcing is mainly motivated by cost savings, higher-skill forms of outsourcing tend to be driven by quality improvement. The organisational structures themselves are also changing and display a tendency towards more co-operative agreements and alliances.

One consequence of increased and broader outsourcing practices should be greater efficiency, induced and enhanced by greater competitiveness. Indeed, given that both time and geography lose their importance as ICTs become ever more powerful and sophisticated, and with markets increasingly deregulated, skilled workers throughout the world compete with one another. This should lead everywhere to an increase in the quality of the workforce and in the efficiency of production, but it is also important to maintain good working conditions (OECD, 2000; ILO, 2002).

Migration

Allowing the inflow of migrants with sought-after skills is one way for countries to fill skills gaps. Most countries, such as New Zealand (see Annex Table C.6.14), have established skill shortage or occupational shortage lists which are advertised on the immigration office (or equivalent) Web site. These lists change over time, but tend to include at least certain types of ICT skills, which generally fall into the advanced user and/or ICT specialist categories.

Migration of highly skilled workers is often thought of in terms of brain drain/brain gain or even brain circulation (Saxenian, 1999a, 1999b; OECD, 2001), but in fact, little is known about its effects. The accumulation of the knowledge stock is an important concern in both developing and developed countries and is related to issues such as the degree of fungibility of skills and location decisions of firms engaging in foreign direct investment (FDI) and R&D. The international migration of highly skilled workers may have both positive and negative effects arising mainly from technological, knowledge and cultural spillovers, as well as migrant workers remittances (see Regets, 2001, for a detailed overview). However, there is little empirical evidence to shed light on such alleged effects.

Until recently, it was widely believed that shortages in the ICT-sector labour market created a climate favourable to the international migration of IT specialists and professionals. However, it appears that some countries are now starting to take a less favourable view of IT migration, in part as a result of the general slowdown that has taken place in the ICT sector, reduced skills shortages and/or an overestimation of skills needs. The United Kingdom removed IT occupations from the occupational shortage list in late 2002, Denmark took IT specialists out of the special immigration scheme in July 2003,[14] and Australia announced in November 2003 that the revised "Migration Occupations in Demand List" no longer contained any ICT specialisations, after having contained up to 26 in the past. Finally, the United States has announced the return to its lower former level of its H-1B visa quota,[15] which includes, but is not exclusively for, the immigration of IT specialists.[16]

Most European countries and developed Asian countries have not adopted special measures to recruit highly skilled workers but continue to rely on existing work permit schemes (McLaughlan and Salt, 2002; see also OECD, 2002). However, where special measures have been introduced, they tend to apply to IT and health (mainly nursing) occupations and intra-company transferees. The information on IT-related migration for selected OECD countries discussed below suggests that, for most countries, migration flows are influenced, among other factors, by historical (sometimes colonial) ties and/or the presence of a common language.

In the *United States*, IT firms have found it increasingly difficult to obtain visas for professionals from Indian consultancy firms, and India's largest IT service provider, Tata Consultancy Services (TCS), with some 5 000 staff in the United States, has encountered longer delays and refusals of visas (*The Economist*, 2003b). The US Department of Homeland Security's Citizenship and Immigration Services) has announced that the ceiling on H-1B visas, which many IT professionals use to work in the United States, will drop in 2004 from 195 000 to its former level of 65 000. Moreover, while computer-related occupations (defined as systems analysis and programming, data communications and networks, and computer systems technical support under the US Department of Labor's [DoL] coding system) accounted for 58% of H-1B approved petitions in FY 2000 and FY 2001,[17] they represented just over 38%

in FY 2002, but still remained the largest occupational group (US DoL, 2003; US Citizenship and Immigration Services, 2001 and 2000).

India accounted for over 48% of approved H-1B petitions in both 2000 and 2001, followed by China (over 8%) and Canada (over 3%), also in both years. However, for computer-related occupations, India was the main country of origin, accounting for 71% of total approvals in 2001 and 63% in 2002. Finally, the median annual compensation of H-1B beneficiaries in computer-related occupations in 2001 was USD 58 000 against a median of USD 55 000 for all occupations.

Australia announced in November 2003 that ICT specialisations no longer figure on the list of migration occupations in demand, as research had shown that Australia no longer had ICT skills shortages (*www.minister.immi.gov.au/media_releases/media03/v03007.htm*). Other government initiatives, such as suspending priority processing of ICT migrant applications and increasing the number of points required to meet the migration pass mark, also aim at reducing the inflow of ICT migrants. Table 6.6 shows arrivals and departures of IT managers and computing professionals in the period 1997/98-1999/2000. The largest flows were between Australia and the United Kingdom, Hong Kong (China) and the United States.

Box 6.4. **Survey of returning IT workers to Bangalore, India**

A survey of IT emigrants returning to Bangalore, India, was carried out in November 2002 (Khadria, 2004). The sample included 45 respondents in different types of software companies. Their mean age was 33 years, and nearly two-thirds were in the 25-35 years age bracket. They were mainly male (39 out of 45), married (35 out of 45), well educated (20 were graduates, 20 post-graduates and four held PhDs; one was educated abroad), and had stayed abroad for a relatively short period of time (17 out of 45 for less than 2 years, six for 2-4 years, ten for 4-6 years; the rest for longer periods of up to 16 years). Also, 35 respondents indicated they would like to emigrate again, although only if offered a lucrative overseas job, and 39 stated that if they emigrated again, they would not wish to remain abroad permanently.

Out of a total of 56 destinations (multiple answers were possible), the United States was the most favoured destination (36), followed by the United Kingdom (7) and Germany (4). Better professional infrastructure and favourable policies for granting visas to IT professionals were among the main reasons for the preference for the United States.

The main reasons for emigrating included: the opportunity to work on projects, mainly in the United States, made available through their employers in India (23 respondents); additional higher education in the host country (the main purpose of 13 respondents, although only nine succeeded); and work experience abroad which was felt to be of quite high value in India (eight respondents). Permanent settlement abroad was never given as an answer.

The respondents returned to India on their own initiative (29, for a variety of reasons, such as family or other personal reasons, but also increased opportunities in India) or were recalled by their employers (nine). Respondents were attracted to Bangalore in particular by abundant employment opportunities, relatively better infrastructure, better remuneration packages, and the availability of experts in the IT sector. The presence of family in Bangalore was also relatively important, as was the climate.

Even though the central and state governments have put in place incentive programmes and other policies aimed at encouraging expatriate professionals to return to India (mostly through tax rebates, housing facilities or financial assistance when setting up a business in Bangalore), only 11 respondents claimed to be aware of them (and very few managed to receive such help after their return). The remaining 34 claimed never to have heard of them, either before or after their return.

Job satisfaction in Bangalore is generally high (41 out of 45 respondents), mainly because of greater professional autonomy, world-class institutional infrastructure, favourable working environment, the cosmopolitan nature of Bangalore, and many opportunities for career advancement. Most respondents agreed that the knowledge and skills obtained overseas through higher education and on-the-job training were very important for their current job in Bangalore, as were the opportunities the stay abroad had given them to learn and familiarise themselves with new technologies. One-fifth of the respondents also mentioned benefiting from professional networks established while overseas.

Table 6.6. **Migration flows in and out of Australia, IT managers and computing professionals, 1997/98-1999/2000**

	Resident arriving	Resident leaving	Visitor arriving	Visitor leaving	Settler arriving
IT managers	746	1 300	1 089	324	334
Computing professionals	4 303	7 640	5 956	2 528	4 456

Source: Australian Department of Immigration and Multicultural and Indigenous Affairs (2003), revised 2004.

Canada has set up a pilot programme to facilitate the processing of IT workers in order to help employers fill critical shortages in the software industry. The programme is part of a government initiative to support the entry of skilled foreign workers (as temporary residents with an employment authorisation) when employers cannot fill vacancies through the domestic market as a result of labour shortages. A pilot software programme for alleviating short-term and temporary skills shortages with temporary residents was introduced in 1997 and became permanent in December 2001. Long-term strategies include re-examination of the educational system with a view to enabling the domestic labour force to meet employers' demands.

Table 6.7 shows the number of foreign IT workers who arrived under the software programme between 1997 and 2002 and some of the main source countries. The number increased steadily between 1997 and 2000, with the exception of 1999, but then declined. India was the largest supplier from the introduction of the programme, and its share increased from around 28% in 1997 to over 63% in 2002. Most of the other source countries have seen their shares diminish. Nevertheless, the sum of the shares of the countries reported in the table increased from over 56% in 1997 to over 80% in 2002.

Most arrivals locate in the main urban areas, and the three largest recipient cities account for around 60% of total arrivals. In 2002, Toronto received 39.9% of total inflows (total Ontario, 69.1%), Vancouver, 10.2% (total British Columbia, 11.9%), and Montreal 9.7% (total Quebec, 10.3%). This geographical pattern has been relatively constant from the start of the programme, although the relative importance of Toronto in total Ontario decreased substantially, from 70.7% in 1997 to 57.8% in 2002.

Since July 2003, *Denmark* no longer includes IT specialists in its job-card scheme, which facilitates the processing or work permits. In 2001 and 2002, specialists under the job-card scheme accounted for 7.6% and 5.5%, respectively, of total residence permits on immigration to Denmark and for 8% and 11.5%, respectively, in the first two quarters of 2003. Moreover, IT specialists accounted for 47% of residence permits given out under the job-card scheme in 2002 (applications after 1 July 2002), and for 43.7% and 41% in the first two quarters of 2003 (Danish Immigration Service, 2003).

In 1998, *France* introduced a fast-track system for IT specialists and highly skilled professionals in response to a shortage of IT professionals. The permits are valid for one year and are renewable and are limited to a specific region and a specific job. Table 6.8 shows the number of work permits issued to

Table 6.7. **Foreign workers entering Canada under the software programme by country of last permanent residence, 1997-2002 (flows)**

	1997		1998		1999		2000		2001		2002	
Total	**311**		**953**		**932**		**1 120**		**960**		**766**	
of which:		%		%		%		%		%		%
India	88	28.3	369	38.7	331	35.5	411	36.7	453	47.2	485	63.3
UK[1]	27	8.7	58	6.1	63	6.8	63	5.6	53	5.5	25	3.3
France	22	7.1	44	4.6	65	7.0	74	6.6	47	4.9	19	2.5
USA	20	6.4	58	6.1	52	5.6	97	8.7	83	8.6	47	6.1
Australia	15	4.8	32	3.4	35	3.8	45	4.0	27	2.8	16	2.1
Israel	3	1.0	18	1.9	16	1.7	0	0.0	16	1.7	23	3.0

1. United Kingdom and Channel Islands.
Source: OECD, based on data from Priorities, Planning and Research Branch, Strategic Research and Statistics, Citizenship and Immigration Canada (2003).

Table 6.8. **Number of work permits issued to permanent and temporary IT managers and engineers in France, 1996-2002**

	1996	1997	1998	1999	2000	2001	2002
Permanent total	4 267	4 582	4 149	5 326	5 990	8 811	7 469
Permanent IT managers/engineers	298	401	699	1 136	1 622	2 641	975
% of total	7.0	8.8	16.8	21.3	27.1	30.0	13.1
Temporary total	4 832	4 674	4 295	5 791	7 502	9 628	9 822
Temporary IT managers/engineers	285	564	796	1 033	986	1 368	792
% of total	5.9	12.1	18.5	17.8	13.1	14.2	8.1
Total IT manager/engineers	583	965	1 495	2 169	2 608	4 009	1 767
% permanent	51.1	41.6	46.8	52.4	62.2	65.9	55.2
% temporary	48.9	58.4	53.2	47.6	37.8	34.1	44.8

Note: The figures exclude immigrants from the EU15 and the European Economic Area (EEA).
Source: Service des statistiques, des études et de la communication, Office des Migrations Internationales (2003).

permanent and temporary IT engineers in France over the period 1996-2002. In 2000 and 2001 the demand for IT specialists was particularly strong with the passage to the year 2000 (Y2K-induced IT problems) and the adoption of the euro. Demand subsequently slumped, resulting in a sharp drop permits granted to IT specialists in 2002. There was a steady increase in both the absolute and relative number of permanent permits delivered to IT managers and engineers between 1996 and 2001, followed by a sharp drop in 2002. The number of temporary permits increased until 1999 and fluctuated thereafter, also with a sharp drop in 2002. Their relative number varied over most of the period, ranging from 5.9% in 1996 to 18.5% in 1998. Moreover, with the exception of 1997 and 1998, relatively more permanent than temporary permits were granted to IT engineers.

Table 6.9 and Figure 6.11 show the number and distribution of work permits granted to IT specialists by region of origin and the main source countries over the period 1999-2002. The sharp drop in permits in 2002 is observed for most regions and countries, except India. During the two years with particularly strong demand for IT specialists, Africa was by far the largest supplier. Moreover, while America's share decreased over the period 1999-2002, Asia's share increased considerably, as did non-EU15 Europe's, although to a lesser extent.

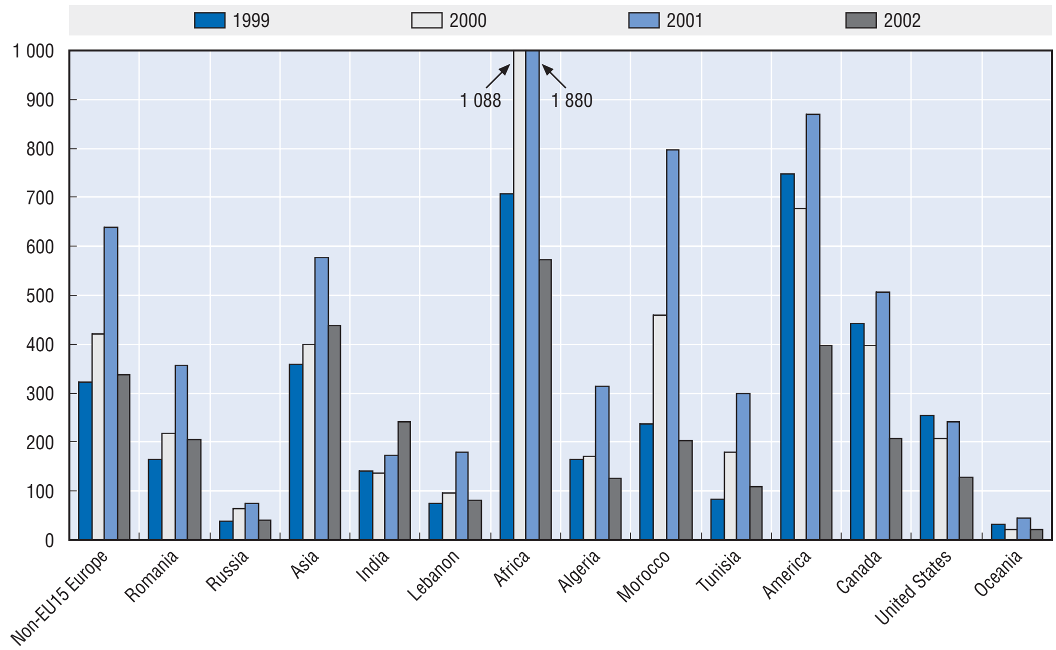
In August 2000, *Germany* introduced the IT specialist temporary relief programme, the Green Card, in order to allow IT specialists from non-EU15 countries to work in Germany for up to five years. Requirements are a good knowledge of either German or English and either a degree in the ICT field or a confirmed offer of a minimum annual salary of EUR 51 000. The initial quota was fixed at 10 000 cards and was subsequently raised to 20 000. However, as Figure 6.12 shows, by June 2003, fewer than three-quarters had been given out. For most countries of origin, between 78% and 98%, are men. Between around half and two-thirds of cardholders are employed in firms of up to 100 employees.

Table 6.9. **Regional shares of total work permits granted to IT specialists in France, 1999-2002**

	1999	2000	2001	2002
Africa	33	42	47	32
America	34	26	22	23
Asia	17	15	14	25
non-EU Europe	15	16	16	19
Oceania	1	1	1	1

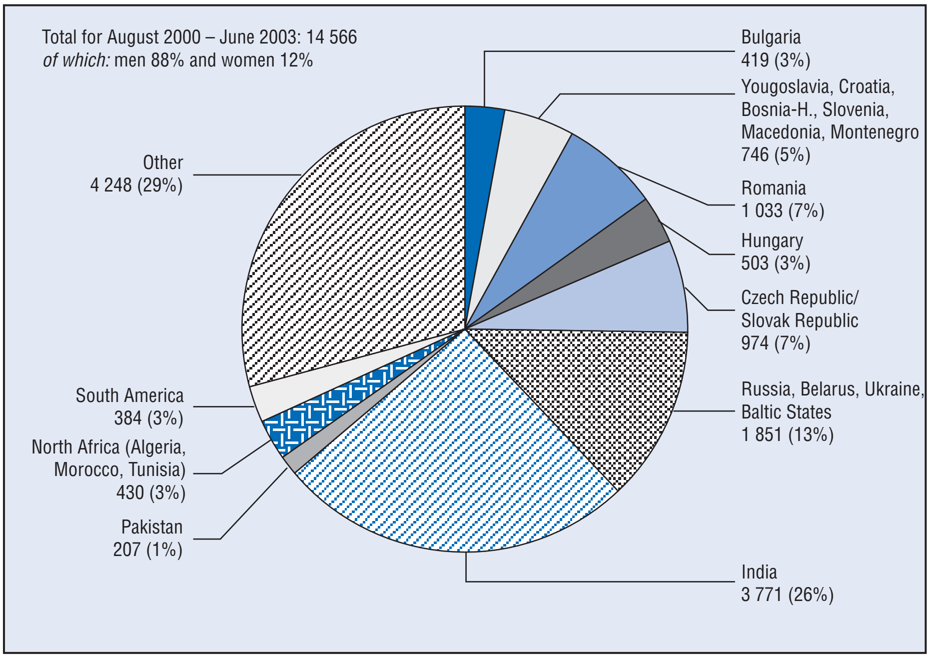
Note: Non-EU Europe refers to non EU15.
Source: Office des Migrations Internationales, 2003.

Figure 6.11. **Total work permits granted to IT specialists in France by region and country of origin, 1999-2002**



Note: Excludes immigrants from the EU15 and the EEA. Non-EU Europe refers to non-EU15.
Source: Office des Migrations Internationales, 2003.

Figure 6.12. **Permits for IT specialists (green cards) delivered in Germany, August 2000-June 2003**



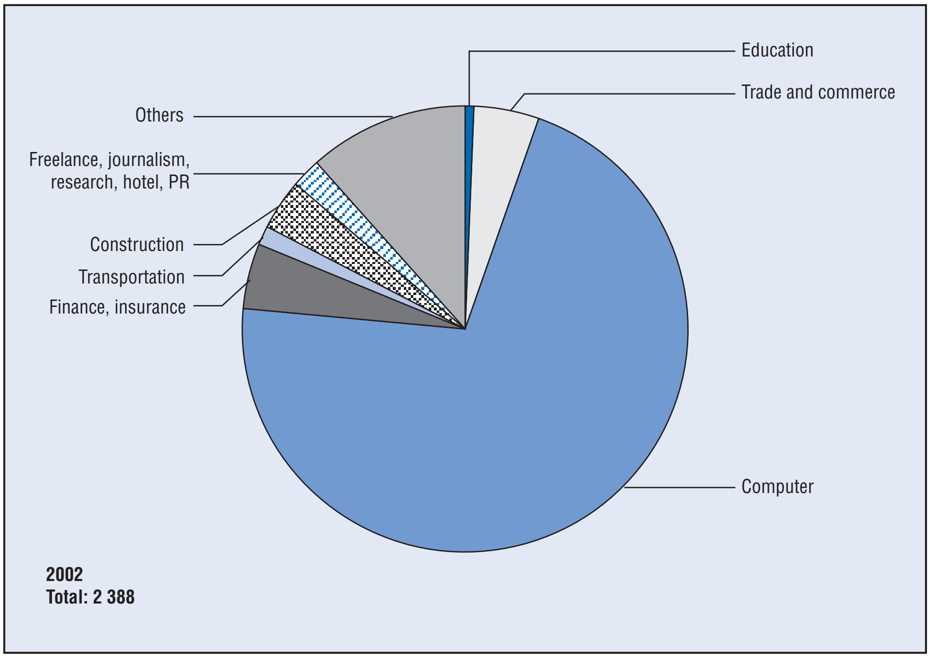
Source: ZAV IT-Sonderteam, Central Placement Office, Arbeitsamt (2003).

Ireland introduced the working visa and work authorisation scheme in June 2000. It is designed to aid sectors where skills shortages are particularly important, such as information and computing technologies. While the scheme does not eliminate the requirement of a work permit, it offers a faster alternative.

Japan records separately persons who enter Japan to work in a Japanese firm as technology specialists (including IT specialists). In 2002, four countries accounted for around 80% of total new foreign entrants under this scheme: 31.9% from China, 21.6% from Korea, 16.2% from the United States and 10% from India. For those who changed status by switching from a student visa, China accounted for 61.3%, Korea for 17.1%, followed by Malaysia and Indonesia with 3% and 2.1%, respectively. While the numbers do not allow for distinguishing between IT specialists and others, Figure 6.13, which shows the sectoral breakdown of visas issued for working in Japanese firms as technology specialists in 2002, indicates that computer-related immigration is relatively important in this group.

Korea's main emphasis has been on the education and training of domestic workers. It has recently loosened somewhat its relatively restrictive immigration policy for temporary employment, owing to labour shortages, particularly in the very high-technology area where it is relatively more difficult to satisfy the need for skilled personnel from the pool of domestic workers. The Korean Ministry of Information and Communication and the Korean Ministry of Justice therefore decided to allow the immigration of highly skilled IT workers through what has been called the IT CARD system. In December 2001, responsibility for this project was transferred to the Promising Information and Communication Companies Association (PICCA). The system operates through the issuance of E-7 visas, improvement of the Stay Permission System, and the issuance of a letter of recommendation. Companies that wish to hire IT immigrants undergo two official audits. Applicant immigrants must have at least five years of engineering experience in IT, e-business or related fields, or a bachelor's degree and two years' experience. If all conditions are satisfied, the Ministry of Information and Communication issues a letter of recommendation. Table 6.10 shows the total number of recommendations since 2000.

Figure 6.13. **Visas issued for working in Japanese firms as technology specialists by sector of activity, 2002**



Source: Japanese Ministry of Justice, Bureau of Immigration (2003).

Table 6.10. **Recommendations for IT CARDs by the Korean Ministry of Information and Communication, 2000-October 2003**

	2000	2001	2002	October 2003	Total
Recommendations	46	169	225	204	644

Source: Promising Information and Communication Companies Association (2003).

In *New Zealand*, IT specialists figure on the Occupational Shortage List (see Annex Table C.6.15 for details), and IT professionals – management and project management staff, policy planning and research staff, systems development staff, and technical advice and consultancy staff – are on the priority occupations list. However, between 11November 2002 and 30 June 2003, less than 2% of total approved work applications were for IT immigrants.

In *Norway*, the number of specialist permits awarded increased considerably in 2001 and 2002 as a result of changes and simplifications in the regulations and requirements governing these types of permits (Table 6.11).

The *United Kingdom* removed IT occupations from the shortage occupations list in late 2002, but the total number of IT work permits granted has changed little. This can be explained, in part, by the fact that a large share of approved work permits are extensions of permits for persons already in the United Kingdom. The evolution of the number of applications granted, by occupation, from April 2002 to September 2003 is shown in Figure 6.14.

Internet recruitment

This section examines online recruitment, a relatively new phenomenon which brings together the use of ICTs and ICT skills in the process of offering and finding employment. Job search and recruitment have moved onto the Internet with relative success, and Internet recruitment firms have been among the most successful dot.com companies. Their success can be explained by the role played by information, which is crucial both for jobseekers looking for job vacancies and information and employers who want to fill jobs and obtain information about jobseekers. Since the Internet offers a very low cost and speedy means[18] of transmitting information widely, on-line job search and recruitment has substantial advantages. As a consequence, more and more people (in a wide variety of occupations and sectors) are using the Internet for job searching, either through so-called job boards, which effectively have the same function as newspaper ads, or through Internet recruitment firms that often maintain job boards as well as databases of CVs. Moreover, many firms now post vacancies on their Web sites, and many also allow people to apply on line.

Advantages for jobseekers include the possibility to search among a very large pool of jobs, in general free of charge. Moreover, on-line recruitment firms offer jobseekers the possibility to search by keyword, job category, location, etc., to personalise and organise their searches, to receive e-mail notification of the progress of their application, as well as job search and career development advice.

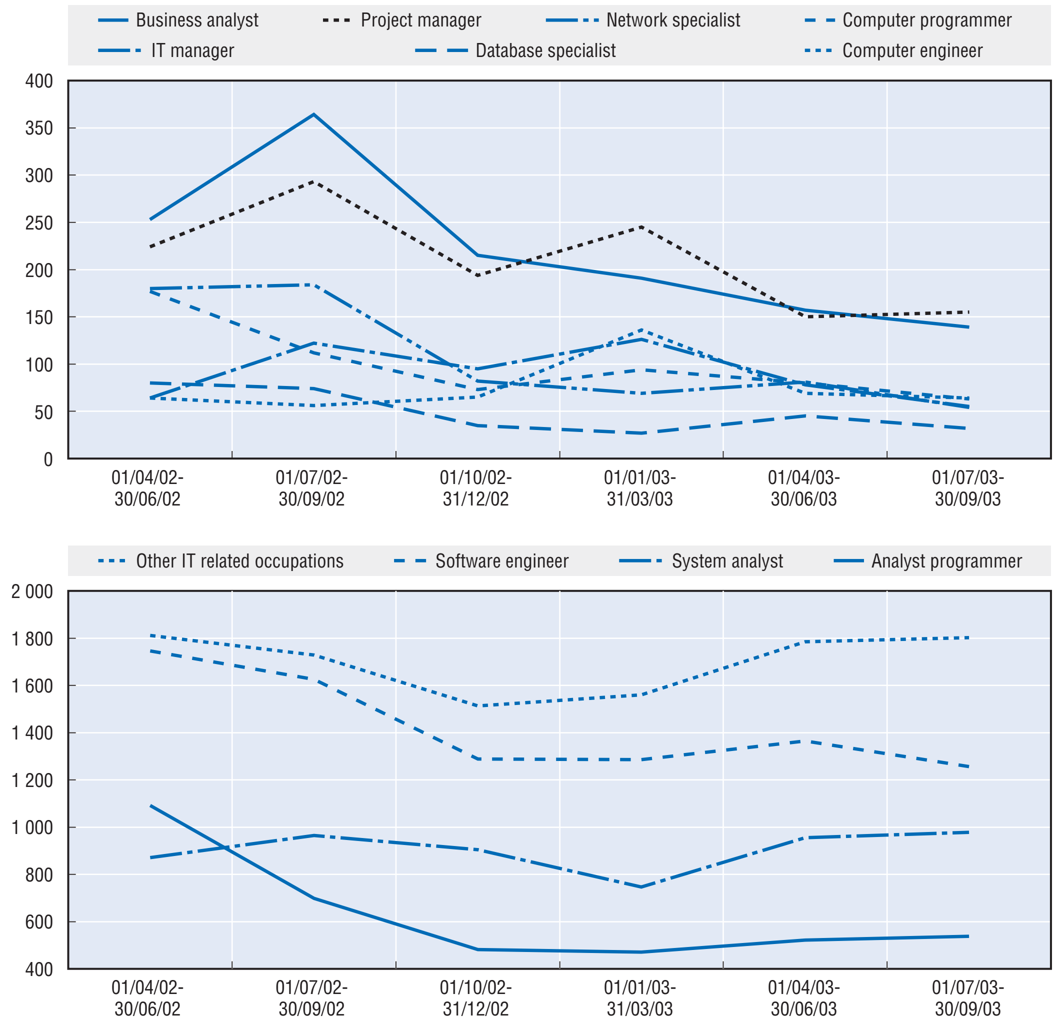
Firms seeking to recruit on line can do so either directly, through their Web site, or indirectly through the intermediary of online recruitment firms. The latter offer search possibilities similar to those for

Table 6.11. **Number of specialist permits issued in Norway, 1995-2002**

Year	1995	1996	1997	1998	1999	2000	2001	2002
Number of specialist permits	296	360	366	420	384	296	779	1 676

Source: Strategy and Documentation Department, Norwegian Directorate of Immigration, UDI (2003).

Figure 6.14. **Number of IT work permits approved in the United Kingdom, by occupation, April 2002-September 2003**



Source: Work Permits UK (2003).

jobseekers, pre-screening services, as well as advantages such as the ability to edit job advertisements, to post them in multiple locations, to track reactions, etc. Moreover, according to Monster, one of many Internet recruitment companies, cost savings are often cited as the main driver of on-line recruitment. Freeman (2002) reports that it has been estimated (by the Employment Management Association) that recruitment over the Internet costs a firm around one-fifth of what it would cost using print media. According to Monster UK, the gains are even more important. They claim that a typical recruitment ad in a national paper costs around GBP 10 000, whereas it costs only GBP 250 to post a vacancy on the Monster site for 60 days. At Careerbuilder.com, pricing for employers depends on the (customised) package purchased. An employer wanting to post a single vacancy in one location for 30 days will typically be charged around GBP 200, but the amount will vary depending on the number of postings and whether other services, such as the Resume Database Service, are also purchased.

Freeman (2002) points out that this type of on-line activity highlights the importance of network economies and of economies of scale, but that a balance is needed between the interests of jobseekers, who prefer sites with many firms and few applicants, and employers who prefer sites with many applicants and few firms. He also argues that, *a priori*, these developments should allow better and speedier matching of jobseekers and employers, speedier clearing of the labour market and reduced transactions costs, and that these gains should ultimately contribute to a more efficient economy. Nevertheless, Kuhn and Skuterud (2004) find some empirical evidence to the contrary, their results indicating that either Internet job searches are ineffective in reducing unemployment durations, or Internet job searchers are negatively selected on unobserved characteristics.

With the launch in September 2003 of EURES (European Employment Services), the European Job Mobility Portal Web site (*http://europa.eu.int/eures/index.jsp*),the European Union has also acknowledged the importance of the Internet as a recruitment tool. EURES is a co-operative network formed by public employment services with the participation of trade unions and employers' organisations. It aims to enhance labour mobility in participating countries (EU15 member states, as well as Iceland, Norway and Switzerland)by advertising vacancies for a wide range of sectors and skill levels from employers that wish to recruit internationally. It allows jobseekers who are interested in moving to another country to post their CVs on line and provides practical information about living and working in participating countries. The service is free of charge for both employers and jobseekers. The vacancy database, which at the outset contained around 11 000 vacancies, is updated daily. The Living and Working Conditions database, which contains details on issues such as finding accommodation and schools, taxes, cost of living, social security and comparability of qualifications, is updated at least twice a year.

- Some illustrations[19]

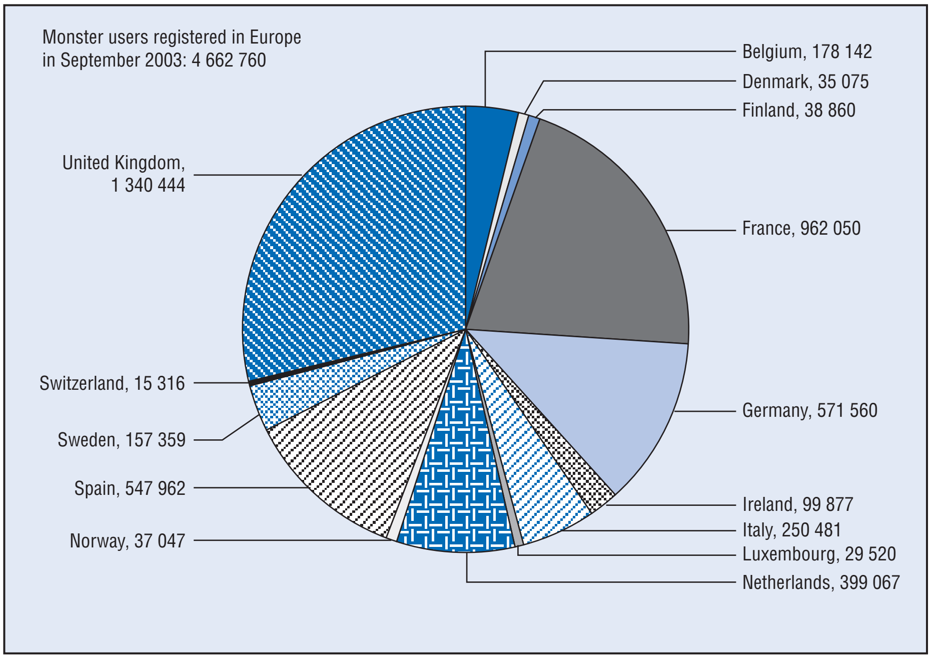
The Monster global network consists of local content and language sites in the United States, Canada, Australia, New Zealand, Singapore, Hong Kong (China), India, and in Europe in Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom. It has over 30 million resumes and a searchable database of over 300 000 employment opportunities. Monster offers company memberships that are scalable and customised to the individual level of service required. Thus, employers can purchase single job postings, or packages ranging from 15 to 6 000 postings. Moreover, job descriptions can be programmed to link to company profiles to give applicants a better understanding of the recruiting company. Figure 6.15 shows the geographical distribution of the over 4.6 million users that were registered in Europe in September 2003.

CareerBuilder.com has around 7 million different visitors each month and expects the number to (more than) double in early 2004 after the launch of the career sites of AOL and MSN, which it will power. It already powers the career sites for more than 350 US national, industry, local and niche sites. It offers more than 400 000 jobs from over 25 000 of the United States' top employers and covers most industries and fields. Companies can search over 7 million CVs.

HotJobs.com is fully integrated with Yahoo!, and when it features on the Yahoo! homepage, there is a 45% increase in traffic and a 49% increase in resume creation. It has recently been awarded leading industry and editorial awards (Weddle's and PC M*agazine*). Jobseekers voted it the best general purpose job board for jobseekers in both 2002 and 2003, and recruiters voted it the most recruiter-friendly general purpose site in 2003 in a survey carried out by Weddle's. It registered 6.6 million different visitors in March 2003 and recorded a total of 13.7 million jobseekers in April 2003. Over 3 million skilled workers are registered in fields such as construction, manufacturing and transportation. Some of the top 50 keywords entered into the HotJobs Mantle on Yahoo! include: driver (12), truck driver (15), electrician (21), construction (22), and part-time (29), a clear indication that on-line recruitment is an economy-wide phenomenon and is not just limited to the ICT sector and/or ICT specialists.

The market share of the top ten on-line recruitment sites in the United States and the United Kingdom in January 2004 is shown in Table 6.12. In the United States, these accounted for 50.7% of total usage of

Figure 6.15. **Geographical distribution of Monster users registered in Europe, September 2003**



Source: Monster (2003).

Table 6.12. **Top ten Internet recruitment sites in the United States and the United Kingdom, January 2004**

Rank	Site	Domain name	Market share
United States			
1	Monster.com	*www.monster.com*	18.4%
2	Yahoo! Hotjobs	*hotjobs.yahoo.com*	12.8%
3	Monster.com – My Monster	*my.monster.com*	5.8%
4	CareerBuilder	*www.careerbuilder.com*	3.8%
5	USAJOBS	*www.usajobs.opm.gov*	2.4%
6	America's Job Bank	*www.jobsearch.org*	2.3%
7	Dice IT Employment	*www.dice.com*	1.5%
8	MSN CareerBuilder Network	*msn.careerbuilder.com*	1.3%
9	Your Benefits Resources	*www.resources.hewitt.com*	1.2%
10	FlipDog.com	*www.flipdog.com*	1.2%
United Kingdom			
1	Jobcentre Plus	*www.jobcentreplus.gov.uk*	9.1%
2	Jobsite	*www.jobsite.co.uk*	5.7%
3	Fish4 Jobs	*fish4.co.uk/jobs*	5.4%
4	Total Jobs	*www.totaljobs.com*	4.8%
5	Reed.co.uk	*www.reed.co.uk*	3.5%
6	Monster.co.uk	*www.monster.co.uk*	2.7%
7	Jobserve	*www.jobserve.co.uk*	2.4%
8	TES Jobs	*www.tesjobs.co.uk*	1.7%
9	WorkThing	*www.workthing.com*	1.7%
10	Guardian Unlimited Jobs	*jobs.guardian.co.uk*	1.6%

Note: Market share refers to the company's share in the total on line recruitment market in the respective country.
Source: Hitwise (2004).

on-line recruitment sites, *versus* 38.5% in the United Kingdom. Monster is the only company that figures in the top ten in both the United States and United Kingdom.

In the United Kingdom, the National Online Recruitment Audience Survey (NORAS), carried out by Enhance Media Limited (2003), examined the demographic, work situation and Internet usage profiles of users of UK on-line recruitment sites (see Box 6.5).[20] Overall, there was little difference in terms of gender (51% male, 49% female for the sample as a whole), but most of the specialist sites show larger differences (see Annex Table C.6.16 for more detail). The average age in the total sample was 31.0 years (33.1 for the generic sites), and 86% of respondents were aged 15-44. More than half of all respondents (56%) were highly educated, having obtained either a degree or a professional qualification, compared to 48% for the generic sites. Just over a third of total and generic respondents (36% and 37%, respectively) were based in the southern part of the United Kingdom, but geographical concentration was fairly weak, with the Midlands accounting for 27% and 28% of total and generic users, respectively, and the north for 20% and 19%.

Box 6.5. Detailed profiles of UK users of on-line recruitment site

Most users were in full-time employment (at least 30 hours a week) on a permanent basis: 42% of total and 47% of generic users. However, the unemployed account for the second largest share: 25% and 28% of total and generic users, respectively. The average number of years of work experience was 10.6 years for the sample as a whole, and 11.7 years for generic users. The average salaries of those working were around GBP 22 500 for the total sample, and around GBP 23 700 for the generic users. Nearly 40% of all those working earned a pre-tax annual income of between GBP 10 000 and GBP 19 999, and a quarter between GBP 20 000 and GBP 29 999.

Nearly 80% of respondents use the Internet every day. Around a quarter visit the recruitment sites included in the survey daily. On average, they visit 5.5 recruitment sites. Over 40% visit from one to three sites to look for a job, and 14% visit more than ten. Both for total and generic users, search engines or links were the most important reason for visiting a particular site (31% and 39%, respectively), followed by recommendation of the site (over 20%). Advertising accounted for only 10% and 13%, respectively, of reported reasons for choosing a site.

Among reasons other than job hunting, recruitment sites are also cited as being used to find information about specific companies or potential employers (around 40%), to compare salaries (around 40%), to obtain information about the industry sector (around 30%), and to seek advice and tips on career management (nearly 30%). Around 70% of users have applied for a job found on the Internet (on line or *via* telephone, letter, etc.). However, fewer than 30% of those who have applied for jobs found on the Internet have obtained one. Other means of looking for a job included local newspapers (over 60%), national newspapers (over 50%), recruitment consultants and headhunters (over 40%). Nevertheless, both total and generic users chose the Internet as the preferred way to look for a job (43% and 39%, respectively), followed by local newspapers (nearly 20%) and recruitment consultants and headhunters (over 10%).

Source: NORAS, Enhance Media Limited, 2003.

The distribution by the employer's sector of activity and by the types of tasks performed by the respondent for the sample as a whole and for users of generic sites is shown in Table 6.13. The results show that most sectors of activity are involved, and that while the IT sector and those that carry out IT-related tasks are important users of Internet recruitment sites, they are not necessarily the main users.

Table 6.13. **NORAS results by sector of employer and type of activity**
Percentages of those working

Industry sector of the employer	Total	Generic	Type of tasks actually carried out	Total	Generic
Accountancy	1	1	Accountancy	4	5
Aviation	4	1	Admin/secretarial	14	15
Banking/finance	5	6	Aviation operations	1	0
Central government	1	1	Banking	1	2
Charity	2	2	Catering	2	2
Construction	5	3	Consulting/strategy/research	3	3
Consultancy	2	2	Creative/artistic/design	2	2
Defence/emergency	2	2	Customer service	6	5
Education	13	6	Domestic	0	0
Engineering	4	4	Editorial	0	1
Health	4	4	Engineering	7	6
Hospitality	3	3	Graduate	2	1
Insurance	1	1	HR/training	3	4
IT	6	10	IT	10	14
Law	1	1	Legal	1	1
Leisure	3	3	Management	6	7
Local government	7	3	Manual	2	3
Manufacturing	5	7	Marketing/PR	4	5
Marketing/advertising/PR	2	3	Medical/health	3	3
Media/entertainment	4	4	Other	4	4
New media	2	1	Public/general local government	5	2
Other	5	6	Retail operations	3	3
Pharmaceutical	1	2	Sales	5	6
Recruitment	2	2	Scientific	4	1
Retail	7	8	Skilled trade	3	3
Telecommunications	4	6	Teaching/lecturing	4	2
Transport	3	3			
Travel	2	2			
Utilities	1	1			

Source: Enhance Media Limited, 2003.

Conclusion

This chapter builds a picture of where people with ICT skills are employed in the economy, focusing both on those with specialist ICT skills as well as those with ICT user skills. The results show that ICT-skilled employment is spread throughout the economy, with certain services sectors having particularly high ratios of ICT-skilled employment to total employment, and the importance of ICT-skilled employment, at both the specialist and the user level, has increased over time. The distribution of skills throughout the economy is important for competitiveness, especially since the increased use of ICTs in production and business processes, which requires a pool of workers with appropriate skills, is expected of to be of crucial importance for countries' productivity and growth.

It is important to distinguish between different types of ICT skills. The general diffusion of ICTs throughout the economy is likely to ensure that at least the basic needs for ICT user skills will be broadly satisfied in future. Indeed, with the general diffusion of ICTs in households and at work, as well as the introduction of ICTs in schools, the pool of people with at least some familiarity with ICTs is likely to increase rapidly. The example of Internet recruitment suggests that these skills are in fact diffusing and are being used by quite a broad cross-section of the population. However, formal education does not appear to be the most effective means of satisfying needs for the skills of advanced users and certain types of specialist skills. These skills needs are likely to change rapidly as new technologies are developed and adopted. Sector-specific training and certification schemes may be more suitable for satisfying these particular skills needs. Chapter 8 outlines the various policies OECD countries are currently deploying in the field of ICT skills.

There is also a geographical dimension to the supply of ICT skills. If skills cannot be satisfied internally, firms can decide to outsource the activities for which they lack skilled labour, either domestically or internationally, or countries can allow the inflow of ICT-skilled migrants. While the latter method is on a downward trend since 2001, there are growing indications that the outsourcing of ICT-related and ICT-enabled activities is gaining momentum. This adds to the evidence that suggests that the ongoing development and diffusion of ICT products and processes, as well as the presence of an ICT-skilled pool of labour, will have an increasingly important impact on the spatial distribution of economic activities in the years ahead.

NOTES

1. This chapter builds on the 2002 OECD Information Technology Outlook, which addressed the evolution in the numbers and the characteristics of ICT workers, as well as concerns about possible skill mismatches in ICT-related jobs.
2. ICT-related occupations included in other OECD publications are: ISCO88 213, 312, 313 and 724. Further distinctions can be made between high-skilled (213, 312, 313), low-skilled (724) and computing occupations (213, 312).
3. Lemaître (2002) discusses two measures of skills that can be obtained from using labour force survey data: educational attainment and job requirements as built into the ISCO classification of occupations. He finds that the former measure, which has traditionally been used as a skills proxy, is a very partial one, and that the latter identifies another dimension of skills which is correlated with the educational measure, and holds up independently. This is the measure used here.
4. A survey of the ICT content of the standard ISCO occupations, which could be used to guide the choice of occupations to be included in such an exercise, would be helpful.
5. While it would be interesting to add educational attainment or wages as a third dimension, the current data set does not allow this. In particular, some detail would be lost in the other two dimensions (occupations and/or industries), as the labour force survey samples are not sufficiently large.
6. The choice of cut-off points was guided by examining industry distributions. The 30% and 10% cut-off points provided a relatively even distribution of industries in most countries.
7. As only 15 occupations were available, it is not possible to establish a list of occupations that closely matches any of the lists for other countries. The best approximation is as follows: the narrow definition includes technicians (agricultural technicians, fishery technicians, technicians in brewery, mechanical engineers, architects, programmers, data processing technicians), and the broad definition includes technicians (see above), as well as management (management staff in private companies, management staff in government sectors, members of parliament) and administration (secretary, clerk, collector for gas, electricity and water, station attendant, typist, stenographer, computer operator).
8. In Census Canada 2001, the experienced labour force excludes first-time jobseekers as well as those who were not in the labour force in 2000 and 2001.
9. For further analysis of the impact of ICTs on economic growth and productivity, see OECD, 2003a.
10. The survey examined whether the present provision was adequate for (self-) instruction but did not attempt to deal with the question of whether or not schools should provide computers for teachers and students. It explored several aspects of the use of ICTs by teachers and students in upper secondary schools. Upper secondary school principals were asked about the number of computers in their schools; the use of computers by teachers; the professional development of teachers and computer technology; the use of ICTs for educational purposes, more specifically in student assignments; the nature of ICT-related co-operation between schools and other institutions; and perceived teacher, software, hardware and organisation-related obstacles to attaining goals involving information technology.
11. Career-Space (http://www.career-space.com) is a consortium of nine major ICT companies: BT, Cisco Systems, IBM Europe, Intel, Microsoft Europe, Nokia, Philips Semiconductors, Siemens AG, Thales. Supported by the European Commission and together with EICTA (the European Information, Communication and Consumer Electronics Industry Technology Association) it has been exploring new ways of addressing skills shortages. The GENIUS consortium consists of nine universities located throughout the EU, four major IT companies (IBM, Intel, BT/Support IT and Philips) and e-Skills (the UK training organisation) and ICEL Ltd. Belgium.
12. Millar (2002a) defines these as R&D, design, editorial, multimedia and other forms of content generation.
13. The survey was carried out over a six-month period in 2001, and research for contracts was conducted for the five-year period from 30 March 1996 to 30 March 2001. Only contracts with a duration of at least two years and exceeding an annual GBP 1 million were included.

14. While IT specialists have been taken off the Danish job-card scheme, some IT specialists are still included indirectly through other categories (*e.g.* engineers, mathematicians, knowledge workers).
15. On the official US Citizenship and Immigration Services (CIS) Web site (*http://uscis.gov/graphics/index.htm*), the H-1B is defined as a non-immigrant classification used by an alien who will be employed temporarily in a specialty occupation or as a fashion model of distinguished merit and ability, and where a specialty occupation is defined as requiring theoretical and practical application of a body of specialised knowledge along with at least a bachelor's degree or its equivalent. A foreign worker can hold H-1B status for a maximum of six years at a time, three years initially followed by a renewal not exceeding three years, after which one year must be spent outside the United States before a subsequent application can be approved.
16. The United States temporarily raised the H-1B visa cap at the end of 1998 (with the American Competitiveness and Workforce Improvement Act in 1998 and subsequently the American Competitiveness in the Twenty-First Century Act in 2000). Because no legislative action was undertaken to prolong this measure beyond October 2003, the quota returned to its former level.
17. In FY 2000 257 640 applications were approved (86.1%), in FY 2001 331 206 (96.8%), and in FY 2002 197 537 (91.8%).
18. Monster UK, an Internet recruitment firm, reports that jobs advertised on line tend to be filled within 30 days, on average, compared to 90 days, on average, for jobs advertised in print. A recent survey of hiring managers by CareerBuilder.com found that 77% fill positions within one month and nearly 50% within two weeks. However, the duration of vacancies varies by industry.
19. The data in this section were provided by the relevant companies; Enhance Media provided the NORAS results.
20. It surveys both generic sites (*i.e.* sites that deal with many industry sectors) and specialist sites. The results are based on 10 000 questionnaires (1 000 for each of the generic sites, and the remaining 5 000 from six specialist sites) completed in October 2002. It is supported by the Association of Online Recruiters (AOLR), a division of the Recruitment and Employment Confederation in the United Kingdom.

REFERENCES

Alliance for Information Systems Skills and the Information Technology National Training Organisation (1999), "Skills 99: IT Skills Summary", University-Industry Interface, project funded by the UK Department for Trade and Industry, reference YAE/08/05/1205.

Arbeitsamt (2003), ZAV IT-Sonderteam, Central Placement Office (ZAV), Arbeitsamt Online, *www.arbeitsamt.de/zav/services/greencard/englisch*.

van Ark, B., R. Inklaar, and R. H. McGuckin (2002), "'Changing Gear' – Productivity, ICT and Service Industries: Europe and the United States„, Research Memorandum GD-60, Groningen Growth and Development Centre, December.

Australian Bureau of Statistics (2002), "Education and Training Experience", Australia 2001, Cat. No. 6278.0 Survey of Education and Training, ABS, Canberra.

Australian Department of Immigration and Multicultural and Indigenous Affairs (2003), research and statistics available at: *www.immi.gov.au/research/index.htm*.

Borghans, L., and B. ter Weel (2002), "Do Older Workers Have More Trouble Using a Computer Than Younger Workers?", ROA-RM-2002/1E, Research Centre for Education and the Labour Market, Faculty of Economics and Business Administration, Maastricht University, February.

Borghans, L., and B. ter Weel (2003b), "Are Computer Skills the New Basic Skills? The Returns to Computer, Writing and Math Skills in Britain", The Institute for the Study of Labour, IZA Discussion Paper No. 751, April 2003; also published in *Labour Economics*, Vol. 11, Issue 1, p. 85-98.

Borghans, L., and B. ter Weel (2003a), "Do We Need Computer Skills to Use a Computer? Evidence from Britain", The Institute for the Study of Labour, IZA Discussion Paper No. 685, January.

Citizenship and Immigration Canada (2003), information available at *www.cic.gc.ca*.

Danish Immigration Service (2003), statistics available under "other figures on immigration", *www.udlst.dk/english/Statistics/figures_immigration.htm*.

Dickson, J., J. Hillage, K. McLoughlin, and J. Regan (2002), "Employers Skill Survey 2002", UK Department for Education and Skills, Research Report 372, September.

DiNardo, J. E., and J-S. Pischke (1997), "The Returns to Computer Use Revisited: Have Pencils Changed the Wage Structure too?", *The Quarterly Journal of Economics*, Vol. 112, No. 1, February, pp. 291-303.

The Economist (2003a), "America's Pain, India's Gain", 9 January.

The Economist (2003b), "Outsourcing to India – Growing Pains", 23 August.

Enhance Media Limited (2003), "National Online Recruitment Audience Survey", Results Winter 2003, *www.enhancemedia.co.uk*

European e-Skills Forum (2004), "Synthesis Report", forthcoming.

Eurostat (2003), NewCronos Database, *http://europa.eu.int/newcronos/*.

Felstead, A., D. Gallie, and F. Green (2002), "Work Skills in Britain 1986-2001", UK Department for Education and Skills, January.

Freeman, R. B. (2002), "The Labour Market in the New Information Economy", NBER Working Paper No. 9254, October.

Habtu, R. (2003), "Information Technology Workers", *Perspectives on Labour and Income* (*Online Edition*), Vol. 4, No. 7.

Hitwise (2004), information available at *www.hitwise.com*.

Information Technology Association of America (2003a), 2003 Workforce Survey, presented at the National IT Workforce Convocation, 5 May, Arlington, VA; available at *www.itaa.org/workforce/*.

Information Technology Association of America (2003b), Report of the ITAA Blue Ribbon Panel on IT Diversity, presented at the National IT Workforce Convocation, 5 May, Arlington, VA; available at *www.itaa.org/workforce/docs/03divreport.pdf*.

International Labour Organisation (2002), "ILO Activities on the Social Dimension of Globalization: Synthesis Report", available at *www.ilo.org/public/english/wcsdg/globali/synthesis.pdf*.

Japanese Ministry of Education, Culture, Sports, Science and Technology (2003), *www.mext.go.jp/english/org/index.htm*.

Japanese Ministry of Justice (2003), Bureau of Immigration, information available at *www.moj.go.jp*/PRESS/030708-2/030708-2.*html*.

Japanese Ministry of Public Management, Home Affairs, Post and Telecommunications (2003), Statistics Bureau, Labour Force Survey, *www.stat.go.jp/english/index.htm*.

Khadria, B. (2004), STI Working Paper on Human Resources in Science and Technology in India and the International Mobility of Highly Skilled Indians, OECD, Paris, forthcoming.

Kuhn, P., and M. Skuterud (2004), "Internet Job Search and Unemployment Durations", *American Economic Review*, Vol. 94, No 1, pp. 218-232.

Lemaître, G. (2002), "Measures of Skill from Labour Force Studies – An Assessment", OECD, DSTI/EAS/IND/SWP(2002)13.

Mann, C. L. (2003), "Globalization of IT Services and White Collar Jobs: The Next Wave of Productivity Growth", Institute for International Economics Policy Brief 03-11, *www.iie.com/publications/pb/pb03-11.pdf*.

McLaughlan, G., and J. Salt (2002), "Migration Policies towards Highly Skilled Foreign Workers", Report for the UK Home Office, available at *www.homeoffice.gov.uk/rds/pdfs2/migrationpolicies.pdf*.

Millar, J. (2002a), "Outsourcing Practices in Europe", STAR Issue Report 27, *www.databank.it/star/list_issue/e.html*.

Millar, J. (2002b), "The Globalisation of Information Processing Services: The Implications of Outsourcing for Employment and Skills in Europe", STAR Issue Report 28, *www.databank.it/star/list_issue/e.html*.

Morgan Chambers (2001), "Outsourcing in the FTSE100: The definitive study – Episode 1: The UK plc", Morgan Chambers, London.

Norwegian Directorate of Immigration, UDI (2003), information available at *www.udi.no/default.asp*?MenuID=3234&intStrukturID=11244&PubID=2624.

OECD (2000), *International Trade and Core Labour Standards*, OECD, Paris.

OECD (2001), *International Mobility of the Highly Skilled*, OECD, Paris.

OECD (2002), *Information Technology Outlook – ICTs and the Information Economy*, OECD, Paris.

OECD (2003a), *ICT and Economic Growth – Evidence from OECD Countries, Industries and Firms*, OECD, Paris.

OECD (2003b), *Employment Outlook – Towards More and Better Jobs*, OECD, Paris.

OECD (2004), Completing the Foundation for Lifelong Learning: An OECD Survey of Upper Secondary Schools, OECD Directorate for Education, OECD, Paris.

Office des Migrations Internationales (2003), information available at: *www.omi.social.fr/*.

Pain, N., and D. van Welsum (2003), "Financial Liberalisation, Alliance Capitalism, and the Changing Structure of Financial Markets", in *Alliance Capitalism and Corporate Management – Entrepreneurial Cooperation in Knowledge Based Economies* (eds. J.H. Dunning and G. Boyd), Edward Elgar, Cheltenham.

Promising Information and Communication Companies Association (2003), "IT CARD System – The Current Status as of October 2003", presentation kindly provided upon request.

Regets, M. C. (2001), "Research and Policy Issues in High-skilled International Migration: A Perspective with Data from the United States", The Institute for the Study of Labour, IZA Discussion Paper No. 366, September.

Saxenian, A. (1999a), "Silicon Valley's Skilled Immigrants: Generating Jobs and Wealth for California", Research Brief Issue No. 21, Public Policy Institute of California, June.

Saxenian, A. (1999b), "The Bangalore Boom: From Brain Drain to Brain Circulation?", Revised paper prepared for *Working Group on Equity, Diversity, and Information Technology*, National Institute of Advanced Study, Bangalore, India, 3-4 December.

Statistics Denmark (2003), "Informationssamfundet Danmark 2003", available in Danish at: *www.dst.dk/Statistik/Publikationer/Informationssamfundet%20Danmark%202003.aspx*.

Statistisches Bundesamt (2002), Im Blickpunkt: Informationsgesellschaft, available at *www.destatis.de/allg/d/veroe/d_blickpkt.htm*.

US Citizenship and Immigration Services (2003), 2002 *Yearbook of Immigration Statistics*, Office of Immigration Statistics.

US Citizenship and Immigration Services, formerly US Immigration and Naturalization Service (2001, 2000), *Statistical Yearbook of the Immigration and Naturalization Service*: 2001 *and* 2000.

US Citizenship and Immigration Services, formerly US Immigration and Naturalization Service (2001, 2000, 1998-1999), *Report on characteristics of specialty occupation workers* (H1B): Fiscal years 2001, 2000, 1998-1999.

US Department of Commerce (1999), "The Digital Workforce: Building Infotech Skills at the Speed of Innovation", Technology Administration, Office of Technology Policy, *www.technology.gov/reports/TechPolicy/digital.pdf*.

US Department of Commerce (2002), "Digital Economy 2002", Economics and Statistics Administration, *www.esa.doc.gov/DigitalEconomy2002.cfm*.

US Department of Commerce (2003a), "Digital Economy 2003", Economics and Statistics Administration, *www.esa.doc.gov/DigitalEconomy2003.cfm*.

US Department of Commerce (2003b), "Education and Training for the Information Technology Workforce", Report to Congress from the Secretary of Commerce, *www.technology.gov/reports/ITWorkForce/ITWF2003.pdf*.

US Department of Education (2003a), "Internet Access in US Public Schools and Classrooms: 1994-2002", National Center for Education Statistics, *http://nces.ed.gov/pubs2004/2004011.pdf*.

US Department of Education (2003b), "Computer and Internet Use by Children and Adolescents in 2001", National Center for Education Statistics, *http://nces.ed.gov/pubs2004/2004014.pdf*.

US Department of Labor (2003), "Notice of Availability of Funds and Solicitation for Grant Applications (SGA) for Business-Led H-1B Technical Skills Training Grants", Employment and Training Administration, Billing code: 4510-30, *http://wdsc.doleta.gov/sga/sga/H-1BFinal_SGA_03-114.doc*.

van Welsum, D., and G. Vickery (2004), "New Perspectives on ICT Skills and Employment", Working Paper (forthcoming), OECD, Paris.

Work Permits UK (2003), information available at *www.workingintheuk.gov.uk/working_in_the_uk/en/homepage/work_permits.html*.

Chapter 7

EMERGING TECHNOLOGY APPLICATIONS

Emerging technology applications underpin the future contributions of ICTs to the economy. Nanotechnology and grid computing provide greater capability at lower cost, RFID and WiFi offer new tracking and communications potential, but control of spam is crucial for the continued development of the Internet's capabilities. Each of these developments is analysed in detail.

Introduction

This chapter discusses selected IT-related developments, their impact on the economy and society and potential implications for governments. It examines the interaction between technological potential, opportunities for commercial exploitation and social acceptance of emerging and/or newly applied technologies. It looks at nanotechnology, wireless fidelity (WiFi), radio frequency identification (RFID), grid computing, and technological solutions being developed to combat spam. Though very diverse, these technological developments share two important characteristics.

First, they represent relatively sudden, rapid advances that combine previous technological innovations, reductions in the cost of certain technologies and other positive economic factors. With the exception of nanotechnology, which is following a longer development time frame, the technological applications discussed in this chapter could fully emerge within the next three to five years. While the technologies discussed are not new, they signal the maturation of the relevant technologies, which has spurred more dynamic development and more sophisticated applications. Their integration with other existing technologies will demonstrate their real significance, and the benefits they present are of profound interest to the public and private sectors and to consumers:

- ***Nanotechnology*** derives from specialty chemical coatings developed in the 1930s and is used today in a broad variety of ways. More importantly, as its development trajectory accelerates, it can improve the performance of ICTs and finds uses across a broad range of scientific and industrial disciplines.
- ***Grid computing*** emerged in the 1960s, with the advent of the first linked mainframe computers. The fundamentals behind grid computing then drove the creation of local area networks, computer clusters and the Internet. The focus now is on expanding the use of computing networks to exploit the collective computing power of interconnected machines.
- **RFID**, a wireless ICT, was first developed in the 1960s, but only recently has the cost structure made it accessible and practical for wide-ranging tracking applications in the industrial, transport, security and consumer goods and services sectors.
- ***WiFi***, which was covered in the 2002 edition of the *Information Technology Outlook* as one of a group of emerging wireless ICTs, has attracted more attention than the others (Bluetooth, satellite and spread spectrum) because of its ability to provide broadband Internet access to dense user communities without requiring costly infrastructure.
- ***Spam*** has its roots in the 1970s, when the Internet was a tool primarily for communication and collaboration between scientists around the world. It is now estimated to account for as much as 60% of all e-mails. This has spurred discussion of its economic costs and has led to efforts on the part of policy makers, software firms and Internet service providers (ISPs) to stem the ever-growing tide.

Second, all of the technologies discussed here highlight new or increased security and safety concerns that arise as a result of the growth and interconnectedness of ICTs. In a brick-and-mortar world, locked doors offered sufficient protection. But with increasingly digital storage and transfer of information, the opportunities for theft or misuse are amplified. As society grows increasingly dependent on access to and use of ICTs, safeguarding the systems is an increasing concern. Furthermore, new technologies present unforeseen risks and can themselves pose threats if they are not correctly understood and responsibly developed. These issues all pose serious challenges for policy makers:

- Nanotechnology has been touted as a completely new science that draws on expertise in all three major scientific disciplines – biology, chemistry and physics – but there are still many unknowns and the potential risks are an important topic of debate. Its potential is widely understood, and it is important to encourage continued R&D to ensure that health, environmental and other risks continue to be better understood.

- Grid computing is more than simple interconnection, as it allows programmes to draw on the unused capacity of a set of networked computers and other hardware. The shared use of computing resources therefore requires the establishment of trust. The resources contributed to the grid by members must be protected, and data must also be protected while it is transferred or stored within the grid. Finally, use of the grid must be monitored to ensure that it is used according to the rules established by its members.
- RFID, a "through-the-air" technology, shares some of WiFi's risks in terms of data security and interception, though these are mitigated by its relatively short operating range. More pressing questions that derive from RFID's fundamental nature as a tracking technology involve privacy and authentication, particularly concerning access or payment systems that use RFID.
- WiFi's flexibility and its "through-the-air" nature are key defining characteristics. They are also causes for action in the area of security, particularly in terms of encryption and access, in order to protect data that are being transferred through "thin air", and also to protect business models from free-rider concerns that could impede investment in WiFi development.
- Spam raises a wide variety of concerns, which range from simple inconvenience to users, to the more complicated issues of economic costs and its potential as a dangerous vehicle for computer viruses and cyber-terrorism. Filtering mechanisms adopted to counteract spam run into the problem of adapting to the ever-changing characteristics of spam while still allowing legitimate e-mail to pass.

Both rapid technological advance and security have economic implications of considerable importance to policy makers. The first will encourage the development of ICTs, possibly in unexpected directions. This will lead to changes in market structures, and policy makers will need to respond flexibly to the resulting dynamics. For their part, security concerns may modify the development trajectory of ICTs and new markets. Given the growing role of technology in the economy, both issues will have increasing prominence.

Nanotechnology

The science of nanotechnology, or molecular manufacturing, involves the creation of tiny structures and materials through the manipulation of individual atoms and molecules. The term nanotechnology has been applied to those products with at least one dimension measuring less than 100 nanometres in size (one nanometre is one billionth of a metre and is about the width of three or four atoms). Carbon nanotubes are one of the most commonly used building blocks of nanotechnology. They are essentially rolled sheets of carbon atoms, which are valued for their remarkable structural strength and ability to conduct heat and electricity. The properties of individual carbon nanotubes vary as a result of differences in their size and structure, thereby making them suitable for diverse uses.

Nanotechnology had its origins in the 1930s, in processes used to create silver coatings for photographic film. Today, it has uses across a broad spectrum of industries. Specialty coatings developed through nanotechnology are commonly employed to make existing products stronger and more durable. Nanoscale materials are incorporated into a wide range of products from spacecraft and industrial equipment and machine tools, to coatings for computer disks and stain-resistant fabrics, to surgical products, sporting goods and cosmetics, to name but a few. Research is ongoing in many fields. Potential applications include the use of nanostructures to break down pollutants in the environment. Healthcare researchers are seeing how nanoproducts may be used to repair and deliver medicines to targeted cells, with implications for cancer treatment and ageing. Computer manufacturers are working to develop molecular-sized microprocessors. It is believed that nanotechnology will eventually affect every economic sector in some way.

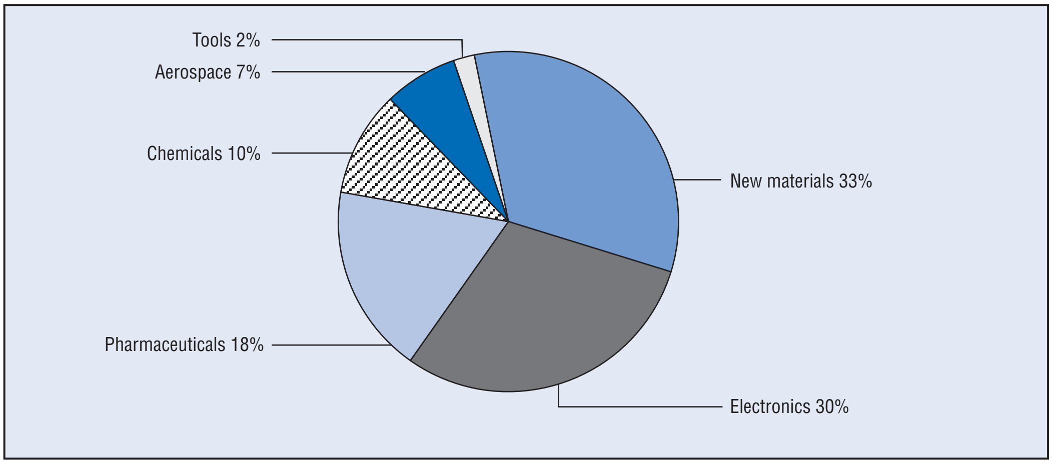
Nanotechnology's relevance to ICTs lies in its potential to dramatically decrease the size and increase the capacity of data processing, transmission and storage devices by utilising the increased ability of materials to conduct energy at the molecular level. In late 2003, Intel announced that it had produced a microprocessor chip with static random access memory (SRAM) cells measuring 65 nanometres to succeed the 130-nanometer SRAM cells widely used on microprocessor chips. The European NanoCMOS initiative (see below) is also examining potential in the 22-45 nanometre range. These innovations could increase the speed and memory capacity of PCs by up to 50% while reducing energy consumption by increasing the number of transistors that can fit on a chip and decreasing the distance electrons have to travel. Another innovation, IBM's successful generation of electrically controlled infrared light from carbon nanotubes, also offers applications for ICTs, particularly in the areas of optical communications and light-sensing equipment. Other firms hold patents on a variety of potential future nanoproducts, such as tiny wires and sensors or thin films for flexible electronic displays, which will certainly drive innovation in the design and development of ICTs. The continued development of increasingly complex software for computer modelling of molecular structures and atomic behaviour will also feed into developments with direct application to ICTs.

The US National Science Foundation (NSF) projects that worldwide annual industrial production in the nanotechnology sectors will reach over USD 1 trillion and create over 2 million jobs by 2015. The increase is expected to centre on the development of new materials, electronics, pharmaceuticals, chemicals, aerospace and tools (Figure 7.1). Approximately two-thirds of these efforts, those devoted to electronics and new materials, such as semiconductors, will be in areas directly relevant to the development of ICTs.

Nanotechnology R&D has high priority on national science agendas in OECD countries, with growth in both public and private funding (Figure 7.2). According to the US NSF, almost all developed countries have had activities in the area of nanotechnology since 2001. The United States, Europe and Japan each spend between USD 500 million and USD 1 billion a year on nanotechnology R&D. In 2003, the United States passed the 21st Century Nanotechnology Research and Development Act authorising USD 3.7 billion in federal subsidies for three years beginning in 2005, for projects supported by the National Nanotechnology Initiative (NNI), a federal R&D programme established in 2001 to co-ordinate and finance the efforts of federal agencies in nanoscale science, engineering and technology (*http://nano.gov*). Government funding for the NNI itself is estimated at USD 864 million for 2004, a 10% increase

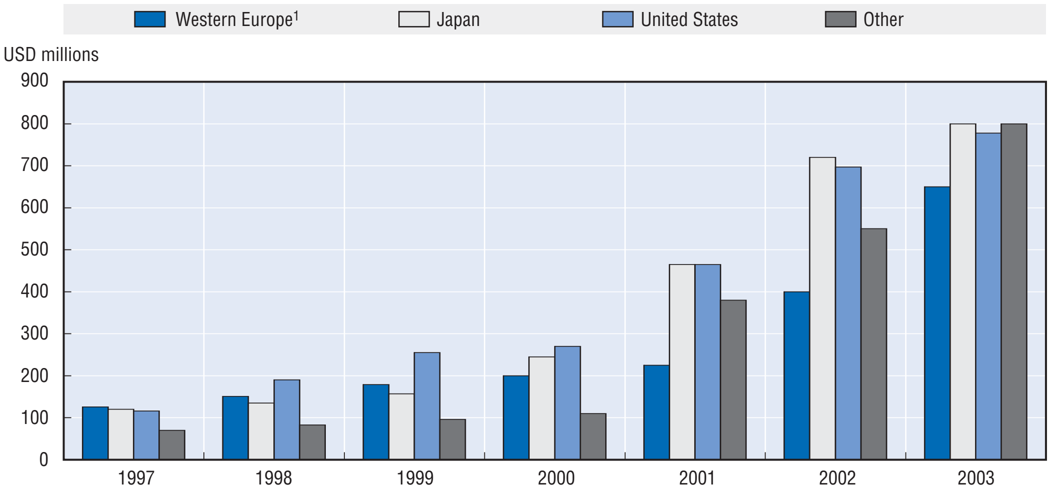
Figure 7.1. **Projected contribution of nanotechnology to the US economy, 2015**

Total of USD 1 012 billion



Source: National Science Foundation (2003).

Figure 7.2. **Estimated government nanotechnology R&D expenditure**



1. EU15 plus Switzerland.
Source: National Science Foundation (2003).

over the previous year, and is projected to increase to USD 886 million for 2005, to constitute roughly 3% of overall US government expenditure on R&D. Japanese and Western European programmes combine government support with academic and private-sector R&D activities. In 2003, spending by western European governments (the European Union plus Switzerland) on nanotechnology R&D totalled about USD 650 million, and in 2004 the European Commission launched a EUR 24 million project called NanoCMOS to examine new semiconductor materials, processes, device architectures and interconnection. Japan spent about USD 800 million in 2003. Korea announced a USD 2 billion Nanotechnology Development Programme in 2003 as a joint effort by nine government agencies for core research, securing R&D infrastructure and bolstering commercial-scale applications of nanotechnology. Australia has also identified nanotechnology as an area for government investment, although most development activity to date has occurred at state level. Canada's National Research Council has established the National Institute for Nanotechnology. Significant nanotechnology programmes also exist in Mexico, Russia, Ukraine, China, Chinese Taipei and Singapore.

Entrepreneurs claim that the industry is reaching the point where investment could lead to marketable innovation on a wide scale. Most in the nanotechnology industry agree that there is currently more initiative than available funding, and that the levels of expertise and financing needed to get started will limit the potential number of players and favour larger firms with substantial financial resources and technological expertise. Analysts estimate that there have been 400-500 new nanotechnology ventures in recent years. Nanotechnology firms of all sizes have begun seeking capital more actively through partnerships, venture capital and other private funding sources, in addition to the government research grants they have relied on for many years. The flurry of recent attention to nanotechnology in the media and government agencies has led some to recall the previous technology bubble and express concern that the sector may be overheating and attracting too much venture capital. In truth, lingering questions about the safety of nanotechnology have limited the flow of investment pending better understanding of the potential dangers.

Emerging issues

The dynamic advances in nanotechnology require a balanced approach that protects intellectual property rights and encourages continued innovation and development, while enabling competition and addressing safety concerns raised by environmental and public activist groups. Priorities need to be set in order to fully exploit the potential and realise the benefits of nanotechnology. This requires expanding traditional areas of competence by bringing together specialised, multidisciplinary knowledge and skills across economic sectors, institutions and borders.

Government, academic institutions and the nanotechnology industry have organised groups to look at nanotechnology's potential as well as its dangers. The US NSF has established the National Nanotechnology Infrastructure Network, a consortium of 13 American universities which offers scientists, researchers and academicians open access to resources for molecular manufacturing. Other national initiatives include Japan's Nanotechnology Researchers Network Centre, which is part of the Ministry of Education, Culture, Sports, Science and Technology. There are also national and regionally based organisations serving the nanotechnology community in Australia, China and Korea.

International activities and agreements have also increased, with programmes such as the European Union Nanoforum, a consortium of nanotechnology institutes, laboratories and firms in Denmark, France, Germany, the Netherlands, Spain and the United Kingdom, to share best practices, link existing networks and co-ordinate nanotechnology activity in the European Community. Similar programmes exist within the Asia-Pacific Economic Cooperation (APEC) Forum and between the United States and both regional groups.

Safety concerns relating to the unknowns in nanotechnology have been cited as one of the main inhibitors to investment and development. Much has been said about "grey goo", or the notion of a chain reaction of nanomachines dissolving matter by consuming atoms in their path in order to replicate. However, experts generally agree that such fears are in the realm of science fiction. More pressing and real dangers stem from the side effects of nanotechnology use, such as inhaling nanocomponents or releasing them into the environment in large quantities. Standards will need to be set for the production, use and disposal of nanoproducts.

These concerns relate specifically to the properties and behaviours of materials, which may differ radically from their standard form at the nano level. Silver, for example, takes on bioactive properties, acting as a bactericide, at the nanolevel, a characteristic that it lacks in its common form. Certain nanoparticles have been known to entangle DNA molecules. Also, laboratory testing has shown carbon nanotubes to cause short-term but sometimes fatal respiratory problems in rats. Such evidence leads to concern over the fallout of nanoparticles in the environment or their entry into the body. As with asbestos, the full effects may not become apparent for a very long time.

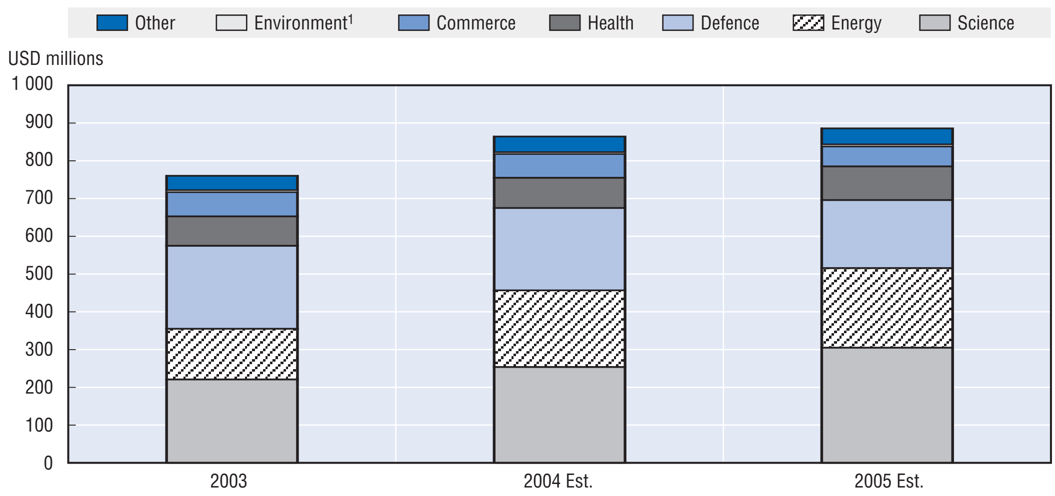
Given these lingering questions about the safety of nanotechnology, despite its potential, some venture capital firms specialised in technology have chosen to avoid nanotechnology ventures that raise environmental questions until the technology is proven safe. This is hindering R&D because of the costs of testing, particularly for smaller firms and in fields such as medicine, as companies focus on products not relating to healthcare which require less testing. This has led industry analysts to believe that the market for nanoproducts may come to be dominated by large firms that are better positioned to turn innovations into revenue. However, even large companies are proceeding with caution; L'Oreal abandoned research on carbon nanotubes after other researchers raised questions about toxicity.

Both detractors and proponents of nanotechnology recognise the need for a multidisciplinary research approach that encompasses the relevant scientific and medical disciplines. Advocates of nanotechnology warn, however, that opportunities could be missed if there is a complete moratorium on R&D. They argue for engaging both groups in dialogue to take steps towards responsibility and accountability in maintaining the public's safety.

Many nanotechnology firms, laboratories and organisations have expressed the need for a forum for shared research and knowledge. In January 2004, the OECD Ministerial Meeting on Science, Technology and Innovation for the 21st Century recognised that fostering broader, more open access to and wider use of research data will enhance the quality and productivity of science systems worldwide, and that increased international co-operation in science and technology is important for meeting a broad range of global challenges, for benefiting from globalisation and for implementing large-scale research projects. The Ministers adopted a Declaration on Access to Research Data from Public Funding, with a call for the development of principles for sharing knowledge gained from publicly funded research activities, taking into account possible restrictions related to security, intellectual property rights and privacy.

The British government has commissioned the Royal Society of Arts to hold several debates. A forum in early 2004 addressed public concerns about nanotechnology, and a Europe-wide study is being conducted with the Royal Academy of Engineering to attempt to identify real risks and unfounded fears. European countries are generally considered to be more active in discussing and researching the risks of nanotechnology than the United States, where efforts have focused more on industrial applications. For example, under 2004 funding for the NNI, almost USD 500 million were allocated to the Departments of Defense, Energy and Commerce, compared to USD 80 million to the National Institutes of Health and USD 5 million to the Environmental Protection Agency (Figure 7.3).

Figure 7.3. **US nanotechnology spending by government agency**



1. Representation barely visible in this graph due to its relative proportion.
Source: Analytical Perspectives: Budget of the United States Government, Fiscal Year 2005.

In the future, nanotechnology will have increasingly economy-wide applications, particularly in the field of ICTs where it is expected to add a new dimension to current trends, such as increased microprocessor speeds and miniaturisation of hardware, and lead to the development of completely new materials and technologies. In recognition of its still undiscovered potential for diverse applications, experts have referred to nanotechnology as a new science, despite its established role in some fields. Realising this potential will require substantial investment, as both the public and private sectors recognise. The public sector, notably in the United States, Korea, Japan and western Europe, have actively supported nanotechnology R&D. Venture capital firms have also increased their participation, albeit cautiously. Both the potential and safety concerns will best be addressed through shared knowledge and multidisciplinary collaboration between governments, scientists and businesses worldwide.

Grid computing

Grid computing refers to the use of the combined data storage and processing capabilities of a networked group of computers. The concept of computing as a utility emerged in the 1960s with the Multics operating system, an early form of open source software. The growth of computer processing power, global networks and data transmission speeds throughout the 1990s brought the practical use of computing as a utility closer. In 1997, the idea of true grid computing emerged at a workshop at the Argonne National Laboratory in Illinois. In the following year, Argonne's Ian Foster and Carl Kesselman of the University of Southern California, published "The Grid: Blueprint for a Future Computing Infrastructure", which is considered the defining work on grid computing.

The development of computing grids has been compared to the advent of power grids in the early 1900s. Power grids allow electricity generated in different locations to be channelled to where it is needed. Similarly, computing grids distribute information processing workloads among workstations where part or all of the compute cycles are idle, thus massing and channelling data processing capacity. What power grids do to optimise the distribution of electricity, computing grids do to optimise the distribution of data storage and processing capacity. For this reason, grid computing is also referred to as utility computing.

The key difference between computing grids and other networked systems, such as local area networks (LANs) and the World Wide Web, is that the primary concern is not file sharing but direct access to software, data and computing capabilities to enable collaborative problem solving. According to Foster and Kesselman, "a computational grid is a hardware and software infrastructure that provides dependable, consistent, pervasive and inexpensive access to high-end computational capabilities" that is concerned with "co-ordinated resource sharing and problem solving in dynamic, multi-institutional virtual organisations" (Foster, 2002). Grid computing co-ordinates a group of resources that have no central control mechanism, using standard, general-purpose interfaces and computing protocols to deliver high amounts of quality service.

This means that grid computing has important industrial and scientific applications when large amounts of computing capability are required to carry out complex modelling and calculations or to process and integrate large amounts of data from diverse sources. Grid computing work essentially falls into five functional categories based on the balance of quality and quantity of work performed (see Table 7.1). At the high end, distributed supercomputing links two or more supercomputers together to perform complex operations incorporating many variable factors, such as modelling climate change or interrelated, individual actions in military simulations. High throughput activities engage the latent capacity of networked workstations to carry out numerous repetitive procedures, as in cryptography or modelling variations in microprocessor chip designs. On-demand work engages the same capability for short episodes in which cost-performance ratios are the primary concern. Examples include real-time image processing for medical scanners or assembled satellite images of cloud formations for meteorological use. Data-intensive uses of grid computing systems process large amounts of information from diverse databases and frequently involve communication and computation between computers to synthesise new information. Examples include processing data generated by high-energy

Table 7.1. **Main functions of grid computing**

Category	Examples	Characteristics
Distributed supercomputing	Distributed interactive simulations, outer-space studies, chemistry computations, climatic modelling	Uses linked supercomputers to solve very large problems requiring large-scale, complex data processing
High throughput computing	Chip design, parameter studies, cryptography	Employs otherwise idle resources in networked workstations to increase aggregate throughput
On-demand computing	Medical instrumentation and imaging, network-enabled solvers, cloud mapping	Integrates remote resources with local computation, episodically for fixed amounts of time
Data-intensive computing	Astronomical survey, physics data, data assimilation	Synthesises information from multiple or large data sources
Collaborative computing	Collaborative design, data exploration, education, on-line games	Supports communication or collaborative work between multiple participants

Source: Foster and Kesselman (1998).

physics experiments and astronomical surveys. Finally, collaborative grid computing allows users to work simultaneously in a shared virtual space, with applications for real-time co-operation on complex projects, as well as for entertainment and education.

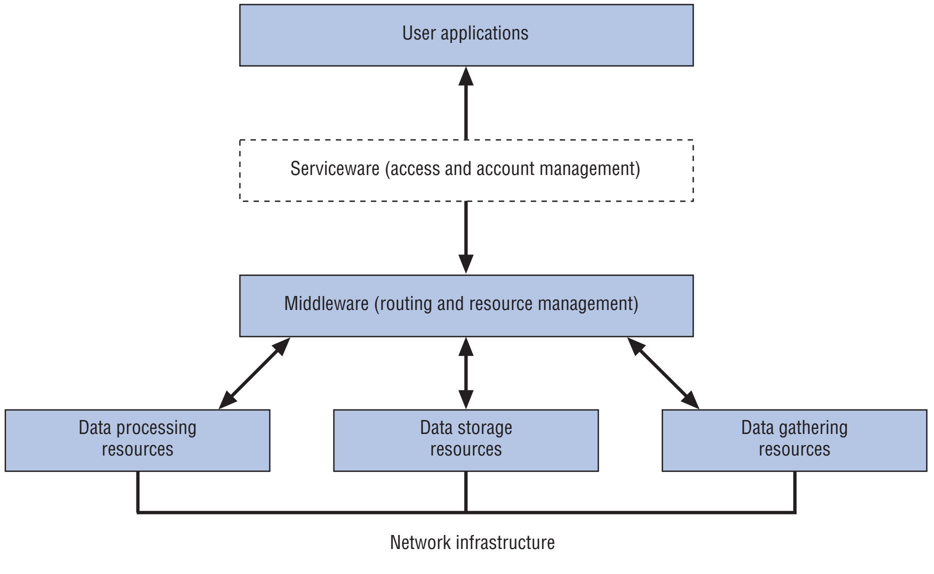
Whatever the function, linked grid communities define the size and shape of the shared computing space, also known as the virtual organisation, which can be either fully contained within a single or set of organisations or incorporate openings for limited or continuous public access. Given these two approaches, Foster and Kesselman (1998) describe grids as evolving within four categories:

- ***Private*:** At the narrow end of the scale, the private grid is characterised by relatively limited size, central management and focused purpose and integrates existing technologies. This type of grid computing can develop super-computing capabilities based on existing hardware and software infrastructures, thereby providing a low-cost alternative for organisations that would otherwise be required to invest in expensive custom-designed supercomputers.
- ***National*:** National grids are typically those developed by governments for national uses such as interagency collaboration on complex scientific or engineering problems. Governments also use grids as latent computing reserves that can be used to handle crisis situations such as natural or environmental disasters.
- ***Virtual*:** Virtual grids exist between institutions collaborating on a common, narrowly defined goal. These typically have no central control mechanism and must share computing resources with competing uses within each institution.
- ***Public*:** Public grids are those developed to serve market needs for supercomputing services, whether for individuals or the purveyors of specialised services. This arrangement faces particular challenges concerning the ability of a computing grid to work with loosely bound resources and the willingness of owners of those resources to contribute them to the common pool.

The needs of a virtual organisation in terms of information sharing and processing will drive the function and design of a specific grid's architecture.

Regardless of their size or purpose, the basic elements of grid architecture are the same (Figure 7.4). They are organised into four main layers. The first two are the interconnecting network and

Figure 7.4. **Architecture of a typical computational grid**



the grid's resources of computers, data storage systems and hardware, such as data gathering sensors and other instruments. The third layer, known as the middleware layer, is the software that organises the grid's resources, directs data traffic and manages the interaction of its elements. The fourth layer, the actual user applications, sometimes includes serviceware, which manages user accounts and measures use of the shared resources.

Grid building and support services are a growing part of the activities of all major computer companies, and international forums and consortia are contributing to this work. Firms such as IBM, Hewlett-Packard, Sun Microsystems and Microsoft, as well as smaller hardware and software providers, participate in R&D projects with academic institutions and offer either marketable packages of necessary components or "one-stop shops" for solutions to building, adapting and maintaining grid computing networks. Firms such as Oracle offer grid computing capabilities to clients as an on-demand service, often within test beds, or smaller, closed grids to be used for experimentation and development. The Globus Alliance (*www.globus.org*) links the Argonne National Laboratory and the University of Southern California as well as the University of Chicago, the University of Edinburgh and the Swedish Center for Parallel Computers, and other academic affiliates in the United States, the United Kingdom, Germany, Poland, Australia and Japan. It offers a toolkit of open-source software to implement the basic services and capabilities of a computational grid. Owing to its collection of basic grid-building tools and its adaptability to specific uses, the Globus Toolkit has become a standard foundation for computational grids.

Multilateral initiatives are playing an important role in the evolution of grid computing. Pilot projects and consortia organised along global, regional, national, or disciplinary lines have been set up in most OECD countries. The European Organisation for Nuclear Research (CERN), which is credited with inventing the Internet to facilitate international collaboration between nuclear physics laboratories, is also a leading player in the development and testing of a worldwide grid for utility computing (*http://gridcafe.web.cern.ch/gridcafe*). CERN has organised the Openlab in collaboration with Oracle, Enterasys Networks, Hewlett-Packard, IBM and Intel, to develop a grid with 15 petabytes (15 million gigabytes) of data storage capacity. Other grid computing projects include the European DataGrid and the EUROGRID, which link EU and accession country laboratories and use test beds for a variety of purposes. The NASA Information Power Grid and the Department of Energy Science Grid, both in the United States, are examples of national initiatives to develop grids to solve complex computational problems. The Grid Physics Network (GriPhyN) and the Particle Physics DataGrid, both test beds for networks of physics labs, are good examples of purpose-built international grids. A feature common to all grid development projects is collaboration on multiple and occasionally competing projects, a clear indication of the resource-sharing philosophy behind the grid concept.

Though most developments in grid computing to date have been driven by research efforts, commercial applications of grids' abilities to store, process and integrate massive amounts of data are already being identified. Preliminary uses are emerging in the life sciences and pharmaceuticals. Novartis, for example, has integrated its network of thousands of PCs and workstations into a supercomputer that uses latent memory and processing cycles to perform chemical modelling for drug research. Similarly, manufacturing applications are foreseen, particularly for product-testing simulations and collaboration. Uses identified in the energy sector include data mapping and visualisation in exploring for natural energy resources. Grid computing can be employed in the services sector as well, for example for economic modelling of markets and risk analysis for financial portfolios. There are no comprehensive estimates of the current size of the grid computing market, but Grid Technology Partners, a consulting firm, estimates that the total market size for all grid computing investment, including hardware and software for all layers of the grid architecture, could reach USD 4.1 billion by 2005 (*www.gridpartners.com*).

Emerging issues

The interconnected quality of grid computing naturally makes it a tool for national, regional and international co-operation. For this reason, development efforts have been characterised by collaboration at various levels. The engagement of multiple organisations in this work means that computer systems and equipment must be interoperable and follow standardised protocols in order to share resources and work together effectively. At the same time, making resources available to others over networks calls for a high level of trust among participants and the establishment of security procedures to protect data within the grid. Existing tools will have to be adapted or new systems will have to be developed to protect grid infrastructures and the software and information that they contain. It is important to limit access to the grid to authorised parties, to authenticate the parties and to monitor their use of the grid's systems and software. There is finally the question of the equitable allocation of the costs of using grid computing to avoid the free-rider concerns that are common to all utilities.

The need of all members of the virtual organisation to share information means that interoperability is a central concern. A common language and protocols are required to guide the interaction of the grid's various components and achieve the desired computing behaviour. Virtual organisations are not fixed structures, so that this behaviour must be able to achieve the desired outcomes but remain flexible and responsive enough to co-ordinate multiple resources and solve complex problems in a changing environment. At the same time, users must be able to operate these complex and dynamic programmes. The Internet Engineering Task Force and World Wide Web Consortium have developed standards such as the Internet Protocol (IP) and the Hyper Text Transfer Protocol (HTTP) for the Internet and the Web, respectively. Similarly, the Global Grid Forum (*www.gridforum.org*), an organisation of several thousand grid practitioners, sets standards and other technical requirements for computational grids to overcome obstacles that inhibit grid creation. The Global Grid Forum holds regular international meetings and issues guidelines on best practices in the development of computational grids.

A less technical, but no less fundamental requisite is that grid partners must trust one another. Because grids are shared systems that rely on resources owned and contributed by the participating partners, standards for use and behaviour within a grid system are very important. Like all shared or public spaces, they require basic ethics and codes of conduct and security. These refer to the protection of hardware and software contributed by grid participants, who should be able to set limits on the levels of access and resources they are willing to contribute. Participants also need to be confident that contributed resources will not be exploited or sabotaged, whether through malicious intent or simple carelessness.

Further, participants need to be assured that data transferred via the grid and stored in shared facilities are protected from interception or access by unauthorised parties. Because components linked in a grid can also be linked to other networks, they potentially offer an infinite number of points of access. Thus, protection from unauthorised external infiltration is also a key concern. Finally, accountability for the grid's use and protection against the disproportionate use of the grid's capabilities to the detriment of other users also need to be considered. These refer to the three A's frequently invoked in the context of information technology (IT) and security: authorisation, authentication and accounting.

- ***Authorisation*:** A first step in ensuring a grid's security is to define the pool of authorised users. The virtual organisation can be designed as a closed system, fully contained within an entity that is either a single or a group of institutions, such as firms, laboratories or government agencies. This helps define the universe of authorised users, provided that the external links of such an entity are protected from infiltration. Alternatively, the design of a grid can incorporate points of entry for external collaborators, whether on a limited or on a continuous basis.
- ***Authentication*:** Whether a grid is fully self-contained or incorporates ports for external access, it is necessary to provide a mechanism within the serviceware to identify authorised users. Because the identity of users needs to be verified, an authentication mechanism must be established to prevent unauthorised access.
- ***Accounting*:** Finally, it is necessary to account for the use of a grid's resources to ensure that they comply with the rules established by a grid's operators. This is a function of the gate-keeping

serviceware, using the middleware's management and allocation of the grid's resource base. In a commercial model of grid use, the serviceware's accounting function could also be used to manage subscriber accounts and billing as necessary.

As was the case early in the development of the Internet, most grid initiatives thus far have been scientifically motivated and largely funded by public money flowing through government agencies and academic and research institutions. As more commercial applications emerge, costs are expected to shift to the private sector in two general ways. Returning to the power grid analogy, firms with fully contained grids, the equivalents of factories that rely solely on their own power-generating facilities, will bear the development costs themselves. But for the grid as a computing utility, larger-scale investment will be needed to build grids large and powerful enough to manage computing requests from a wide range of users. This will lead to the development of business models to support paid access and use that provide returns on such investment.

New tracking applications: Radio Frequency Identification

Radio Frequency Identification (RFID) is a subset of the ICT field known as automatic identification and data capture (AIDC). RFID is based on wireless systems that allow for non-contact reading of information on products, places, times or transactions. The function is similar to that of barcodes in that RFID captures specific, concisely encoded data, but it is more effective than barcodes for tracking such things as inventory, manufacturing flows, livestock, toll-booth traffic and other moving objects in environments where bar code labels would be sub-optimal or could not survive, or where information needs to be automatically updated. Other applications include security and recognition systems, such as building access badges and anti-theft devices for automobiles.

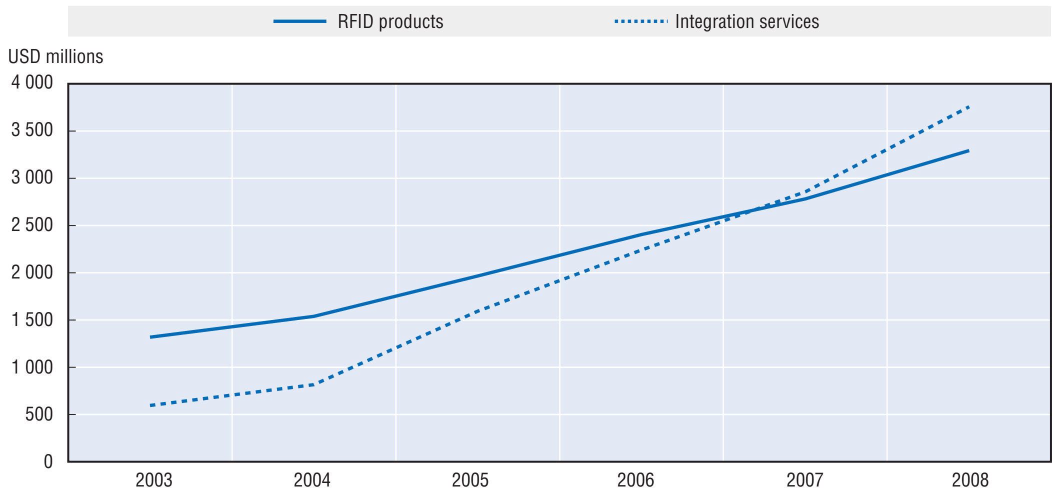
An RFID system functions on the basis of information collected by a data reader, also called an interrogator, from transponders, called tags or cards, composed of an antenna and a chip that contains data. These tags can either be placed on the surface of an object, such as a car windscreen, or be contained within it, such as a cargo crate, and can be reprogrammed with new or updated data as necessary. Through an antenna, the reader transmits a radio signal, which the tag receives, using the energy it gets from the signal for the verification and the exchange of data. The reader then sends collected data to a controlling computer for processing and management. Current RFID systems typically work at close range, frequently as little as 15 centimetres (six inches) and potentially up to eight metres (25 feet), depending on the size of the antenna and the strength of the signal.

RFID was first developed in the 1960s, but it was not widely used for tracking and access until the 1980s, when technological developments brought costs down and expanded the potential for applications. Developments in RFID technology continue to increase memory capacity, reading range and speed of processing. It is highly unlikely that the technology will ultimately replace the barcode. However, RFID will continue to grow in its established niches where barcode or other optical technologies are less or not effective. If some commonality of standards can be achieved – so that RFID equipment from different manufacturers can be used interchangeably – the market will very likely grow quickly.

Most RFID investment to date has been concentrated on hardware, software and related goods, with worldwide sales estimated at USD 1.3 billion in 2003. Less money has been invested in integrating RFID into current IT and logistics infrastructures. Sales for integration services, estimated at almost USD 600 million in 2003, have been increasing and outpacing growth in product sales. Worldwide sales of RFID integration services are expected to reach USD 1 billion in 2006 and surpass sales of RFID products in 2007 at approximately USD 2.8 billion (Figure 7.5). This convergence reflects an anticipated strategic shift over time, as companies move to increase efficiency gains, first by simply employing new technology, then by fully integrating it in their business processes.

Applications of RFID in distribution have yielded increases in the speed, accuracy and efficiency of supply-chain management. These improvements stem from a reduction in the time spent performing labour-intensive activities, such as the inventory of individual items, and better demand planning to

Figure 7.5. **Worldwide RFID products and integration services sales**



Source: Allied Business Intelligence, Inc. (2004).

co-ordinate just-in-time delivery of products to distribution centres, warehouses and stores. In late 2003, Wal-Mart a large, mass-market, packaged goods retailer in the United States, with sales of USD 244 billion in 2003, required its 100 largest suppliers to incorporate RFID into their product packaging and delivery systems by 2006, in order to better manage and monitor incoming and outgoing stocks. (The US Department of Defense has imposed a similar requirement on all of its suppliers, with a compliance deadline of January 2005.) In retail customer relations, RFID is used to provide product information to consumers and can provide customer information to stores based on purchasing data gathered at check-out.

Industrial applications of RFID include tracking of individual products through the manufacturing process, with implications for better flow management and improved quality control (see Chapter 3 on developments and issues related to business value chains and distribution). As with retail operations, RFID in manufacturing can facilitate just-in-time delivery of parts to production plants and real-time product routing, thereby avoiding surplus storage or interruptions in the supply of necessary components. RFID signals can be used to trace and locate items that have failed quality tests in the production process and can signal product authenticity, thereby safeguarding against counterfeiting. The non-contact nature of RFID technology makes it particularly suitable for the combined tracking of multiple items as grouped single units in palettes or crates, as well as for the tracking and shipment of livestock.

Manufacturers often bear the brunt of RFID investment costs as business models in the retail sector emphasise savings, and retailers use their market power to impose conditions (as in the case of Wal-Mart, mentioned above). For retail, analysts estimate that RFID can improve demand forecasting by 10-20% and reduce inventory levels by 10-30%, lowering running inventory costs by about 5% and warehouse labour costs by an estimated 8%. In addition, improved product information and fewer stock shortfalls can improve sales by an estimated 2%. While RFID tags can cost as little as USD 0.05, reader and software costs vary depending on the complexity of the system. According to some estimates, investment costs for implementing RFID for a large consumer packaged good manufacturer could amount to between USD 13 million and USD 23 million. A study by A.T. Kearney, Inc., to analyse the cost and savings functions of RFID at a large US grocery manufacturer and an over-the-counter drug manufacturer found that the companies, each averaging USD 5 billion in annual sales, could expect to pay USD 155 million over ten years for RFID tags and readers. This economic model could put smaller manufacturers at a disadvantage in terms of their ability to absorb the necessary investment costs, particularly as larger companies seek greater market share in order to realise economies of scale.

RFID uses in road transport have included monitoring of speeding and collection of road tolls through services whereby subscribers' vehicles are fitted with an RFID tag which is counted by toll stations every time they pass through. Exxon/Mobil has taken a similar approach to speed up transactions at gas stations. RFID systems are also used for fare monitoring for mass transit in some major cities via a card system that is closely related to the RFID card keys used to control security in authorised access facilities. Other security applications include a widespread anti-theft system for automobiles, which employs RFID technology for ignition-key recognition. Still other uses include the tagging of domestic pets with RFID chips containing ownership and veterinary information.

Emerging issues

Uses of RFID, even in established fields, are still developing, and many firms now investing in the technology do so under pilot programmes. Nevertheless, much research on potential applications is already under way. The main advances are expected to derive from more fully integrating RFID systems into broader business practices and interlinking organisations' RFID databases. New uses for RFID are also being examined in the area of ICTs and consumer services, with hybrid products, such as cellular telephones that function as no-contact credit or identification cards, in the experimental phase. But these new uses highlight concerns and potential policy issues, such as safeguarding consumer privacy and security, preventing fraud and developing industry standards for accepted practices and the interoperability of equipment.

The main uses of RFID systems in firms' logistics operations so far have been in the areas of production flow and supply-chain and inventory management. But RFID processes and databases can also be integrated with other back-office operations, such as accounting and personnel, with implications for better management of cash flow and workers' schedules. On the front end, RFID can help increase sales when databases are linked with those of customers to establish automated stock deliveries and invoicing. It can help to better understand consumption patterns, manage the client relationship, and tailor supply to demand. At the consumer level, firms can profile purchasing behaviour, again allowing a tailored approach to meeting individual customers' needs and improving customer service through features such as loyalty programmes.

The public sector can also improve its back-office and administrative functions, from supply and logistics to transport services, using RFID systems to co-ordinate activities between departments and vendors. Government can also improve the reach and efficiency of public services through measures such as RFID-enabled identity cards for citizens, which would allow various agencies to share relevant databases to better meet the needs of individuals.

Software companies and consulting firms are beginning to offer products and services that will help firms better integrate RFID systems into their business processes. Microsoft announced that it would begin incorporating RFID support into its business software packages for small and medium-sized firms by 2005, with an ultimate aim of requiring as little integration as possible "out of the box". The other main IT industry firms, such as Intel, IBM and Sun Microsystems, as well as Texas Instruments, NCR and Accenture, have also announced products and services focused on using integrated RFID solutions to enhance company performance.

New uses of RFID technology seek to integrate it with other technologies. A founder of Apple computers, for example, launched a company to integrate RFID and the Global Positioning System (GPS) so that people would be able to keep track of property, pets or individuals carrying RFID tags through a network of base antennae installed around a community. Such a system could, for example, help retrieve a parked car or notify a parent that a child has arrived at school. RFID technology is also being tested with cellular telephones and other portable communication devices, which could then act as no-contact credit cards, mass transit passes or serve other functions. RFID could also be used as a gatekeeper to wireless communications networks, for example to limit access to WiFi networks in public spaces to registered subscribers.

The tracking capabilities of RFID have understandably raised concerns about individual privacy. Consumer and civil liberties advocates particularly have warned that governments would be able to follow citizens' every move through tags and dense networks of RFID readers, or through interlinked RFID profiles collected from a multitude of data readers. Industry associations say, however, that such a system would be prohibitive in terms both of hardware costs and of managing the very large database such a system would generate. The tracking of consumer behaviour in stores and other environments is, however, a very real possibility; firms and agencies could assemble individual profiles of customers without their knowledge or consent. One supermarket chain in the United Kingdom endured a storm of adverse consumer reaction in 2003 when they implemented a pilot programme of surveillance cameras activated by the movement of RFID-tagged products and compared images of the consumer removing the product from the shelf and taking the item through checkout. Clearly, customer confidence in the retailer will play an important part in any implementation of tracking systems at the consumer end.

Consumer rights groups have called for regulation concerning the use of the data collected, particularly because linked databases between groups of firms, agencies and other organisations could indeed approximate the comprehensive government database that industry experts deem impractical. Such a multi-faceted system could provide benefits in fields like law enforcement, by enabling the tracking of stolen goods or credit cards, and even help to ensure against identity theft. However, protecting the rights of the law-abiding should dominate.

In addition to regulating the use of legitimately collected data, it is important, as with any ICT, to protect against the theft or interception of data by third parties. The nature of RFID makes reader-tag transactions particularly vulnerable to eavesdropping, although the short distance and low frequency used provide natural safeguards. Operating range, signal frequency and encryption can be used to mitigate the risk, but as the technology becomes more sophisticated and RFID systems are employed in a greater variety of environments, it will be necessary to work towards higher levels of data security to protect against intentional fraud. Experts say that Europe's experience with a higher incidence of online fraud will mean a more cautious adaptation of these technologies for consumer use, particularly to replace magnetic strip credit cards. In the United States, work has focused on developing purely no-contact transactions, such as those based on the Exxon/Mobil Speedpass, which allow subscribing motorists to pay for gasoline, a carwash or roadside food by holding an RFID tag to a sensor at the gas pump or payment register. In contrast, although some European companies have replaced magnetic strip credit cards with RFID-enabled cards, they still rely on personal signatures or PIN codes to serve as verification mechanisms.

The risks and the disparity in approaches highlight the need for standards and protocols to guide the collection and use of data and ensure the interoperability of systems. As RFID systems proliferate, the regulation and equitable distribution of radio signal frequencies will be an important issue. Hardware and software components, which are now furnished by a diversity of firms that use various standards, will have to be compatible. As in the early stages of PC development, the various parts were only compatible with parts from the same or allied manufacturers. An important first step has been taken by the International Organization of Standards (ISO), which has contracted with VeriSign to establish and operate a database of product identification numbers for the creation of tags, much the way it does for ".com" and ".net" Internet domain names. Wide-ranging standardising measures will also likely need to be taken.

Wireless fidelity (WiFi)

Wireless technology, already established as the new generation of technology for telephony, text messaging, e-mail and other communication services, is also expanding into the area of personal computers and the Internet. Since the 2002 edition of the *Information Technology Outlook*, WiFi has become one of the main international standards for wireless broadband Internet access and networking, with widespread use in businesses, homes and public spaces. WiFi is an Ethernet standard (also known by its technical name of 802.11b) based on radio signals with a frequency of 2.4 Ghz and capable of speeds of up to 11 Mbps. For local area network access, it provides a typical working radius of 100 meters

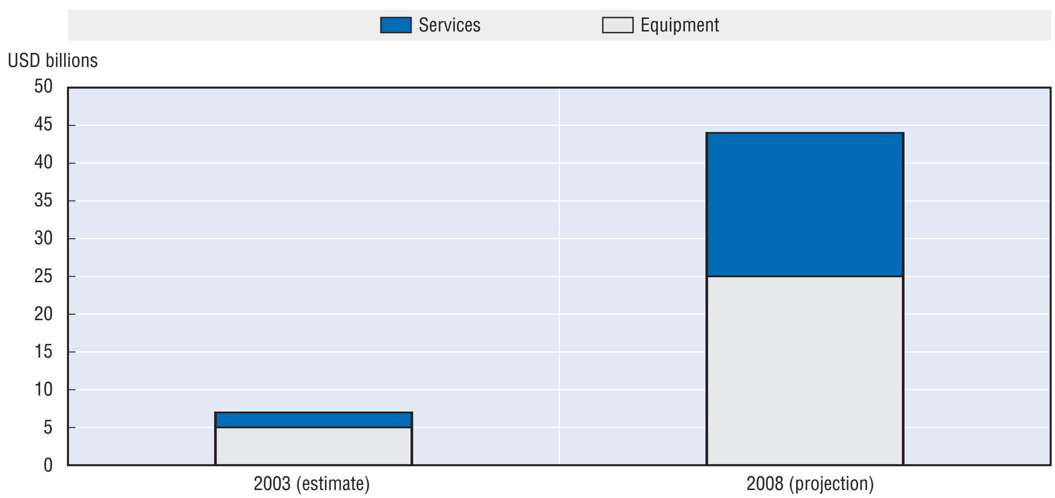
(330 feet) from a given base station or "hotspot" (although a direct line of sight and directional dish antennae allow the signal to travel much farther). Depending on the consumption of bandwidth, the base can serve several users simultaneously.

WiFi has developed rapidly in the last two years. Though still a novelty to the general public, it is increasingly a utility for business people and is quite commonplace in new office complexes, many major airports, transportation hubs, business hotels, conference and convention centres, cafés and even some fast-food restaurants in developed countries. WiFi has also spread quickly to the academic market and is now a fixture at leading universities, libraries and research centres.

Comprehensive and comparable figures are not readily available from either companies or government agencies, but anecdotal evidence points convincingly to a strong growth trend. According to Insight Research Corporation, worldwide 2003 WiFi revenue is estimated at USD 7 billion, with USD 5 billion accounting for equipment sales, including core networks, hotspots and end-user devices, and USD 2 billion attributed to sales of WiFi services. Projections for 2008 are total revenue of USD 44 billion, with equipment and services sales representing USD 25 billion and USD 19 billion respectively (see Figure 7.6).

WiFi is fast becoming an added-value service used by travel-related businesses to attract business travellers. Northern California, for example, has seen a proliferation of roadside hotels offering guests free WiFi Internet access. Even some smaller airports offer free WiFi in an attempt to attract fliers away from larger airports where they are sure to get online at no cost while they wait for their flight. Several international airlines are experimenting with wireless computing aboard planes; Lufthansa uses Connexion, a satellite-based system developed by Boeing, and the United Arab Emirates introduced WiFi technology developed with Inmarsat. A new, weatherproof access point has been developed by D-Link in the United States, which, with a working radius of 600 metres (2 000 feet), could provide wireless networking for groups of buildings such as corporate compounds or resorts. Verizon, the US telephone company has equipped many of its public payphones around New York City with WiFi antennae and thus created hotspots all around the city. It provides passwords to its fixed-line and mobile telephone subscribers. Telephone companies in other cities have followed suit. T-Mobile has the largest commercial network of hotspots in the United States with 3 000 across the country. They are monitored by a national operations centre, which helps ensure high quality of service.

Figure 7.6. **Worldwide WiFi revenue**



Source: The Insight Research Corporation (2003).

WiFi technology is still a small but quickly spreading part of the home market for broadband Internet. Major cable and Internet suppliers are adding WiFi installation and support to their subscription services to meet customer demand for broadband connections and wireless LANs for multiple home or business computers. In the United States, Time Warner Cable, a market leader, provides WiFi installation and support services for 50 000 of its 3 million high-speed Internet subscribers nationwide (Biederman, 2004). Other broadband companies, like Comcast Cable Communications and RCN, both major players, as well as retailers of computer equipment increasingly offer WiFi installation packages that include hardware and security setups. Installation prices range from USD 100 to USD 300, including equipment, and ISPs typically add USD 10-15 to the standard subscription rate, for a total of about USD 50 a month.

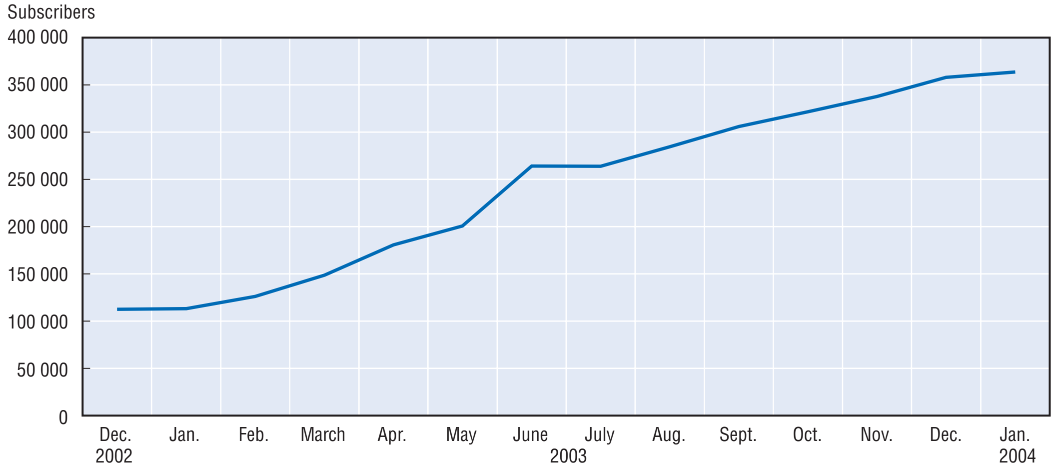
In Europe, WiFi development has lagged the United States but is expected by some to overtake it. A WiFi survey of eastern and western European countries conducted at the end of 2003 found 96 service providers in 19 countries, but over 70% of about 1 000 public hotspots are located in a very small number of countries (Cellular Online, 2004). To date, most hotspots in Europe have been placed for public access as a part of commercial networks, often on a pre-paid basis. Prices for WiFi service in Europe are higher than those in the United States and Asia, but tariff categories are shifting downwards, with more service providers recognising the need to balance pre-paid models with long-term, subscription-based revenue streams. By some estimates, subscription revenues for European WiFi hotspots will rise from EUR 18 million in 2003 to over EUR 1 billion by 2006 (Frost and Sullivan, cited in m-Travel.com, 2003). Though strong subscriber growth is expected in the long run, it appears that public access WiFi networks will continue to lead short-term growth.

Predictions of accelerating future WiFi growth in Europe are based on the lag in adoption of home and office PCs compared with North America, which is counterbalanced by higher mobile penetration. This means that future network expansion will include hardware in which WiFi capability is already installed, rather than requiring the upgrading of existing fixed networks. Also, GSM has laid the cultural groundwork for mobile communication in Europe, and this, combined with the region's high population density, offers a positive environment for WiFi rollout. Further, the density and extent of public transport in Europe could serve as an underlying "floor plan" for public access WiFi networks, with hotspot coverage extended along mass transit routes. For example, in 2003, the city of Paris launched a test programme of WiFi hotspots along major bus and metro routes as a precursor to a possible citywide network in the near future.

Korea is the undisputed leader in WiFi development with over 8 500 hotspots, or over half the world's total, reported at mid-2003, and USD 100 million has been allocated to increase the number to 16 000 in the medium term. The total number of WiFi users in Korea was expected to grow from 150 000 to over 1 million in 2003 alone. This strong growth pattern follows the inroads made by broadband Internet, and many WiFi subscribers are switching over from fixed-line services (Figure 7.7). Monthly subscription rates of around USD 20 are well below rates in Europe and the United States, and Korea Telecom, the market leader, predicted 2003 WiFi revenues of USD 125 million. This dynamic market is also seen as test bed for future developments in communication technologies.

Wireless technology is generally agreed to be a leading platform for future high-speed Internet development. To this end, technology companies are working on new products that can improve performance characteristics, such as operating range, transmission speed and security. Intel predicts that growth in wireless communication will resemble the strong growth of Internet in the 1990s. Intel's efforts now focus on WiMax, or 806.16, to replace 802.11b as the international standard for wireless computing. The technology is still under development and hurdles such as radio spectrum availability persist. Intel has partnered with several equipment manufacturers in the United States and is working with telecommunications service providers in other countries on a pilot basis. An antenna atop Intel corporate headquarters was able to receive a 7 Mb data signal (enough to carry high-definition television) from up to 12 miles away. This could represent an alternative to WiFi as a last-mile technology, and WiMax networks could challenge cable and telephone service providers in the high-speed Internet market.

Figure 7.7. **Korea Telecom WLAN subscriptions**



Source: Korea Telecom (2004).

Wireless technology is also acknowledged as the solution to last-mile problems for remote and rural areas and other areas where installation of fixed infrastructure for high-speed Internet access would not be cost-effective. As a result, WiFi or related technologies are seen as the key to extending Internet access to villages but also to urban areas with less developed infrastructure, particularly in developing countries. This would facilitate delivery of important social, educational, and government services via broadband Internet to these areas.

Emerging issues

From the start, the hurdles facing WiFi have centred on two issues: access and security. One of WiFi's major advantages is its capacity to serve multiple users from a single hotspot. This has led to the formation of community networks in which multiple users share a single subscription to Internet services. Amplifying equipment can extend WiFi signals to wider areas and some communities have provided WiFi in parks and other public spaces free of charge. However, unmonitored use of WiFi hotspots, for example by neighbouring apartment dwellers, is an issue, as private users often do not activate encryption and authentication functions that are available as a standard feature of WiFi equipment, leaving the door open for free riders. Such activities could threaten the profitability of WiFi business models, but ISPs have responded quite rapidly, using encrypted transmissions and requiring authorised users to enter passwords in order to access the service.

Security solutions have also proved somewhat elusive. Wireless Equivalent Privacy (WEP) is the security architecture used in existing WiFi networks. It works by encrypting transmissions with a key of 40 or 104 bits, which must match the key programmed into a receiving device. However, determined hackers can derive the keys by eavesdropping on wireless transmissions, and as the keys must be changed on each receiving station, it has not proved practical to undertake the frequent updates necessary to prevent break-ins. Though WEP is widely applied, industry experts acknowledge that it is a less than optimal security solution. A newer system known as WiFi Protected Access (WPA) offers greater security and ease of use, but it poses compatibility problems for older equipment and can require extensive software upgrading. Users of public hotspots are particularly vulnerable because few public access networks are encrypted since it would be pointless to hand out secret keys to all who ask for them.

Two new standards, 802.1x and 802.11i are seen as likely successors to WEP. 802.1x is a standard for passing the Extensible Authentication Protocol, a widely used method of authentication, over wireless networks. T-Mobile has been testing 802.1x on a selection of its hotspots across the United States since late 2003 and is expected to roll out the new security standard across its entire network in mid-2004. The project, called Wireless Provision Services, is being carried out in partnership with Microsoft; it allows Windows XP users to detect and connect to 802.1x-protected T-Mobile hotspots and provides automatic subscriber authentication. 802.11i is expected to implement better security functionalities in WiFi, with a projected rollout by the end of 2004.

As WiFi use continues to expand, new problems will arise, particularly concerning allocation and crowding of radio frequencies. WiFi operates in the unlicensed spectrum, and current users already encounter interference from neighbouring networks and other devices, such as cellular phones and microwave ovens. As the number of users and wireless devices multiply, the problem will become worse.

As WiFi technology evolves, questions of interoperability will emerge. The Chinese government recently came under fire for introducing a separate, national WiFi standard and setting a June 2004 compliance date for equipment makers. US foreign affairs and trade representatives have criticised this measure as a protectionist trade barrier. Some major suppliers of WiFi technology have announced that they would not be able to meet the deadline, citing both technical and philosophical concerns, and potentially forfeiting at least temporary access to the world's second largest PC market.

Interoperability concerns also arise in the context of evolving technology. Some proposed security standards, for example, would require the addition of a processor solely to handle data encryption. These standards would be inoperable on much of the hardware currently in use. A similar problem affects any consideration of integrating new and existing wireless technologies like the faster 802.11g protocol, which is supplanting WiFi in many places. New technologies like WiMax are generally assigned frequencies in the higher end of the spectrum and the signals would have to be converted to travel through existing networks. Also, while higher frequencies are preferable for broadband transmission, they are less effective over longer distances and through physical barriers. The additional signal strength and equipment required to provide coverage would increase deployment costs steeply. This problem will only be exacerbated as other wireless, frequency-consuming technologies are developed, such as RFID (see above).

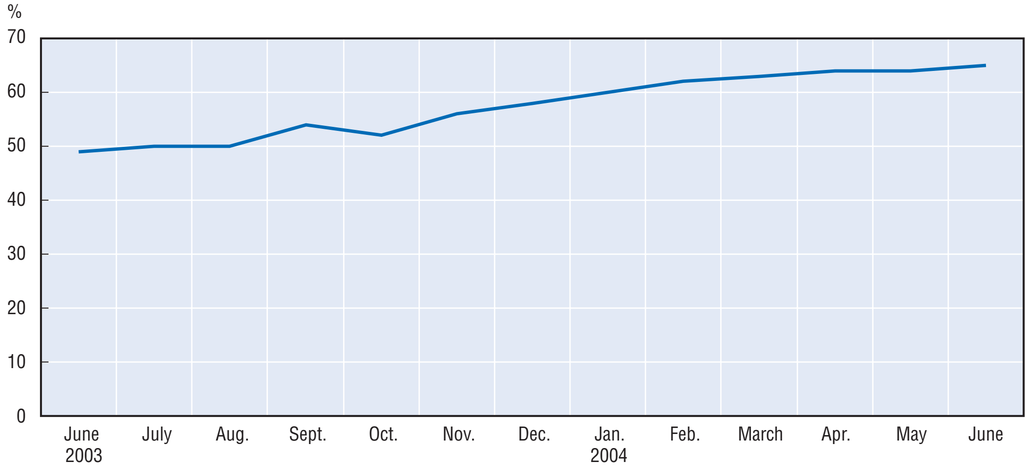
Anti-spam technologies

Spam is of important and increasing concern to users, ISPs and policy makers. It is commonly characterised by unsolicited electronic commercial messages sent in bulk. Moreover, it is often unwanted and sent indiscriminately and/or repetitively to addresses gathered without the users' knowledge or consent, sometimes from disguised senders, and it may carry offensive or fraudulent content.

The first known spam was a product announcement sent by a physicist to his colleagues in the 1970s, when the Internet was a tool primarily for communication and collaboration between scientists around the world. That initial use of the Internet for unsolicited commercial purposes drew a wave of negative response from the user community of the time. Since then, the development of ICTs generally and the growth of e-mail in particular have created a prime medium for the proliferation of spam. Despite efforts on the part of individuals, ISPs and some governments, spam has even outpaced the growth of e-mail. According to some measures, in early 2004 spam accounted for over 60% of the 40 billion e-mails sent every day (Figure 7.8). By some estimates, this share could reach 75% by 2007.

Spammers use certain common tools, and this has complicated efforts to stop spam. Foremost is the fact that e-mail is essentially free. After the start-up costs of creating an email account, there are no financial constraints on the number of messages sent, so that spam is a particularly cost-efficient form of direct marketing. Further, spammers have taken advantage of a weakness in the programming of the simple mail transfer protocol (SMTP) to change the source information displayed in an e-mail message. They also use FormMail protocols, which are easily programmed for mass, anonymous e-mailing. To disguise their messages, spammers have in some cases broken into proprietary networks and stolen

Figure 7.8. **Spam as a share of all e-mail messages**



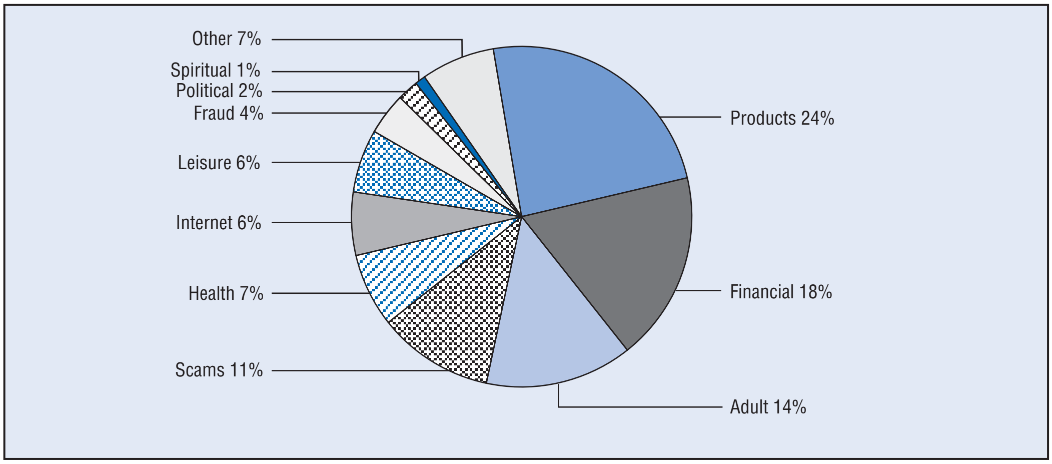
Source: Brightmail (March 2004).

identity and account information of individuals or organisations. Such tactics make spammers hard to identify as messages can be sent from sources that do not exist or masquerade as reputable senders, using real senders' identities.

The purpose of spam varies. It is commonly considered a form of direct advertising, but it is sometimes used to build lists of functioning e-mail addresses and sell them to companies. Spam content falls into ten main categories, with product and financial offers and adult materials making up over half the volume of messages. A further 15% is comprised of fraudulent offers or swindles that prey on unwary or uninitiated Internet users (Figure 7.9).

Consumer trust is essential for the growth and success of e-commerce. If the Internet is to increase commercial growth, users must have confidence in the security and usability of this electronic medium.

Figure 7.9. **Categories of spam messages**



Source: Brightmail (February 2004).

The significant increase of spam threatens to erode consumer confidence on line, which in turn negatively affects the growth of the digital economy. Spam's intrusiveness and the fact that much of it is linked to fraudulent or deceptive or adult commercial activities has harmed the development of e-commerce by reducing consumer trust and diminishing the credibility of e-mail marketing.

Beyond its nuisance value for users, high volumes of spam carry costs for individuals, firms and service providers. Consumers waste time deleting repeated unsolicited commercial messages, and those who use a dial-up service may be billed for additional communications charges by ISPs or telephone companies (or both). In addition, costs incurred by ISPs in dealing with spam tend to be passed on to consumers. Companies face a variety of costs, including productivity losses when employees have to deal with spam as well as additional costs for network and computing resources, the costs of deploying the technical tools and allocating the necessary human resources to deal with spam. They also face security risks due to spam attacks, such as e-mail-borne viruses and worms, and the potential for legal liability. ISPs and e-mail service providers (ESPs) incur many of these same costs: processing costs incurred for accommodating and routing excess incoming mail, investments in filtering technology, and legal fees incurred fighting spammers in court. Spam affects their network bandwidth, data storage, staff time and phone-line availability. Spam is also associated with costs relating to lost privacy and identity theft, proliferation of fraudulent or offensive content, propagation of viruses and other security risks, and loss of consumer confidence in communication networks.

Some countries have taken legislative action against spam, but the results are mixed. The volume of spam and its share of all e-mail communication have increased continuously despite the introduction of spam legislation in more than half of OECD countries. One of the difficulties for combating spam is its frequently cross-border nature. Technological solutions are also important for combating spam and are made available by a wide array of software vendors. Many new products and services have recently come on the market, aimed at providing technical solutions for individual users, service providers and organisations. The different types of technical solutions described below are often used in combination for maximum efficiency in blocking spam while allowing access to legitimate email.

Whitelists and blacklists

Whitelists and blacklists are the most basic forms of spam filtering. They can be established by users on their own e-mail accounts or on servers. Whitelists are lists of recognised senders who are accepted as legitimate and whose messages are sent directly to the user's inbox. Similarly, blacklists are lists of recognised senders who are known as spammers, and whose messages are either deleted or filtered to a user's spam folder. Blacklists can be established in a collective way. Once enough recipients in a certain user community object to a particular message, the message is automatically transferred to other users' spam folders.

Problems with these filters occur because sender information can be disguised. While whitelists help to filter spam, they are prone to spoofing, or falsification of e-mail source data. In addition, blacklists can block legitimate messages by blocking innocent Internet users connected through blocked ISPs. There have even been cases of blocking of entire country domains. Many ISPs argue that blacklists have had the effect of victimising the wrong people, including ISPs that unknowingly host spammers, Internet users who may have been spoofed by a spammer and addresses adjacent to that of the alleged spammer.

Heuristic filters

Heuristic filters scan messages for keywords or combinations of characters that are common to spam and use certain terms and references as identifiers. Heuristic filters score messages on the basis of how frequently such terms appear. Users can set a threshold above which such messages are considered spam.

Heuristic filters scan and sort messages according to fixed criteria. They are therefore less easily adapted when spammers employ new tricks to circumvent them. As a result they tend to let some spam slip through and filter out small quantities of legitimate messages. The potential loss of legitimate messages, known as false positives, is of great concern to e-mail users, who might thus consider spam filters as worse than the problem they are intended to solve.

Bayesian filters

Like heuristic filters, Bayesian filters use keywords, combinations of characters, or portions of HTML code to sort messages, but they compare statistical information about the rate at which these appear in messages identified as spam to those identified as legitimate. They assign a score to each of the signals, based on its frequency of occurrence in spam, and they assign a score to the whole message on the basis of the average of the scores of individual signals. As with heuristic filters, users set the filter threshold, but Bayesian filters also have the capacity to learn and adapt quickly to new spamming tricks and the types of messages a particular user receives.

Also like heuristic filters, Bayesian filters run the risk of allowing spam to pass through while filtering out some legitimate messages, but they are considered to be much more accurate. To function effectively, the filter needs time to learn the distinguishing characteristics of spam and legitimate messages by being presented with samples of each.

Other solutions

There are a number of other anti-spam tools. Behavioural analysis tools look for patterns such as large numbers of recipients. Address-validation tools reverse domain name system lookups to ensure the sender is not trying to cloak his identity. New products are also emerging that can scan for graphics, such as skin tones to combat adult content, but these tools are still in their infancy. Another new technology recently introduced is a challenge-response technology, which requires a sender to verify his or her identity before being added to a whitelist that enables him or her to send e-mail unrestricted.

Emerging issues

It is very hard to use purely automated processes to determine whether or not a particular message is spam. Computer algorithms to identify spam leave room for error and circumvention. Moreover, relatively newly introduced technologies such as challenge-response technology place an extra burden on legitimate senders. In addition, list owners with many subscribers such as newsletter mailers (automated response systems) have difficulty answering challenge-response e-mails personally, so subscribers' newsletters may be stopped.

Another approach to spam filtering is the consensus model, whereby people who receive messages that they consider to be spam report them to a co-ordinating entity. A computer programme is used to co-ordinate all of the input. A properly compiled list of known spammers would also be a significant improvement over current unco-ordinated blacklists, although it is nearly impossible to deliver perfect filter systems. Moreover, many spammers are technologically sophisticated enough to cover their tracks, adjust their systems to slip through filters and scale other technological barriers. They can electronically commandeer unprotected computers, turning them into a tool for spamming. As long as spam costs are so low, spammers have a vested interest in finding ways to defy technological limits.

Anti-spam solutions inevitably add cost and latency for both service providers and consumers. An effective e-mail filtering service can entail considerable added costs for service providers and they often have some side effects on the efficiency of communications.

Efforts to find technical solutions to spam prevention/reduction have been made both at the individual company level and by many companies in a collective and co-operative way. As spam becomes a major issue, more and more technology companies have discussed solutions to counter spam. These have included technological measures as well as legal action, such as the lawsuits filed by America Online, Earthlink, Yahoo! and Microsoft against 220 known spammers.

Spam is not the problem of any single country. It is a worldwide problem. With Internet access and use continuing to grow in developing countries, spam may expand further. It is increasingly clear that domestic efforts must be supplemented by internationally co-ordinated strategies to address the cross-border challenges posed by spam. In February 2004, the OECD hosted a workshop bringing together experts from government, the private sector and civil society to address these issues. The discussions at this workshop set the orientation for the OECD's ongoing work on spam.

Greater public awareness and education are needed to foster safer computing practices. In this respect, anti-spam strategies might be linked to general e-security campaigns. On the technical side, continued support for the development and deployment of technical tools to fight spam is necessary to help ensure that spam does not elude the filters of ISPs and others. On the whole, a blended approach combining regulatory, self-regulatory, technical solutions and user awareness offers the best prospects for reducing spam.

Conclusion

All of the emerging technologies discussed in this chapter – nanotechnology, grid computing, RFID, WiFi and anti-spam technologies – are a step forward in sophisticated applications as maturing technologies find new commercial applications and use. These developments underpin the increasingly important role ICTs play in the economy through their potential contribution to output and productivity and the continued growth of the overall market for ICT goods and services, in spite of the cyclical corrections of recent years. As new ICT applications emerge, however, new issues have to be addressed, particularly as such technologies challenge established systems of trust. Trust is recognised as a key component of the uptake and use of ICTs, and its role increases with greater global interconnectedness. New technologies present new risks and uncertainties, and it is important to respond to the challenges they pose for information and system security, privacy and public safety in both their development and their application. A pro-active and collaborative approach to research and development, including co-operation across borders and economic sectors, has led to the current dynamic trajectory in the more sophisticated applications. In this way, governments can continue to address the challenges and create opportunities to realise further the potential of technological change.

OECD governments are supporting the development of new ICT technologies, including extensive efforts to develop further the technologies analysed in this chapter. As Chapter 8 notes, research and development programmes are the most common government ICT policy initiatives. These focus essentially on R&D in the ICT sector itself, often with a particular focus on nanotechnology, grid and wireless technology developments. In ICT-related fields, they include broader support for the technologies underlying particular applications and more general support for science and technology, for example through generic technology programmes and tax incentives. Furthermore, programmes to encourage venture capital and to promote the formation of innovative networks and clusters of firms will affect the development of ICT when the relevant technologies, including those analysed in this chapter, are closer to commercialisation.

REFERENCES

Allied Business Intelligence (ABI) Research (2004), “RFID integration to surpass product revenue”, 10 February, *www.abiresearch.com/usingrfid.html*.

Biederman, M. (2004), “The Cable Guy Reimagined as Wireless Guru”, *The New York Times*, 29 January.

Cellular Online (2004), “WiFi Tariffs in Europe Report”, January, *www.cellular.co.za/news_2004/Jan/011704-wifi_tariffs_in_europe_report.htm*.

The Foresight Institute, United States (2004), *http://www.foresight.org/ghindex.html*.

Foster, I. (2002), “What is the Grid? A Three Point Checklist”, Argonne National Laboratory & University of Chicago.

Foster, I. and C. Kesselman (1998), *The Grid: Blueprint for a Future Computing Infrastructure*, Morgan Kaufmann Publishers.

Grid Technology Partners (2004), *www.gridpartners.com*.

The Insight Research Corporation (2003). “WiFi in North America and Europe: Telecommunications’ Future”, *www.insight-corp.com*.

Korea Telecom (2003), *www.kt.co.kr*.

m-Travel.com (2003), “European WiFi growing faster than in America”, 24 October, *www.m-travel.com/31024.shtml*.

National Science Foundation, United States (2003), *www.nsf.gov/nano*.

Chapter 8

ICT POLICY DEVELOPMENTS

ICT *policies are increasingly integrated into economic strategies and co-ordinated across government. This chapter outlines recent policy shifts and continuities in* OECD *countries. Policies focus on* R&D *and technology diffusion, including building* ICT *skills. Broadband priorities are matched by growing interest in digital content and delivery. Evaluation of* ICTs *and economic development is a new focus.*

This chapter analyses recent information and communication technology (ICT) policies and programmes in OECD countries. It is divided into four sections: general policy approaches and the ICT policy environment; specific ICT policies and programmes; policies for small and medium-sized enterprises (SMEs) and digital delivery; and evaluation and assessment of ICT policies. Thirty countries provided detailed information on their ICT policies and programmes: 28 OECD countries plus Estonia and Singapore. Individual country responses are posted on the OECD Information Economy Web page.

Developments since 2001

Analysis of replies to the OECD IT policy questionnaire 2003 shows that government policies (as measured by frequencies of responses, summarised in Table 8.1) focus primarily on:

- General ICT policy environment (visions, plans, policy co-ordination).
- ICT innovation (R&D support programmes and government development projects).

Table 8.1. **Summary of OECD country ICT policy responses, 2003**

	Number of country responses
ICT policy environment	**22**
Fostering ICT innovation	**26**
Research and development programmes	26
Government development projects	21
Innovation networks and clusters	18
Government procurement	17
Venture finance	16
Increasing diffusion and use	**25**
Professional/managerial ICT skills	24
Government online, government as model users	22
Diffusion to business	21
Diffusion to individuals and households	21
Content	16
Organisational change	10
Demonstration programmes	10
ICT business environment	**25**
Competition in ICT markets	19
Intellectual property rights	19
Trade and foreign direct investment	15
International co-operation	15
Enhancing the infrastructure	**26**
Broadband	24
Electronic settlement/payments	22
Standards	20
Promoting trust online	**27**
Security of information systems and networks	23
Privacy protection	18
Consumer protection	15
Policies related to small and medium-sized enterprises	**14**
Digital delivery	**15**
Healthcare	12
Government services	9
Business services	7
Assessment and evaluation	**17**
Total responding countries	**30**

Source: OECD, based on 30 responses to the OECD "IT policy questionnaire, 2003".

- Diffusion and use (ICT skills, government on line, diffusion to households and business).
- ICT business environment (with a focus on getting the environment right, notably in the area of competition and intellectual property rights).
- Enhancing the infrastructure (broadband, electronic settlements, authentication and digital signatures, standards).
- Promoting trust (security of information systems and networks).

The main shift in general government strategies has been towards mainstreaming ICT policies, *i.e.* seeing them in terms of their contribution to growth and employment, rather than as technical programmes implemented by specialised ICT agencies. At the same time, there are efforts to ensure that ICT policies are focused and co-ordinated to maximise their impact and broaden the use of ICTs. Policy evaluation is also receiving more attention than in the past (see Tables 8.1 and 8.2). The main challenge for ICT policy makers is to develop and deliver policies that maintain and enhance the dynamism of the ICT sector and the impacts of ICT use across the economy within the broader framework of general economic strategies, *i.e.* a shift from infant industry strategies to the broader incorporation of ICTs into policies for growth and employment.

Areas that have received greater attention are ICT-based R&D and innovation, including sectoral and structural transformation to better realise the benefits of ICT. There is strong emphasis on policies to promote professional/managerial ICT skills and ICT diffusion to businesses, individuals and households. There is also a clear refocusing of e-government activities and digital networking of some aspects of public administration. There has been greater emphasis on the development of broadband, in terms of infrastructure build-out and provision of high-speed service, with the most advanced countries focusing on increasing uptake of installed capacity and paying more attention to digital content and digital delivery. Finally, promoting trust on line has received increasing attention from policy makers, as issues of network security, protecting data, privacy and consumers, and combating spam have gained importance with the rapid growth in high-speed networked electronic communication.

Table 8.2. **Summary of OECD country ICT policy responses, 2001**

	Total number of country responses
General policies	**20**
Policy environment and broad policy visions	20
Technology development	**20**
R&D programmes	19
Development of ICTs for government use	12
Government procurement	11
Venture finance	9
Technology diffusion	**21**
Diffusion to individuals and households	20
Diffusion to businesses	20
Government services online	19
SMEs	18
Programmes to demonstrate benefits of IT use	17
IT environment	**20**
Electronic settlement, authentication, and security	19
Intellectual property rights	14
Standards	11
Globalisation	**18**
International cooperation	17
Trade and foreign direct investment	8
Total responding countries	**21**

Source: OECD, based on 21 responses to the OECD "IT Policy Questionnaire, 2001".

Policies specifically addressing ICTs and SMEs appear to have lower priority, possibly because they have been absorbed into mainstream policies for ICT diffusion and training, which often emphasise SMEs within general programmes. Compared with the 2001 survey, there is considerable policy continuity, but some areas, such as awareness and demonstration programmes and SME-specific programmes, now receive less attention, as there are now high levels of business connectivity and the focus is moving towards more complex e-business strategies.

ICT policy environment

To benefit fully from information and communication technology an appropriate policy environment for development, investment, diffusion and use is essential. This section briefly reviews the broad ICT policy environment relating to information technology, information infrastructure, the information and Internet economy and information society, including broad policy visions. It highlights the main areas of policy focus and different ICT policy priorities, new policy directions and developments, and the institutional setting for ICT policy formulation and co-ordination mechanisms.

Analysis of the general policy approaches of 30 countries shows that, beyond increasing diffusion and application of ICTs as an end in itself, countries increasingly attempt to maximise the benefits to be gained through more effective use of ICTs and knowledge-based economic activities.

The main areas of general policy focus in many countries are:

- Development and dissemination of the necessary skills for the integration and use of ICTs in both business and daily life; ICT user skills through the education system and specialist ICT skills through professional training and lifelong learning programmes for targeted groups.
- Continued development of ICT infrastructure and technology, particularly the rollout of broadband services, the development of interoperable platforms, and greater attention to digital content.
- Continued development of e-government, including streamlining of administrative procedures, facilitation of co-operation between departments and interaction with citizens and business.
- Other important efforts focus on creating an enabling environment, particularly through economic, legal and security structures that support the development of investment in ICTs and the growth of e-commerce and, increasingly, e-business.

New policy directions and priorities vary considerably. However, new areas of concentration include encouraging access to and effective use of ICTs, and further refining and implementing an appropriate legal and economic environment for the continued growth of the ICT sector and technology adoption in other economic sectors. These areas of policy emphasis help to foster ICT innovation, particularly through co-operation between business, universities and R&D bodies, and to mainstream ICTs into the economy as a whole. A considerable number of countries also increasingly emphasise the technology base, including infrastructure development, broadband rollout, ensuring interoperability of systems and combating spam. Other new directions include supporting the growth of e-business, developing digital content and services, and new international co-operation initiatives.

Institutional settings across all countries showed a consistent pattern of horizontal co-operation among ministries on ICT issues, including a designated co-ordinating body. Many countries now report that responsibility for development of an information economy is part of broader economic development efforts. This represents a shift in countries where ICTs were previously under the jurisdiction of ministries involved in science and technology or telecommunications. While these still play an important role, the changes indicate greater recognition of ICT as an important contributor to national economic development, and present new policy challenges to maintain the dynamic contribution of ICT development and use in more integrated policy settings.

Specific policies and programmes

This section covers five main areas: fostering innovation in ICTs, increasing diffusion and use, the ICT business environment, enhancing infrastructure and promoting trust on line. Country responses highlight R&D support programmes, the development of ICT skills, government as a model user for increasing diffusion and use, broadband infrastructure, electronic payment systems, and trust on line, particularly the security of information systems and networks (see Annex Table C.8.1).

Fostering ICT R&D *and innovation*

Research and development programmes in responding countries take three approaches: *i*) direct focus on R&D in the ICT sector; *ii*) focus on ICT R&D in the context of applications to other sectors; and *iii*) focus on technological and scientific R&D generally, including, but not specific to, the ICT sector. Generally, more developed countries report that R&D efforts tend to follow a combination of the first two approaches, while countries with lower per capita GDP adopt a more general R&D promotion strategy designed to increase R&D intensity overall.

- Responding countries noted that R&D efforts in the ICT sector focus on new technologies such as IPv6, wireless and broadband, as well as development of ultra-high-speed networking and grid computing and anti-spam technologies (see Chapter 7). Usability and application, particularly in e-business, healthcare and education, are guiding principles of many ICT-sector R&D programmes. Many countries' programmes are administered at national level through ministries active in the science and technology sector or through national technology agencies or institutes charged with developing ICTs of public interest. A few countries listed efforts organised at sub-national levels and participation in regional and international initiatives.
- Research efforts and their application in ICT-related fields tend to focus on a handful of common areas. Some of the fields are consistent and complementary with the EU Sixth Framework Programme, although only Hungary, Norway, Switzerland and Turkey (none EU members at the time of answering) specifically cited the programme. R&D fields include microtechnology and nanotechnology, intelligent systems and user interfaces. Application of ICTs in other specific sectors focus on robotics, space sciences, transport and logistics (see Chapter 7).
- The R&D strategies of some countries, notably those with lower per capita GDP, have general national innovation goals that include ICTs, sometimes listed as a top national research priority, but do not include programmes specifically targeted at ICTs. National strategies prevail among countries in this group, with a main focus on the development and dissemination of knowledge, particularly to SMEs and local government. Countries in this group also noted participation in international R&D programmes and initiatives; some work with more technologically advanced countries to learn best practices to accelerate development in these areas.

Government development projects in responding countries tend to focus on e-government applications. Goals of more efficient, transparent and accessible public administration and possible broader demonstration effects drive development in agencies and government suppliers (SMEs in particular). Among the specific initiatives cited are: electronic citizen cards and signatures for online transactions with the public sector, development of public registers and information databases for interagency and/or public access, interoperable standards among agencies and technical specifications for electronic transactions between government and businesses. Some interoperability initiatives include international co-operation to define technical standards.

Innovation networks and clusters exist in various forms in a majority of countries. Some governments have programmes to promote the formation of "centres of competence" or "centres of excellence", both along sector value chains and across sectors. There appears to be no single systematic pattern, with the focus sometimes on linkages between academic institutions, research centres and firms, sometimes on technology parks, and occasionally on participation in international innovation networks.

Government procurement is also an innovation tool, as governments set requirements for e-procurement processes in line with their e-government goals. About half of the responding governments either have already or are in the process of setting up electronic procurement platforms which give supplier firms access to government purchasing activities and calls for tender. This also has the effect of encouraging suppliers to adopt electronic commerce and spread electronic certification and authentication. Some governments have included preferential treatment or quotas for SME participation in e-procurement.

Venture finance for ICT development projects was reported by just under half of the countries, mostly in the form of equity capital for new ventures, and typically as co-investment with business angels or other sources of capital in the private or public sectors. Financing commonly focuses on high-risk, high-technology SME ventures that have reached the close-to-market stage. Other types of assistance in the area of venture finance include tax benefits for investors and business forums and other networking opportunities organised by governments for entrepreneurs and investors.

Increasing diffusion and use

Efforts relating to **ICT *skills* (*specialists and basic and advanced users*)** were the most frequently mentioned of all ICT policy areas, along with R&D programmes and broadband rollout and use. This shows the high policy priority given to enhancing human resources and developing ICT skills in increasingly knowledge-based and globalised economies, as analysed in Chapter 6. Initiatives aim to develop specialist ICT skills along with wider development of general ICT user skills:

- The main focus is the integration of ICT skills into education at all levels from elementary to postgraduate, accompanied by competence certification (including the European Computer Driving License) that serve to define skills at standard ICT user levels, and at specialist ICT professional and expert skill levels.
- Making ICT skills an integral part of the education and vocational training systems also requires qualified teachers and the creation of on-line and distance learning programmes through virtual schools and universities.
- Some countries have developed programmes for aligning education and vocational training mechanisms with industry and sector needs, for example by promoting ICT careers and recruitment/graduate quotas in relevant fields for ICT specialists.
- Some ICT programmes have specific targets, such as bringing women, the unemployed or the disabled into the workforce or relaxing immigration requirements for needed specialist skills, as well as being increasingly concerned with the impacts of international sourcing (see Chapters 2 and 6).
- Managerial/specialist ICT skill combinations (e-business skills) are largely geared towards SMEs, including consultation and advisory services to improve e-business innovation strategies.

Government on line and as a model user is clearly recognised as an important tool for communicating with citizens and business, for streamlining administrative processes and for helping stimulate the integration of ICTs into economic activities more generally (see also the OECD E-government Project). Governments have increasingly seen this as an area in which they have the policy leverage to improve their own ICT-related capabilities, skills and organisation.

- The most often mentioned feature of government on line is the establishment of a single window or portal for citizens and/or businesses to access the full range of government services available electronically. Cited less often were portals for agency interaction within government and shared access to databases and registers for accounting, procurement, judicial and other administrative functions.
- Some specific services mentioned as being provided through government portals include tax filing, business registration and interaction with the healthcare and social security systems. Some countries also noted mechanisms for citizen feedback and participation in government decision-making. While many countries have facilities for online transactions, the development and expansion of online services continues actively.

- Secure electronic certification and identification for businesses and citizens have been identified as central to the development of e-government. Further, the development of service standards and interoperable platforms such as XML are an important focus.

Models for ***technology diffusion to businesses*** are diverse and initiatives combine many different elements. Chapter 3 outlines the increasing economic potential for businesses to adopt e-business solutions. It points out the complexity of adoption strategies and the role that policy may play in enhancing diffusion through R&D incentives for new applications, skill formation, and information on and demonstrations of best practice and benefits from use. Detailed peer reviews of policies for ICT diffusion to business are being undertaken and are available on the OECD Information Economy Web page.

- Most commonly the policy focus has been on adoption of ICTs by SMEs and on the promotion of e-commerce, although as connectivity increases in leading countries the focus is shifting to more complex applications and policies for SMEs are being integrated into more general policies.
- Also frequently cited were the creation of forums for co-operation by government, academia and the private sector on either an industry-specific or economy-wide basis to share knowledge and guidance. A variant includes "business clubs" or other associations for the exchange of best practices and networking of enterprises for the specific purpose of ICT diffusion to business.
- Less frequently cited were more ambitious multifaceted programmes relating to financial, legal or technological frameworks for business ICT use. Several countries mentioned incentive programmes with awards for excellence in e-commerce or related technology-based innovation.

Programmes for ***diffusion to individuals and households*** typically follow one or several models to expand individual use and help overcome the remaining ICT "access" divide and the developing "use" divide outlined in Chapter 4. These include:

- Integration of ICT literacy into education at elementary and secondary school levels to develop ICT user skills. In most cases, this is complemented by encouragement of technology programmes in higher education and reinforced by user skill development for those already in the workforce.
- Development or encouragement of community access points, whether via private-sector cybercafes or through public-sector settings such as libraries and community centres. These tend to target underprivileged communities and those outside of major urban centres.
- Specific targeting of certain groups. Most frequently, these address the disabled or unemployed, although some countries have specific programmes for those entering the workforce, the elderly and low-income households.
- Enabling legal or financial measures. These include grant programmes for public service, government financial assistance tied to ICT investment, tax incentives and specific programmes such as subsidies for teachers and provision of recycled hardware to low-income households.
- Finally, a few countries rely on government provision of backbone infrastructure and/or have created experimental model wired communities to spread household use.

Responding countries increasingly cite ***content development*** activities. However, initiatives are diverse, and no single main theme emerges in cross-country analysis. A wide range of initiatives aim to develop and exploit public-sector digital content and to support development of commercially viable digital content. Content development is frequently tied to: *i*) the provision of information in the context of e-government; *ii*) the preservation of the national cultural heritage through the digitisation of archives, historic documents and library resources in particular; and *iii*) initiatives in academia and scientific research, such as content developed especially for schools, and publication of land surveys or the results of other public research. Activities supporting the development of digital content include clarification of rules governing intellectual property rights (IPR) (see below) in order to encourage broad participation in content provision, particularly by the private sector.

Some initiatives to facilitate the development of online content consider broadband in terms of delivery capacity and encouragement of uptake. Generally, content development has been left to market forces with underpinning government action, for example, in the area of management of digital and intellectual property rights or provision of incentives to firms or non-profit organisations working with the content industry. Some aspects of digital content development and delivery are analysed in Chapter 5 and a more comprehensive work programme on digital content for broadband is being undertaken following the OECD Council Recommendation on Broadband Development (see Box 8.1).

Organisational change did not emerge as a priority activity beyond the streamlining of administrative and communications processes within and between economic sectors. A few countries mentioned projects that transform organisational models, such as the study and promotion of telework carried out in collaboration with labour market organisations by some governments. This has been linked to efforts to improve working life through the use of ICT to help specific groups, such as the disabled, to enter the workforce. However, few countries address the question of organisational change specifically, although it is part of initiatives for the diffusion of technology to business, particularly in terms of the exchange of best practices and co-operation among various business sectors. The issue of organisational change is also an important component of e-government activities and is discussed in more detail in these sections.

Demonstration programmes tend to be tied to other diffusion activities, particularly those involving government as a model user or programmes targeting sectors such as education or SMEs.

ICT *business environment*

Competition in ICT markets was mentioned by most responding countries in the context of telecommunications liberalisation, local loop unbundling and introduction of competition in the telecommunications services market. Most countries have either completely liberalised fixed-line telecommunications, with a very few still actively engaged in this process, including the privatisation of public monopoly incumbents and the introduction of full competition. Typically, mobile services markets in responding countries are well developed, with competition by several players. This is the case in countries that have not fully liberalised fixed-line telecommunications markets, and some mobile services have encroached on the fixed-line market with comparatively favourable prices. For a more complete discussion of telecommunications liberalisation and policy, see the OECD *Communications Outlook* 2003.

A few countries provided information about programmes to assist new firms in the ICT sector by lowering barriers to entry into competitive markets. These typically focus on improving financing for new firms and SMEs that are developing ICT products and other innovative goods and services. Efforts include more sources of financing at the local level and increased networking opportunities with venture capitalists and business angels, as well as providing incentives for these investors.

Treaties and conventions of the World Intellectual Property Organisation (WIPO) and directives of the European Union guide policies on ***intellectual property rights***. An issue of particular importance is whether software falls under copyrights or patents. Debate centres on whether software should be protected on the basis of its written code or on the function it performs. EU members, including some new ones, mention specifically that they follow the European Union directive and consider software code "a literary work" and subject to copyright. In contrast the application or idea that underlies software functions may be considered an invention, and protected by a patent.

Campaigns to reduce digital piracy, either by raising awareness or through investigation and enforcement, were specifically mentioned by several countries. Awareness campaigns typically include information for creators and distributors about digital rights management as well as education for consumers about the value and need to protect intellectual property. In a related effort, some countries have established online patent and copyright portals, registries and databases for use by IPR holders and researchers. Other efforts seek to reduce piracy by increasing penalties and cracking down on use of pirated software by businesses and government agencies.

Box 8.1. Open source software

Open source is increasingly important in all applications, but it has made its major impact in running computer servers. In computer software, open source refers to source code that can be freely accessed and duplicated. The aim is to allow support and improvements to take place independent of a particular software publisher. It is widely estimated that about two-thirds of the world's Internet servers run on open source systems, mainly Apache, which is used in almost three times as many servers as Microsoft programmes. Other open-source software, such as SunONE and Zeus, account for a smaller share. Server software is part of a wide array of computer tools with openly accessible source codes, such as the almost ubiquitous SendMail e-mail router and Perl programming language. Much early Internet development relied on open source because the sponsoring government agencies encouraged sharing.

Countries view open source software as an important new way of enhancing interoperability and increasing competition and security. Eight of the countries that responded to the ICT Policy Questionnaire (Australia, Germany, Greece, Italy, the Netherlands, Singapore, Turkey and the United Kingdom) specifically mentioned the inclusion or consideration of open source in their national IT strategies. Approaches range from broad inclusion and promotion of open source in national IT use to a more narrow use of open source for specific applications.

Germany expressed the strongest commitment to open source software, noting that the country's strategy is primarily based on its belief in diversity in the software landscape. This approach relates to the presence in Germany's IT industry of both international software companies and numerous independent developers, and policy aims to ensure continued patent protection of conventional inventions involving computers which are of a technical nature, while preventing the rise of a "software monoculture". The innovative and competitive momentum triggered by SMEs is given as one of the main reasons to reduce dependence on single software systems and promote an independent developer market. Further, developers and experts can access and inspect open source code and the software community is better able to improve security. The German e-government strategy reinforces this belief in flexibility, interoperability and diversity, with the Bundestag's decision to use Linux for some applications and to promote the use of open source products in the federal administration.

The Netherlands, with a recently launched three-year, EUR 3 million programme for the use of open source in the public sector, also takes a very positive view. The main activities under this programme are to: *i)* promote the use of open standards for the exchange and storage of data wherever possible, with the eventual goal of making open, supplier-independent standards mandatory within government; and *ii)* promote consideration of open source solutions whenever public-sector IT investment decisions are to be made. In this way the programme aims to reduce the cost and enhance the effectiveness of IT systems within government. The decentralised nature of IT decision making in the Dutch public sector means that the programme will require voluntary buy-in by public administrations. To facilitate this, the government will prepare a catalogue of recommended open standards, a software licence model under which government-produced software may be made available, and an Internet exchange platform where software can be exchanged among government bodies.

The other countries all expressed strong support for the use of open source software, although they tend to see it in terms of a narrower role in national e-strategies:

- Australia sees open source software as a key enabler for business, by encouraging greater levels of connectivity and integration within an organisation, and outside the organisation with business partners, customers and suppliers.
- Greece envisages the use of open source software in projects where governments develop new information technologies for their own purposes, such as information services, electronic payments and government revenue collection, provided it complies with prerequisites of interoperability, security and technical support.
- Italy sees open source use in digital delivery, specifically through Web-based technology transfer to schools, with the establishment of data repositories, documents and software for educational uses.
- The Turkish Ministry of Finance has initiated a project to automate the daily tasks of accounting offices and centralise detailed public accounts information on a daily basis. The system has a multi-tier application architecture, built on open systems and Internet technology.
- The United Kingdom has invited proposals for developing generic grid middleware with substantial involvement from industry and conformity to the open source/open standard strategy for grid development.
- Singapore, in its response, includes open source interoperability with distributed (grid and peer-to-peer) computing, mobile applications, IPv6 and *ad hoc* networking as a key development area to monitor and undertake trials where appropriate.

***Trade and foreign direct investment* (FDI)** initiatives were approximately evenly distributed among countries that highlighted one or the other, or emphasised both equally:

- Trade activities include bodies that promote ICT exports and seek out export opportunities. Some countries have programmes to help ICT firms, especially SMEs, and innovation clusters to access global markets and collaborate with networks abroad. Other trade-enhancing policies focus on creating an enabling environment for electronic transactions, such as streamlined and transparent regulation for e-commerce, and the exemption of electronic transactions from customs duties.
- Some efforts to attract FDI feature promotional campaigns that target specific investor countries or international investment in priority fields such as nanotechnology or biotechnology. Several countries mentioned tax incentives to invest in local personnel or R&D, as well as technology parks that serve as free-trade zones to draw investment and high-technology companies.

Often-mentioned ***international co-operation*** activities include participation in multilateral treaties and organisations such as the G8, the OECD, the United Nations Conference on Trade and Development (UNCTAD), WIPO, the World Summit on the Information Society (WSIS), and the World Trade Organization (WTO). Several countries also cited specific initiatives such as the eEurope+ Action Plan, the EU EUREKA programme, grid projects and forums to develop international standards and statistical indicators. A few noted involvement in mostly regional efforts to provide developing countries and transition economies with development assistance and expertise and advice in formulating ICT policy.

Enhancing the infrastructure

Broadband strategies are formulated at national level and in some cases are integral to general economic development strategies (see Box 8.2). Several responding countries report co-operation with and co-ordination of provincial and local efforts to formulate programmes for infrastructure and content development and to enhance demand. All countries are now concerned with the rising tide of spam which congests networks and threatens their viability.

Efforts to increase broadband supply reveal several trends:

- Countries generally see competition leading supply and have passed legislation to encourage investment and private-sector participation and include technology neutrality as part of national broadband development strategies.
- Some countries focus on wireless broadband, which is seen not as replacing but rather as complementing fixed-line services. Wireless strategies are tied to the expansion of broadband to SMEs and the development of public access points.
- A few countries have focused special programmes on rural areas with measures such as demand aggregation, tax incentives and preferential financial treatment, to help encourage development.

In several countries, programmes to increase demand include financial incentives such as tax credits for individual broadband subscriptions. Efforts are also under way to develop content and services. Survey responses name healthcare as a leading sector for broadband applications, with several noting e-health initiatives and programmes to support home nursing and care for the elderly. Several countries also mentioned delivery of local e-government and public services and programmes aimed at SMEs. These include efforts to educate local authorities and small businesses about broadband and to encourage its implementation and use. Programmes in the field of education were cited less frequently.

In most countries, programmes related to e-government lead the development of ***electronic payment*** frameworks. Governments have incorporated electronic payment into a variety of functions, notably e-procurement practices, intra-government payments, automated calculation and payment of taxes and customs, and other transactions with the business sector. In this way, governments intend to provide a demonstration and improve awareness of electronic payment systems, and use them to drive

Box 8.2. **Recommendation of the OECD Council on Broadband Development**

In 2004 the Governing Council of the OECD issued its Recommendation on Broadband Development setting out the principles governing policy actions to encourage the development and uptake of broadband Internet technology. This measure recognises the role of broadband in the development, adoption and use of ICTs and its strategic importance to all countries because of its ability to accelerate the contribution of ICTs to economic growth in all sectors, enhance social and cultural development, and facilitate innovation.

The recommendation states that, in establishing or reviewing their policies to assist the development of broadband markets, promote efficient and innovative supply arrangements and encourage effective use of broadband services, countries should implement:

- Effective competition and continued liberalisation in infrastructure, network services and applications in the face of convergence across different technological platforms that supply broadband services and maintain transparent, non-discriminatory market policies.
- Policies that encourage investment in new technological infrastructure, content and applications in order to ensure wide take-up.
- Technologically neutral policy and regulation among competing and developing technologies to encourage interoperability, innovation and expand choice, taking into consideration that convergence of platforms and services requires the reassessment and consistency of regulatory frameworks.
- Recognition of the primary role of the private sector in the expansion of the coverage and use of broadband, with complementary government initiatives that take care not to distort the market.
- A culture of security to enhance trust in the use of ICT by business and consumers, effective enforcement of privacy and consumer protection, and, more generally, strengthened cross-border co-operation by all stakeholders to reach these goals.
- Both supply-based approaches to encourage infrastructure, content and service provision and demand-based approaches, such as demand aggregation in sparsely populated areas, as a virtuous cycle to promote take-up and effective use of broadband services.
- Policies that promote access on fair terms and at competitive prices to all communities, irrespective of location, in order to realise the full benefits of broadband services.
- Assessment of the market-driven availability and diffusion of broadband services in order to determine whether government initiatives are appropriate and how they should be structured.
- Regulatory frameworks that balance the interests of suppliers and users, in areas such as the protection of intellectual property rights, and digital rights management without disadvantaging innovative e-business models.
- Encouragement of research and development in the field of ICT for the development of broadband and enhancement of its economic, social and cultural effectiveness.

creation of the necessary rules, standards and technological tools. Among these are legislation and regulation to protect electronic payments and enhance trust and security, and a legal framework that addresses electronic transactions issues in the area of certification, authentication and electronic signatures. Governments are also working on handling electronic transactions within government or with the business community, including XML and other technical specifications. There are also initiatives of business groups, particularly in the financial sector, to implement features necessary for the future development of electronic payment. In a few cases, research is under way to expand electronic payments to technologies beyond the Internet, such as mobile phones, to accelerate development of payment technologies and systems.

Standards are defined and set at various levels within government, often in co-operation with other sectors or organisations:

- At the international level, most countries have established agencies that participate in and co-operate with regional and international bodies such as the International Organization for

Standards (ISO). Such agencies participate both in the negotiation of standards adopted by the international community and manage the adoption and implementation of these measures in their home countries. Standards activities include system specifications and interoperability, use of languages and classification of electronic products and processes.

- Nationally, many countries tie the development of ICT standards to their e-government efforts and online public services. These are meant to facilitate electronic communication between systems within government agencies as well as between government and private-sector systems for functions such as e-procurement, tax assessment, document filing and registration. Generally, governments work with business, academia and research institutions to define appropriate frameworks. A few specifically note efforts to implement IPv6 (version 6 of the Internet Protocol) at national level, and some report opting specifically for open-source approaches.
- A few countries rely overwhelmingly on private-sector initiatives to develop sector-wide standards and other norms and subsequently adopt standards developed by corporate and industry consortia at national level. These standards include structuring information management systems, business-to-business and business-to-government communications and e-commerce.

Promoting trust on line

Security of information systems and networks is an important area of focus for most countries. The most widespread activities are concentrated in key areas:

- Establishment of computer emergency response teams (CERTs) and the supporting computer incident/virus reporting systems were the single most frequently named action.
- Certification mechanisms are also widespread, whether in the form of authentication for businesses, online identification for individuals, or establishment of protocols for digital signatures.
- Several countries highlighted protection of public key infrastructure (PKI) as a priority, with co-ordinating and advisory bodies formed at the highest levels of government. Security aspects of spam are receiving increased attention.
- Several countries also cited adoption and publication of the OECD *Security Guidelines* as an important component of awareness and policy action, while others referred to the development of legislation dealing with cybercrime and awareness programmes for the public about online security.

Privacy protection is recognised as a priority, but there are several different patterns:

- Most often noted was the development of legislation regarding the privacy of individuals and the transfer and sharing of personal data; specifically mentioned was compliance with the European Union directive in this area.
- Other notable actions include the development of policy and technological mechanisms to provide protection through encryption, with efforts to strike a balance between privacy concerns and information needs for public security.

Consumer protection efforts are more concentrated in key areas:

- Foremost was the development of awareness campaigns to educate consumers about risks and measures to protect against fraudulent practices.
- Legal frameworks, of which some deal specifically with the question of e-commerce, while others are derivations or expansions of existing laws on consumer protection. Legislation sometimes addresses specific concerns, such as the protection of children, and is bolstered by codes of conduct to guide self-regulatory approaches and cross-border initiatives in some cases.

Special topics

Policies for small and medium-sized enterprises

Policies benefiting SMEs include both general ICT promotion programmes in which they receive special attention and specifically targeted programmes. Targeted programmes aim at enhancing ICT skills, trade promotion, broadband use, consumer protection, or involvement in government procurement. Programmes relating to SME e-business promotion and facilitation are also highlighted. Forward-looking recommendations for SME policies are outlined in Box 8.3; they largely aim at setting the ICT policy framework for businesses of all sizes.

- Most countries mentioned programmes that include information campaigns about the benefits of ICTs and e-business. These are typically developed in combination with, or are supported by, initiatives to provide training in ICT skills for workers and consultation and advisory services regarding e-business implementation and innovation strategies.

- A goal of SME-focused programmes has often been first to get enterprises on line, by introducing an intranet to streamline practices within firms and then to develop a Web site for external communications. Several countries noted programmes specifically aimed at development of a Web site, such as provision of basic Web hosting. Further steps have included encouragement of e-business, in some cases with targeted assistance and awards for excellence.

Box 8.3. **ICTs, e-business and SMEs: Key policy recommendations**

- Move beyond policies for basic connectivity and ICT readiness to facilitate more widespread uptake and use of complex ICT applications and e-business by small firms. Target programmes where there are demonstrated market failures (*e.g.* R&D incentives, frameworks for standards, skills formation, information and demonstrations on best practice and benefits from adoption and use of ICT), taking into account that commercial considerations and returns drive business adoption of new technologies.
- Encourage rollout of affordable quality broadband networks to underpin competitiveness and growth. Continue to liberalise network infrastructure and promote broadband competition and liberalisation in network services and applications. Where the need exists, and without pre-empting private initiative or inhibiting competition, complement private investment with public financial assistance to expand coverage for under-served groups and remote areas.
- Strengthen the infrastructure for trust, security (including spam and viruses), privacy and consumer protection. Intellectual property protection of ICT innovations and digital products is necessary to build confidence among SMEs if firms are to take full advantage of the potential of domestic and cross-border online activities.
- Expand, in conjunction with business and consumer groups, SMEs' use of low-cost online dispute resolution mechanisms. Strengthen cross-border co-operation between stakeholders and the development of rules with cross-border application.
- Develop and distribute digital content, including by expanding the commercial use of information about the public sector, education and health care. E – government services to enterprises should be used as a tool to improve efficiency of government interaction and operations with SMEs.
- Reduce ICT skill impediments to the growth of SMEs. Strengthen government and private roles to improve basic ICT skills and develop frameworks to encourage higher-level ICT and e-business skills formation (marketing, organisational, security, trust and management skills in addition to ICT skills) in conjunction with education institutions, business and individuals.

Source: "ICTs, e-business and SMEs", report prepared for the OECD SME Ministerial, held in Istanbul, June 2004.

- In terms of technology, several countries mentioned support for innovation and co-operation programmes between SMEs and R&D institutions. Programmes to help commercialise emerging technologies have also been created.
- Specific government activities to help SMEs also target creation of an enabling environment, including information security policy, mitigation of investment risk and liability from online activities, and related financial incentives such as grants and tax benefits. Finally, in several countries, public procurement policy favours SME technology suppliers.

Digital delivery

Specific digital delivery policies include those to encourage and enhance the online delivery of services. The focus in this section is on initiatives for healthcare and business services which are analysed in Chapter 5. Policies for digital delivery are also extensive in government services and education, as well as through support for the development of commercially viable digital content.

Healthcare has focused efforts in three key areas: patient care, administration and training:

- Most countries' development plans have specific efforts for more patient-centred approaches to healthcare and programmes aimed at increasing information flows to improve delivery efficiency. Tools include shared patient databases such as case files, diagnosis and prescriptions. Important supporting activities include electronic patient ID cards and regulations concerning the transfer of patient data to improve effectiveness of healthcare delivery.
- Initiatives to improve the administration of healthcare systems seek to improve information exchange between departments. This includes definition of interoperable system standards such as XML and protocols for online collaboration. Other functions, such as online delivery of health insurance certificates, making of appointments and procurement, are also included.
- Training and provision of information aim at both caregivers (supply) and patients (demand). On the caregiver side, there are information sites about disease management, training programmes and support for home healthcare workers. On the patient side, support for in-home care help can alleviate the burden on public healthcare institutions.
- Several countries mentioned that advanced, multifaceted programmes using ICT more comprehensively in healthcare are still in the planning stages.

Digital delivery of ***business services*** is very heterogeneous. Policy priority areas and features vary considerably across countries and the definitions of "business services" and "digital delivery" vary. As a result, policies are described in terms of their domain of activity rather than specific programmes.

- In the area of legislation and regulation, activities include the creation of guiding frameworks for distance marketing and financial services offered by businesses, in particular with reference to EU directives. Management of digital rights is also of interest for business services suppliers.
- Several countries actively provide online business support services to business, notably for SMEs, including financial and advisory activities to them.
- A third common set of features is the exchange of administrative information, frequently channelled through portal sites, between business and government to improve the efficiency of government service provision and lighten the administrative burden on business. Programmes include business registration, delivery and filing of forms and documents, and reporting of industrial accidents and/or projects with a public interest component (*e.g.* construction projects).

Digital delivery of ***government services*** is closely linked to e-government efforts and has some common features and initiatives:

- A defined action plan in many cases drives digital delivery of government services. This includes delivery of government services as a stimulant to development of digital delivery in regional administrations and other economic sectors. Frequently, the action plan also establishes R&D centres to support future activities.

- Digital delivery of government services to citizens tends to centre on opt-in subscription approaches, with mailboxes for the delivery of electronic information and documents, typically accompanied by notification of the arrival of new materials.

Policy assessment and evaluation

Most OECD countries conduct some form of assessment and evaluation of their ICT policies and programmes. While some countries listed specific assessment and evaluation programmes, others noted that these were an intrinsic part of government initiatives and projects, so that programmes whose sole purpose is assessment and evaluation have not been established. Many countries cite international benchmarks as part of their assessment methodology. Further, most countries report looking at the results of ICT policies within the broader context of evaluating economic growth and employment.

Country responses indicate that evaluation approaches are distributed fairly evenly among those that favour qualitative analysis, those that look more closely at quantitative analysis, and those that use both. A handful of countries reported looking at a broad range of indicators and other factors, but most focused on particular aspects of ICT development and use. For individual countries, the focus is on one or more of the following categories:

- The results of applications of ICTs in specific sectors, such as impacts on agricultural or industrial production or changes in financial and other services sectors.
- E-business, in terms of the investment in and value resulting from e-business development and skills training, adoption by SMEs, the contribution to and commercialisation of innovations and the growth in electronic and traditional commerce.
- E-government, in terms of improved government service, organisation, communication and efficiency. Additionally, countries tend to look at Web site organisation, user interfaces and the experience of individuals and firms when using online government information and services.
- The general experience of users with the development of the information society, including perception of services delivered on line and user confidence, skills and know-how related to ICT diffusion and use among firms and individuals.

Where assessment results are available, countries have noted growth in both diffusion and demand for networked services and positive impacts from their use. This pattern extends across the range of available information technologies, although in many countries there has been particular focus on the diffusion and uptake of high-speed broadband services. In terms of services provided over networked systems, governments have reported increased efficiency in public administration through the use of electronic processes and shared information resources where they have been instituted. Similar efficiency gains have been noted in government-to-business and business-to-business interactions. While few countries identified ICTs alone as an engine of economic growth, they noted the positive impacts of ICTs combined with enhanced skills and organisational change. Together with the growing role of economic development bodies in formulating ICT policy, this shows increased recognition of the contribution ICTs make to economic development.

Conclusion

In the two years since the *Information Technology Outlook* 2002 national ICT strategies have shown considerable continuity while integrating ICT policies more closely into economic development strategies. Policies addressing information technology are increasingly seen as part of an overall approach to growth and employment. This is reflected in the organisational structure of policy-making bodies, where links between economic development and technology agencies have been strengthened.

On the supply side, there has been an increased focus on innovation, particularly through ICT research and development programmes. On the demand and use side, technology diffusion is of continuing importance, with increased attention focused on developing ICT user skills and specialist skills. There is greater emphasis on providing government services on line, with governments seeking to develop streamlined, user-centred approaches that also serve demonstration purposes. Other priority diffusion policy areas include raising the quality of Internet services *via* broadband adoption and use and development of digital content. At the same time, former areas of emphasis, such as technology awareness and diffusion to SMEs have in many cases been absorbed into broader policies. Finally, enhancing trust online continues to be an area of focus, particularly in terms of system and information security. As IT policies and programmes are implemented, there is an increasing focus on assessment and evaluation, which will help inform government measures and improve their effectiveness in future. The major challenge is to develop and deliver policies that maintain and enhance the dynamism of the ICT sector and the impacts of ICT use across the economy within the broader framework of general economic strategies for growth and employment.

Annex A

ICT AND INTERNET FIRMS

Introduction

This annex explores the experience and performance of information and communication technology (ICT) and Internet firms. It examines the top 250 ICT firms (in all ICT sectors, see Box A.1) and the top 10 firms in each of the six major ICT industry sectors: communication equipment and systems, electronics and components, information technology (IT) equipment and systems, IT services, software and telecommunications. The final section examines the top 50 Internet firms.

The leading ICT firms have experienced a sharp downturn over the past few years and are seeing the early stages of recovery. Fortunes have been mixed, with some sectors performing better than others and some firms prospering while others have suffered. Overall, however, revenues of the largest ICT firms have held up well through the period. Although profitability has slipped, there are signs of an upturn. In general, services firms and IT equipment and systems firms have grown, while communications equipment firms have faced strong challenges. At national level, the rankings of Japanese electronics conglomerates appear to have slipped in terms of revenue, while equipment producers in Chinese Taipei and Hong Kong (China) have strengthened markedly. There are also signs of some consolidation at the top, with an increasing share of top 250 revenues going to the largest firms.

Box A.1. Identifying the top ICT firms

A variety of sources were used to identify the top 250 ICT firms. They include *Business Week*'s Information Technology 100, various Forbes company listings and a number of other Internet listings (including Wall Street Research Network, Yahoo!Finance and MultexInvestor). Once candidates for a top 250 listing were identified, details were sourced from company annual reports, Securities Exchange Commission 10K and 20F forms, and from Yahoo!Finance and MultexInvestor. Details were also sourced from the Forbes listing of the largest private firms or from company Web sites.

Each of the top 250 firms is classified by ICT industry sector – communication equipment and systems, electronics and components, IT equipment and systems, IT services, software and telecommunication services. Because many firms operate in more than one market segment, classification is far from straightforward. Where possible, firms are classified according to their official industry classification (primary SIC). Where that is not possible, they are classified according to their main ICT-related activity, on the basis of revenue derived from that activity. In some cases a firm's primary SIC does not fully reflect its activities (*e.g.* IBM, which now derives a majority of its revenues from services and software). However, primary SIC classifications are followed for consistency. It should also be noted that IBM falls under the category IT equipment *and* systems. Where conglomerates have substantial ICT-related activities they are classified according to their major activities – principally electronics and components (*e.g.* Siemens). Others with minority ICT-related activities (*e.g.* Hutchison Whampoa) are excluded. This necessarily involves a degree of judgement. Nevertheless, a consistent and workable framework has been established.

The top 250 ICT firms are ranked by total revenue in the most recent financial year ending during 2003, or on the basis of the most recent four quarters to October 2003, with historical data drawn from company annual reports. In each case, company name, country, industry, revenue, employment, R&D expenditure, net income and market capitalisation are recorded. Income data are reported using US generally accepted accounting principles (GAAP) wherever possible. The country base is the place of registration for taxation purposes.

Similarly, revenues of the top 50 Internet firms have held up well. They continued to grow in nominal terms in 2002 and 2003, and combined incomes returned towards the breakeven point in 2003 after massive losses in 2001 and 2002.

Top 250 ICT firms

In 2003, the top 250 ICT firms (tracking the same panel of 250 firms over time) earned total revenue of USD 2 420 billion, some USD 50 billion higher than 2000 revenues (Figure A.1).[1] Average revenue was almost USD 9.7 billion. Employment numbers are incomplete, but it is clear that they employ at least 9.5 million people worldwide, around 60% of total ICT sector employment. R&D information is not available for all firms, but those that report R&D expenditure spent a total of around USD 125 billion, or 6.8% of revenue, on R&D during 2002.

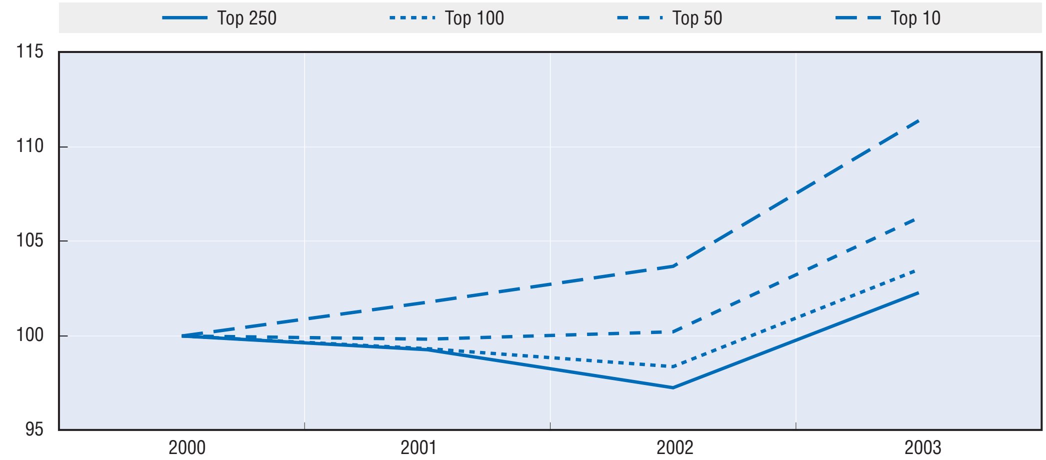
The top 250 firms' revenues have been remarkably stable for the last four years, dropping from a high in 2000 of USD 2 368 billion, to a low in 2002 of USD 2 302 billion. Preliminary data for 2003 suggest a recovery to around USD 2 420 billion. However, at 9.4 million, employment was some 480 000 lower in 2002 than in 2000, down by around 2.5%. Average employment among the 244 firms for which data are available fell from 40 800 in 2000 to a little less than 39 000 in 2002.

While total revenue has been relatively stable over the last four years, net income fell dramatically during 2001 and 2002. Data are incomplete, with net income for seven firms unrecorded (seven of the ICT top 250 are private firms). For the remaining 243 firms, net income declined from a USD 198 billion net profit in 2000 to a net loss of USD 205 billion in 2002. An average firm profit of around USD 814 million in 2000 turned into an average loss of some USD 845 million in 2002. Preliminary data for 2003 suggest that profitability has returned, with an aggregate net profit of USD 32 billion recorded for the 228 firms to have reported. However, many firms are significantly revising their reported results.

The top 100 ICT firms accounted for around 87% of the top 250 revenues in 2003 (USD 2 112 billion), the top 50 for 71% (USD 1 717 billion) and the top 10 for 29% (USD 699 billion). In all cases the shares were marginally higher than in 2000, suggesting some increased concentration. Shares of employment were similar, with the top 100 accounting for 85% (8 million) of top 250 employment in 2002, the top 50 for 65% (6 million) and the top 10 for 27% (2.6 million). In 2003, the top 100 ICT firms had an average USD 21 billion in revenue, the top 50 USD 34 billion and the top 10 USD 70 billion. The top 100 employed an average of 80 000, the top 50 employed an average of 122 000 and the top 10 an average of 257 000. Among firms reporting R&D expenditure, those in the top 100 spent an average of 5% of 2002 revenue on R&D, those in the top 50 an average of 4.9% and those in the top 10 an average of 4.5%. Smaller firms have been spending a somewhat higher share of revenue on R&D, but this may be due to specialisation in some sectors and the diversification of large conglomerate operations in others.

Figure A.1. **Top ICT firms' revenue**

Index 2000 = 100 current USD



Note: 2003 revenues based on financial year reported in 2003 or most recent four quarters.
Source: OECD, compiled from annual reports, SEC filings and market financials.

The larger firms at the top of the revenue rankings in 2003 performed somewhat better than those lower in the rankings. Total revenue of the top 250 ICT firms in 2003 were 0.75% higher than in 2000, whereas top 100 revenues were 1.1% a year higher, top 50 revenues 2.0% a year higher and top 10 revenues 3.7% a year higher.

Top 250 ICT *firms by country and region*

In 2003, the top 250 ICT firms reported 25 countries as bases (*i.e.* the country in which the firm is registered) (Table A.1). However, most of the top 250 firms are multinationals and earn a significant share of their revenues outside their country of registration.[2] No less than 139 of the top 250 firms (56%) were based in the United States, 39 (16%) in Japan and 11 (4.4%) in Chinese Taipei. No other country had more than ten. Nine were based in France, eight in the United Kingdom, seven in Canada, five in Germany, four in Korea, three in China, the Netherlands, Sweden and Switzerland, two in Bermuda, India and Singapore and one in Australia, the Cayman Islands, Denmark, Finland, Israel, Italy, Mexico, Norway, Portugal and Spain. There are some signs of a shift towards Asia, with 11 fewer US-based firms in the 2003 top 250 than in the 2001 cohort, and an additional five firms from Chinese Taipei, three from China, two from India and one each from Korea and Singapore.

Firms based in the United States accounted for USD 940 billion of top 250 revenue in 2003 (41% of the OECD total), and almost 40% of total OECD firm employment and 46% of the overall net loss of OECD firms (USD 99 billion). Firms based in Japan accounted for 28.5% of OECD total top 250 revenues in 2003 (USD 656 billion), 27% of total OECD employment and close to 10% of the overall net loss. Firms based in the European Union made up 23% of OECD firm revenues and almost 26% of total OECD firm employment for the top firms suggesting that European firms are somewhat more labour-intensive. Firms based in the United Kingdom accounted for 4% of revenue (USD 101 billion), employed 346 000 and realised a net loss of USD 45 billion. Firms based in France accounted for 4% of top 250 revenue (USD 99 billion), 5.3% of employment and realised a net loss of USD 25.5 billion. Firms based in Canada accounted for 1.7% of top 250 revenue (USD 41 billion), employed 193 000 and realised a net loss of USD 4.4 billion.

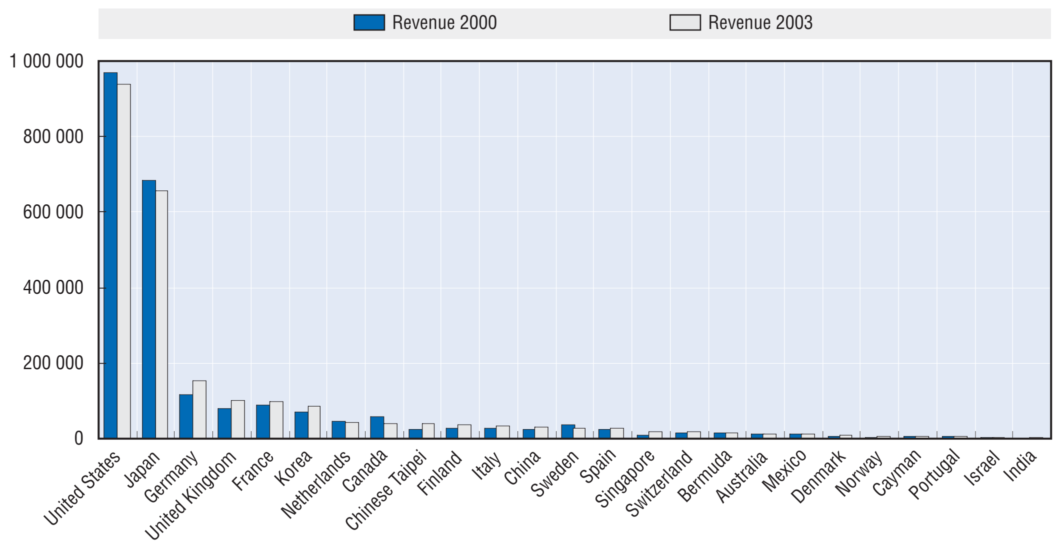
Table A.1. **Country/economy representations in top 250 ICT firms**
By country/economy of registration, USD millions and percentage

	Firms	Revenue 2000	Revenue 2003	Employees 2000	Employees 2002	Net income 2000	Net income 2002	Growth (revenue)
Australia	1	11 246	13 242	50 761	44 977	1 750	2 182	5.6
Bermuda	2	15 120	16 357	84 300	88 000	797	–15	2.7
Canada	7	57 861	41 073	253 747	193 166	693	–4 396	–10.8
Cayman	1	6 448	6 486	42 800	45 779	310	153	0.2
China	3	25 020	29 556	170 965	191 612	5 627	7 083	5.7
Denmark	1	5 787	7 957	19 946	22 263	1 143	576	11.2
Finland	1	27 868	37 670	58 708	57 716	3 613	3 190	10.6
France	9	88 423	98 636	542 884	499 661	4 839	–25 551	3.7
Germany	5	116 094	153 213	655 717	751 580	13 783	–21 212	9.7
India	2	706	1 699	18 000	18 000	140	348	34.0
Israel	1	2 061	1 854	8 697	6 899	66	–164	–3.5
Italy	1	27 516	32 983	107 171	101 713	3 231	781	6.2
Japan	39	684 249	656 382	2 465 087	2 366 170	7 505	–20 603	–1.4
Korea	4	70 438	86 657	283 495	280 763	6 753	8 483	7.2
Mexico	1	11 906	10 786	72 320	63 775	2 916	2 026	–3.2
Netherlands	3	46 812	42 492	266 933	216 878	15 863	–17 473	–3.2
Norway	1	3 701	7 464	24 950	23 000	–123	43	26.3
Portugal	1	4 721	5 253	18 500	23 100	495	369	3.6
Singapore	2	10 066	19 180	95 000	115 000	2 805	1 092	24.0
Spain	1	24 100	26 739	145 730	161 029	725	1 800	3.5
Sweden	3	37 126	29 121	137 169	116 543	3 347	–2 828	–7.8
Switzerland	3	16 798	17 196	68 508	68 044	3 350	1 032	0.8
Chinese Taipei	11	24 899	40 002	73 022	96 128	3 753	1 856	17.1
United Kingdom	8	80 938	101 419	397 967	345 554	7 670	–44 991	7.8
United States	139	967 950	937 910	3 841 756	3 525 113	106 675	–99 184	–1.0
OECD	228	2 283 535	2 306 194	9 411 349	8 861 045	184 229	–215 757	0.3
EU	33	459 385	535 484	2 350 725	2 296 037	54 710	–105 339	5.2
Total	250	2 367 857	2 421 327	9 904 133	9 422 463	197 726	–205 404	0.7

Note: 2003 revenues based on financial year reported in 2003 or most recent four quarters.
Source: OECD, compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/742388060812

Figure A.2. **Top 250 ICT firms revenue by country/economy of registration**
USD millions



Note: 2003 revenues based on financial year reported in 2003 or most recent four quarters.
Source: OECD, compiled from annual reports, SEC filings and market financials.

Firm performance across countries has been mixed in recent years. Top 250 firm revenues declined in seven countries between 2000 and 2003 and increased in the other 18 (Figure A.2). The seven top 250 firms based in Canada experienced an 11% revenue decline over the three years to 2003, three firms based in Sweden experienced an 8% decline in revenues and those based in the Netherlands, Mexico and Israel experienced declines of around 3.5%. In contrast, firms based in India had a 34% a year increase in revenues between 2000 and 2003, those based in Norway a 26% increase, those based in Singapore a 24% increase and those based in Chinese Taipei a 17% increase. Obviously, where there are few firms, performance is firm-based rather than market-based.

Net income was negative for firms based in ten countries in 2002, most notably the United States, the United Kingdom, France, Germany, Japan and the Netherlands; it was positive in the other 15, most notably in Korea and China. R&D expenditures by firms based in Sweden, Finland, the Netherlands and Germany accounted for a somewhat larger share of revenue than the average across the top 250 firms worldwide. This probably reflects the sectoral composition of firms, different levels of specialisation and their roles in global production systems.

Top 250 ICT firms by sector

Since the top 250 list was first compiled in 2001, there has been some decline in the number of electronics, equipment and systems producers and an increase in the number of services providers (Table A.2). By sector, 82 (33%) of the top 250 firms in the current compilation were electronics and components manufacturers, 47 (19%) were IT equipment and systems producers, 38 (15%) were telecommunication services providers and a further 38 were IT services providers, 25 (10%) were software publishers and 20 (8%) were communication equipment and systems producers.

Electronics and components firms and telecommunication services firms accounted for the largest shares of top 250 revenues in 2003, at around USD 830 billion and USD 760 billion, respectively (Figure A.3). IT equipment firms earned USD 440 billion in revenues, IT services and communications equipment firms earned USD 145 billion and USD 160 billion, respectively, and software firms accounted for just USD 83 billion. Electronics and components firms accounted for around 40% of total top 250 firms employment in 2002, telecommunications firms for 28%, IT equipment and systems firms for 15%, IT services firms for 9%, communications equipment firms for 6% and software firms for 3%.

In 2003, average revenue was highest among telecommunication services firms in the top 250, at USD 20 billion. Electronics and components firms averaged revenues of USD 10 billion, IT equipment firms USD 9.4 billion and communications equipment firms USD 8 billion. Software and services firms tend to be smaller, averaging revenues of USD 3.3 billion and USD 3.8 billion, respectively.

In recent years, revenue growth was strongest for the software, IT services and telecommunications firms, all of which increased revenues by 5% a year or more between 2000 and 2003 (Table A.2 and Figure A.4). IT equipment and

Table A.2. **Top 250 ICT firms by sector**
USD millions and percentage

Sector	Revenue 2000 USD millions	Revenue 2003* USD millions	Growth %	Employees 2000	Employees 2002	Growth %	Net income 2000 USD millions	Net income 2002 USD millions	R&D share of sales %
Communications equipment	231 625	159 350	−11.7	866 740	564 138	−19.3	9 174	−39 710	15.8
Electronics and components	845 043	830 685	−0.6	3 954 999	3 780 118	−2.2	63 574	−21 658	7.3
IT equipment	437 396	441 256	0.3	1 479 904	1 402 105	−2.7	22 180	−6 429	6.4
Services	123 420	143 533	5.2	767 759	831 227	4.1	9 746	5 384	3.0
Software	70 634	82 897	5.5	243 293	244 484	0.2	15 677	3 710	15.1
Telecommunications	659 740	763 606	5.0	2 591 438	2 600 391	0.2	77 375	−146 701	1.7
Total	2 367 857	2 421 327	0.7	9 904 133	9 422 463	−2.5	197 726	−205 404	6.8

Note: 2003 revenues based on financial year reported in 2003 or most recent four quarters.
Source: OECD, compiled from annual reports, SEC filings and market financials.

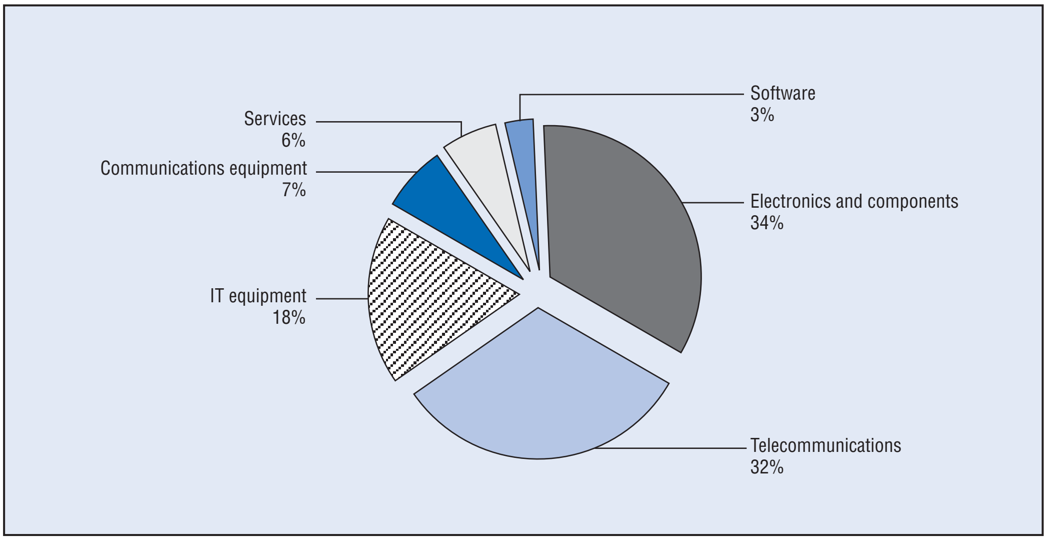
StatLink: http://dx.doi.org/10.1787/430554363034

systems firms have seen revenues recover to 2000 levels, after declining by USD 25 billion. Revenues declined in the other sectors. Communications equipment firms' revenues fell by 12% a year between 2000 and 2003, while electronics and components firms' revenues fell marginally. There are differences in performance between specialist semiconductor firms (*e.g.* Intel) and multi-product electronics firms (*e.g.* Mitsubishi), but there are too few specialised semiconductor firms in the top 250 for detailed disaggregated analysis.

While revenues increased, firms in the telecommunications sector experienced substantial net losses of USD 147 billion in 2002 (Figure A.5). The communications equipment sector realised net losses of USD 40 billion and the electronics and components sector realised net losses of USD 22 billion. The IT equipment and systems sector also realised an aggregate loss of USD 6.4 billion. In contrast, the IT software and services sectors realised net profits in 2002 of USD 3.7 billion and USD 5.4 billion, respectively.

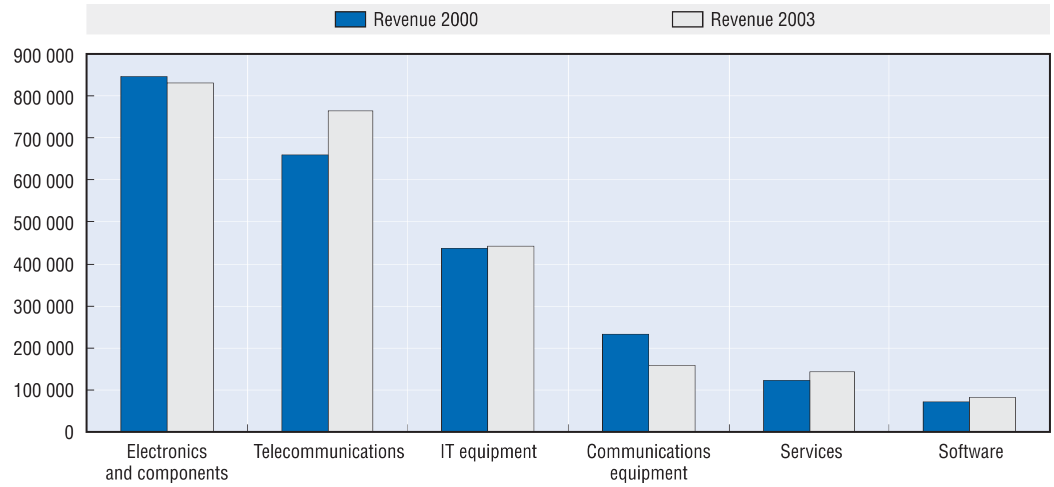
Employment growth over the period 2000-02 was strongest among the IT services firms in the top 250, with a 4% a year increase. Software and telecommunications sector employment was steady over the period, while other sectors shed jobs. The biggest fall in employment occurred among communications equipment firms, which saw employment fall by almost 19% a year.

Figure A.3. **Top 250 ICT firms revenue shares by sector, 2003**
Percentages



Note: 2003 revenues based on financial year reported in 2003 or most recent four quarters.
Source: OECD, compiled from annual reports, SEC filings and market financials.

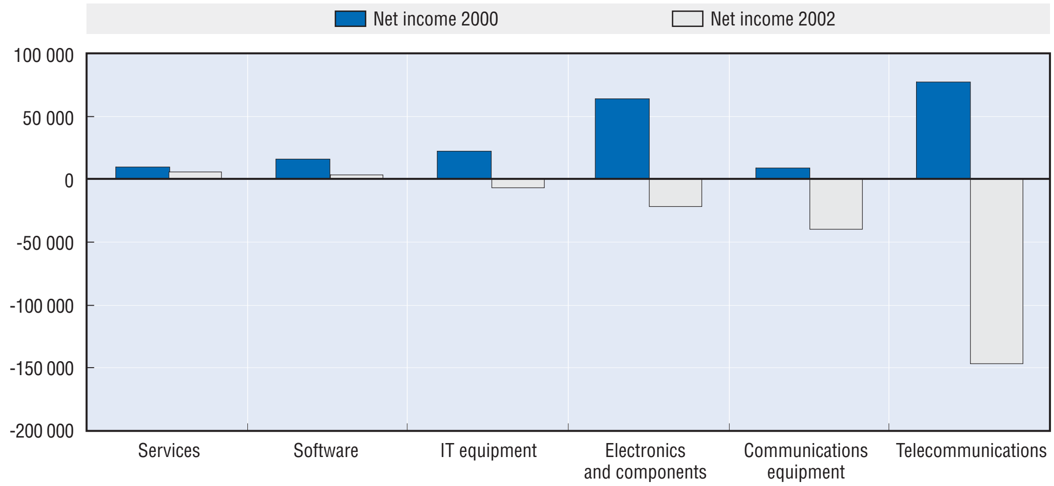
Figure A.4. **Top 250 ICT firms revenue by sector**
USD millions



Note: 2003 revenues based on financial year reported in 2003 or most recent four quarters.
Source: OECD, compiled from annual reports, SEC filings and market financials.

R&D data are incomplete, but it is clear that the largest share of top 250 ICT firm R&D is done by electronics and components firms (44% of the top 250 total), IT equipment and systems firms (20%) and communications equipment firms (20%). However, R&D expenditures by software and telecommunications services firms increased more rapidly over the period 2000-02 – by 4.6% and 2.4% a year, respectively. In 2002, those communication equipment sector firms in the top 250 reporting R&D expenditure spent almost 16% of revenues on R&D, software firms spent 15%, electronics and components firms 7.3%, IT equipment and systems firms 6.4%, IT services firms 3.0% and telecommunications services firms less than 2%. R&D expenditure shares were bolstered to some extent by cyclically lower revenues, most notably among communications equipment and systems firms. Nevertheless, high levels of technological innovation continue to characterise the ICT producing sector.

Figure A.5. **Top 250 ICT net income by sector**
USD millions



Source: OECD, compiled from annual reports, SEC filings and market financials.

Sectoral variations in terms of average profits reflect the impact of the recent downturn and valuation write-downs in telecommunications. While data are incomplete, telecommunications services firms averaged a net loss of USD 3.9 billion and communications equipment firms averaged a net loss of USD 2 billion in 2002. Electronics and component firms averaged a net loss of around USD 260 million, and IT equipment firms averaged a net loss of around USD 150 million. In contrast, other sectors realised average net profits – USD 154 million among IT services firms and USD 148 million among software firms. Preliminary data for 2003 indicate a recovery of profitability, albeit unevenly, with top 250 communication equipment manufacturers realising an overall net loss of around USD 200 million and all other sector realising net profits with strong gains in profitability in software and, to a lesser extent, in telecommunication and IT services.

However, sectoral differences in profitability during the downturn and recovery do not necessarily indicate an underlying shift from hardware to services, but may reflect relative capital and labour intensity and relative levels of competition, with more scope to control costs quickly in labour-intensive industries (*e.g.* IT services) than in capital-intensive ones (*e.g.* electronics equipment manufacturing and semiconductors). The main feature of the last five years has been overly enthusiastic investment in communications infrastructures and a subsequent collapse, driven as much by regulatory change and industry inexperience as by market forces. The effects have been compounded by a synchronisation of investment due to the perceived Y2K "bug" and the ready availability and low cost of capital for ICT firms owing to historically high dot.com era stock market valuations.

Individual firm performance

There have been around 35 entries into and exits from the top 250 ICT firms since the list was compiled in 2001 (OECD, 2002). Some of those exiting have not reported recent results (*e.g.* MCI/Worldcom) and others have been taken over (*e.g.* Compaq by Hewlett Packard, C-MAC Industries by Solectron, SCI Systems by Sanmina, etc.). Most, however, have simply dropped below the revenue cut line (*e.g.* ACT Manufacturing, ASM International, Ciena, Cirrus Logic, Comark, ECI Telecom, Iomega, Kemet, Kingston Technology, etc.). New entrants are the result of forces such as deregulation and privatisation in telecommunications, spin-offs and organic growth. Chief among new entrants are telecommunications firms (*e.g.* China Mobile, China Unicom, Singtel, Tele2 and Telenor). Spin-offs include Benq and Infineon Technologies. Rapidly growing new entrants include Dassault Systemes, Elite Computer Systems, GTSI, Infogrames/Atari, Infosys, Level 3 Communications, Lite-on Technology, Nvidia, Trend Micro, UTStarcom, Verisign and Wipro.

Across the top 250 ICT firms, 129 had increasing revenues between 2000 and 2003, and 121 suffered declines. Nine of the top 250 firms saw growth in excess of 50% a year (Acer, Nvidia, EliteGroup, Trend Micro, Platinum Equity, Vodafone, Infosys, Level 3 Communications and UTStarcom). Of the 20 fastest-growing ICT firms in the top 250, ten were based in the United States and five in Chinese Taipei, one was in the top 50 (Vodafone) and four were in the top 100. Nine of the 20 fastest-growing firms were software or services firms and 11 were hardware manufacturers. Interestingly, four of the 20 fastest-growing firms were privately owned, although there were only seven privately owned firms in the top 250, of which only one suffered declining revenues over the period. At the other end of the scale, 19 of the top 250 ICT firms experienced a decline in revenues of more than 20% a year between 2000 and 2003. Of these, 14 were based in the United States, one was in the top 50 (Ericsson) and four were in the top 100, and 18 were hardware manufacturers.

Top 50 ICT firms

A listing of the top 50 ICT firms (Table A.3) suggests a relatively concentrated industry, as they accounted for 71% of the top 250 firms' revenue in 2003. Top 50 revenues were relatively stable over the period 2000-03, increasing by 2% from USD 1 617 billion to USD 1 718 billion. Data on employment are incomplete, but there appears to be a decline of around 250 000 to some 6.1 million over the period 2000-02. In 2003, the top 50 ICT firms averaged revenues of USD 34 billion and employed an average of 121 000. In 2000, they earned a total USD 125 billion in net income, but had a net loss of USD 95 billion in 2002. On average, they earned USD 2.5 billion in 2000 and lost USD 1.9 billion in 2002. Preliminary data suggest a return to profitability in 2003, with total net income reaching USD 45 billion and averaging USD 1 billion. Average R&D expenditures by the top 50 firms for which data are available were just over USD 2 billion. In 2003, 18 of the top 50 ICT firms were based in the United States, 13 in Japan, three in Korea, two in France, Germany and the United Kingdom, and one in Australia, Bermuda, Canada, China, Finland, Italy, Netherlands, Singapore, Spain and Sweden.

In terms of 2003 revenue, the largest firms in the top 50 were NTT, IBM, Siemens, Hewlett-Packard (including Compaq), Verizon, Hitachi, Sony, Matsushita Electric, France Telecom and Deutsche Telekom. At the other end of the spectrum are the seven firms that earned revenues of less than USD 15 billion in 2003 (Korea Telecom, Telstra, Flextronics, Accenture, Ricoh, Ericsson and BCE). In terms of employees, the rankings are similar, with eight firms (Siemens, IBM, Hitachi, Matsushita, Deutsche Telekom, Verizon, NTT and France Telecom) employing more than 200 000 in 2002. In 2002, 28 of the top 50 ICT firms employed fewer than 100 000.

Table A.3. **Top 50 ICT firms**

Current USD millions and number employed

Company	Country	Industry	Revenue 2000	Revenue 2003	Employees 2000	Employees 2002	R&D 2000	R&D 2002	Net income 2000	Net income 2003	Market cap 2003
NTT	Japan	Telecoms	92 679	91 026	224 000	213 062	3 178	3 118	–603	1 945	31 747
IBM	USA	IT equipment	85 089	86 902	316 303	315 889	5 084	4 750	8 093	5 892	141 805
Siemens	Germany	Electronics	64 405	85 894	419 000	426 000	4 425	5 490	6 528	2 573	53 873
Hewlett Packard	USA	IT equipment	48 870	71 256	158 600	141 000	2 627	3 312	3 697	2 067	59 228
Verizon	USA	Telecoms	64 707	67 734	260 000	245 000	. .	. .	11 797	9 874	99 159
Hitachi	Japan	Electronics	72 725	67 157	323 827	306 989	3 930	3 307	154	. .	12 226
Sony	Japan	Electronics	62 046	63 353	189 700	168 000	3 660	3 455	1 131	921	33 785
Matsushita	Japan	Electronics	68 711	62 744	314 267	291 232	4 881	4 514	874	–155	21 745
France Telecom	France	Telecoms	30 480	52 048	188 866	211 554	530	680	3 313	– 21 742	24 140
Deutsche Telekom	Germany	Telecoms	37 559	50 528	170 000	255 896	642	849	5 437	. .	47 260
Vodafone	UK	Telecoms	11 929	47 962	29 465	67 178	109	164	838	– 15 504	122 931
Toshiba	Japan	IT equipment	53 349	47 944	190 870	176 398	3 103	2 601	–305	148	13 679
Samsung	Korea	Electronics	34 573	47 613	173 000	173 000	1 332	2 500	4 768	5 946	40 404
SBC	USA	Telecoms	51 374	42 310	220 090	175 980	. .	. .	7 800	7 844	67 703
NEC	Japan	IT equipment	48 343	41 090	154 787	141 909	2 924	2 661	97	–208	12 080
Fujitsu	Japan	IT equipment	48 484	38 480	188 053	170 111	3 722	2 790	397	–1 017	9 226
Nokia	Finland	Comms equip	27 868	37 670	58 708	57 716	2 371	2 879	3 613	4 469	74 012
AT&T	USA	Telecoms	46 850	36 480	84 800	71 000	313	254	4 669	1 830	18 297
Dell Computer	USA	IT equipment	25 265	35 404	40 000	39 100	374	452	1 666	2 122	82 350
Telecom Italia	Italy	Telecoms	27 516	32 983	107 171	101 713	247	124	3 231	. .	45 812
Microsoft	USA	Software	22 956	32 187	47 600	50 500	3 772	4 307	9 421	9 993	285 413
Mitsubishi	Japan	Electronics	35 021	30 848	116 588	116 192	1 615	1 632	230	–94	. .
BT	UK	Telecoms	28 356	30 460	132 000	108 600	552	540	2 111	6 724	22 568
Philips	Netherlands	Electronics	34 736	29 947	219 000	170 000	2 553	2 871	8 786	–2 498	21 471
Intel	USA	Electronics	33 726	28 527	86 100	78 700	3 897	4 034	10 535	4 560	177 332
Telefonica	Spain	Telecoms	24 100	26 739	145 730	161 029	. .	. .	725	. .	47 180
Motorola	USA	Comms equip	30 931	26 293	121 000	97 000	4 440	3 754	817	578	23 947
Canon	Japan	Electronics	25 020	25 760	86 673	97 802	1 805	1 864	1 244	2 044	42 202
Sprint	USA	Telecoms	23 145	25 604	84 100	72 200	. .	. .	–732	3 350	. .
KDDI	Japan	Telecoms	14 159	23 591	7 361	9 300	73	67	–99	486	13 063
Bell South	USA	Telecoms	26 151	22 399	103 900	77 000	. .	. .	4 220	3 126	41 612
EDS	USA	Services	18 856	21 731	122 000	137 000	24	0	1 143	458	10 608
Sanyo Electric	Japan	Electronics	18 005	19 856	83 519	80 500	928	853	201	116	. .
Cisco Systems	USA	Comms equip	18 928	18 878	38 000	36 000	2 704	3 448	2 668	3 578	133 215
Alcatel	France	Comms equip	28 815	18 694	131 598	75 940	2 610	2 100	–521	– 4 258	13 203
LG Electronics	Korea	Electronics	20 085	18 080	55 000	55 000	312	551	356	297	. .
3M	USA	Electronics	16 699	17 179	75 026	68 774	1 101	1 066	1 782	2 177	56 129
Emerson	USA	Electronics	15 545	17 042	123 400	111 500	594	530	1 422	1 278	22 757
Sharp	Japan	Electronics	17 210	16 834	49 748	46 518	1 363	1 154	261	274	11 433
Tech Data	USA	Services	16 992	15 739	10 500	8 000	. .	. .	128	– 200	1 900
Xerox	USA	Electronics	18 751	15 716	91 500	67 800	1 064	917	–273	139	7 544
China Mobile	China	Telecoms	13 581	15 527	38 345	59 633	. .	. .	2 915	3 954	40 608
Qwest	USA	Telecoms	16 610	15 487	67 000	50 788	. .	. .	–81	. .	5 984
BCE	Canada	Telecoms	12 597	14 987	74 910	66 266	. .	. .	3 200	1 417	17 993
Ericsson	Sweden	Comms equip	29 866	14 971	105 129	85 198	4 587	4 424	2 300	–2 670	23 844
Ricoh	Japan	Electronics	12 870	14 732	67 300	74 600	591	644	373	615	13 997
Accenture	Bermuda	Services	11 331	13 397	71 300	75 000	252	235	2 464	498	19 691
Flextronics	Singapore	Electronics	6 959	13 379	75 000	95 000	. .	. .	159	–84	6 585
Telstra	Australia	Telecoms	11 246	13 242	50 761	44 977	29	28	1 750	2 216	31 250
Korea Telecom	Korea	Telecoms	10 686	13 104	52 533	48 668	. .	. .	789	. .	. .

Note: 2003 revenues based on financial year reported in 2003 or most recent four quarters.
Source: OECD, compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/578212753614

While a number of ICT firms have been cutting R&D budgets to control costs during difficult times, others see the need to maintain and even increase expenditure in order to innovate in the years ahead. Overall, 22 of the top 50 ICT firms reduced R&D expenditure between 2000 and 2002, and just nine significantly increased it. R&D expenditure data are not available for 11 of the top 50 ICT firms. Of the others, six spent more than USD 4 billion on R&D in 2002 (Siemens, IBM, Matsushita, Ericsson, Microsoft and Intel). Across the top 50, firms reporting R&D expenditure spent an average of 5% of 2002 revenues on R&D. R&D intensity varied considerably. A collapse in sales saw Ericsson investing close to 30% of revenue in R&D in 2002, while six other top 50 firms invested between 10% and 20% (Cisco Systems 18%, Microsoft 15%, Intel 15%, Motorola 14%, Alcatel 11% and Nokia 10%).

Profitability was also mixed. In 2002, 18 of the top 50 ICT firms made a net profit of USD 1 billion or more, with five firms making more than USD 4 billion (Microsoft USD 7.8 billion, Samsung USD 5.9 billion, SBC Communications USD 5.7 billion, China Mobile USD 4.5 billion and Verizon USD 4 billion). No fewer than 19 of the top 50 reported a net loss for 2002, with four (all telecommunications services firms) reporting losses of more than USD 20 billion (France Telecom, Deutsche Telekom, Vodafone and Qwest). Preliminary results show that 22 of the top 50 made a net profit of USD 1 billion or more in 2003.

Market capitalisation has been affected by the dot.com phenomenon, with steep declines in the market valuation of many of the leading ICT firms. Data are incomplete, but recorded ICT top 50 market capitalisation fell some 11% a year between 2001 and 2003. Market capitalisation data are unavailable for seven of the top 50, but 13 of the rest increased their market valuation and 30 lost value. Among those experiencing an increase were: Telecom Italia, Accenture, 3M, Siemens, Dell, Xerox, Canon, Hewlett-Packard and Cisco Systems. Major declines were suffered by: Alcatel, Qwest, AT&T, Fujitsu, BT, EDS, NEC, SBC Communications, NTT and Hitachi.

Nine firms have entered or exited the ICT top 50 since 2001. Compaq is no longer listed following its takeover by Hewlett-Packard, PricewaterhouseCoopers Consulting was taken over by IBM and MCI/Worldcom has not reported during restructuring. Other firms exiting have simply lost ground in the rankings: Sun Microsystems fell from 42nd to 52nd, Lucent Technologies fell from 20th to 66th, Solectron fell from 48th to 56th and Nortel Networks fell from 26th to 59th. New entrants include the newly listed Samsung Electronics, LG Electronics and China Mobile, and a number of rapid risers including: Vodafone at 11th in 2003 from 61st in 2001, Ricoh at 45th from 53rd, Flextronics at 48th from 55th and Korea Telecom at 49th from 65th. Of the 2003 top 50, the big risers in revenue terms between 2000 and 2003 were: Vodafone, Flextronics, France Telecom, KDDI, Microsoft, Dell, Samsung and Deutsche Telekom.

Top 10 firms in each sector

Because large electronics and telecommunications firms dominate the top 50, the listing does not reveal much about the major players in other industry sectors or about their performance. This section explores the activities of the top 10 firms in each ICT industry sector: communications equipment and systems, electronics and components, IT equipment and systems, IT services, software and telecommunication services.

Communications equipment and systems

Five of the top 10 communications equipment and systems firms are in the top 50 ICT firms, and another two are in the top 100 in terms of 2003 revenue. The top 10 generated combined revenues of USD 148 billion in 2003 (Table A.4). In 2002, they employed a total of 490 000 and spent 15.5% of revenue on R&D. Recent difficulties in the sector are reflected in the turnaround in net income, with a total top 10 profit of USD 7.4 billion in 2000 becoming an aggregate loss of USD 20 billion in 2002.

Between 2000 and 2002, total revenues of the top 10 fell by 17% a year. Preliminary results for 2003 suggest continued difficulties, although combined revenues rose to USD 148 billion. Between 2000 and 2002, total employment fell by 18% a year and total net income declined by more than USD 27 billion. Nonetheless, since 2001 only two firms exited the top 10 (Marconi which fell from 8th in 2000 to 11th in 2003, and Tellabs which fell

Table A.4. **Top 10 communications equipment and systems firms**

USD millions and number employed

Company	Country	Revenue 2000	Revenue 2002	Revenue 2003	Employees 2000	Employees 2002	R&D 2000	R&D 2002	Net income 2000	Net income 2002
Nokia	Finland	27 868	28 317	37 670	58 708	57 716	2 371	2 879	3 613	3 190
Motorola	United States	30 931	26 679	26 293	121 000	97 000	4 440	3 754	817	–2 485
Cisco Systems	United States	18 928	18 915	18 878	38 000	36 000	2 704	3 448	2 668	1 893
Alcatel	France	28 815	18 427	18 694	131 598	75 940	2 610	2 100	–521	–5 284
Ericsson	Sweden	29 866	14 966	14 971	105 129	85 198	4 587	4 424	2 300	–1 952
Nortel Networks	Canada	27 948	10 560	9 600	94 500	36 960	3 663	2 230	–2 995	–3 585
Lucent	United States	28 904	12 321	8 720	126 000	47 000	3 179	2 310	1 219	–11 735
L-3 Communications	United States	1 910	4 011	4 675	14 000	27 000	24	35	83	178
Avaya	United States	7 732	4 956	4 372	31 000	18 800	468	459	–375	–666
Qualcomm	United States	3 197	3 040	3 936	6 300	8 100	340	452	622	360
Total		206 098	142 192	147 809	726 235	489 714	24 386	22 091	7 430	–20 087

Note: 2003 revenues based on financial year reported in 2003 or most recent four quarters.
Source: OECD, compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/084226704547

from 10th to 14th) and were replaced by Qualcomm and by L-3 Communications, which was one of the fastest-growing communications equipment and systems firms over the period, with revenues increasing by 35% a year. L-3's employment almost doubled and net income increased by 47% per year.[3] Increases reflect opportunities in security, defence-related and mobile communications markets.

Among the top 10 communications equipment and systems firms only L-3, Nokia and Qualcomm enjoyed growth between 2000 and 2003. All other firms in the communications equipment and systems top 10 suffered declining revenues. Lucent and Nortel saw revenues decline by more than 30% a year, while Ericsson, Avaya and Alcatel saw revenues fall by around 15%-20% a year. All top 10 communications equipment and systems firms shed jobs, with the exception of L-3 Communications and Qualcomm. All but Nokia, Cisco Systems, L-3 Communications and Qualcomm showed losses in 2002, whereas all but Nortel, Alcatel and Avaya had realised a profit during 2000. It is clear that communications equipment firms have been severely affected by the recent downturn and sudden slowdown in telecommunications infrastructure investment.

Electronics and components

Leading electronics firms tend to very large. All of the top 10 electronics and components firms are in the top 50 ICT firms, along with seven more. They tend to be relatively diversified, with many conglomerates – except Intel – in the sector having significant non-ICT business.

The top 10 electronics and components firms generated combined revenues of USD 462 billion in 2003 (Table A.5). In 2002, they employed a total of almost 2 million people, spent 7% of revenue on R&D and realised an aggregate profit of just over USD 2 billion. Between 2000 and 2002, total revenue of the top 10 fell by 1.7% a year. Preliminary results for 2003 suggest improving revenues. Between 2000 and 2002, total employment fell by almost 3% a year and total net income by 75% a year. Nevertheless, six of the top 10 firms made a profit in 2002. Preliminary results for 2003 suggest a return to higher levels of profitability with aggregate net income for the nine firms reporting of over USD 13 billion. Samsung was one of the faster growing electronics and components firms over the 2000-03 period, with revenues and net income both increasing by 11% per year.[4] Results reflect some consolidation, especially in contract electronics manufacturing.

Table A.5. **Top 10 electronics and components firms**

USD millions and number employed

Company	Country	Revenue 2000	Revenue 2002	Revenue 2003	Employees 2000	Employees 2002	R&D 2000	R&D 2002	Net income 2000	Net income 2002
Siemens	Germany	64 405	79 260	85 894	419 000	426 000	4 425	5 490	6 528	2 450
Hitachi	Japan	72 725	63 625	67 157	323 827	306 989	3 930	3 307	154	–3 851
Sony	Japan	62 046	60 437	63 353	189 700	168 000	3 660	3 455	1 131	122
Matsushita	Japan	68 711	56 415	62 744	314 267	291 232	4 881	4 514	874	–3 412
Samsung	Korea	34 573	49 641	47 613	173 000	173 000	1 332	2 500	4 768	5 877
Mitsubishi	Japan	35 021	29 101	30 848	116 588	116 192	1 615	1 632	230	–622
Philips	Netherlands	34 736	30 019	29 947	219 000	170 000	2 553	2 871	8 786	–3 025
Intel	USA	33 726	26 764	28 527	86 100	78 700	3 897	4 034	10 535	3 117
Canon	Japan	25 020	23 448	25 760	86 673	97 802	1 805	1 864	1 244	1 521
Sanyo	Japan	18 005	15 223	19 856	83 519	80 500	928	853	201	13
Total		448 967	433 933	461 700	2 011 674	1 908 415	29 026	30 519	34 452	2 191

Note: 2003 revenues based on financial year reported in 2003 or most recent four quarters.
Source: OECD, compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/203334026075

Among the top 10 electronics and components firms, in addition to Samsung, Siemens (excluding Infineon Technologies), Sanyo, Canon and Sony enjoyed growth of 1% a year. On the other hand, Intel's revenues in 2002 were down by 5.4% a year on 2000, Philips by 4.8% a year, Mitsubishi Electric's by 4.1%, Matsushita's by 3% and Hitachi's by 3.2%. All top 10 electronics and components firms except Canon and Siemens shed jobs. Whereas all top 10 firms had realised a profit during 2000, Hitachi, Matsushita, Phillips and Mitsubishi suffered losses in 2002. Preliminary data show that six of the top 10 made a profit in 2003.

IT equipment and systems

Leading IT equipment and systems firms are also large, although only six of the top 10 were in the ICT top 50. A number of the IT equipment and systems firms are also diversified, but tend to be diversified within ICTs (*i.e.* producing IT equipment, software and services). The top firm, IBM, derives a greater share of revenue from services and software than most of the others in the sector. In 2000, IBM earned the largest single share of its revenue from hardware, but in 2002 45% of IBM's revenue came from services, 34% from hardware and 16% from software (see Box A.2). Some other firms in this group also have significant services activities. For example, services contributed 44% of Fujitsu's 2002 revenues and 18% of Hewlett-Packard's.

Total revenue of the IT equipment and systems top 10 amounted to USD 353 billion in 2003 (Table A.6). In 2002, they employed just over 1 million people and spent 6% of revenue on R&D. Between 2000 and 2002, their total revenue fell by 2.6% a year. However, preliminary data for 2003 show a recovery. Between 2000 and 2002, total employment fell by 2.8% a year and total net income dropped sharply, from a USD 16.6 billion net profit to a USD 4 billion net loss, although four of the top 10 showed a profit in 2002. Again preliminary data for 2003 show a return to profitability, with aggregate net income reaching around USD 6.8 billion.

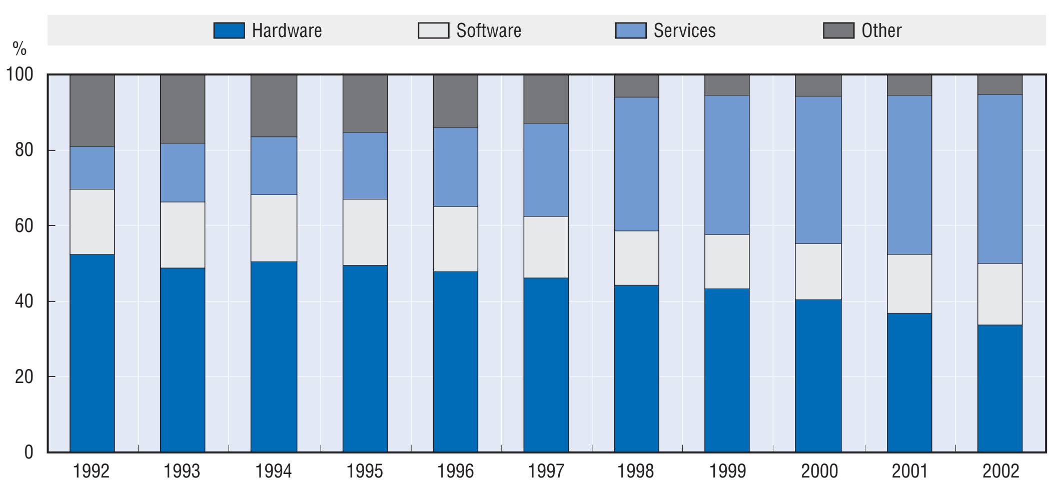
New entrants into the IT equipment top 10 since 2001 include: Hon Hai Precision, Seagate and Apple Computer. Exits include Compaq Computer, which was taken over by Hewlett-Packard, and Gateway and EMC, which fell to 18th and 12th place, respectively. Hon Hai Precision was one of the faster growing IT equipment firms over the 2000-03 period, with revenues increasing by 37% a year. Other IT equipment firms in the top 250 enjoying rapid growth included: Acer (with revenue increasing 74% a year), EliteGroup Computer (65% a year), Lite-on Technology (46% a year), Benq (32% a year), Logitech (24% a year) and Compal Electronics (23% a year). Five of the six fastest-growing IT equipment firms are based in Chinese Taipei, which reflects in part the impacts of exchange rate changes during the late 1990s and the globalisation of ICT manufacturing (see Chapter 2).

Among the top 10 IT equipment firms Hon Hai Precision (see above), Dell (with revenue increasing 12% a year) and Hewlett-Packard (with revenue increasing 13% a year) enjoyed strong growth. However, Sun Microsystems' 2003 revenues were down by10% a year from 2000, Apple's by 8% a year, Fujitsu's by 7% a year, NEC's by around 5% a

Box A.2. The transition to services

Few firms better illustrate the shift towards IT services than IBM. Between 1992 and 2002, IBM's total revenue increased from USD 64.5 billion to USD 81.2 billion, at an annual average rate of 2.3%. Over the same period, IBM's services revenue increased from USD 7.4 billion to USD 36.4 billion, or by 17.3% a year. And yet, IBM is registered with the US Securities Exchange Commission under the industry classification "Computer and Office Equipment" (SIC 3570).

Figure A.6. **IBM's revenues by market segment, 1992-2002**



Source: OECD, compiled from annual reports and SEC filings.

Table A.6. **Top 10 IT equipment and systems firms**
USD millions and number employed

Company	Country/ economy	Revenue 2000	Revenue 2002	Revenue 2003	Employees 2000	Employees 2002	R&D 2000	R&D 2002	Net income 2000	Net income 2002
IBM	United States	85 089	81 186	86 902	316 303	315 889	5 084	4 750	8 093	3 579
Hewlett Packard	United States	48 870	56 588	71 256	158 600	141 000	2 627	3 312	3 697	– 903
Toshiba	Japan	53 349	43 018	47 944	190 870	176 398	3 103	2 601	–305	–1 954
NEC	Japan	48 343	41 562	41 090	154 787	141 909	2 924	2 661	97	–2 488
Fujitsu	Japan	48 484	39 931	38 480	188 053	170 111	3 722	2 790	397	–3 050
Dell Computer	United States	25 265	31 168	35 404	40 000	39 100	374	452	1 666	1 246
Sun Microsystems	United States	15 721	12 496	11 434	43 300	39 100	1 630	1 832	1 854	–587
Hon Hai Precision	Chinese Taipei	2 900	6 780	7 428	9 000	9 000	. .	. .	. .	. .
Seagate	Cayman	6 448	6 087	6 486	42 800	45 779	587	698	310	153
Apple Computer	United States	7 983	5 742	6 210	8 568	10 211	380	446	786	65
Total		342 451	324 558	352 634	1 152 281	1 088 497	20 431	19 542	16 594	–3 940

Note: 2003 revenues based on financial year reported in 2003 or most recent four quarters.
Source: OECD, compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/236762260170

year and Toshiba's by 3.5%. All top 10 IT equipment firms except Apple Computer shed jobs. All but IBM, Dell, Seagate and Apple suffered a loss in 2002, whereas all but Toshiba had made a profit during 2000.

IT *services*

Only four of the top 10 IT services firms ranked in the ICT top 50, although all ten ranked in the top 100 ICT firms. Their total revenue amounted to almost USD 100 billion in 2003, up from USD 89 billion in 2000 (Table A.7). They employed some 544 000 people in 2002 and earned a combined net profit of USD 4.1 billion. As noted, a number of the larger IT equipment and systems firms earn a significant share of their revenue from services. In 2002, if revenues attributed to activities rather than firms, IBM's services revenue (around USD 36 billion) would put it at the top of the IT services list.

Top 10 IT services firms' revenues increased 5.4% a year between 2000 and 2002, and preliminary results for 2003 suggest continued growth. Between 2000 and 2002, total employment grew by 4.2% a year, but net income fell by an annual 26%. Preliminary data for 2003 suggest a return to increasing profitability, with net profits rising to USD 4.3 billion. Firms that reported R&D expenditure spent an average of 2.1% of 2002 revenues on R&D, although as a group the top 10 spent less than 1%.

There has been relatively little change at the top of the IT services sector since 2000. With the reclassification of Ingram Micro to distribution, it is replaced in the top 10 by First Data, which ranked 11th in 2000. Following a merger

Table A.7. **Top 10 IT services firms**
USD millions and number employed

Company	Country	Revenue 2000	Revenue 2002	Revenue 2003	Employees 2000	Employees 2002	R&D 2000	R&D 2002	Net income 2000	Net income 2002
EDS	United States	18 856	21 502	21 731	122 000	137 000	24	0	1 143	1 116
Tech Data	United States	16 992	17 198	15 739	10 500	8 000	. .	. .	128	111
Accenture	Bermuda	11 331	13 105	13 397	71 300	75 000	252	235	2 464	245
CSC	United States	9 345	11 379	11 347	68 000	90 000	. .	. .	403	334
First Data	United States	5 922	7 636	8 129	30 071	29 000	. .	. .	930	1 238
ADP	United States	6 168	7 004	7 147	41 000	40 000	460	475	841	1 101
CapGemini Ernst and Young	France	6 359	6 648	6 632	59 549	52 683	. .	. .	395	–485
SAIC	United States	5 300	5 771	5 903	40 000	40 000	. .	. .	800	19
Unisys	United States	6 885	5 607	5 709	37 400	36 400	334	273	225	223
Affiliated Computer Services	United States	1 963	3 063	3 787	21 000	36 200	. .	. .	109	230
Total		89 120	98 914	99 520	500 820	544 283	1 070	983	7 438	4 131

Note: 2003 revenues based on financial year reported in 2003 or most recent four quarters.
Source: OECD, compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/533043587381

with Concord EFS, First Data is the fastest-growing of the established top 10 IT services firms, with an increase of 11% a year in revenue between 2000 and 2003. Following the takeover of PricewaterhouseCoopers consulting by IBM, it has been replaced by the very rapidly growing Affiliated Computer Services, with revenues increasing by more than 20% a year since 2000. Revenues of eight of the top 10 grew over the period, while those of Unisys and Tech Data declined. Just one of the top 10 IT services firms made a net loss in 2002 (CapGemini Ernst and Young).[5]

Software

Software firms tend to be somewhat smaller than firms in other ICT sectors. Only one of the top 10 software firms ranked in the ICT top 50 (Microsoft) and only three ranked in the top 100 ICT firms. The top 10 earned a total of USD 60 billion in 2002, up by more than 4% a year from 2000; they employed 179 000 people and spent some USD 8.2 million on R&D (Table A.8). Preliminary data for 2003 suggest continued growth, with combined top 10 revenues up by more than 6% a year from 2000. Microsoft continues to be the clear leader, accounting for almost 50% of total top 10 revenues in 2003.[6]

Table A.8. **Top 10 software firms**

USD millions and number employed

Company	Country	Revenue 2000	Revenue 2002	Revenue 2003	Employees 2000	Employees 2002	R&D 2000	R&D 2002	Net income 2000	Net income 2002
Microsoft	United States	22 956	28 365	32 187	47 600	50 500	3 772	4 307	9 421	7 829
Oracle	United States	10 231	9 673	9 475	42 927	40 650	1 010	1 076	6 297	2 224
SAP	Germany	5 747	7 772	9 044	24 480	29 374	889	858	565	533
Softbank	Japan	3 927	3 232	3 449	7 219	6 865	. .	. .	78	–708
CA	United States	6 094	2 964	3 116	18 200	17 500	1 110	678	696	–1 102
Electronic Arts	United States	1 420	1 725	2 504	3 500	4 270	256	381	117	102
Peoplesoft	United States	1 772	1 949	1 941	8 019	8 293	321	341	146	183
Intuit	United States	1 037	1 358	1 651	6 000	6 500	166	204	306	140
Veritas Software	United States	1 187	1 507	1 579	4 784	5 647	176	273	–628	57
Amdocs	United States	1 118	1 614	1 427	8 400	9 400	75	124	6	–5
Total		55 491	60 159	66 372	171 129	178 999	7 774	8 242	17 003	9 253

Note: 2003 revenues based on financial year reported in 2003 or most recent four quarters.
Source: OECD, compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/888547040415

Between 2000 and 2002, total employment in the software top 10 increased by 2.3% a year, but net income fell by 26% a year, with a net profit of USD 17 billion shrinking to USD 9.3 billion. Preliminary data for 2003 indicate a resurgence of profitability, with aggregate net profits of the top 10 reaching USD 13.7 billion. Firms in the top 10 that report R&D expenditure spent an average of 14.5% of 2002 revenues on R&D, and the group as a whole spent an average of 13.7%.[7]

Among the changes since 2000 are Compuware (falling from 6th in 2000 to 13th in 2003), Siebel Systems (falling from 7th to 11th) and BMC Software (falling from 9th to 14th). New entrants include Intuit (up from 14th), Veritas (up from 15th) and Amdocs (up from 17th). Growth performance has been varied within the software sector, with some market segments performing well (*e.g.* security and virus protection) and others performing less well. Among the software top 10, seven firms experienced revenue growth between 2000 and 2003 (Electronic Arts 21% a year, Intuit 17% a year, SAP 16% a year, Microsoft 12% a year, Veritas 10% a year, Amdocs 8.5% a year and Peoplesoft 3% a year). Computer Associates, Softbank and Oracle experienced revenue declines over the period. Nevertheless, only three of the top 10 had a net loss in 2002, and only two (Softbank and Computer Associates) are likely to show a loss in 2003.

Telecommunication services

In recent years, firms in the telecommunication services sector have experienced some of the largest losses in corporate history. Nevertheless, revenues remain strong. Detailed analysis of the telecommunication services sector can be found in the OECD's *Communications Outlook* 2003. In 2003, the telecommunication services top 10 earned revenues totalling USD 478 billion, with revenues increasing at 4.8% a year between 2000 and 2003, and employment increased to 1.6 million between 2000 and 2002. However, owing to what with hindsight seem overly ambitious investments followed by restructuring profitability has been adversely affected, with a top 10 net profit of USD 39 billion in 2000 turning into a net loss of USD 76 billion in 2002, led by significant losses at Deutsche Telekom, Vodafone and France Telecom.

Changes in the top 10 include Worldcom/MCI which has not reported annual results since 2001 and Bell South which fell to 13th place, with declining revenues throughout the 2000 to 2003 period. Vodafone and Telefonica, with

Table A.9. **Top 10 telecommunication services firms**
USD millions and number employed

Company	Country	Revenue 2000	Revenue 2002	Revenue 2003	Employees 2000	Employees 2002	R&D 2000	R&D 2002	Net income 2000	Net income 2002
NTT	Japan	92 679	87 948	91 026	224 000	213 062	3 178	3 118	–603	–6 657
Verizon	United States	64 707	67 625	67 734	260 000	245 000	. .	. .	11 797	4 079
France Telecom	France	30 480	46 600	52 048	188 866	211 554	530	680	3 313	–20 500
Deutsche Telekom	Germany	37 559	50 650	50 528	170 000	255 896	642	849	5 437	–23 195
Vodafone	United Kingdom	11 929	33 109	47 962	29 465	67 178	109	164	838	–23 413
SBC	United States	51 374	43 138	42 310	220 090	175 980	. .	. .	7 800	5 653
AT&T	United States	46 850	37 827	36 480	84 800	71 000	313	254	4 669	–13 082
Telecom Italia	Italy	27 516	31 200	32 983	107 171	101 713	247	124	3 231	781
BT	United Kingdom	28 356	30 685	30 460	132 000	108 600	552	540	2 111	–1 093
Telefonica	Spain	24 100	31 800	26 739	145 730	161 029	. .	. .	725	1 800
Total		415 550	460 582	478 270	1 562 122	1 611 012	5 570	5 729	39 317	–75 626

Note: 2003 revenues based on financial year reported in 2003 or most recent four quarters.
Source: OECD, compiled from annual reports, SEC filings and market financials.

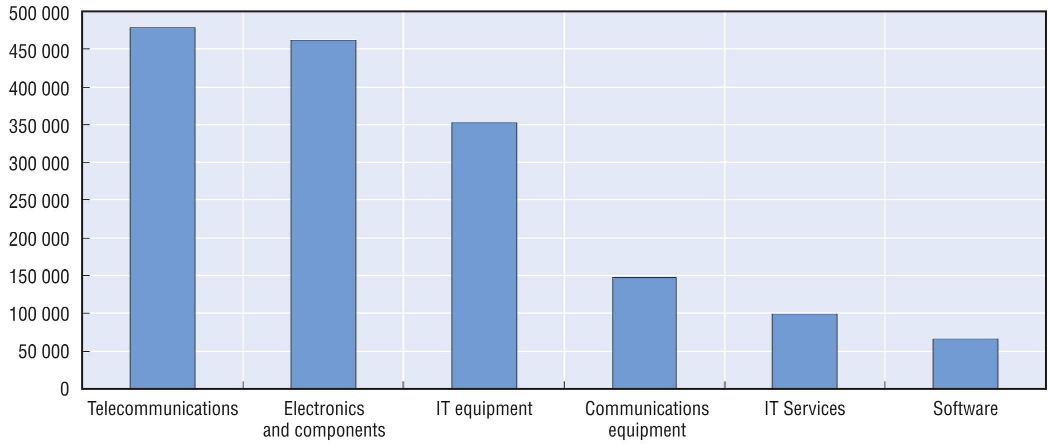
StatLink: http://dx.doi.org/10.1787/334150085155

strong revenue growth, have entered the top 10. Indeed, Vodafone has experienced one of the strongest growth rates in the sector, in large part by aggressive expansion through mergers and acquisitions (see Chapter 2).

ICT *sector comparisons*

A comparison of the performance of the top 10 firms in each sector shows that telecommunication services is the largest sector in terms of revenues and the electronics sector is a close second (Figure A.7), followed by the IT equipment and systems sector. In terms of growth in revenue over the 2000-03 period, the software, services and IT systems and electronics sectors enjoyed growth, while the communication equipment sector contracted. Revenue growth was strongest in the software top 10 (6.1% a year), followed by telecommunications services (4.8% a year), IT services (3.7% a year) and the IT equipment and electronics (less than 1% a year) (Figure A.8). Communications equipment revenues declined overall by 10.5% a year. In all the sectors, the leading ICT firms have performed relatively well during difficult times, although conditions in communication equipment and systems have been very difficult since 2000. Comparisons across different groups are however increasingly challenging given developments in communications and digital content (see Box A.3).

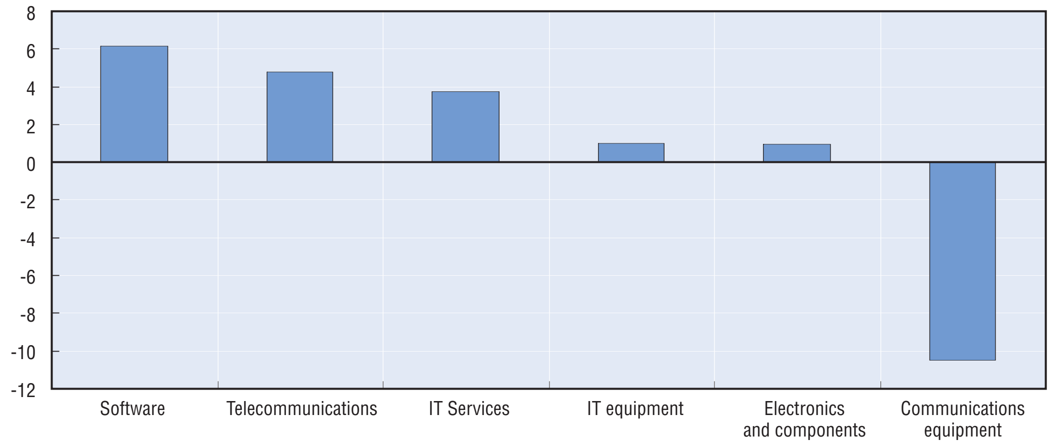
Figure A.7. **Relative size of ICT top 10 by revenue, 2003**
USD millions



Note: 2003 revenues based on financial year reported in 2003 or most recent four quarters.
Source: OECD, compiled from annual reports, SEC filings and market financials.

Figure A.8. **Revenue growth of ICT top 10, 2000-03**

Annual percentage change



Note: 2003 revenues based on financial year reported in 2003 or most recent four quarters.
Source: OECD, compiled from annual reports, SEC filings and market financials.

Box A.3. Communications, content and convergence

Liberalisation and privatisation in telecommunications, digitisation and the increasing overlap between different information, communication and content activities are among the most important forces affecting ICT firms. These forces make it increasingly difficult to track ICT industry and firm activities using established and neatly separated statistical classifications. Two things are happening.

- What were formerly national monopoly telecommunications services providers are now moving into the ICT industry as rapidly growing, multifaceted global firms. They often provide a wide range of voice and data communications services, fixed and mobile services and, increasingly, on-line communities and e-business enabling services, and are beginning to carry content. Vodafone, with its rapid global growth, and Deutsche Telekom with T-online are indicative of what are becoming widespread developments. Many former national carriers already qualify for inclusion in the ICT top 250 on a revenue basis and many others will soon do so. The point will soon be reached where a significant percentage of the ICT top 250, based on revenues or market capitalisation, is taken up by diversified telecommunications services providers.
- Increasing digitisation of content in traditional sectors and rapid growth of overlapping broadcasting, publishing and audiovisual services are spawning new products to exploit digital content, particularly in consumer markets, with data, text, music, film and images all being delivered in new ways through new forms of digital publishing and the activities of many of the leading firms are evolving rapidly (*e.g.* News Corp, Vivendi and Apple Computer) (see Chapter 5 for a discussion of digital delivery and digital content). Because the definition of ICT activities adopted here is those that "process, deliver, and display information electronically", content and media industries present new challenges. Many broadcasting, media and publishing firms are large, so a significant number of emerging content providers are also "born large". Firms such as Time Warner and News Corporation enter the digital content era with worldwide operations. Such firms will increasingly take significant places on any listing of ICT firms, based on revenues or market capitalisation.

For the time being, it is possible to introduce communications and content firms into the listing of leading IT, equipment, software and services firms. In the longer term, however, the challenge of accommodating communications and content, while retaining a perspective on IT services and software activities, remains.

Top 50 Internet firms

There are no set criteria for identifying and categorising Internet firms (see Box A.4). This section looks at a group of 50 leading Internet firms, identified from two market-based listings of Internet and related firms. They are analysed separately because not all are ICT firms and because, while potentially important for the development and restructuring of the ICT sector, some are relatively small and would be excluded from the ICT 250 on a revenue basis. In compiling the list, major hardware and infrastructure providers were excluded (*e.g.* equipment manufacturers and

Table A.10. **Top 50 Internet firms**

USD millions and number of employees

Company	Activity	Revenue 1998	Revenue 2000	Revenue 2003	Net income 1998	Net income 2000	Net income 2003	Employees 2003	Market cap
AOL (Excl. TWE)*	Search and portal	2 600	7 605	8 658	92	1 855	808	60 000	69 990
InteractiveCorp	Retail	2 760	2 965	5 445	77	–148	104	23 200	28 311
Amazon.com	Retail	610	2 762	4 463	–125	–1 411	–86	7 500	23 049
Charles Schwab	Web services	3 178	5 788	3 945	410	718	114	16 700	18 365
Sabre	Web services	2 306	1 956	2 021	232	144	131	6 300	3 179
E Trade	Web services	890	1 973	1 918	–57	19	85	3 500	3 783
Ebay	Retail	86	431	1 689	7	48	344	4 000	38 820
Veritas	Software	211	1 187	1 579	52	–628	78	5 647	15 249
Symantec	Software	533	746	1 407	85	170	248	4 300	9 972
Apollo Group	Content	45	610	1 340	5	71	247	5 857	11 531
Yahoo	Search and portal	245	1 110	1 247	–14	71	209	3 600	27 464
Adobe	Software	895	1 266	1 231	105	288	223	3 341	10 030
Verisign	Web services	39	475	1 112	–20	–3 116	–315	3 200	3 572
WebMD	Search and portal	49	592	954	–54	–3 100	–32	5 450	2 483
BEA Systems	Software	166	464	934	–23	–20	84	3 063	5 451
Priceline.com	Retail	35	1 235	877	–112	–330	–31	290	1 257
Checkpoint Software	Software	365	691	667	18	–3	31	3 930	553
Terra Networks	Search and portal	14	363	653	–4	–1 460	–2 211	2 494	3 485
Ameritrade	Web services	162	655	652	0	–14	36	2 150	6 039
Knight Trading	Web services	411	1 257	548	96	260	–2	1 027	1 614
CMGI	Web services	92	858	471	32	–1 365	–390	2 414	661
Macromedia	Software	140	264	337	1	9	2	1 085	1 820
Research in Motion	Web services	21	85	307	0	10	–149	1 950	3 394
Quest Software	Software	35	166	276	2	–25	12	1 813	1 278
Openwave	Web services	29	148	268	–26	–288	–217	1 455	873
Doubleclick	Web services	139	506	265	–18	–157	–109	1 111	1 662
Tibco Software	Software	53	254	263	–13	–25	7	1 030	1 344
S1 Corp	Software	24	190	256	–31	–1 178	–40	1 219	452
RSA SEC	Software	171	280	245	29	206	–53	993	997
Internet Sec	Software	57	195	244	–4	18	5	1 215	726
CNET Networks	Content	58	264	239	3	–484	–331	1 800	1 323
PEC Solutions	Consulting and design	42	68	189	5	7	22	1 340	442
Realnetworks	Software	66	242	188	–20	–110	–50	689	1 216
Sapient	Consulting and design	165	538	182	9	47	–44	1 425	621
Open Text	Software	45	113	178	–1	25	28	1 196	877
Vignette	Software	16	367	154	–26	–532	–203	856	736
Freemarkets	Web services	9	91	152	0	–156	–24	1 001	384
Infospace	Consulting and design	19	215	145	–29	–282	–109	596	690
Digital Insight	Web services	13	54	141	–8	–58	4	624	642
Harris Interactive	Web services	20	51	131	–5	–21	11	731	446
Portal Software	Software	9	103	121	–8	–8	–72	580	651
Net bank	Web services	7	38	97	5	9	46	2 128	662
Red Hat	Software	23	42	91	–3	–42	–7	566	2 224
Ask Jeeves	Search and portal	1	96	89	–7	–190	10	347	962
Digital River	Web services	3	31	88	–14	–38	10	481	998
Valueclick	Web services	2	64	76	0	–55	4	419	779
Lastminute.com	Retail	0	6	70	0	–59	–64	916	995
ChinaDotCom	Search and portal	4	110	64	–9	–60	3	952	921
Ulticom	Software	12	26	29	2	2	–2	245	466
Liberate Technologies	Software	14	22	28	–20	–81	–399	268	421

Note: 2003 revenues based on financial year reported in 2003 or most recent four quarters. Employment and market capitalisation for AOL refer to AOL TWE, whereas revenue and income data refer to AOL only.
Source: OECD, compiled from Wall Street Research Network and Fortune e-50 listings, annual and market reports and SEC filings.

StatLink: http://dx.doi.org/10.1787/523603331556

Box A.4. **Methodology used to identify Internet firms**

In the absence of set criteria to identify Internet firms, the top 50 Internet-related firms were identified by reference to the Wall Street Research Network's (WSRN) Internet stocks listing and the Fortune e-50 (used for the FEX index). Once identified, primarily on the basis of market capitalisation, company data were sourced from annual reports, SEC filings and a number of financial and market sources (including Yahoo!Finance and MultexInvestor). Five years of revenue and net income are reported, along with current employment and market capitalisation as at October 2003. Revenue and income data for 2003 are for financial years reported during 2003, or for the most recent four quarters to the end of October 2003. Internet firms are categorised by market sector using a simplified version of the WSRN classification. These include: consulting and design, content (including on-line communities), Web services, retail, software, search and portal. While far from definitive, this gives some indication of development of important Internet firms.

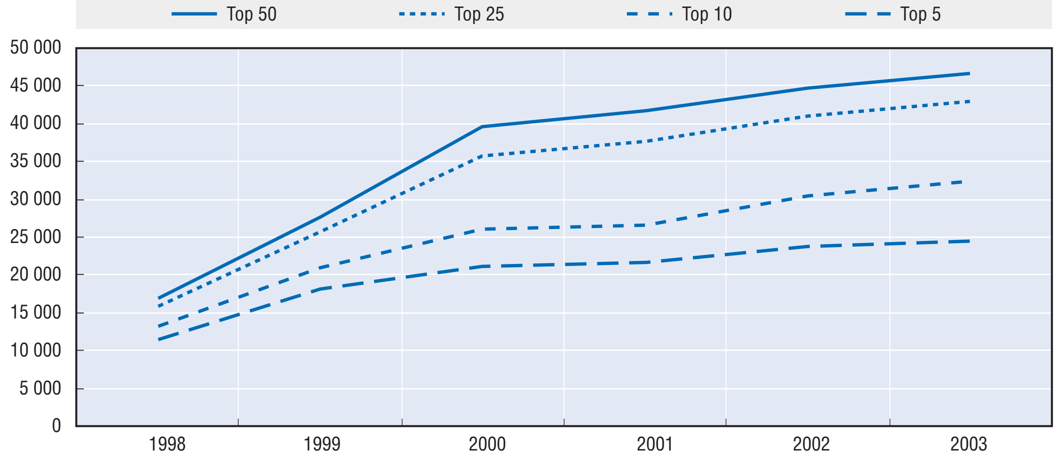
ISPs included in the top 250 list) in order to focus on e-commerce and digital content enablers that derive all or most of their revenues from Internet-related operations. The analysis is based primarily on US-listed firms and is therefore only a partial snapshot. However, it provides a window onto an important area of development, especially during the years of the dot.com boom and bust and its aftermath, and because the stock market listing adds the all-important perspective of investment.

In October 2003, the top 50 Internet firms had a combined market capitalisation of USD 314 billion. In 2003, they earned combined revenues of USD 46.7 billion and realised a net loss in excess of USD 2 billion (based on preliminary data) (Figure A.9). They employ around 200 000 people. The Internet top 50 is top-heavy in revenue terms, with the top 25 earning 92% of total top 50 revenues in 2003, the top 10 earning 70% and the top five earning 53%. In 2003, 13 of the top 50 earned in excess of USD 1 billion in 2003, five earned in excess of USD 2 billion, two in excess of USD 5 billion and one in excess of USD 8 billion (AOL at almost USD 8.7 billion). The top five employed 58% of all top 50 firm employees, the top 10 70% and the top 25 89%.

Revenue and income details were tracked for the five years 1998-2003 in order to explore the development of the Internet sector during the difficult dot.com period. Total top 50 Internet firms' revenues increased from USD 17 billion in 1998 to USD 47 billion in 2003, or by 23% a year. Unlike the top 250 ICT firms, the larger Internet firms grew more slowly than the smaller ones. The top 25 increased their combined revenues by 22% a year, the top 10 by 20% a year and the top five by 17% a year. Nevertheless, on average, Internet firms grew much more quickly than the traditional ICT firms.

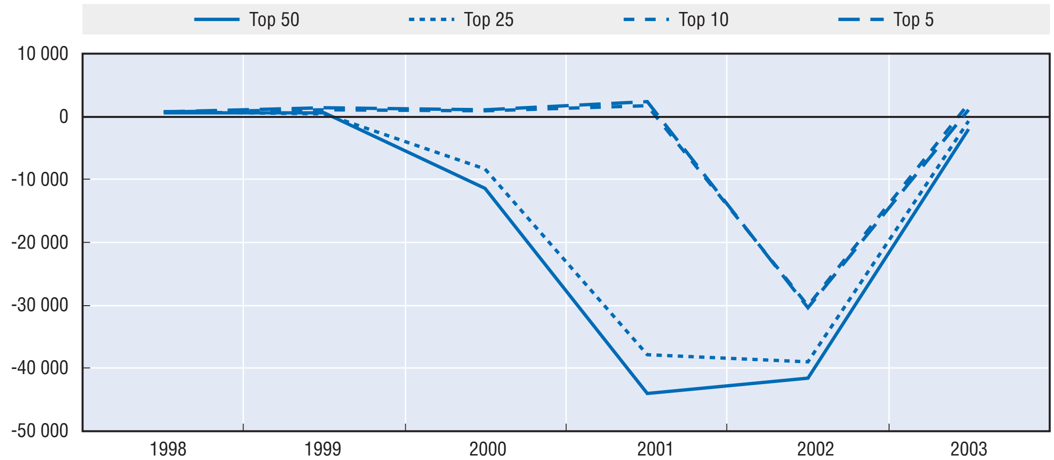
Figure A.9. **Top 50 Internet firm revenues, 1998-2003**

USD millions



Source: OECD, compiled from Wall Street Research Network and Fortune e-50 listings, annual and market reports and SEC filings.

Figure A.10. **Top 50 Internet firm incomes, 1998-2003**
USD millions



Source: OECD, compiled from Wall Street Research Network and Fortune e-50 listings, annual and market reports and SEC filings.

Revenues of the top 50 Internet firms appear to have continued to grow throughout the period, albeit more slowly during 2000-2002. However, profitability was severely affected by the dot.com downturn. Overall, their combined net income peaked in 1999 at USD 520 million, before falling to a combined net loss of USD 44 billion in 2001 (Figure A.10). Losses have since been stemmed, with the top 50 moving towards a net loss of USD 2 billion in 2003. The top 25 Internet firms' combined net income peaked in 1998 at USD 780 million, before falling to a net loss of USD 39 billion in 2002. However, the income of both the top 10 and top 5 peaked as late as 2001, before declining to a loss of USD 30 billion in 2002. Unlike top 50 and top 25 net incomes, top 10 and top 5 net incomes turned positive again in 2003. Overall the larger Internet firms turned down sharply but briefly and have now returned to profit, but the smaller ones have struggled since 1999.

Internet firms by sector

The top 50 Internet firms operate in different market segments, including consulting and design, content, retail, search and portal, software, and Web services. In terms of revenue, retail was the largest in 2003, closely followed by Web services (Table A.11). Search and portal came third. The top Internet firms in the retail segment also enjoyed the highest average revenues in 2003, at USD 2.5 billion. Search and portal firms earned an average of almost USD 1.9 billion in 2003, the two content firms an average of USD 790 million, Web services USD 762 million, software USD 457 million and consulting and design firms an average USD 172 million.

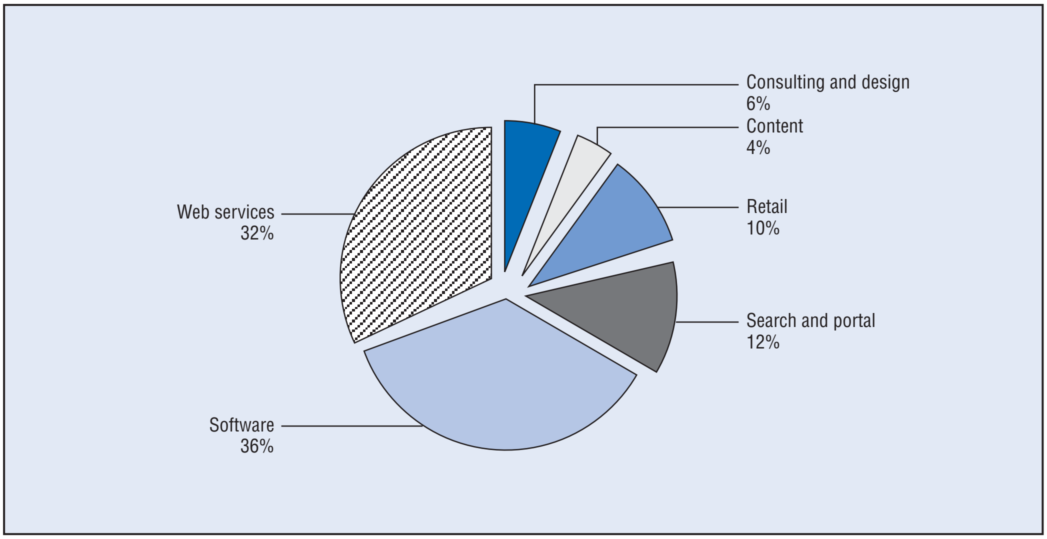
Table A.11. **Top 50 Internet firms by sector**
USD millions and average annual percentage change

Sector	Firms	Revenue 1998	Revenue 2003	Change %	Net income 1998	Net income 2003	Employees	Market cap
Consulting and design	3	225	515	18.0	–15	–131	3 361	1 753
Content	2	103	1 579	72.8	8	–84	7 657	12 854
Retail	5	3 491	12 544	29.1	–152	267	35 906	92 432
Search and portal	6	2 913	11 664	32.0	5	–1 213	72 843	105 305
Software	18	2 836	8 226	23.7	145	–109	32 036	54 463
Web services	16	7 322	12 191	10.7	628	–767	45 191	47 053
Total	50	16 889	46 720	22.6	618	–2 036	196 994	313 860

Note: 2003 revenues based on financial year reported in 2003 or most recent four quarters.
Source: OECD, compiled from Wall Street Research Network and Fortune e-50 listings, annual and market reports and SEC filings.

StatLink: http://dx.doi.org/10.1787/175761547835

Figure A.11. **Top 50 Internet firm revenues by sector**
USD millions



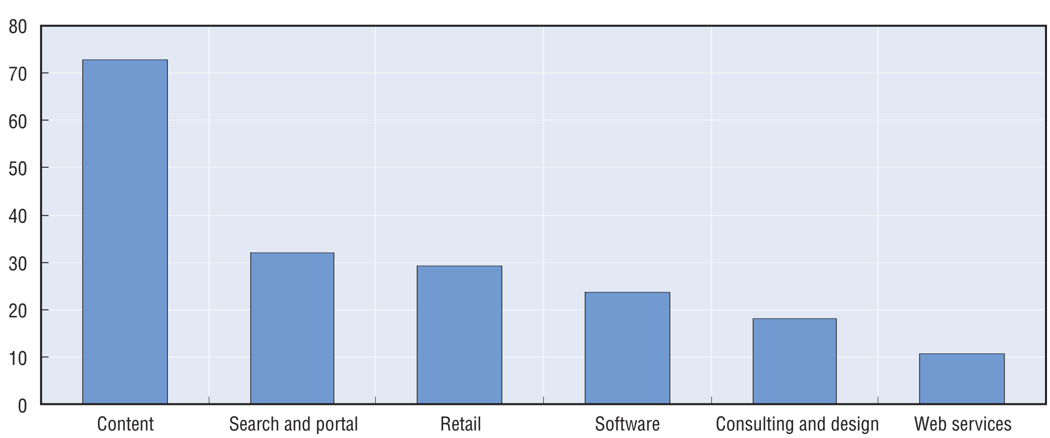
Source: OECD, compiled from Wall Street Research Network and Fortune e-50 listings, annual and market reports and SEC filings.

Over the period 1998-2003, revenues of the two top 50 Internet firms in the content sector grew most rapidly, and the top 50 firms in search and portal, retail and software also enjoyed annual growth rates in excess of 20%. The top 50 firms in the Web services sector and consulting and design experienced growth below the Internet top 50 average of 23% a year.

With almost 73 000 employees overall, the search and portal segment is the largest employer, although AOL (TWE) alone accounted for 60 000. Web services firms employ a further 45 000, Internet retailers 36 000 and software firms 32 000 (Figure A.11). Leading Internet firms in other market segments are relatively small. Average employment is highest among firms in the search and portal sector (12 140). The Internet retailers among the top 50 employed an average of almost 7 200. Firms in the other sectors employed fewer than the average of the overall Internet top 50 (3 940).

While revenue growth across Internet market segments has generally been strong, profit performances have been mixed (Figure A.12). Consulting, content, retail and software sectors have seen incomes remain relatively

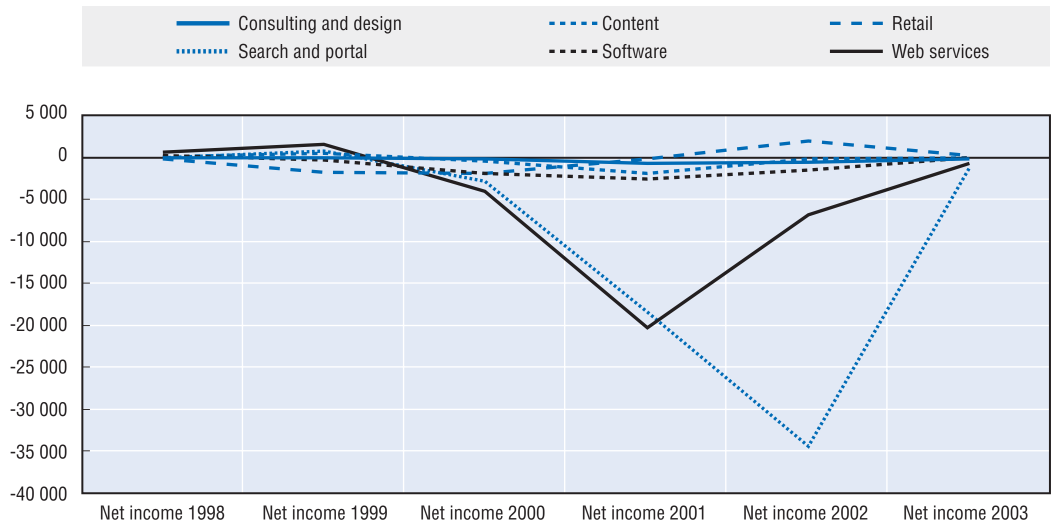
Figure A.12. **Top 50 Internet firms, average annual revenue growth by sector, 1998-2003**
Percentages



Source: OECD, compiled from Wall Street Research Network and Fortune e-50 listings, annual and market reports and SEC filings.

Figure A.13. **Top 50 Internet firms: net income by sector, 1998-2003**

USD millions



Source: OECD, compiled from Wall Street Research Network and Fortune e-50 listings, annual and market reports and SEC filings.

stable; all had net losses in 2001, but variously had net profits and losses in the surrounding years (Figure A.13). The Web services and search and portal sectors have experienced much more variation in profitability. The most dramatic losses have been among search and portal firms, largely owing to AOL restructuring charges in 2002 and, to a lesser extent, to the performance of WebMD. Verisign had the greatest negative impact on profitability in the Web services sector.

Individual firm performances and activities

Nineteen of the Internet top 50 had a market capitalisation in excess of USD 2 billion in October 2003, nine had a market capitalisation in excess of USD 10 billion and four were capitalised at more than USD 25 billion (AOL Time Warner at USD 70 billion, Ebay USD 39 billion, InteractiveCorp USD 29 billion and Yahoo! USD 27 billion). Four of the Internet top 50 firms had revenue growth in excess of 100% a year over the period 1998-2003 (LastMinute.com, Ask Jeeves, Terra Networks and ValueClick). Only five firms experienced single-digit revenue growth over the period (RSA Securities, Adobe, Knight Trading, Charles Schwab and Sapient), and one (Sabre) had lower revenue in 2003 than in 1998. In 2003, 23 of the top 50 Internet firms realised a net loss; ten lost more than USD 100 million, and one (Terra Networks) lost more than USD 2 billion. The remaining 27 realised net profits during 2003; nine had profits in excess of USD 100 million.

The activities of firms in the Internet top 50 are heterogeneous. In terms of the primary SIC classification, 17 different industries were represented: 14 report packaged software (SIC 7372) as their primary activity; six report information retrieval services (7375); five report computer programming services (7371) and computer systems design (7373); three report business services (7389) and bank holding (6712); and two report security brokers and dealers (6211), travel agency (4724) and publishing and printing (2731). One firm reports each of the following: advertising agency (7311); education (8221). motion picture and video production (7812); computer related services (7379); computer processing services (7374); advertising (7319); investment (6799); and communications services (4899). Table A.12 highlights the diversity of Internet activities and of the backgrounds of firms undertaking most or all of their activities via the Internet or enabling other firms to do so.

Conclusion

The ICT-producing sector makes an important contribution to productivity and growth in many countries (see Chapter 1). Through its contribution to innovation and to improvements in business processes, it also underpins productivity gains across all industries and provides tools to help other sectors to grow (see Chapter 3). The top 250 ICT firms account for around 50% of total ICT-sector employment in OECD countries. Tracking their activities and performance provides a window on developments and trends across the sector as a whole well in advance of the release of official national statistics.

Analysing the top 250 ICT firms captures the winners, but what is striking about recent performance is the resilience of revenue and the relatively rapid return to profitability of this top group of firms. Their revenues fell a little in 2001 and 2002 before recovering in 2003, while the group of Internet firms continued to increase revenues, despite the dramatic losses both ICT and Internet firms experienced in 2001 and 2002. However, employment fell by around 5% between 2000 and 2002, and the question remains whether the return to revenue growth and profitability will bring a return of employment growth. The performance of this group of firms suggests that many of the larger ICT firms can withstand difficult business conditions and are capable of developing new products and services to meet evolving customer demands.

Table A.12. **Top 50 Internet firms by activity**

Company	Primary SIC	Activity
AOL (TWE)	7812	Parent company of America Online, Inc. and Time Warner Inc. The Company is engaged in AOL Internet services, cable, filmed entertainment, television networks, music and publishing.
InteractiveCorp	2731	Formerly known as USA Interactive, it is a multi-brand interactive commerce company which enables direct-to-consumer transactions including home shopping, ticketing, travel, teleservices and local services. During 2002, InterActiveCorp acquired a majority interest in Expedia.
Amazon.com	2731	An online retailer offering items including books, music, DVD/video, toys, electronics, software, and home products.
Charles Schwab	6712	Engaged, through its subsidiaries, in securities brokerage and related financial services. The Company offers a broad range of products, services and advice to address its clients' investment and financial needs.
Sabre	4724	Engaged in travel commerce, retailing travel products and providing distribution and technology solutions for the travel industry. It includes Travelocity, Sabre Travel Network, GetThere and Sabre Airline Solutions.
E Trade	6211	Provides online financial services, including value-added investing, banking, research and educational tools. It also offers automated order placement and execution, portfolio tracking and other services.
Ebay	7389	Has developed a Web-based community in which buyers and sellers are brought together in an auction format to buy and sell items such as antiques, coins, collectibles, computers, memorabilia, stamps and toys.
Veritas	7372	Supplier of storage software products and services, including storage management, data protection and high availability software.
Symantec	7372	A world leader in Internet security technology, provides a broad range of content and network security solutions to individuals and enterprises.
Apollo Group	8221	University of Phoenix Online, a division of the University of Phoenix, is an online provider of accessible, accredited education programmes for working adults.
Yahoo	7373	A global Internet communications, commerce, and media company that offers a very widely used branded network of services.
Adobe	7372	Offers software products for consumers, businesses and professional customers to create, manage and deliver content.
Verisign	7371	Provides digital trust services needed by Web sites, enterprises and individuals to conduct secure communications and electronic commerce on-line.
WebMD	7374	Provides connectivity and services to the healthcare industry to improve administrative efficiencies and clinical effectiveness.
BEA Systems	7371	A provider of e-commerce infrastructure software for companies to build e-commerce systems.
Priceline.com	7375	Provides an e-commerce service where customers enter prices they're willing to pay for products or services and then the Company contacts sellers to determine whether they can fulfil the customer's order.
Checkpoint Software	7372	Provides secure enterprise networking solutions for customers to implement centralised policy-based management with enterprise-wide distributed deployment.
Terra Networks	7375	Provides Internet access and local-language interactive content and services to Spanish and Portuguese-speaking residential and small office/home office customers in Spain, Brazil, Mexico, Peru, Chile and Guatemala.
Ameritrade	6211	Provides discount securities brokerage and clearing execution services and related financial services, including electronic trading and market data and research services.
Knight Trading	6712	Market maker in Nasdaq securities and in the over-the-counter Third Market in exchange-listed equity securities, primarily listed on the New York Stock Exchange and American Stock Exchange.
CMGI	6799	A diversified Internet operating and development company that operates in: Enterprise Software and Services, eBusiness and Fulfilment, and Managed Application Services.
Macromedia	7372	Software supplier to enables business users, developers and designers to create and deliver content on the Internet, fixed media, wireless and digital devices: Macromedia MX Products, Information Convenience Products, and Mobile and Device Products.
Research in Motion	4899	A designer, manufacturer and marketer of wireless solutions for the mobile communications market.
Quest Software	7372	Provides application and information availability software to enhance the performance and reliability of e-business, enterprise and custom applications and deliver information across the enterprise.
Openwave	7372	A provider of open Internet-based communication infrastructure software and applications, including wireless Internet infrastructure and browsers, unified messaging, mobile e-mail, directory services.
Doubleclick	7319	Provides interactive marketing and advertising solutions for a broad range of integrated media, technology and data solutions to advertisers, Web publishers and merchants.
Tibco Software	7373	Successor to a portion of the business of Teknekron Software, provides software solutions enabling businesses to integrate internal operations, partners, and customer channels.

Table A.12. **Top 50 Internet firms by activity** (*cont.*)

Company	Primary SIC	Activity
S1 Corp	7372	Provides enterprise software for financial organisations, including banks, credit unions, investment firms and insurance companies, to automate the channels for interaction with customers.
RSA SEC	7371	A provider of electronic security solutions for electronic businesses.
Internet Sec	7372	Provider of Internet security management solutions to protect distributed computing environments from attacks, misuse and security policy violations.
CNET Networks	7375	Media company producing a branded Internet network, a computer product database and television and radio programming for consumers and businesses.
PEC Solutions	7379	Provides professional technology services that enable government entities to utilise the Internet and other technologies to enhance productivity and improve services to the public.
Realnetworks	7371	Provider of media delivery and digital distribution solutions for the Internet, to enable consumers to experience and content providers to deliver multimedia content.
Sapient	7373	Provides a range of business and technology consulting services, identifying, implementing and supporting technology-enabled solutions.
Open Text	7372	Develops, markets, licenses and supports collaborative knowledge management application software for use on intranets, extranets and the Internet that enables users to find electronically stored information and work together.
Vignette	7372	Provider of Internet application software products and services, to create and extend business relationships with customers.
Freemarkets	7375	Provides software, services and information to help companies improve their sourcing and supply management processes and enhance the capabilities of their supply management organisation. The Company's customers are buyers of industrial parts, raw materials, commodities and services. The Company's solutions combine software, services and information to address the global supply management market.
Infospace	7373	Develops and delivers a wireless and Internet platform of software and application services, including re offering of its products and application services by customers to their customers.
Digital Insight	7375	Provides Internet banking services to credit unions, banks and savings and loans, including online banking, bill payment, cash management, target marketing and eCommerce portal capabilities.
Harris Interactive	7389	Market research and consulting firm that produces The Harris Poll, and has developed the Internet method to conduct market research.
Portal Software	7371	Develops, markets and supports real time customer management and billing software for providers of Internet based services.
Net Bank	6712	Bank holding company for Atlanta Internet Bank, a federally chartered Internet-based savings bank.
Red Hat	7372	Developer/provider of open source software and services, including Red Hat Linux operating system, whose publicly available source code can be copied, modified and distributed with minimal restriction.
Ask Jeeves	7389	Develops online personal service infrastructure to provided real-time access to information, products and services.
Digital River	7373	Provides comprehensive electronic commerce outsourcing solutions to software publishers and online retailers, with revenue primarily from transaction and service fees.
Valueclick	7311	Provider of Internet advertising for publishers of Web sites and online advertiser.
Lastminute.com	4724	Offers United Kingdom, France, Germany and Sweden consumers last-minute opportunities for airline tickets, hotel rooms, entertainment, restaurant reservations, speciality services, gifts and auctions.
ChinaDotCom	7375	A pan-Asian Internet company delivering content, community and commerce through its portal network to Chinese language audiences, emphasising the Greater China region.
Ulticom	7372	Provider of service-enabling signalling software for wireline, wireless and Internet communications, to interconnect complex switching, database and messaging systems, and manage number, routing and billing information.
Liberate Technologies	7372	Provides a range of infrastructure software and services for cable and telecommunications networks, including technologies specifically engineered to deliver interactive television services for digital television, and that automate many of the processes related to provisioning, deploying and managing high-speed Internet and telephony services over cable networks.

Source: OECD, compiled from company Web sites, Wall Street Research Network and MultexInvestor listings.

StatLink: http://dx.doi.org/10.1787/787415600200

Table A.13. **Primary SIC and activity of top 10 ICT firms by sector**

Company	Primary SIC	Activity
		Communication equipment and systems
Nokia	4813	Supplier of data, video and voice network solutions, mobile and fixed access solutions, and broadband and IP network solutions. Nokia is a leading manufacturer of mobile phones and a pioneer in digital multimedia terminals for digital TV and interactive services.
Motorola	3663	Provider of integrated communications solutions and embedded electronic solutions such as: software-enhance wireless telephone radio and satellite communications; embedded semiconductor products and embedded electronic systems.
Cisco Systems	3577	A worldwide leader in networking for the Internet. Cisco Internet Protocol based networking solutions are the foundation of the Internet and are installed at corporations, public institutions and telecommunication companies.
Alcatel	3669	Provider of communications equipment including ADSL equipment, terrestrial and submarine optical networks, public switching, fixed wireless access and intelligent network
Ericsson	3661	International leader in telecommunications, recognised for its advanced systems and products for wired and mobile communications in public and private networks. It also provides wireless communication and Internet-based technology.
Nortel Networks	3661	Engaged in the telecommunications equipment industry, which consists of the research and the design, development, manufacture, marketing, sale, installation, financing, support and servicing of enterprise, public carrier, wireless and broadband networks.
Lucent Technologies	4813	Designer, developer and manufacturer of communications systems, software and products. It sells public/private communications systems, supplies systems and software to network operators and service providers, and sells related microelectronic components.
L-3 Communications	3669	A supplier of secure communication systems and specialised communication products, including secure, high data rate systems, microwave components, avionics and ocean systems, and telemetry and space products.
Avaya	3661	A provider of communications systems and software for enterprises, including businesses, government agencies and other organisations.
Qualcomm	3663	Developer of code division multiple access (CDMA) technology that is one of the three main technologies used in digital wireless phone networks.
		Electronics and components
Siemens	8711	An electronics and engineering company that operates worldwide, delivering advanced solutions for e-business, mobile communications, manufacturing, transportation, health care, energy and lighting.
Hitachi	3511	Manufactures and markets a wide range of products, including computers, semiconductors, consumer products and power and industrial equipment. It is one of the world's leading global electronics companies.
Sony	3651	Engaged in the development, manufacture and sale of various kinds of electronic equipment, instruments and devices. It is also engaged worldwide in the development, production, manufacture and distribution of recorded music in all commercial formats.
Matsushita Electric	3651	Major producer of electronic and electric products. It offers a comprehensive range of products, systems and components for consumer, business and industrial use. Brand names include Panasonic, National, Technics, Quasar, Victor and JVC.
Samsung Electronics	3674	Large diversified electronics firm, with increasing activities in digital and mobile technologies.
Mitsubishi Electric	3674	Large conglomerate electronics firm.
Philips Electronics	3651	Products, systems and services are delivered in the fields of lighting, consumer products, consumer electronics, domestic appliances and personal care, components, semiconductors, medical systems and business electronics.
Intel	3674	World's largest semiconductor chip maker, supplies the computing and communications industries with chips, boards, systems and software that are integral in computers/servers and networking and communications products.
Canon	3861	Designs, develops and manufactures a variety of high-tech products including business machines and systems, cameras, computers, printers, faxes, semiconductor production equipment, medical equipment, typewriters and copiers.
Sanyo Electric	3663	Manufactures a broad range of electronic products, including AV, IT and communications equipment.
		IT equipment and systems
IBM	3571	Develops, manufactures, and sells information processing products, including computers and microelectronics technology, software, networking systems, and information technology-related services operating on a worldwide basis.

Table A.13. **Primary SIC and activity of top 10 ICT firms by sector** (*cont.*)

Company	Primary SIC	Activity
Hewlett-Packard	3571	Global provider of computing and imaging solutions and services for business and home, including: Imaging and Printing, Computing Systems, Information Technology Services, and Measurement Systems.
Toshiba	3621	An integrated manufacturer of electrical and electronic products spanning information and communications equipment and systems, including personal computer (PC) and other computer systems, storage devices, telecommunications equipment, etc.
NEC	3571	Provider of Internet solutions, dedicated to meeting the specialised needs of its customers in the key computer, network and electron device fields.
Fujitsu	3572	Provider of customer-focused information technology (IT) solutions for the global marketplace. Provides IT and communications solutions designed to help customers unleash the possibilities of the Internet for their business success.
Dell Computer	3571	World's largest direct computer systems company. Offers its customers a full range of computer systems, ranging from desktops to peripheral hardware; including computer software and related services.
Sun Microsystems	7373	Worldwide provider of products, services and support solutions for building and maintaining network computing environments. It sells scalable computer systems, high-speed microprocessors and a complete line of related high performance software.
Hon Hai Precision	3571	A global leader in providing mechanical solutions. It is the largest manufacturer of connectors for use in PCs in Chinese Taipei, and a leading manufacturer of connectors and cable assemblies around the world.
Seagate	3572	Founded in 1979, it was the first company to build 5.25„ hard disc drives specifically for the PC. Since then Seagate has been a major producer of disc storage devices.
Apple	3571	Designs, manufactures and markets personal computers and related personal computing and communication solutions. Recently launched i-tunes music business.
		IT services
EDS	7373	Professional services firm that applies consulting, information and technical expertise to enhance clients' business performance. Services include the management of computers, networks, information systems, business operations and related personnel.
Tech Data	5045	Provider of information technology products, logistics management and other value-added services. It distributes microcomputer hardware and software products to value-added resellers, corporate resellers, retailers, direct marketers and Internet resellers.
Accenture	8742	A provider of management and technology consulting services and solutions which help clients capitalise on their most important business and technology opportunities.
CSC	7373	One of the world leaders in the IT services industry. Its services include outsourcing, system integration and IT and management consulting and other professional services.
First Data	7374	Provides high-volume information processing and related services, payment instruments, card issuer services, and merchant processing services.
ADP	7374	Provides computerised transaction processing, data communication and information services, especially in payroll and human resources information management.
CapGemini Ernst and Young	..	Combined software, services and consulting business.
SAIC	7379	Largest US employee-owned research and engineering company, providing information technology, systems integration and e-solutions to commercial and government customers.
Unisys	7373	Worldwide information services and technology company, which provides services, systems and solutions that help customers apply information technology.
Affiliated Computer Services	7373	Global company delivering comprehensive business process and IT outsourcing solutions to commercial and government clients.
		Software
Microsoft	7372	Develops, manufactures, licenses and supports a wide range of software products for a multitude of computing devices, including scalable operating systems for servers.
Oracle	7372	Supplier of software for information management. Oracle develops, manufactures, markets and distributes computer software that is categorised as systems software and Internet business applications software.
SAP	7372	International developer and supplier of integrated business software designed to provide cost-effective comprehensive solutions for businesses.
Softbank	7372	Softbank is a provider of information infrastructure and distribution services to the computer industry in Japan.
Computer Associates	7372	A leading e-business software company. CA's solutions address all aspects of e-business process management, information management and infrastructure management.
Electronic Arts	7372	Creates, markets and distributes interactive entertainment software for a variety of hardware platforms.
Peoplesoft	7372	Designs, develops, markets and supports a family of enterprise application software products for use throughout large and medium-sized organisations, including corporations, higher education institutions, and government agencies.

Table A.13. **Primary SIC and activity of top 10 ICT firms by sector** (*cont.*)

Company	Primary SIC	Activity
Intuit	7372	Provider of small business, tax preparation and personal finance software products and services that simplify complex financial tasks for small businesses, consumers and accounting professionals.
Veritas Software	7372	An independent supplier of storage software products and services, including storage management, data protection and high availability software.
Amdocs	7372	Provides software products and services known as business support systems (BSS) to major communications companies.
		Telecommunication services
NTT	4813	Operates as a provider of fixed line and wireless voice transmission, data transmission, leased circuit, telecommunications equipment sales, systems integration, etc.
Verizon Communications	4813	Provider of wireline and wireless communications in the United States.
France Telecom	4813	Provides consumers, businesses and other telecommunications operators with a range of services, including fixed line and mobile telecommunications, data transmission, Internet, multimedia and other value-added services.
Deutsche Telekom	4813	A telecommunications services provider that organises its businesses into four main divisions: T-Com, T-Mobile, T-Systems and T-Online.
Vodafone	4899	Provides a range of mobile telecommunications services, including voice and data communications. It operates in 28 countries worldwide.
SBC Communications	4813	Provides communications services and products in the United States through its subsidiaries, including local exchange services, wireless communications, long-distance services, Internet services, telecommunications equipment and directory advertising and publishing.
AT&T	4813	Provides voice and data communications services, including domestic and international long distance, regional, local and Internet communications services.
Telecom Italia/Olivetti	4813	A fixed telecommunications operator, with approximately 27.1 million subscriber fixed lines installed (including ISDN equivalent lines). Through Telecom Italia Mobile it is also a mobile telecommunications operator.
BT	4813	Provides telecommunication services, principally in the United Kingdom. The Company's main services and products are fixed voice and data calls, the provision of fixed exchange lines.
Telefonica	4813	A telecommunications company that operates in Spanish and Portuguese speaking markets, providing a wide range of services, including fixed and mobile telephony, Internet and broadband, content, directories and applications.

Source: OECD, compiled from company Web sites, Wall Street Research Network and MultexInvestor listings.

StatLink: http://dx.doi.org/10.1787/036427787468

NOTES

1. All values are expressed in current USD.
2. Most of the top 250 firms have a significant share of sales outside their country of registration (base). For example, IBM earned almost 60% of its revenue from non-US sales in 2002, a share that has increased over time. Similarly, Nokia's top 10 markets in 2002 accounted for 50% of sales, but did not include Finland; 54% of its 2002 sales revenue came from Europe, 24% from Asia-Pacific and 22% from the Americas. Services firms also operate globally, with the largest IT services firm, EDS, earning around 45% of its 2002 revenue outside the United States. Firms registered in the Cayman Islands and Bermuda earn little or no revenue in their domestic market. Hence, top 250 firm performance is not necessarily related to domestic market conditions in their country of registration.
3. Other communications equipment and systems firms in the top 250 ICT firms enjoying rapid growth included: UTStarcom (with revenue increasing 52% a year), Nokia (11% a year), Qualcomm (7% a year) and Dassault Systemes (6% a year).
4. Other electronics and components firms in the top 250 enjoying rapid growth included: Nvidia (almost doubling revenue year on year), Sanmina (increasing revenue 34% a year following the merger with SCI) and Singapore-based Flextronics (24% a year).
5. Other IT services firms in the top 250 ICT firms enjoying rapid growth since 2000 included: Platinum Equity (with revenue increasing 60% a year), Infosys (55% a year), Software House International (30% a year), Affiliated Computer Systems and CGI Group (25% a year), DST Systems (21% a year) and SunGard Data Systems (18% a year). Just ten of the 38 IT services firms in the ICT top 250 experienced declining revenues between 2000 and 2003.
6. Microsoft also accounts for 40% of the total revenue of all 25 software firms in the ICT top 250.
7. No fewer than ten of the 25 software firms in the ICT top 250 have increased their R&D expenditures by more than 10% a year since 2000.

Annex B

METHODOLOGY AND DEFINITIONS

This annex describes the definitions and classifications adopted in Chapters 1 *and* 2 *of the present edition of the* Information Technology Outlook. *These definitions and classifications, and the data collected on that basis, draw wherever possible on work by the* OECD *Working Party on Indicators for the Information Society* (WPIIS) *which seeks to improve the international comparability and collection of statistics and data on the Information Economy and Information Society.*

Chapter 1

Short-term developments

Indicators are taken from the sources cited at the bottom of each graph. Refer to these sources for more details. Note that definitions of goods and services groupings vary across countries.

Major ICT *firms*

See Annex A for further details.

Semiconductors

Data are provided by the World Semiconductor Trade Statistics (WSTS), an industrial association of about 70 semiconductor manufacturers representing about 90% of the market in terms of value of production. WSTS collects revenue statistics directly from its members. The figures provided cover only the "commercial" (merchant) semiconductor market and not internal or "captive" consumption (*www.wsts.org*).

ICT *sector value added and employment*

To the extent possible, data on value added and employment were collected according to the official 1998 OECD industry-based definition of the ICT sector which comprises ICT goods and services. The existence of a widely accepted definition of the ICT sector is the first step towards comparisons over time and across countries. However, the definition is not yet consistently applied and data provided by Member countries have been combined with different data sources to estimate ICT aggregates that are compatible with national accounts totals. For this reason, the statistics presented here may differ from figures contained in national reports and in previous OECD publications (see OECD, 2003, *Science, Technology, and Industry Scoreboard* 2003, p. 96). When such data were not available, the footnotes clarify the scope for each country. The full official ISIC (International Standard Industrial Classification of All Economic Activities) Revision 3 codes are:

Manufacturing

3000 Manufacture of office, accounting and computing machinery.

3130 Manufacture of insulated wire and cable.

3210 Manufacture of electronic valves and tubes and other electronic components.

3220 Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy.

3230 Manufacture of television and radio receivers, sound or video recording or reproducing apparatus, and associated goods.

3312 Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment.

3313 Manufacture of industrial process control equipment.

Services: goods-related

5150 Wholesale of machinery, equipment and supplies.

7123 Renting of office machinery and equipment (including computers).

Services: intangible

6420 Telecommunications.

7200 Computer and related activities.

ICT *skilled employment*

See Chapter 6 for further details.

ICT *goods production*

Data on production of ICT goods were compiled from Reed Electronics Research, *Yearbook of World Electronics Data* 2004 and previous years. The six main groups that comprise ICT goods, and their corresponding Standard International Trade Classification (SITC) Revision 3 codes, are as follows:

- Electronic data processing (EDP) equipment: 752.1, 752.2, 752.3, 752.6, 752.7, 752.9, 759.9.
- Office equipment: 751.1, 751.2, 763.3, 763.8, 751.3, 759.1.
- Control and instrumentation: 778.7, 874.1, 874.2, 874.3, 874.4, 874.5, 874.6, 874.7
- Radiocommunications (including mobiles) and radar: 764.3, 764.8, 764.9, 874.1.
- Telecommunications: 764.1, 764.9, 763.8.
- Consumer equipment: 763.8, 764.8, 761.1, 761.2, 763.3, 763.8, 762.1, 762.2, 762.8, 881.1, 885.3, 885.4, 885.7, 898.2.
- Components: 776.2, 776.3, 776.4, 776.8, 771.1, 771.2, 778.6, 772.2, 772.3, 772.4, 772.5, 764.2, 764.9, 898.4, 761.1.

Research and development

To the extent possible, data on R&D expenditure in the ICT sector were collected according to the official OECD industry-based definition. Country footnotes explain actual coverage.

Venture capital

Data are drawn from the OECD venture capital database, which draws on publications provided by venture capital associations.

ICT *markets*

Data on markets were compiled from data provided directly by International Data Corporation (IDC), Framingham, Massachusetts. IDC defines information and communication technology (ICT) markets as revenue paid by businesses, households, government agencies and educational institutions to vendors for the following four main ICT segments:

1. IT hardware: servers, personal computers (PCs), workstations, data communications equipment and add-ons purchased from an external agent or corporation, including:
   - Computer system central units: basic CPU or central electronic complex, with initial memory, processor upgrades, cooling as necessary, etc., including multi-user systems (servers) and single-user systems (PCs and workstations).
   - Storage devices: including those sold initially with systems and those incorporated later as add-ons, for both multi-user and single-user systems.
   - Printers: both for multi-user systems and for PC/workstations.
   - Bundled operating systems: within system values, both single-user and multi-user.
   - Data communications equipment: LAN hardware and other data communication equipment.
2. Software: purchases of all software products and external customisation of computer programmes. This excludes expenses related to the internal (*e.g.* wages, rent) customisation of computer programmes and includes systems software and utilities, application tools and application solutions.
3. IT services: IT services provided to a corporation by an external agent, above and beyond the services provided by an internal information systems (IS) team. Includes IT consulting, implementation services, operations management, IT training and education, processing services and IT support services.
4. Telecommunications: expenditure on public network equipment (such as switching, transmission and mobile communications infrastructure), private network equipment (such as telephone sets, PBXs and key systems, mobile and other equipment) and telecommunications services (such as fixed and mobile telephony, switched data, leased lines and cable TV services).

Trade

ICT *goods*

The OECD, through the WPIIS, has developed a commodity-based definition of the ICT sector based on the CPC (Central Product Classification) and the Harmonised System (HS). A classification of ICT goods has been agreed. See "A proposed classification of ICT goods, document ref. DSTI/ICCP/IIS(2003)1/REV2", available at: *www.oecd.org/dataoecd/5/61/22343094.pdf*.

For ICT goods, the ICT commodities list is more accurate than the industry-based sector definition used previously, which only approximated the ICT sector. For ICT goods, trade data were extracted from the OECD International Trade Statistics Database (ITS).

Following the OECD proposed classification of ICT goods, the present publication groups the detailed codes of ICT goods into five broad categories: Telecommunications equipment, Computer and related equipment, Electronic components, Audio and video equipment, and Other ICT goods. Code details are provided in the above-mentioned publication.

Software goods, which are not included in the ICT goods classification listed above, were defined using the Harmonised System (HS) Rev. 2 and include the following product groups:

- 852431: discs, recorded, for laser reading systems, for reproducing phenomena other than sound or image.
- 852439: discs, recorded, for laser reading systems, for reproducing sound and image or image only.
- 852440: magnetic tapes, recorded, for reproducing phenomena other than sound or image.
- 852491: recording media (excluding those for sound or image recordings, discs for laser reading systems, magnetic tapes, cards incorporating a magnetic stripe and goods of Chapter 37).
- 852499: recorded media for sound or image reproducing phenomena, including matrices and masters for the production of records (excluding gramophone records, discs for laser reading systems, magnetic tapes, cards incorporating a magnetic stripe and goods of Chapter 37).

ICT *services*

For ICT services, an industry-based definition was used. The two ICT services sectors correspond to the following Balance of Payments Coding System (BPM5) categories (for a full list, see *www.imf.org/external/np/sta/bopcode/topical.htm*):

- 245: communications services
- 262: computer and information services.

Chapter 2

Trade performance indicators

Revealed comparative advantage

$$RCA_i^j = \frac{\left(X_i^j \middle/ X_T^j \right)}{\left(X_i^O \middle/ X_T^O \right)}$$ where X_i^j stands for exports for industry *i* from country *j*, X_T^j stands for total manufacturing exports from country *j*, and X_i^O denotes total OECD exports for industry *i*.

Grubel-Lloyd Index

$$GLI_i = \left[1 - \left|M_i - X_i\right| \left(M_i + X_i \right)\right]$$ where M_i and X_i stand for imports and exports for industry I respectively.

FDI *flows*

FDI data from the OECD *International Direct Investment Statistics Yearbook* cover the following ICT-related sectors (the corresponding ISIC Rev. 3 codes are in parentheses):

- Office machinery, computers, radio, TV and communication equipment (30, 32).
- Telecommunication services (642).

Mergers and acquisitions

Detailed analysis of cross-border M&As is based on Dealogic data (*www.dealogic.com*). Chapter 2 endnotes 5 to 11 provide information on definition, and on industry and geographical coverage.

A*nnex* C

TABLES

Table C.1.1. **OECD trade in ICT goods, 1996-2002**

USD millions and percentage growth

	1996	1997	1998	1999	2000	2001	2002	CAGR
EXPORTS								
Communication equipment	71 258	81 877	92 502	108 419	140 809	126 230	112 517	7.9
IT and related equipment	158 419	177 376	178 026	192 168	220 178	199 868	182 552	2.4
Electronic components	157 361	173 187	169 442	192 192	243 439	186 034	184 154	2.7
Audio and Video equipment	54 706	54 808	57 682	61 776	67 202	63 117	66 556	3.3
Other ICT related goods	53 022	56 331	57 386	59 929	69 274	67 871	69 081	4.5
Total ICT	494 766	543 579	555 038	614 485	740 902	643 120	614 860	3.7
ICT share of merchandise exports	13.0%	13.7%	13.9%	15.0%	16.7%	14.9%	13.9%	
IMPORTS								
Communication equipment	56 069	60 983	72 676	93 526	128 129	112 619	96 541	9.5
IT and related equipment	196 968	216 039	231 995	258 111	284 749	251 276	243 148	3.6
Electronic components	143 965	154 005	152 452	173 661	229 818	179 038	163 346	2.1
Audio and Video equipment	65 169	65 089	71 057	75 739	85 720	84 459	92 178	5.9
Other ICT related goods	46 254	47 973	49 989	52 499	59 165	59 755	59 997	4.4
Total ICT	508 426	544 089	578 171	653 536	787 580	687 147	655 210	4.3
ICT share of merchandise imports	13.3%	13.7%	14.3%	15.2%	16.5%	14.9%	13.9%	

Note: Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/225070133050

Table C.1.2. **OECD trade in ICT goods, 1996-2002**

USD millions and percentage growth

	Exports				Imports			
	1996	1999	2002	CAGR	1996	1999	2002	CAGR
Australia	2 111	1 754	1 678	–3.7	9 211	10 080	9 417	0.4
Austria	3 025	4 547	6 204	12.7	5 366	7 575	7 380	5.5
Belgium	8 463	9 547	10 561	3.8	9 534	11 810	12 713	4.9
Canada	12 080	15 730	11 953	–0.2	23 533	29 451	24 739	0.8
Czech Republic	885	1 339	4 790	32.5	2 732	2 886	5 838	13.5
Denmark	3 548	4 016	5 435	7.4	5 166	5 464	6 693	4.4
Finland	5 935	9 353	9 822	8.8	4 214	5 144	5 269	3.8
France	25 892	32 768	27 827	1.2	28 951	35 103	31 724	1.5
Germany	41 631	50 793	59 075	6.0	46 477	59 809	63 259	5.3
Greece	160	306	397	16.4	1 241	2 565	2 161	9.7
Hungary	664	5 944	8 941	54.3	1 485	5 836	8 676	34.2
Iceland	2	5	13	43.2	164	227	194	2.9
Ireland	13 271	23 523	27 198	12.7	9 302	14 543	17 726	11.3
Italy	13 046	11 781	11 278	–2.4	18 458	21 630	20 440	1.7
Japan	103 213	101 359	95 018	–1.4	47 858	48 874	55 099	2.4
Korea	29 171	45 061	55 021	11.2	21 000	28 155	32 288	7.4
Luxembourg	. .	1 110	1 300	. .	. .	1 139	1 283	. .
Mexico	16 410	30 432	36 154	14.1	14 774	26 834	32 701	14.2
Netherlands	25 022	35 395	31 583	4.0	25 021	38 619	29 848	3.0
New Zealand	232	178	189	–3.4	1 620	1 630	1 506	–1.2
Norway	1 301	1 502	1 345	0.6	3 208	3 585	3 505	1.5
Poland	648	1 272	2 190	22.5	2 989	4 707	5 172	9.6
Portugal	1 369	1 781	2 012	6.6	2 701	3 669	3 652	5.2
Slovak Republic	. .	409	624	. .	. .	904	1 423	. .
Spain	4 969	6 055	5 897	2.9	10 565	13 883	13 081	3.6
Sweden	11 164	15 098	8 783	–3.9	8 988	10 384	8 202	–1.5
Switzerland	4 141	4 337	3 604	–2.3	7 263	8 572	7 504	0.5
Turkey	504	924	1 714	22.6	2 592	4 759	3 813	6.6
United Kingdom	41 844	49 226	51 657	3.6	45 625	56 030	49 516	1.4
United States	124 066	148 940	132 596	1.1	148 391	189 669	190 385	4.2
Total	494 766	614 485	614 860	3.7	508 426	653 536	655 210	4.3

Note: Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/414422478450

Table C.1.3. **OECD trade in communication equipment, 1996-2002**

USD millions and percentage growth

	Exports				Imports			
	1996	1999	2002	CAGR	1996	1999	2002	CAGR
Australia	417	412	264	–7.3	1 606	2 495	1 989	3.6
Austria	261	562	965	24.4	642	1 663	1 461	14.7
Belgium	1 209	1 624	1 633	5.1	1 151	2 032	1 923	8.9
Canada	3 526	5 836	4 023	2.2	2 877	4 193	4 056	5.9
Czech Republic	72	87	584	41.6	647	568	718	1.8
Denmark	681	1 349	2 308	22.5	914	1 241	2 230	16.0
Finland	3 477	6 131	7 345	13.3	562	799	818	6.5
France	4 245	8 359	7 362	9.6	2 768	4 858	4 533	8.6
Germany	7 888	11 232	13 406	9.2	4 293	6 897	9 011	13.2
Greece	64	156	210	22.1	322	965	748	15.0
Hungary	30	66	2 928	114.0	391	488	1 082	18.5
Iceland	0	0	1	121.0	37	54	41	1.4
Ireland	889	3 434	2 228	16.6	419	1 762	1 613	25.2
Italy	2 210	2 978	2 683	3.3	2 476	4 773	4 286	9.6
Japan	10 407	8 490	5 212	–10.9	4 343	4 191	3 677	–2.7
Korea	2 099	5 073	11 269	32.3	1 713	1 713	1 787	0.7
Luxembourg	. .	220	540	. .	. .	317	524	. .
Mexico	2 144	5 372	7 447	23.1	1 488	3 380	3 002	12.4
Netherlands	1 608	3 115	2 337	6.4	1 805	4 680	3 497	11.7
New Zealand	81	85	71	–2.1	392	450	279	–5.5
Norway	470	500	410	–2.2	750	896	738	–0.3
Poland	75	100	180	15.6	662	1 310	1 291	11.8
Portugal	81	115	128	8.1	409	813	748	10.6
Slovak Republic	. .	39	33	. .	. .	154	257	. .
Spain	930	1 364	1 235	4.8	2 448	4 013	3 004	3.5
Sweden	5 752	10 052	4 533	–3.9	1 272	2 072	1 613	4.0
Switzerland	767	765	641	–3.0	1 076	1 483	1 245	2.5
Turkey	110	86	118	1.2	536	1 971	733	5.4
United Kingdom	7 224	11 381	16 263	14.5	6 882	10 075	8 767	4.1
United States	14 540	19 435	16 160	1.8	13 188	23 219	30 870	15.2
Total	71 258	108 419	112 517	7.9	56 069	93 526	96 541	9.5

Note: Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/125854776504

Table C.1.4. **OECD trade in computer and related equipment, 1996-2002**
USD millions and percentage growth

	Exports				Imports			
	1996	1999	2002	CAGR	1996	1999	2002	CAGR
Australia	1 270	779	805	–7.3	4 181	4 169	3 874	–1.3
Austria	520	781	1 360	17.4	1 761	2 304	2 201	3.8
Belgium	2 581	3 243	3 949	7.3	3 670	4 457	4 911	5.0
Canada	4 028	4 513	2 833	–5.7	8 359	9 772	8 633	0.5
Czech Republic	178	265	2 362	53.9	876	860	2 096	15.6
Denmark	990	916	1 083	1.5	2 323	2 247	2 270	–0.4
Finland	974	854	292	–18.2	1 369	1 611	1 199	–2.2
France	8 722	9 603	6 333	–5.2	11 957	13 922	11 751	–0.3
Germany	10 162	12 941	14 311	5.9	18 001	26 386	25 023	5.6
Greece	20	67	67	22.7	336	757	661	11.9
Hungary	34	3 317	2 378	103.2	322	1 804	2 030	35.9
Iceland	1	0	1	5.6	66	92	80	3.3
Ireland	9 609	15 671	15 222	8.0	6 017	8 733	7 893	4.6
Italy	4 438	3 151	2 268	–10.6	6 705	7 616	6 659	–0.1
Japan	27 913	25 672	23 139	–3.1	18 362	19 338	21 171	2.4
Korea	5 420	10 315	16 109	19.9	3 627	4 065	5 116	5.9
Luxembourg	. .	93	196	. .	. .	322	371	. .
Mexico	3 778	9 335	11 885	21.0	1 961	3 940	8 617	28.0
Netherlands	13 957	20 388	21 569	7.5	14 479	23 650	19 088	4.7
New Zealand	66	31	24	–15.4	666	652	661	–0.1
Norway	345	449	265	–4.3	1 395	1 609	1 550	1.8
Poland	59	80	97	8.5	978	1 420	1 419	6.4
Portugal	59	87	314	32.3	783	983	841	1.2
Slovak Republic	. .	130	78	. .	. .	276	350	. .
Spain	1 498	1 630	1 060	–5.6	3 393	4 012	3 710	1.5
Sweden	763	569	812	1.0	3 219	3 151	2 706	–2.9
Switzerland	816	1 162	480	–8.5	3 490	4 267	3 495	0.0
Turkey	15	56	35	14.6	658	1 022	846	4.3
United Kingdom	17 000	19 979	15 377	–1.7	17 927	25 519	20 487	2.2
United States	43 203	46 091	37 850	–2.2	60 087	79 155	73 441	3.4
Total	158 419	192 168	182 552	2.4	196 968	258 111	243 148	3.6

Note: Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/001241804074

Table C.1.5. **OECD trade in electronic components, 1996-2002**
USD millions and percentage growth

	Exports				Imports			
	1996	1999	2002	CAGR	1996	1999	2002	CAGR
Australia	131	217	215	8.6	1 225	1 062	827	–6.3
Austria	1 382	1 839	2 589	11.0	1 320	1 789	2 038	7.5
Belgium	1 523	1 512	1 489	–0.4	1 815	1 994	1 855	0.4
Canada	3 124	3 641	2 826	–1.7	7 521	8 780	4 597	–7.9
Czech Republic	491	760	1 107	14.5	496	774	2 114	27.3
Denmark	489	510	558	2.2	671	954	1 004	7.0
Finland	733	1 510	1 229	9.0	1 587	2 005	2 465	7.6
France	7 670	9 184	7 740	0.2	7 113	8 993	7 322	0.5
Germany	9 889	12 538	14 660	6.8	11 886	14 271	14 876	3.8
Greece	13	25	25	11.0	94	217	107	2.3
Hungary	314	704	1 571	30.8	380	1 731	4 294	49.8
Iceland	0	0	0	114.0	7	12	12	7.4
Ireland	2 103	3 358	7 957	24.8	1 994	3 304	7 419	24.5
Italy	3 719	3 391	4 069	1.5	4 849	4 293	3 932	–3.4
Japan	42 108	41 543	39 870	–0.9	15 707	15 777	19 232	3.4
Korea	14 348	24 439	20 398	6.0	10 528	19 040	20 608	11.8
Luxembourg	. .	340	105	. .	. .	289	131	. .
Mexico	4 080	5 432	4 182	0.4	8 240	14 816	14 916	10.4
Netherlands	5 215	6 634	2 391	–12.2	3 950	5 084	1 881	–11.6
New Zealand	38	34	52	5.1	135	172	175	4.5
Norway	158	171	210	4.8	365	373	322	–2.0
Poland	287	421	600	13.1	575	849	1 374	15.6
Portugal	482	633	729	7.1	736	965	1 182	8.2
Slovak Republic	. .	139	262	. .	. .	230	399	. .
Spain	737	1 094	1 115	7.1	1 550	2 091	2 057	4.8
Sweden	3 551	3 027	2 028	–8.9	2 707	3 273	1 737	–7.1
Switzerland	887	976	880	–0.1	1 052	1 126	966	–1.4
Turkey	45	54	55	3.4	688	979	1 398	12.6
United Kingdom	9 025	9 625	11 976	4.8	12 324	11 096	8 899	–5.3
United States	44 817	58 442	53 265	2.9	44 452	47 322	35 206	–3.8
Total	157 361	192 192	184 154	2.7	143 965	173 661	163 346	2.1

Note: Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/308527873188

Table C.1.6. **OECD trade in audio and video equipment, 1996-2002**

USD millions and percentage growth

	Exports				Imports			
	1996	1999	2002	CAGR	1996	1999	2002	CAGR
Australia	53	60	66	3.9	1 195	1 261	1 696	6.0
Austria	280	705	537	11.5	922	1 044	819	–2.0
Belgium	2 512	2 573	2 749	1.5	2 003	2 179	2 811	5.8
Canada	211	296	432	12.7	2 086	2 852	3 584	9.4
Czech Republic	32	115	535	59.6	310	321	424	5.4
Denmark	723	660	773	1.1	897	672	806	–1.8
Finland	198	140	174	–2.1	355	414	437	3.5
France	2 417	2 779	2 650	1.5	3 916	4 017	4 426	2.1
Germany	4 324	3 901	4 542	0.8	7 528	7 072	8 288	1.6
Greece	9	18	29	22.3	315	376	438	5.6
Hungary	209	1 745	1 742	42.4	214	1 515	867	26.2
Iceland	0	0	0	12.1	28	39	31	1.6
Ireland	400	622	476	3.0	643	426	468	–5.1
Italy	846	521	486	–8.8	2 172	2 395	2 962	5.3
Japan	13 753	17 078	17 974	4.6	5 551	5 604	6 779	3.4
Korea	6 831	4 710	6 566	–0.7	1 213	1 115	1 939	8.1
Luxembourg	. .	370	378	. .	. .	160	200	. .
Mexico	5 682	8 649	10 249	10.3	1 773	2 620	3 702	13.1
Netherlands	2 094	2 383	1 502	–5.4	3 078	3 383	3 597	2.6
New Zealand	7	3	3	–13.1	259	218	251	–0.5
Norway	39	55	68	9.5	378	397	533	5.9
Poland	169	610	1 179	38.2	347	674	619	10.1
Portugal	637	850	702	1.6	510	555	539	0.9
Slovak Republic	. .	62	183	. .	. .	84	196	. .
Spain	1 172	1 313	1 675	6.1	1 852	2 147	2 640	6.1
Sweden	291	588	505	9.6	840	980	1 241	6.7
Switzerland	135	108	117	–2.2	811	781	878	1.3
Turkey	310	693	1 466	29.6	269	307	296	1.6
United Kingdom	4 263	3 116	2 491	–8.6	4 599	5 064	6 395	5.6
United States	7 110	7 054	6 307	–2.0	21 104	27 066	34 316	8.4
Total	54 706	61 776	66 556	3.3	65 169	75 739	92 178	5.9

Note: Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/164867412725

Table C.1.7. **OECD trade in other ICT related goods, 1996-2002**
USD millions and percentage growth

	Exports				Imports			
	1996	1999	2002	CAGR	1996	1999	2002	CAGR
Australia	239	285	328	5.4	1 004	1 093	1 030	0.4
Austria	582	659	753	4.4	720	775	862	3.0
Belgium	639	595	741	2.5	896	1 148	1 213	5.2
Canada	1 190	1 443	1 838	7.5	2 690	3 854	3 869	6.2
Czech Republic	112	113	203	10.4	403	362	486	3.2
Denmark	665	581	713	1.2	361	350	384	1.0
Finland	552	718	781	6.0	341	316	349	0.4
France	2 838	2 843	3 743	4.7	3 198	3 313	3 692	2.4
Germany	9 368	10 180	12 156	4.4	4 768	5 182	6 062	4.1
Greece	55	40	66	3.2	174	250	207	3.0
Hungary	77	111	322	27.0	178	297	403	14.6
Iceland	1	5	12	52.2	25	30	32	3.6
Ireland	270	438	1 315	30.2	229	319	332	6.4
Italy	1 833	1 740	1 773	–0.6	2 256	2 553	2 601	2.4
Japan	9 031	8 576	8 823	–0.4	3 895	3 964	4 239	1.4
Korea	474	524	678	6.1	3 918	2 222	2 839	–5.2
Luxembourg	. .	86	80	. .	. .	51	57	. .
Mexico	726	1 644	2 392	22.0	1 313	2 079	2 463	11.1
Netherlands	2 148	2 875	3 784	9.9	1 709	1 822	1 785	0.7
New Zealand	39	26	38	–0.5	168	138	139	–3.1
Norway	288	327	392	5.3	320	311	362	2.1
Poland	57	60	134	15.2	428	455	469	1.5
Portugal	111	97	139	3.9	262	353	342	4.5
Slovak Republic	. .	39	68	. .	. .	159	221	. .
Spain	633	655	812	4.3	1 321	1 621	1 671	4.0
Sweden	806	861	905	2.0	950	907	905	–0.8
Switzerland	1 536	1 326	1 487	–0.5	834	914	920	1.7
Turkey	24	36	40	8.7	441	480	540	3.4
United Kingdom	4 332	5 125	5 549	4.2	3 893	4 275	4 968	4.1
United States	14 396	17 918	19 014	4.7	9 560	12 906	16 553	9.6
Total	53 022	59 929	69 081	4.5	46 254	52 499	59 997	4.4

Note: Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/520471457455

Table C.1.8. **OECD trade in software goods, 1996-2002**

USD millions and percentage growth

	Exports				Imports			
	1996	1999	2002	CAGR	1996	1999	2002	CAGR
Australia	22	63	60	18.3	197	478	336	9.3
Austria	213	894	1 080	31.1	152	344	339	14.3
Belgium	173	230	264	7.3	323	332	428	4.8
Canada	295	220	229	–4.1	829	1 118	1 028	3.7
Czech Republic	143	20	38	–19.8	72	107	63	–2.3
Denmark	115	126	135	2.7	179	244	179	0.0
Finland	30	60	40	4.9	115	121	149	4.4
France	428	497	581	5.2	980	1 031	1 165	2.9
Germany	734	816	1 774	15.8	946	1 236	1 211	4.2
Greece	24	29	16	–7.1	43	143	69	8.1
Hungary	15	32	19	4.1	9	99	111	51.7
Iceland	0	0	0	7.9	9	15	10	2.7
Ireland	3 567	3 521	2 097	–8.5	636	376	197	–17.7
Italy	89	97	80	–1.6	558	880	882	7.9
Japan	254	357	325	4.2	560	487	519	–1.3
Korea	27	78	166	35.6	438	334	575	4.6
Luxembourg	. .	19	84	. .	. .	46	77	. .
Mexico	36	21	67	11.1	178	254	282	8.0
Netherlands	569	906	891	7.8	521	497	516	–0.2
New Zealand	8	4	4	–12.5	74	70	61	–3.1
Norway	20	28	20	–0.4	149	208	177	2.9
Poland	38	29	49	4.6	16	49	73	28.6
Portugal	4	10	6	7.2	62	120	123	12.1
Slovak Republic	. .	5	10	. .	. .	22	32	. .
Spain	53	68	202	24.8	267	343	415	7.7
Sweden	87	133	548	35.9	266	226	320	3.1
Switzerland	305	152	182	–8.3	487	591	674	5.6
Turkey	11	15	6	–9.3	43	79	97	14.7
United Kingdom	1 102	955	1 314	3.0	1 137	1 592	1 613	6.0
United States	3 087	3 417	2 850	–1.3	698	828	917	4.6
Total	11 449	12 803	13 138	2.3	9 943	12 271	12 638	4.1

Note: Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/836466814663

Table C.2.1. **ICT goods trade as a share of total trade, 1996-2002**

Percentages

	1996	1997	1998	1999	2000	2001	2002
Australia	9.3	9.1	8.9	9.7	10.1	8.9	8.2
Austria	6.8	7.7	8.5	9.2	10.0	9.8	9.5
Belgium	5.5	5.6	5.9	6.2	6.9	7.2	5.6
Canada	9.9	10.0	9.9	9.9	11.3	9.0	7.7
Czech Republic	7.4	7.0	7.6	7.6	9.8	11.5	13.4
Denmark	9.1	9.7	9.7	10.2	10.8	10.3	11.6
Finland	14.2	15.8	18.2	19.7	22.5	19.8	19.3
France	9.8	10.6	11.4	11.4	12.6	11.1	9.8
Germany	9.2	9.5	10.1	10.9	12.4	12.0	11.4
Greece	3.7	4.8	6.1	7.1	7.2	6.4	5.9
Hungary	7.3	17.0	19.5	22.2	25.6	24.3	24.5
Iceland	4.2	4.4	5.0	5.1	6.4	4.7	4.6
Ireland	26.9	29.2	29.6	32.5	34.3	37.5	32.0
Italy	6.8	6.8	7.0	7.3	7.6	7.2	6.4
Japan	19.9	19.8	20.1	20.7	22.2	20.3	19.9
Korea	18.7	21.8	23.6	27.8	30.2	26.5	27.8
Luxembourg	. .	. .	. .	12.2	13.0	16.0	12.8
Mexico	16.8	17.5	19.1	20.6	22.2	23.1	21.1
Netherlands	14.7	17.1	19.9	21.9	23.5	21.2	18.1
New Zealand	6.4	6.4	6.9	6.9	7.3	6.1	5.9
Norway	5.3	5.7	6.6	6.4	5.4	5.5	5.1
Poland	5.9	6.6	7.5	8.2	8.1	8.0	7.7
Portugal	6.8	6.9	7.7	8.5	8.5	9.2	8.5
Slovak Republic	. .	6.1	6.4	6.2	5.9	6.6	6.6
Spain	6.9	6.7	7.1	7.7	7.7	7.2	6.5
Sweden	13.7	15.2	15.6	16.6	17.9	13.2	11.5
Switzerland	7.2	7.3	7.5	8.1	8.4	7.5	6.5
Turkey	4.6	5.3	6.7	8.4	8.7	6.1	6.4
United Kingdom	16.0	15.2	16.8	17.7	19.8	17.2	15.8
United States	19.2	19.4	18.9	19.7	20.8	18.3	17.4
OECD	13.1	13.7	14.1	15.1	16.6	14.9	13.9

Note: Partial totals based on available data.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/547807102806

Table C.2.2. **ICT goods export/import ratio, 1996-2002**

	1996	1997	1998	1999	2000	2001	2002
Australia	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Austria	0.6	0.6	0.6	0.6	0.7	0.8	0.8
Belgium	0.9	0.8	0.9	0.8	0.9	0.9	0.8
Canada	0.5	0.6	0.5	0.5	0.6	0.5	0.5
Czech Republic	0.3	0.4	0.5	0.5	0.5	0.7	0.8
Denmark	0.7	0.7	0.8	0.7	0.7	0.7	0.8
Finland	1.4	1.5	1.7	1.8	1.8	1.7	1.9
France	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Germany	0.9	0.9	0.9	0.8	0.9	0.9	0.9
Greece	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Hungary	0.4	0.9	1.0	1.0	1.0	0.9	1.0
Iceland	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Ireland	1.4	1.5	1.4	1.6	1.5	1.8	1.5
Italy	0.7	0.6	0.6	0.5	0.5	0.6	0.6
Japan	2.2	2.2	2.3	2.1	1.8	1.6	1.7
Korea	1.4	1.4	1.8	1.6	1.6	1.5	1.7
Luxembourg	. .	. .	. .	1.0	0.9	0.9	1.0
Mexico	1.1	1.1	1.1	1.1	1.1	1.0	1.1
Netherlands	1.0	1.0	1.0	0.9	1.0	1.0	1.1
New Zealand	0.1	0.1	0.2	0.1	0.1	0.1	0.1
Norway	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Poland	0.2	0.3	0.3	0.3	0.3	0.3	0.4
Portugal	0.5	0.5	0.5	0.5	0.5	0.5	0.6
Slovak Republic	. .	0.3	0.3	0.5	0.5	0.5	0.4
Spain	0.5	0.5	0.5	0.4	0.4	0.5	0.5
Sweden	1.2	1.3	1.2	1.5	1.4	1.0	1.1
Switzerland	0.6	0.5	0.5	0.5	0.5	0.5	0.5
Turkey	0.2	0.2	0.3	0.2	0.2	0.4	0.4
United Kingdom	0.9	0.9	0.9	0.9	0.8	1.0	1.0
United States	0.8	0.9	0.8	0.8	0.8	0.8	0.7
OECD	1.0	1.0	1.0	0.9	0.9	0.9	0.9

Note: Partial totals based on available data.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/082401148547

Table C.2.3. **Revealed comparative advantage in ICT goods, 1996-2002**

	1996	1997	1998	1999	2000	2001	2002
Australia	0.27	0.25	0.22	0.21	0.19	0.20	0.19
Austria	0.41	0.46	0.48	0.49	0.52	0.59	0.63
Belgium	0.38	0.36	0.38	0.36	0.37	0.43	0.35
Canada	0.49	0.50	0.49	0.44	0.49	0.38	0.34
Czech Republic	0.31	0.31	0.38	0.33	0.44	0.64	0.89
Denmark	0.54	0.57	0.59	0.55	0.52	0.55	0.70
Finland	1.13	1.23	1.44	1.49	1.52	1.47	1.58
France	0.70	0.72	0.77	0.72	0.72	0.70	0.66
Germany	0.63	0.62	0.63	0.63	0.66	0.69	0.71
Greece	0.11	0.14	0.17	0.19	0.26	0.25	0.27
Hungary	0.39	1.26	1.49	1.59	1.66	1.65	1.87
Iceland	0.01	0.01	0.01	0.02	0.04	0.03	0.04
Ireland	2.12	2.21	2.09	2.23	2.07	2.66	2.22
Italy	0.40	0.36	0.35	0.33	0.32	0.35	0.32
Japan	1.93	1.80	1.74	1.62	1.54	1.57	1.64
Korea	1.80	1.94	1.84	2.10	2.14	2.08	2.44
Luxembourg	. .	. .	. .	0.95	0.85	1.23	1.09
Mexico	1.32	1.35	1.52	1.49	1.39	1.62	1.63
Netherlands	1.08	1.17	1.36	1.39	1.37	1.36	1.30
New Zealand	0.13	0.12	0.18	0.10	0.09	0.08	0.10
Norway	0.20	0.21	0.27	0.22	0.14	0.17	0.16
Poland	0.20	0.26	0.33	0.31	0.27	0.33	0.38
Portugal	0.43	0.42	0.44	0.49	0.46	0.57	0.55
Slovak Republic	. .	0.23	0.26	0.27	0.23	0.30	0.31
Spain	0.37	0.35	0.37	0.36	0.32	0.35	0.34
Sweden	1.04	1.12	1.12	1.19	1.14	0.82	0.78
Switzerland	0.40	0.37	0.37	0.36	0.35	0.35	0.30
Turkey	0.17	0.18	0.28	0.23	0.24	0.25	0.34
United Kingdom	1.24	1.12	1.26	1.22	1.18	1.25	1.29
United States	1.53	1.49	1.43	1.43	1.40	1.39	1.38
OECD	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Note: Partial totals based on available data.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/603833435671

Table C.2.4. **Grubel Lloyd Index for ICTgoods trade, 1996-2002**

	1996	1997	1998	1999	2000	2001	2002
Australia	0.37	0.38	0.34	0.30	0.30	0.35	0.30
Austria	0.72	0.77	0.75	0.75	0.84	0.88	0.91
Belgium	0.94	0.91	0.93	0.89	0.93	0.92	0.91
Canada	0.68	0.72	0.71	0.70	0.77	0.69	0.65
Czech Republic	0.49	0.55	0.68	0.63	0.71	0.79	0.90
Denmark	0.81	0.85	0.87	0.85	0.85	0.85	0.90
Finland	0.83	0.79	0.74	0.71	0.71	0.73	0.70
France	0.94	0.97	0.97	0.97	0.95	0.94	0.93
Germany	0.95	0.96	0.92	0.92	0.93	0.93	0.97
Greece	0.23	0.24	0.21	0.21	0.33	0.31	0.31
Hungary	0.62	0.96	1.00	0.99	0.99	0.97	0.98
Iceland	0.02	0.03	0.03	0.05	0.08	0.08	0.13
Ireland	0.82	0.80	0.84	0.76	0.79	0.72	0.79
Italy	0.83	0.77	0.74	0.71	0.71	0.75	0.71
Japan	0.63	0.62	0.61	0.65	0.70	0.76	0.73
Korea	0.84	0.82	0.73	0.77	0.78	0.79	0.74
Luxembourg	. .	. .	. .	0.99	0.93	0.97	0.99
Mexico	0.95	0.94	0.93	0.94	0.97	0.98	0.95
Netherlands	1.00	0.99	0.98	0.96	0.99	0.98	0.97
New Zealand	0.25	0.26	0.35	0.20	0.19	0.21	0.22
Norway	0.58	0.60	0.59	0.59	0.56	0.60	0.55
Poland	0.36	0.41	0.46	0.43	0.44	0.51	0.59
Portugal	0.67	0.68	0.62	0.65	0.69	0.71	0.71
Slovak Republic	. .	0.47	0.51	0.62	0.63	0.64	0.61
Spain	0.64	0.67	0.65	0.61	0.60	0.63	0.62
Sweden	0.89	0.86	0.90	0.82	0.84	0.98	0.97
Switzerland	0.73	0.71	0.69	0.67	0.68	0.69	0.65
Turkey	0.33	0.33	0.43	0.33	0.31	0.54	0.62
United Kingdom	0.96	0.97	0.96	0.94	0.90	0.98	0.98
United States	0.91	0.93	0.90	0.88	0.88	0.89	0.82
OECD	0.99	1.00	0.98	0.97	0.97	0.97	0.97

Note: Partial totals based on available data.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/841740663036

Table C.2.5. **Worldwide FDI, cross-border M&As and activities of affiliates, 1990-2002**
USD billions in current prices, numbers of employees and percentages

	1990	2000	2001	2002	CAGR 1990 2002
FDI inflows	209	1 393	824	651	9.9
FDI outflows	242	1 201	711	647	8.5
FDI inward stock	1 954	6 147	6 607	7 123	11.4
FDI outward stock	1 763	5 992	6 319	6 866	12.0
Cross border M&As	151	1 144	594	370	7.8
Sales of foreign affiliates	5 675	15 680	18 517	17 685	9.9
Gross product of foreign affiliates	1 458	3 167	3 495	3 437	7.4
Total assets of foreign affiliates	5 899	21 102	24 952	26 543	13.4
Exports of foreign affiliates	1 197	3 572	2 600	2 613	6.7
Employment by foreign affiliates ('000)	24 262	45 587	53 581	53 094	6.7
GDP at factor cost	21 672	31 895	31 900	32 227	3.4
GFCF	4 819	6 466	6 680	6 422	2.4
Royalties and fees receipts	30	66	73	72	7.6
Exports of goods and non factor services	4 300	7 036	7 430	7 838	5.1
FDI inward flows as % GFCF	4.0	22.0	12.3	10.1	
FDI outward flows as % GFCF	4.7	20.6	10.6	10.1	
FDI inward stock as % GDP	8.9	20.0	20.7	22.1	
FDI outward stock as % GDP	8.4	19.6	19.8	21.3	

Note: GFCF = gross fixed capital formation.
Source: UNCTAD World Investment Report.

StatLink: http://dx.doi.org/10.1787/218426736233

Table C.2.6. **ICT-sector cross-border M&As, 1995-2003**
Number of announced and completed deals and value of deals, USD millions

	Announced number	Completed number	Value of announced USD millions	Value of completed USD millions
1995	399	376	30 966	27 153
1996	496	470	57 460	48 414
1997	745	707	89 137	89 809
1998	1 044	1 021	146 781	144 250
1999	1 863	1 765	372 967	311 928
2000	2 508	2 422	638 012	582 319
2001	1 895	1 810	151 396	233 529
2002	1 472	1 364	126 411	102 341
2003	1 145	972	73 293	81 309
Total	11 567	10 907	1 686 422	1 621 051

Source: Dealogic; OECD analysis.

StatLink: http://dx.doi.org/10.1787/417634068661

Table C.2.7. **Completed ICT-sector cross-border M&As by industry, 1995-2003**
Number of deals

	Communications equipment	IT equipment	Electronics equipment	IT services	IT wholesale	Media and content	Communications services
1995	28	25	61	96	60	43	63
1996	28	27	52	136	75	66	86
1997	59	57	86	208	85	51	161
1998	59	51	131	364	90	53	273
1999	79	59	155	693	110	165	504
2000	108	78	244	834	150	346	662
2001	87	38	218	766	99	205	397
2002	90	28	194	582	59	126	285
2003	51	18	141	374	51	102	235
Total	589	381	1 282	4 053	779	1 157	2 666

Note: ICT sector M&As are those in which the target reports a primary industry code in the ICT producing sector.
Source: OECD, based on Dealogic.

StatLink: http://dx.doi.org/10.1787/301513460017

Table C.2.8. **Completed ICT-sector cross-border M&As by industry, 1995-2003**

Value of deals, USD millions

	Communications equipment	IT equipment	Electronics equipment	IT services	IT wholesale	Media and content	Communications services
1995	1 352	1 121	2 382	4 186	1 369	6 318	10 424
1996	735	2 802	1 000	6 986	3 586	5 020	28 285
1997	2 563	2 089	5 599	5 369	5 725	8 718	59 746
1998	6 384	2 262	19 006	9 698	2 949	14 570	89 381
1999	12 991	7 080	14 631	29 218	2 384	16 288	229 336
2000	87 658	13 935	33 611	34 130	5 488	35 646	371 850
2001	19 507	3 712	20 317	18 656	1 496	14 491	155 350
2002	2 274	9 640	8 367	7 708	1 990	13 004	59 357
2003	4 175	922	7 334	8 336	2 686	10 726	47 130
Total	137 640	43 563	112 247	124 287	27 674	124 782	1 050 859

Note: ICT sector M&As are those in which the target reports a primary industry code in the ICT producing sector.
Source: OECD, based on Dealogic.

StatLink: http://dx.doi.org/10.1787/227351754630

Table C.2.9. **Completed ICT-sector cross-border M&As by country of target, 1995-2003**

Value of deals, USD millions

	1995	1996	1997	1998	1999	2000	2001	2002	2003
Australia	2 522	475	12 044	664	14 710	1 836	9 125	1 313	1 245
Austria	0	22	771	5 586	36	1 645	184	785	17
Belgium	323	2 485	46	31	1 092	6 089	4 729	589	159
Canada	1 976	281	390	1 996	13 450	75 617	5 422	2 300	2 019
Czech Republic	1 469	34	0	285	214	969	503	109	1 053
Denmark	1	4	263	3 519	1 479	3 855	551	1 411	37
Finland	3	541	7	1 491	324	2 461	748	8 519	266
France	1 045	996	13 342	9 324	6 551	8 164	11 881	1 849	5 726
Germany	1 041	14 244	2 028	3 396	6 682	97 189	22 454	6 805	13 274
Greece	0	528	0	2 231	2 936	16	89	315	683
Hungary	852	12	1 205	162	402	4 001	64	920	405
Iceland	0	0	0	0	0	0	7	56	9
Ireland	30	294	1 031	168	6 201	3 963	5 803	682	149
Italy	1 843	2 031	11 431	2 188	9 403	6 428	439	1 671	1 136
Japan	263	761	556	18 442	17 795	15 040	13 198	647	6 962
Korea	0	0	0	2 294	1 538	3 002	7 642	9 861	635
Luxembourg	0	1 140	0	277	911	2 399	1	8 176	314
Mexico	86	23	867	400	11	20 701	1 192	1 810	19
Netherlands	500	132	4 000	11 756	13 598	22 565	926	7 061	7 961
New Zealand	6	141	32	411	145	42	142	825	156
Norway	0	0	279	36	1 327	6 258	588	213	275
Poland	56	14	9	932	877	6 275	1 487	272	520
Portugal	1 016	1 115	2 073	0	1 545	1 169	924	276	769
Slovak Republic	0	0	0	0	41	911	180	8	0
Spain	1 982	294	7 862	173	3 423	16 342	2 780	2 490	3 099
Sweden	0	843	607	343	2 425	12 279	925	1 751	1 397
Switzerland	180	23	613	8 802	703	6 792	8 449	96	2 716
Turkey	24		0	23	0	1 942	0	1	
United Kingdom	6 718	2 987	2 980	5 604	67 456	104 381	25 105	5 471	6 034
United States	2 099	11 879	11 340	27 737	103 193	57 649	77 566	13 329	10 797
Non-member	3 081	6 886	15 261	34 582	31 229	86 398	27 751	19 617	10 592
Unspecified	39	228	772	1 399	2 232	5 942	2 676	3 115	2 886
Total World	27 153	48 414	89 809	144 250	311 928	582 319	233 529	102 341	81 309
Total OECD	24 033	41 300	73 776	108 269	278 466	489 979	203 102	79 609	67 830

Note: Unspecified refers to cases where there is no individually specified country target.
Source: OECD, based on Dealogic.

StatLink: http://dx.doi.org/10.1787/465267182085

Table C.2.10. **Completed ICT-sector cross-border M&As by country of bidder, 1995-2003**
Value of deals in USD millions

	1995	1996	1997	1998	1999	2000	2001	2002	2003
Australia	398	441	3 132	82	2 447	653	13 574	1 529	8 033
Austria	45	0	0	0	1	244	161	41	72
Belgium	8	1 237	161	334	1 030	813	390	72	0
Canada	850	4 113	939	23 814	2 915	26 491	5 269	571	1 734
Czech Republic	0	0	0	0	0	0	0	4	0
Denmark	0	9	406	42	418	934	1 463	66	1 196
Finland	8	0	316	739	1 610	2 293	515	537	149
France	167	273	3 059	9 538	13 349	78 282	8 902	8 207	9 307
Germany	3 141	829	3 575	1 814	59 186	22 081	41 285	4 387	129
Greece	0	0	0	818	0	135	26	1	285
Hungary	0	0	0	18	40	2	0	0	0
Iceland	0	0	0	0	0	0	16	20	20
Ireland	7	24	27	138	209	489	332	70	0
Italy	139	728	2 841	8 462	5 844	10 489	3 787	49	841
Japan	1 104	1 852	1 437	1 457	1 480	12 897	12 381	2 309	102
Korea	1 150	319	178	33	23	0	16	24	93
Luxembourg	61	14	0	551	1 384	6 988	5 281	575	78
Mexico	0	0	96	0	0	213	300	569	864
Netherlands	1 324	1 297	3 838	1 572	7 656	22 506	7 951	3 556	79
New Zealand	10	0	0	0	830	262	218	2	8
Norway	153	1	161	393	778	3 881	531	1 203	46
Poland	0	0	0	0	0	0	0	0	0
Portugal	0	0	0	3 163	156	2 409	1 274	854	82
Slovak Republic	0	0	0	0	0	0	0	0	0
Spain	200	0	1 843	8 103	1 644	33 653	3 434	1 964	53
Sweden	14	218	297	2 257	660	6 569	929	8 642	264
Switzerland	204	368	9	551	4 299	1 061	898	45	577
Turkey	0	0	0	0	0	0	0	61	0
United Kingdom	1 761	6 772	7 082	7 567	76 398	57 270	40 293	5 229	8 881
United States	7 690	4 144	12 021	21 342	33 071	57 113	35 021	16 618	11 842
Non-member	519	1 722	3 253	8 969	24 861	57 724	14 284	13 208	4 610
Unspecified	8 199	24 053	45 138	42 492	71 639	176 865	35 001	31 927	31 964
Total World	27 153	48 414	89 809	144 250	311 928	582 319	233 529	102 341	81 309
Total OECD	18 435	22 638	41 418	92 789	215 428	347 729	184 244	57 206	44 735

Note: Unspecified refers to cases where there is no individually specified country bidder.
Source: OECD, based on Dealogic.

StatLink: http://dx.doi.org/10.1787/284413102732

Table C.2.11. **China's trade in ICT goods, 1996-2002**
USD millions and percentage growth

	1996	1997	1998	1999	2000	2001	2002	CAGR
Exports								
Communication equipment	2 417	2 685	3 004	3 738	6 675	8 759	10 801	28.3
IT and related equipment	5 317	7 513	10 168	11 697	16 577	21 076	33 253	35.7
Electronic components	3 782	4 922	5 781	7 766	11 263	11 371	15 520	26.5
Audio and video equipment	6 283	7 168	7 501	8 453	11 165	12 616	17 855	19.0
Other ICT-related goods	785	906	965	1 009	1 316	1 483	1 948	16.3
Total ICT	18 584	23 194	27 419	32 663	46 996	55 305	79 377	27.4
Imports								
Communication equipment	2 861	2 453	4 427	4 904	6 297	7 416	6 792	15.5
IT and related equipment	2 877	3 864	5 300	6 968	9 883	11 607	15 929	33.0
Electronic components	7 375	9 664	12 149	18 386	28 432	31 333	44 849	35.1
Audio and video equipment	1 889	1 989	1 961	2 345	2 920	2 796	3 978	13.2
Other ICT-related goods	1 848	1 618	1 677	2 169	3 065	4 117	4 900	17.6
Total ICT	16 850	19 588	25 514	34 771	50 597	57 269	76 447	28.7

Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/474251208235

Table C.2.12. **Foreign-owned enterprises in Sweden's ICT sector, 2001**

Numbers and percentage shares

	Enterprises	Employees	Sector employment	Share of total employees
Manufacturing				
Office machinery	4	461	1 207	38
Computers	8	195	2 288	9
Cable and wire	6	1 273	12 353	10
Electronic components	19	1 960	6 154	32
Communication equipment	6	6 392	35 277	18
Radio and TV	7	1 393	5 014	28
Industrial equipment	25	2 360	6 526	36
Instruments	7	2 307	2 790	83
Total manufacturing	82	16 341	71 609	23
Services				
Electrical wholesale	143	6 177	11 875	52
Office machinery wholesale	169	7 102	21 716	33
Other equipment wholesale	501	11 052	27 350	40
Total ICT wholesale	813	24 331	60 941	40
Renting office machinery	14	169	349	48
Telecommunications	60	4 863	26 126	19
Hardware consultancy	8	210	3 433	6
Software consultancy	416	20 050	74 174	27
Data processing	23	2 532	6 226	41
Database services	11	589	1 469	40
Maintenance	9	1 158	1 750	66
Other computer related services	20	553	1 213	46
Total computer services	487	25 092	88 265	28
Total	1 456	70 796	247 290	29
Total all industries	7 821	520 081		

Source: NUTEK, 2001.

StatLink: http://dx.doi.org/10.1787/838678484073

Table C.2.13. **Swedish-owned ICT sector enterprises operating overseas, 2001**

Numbers and percentage shares

	Firms	Jobs	Share
Total			
ICT equipment manufacturing	17	103 705	6.8
Office machinery	6	875	0.1
Communication equipment	11	102 830	6.7
ICT services	84	117 355	7.7
Communications and post	9	71 865	4.7
Computer and related services	75	45 490	3.0
Total ICT	202	442 120	28.9
All industries	854	1 532 177	100.0
Abroad			
ICT equipment manufacturing		59 587	6.0
Office machinery		369	0.0
Communication equipment		59 218	6.0
ICT services		21 900	2.2
Communications and post		6 886	0.7
Computer and related services		15 014	1.5
Total ICT		162 974	16.5
All industries		987 499	100.0
Sweden			
ICT equipment manufacturing		44 118	8.1
Office machinery		506	0.1
Communication equipment		43 612	8.0
ICT services		95 455	17.5
Communications and post		64 979	11.9
Computer and related services		30 476	5.6
Total ICT		279 146	51.2
All industries		544 678	100.0

Source: NUTEK, 2001.

StatLink: http://dx.doi.org/10.1787/275162856107

Table C.2.14. **IMF balance of payments categories**

7	**Computer and information services**
7.1	Computer services
7.2	Information services
7.2.1	News agency services
7.2.2	Other information provision services
9	**Other business services**
9.1	Merchanting and other trade related services
9.1.1	Merchanting
9.1.2	Other trade related services
9.2	Operational leasing services
9.3	Miscellaneous business, professional, and technical services
9.3.1	Legal, accounting, management consulting, and public relations
9.3.1.1	Legal services
9.3.1.2	Accounting, auditing, bookkeeping, and tax consulting services
9.3.1.3	Business and management consulting, and public relations
9.3.2	Advertising, market research, and public opinion polling
9.3.3	Research and development
9.3.4	Architectural, engineering, and other technical services
9.3.5	Agricultural, mining, mining, and on site processing services
9.3.5.1	Waste treatment and depollution
9.3.5.2	Agricultural, mining and other on site processing services
9.3.6	Other business services
9.3.7	Services between related enterprises, n.i.e.

Source: OECD (2002a).

StatLink: http://dx.doi.org/10.1787/846281800327

Box C.3.1. **Business ICT diffusion in selected OECD countries, 1994-2003 survey methodology**

Chapter 3 relies on statistical surveys conducted by national statistical offices (or other government collection agencies) and other statistical surveys.

The official surveys are usually based on postal questionnaires that concentrate on Internet processes. They tend to emphasise e-commerce but sometimes also cover integration of orders/purchases systems with other ICT systems and information sharing facilitated by ICT, by type of information and recipient and other e-business aspects. Among the results used here are those of: Australia (Australian Bureau of Statistics, ABS), Canada (Statistics Canada), EU (European Community Survey on ICT Usage), United States (Bureau of the Census).

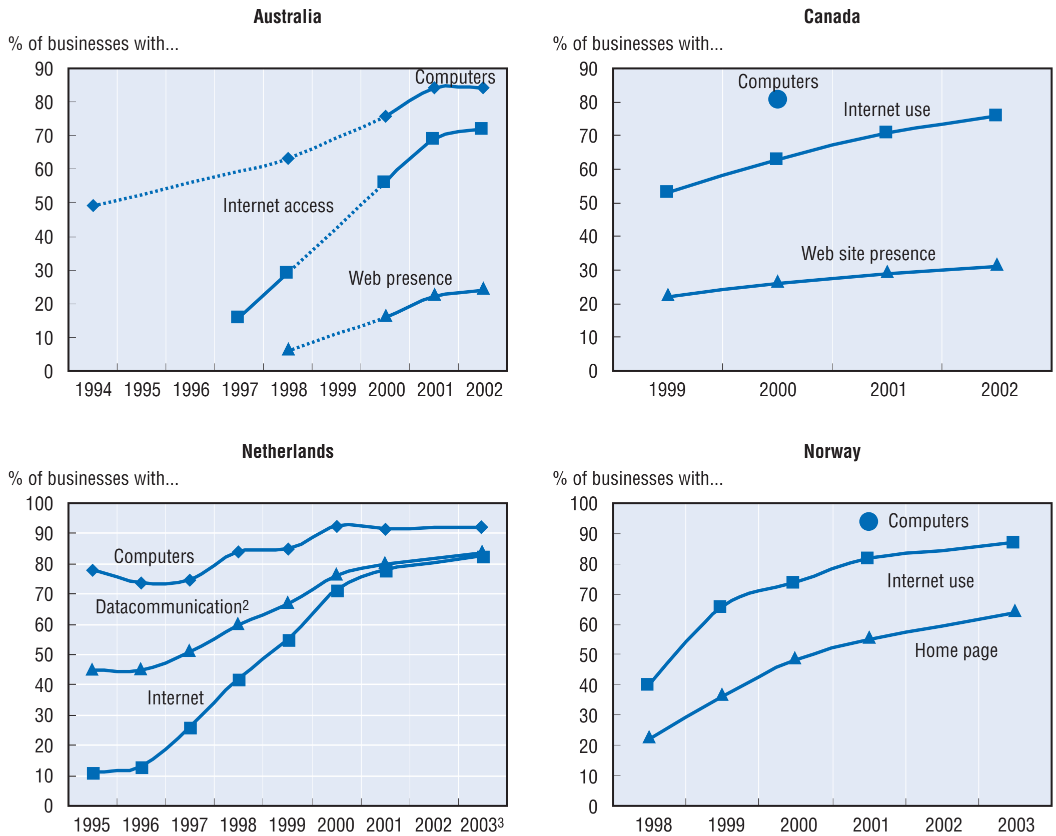
Among the other statistical surveys used are the following:

- Empirica (European e-Business Watch, *www.ebusiness-watch.org*) In 2002-03, 15 sectors of the European economy covered through telephone interviews of a sample of 10 500 enterprises, randomly drawn from selected sectors. Firms with 0-9, 10-49, 50-249, and 250+ employees are included. The data are mostly for EU4 (Germany, France, United Kingdom, Italy) or EU5 (EU4 plus Spain) and are weighted either by the number of enterprises (% of enterprises) or by employment (enterprises comprising X% of employment).
- 2003 International Benchmarking Study of the UK Department of Trade and Industry (DTI) (*www.ukonlineforbusiness.gov.uk/benchmarking2003/PDFs/dti-2003_exec_summ.pdf*). Using telephone interviews, it covered businesses in 11 countries (United Kingdom, Australia, Canada, France, Germany, Italy, Japan, Ireland, Korea, Sweden and the United States). Over 8 000 businesses of all sizes in eight sectors were questioned, including 3 114 in the United Kingdom and 500 in each of the other ten countries. All data are weighed by employment.
- B2B Metrics project of the IFO *Institute for Economic Research*, Nomura Research Institute, Prest, University of Manchester, RCS Conseil and VATT commissioned by the Directorate General Information Society of the EU (*www.b2b-metrics.de/aims.htm*). German 2003 mail surveys cover the automotive value chain, co-operative wholesale distribution and multinational retail chains (including mail order). The German sample contained 1 200 firms from the automotive value chain and 372 from the distribution segment. The Japanese sample consisted of 602 firms from the automotive chain and 391 from distribution, the Finnish of 45 (automotive) and 70 (distribution).
- E–business Nordic.com survey (*www.pls.dk/homepage/uk/news/2003/index_EBusinessNordic2003.html*). In 2003 telephone interviews covered over 4 300 businesses with at least ten employees in Denmark, Finland, Norway and Sweden.

The latter type of survey may raise the following problems:* they may not include small to very small firms, response rates may be smaller (replies to official surveys are sometimes mandatory) and may have problems of self-selection (increasing the effect of non-response bias), questions are more difficult to validate owing to interview method and resource constraints for following up non-response and they may not produce long time series. However, most of these problems can also arise in official surveys. The advantages of phone-based interviews run by entities that are not national statistical offices may be that results to inform policy makers can be obtained faster, more cheaply and without long initial lead times. Questions can be more tailored and explained (especially to smaller firms), and they can delve more deeply into more complex questions relating to e-business (internal and external integration, use of ICTs in production and R&D, etc.).

* These points benefited from discussions with Ivan Bishop (UK Department of Trade and Industry), Hannes Selhofer (Empirica) and Sheridan Roberts (OECD).

Figure C.3.1. **Business ICT diffusion in selected OECD countries, 1994-2002/2003**[1]



1. Share of businesses with 1 and more employee at the end of June for Australia; with 5 and more employees for the Netherlands.
2. External data communication *via* computer-mediated networks (public Internet, secured networks, older EDI etc.)
3. Forecasts of the businesses in the 2001-2003 *Automatiseringsenquête* Survey.

Source: OECD, based on data from national sources.

Table C.3.1. **Use of ICTs to improve the efficiency of internal business processes**

EU5 by sector (2003)	To share documents/ collaborative work	To automate travel reimbursement	To track working hours/ production time	To support human resources management
2003 total (EU5, 7 sectors)	39	13	21	20
Food, beverages and tobacco	34	6	17	13
The chemical industries	55	18	34	29
Electrical machinery and electronics	54	26	36	36
Transport equipment	50	17	41	33
Retail	26	7	9	11
Tourism	32	5	9	13
ICT services	72	36	52	47
EU5 by country (2003)				
Germany	39	19	28	19
Spain	37	11	14	18
France	35	1	14	17
Italy	34	12	20	18
United Kingdom	47	14	23	28

Notes: Figures for sectors, countries and totals are employment-weighted {read: "enterprises comprising […] % of employment (within a sector/ country)"}. Figures for size-classes are to be read as "% of enterprises (within a size-class)". Base: all enterprises. N = 3515 for EU5, 7 sectors. N-100 per sector in one country. EU5 includes Germany, Spain, France, Italy, United Kingdom. EU4 omits Spain.

Source: e-Business W@tch (2003).

StatLink: http://dx.doi.org/10.1787/877306377201

Table C.3.2. **E-business processes, EU5, 2003**

Sector	E-product design*	On line collaboration to forecast product demand	On line management of capacity/ inventory	On line exchange of documents with suppliers	On line exchange of documents with customers
Total (EU5, 7 sectors)	20	14	16	44	37
Food, beverages and tobacco	11	12	13	44	41
The chemical industries	15	14	21	43	44
Electrical machinery and electronics	21	17	20	47	43
Transport equipment	44	20	19	5	59
Retail	12	11	13	41	22
Tourism	13	11	12	37	31
ICT services	44	26	21	50	61
EU5 *by size-class* (2003)					
0-49 employees	12	10	9	37	28
50-249 employees	18	13	16	42	39
250+ employees	22	18	22	49	44
EU5 *by country* (2003)					
Germany	20	10	12	38	34
Spain	12	16	16	51	42
France	21	18	13	45	42
Italy	18	12	19	34	28
United Kingdom	24	19	20	53	43

Notes: Figures for sectors, countries and totals are employment weighted {read: "enterprises comprising […] % of employment (within a sector/ country)"}. Figures for size classes are to be read as "% of enterprises (within a size class)". Base: all enterprises. N = 3515 for EU5, 7 sectors. N-100 per sector in one country. EU5 includes Germany, Spain, France, Italy, United Kingdom. EU4 omits Spain.

* E product design = on line collaboration of business partners for designing products/services.

StatLink: http://dx.doi.org/10.1787/060108502250

Table C.3.3. **E-business software solutions, EU5, 2003**

EU5 by sector (2003)	CRM	SCM	ERP
Total (EU5, 7 sectors)	15	8	24
Food, beverages and tobacco	10	5	21
The chemical industries	16	14	48
Electrical machinery and electronics	24	11	46
Transport equipment	25	20	72
Retail	7	5	12
Tourism	13	3	7
ICT services	42	15	27
EU5 *by size-class* (2003)			
0-49 employees	6	4	9
50-249 employees	17	7	28
250+ employees	23	13	44
EU5 *by country* (2003)			
Germany	22	12	39
Spain	7	12	11
France	14	5	21
Italy	11	5	27
United Kingdom	16	5	12

Notes: Figures for sectors, countries and totals are employment weighted {read: "enterprises comprising […] % of employment (within a sector/ country)"}. Figures for size-classes are to be read as "% of enterprises (within a size-class)". Base: all enterprises. N = 3515 for EU5, 7 sectors. N-100 per sector in one country. EU5 includes Germany, Spain, France, Italy, United Kingdom. EU4 omits Spain.

StatLink: http://dx.doi.org/10.1787/102510732026

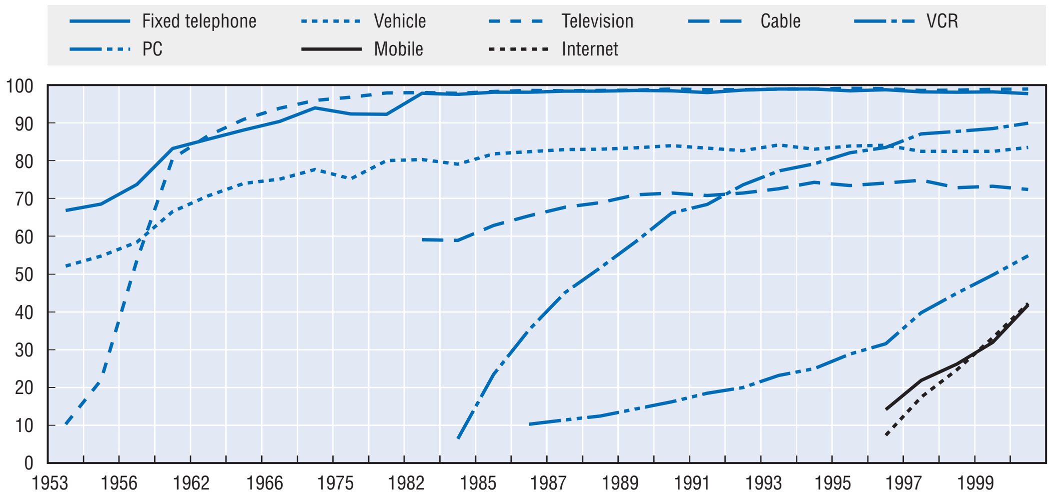
Table C.3.4. **E-business impact on operations, by size class and sector, EU4, 7 sectors 2002-03**

Companies saying that e-business has at least some significance for the way they operate			
	2002	2003	Weighting
< 50 employees	47	49	Enterprise
50-249 employees	55	63	Enterprise
250+ employees	60	66	Enterprise
Total	54	59	Employment
Importance of e-business across sectors (as perceived by companies)			
	Very important	Some importance	weighting
Food and beverages	7	36	Employment
Chemical industries	7	52	Employment
Electronics	14	53	Employment
Transport equipment	5	73	Employment
Retail	7	39	Employment
Tourism	18	43	Employment
ICT services	33	51	Employment

Note: 7 sectors. Data weighting indicated in right-hand column.
Source: e Business W@tch, Base: all enterprises, EU5 (Germany, Spain, France, Italy, Great Britain).

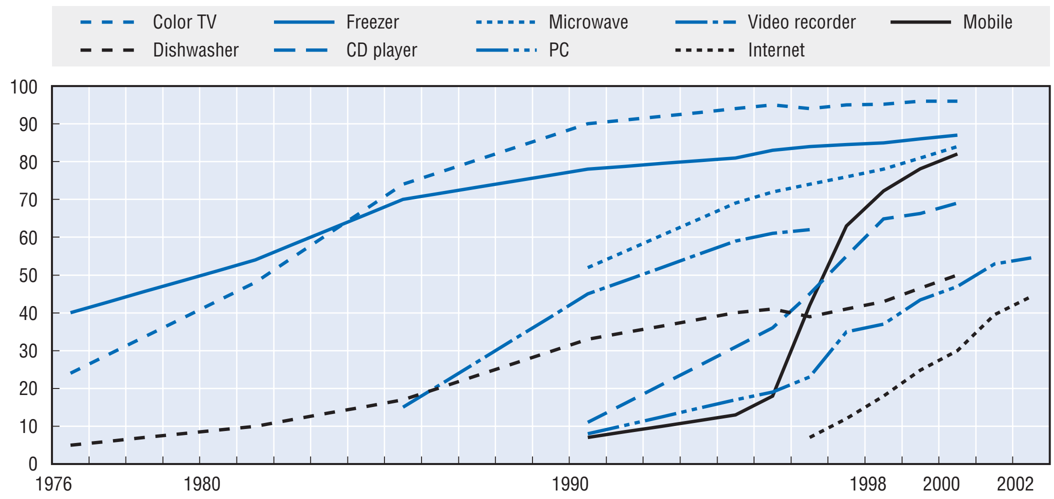
StatLink: http://dx.doi.org/10.1787/318681050237

Figure C.4.1. **Historical diffusion of selected goods, Canada**
Percentage of diffusion in households



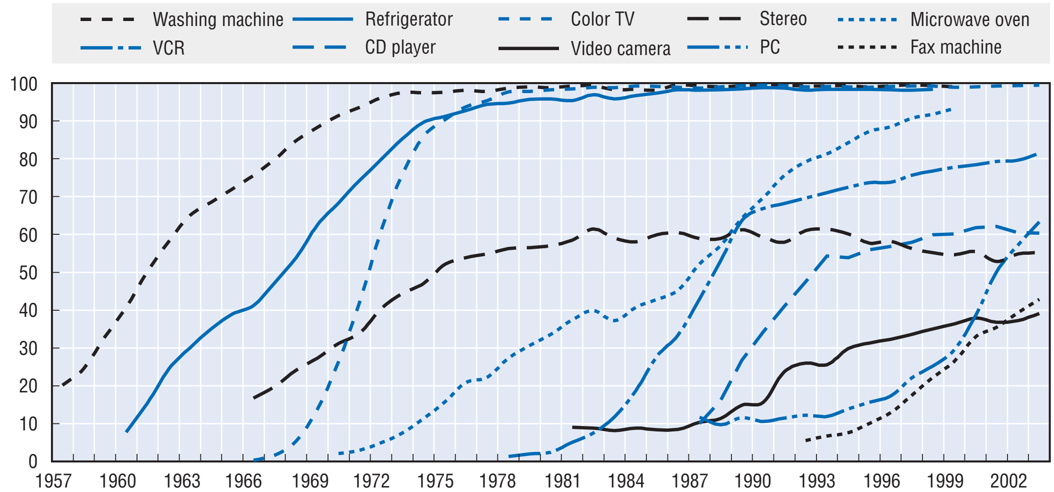
Source: Sciadas (2002b).

Figure C.4.2. **Historical diffusion of selected goods, Finland**
Percentage of diffusion in households



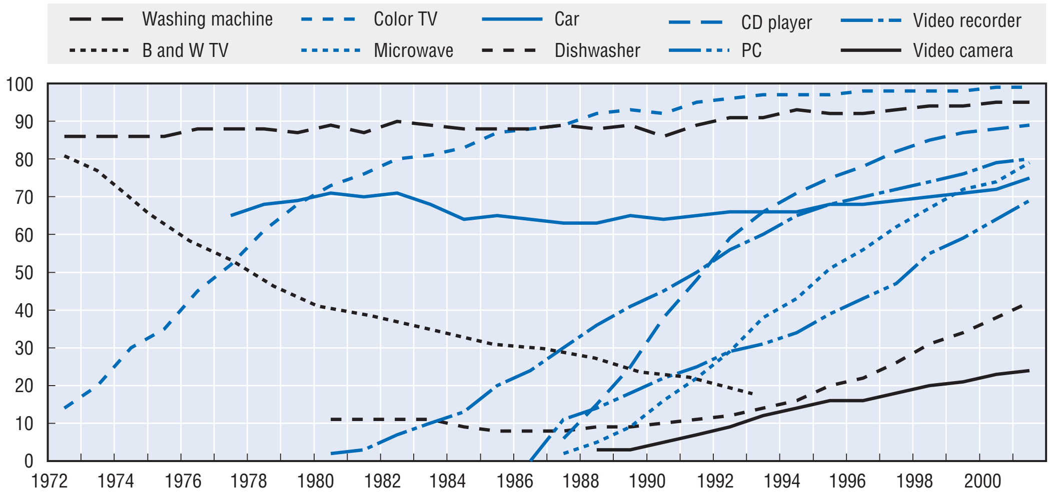
Source: Statistics Finland (2003).

Figure C.4.3. **Historical diffusion of selected goods, Japan**
Percentage of diffusion in households



Source: OECD, based on data from the Economic and Planning Agency, Japan.

Figure C.4.4. **Historical diffusion of selected goods, Netherlands**
Percentage of diffusion in households



Source: OECD, based on data from Statistics Netherlands.

Table C.4.1. **Households and individuals with access to a home computer in selected OECD countries, 1986-2003**

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	Percentage of households																	
Australia									26.9		33.5		44.0	47.0	53.0	58.0	61.0	
Austria[1]															34.0		45.4	49.3
Belgium														45.4			44.6	
Canada[2]	10.3				16.2	18.5	20.0	23.0	25.0	28.8	31.6	36.4	40.6	50.0	61.3	64.0		
Denmark					15.0			27.0	33.0	37.0	45.0	48.0	53.0	60.0	65.0	69.6	72	
Finland[1]					8.0				17.0	19.0	23.0	35.0	37.0	43.4	47.0	52.9	54.5	
France[3]		7.0		8.2			11.0			14.3	15.0	16.0	19.0	23.0	27.0	32.4	36.6	41.0
Germany[1, 4]												39.8	44.9	47.3	53.4	57.2	57.9	
Ireland													18.6		32.4			42.3
Italy															29.4			
Japan[5]		11.7	9.7	11.6	10.6	11.5	12.2	11.9	13.9	15.6	17.3	22.1	25.2	29.5	38.6	50.1	57.2	63.3
Japan[6]										16.3	22.3	28.8	32.6	37.7	50.5	58.0	71.7	
Japan[7]																	40.4	
Korea[8]															71.0	76.9	78.6	77.9
Mexico											3.1		5.7		10.4	11.6	15.2	
Netherlands[9]		11.0	14.0	18.0	22.0	25.0	29.0	31.0	34.0	39.0	43.0	47.0	55.0	59.0	64.0	69.0		
New Zealand[3]	6.7	8.6	9.6	11.5	11.6	13.3	15.9	17.1	18.6	21.7	24.8	27.6	32.9	37.5	42.8	46.6	52.0	
Norway[10]																		68.0
Portugal										11.0		14.0		21.0	29.4	n.a.		38.3
Spain															30.4			
Sweden														56.7	59.9	69.2		
Switzerland															59.9	69.2		
Turkey[11]															12.3			
United Kingdom[12]	16.0										26.0		33.0		47.0	52.9	54.5	
United States[13]				14.4	15.2				23.0			36.6	42.1		51.0	56.5		
	Percentage of individuals[14]																	
Australia													38.0		46.0	53.0	55.3	
Netherlands[15]													60.0	66.0	70.0	74.0	78.0	
Norway		13.0							33.0	39.0	43.0	50.0	57.0	67.0	71.0	76.0		
Sweden									23.4	27.6	34.3	40.3	52.1	61.4	64.7	67.4	69.7	

1. For 2002 and 2003, first quarter data from the EU Community Survey on Household Use of ICT.
2. Until 1996, May of each year. Household Facilities and Equipment Survey; from 1997, Survey of Household Spending.
3. June of each year.
4. Except for 2002, as of 31 December of the respective year.
5. Fiscal year ending in March. Consumer Survey, Economic and Social Research Institute, Cabinet Office.
6. Fiscal year ending in March. Information and Communications Policy Bureau, Ministry of Public Management, Home Affairs, Posts and Telecommunications. Communication Trends Survey.
7. Survey of Households Economy.
8. Ministry of Information and Communication.
9. CBS, Sociaal-economish panelonderzoek (SEP).
10. Spring 2003 Statistics Norway's Omnibus survey.
11. Households in urban areas only.
12. March 2001-April 2002 (financial year) instead of 2001
13. November of each year, except August for 2000 and September for 2001.
14. Age cut off: Australia (18+), Netherlands (12+), Norway (9-79), Sweden (16-84). Norwegian media barometer for Norway.
15. From CBS, POLS survey.

Source: OECD, compiled from national statistical offices or national sources.

StatLink: http://dx.doi.org/10.1787/724400130157

Table C.4.2. **Households with access to the Internet[1] in selected OECD countries, 1996-2003**

	1996	1997	1998	1999	2000	2001	2002	2003
	Percentage of households							
Australia	4.4		16.0	22.0	32.0	42.0	46.0	
Austria[2]					19.0		30.8	36.2
Belgium				14.0		28.0		
Canada		16.0	22.6	28.7	40.1	48.7	51.4	54.5
Denmark	5.0	10.0	22.0	33.0	46.0	48.0	59.0	
Finland[2]			12.0	24.7	30.0	39.5	44.3	
France[3]				6.5	11.9	18.1	23.0	28.0
Germany[2]			10.7	16.4	27.3	36.0	43.3	
Ireland			5.0		20.4			33.6
Italy				7.7	18.8			
Japan[4]					34	35.1	48.8	52.0
Japan[5]							40.7	44.0
Japan[6]	3.3	6.4	11.0	19.1	34.0	60.5	81.4	
Korea[7]						39.9	51.3	
Mexico						6.2		
Norway[8]								55.0
Portugal				5.0	9.0	13.0		21.7
Sweden				42.3	48.2	53.3		
Turkey[9]					6.9			
United Kingdom[10]			9.0	14.0	27.0	38.0	44.0	48.0
United States[11]			26.2		41.5	50.5		
	Percentage of individuals with access at home through a PC							
Netherlands[11]			16.0	26.0	45.0	56.0	64.0	
Sweden			30.7	46.3	53.0	58.0	61.5	

1. For Denmark, Ireland, the Netherlands and before 1999 for the United Kingdom, access to the Internet *via* a home computer; for the other countries access to the Internet through any device (*e.g.* computer, phone, TV, etc.).
2. As of 31 December of the year concerned; for 2002 and 2003, first quarter data from the EU Community Survey on Household Use of ICT.
3. June of each year.
4. Survey of Household Economy. Device that can access the Internet.
5. Survey of Household Economy. PC that can access the Internet.
6. End of the calendar year. Use of the Internet by a household member from home or other location.
7. Based on share of households with a computer and Internet access. KNSO, *Computer and Internet Use Survey*.
8. From spring 2003 Statistics Norway's *Omnibus Survey* 9. Households in urban areas only.
9. April-June quarter.
10. November of each year, except August for 2000.
11. Fall of each year.

Source: OECD, compiled from national statistical offices or national sources.

StatLink: http://dx.doi.org/10.1787/345773571625

Table C.5.1. **Top ten computer and Internet sites in the United Kingdom and the United States, January 2004**

United Kingdom

Rank	Name	Domain	Market share
1.	MSN UK	*www.msn.co.uk*	10.4
2.	MSN Hotmail	*www.hotmail.com*	7.3
3.	Google	*www.google.com*	7.1
4.	Google UK	*www.google.co.uk*	5.8
5.	Freeserve	*www.freeserve.com*	4.7
6.	MSN.co.uk Search	*search.msn.co.uk*	2.9
7.	Yahoo! UK and Ireland	*uk.yahoo.com*	2.5
8.	Yahoo!	*www.yahoo.com*	2.0
9.	Yahoo! Europe Mail	*uk.mail.yahoo.com*	2
10.	Gator eWallet	*www.gator.com*	1.9

United States

Rank	Name	Domain	Market share
1.	Yahoo! Mail	*mail.yahoo.com*	14.4
2.	Yahoo!	*www.yahoo.com*	13.7
3.	MSN Hotmail	*www.hotmail.com*	8.3
4.	Google	*www.google.com*	6.6
5.	Yahoo! Search	*search.yahoo.com*	5.1
6.	MSN	*www.msn.com*	5
7.	My Yahoo!	*my.yahoo.com*	3
8.	MSN Search	*search.msn.com*	1.8
9.	MetaReward	*www.metareward.com*	1.7
10.	Yahoo! Address Book	*address.yahoo.com*	1.6

Source: OECD, based on Hitwise.

StatLink: http://dx.doi.org/10.1787/641826784508

Table C.5.2. **Top ten business and finance sites in the United Kingdom and the United States, January 2004**

United Kingdom

Rank	Name	Domain	Market share
1.	Lloyds TSB	*www.lloydstsb.co.uk*	2.5
2.	BigFix	*www.bigfix.com*	2.3
3.	O2.co.uk	*www.o2.co.uk*	1.9
4.	HSBC UK – Personal Banking	*www.ukpersonal.hsbc.com*	1.8
5.	Barclays Personal Banking	*www.personal.barclays.co.uk*	1.5
6.	HSBC Bank UK	*www.hsbc.co.uk*	1.4
7.	Right Move	*www.rightmove.co.uk*	1.4
8.	Egg	*www.egg.com*	1.4
9.	BT	*www.bt.com*	1.3
10.	Vebra.com	*www.vebra.com*	1.3

United States

Rank	Name	Domain	Market share
1.	Yahoo! Finance	*finance.yahoo.com*	4.1
2.	Bank of America	*www.bankofamerica.com*	2.7
3.	Monster.com	*www.monster.com*	2.2
4.	PayPal	*www.paypal.com*	2.1
5.	Wells Fargo –Online Banking	*banking.wellsfargo.com*	1.6
6.	Yahoo! Hotjobs	*hotjobs.yahoo.com*	1.6
7.	Wells Fargo	*www.wellsfargo.com*	1.4
8.	Yahoo! Small Business	*smallbusiness.yahoo.com*	1.3
9.	MSN MoneyCentral	*moneycentral.msn.com*	1.3
10.	Ameritrade.com	*www.ameritrade.com*	1

Source: OECD, based on Hitwise.

StatLink: http://dx.doi.org/10.1787/527223812078

Table C.5.3. **Top ten business information sites (sub category of business and finance) in the United Kingdom and the United States, January 2004**

United Kingdom

Rank	Name	Domain	Market share
1.	Yell.com	*www.yell.com*	10.7
2.	FT.com	*www.ft.com*	5.8
3.	Yahoo! UK and Ireland Finance	*uk.finance.yahoo.com*	4.6
4.	Netscape White Pages	*wp.netscape.com*	4.5
5.	MSN MoneyCentral	*moneycentral.msn.com*	4.4
6.	Yahoo! Finance	*finance.yahoo.com*	3.6
7.	ThomsonLocal.com	*www.thomsonlocal.com*	3.3
8.	hemscott.NET	*www.hemscott.net*	3.2
9.	Kellysearch	*www.kellysearch.com*	3.1
10.	This Is Money	*www.thisismoney.com*	2.7

United States

Rank	Name	Domain	Market share
1.	Yahoo! Finance	*finance.yahoo.com*	29.1
2.	MSN MoneyCentral	*moneycentral.msn.com*	8.8
3.	Internal Revenue Service	*www.irs.gov*	6.7
4.	Netscape White Pages	*wp.netscape.com*	6.2
5.	Yahoo! Yellow Pages	*yp.yahoo.com*	5.2
6.	Market Watch	*www.marketwatch.com*	3.4
7.	CNN Money	*money.cnn.com*	2.6
8.	SuperPages.com –Yellow Pages	*yp.superpages.com*	2.5
9.	SMARTpages.com	*www.smartpages.com*	2.3
10.	Switchboard.com	*www.switchboard.com*	1.9

Source: OECD, based on Hitwise.

StatLink: http://dx.doi.org/10.1787/347506046053

Table C.5.4. **Top ten health and medical sites in the United Kingdom and the United States, January 2004**

United Kingdom

Rank	Name	Domain	Market share
1.	Norwich Union UK	*www.norwich-union.co.uk*	5.7
2.	Weight Watchers UK	*www.weightwatchers.co.uk*	3.9
3.	Boots	*www.boots.com*	3.8
4.	eDiets UK	*www.edietsuk.co.uk*	3.7
5.	Department of Health	*www.doh.gov.uk*	2.1
6.	National Center for Biotechnology Information	*www.ncbi.nlm.nih.gov*	2.1
7.	NHS Direct	*www.nhsdirect.nhs.uk*	1.9
8.	Slimming World	*www.slimming world.co.uk*	1.8
9.	BBCi Health	*www.bbc.co.uk/health*	1.6
10.	BBCi Sport Academy	*news.bbc.co.uk/sportacademy*	1.5

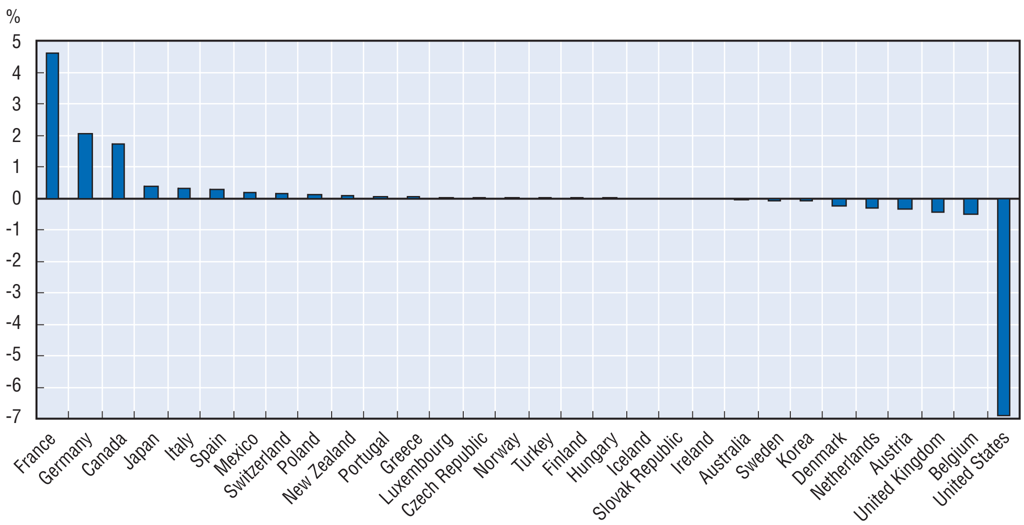
United States

Rank	Name	Domain	Market share
1.	My WebMD	*my.webmd.com*	4.2
2.	WebMD	*www.webmd.com*	3.9
3.	Weight Watchers	*www.weightwatchers.com*	3.8
4.	Medco Health	*www.medcohealth.com*	1.8
5.	drugstore.com	*www.drugstore.com*	1.6
6.	Yahoo! Health	*health.yahoo.com*	1.6
7.	MSN Health	*health.msn.com*	1.4
8.	National Library of Medicine	*www.nlm.nih.gov*	1.4
9.	National Center for Biotechnology Information	*www.ncbi.nlm.nih.gov*	1.4
10.	Atkins Nutritionals	*www.atkins.com*	1.2

Source: OECD, based on Hitwise.

StatLink: http://dx.doi.org/10.1787/437175305782

Figure C.5.1. **Change In share of global P2P user base on fast-track networks, 2002-03**



Source: OECD, based on BigChampagne data. The strong growth rates for European countries can be explained by the fact that P2P has become popular later than in, for instance, the United States. As one would expect, countries with lower initial shares experience stronger growth.

Table C.5.5. **Percentage of enterprises using Internet-based business solutions in the service provider and telecommunications sector, late 2001**

	United States	Canada	United Kingdom, France and Germany
E-marketing	74	64	47
Customer service and support	86	54	74
E-commerce	69	46	39
Finance and accounting	42	36	26
Human resources	37	44	29
Procurement/MRO	44	20	31
Sales force automation	50	26	27
Supply chain management	27	25	17

Source: Varian, H., R.E. Litan, A. Elder and J. Shutter (2002), *The Net Impact Study*, January 2002, V2.0; Canadian e-Business Initiative (CEBI) (2002); *Net Impact Study Canada: The SME Experience*, CEBI. Available at: *www.netimpactstudy.com* (accessed January 2003).

StatLink: http://dx.doi.org/10.1787/842867462474

Table C.6.1. **Europe: Occupations included in the narrow and broad definitions of ICT-skilled employment**

121:	Directors and chief executives
122:	Production and operations managers
123:	Other specialist managers
211:	Physicists, chemists, and related professionals
212:	Mathematicians, statisticians and related professionals
213:	**Computing professionals**
214:	Architects, engineers, and related professionals
241:	Business professionals
242:	Legal professionals
243:	Archivists, librarians, and related information professionals
312:	**Computer associate professionals**
313:	**Optical and electronic equipment operators**
341:	Finance and sales associate professionals
342:	Business services agents and trade brokers
343:	Administrative associate professionals
411:	Secretaries and keyboard-operating clerks
412:	Numerical clerks
724:	**Electrical and electronic equipment mechanics and fitters**

***Narrow definition*:** similar to the IT specialists, or practitioners group, using the occupations previously used in OECD publications: ISCO88 categories.
***Broad definition*:** attempt to capture those classified as IT specialists, as well as those who can be considered as sector specific users and generic users: ISCO88 categories.
All occupations listed are in the broad definition, only occupations in bold are in the ***narrow definition***.
Source: OECD, based on EULFS (2003).

StatLink: http://dx.doi.org/10.1787/073073741347

Table C.6.2. **United States: Occupations included in the narrow and broad definitions of ICT-skilled employment**

Financial managers	7	Medical scientists	83
Personnel and labor relations managers	8	Librarians	164
Purchasing managers	9	Archivists and curators	165
Managers, marketing, advertising, and public relations	13	Economists	166
Accountants and auditors	23	Urban planners	173
Underwriters	24	Lawyers and Judges	178
Other financial officers	25	**Electrical and electronic technicians**	**213**
Management analysts	26	**Computer programmers**	**229**
Buyers, wholesale and retail trade except farm products	29	**Tool programmers, numerical control**	**233**
Architects	43	Supervisors and Proprietors, Sales Occupations	243
Aerospace engineer	44	Insurance sales occupations	253
Metallurgical and materials engineers	45	Real estate sales occupations	254
Mining engineers	46	Securities and financial services sales occupations	255
Petroleum engineers	47	Sales occupations, other business services	257
Chemical engineers	48	**Supervisors, computer equipment operators**	**304**
Nuclear engineers	49	Supervisors, financial records processing	305
Civil engineers	53	Chief communications operators	306
Agricultural engineers	54	**Computer operators**	**308**
Engineers, electrical and electronic	**55**	**Peripheral equipment operators**	**309**
Engineers, industrial	56	Secretaries	313
Engineers, mechanical	57	Typists	315
Mmarine and naval architects	58	Bookkeepers, accounting, and auditing clerks	337
Engineers, n.e.c.	59	Payroll and timekeeping clerks	338
Surveyors and mapping scientists	63	Billing clerks	339
Computer systems analysts and scientists	**64**	Cost and rate clerks	343
Operations and systems researchers and analysts	**65**	Billing, posting, and calculating machine operators	344
Actuaries	66	Bank tellers	383
Statisticians	67	Data-entry keyers	385
Mathematical scientists, n.e.c.	68	Statistical clerks	386
Physicists and astronomers	69	**Electronic repairers, communications and industrial equipment**	**523**
Chemists, except biochemists	73	**Data processing equipment repairers**	**525**
Atmospheric and space scientists	74	**Telephone line installers and repairers**	**527**
Geologists and geodesists	75	**Telephone installers and repairers**	**529**
Physical scientists, n.e.c.	76	Miscellaneous electrical and electronic equipment repairers	533
Agricultural and food scientists	77	Electrical power installers and repairers	577
Biological and life scientists	78	**Electrical/electronic equipment assemblers**	**683**
Forestry and conservation scientists	79	Numerical control machine operators	714

All occupations listed are in the broad definition, only occupations in bold are in the ***narrow definition***.
Source: OECD, based on CPS.

StatLink: http://dx.doi.org/10.1787/437401035185

Table C.6.3. **United States: classification of industries according to the intensity of broad ICT-skilled employment**

high-intensive (> 30%)				medium-intensive (10-30%)				low intensive (< 10%)			
	ind.	broad	rank		ind.	broad	rank		ind.	broad	rank
Accounting, auditing, and bookkeeping services	890	82.7	1	Real estate, including real estate-insurance offices	712	43.6	26	Furniture and home furnishings	501	35.7	51
Savings institutions, including credit unions	701	72.3	2	Scientific and controlling instruments	371	43.1	27	Electrical goods	512	35.5	52
Computer and data processing services	732	70.6	3	Not specified utilities	472	43.0	28	Miscellaneous wholesale, durable goods	532	35.3	53
Legal services	841	70.1	4	Food stores, n.e.c.	611	42.5	29	Screw machine products	290	35.3	54
Security, commodity brokerage, and investment companies	710	66.8	5	Public finance, taxation, and monetary policy	921	42.4	30	Electrical repair shops	752	35.3	55
Banking	700	61.3	6	Research, development, and testing services	891	41.6	31	Not specified machinery	332	35.3	56
Credit agencies, n.e.c.	702	60.5	7	Electrical machinery, equipment, and supplies, n.e.c.	342	41.1	32	Hardware stores	581	35.3	57
Engineering, architectural, and surveying services	882	60.3	8	Not specified wholesale trade	571	40.4	33	Gift, novelty, and souvenir shops	661	34.9	58
Insurance	711	58.4	9	Catalog and mail order houses	663	40.0	34	Music stores	640	34.8	59
Management and public relations services	892	57.0	10	Farm supplies	561	39.9	35	Economic programs administration	931	34.2	60
Telegraph and miscellaneous communications services	442	57.0	11	Misc wholesale, non-durable goods	562	39.7	36	Gasoline service stations	621	34.1	61
Radio, TV, and communication equipment	341	56.4	12	Variety stores	592	39.4	37	Stores, book and stationery	652	34.0	62
Telephone communications	441	54.9	13	Electric light and power	450	39.0	38	Petroleum refining	200	33.2	63
Computers and rel. equipment	322	53.0	14	Mobile home dealers	590	38.9	39	Aircraft and parts	352	32.5	64
Guided missiles, space vehicles, and parts	362	50.5	15	Metals and minerals, except petroleum	511	38.3	40	Lumber and building material retailing	580	32.2	65
Office and accounting machines	321	49.6	16	Motor vehcls and equipment	500	37.9	41	Apparel, fabrics, and notions	542	32.1	66
Not specified electrical machinery, equipment, and supplies	350	48.8	17	Stores, radio, TV, and computer	633	37.9	42	General government, n.e.c.	901	31.5	67
Photographic equipment and supplies	380	48.1	18	Stores, apparel and accessory, except shoe	623	37.9	43	Paper and paper products	540	30.5	68
Liquor stores	650	47.6	19	Petroleum products	552	37.8	44	Advertising	721	30.4	69
Miscellaneous vehicle dealers	622	47.5	20	Machinery, equipment, and supplies	530	37.7	45	Stores, furniture and home furnishings	631	30.3	70
Stores, dairy products	602	47.5	21	Jewelry stores	660	37.3	46	Stores, sporting goods, bicycles, and hobby	651	29.9	71
Fuel dealers	672	45.3	22	Professional and commercial equipment and supplies	510	36.9	47	Groceries and related products	550	29.7	72
Environmental quality and housing programs administratio	930	44.6	23	Not specified retail trade	691	35.9	48	Shoe stores	630	29.3	73
Stores, Retail nurseries and garden	582	44.2	24	Stores, Miscellaneous retail	682	35.9	49	Radio and television broadcasting and cable	440	29.1	74
Libraries	852	43.6	25	Scrap and waste materials	531	35.9	50	Stores, Auto and home supply	620	28.9	75

Table C.6.3. **United States: classification of industries according to the intensity of broad ICT-skilled employment** (*cont.*)

high-intensive (> 30%)				medium-intensive (10-30%)				low intensive (< 10%)			
	ind.	broad	rank		ind.	broad	rank		ind.	broad	rank
Hardware, plumbing and heating supplies	521	28.8	76	Retail florists	681	20.8	103	Motor vehicles and motor vehicle equipment	351	14.8	130
Lumber and construction materials	502	28.4	77	Video tape rental	801	20.5	104	Toys, amusement, and sporting goods	390	14.7	131
Gas and steam supply systems	451	28.4	78	Oil and gas extraction	42	20.5	105	Other rubber products, and plastics footwear and belting	211	14.6	132
Stores, misc general merchandise	600	28.4	79	Stores, household appliance	632	19.7	106	Leather products, except footwear	222	14.5	133
Drugs	181	28.3	80	Services incidental to transportation	432	19.4	107	Grain mill products	110	14.4	134
Electric and gas, and other combinations	452	28.0	81	Medical, dental, and optical instruments and supplies	372	19.4	108	Miscellaneous plastics products	212	14.0	135
Business services, n.e.c.	741	27.7	82	Human resources programs administratio	922	19.2	109	Chiropractors offices and clinics	821	13.7	136
Forestry	31	27.6	83	Drug stores	642	18.8	110	Physicians offices and clinics	812	13.6	137
Engines and turbines	310	27.6	84	Beverage industries	120	18.7	111	Miscellaneous petroleum and coal products	201	13.5	138
Motor vehicle dealers	612	27.5	85	Primary aluminum industries	272	18.4	112	Water supply and irrigation	470	13.3	139
Household appliances	340	27.0	86	Department stores	591	18.2	113	Pulp, paper, and paperboard mills	160	13.1	140
Ordnance	292	26.7	87	Nonmetallic mining and quarrying, except fuel	50	17.9	114	Executive and legislative offices	900	12.8	141
National security and international affairs	932	26.6	88	Printing, publishing, and allied industries, except newspapers	172	17.1	115	Misc fabricated metal products	300	12.7	142
Soaps and cosmetics	182	25.9	89	Colleges and universities	850	17.1	116	Blast furnaces, steelworks, rolling and finishing mills	270	12.0	143
Farm-product raw materials	551	25.7	90	Pipe lines, except natural gas	422	17.0	117	Labor unions	873	11.7	144
Industrial and miscellaneous chemicals	192	25.2	91	Religious organisations	880	17.0	118	Wood buildings and mobile homes	232	11.3	145
Drugs, chemicals and allied products	541	25.1	92	Construction and material handling machines	312	16.8	119	Metal forgings and stampings	291	10.9	146
Museums, art galleries, and zoos	872	24.5	93	Not spec manufacturing industries	392	16.8	120	Fishing, hunting, and trapping	32	10.9	147
Grocery stores	601	24.4	94	Metalworking machinery	320	16.7	121	Railroads	400	10.8	148
Agricultural chemicals	191	24.3	95	Farm machinery and equipment	311	15.7	122	Agricultural services, n.e.c.	30	10.6	149
Sewing, needlework and piece goods stores	662	23.9	96	Funeral service and crematories	781	15.7	123	Miscellaneous manufacturing industries	391	10.6	150
Misc personal services	791	23.4	97	Theaters and motion pictures	800	15.6	124	Justice, public order, and safety	910	10.5	151
Personnel supply services	731	23.2	98	Machinery, except electrical, n.e.c.	331	15.6	125	Health services, n.e.c.	840	10.4	152
Membership organisations, n.e.c.	881	22.5	99	Vending machine operators	670	15.6	126	Social services, n.e.c.	871	10.3	153
Sugar and confectionery products	112	22.0	100	Paints, varnishes, and rel. products	190	15.3	127	Canned, frozen and preserved fruits and vegetables	102	10.2	154
Alcoholic beverages	560	21.9	101	Retail bakeries	610	15.2	128	Newspaper publishing and printing	171	10.1	155
Automotive rental and leasing, w/out drivers	742	21.7	102	Miscellaneous food preparations and kindred products	121	15.2	129	Dairy products	101	10.1	156

Table C.6.3. **United States: classification of industries according to the intensity of broad ICT-skilled employment** *(cont.)*

high-intensive (> 30%)				medium-intensive (10-30%)				low intensive (< 10%)			
	ind.	broad	rank		ind.	broad	rank		ind.	broad	rank
Tobacco manufactures	130	10.0	157	Fabricated structural metal products	282	7.2	184	Barber shops	780	3.1	211
Warehousing and storage	411	9.7	158					Bakery products	111	3.1	212
				Miscellaneous entertainment and recreation services	810	7.1	185				
Paperboard containers and boxes	162	9.6	159	Water transportation	420	7.0	186	Bowling centers	802	3.0	213
				Trucking service	410	6.6	187	Coal mining	41	3.0	214
Cutlery, handtools, and general hardware	281	9.6	160								
Hospitals	831	9.6	161	Yarn, thread, and fabric mills	142	6.5	188	Child day care services	862	2.7	215
Railroad locomotives and equipment	361	9.5	162					Taxicab service	402	2.5	216
				Cycles and miscellaneous transportation equipment	370	6.5	189				
Other primary metal industries	280	9.3	163	Detective and protective services	740	6.3	190	Automotive parking and carwashes	750	2.3	217
Hotels and motels	762	9.3	164	Automotive repair and rel. services	751	6.3	191	Nursing and personal care facilities	832	2.3	218
Tires and inner tubes	210	9.1	165	Miscellaneous wood products	241	6.3	192	Veterinary services	12	2.2	219
Air transportation	421	9.0	166	Elementary and secondary schools	842	6.1	193	Agricltrl production, livestock	11	2.1	220
Sanitary services	471	8.9	167	Metal mining	40	6.0	194				
								Lodging places, except hotels and motels	770	1.5	221
Misc repair services	760	8.7	168					Eating and drinking places	641	1.2	222
				Residential care facilities, w/out nursing	870	5.9	195				
Educational services, n.e.c.	860	8.6	169	Vocational schools	851	5.8	196	Private Households	761	1.1	223
Iron and steel foundries	271	8.6	170	Landscape and horticultural services	20	5.7	197	Logging	230	1.0	224
				Glass and glass products	250	5.5	198	Beauty shops	772	0.5	225
Miscellaneous paper and pulp products	161	8.1	171								
								Not specified food industries	122	0.0	226
Apparel and accessories, except knit	151	7.9	172	Services to dwellings and other buildings	722	5.2	199				
				Plastics, synthetics, and resins	180	5.0	200	Knitting mills	132	0.0	227
Laundry, cleaning, and garment services	771	7.9	173								
Carpets and rugs	141	7.9	174	Agricultural production, crops	10	5.0	201				
								Dyeing and finishing textiles, except wool and knit goods	140	0.0	228
Meat products	100	7.8	175	Dentists offices and clinics	820	4.7	202	Leather tanning and finishing	220	0.0	229
				US Postal Service	412	4.7	203	Structural clay products	252	0.0	230
Miscellaneous fabricated textile products	152	7.8	176								
Construction	60	7.6	177	Bus service and urban transit	401	4.2	204	Pottery and related products	261	0.0	231
				Footwear, except rubber and plastic	221	4.1	205	Not specified metal industries	301	0.0	232
Miscellaneous non-metallic mineral and stone products	262	7.6	178								
Miscellaneous professional and rel. services	893	7.5	179	Job training and vocational rehabilitation services	861	4.0	206	Watches, clocks, and clockwork operated devices	381	0.0	233
Optometrists offices and clinics	822	7.4	180	Miscellaneous textile mill products	150	4.0	207	Shoe repair shops	782	0.0	234
Ship and boat building and repairing	360	7.4	181					Dressmaking shops	790	0.0	235
				Health practitioners offices and clinics, n.e.c.	830	3.8	208				
Furniture and fixtures	242	7.4	182	Sawmills, planing mills, and millwork	231	3.1	209	Family child care homes	863	0.0	236
				Direct selling establishments	671	3.1	210				
Cement, concrete, gypsum, and plaster products	251	7.2	183								

Source: OECD, based on CPS (2003).

StatLink: http://dx.doi.org/10.1787/636043371585

Table C.6.4. **Japan: classification of industries according to the intensity of ICT-skilled employment**

	Broad definition	Intensity	Rank		Narrow definition	Intensity	Rank
46	Information and research services	**88.4**	1	46	Information and research services	**61.1**	1
50	Public services	**61.3**	2	45	Business services	**17.3**	2
37	Financial, insurance	**59.1**	3	18	Electronic machinery and instruments	**15.2**	3
24	Electricity, gas, heat provision, water	**58.8**	4	24	Electricity, gas, heat provision, water,	**11.8**	4
27	Communication	**57.6**	5	17	Machinery, precision machinery, arms	**10.3**	5
36	Financial, insurance, real estate	**53.1**	6	12	Chemical products , oil products, coal products	**9.5**	6
45	Business services	**51.9**	7	14	Metal machinery	**9.4**	7
38	Real estate	**40.0**	8	19	Machinery and instruments for transportation	**8.2**	8
30	Wholesale	**35.1**	9	43	Other services	**7.3**	9
12	Chemical products, oil products, coal products	**34.9**	10	39	Services	**6.3**	10
18	Electronic machinery and instruments	**34.8**	11	8	Construction	**5.8**	11
17	Machinery, precision machinery, arms	**32.2**	12	9	Manufaturing	**5.8**	12
23	Electricity, gas, heat provision, water, transportation, communications	**32.2**	13	15	Steel	**5.4**	13
43	Other services	**32.1**	14	11	Chemistry	**5.1**	14
25	Transportation, communication	**30.2**	15	40	Professional services	**5.0**	15
39	Services	**29.0**	16	27	Communication	**4.5**	16
14	Metal machinery	**28.9**	17	5	Non-agriculture nor forestry	**4.0**	17
5	Non-agriculture nor forestry	**27.3**	18	1	Industry total	**3.9**	18
1	Industry total	**26.2**	19	50	Public services	**2.8**	19
19	Machinery and instruments for transportation	**25.5**	20	13	Other chemical products	**2.6**	20
11	Chemistry	**25.3**	21	30	Wholesale	**1.9**	21
40	Professional services	**25.1**	22	23	Electricity, gas, heat provision, water, transportation, communications	**1.8**	22
26	Transportation	**24.7**	23	48	Other services	**1.7**	23
8	Construction	**24.6**	24	16	Steel products	**1.6**	24
9	Manufacturing	**24.5**	25	22	Other manufacturing	**1.5**	25
48	Other services	**24.4**	26	20	Other manufacturing	**1.4**	26
15	Steel	**24.3**	27	38	Real estate	**1.4**	27
28	Wholesale, retail, restaurants, financial, insurance, immobilier	**23.9**	28	21	Foods, drinks, cigaretts, feeds manufacturing	**1.3**	28
22	Other manufacturing	**22.2**	29	25	Transportation, communication	**1.2**	29
34	Other retails	**21.3**	30	36	Financial, insurance, real estate	**1.2**	30
7	Mining	**20.0**	31	37	Financial, insurance	**1.2**	31
13	Other chemical products	**20.0**	32	28	Wholesale, retail, restaurants, financial, insurance, immobilier	**0.6**	32
20	Other manufacturing	**19.4**	33	26	Transportation	**0.6**	33
29	Wholesale, retail, restaurants	**19.1**	34	29	Wholesale, retail, restaurants	**0.6**	34
16	Steel products	**19.0**	35	42	Education	**0.5**	35
41	Medical care	**17.6**	36	34	Other retails	**0.3**	36
47	Entertainment	**17.6**	37	31	Retail, restaurants	**0.1**	37
42	Education	**17.1**	38	2	Agriculture and forestry	**0.0**	38
4	Forestry	**16.7**	39	3	Agriculture	**0.0**	39
21	Foods, drinks, cigaretts, feeds manufacturing	**15.8**	40	4	Forestry	**0.0**	40
32	Cloths, furnitures, home appliances	**15.0**	41	6	Fishery	**0.0**	41
33	Retails on foods and drinks	**14.6**	42	7	Mining	**0.0**	42
31	Retail, restaurants	**13.6**	43	10	Fiber	**0.0**	43
10	Fiber	**13.5**	44	32	Cloths, furnitures, home appliances	**0.0**	44
44	Personal services	**13.5**	45	33	Retails on foods and drinks	**0.0**	45
49	Social insurance, social welfare	**12.0**	46	35	Restauratns	**0.0**	46

Table C.6.4. **Japan: classification of industries according to the intensity of ICT-skilled employment** (*cont.*)

	Broad definition	Intensity	Rank		Narrow definition	Intensity	Rank
51	Non-classified industry	**5.4**	47	41	Medical care	**0.0**	47
6	Fishery	**3.6**	48	44	Personal services	**0.0**	48
35	Restauratns	**3.1**	49	47	Entertainment	**0.0**	49
2	Agriculture and forestry	**1.5**	50	49	Social insurance, social welfare	**0.0**	50
3	Agriculture	**1.1**	51	51	Non-classified industry	**0.0**	51

Note: This classification includes both industry totals and sub-group totals.
Source: OECD, based on data provided by the Japanese Ministry of Public Management, Home Affairs, Post and Telecommunications; Statistics Bureau, Labour Force Survey.

StatLink: http://dx.doi.org/10.1787/172556327236

Table C.6.5. **Korea: Occupations included in the narrow and broad definitions of ICT-skilled employment**

Managers in financial intermediation service	Librarians and archivists
Other managers in business service	Web and multimedia designers
Managers in production	Draught persons (CAD)
Managers in information and communication	Multimedia directors (including web directors)
Managers in sales	Trader brokers
Human resource management and labor relation professionals	Real estate agents and brokers
Business consultant	Construction engineers
Certified public accountants	Civil engineers
Taxation accountants	Landscape engineers
Advertising and public relations professionals	Town planners
Marketing and market research professionals	Land surveying and mapping engineers
Other business and accounting professionals n.e.c.	Quantity surveyors
Accounting clerks	Mechanical engineer
Book keeping clerks	Factory automation and robot operators
Statistical survey clerks	Material engineers
Secretary	Chemical engineers
Clerks helper and word processor operators	**Electronic engineers**
Financial investment and credit analysts	Electric engineers
Financial fund managers	**Computer and office equipment fitters and mechanics**
Stock dealers	**Other electrical and electronical equipment fitters and mech**
Actuaries	**Computer engineers**
Other finance intermediation and insurance professionals n.e	**Telecommunication engineers**
Financial clerks	**Computer system analysts and designers**
Insurance clerks	**System software developers and programmers**
Bank tellers	**Application software developers and programmers**
Insurance agents and brokers	**Network system analysts and developers**
Insurance sales representatives	**Computer security engineers**
Natural science researchers	**Web developers and engineers**
Biological science researchers	**System administrators**
Judges	**Information technology consultants**
Attorney	**Telecommunication equipment fitters and mechanics**
Jurists	**Telecommunication line and cable installers**
Desk top publishers	Industrial Safety Engineer

All occupations listed are in the broad definition, only occupations in bold are in the ***narrow definition***.
Source: OECD, based on data provided by the Korean Work Information Center, Human Resource Development Service.

StatLink: http://dx.doi.org/10.1787/857706866853

Table C.6.6. **Korea: classification of industries according to the intensity of broad ICT-skilled employment**

Industry	Broad	Rank
Insurance and pension funding	88.9	1
Activities auxiliary to financial intermediation	86.4	2
Computer and related activities	84.0	3
Financial institutions, except insurance and pension funding	72.1	4
Research and development	66.7	5
Professional, scientific and technical services	60.0	6
Real estate activities	47.4	7
Electricity, gas, steam and hot water supply	36.6	8
Post and telecommunications	34.4	9
MF of computers and office machinery	32.5	10
MF of medical, precision and optical instruments, watches and clocks	25.8	11
MF of electronic components, radio, tv and communication equipment	23.7	12
MF of other machinery and equipment	22.2	13
MF of chemicals and chemical products	21.3	14
Collection, purification and distribution of water	18.7	15
Publishing, printing and reproduction of recorded media	18.6	16
MF of other transport equipment	17.9	17
General construction	17.7	18
MF of basic metal	17.6	19
MF of motor vehicles, trailers and semitrailers	14.9	20
Motion picture, broadcasting and performing arts industries	14.4	21
MF of coke, refined petroleum products and nuclear fuel	14.3	22
Membership organizations n.e.c.	13.9	23
Wholesale trade and commission trade, except of motor vehicles and motorcycles	13.8	24
MF of electrical machinery and apparatuseses	13.3	25
Sale of motor vehicles and motorcycles ; retail sale of auto	13.3	26
Sewage and refuse disposal, sanitation and similar activities	12.4	27
MF of fabricated metal products	12.2	28
MF of rubber and plastic products	12.0	29
Water transport	11.8	30
Manufacture of pulp, paper and paper products	11.5	31
MF of other non metalic mineral products	11.4	32
Public administration and defence ; compulsory social security	11.4	33
Extra territorial organizations and bodies	11.3	34
Maintenance and repair services	11.1	35
Manufacture of tabacco products	10.4	36
MF of furniture; manufacturing of articles n.e.c.	9.8	37
Air transport	9.7	38
Special trade construction	8.9	39
Supporting and auxiliary transport activities; activities of travel agencies	8.8	40
Manufacture of textiles, excepts sewn wearing apparel	8.3	41
Renting of machinery and equipment	7.4	42
Business support services	7.1	43
MF of wood and of products of wood and cork, except furniture; mf of articles of straw and plaiting materials	6.6	44
Manufacture of food products and beverages	6.5	45
Tanning and dressing of leather	6.4	46
Human health and veterinary activities	5.7	47
Manufacture of sewn wearing apparel and fur articles	5.3	48
Mining of coal, crude petroleum and natural gas, uranium ore	4.6	49
Education	4.5	50
Other recreational, cultural and sporting activities	4.1	51
Mining of other non ferrous metal ores	4.0	52
Retail trade, except motor vehicles and motorcycles	3.9	53
Social work activities	3.7	54
Land transport ; transport *via* pipelines	1.9	55
Fishing	1.1	56
Other services activities	0.6	57
Hotels and restaurants	0.4	58
Agriculture	0.1	59
Forestry	0.0	60
Recycling	0.0	61
Private households with employed persons	0.0	62

Source: OECD, based on data provided by the Korean Work Information Center, Human Resource Development Service.

StatLink: http://dx.doi.org/10.1787/363811807686

Table C.6.7. **Australia: Occupations included in the narrow and broad definitions of ICT-skilled employment**
ASCO 4-digit

1112	General managers	2293	Mathematicians, statisticians and actuaries
1211	Finance managers	2294	Business and organisation analysts
1212	Company secretaries	2299	Other business and information professionals
1213	Human resource managers	2521	Legal professionals
1221	Engineering managers	2522	Economists
1222	Production managers	2523	Urban and regional planners
1223	Supply and distribution managers	**3123**	**Electrical engineering associate professionals**
1224	**Information technology managers**	**3124**	**Electronic engineering associate professionals**
1231	Sales and marketing managers	3211	Branch accountants and managers (financial institution)
1291	Policy and planning managers	3212	Financial dealers and brokers
2111	Chemists	3213	Financial investment advisers
2112	Geologists and geophysicists	**3294**	**Computing support technicians**
2113	Life scientists	3399	Other managing supervisors (sales and service)
2114	Environmental and agricultural science professionals	**4314**	**Electronic instrument tradespersons**
2115	Medical scientists	**4315**	**Electronic and office equipment tradespersons**
2119	Other natural and physical science professionals	**4316**	**Communications tradespersons**
2121	Architects and landscape architects	5111	Secretaries and personal assistants
2122	Quantity surveyors	5911	Bookkeepers
2123	Cartographers and surveyors	5912	Credit and loans officers
2124	Civil engineers	5993	Insurance agents
2125	**Electrical and electronics engineers**	5995	Desktop publishing operators
2126	Mechanical, production and plant engineers	6121	Keyboard operators
2127	Mining and materials engineers	6141	Accounting clerks
2211	Accountants	6142	Payroll clerks
2212	Auditors	6143	Bank workers
2213	Corporate treasurers	6144	Insurance clerks
2221	Marketing and advertising professionals	6145	Money market and statistical clerks
2231	**Computing professionals**	**9918**	**Electrical and telecommunications trades assistants**
2292	Librarians		

All occupations listed are in the broad definition, only occupations in bold are in the ***narrow definition***.
Source: OECD, based on data provided by the Australian Bureau of Statistics.

StatLink: http://dx.doi.org/10.1787/824773353062

Table C.6.8. **Australia: classification of industries according to the intensity of broad ICT-skilled employment**

Industry		Broad	Rank
73	Finance	88.5	1
75	Services to finance and insurance	82.7	2
74	Insurance	70.9	3
78	Business services	52.0	4
82	Defence	51.6	5
15	Services to mining	41.4	6
36	Electricity and gas supply	41.3	7
71	Communication services	40.9	8
12	Oil and gas extraction	**37.1**	9
81	Government administration	35.1	10
37	Water supply, sewerage and drainage services	34.3	11
25	Petroleum, coal, chemical and associated product manufacturing	31.3	12
46	Machinery and motor vehicle wholesaling	31.1	13
91	Motion picture, radio and television services	31.1	14
65	Other transport	**30.6**	15
13	Metal ore mining	29.1	16
45	Basic material wholesaling	26.9	17
24	Printing, publishing and recorded media	26.6	18
62	Rail transport	26.5	19
66	Services to transport	26.1	20
47	Personal and household good wholesaling	24.4	21
03	Forestry and logging	**22.8**	22
77	Property services	22.2	23
28	Machinery and equipment manufacturing	20.7	24
92	Libraries, museums and the arts	18.7	25
63	Water transport	**18.6**	26
23	Wood and paper product manufacturing	16.7	27
96	Other services	16.6	28
21	Food, beverage and tobacco manufacturing	16.3	29
67	Storage	14.7	30
41	General construction	14.1	31
27	Metal product manufacturing	13.9	32
61	Road transport	13.5	33
26	Non metallic mineral product manufacturing	13.4	34
04	Commercial fishing	**12.7**	35
93	Sport and recreation	11.9	36
02	Services to agriculture; hunting and trapping	**11.5**	37
53	Motor vehicle retailing and services	11.4	38
84	Education	11.3	39
42	Construction trade services	11.2	40
11	Coal mining	**10.9**	41
22	Textile, clothing, footwear and leather manufacturing	10.8	42
64	Air and space transport	9.9	43
29	Other manufacturing	9.5	44
52	Personal and household good retailing	8.9	45
95	Personal services	8.4	46
86	Health services	7.9	47
14	Other mining	**7.6**	48
87	Community services	6.5	49
01	Agriculture	4.3	50
57	Accommodation, cafes and restaurants	3.6	51
51	Food retailing	3.0	52
97	Private households employing staff	0.0	53

Numbers in bold are based on estimates subject to sampling variability too high for most practical purposes.
Source: OECD, based on data provided by the Australian Bureau of Statistics.

StatLink: http://dx.doi.org/10.1787/702107484760

Table C.6.9. **List of IT occupations based on Census Canada, 2001**

IT occupations	Employment share of total IT occupations, 2001 (based on the experienced labour force), %	Unemployment rate (total for IT occupations: 4.7%)
Professional		
Computer engineers (except software engineers)	6.9	4.1
Information systems analysts and consultants	26.6	3.3
Database analysts and data administrators	3.5	4.0
Software engineers	6.7	3.9
Computer programmers and interactive media developers	24.9	5.4
Web designers and developers	5.7	8.4
Technical		
Computer and network operators and web technicians	11.8	4.9
User support technicians	12.1	5.2
Systems testing technicians	1.7	6.4

Source: Habtu, 2003.

StatLink: http://dx.doi.org/10.1787/107251607643

Table C.6.10. **Summary results from simple productivity regressions**

Dependent variable: gross value added per employee	ICT employment	P-value	Adjusted R^2	Number of observations
Austria	1.13	0.0006	0.32	31
Germany	0.61	0.0058	0.32	20
Spain	1.00	0.0155	0.12	40
Finland	0.61	0.0705	0.09	28
France	1.50	0.0000	0.38	37
Italy	1.57	0.0000	0.35	39
Netherlands	2.55	0.0072	0.37	16
Portugal	0.99	0.0117	0.30	18
Sweden	0.56	0.2378	0.02	28
United Kingdom	0.72	0.0452	0.09	36

Note: The productivity data refer to 2001 and the employment data to 2002. Some outliers have been removed.
Source: OECD, based on EULFS and NewCronos (2003).

StatLink: http://dx.doi.org/10.1787/776752115738

Table C.6.11. **Relative importance of computer training by country and by industry,[1] 1999**

	D Manufacturing	E Electricity, gas and water supply	F Construction	G Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods	H Hotels and restaurants	J Financial intermediation	K Real estate, renting and business activities	O Other community, social, personal service activities
EU15	2 EMF	1 (COMP)	1 (COMP)	4 SAM	3 PSWL	2 SAM	1 (COMP)	2 SERV
Belgium	2 EMF	2 EMF	4 EMF	2 EMF	6 EPOSH	2 EMF	2 EMF	1 (COMP)
Denmark	1 (COMP)	2 EMF	2 EMF	4 EMF	3 LGE	1 (COMP)	1 (COMP)	4 SERV
Germany	2 EMF	1 (COMP)	2 PSWL	2 SAM	6 SERV	2 SAM	2 SERV	1 (COMP)
Greece	2 EMF	1 (COMP)	4 EMF	2 SAM	10 EPOHS	2 AFN	1 (COMP)	2 EMF
Spain	4 EMF	2 EMF	3 EPOHS	3 SAM	3 LGE	3 AFN	1 (COMP)	1 (COMP)
France	2 EMF	5 LGE	1 (COMP)	2 SAM	1 (COMP)	2 SAM	1 (COMP)	1 (COMP)
Ireland	2 OFFW	1 (COMP)	1 (COMP)	3 SAM	5 EPOHS	2 PSWL	1 (COMP)	2 SERV
Italy	4 EMF	3 EMF	5 EPOHS	3 PSWL	3 EPOHS/SERV	4 SAM	1 (COMP)	6 PSWL
Luxembourg	5 EMF			3 SAM		3 AFN	1 (COMP)	6 SERV
Netherlands	2 EMF	4 PSWL	4 EPOHS	3 SAM	6 SERV	2 AFN	1 (COMP)	2 EPOHS
Austria	2 EMF	1 (COMP)	3 EMF	2 SAM	4 MAD	2 SAM	1 (COMP)	3 MAD
Portugal	2 EMF	3 EMF	1 (COMP)	3 SAM	5 SERV	2 PSWL	1 (COMP)	4 EMF
Finland	3 EMF	2 EMF	2 PSWL	2 SAM	1 (COMP)	2 SAM	1 (COMP)	2 PSWL
Sweden	2 EMF	2 EMF	4 EMF	2 SAM	2 SERV	1 (COMP)	1 (COMP)	1 (COMP)
United Kingdom	2 EMF	1 (COMP)	1 (COMP)	6 MAD	2 PSWL	3 MAD	3 EMF	5 EPOHS

Table C.6.11. **Relative importance of computer training by country and by industry,**[1] **1999** (*cont.*)

	D Manufacturing	E Electricity, gas and water supply	F Construction	G Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods	H Hotels and restaurants	J Financial intermediation	K Real estate, renting and business activities	O Other community, social, personal service activities
Norway	2 EMF	1 (COMP)	3 EMF	2 SAM	5 SAM	2 SAM	1 (COMP)	1 (COMP)
Bulgaria	3 EMF	3 EMF	3 EMF	4 EMF	4 SERV	3 LGE	3 SERV	2 EMF
Czech Republic	6 EMF	2 EMF	4 EPOHS	3 LGE	5 LGE	1 (COMP)	1 (COMP)	2 LGE
Estonia	7 EMF	4 LGE	7 EMF	4 PSWL	6 LGE	3 AFN	7 AFN	2 EPOHS
Hungary	2 EMF	2 EMF	6 EMF	3 SAM	2 SERV	2 AFN	2 SAM	1 (COMP)
Lithuania	6 EMF	6 EMF	4 EMF	4 MAD	5 SERV	5 AFN	4 AFN	2 EMF
Latvia	8 SERV	2 EMF	5 EMF	3 SAM	7 SERV	2 AFN	3 SERV	4 AFN
Poland	5 EMF	4 EMF	4 EMF	2 SAM	5 EMF	6 PSWL	3 SERV	1 (COMP)
Romania	4 PSWL	3 PSWL	3 PSWL	7 SAM	7 SERV	2 AFN	2 PSWL	2 SERV
Slovenia	4 EMF	3 EMF	3 EMF	7 SAM	5 SERV	2 AFN	4 EMF	1 (COMP)

LGE = languages; SAM = Sales and marketing; AFN = Accounting and finance; MAD = Management (including human resource management and quality management) and administration; OFFW = Office work; PSWL = Personal skills/development, working life (including company knowledge and introduction courses); COMP = Computer science/computer use; EMF = Engineering and manufacturing (production techniques for goods and services including operations and maintenance of automated systems, quality control and development of new materials, products and services); EPOHS = Environmental protection, occupational health and safety; SERV = Services (personal, transport, security; *e.g.* including hotel and restaurant, travel and tourism). OTHER = Other field of training was excluded from the rankings.

1. The table summarises results from the second Eurostat survey on continuing vocational training, defined as training measures or activities that are fully or partly financed by the enterprise for their employees who have a working contract. It shows the rank of computer training (in terms of percentage of total hours of training) among all fields of training (except “Other”), by main NACE industry and by country. The second line indicates the most important field of training in each industry. While this makes it possible to obtain an indication of the relative importance of computer (vocational) training in each industry and in each country, it is not possible to make absolute comparisons. The relative importance of computer training in NACE K: Real estate, renting and business activities in EU countries was the most important type of training in this industry in 12 out of the 15 countries. Moreover, it appears that computer training is, overall, relatively more important in the EU and Norway. In the other countries, computer training tends to be relatively more important in NACE 0: Other community, social, personal service activities. Each cell in the table shows the rank of computer training among all fields of training (excluding “Other”) by industry and by country, and the most important field of training (excluding “Other”) by industry and by country.

Source: Eurostat, Newcronos, CVTS2, 2003.

StatLink: http://dx.doi.org/10.1787/050338451420

Table C.6.12. **Australia: relative importance of computer training, by industry, 2001**

Industry	Rank of computer training among all fields of training (12) by industry	Most important field of training by industry	Percentage of total computer training accounted for by each industry	Ranking[1]
Agriculture, forestry and fishing	6	Health and safety	0.5	18
Mining	6	Health and safety	1.0	17
Manufacturing	4	Health and safety	7.5	5
Electricity, gas and water supply	4	Health and safety	1.2	14
Construction	6	Health and safety	1.2	15
Wholesale trade	2	Management and professional	5.9	7
Retail trade	7	Sales and personal service	3.8	8
Accommodation, cafes and restaurants	7	Health and safety	1.2	16
Transport and storage	6	Health and safety	2.9	11
Communication services	5	Management and professional	3.4	9
Finance and insurance	2	Management and professional	8.4	4
Property and business services	2	Management and professional	17.2	2
Government administration and defence	2	Management and professional	14.3	3
Education	2	Management and professional	17.3	1
Health and community services	4	Technical and para professional	7.0	6
Cultural and recreational services	4	Management and professional	2.4	12
Personal and other services	5	Management and professional	3.3	10
Unknown	7	Management and professional	1.4	13
Total	4	Management and professional	100.0	

1. Industry rank is based on its share of total computer training.
Source: Australian Bureau of Statistics, 2002.

StatLink: http://dx.doi.org/10.1787/141114671151

Table C.6.13. **Australia: relative importance of computer training, by occupation, 2001**

Occupation	Rank of computer training among all fields of training (12) by occupation	Most important field of training by occupation	Percentage of total computer training accounted for by each occupation	Ranking[1]
Managers and administrators	2	Management and professional	8.0	4
Professionals	3	Management and professional	38.7	1
Associate professionals	4	Management and professional	14.1	3
Tradespersons and related workers	8	Trade and Craft	3.2	6
Advanced clerical and service workers	3	Management and professional	5.6	5
Intermediate clerical, sales and service workers	4	Management and professional	23.0	2
Intermediate production and transport workers	8	Health and safety	1.9	8
Elementary clerical, sales and service workers	6	Sales and personal service	3.2	7
Labourers and related workers	9	Health and safety	0.9	10
Unknown	7	Management and professional	1.4	9
Total	4	Management and professional	100.0	

1. The rank of the occupation is based on its share of total computer training.
Source: Australian Bureau of Statistics, 2002.

StatLink: http://dx.doi.org/10.1787/753758734425

Table C.6.14. **Information technology professionals on the Priority Occupations List in New Zealand, February 2004**

Groupings	Positions	Required IT skills*	Level(s)
Management and project management	Project director Research and development manager Chief information officer Project manager (large projects) Project manager (mid range projects)	Project managment	Manager Senior manager Director
Policy planning and research	Principal solutions architect Senior solutions architect Principal research engineer Senior research engineer	Java, SQL, OO, CCNE Oracle, C++, Cisco Developer 2000 Dreamweaver, Embedded C	Specialist practitioner Senior specialist Manager
Systems development	Senior software project manager Technical consultant – Applications development Senior systems analyst Senior systems programmer Principal design engineer Senior design engineer Web/multimedia architect e Business architect Senior e Business consultant	Java, SQL, OO, CCNE Oracle, C++, Cisco Developer 2000 Dreamweaver Embedded C	Specialist practitioner Senior specialist Manager
Technical advice and consultancy	Principal support consultant Senior support consultant Senior support specialist Senior principal consultant Principal consultant IT technical specialist	Java, SQL, OO, CCNE Oracle, C++, Cisco Developer 2000 Dreamweaver Embedded C	Experienced practitioner Supervisor Specialist practitioner Senior specialist Manager

Note: The Priority Occupations List also includes occupational groups other than IT professionals (mainly health/medical occupations).
* One or more required.
Source: New Zealand Immigration Service, 2004.

StatLink: http://dx.doi.org/10.1787/365217035886

Table C.6.15. **IT skills covered by New Zealand's Occupational Shortage List,[1] December 2003**

ActiveX	AS400	ASP (Active Server Pages)
ASP.net	Basic.net	BPR (Business Process Re-engineering)
C	C++	CCDPI
CCNA (Cisco Certified Network Admin)	CCNE (Cisco Cert Network Engineer) CGI	Cisco
CISSP (Security)	Citrix	Clipper
CNA (Certified Novell Administrator)	CNE (Certified Novell Engineer)	CNP
COM	Corba	CSSI
CTI (Computer Telephony Integration)	DCOM	Delphi
Developer 2000	Dreamweaver	DHTML
EJB (Enterprise Java Beans)	Embedded C	e-security
Firewall (security)	GIS (Geographical Information Systems)	HP UX
IVR (Interactive Voice Response)	JAD (Joint Application Development)	Jade
Java	JSP	J2EE
Knowledge Management	LINUX	Lisp
Master CNE	Maya	MCP – Microsoft Certified Professional
MCT	MCSE Msoft Cert Systems Engineer	MCSD – Solution Developer
MCDA – Database Administrator	MX Exchange	Netview
Network Design	Novell Netware	OO.net
Oracle	Oracle Case	Oracle Financials
OS400	Perl	PeopleSoft
PL/SQL	Power Builder	Pro *C
Progress (security)	Project management	RAD (Rapid Application Development)
Rational Rose	REXX	RF Engineers
RS6000	SAP	SAS
SMS Server	Solaris	SQL
SUN	SunOs	Sybase
TCP/IP	UML	Unix
Vignette	Visual Basic	Visual C++
Wireless Engineers	WML	XML

1. Applicants for visas or permits must have a minimum of three years full time work experience in at least one of the skills identified on the shortage list (Annex Table C.6.14) and have completed a recognised programme of formal training in that area.

Source: New Zealand Immigration Service, 2003.

StatLink: http://dx.doi.org/10.1787/455083255518

Table C.6.16. **Internet recruitment, detailed NORAS results**

Percentages

		Total	Generic	Generic sites					Specialist sites		
				Fish4Jobs	Peoplebank	PlanetRecruit	Total Jobs	Workthing	AndersElite	Jobs AC	Prospects
	Unique users			817 398	138 140	238 564	627 620	422 026	29 269	190 388	193 755
Gender (base: all)	Male	51	54	45	56	69	52	47	83	45	39
	Female	49	46	55	44	31	48	53	17	55	61
Age (base: all)	15-24	31	25	31	19	21	24	29	15	12	66
	25-34	35	38	33	33	43	39	40	39	44	26
	35-44	20	22	21	28	23	21	18	23	28	5
	45-54	11	12	12	16	10	13	10	16	13	2
	55-64	3	3	3	4	3	3	3	7	3	1
	65+	0	0	0	0	0	0	0	0	0	0
	Average age	31.9	33.1	32.4	35.1	32.9	33.2	31.8	36.2	34.9	24.5
Level of education (base: all)	GCSE/O level/CSE	12	15	23	15	9	14	12	5	1	1
	A/AS level/vocational training	28	32	37	33	28	31	30	29	5	15
	Degree/professional qualification	56	48	32	47	61	50	53	63	93	82
	No qualifications	4	5	8	5	3	5	5	2	1	2
Geography (base: all)	North	20	19	33	15	14	17	18	19	22	27
	Midlands	27	28	30	31	26	26	28	31	27	26
	South	36	37	25	38	43	41	40	28	30	30
	Scotland	6	6	6	6	5	7	6	7	10	9
	Wales	3	3	5	2	1	3	3	4	3	3
	Non-UK	6	6	2	7	11	6	4	11	8	4
Working status (base: all)	FT perm	42	47	48	45	41	53	47	53	39	20
	FT temp	12	9	8	9	12	10	9	17	26	15
	PT perm	6	5	7	4	4	6	4	1	4	6
	PT temp	5	3	3	4	4	3	4	4	8	6
	Retired	0	1	1	1	0	0	1	0	0	0
	Unemployed	25	28	25	31	34	22	29	20	14	28
	FT education	8	4	4	4	2	3	4	2	7	23
	Other	3	3	3	3	3	3	3	3	2	3
Work experience since leaving FT education (base: all)	Still studying	10	5	6	6	4	5	6	3	8	24
	< 1 year	11	8	8	5	9	7	10	9	9	35
	1-3 years	15	13	12	11	13	13	17	10	18	23
	3-5 years	10	11	11	8	15	11	11	10	13	5
	5-10 years	14	16	15	14	16	17	18	15	17	5
	10 15 years	12	13	14	15	12	14	12	14	13	3
	15 20 years	10	12	13	14	12	11	9	11	8	1
	> 20 years	18	22	22	29	19	21	18	30	15	3
	Average years	10.6	11.7	11.9	13.8	10.9	11.6	10.3	13.1	9.7	3.3

Table C.6.16. **Internet recruitment, detailed NORAS results** (*cont.*)

Percentages

		Total	Generic	Generic sites					Specialist sites		
				Fish4Jobs	Peoplebank	PlanetRecruit	Total Jobs	Workthing	AndersElite	Jobs AC	Prospects
Pre-tax annual income (base: all working)	< £9 999	13	11	17	8	8	10	10	3	9	31
	£10 000-19 999	38	39	48	36	27	38	41	17	29	49
	£20 000-29 999	25	25	20	29	24	27	24	28	38	10
	£30 000-39 999	10	10	5	13	13	11	10	25	15	3
	£40 000-49 999	4	4	2	6	6	4	4	12	2	0
	£50 000-59 999	2	2	1	1	5	2	2	4	1	1
	Average	£22 494	£23 682	£18 265	£24 707	£31 778	£23 142	£22 441	£31 460	£23 040	£14 345

Notes: Unique users = the number of different people visiting a site over a specified period of time.

Because of space constraints, results for only three of the six specialist sites included in the survey are included. For the three specialist sites, as well as for PeopleBank, the number of unique users was measured in October 2002. The other three specialist sites surveyed were: AviationJobSearch, HotRecruit, and JobsGoPublic.

Salary bands over GBP 60 000 had very low percentages (0 3%) and are not shown.

Source: NORAS Winter 2003 results, Enhance Media Limited.

StatLink: http://dx.doi.org/10.1787/828020738440

Table C.6.17. **ICT occupations in the United Kingdom, based on Standard Occupational Classification 1990**

IT/computing	
126	Computer systems managers
214	Software engineers
320	Computer analysts, programmers (*incl. robot programmers*)
490	Computer operators (*incl. data processors,* VDU *operators, data entry clerks and database assistants*)
526	Computer engineers, installation and maintenance (Includes computer repairers)
Electronic/electrical	
212	Electrical engineers
213	Electronic engineers
302	Electrical, electronic technicians
520	Electrical production fitters
521	Electricians, electrical maintenance fitters
522	Electrical engineers (non professional)
529	Other electrical/electronic trades nec
850	Assemblers, etc. (electronic goods)
Telecommunications and broadcasting equipment related occupations (nes)	
386	Camera, sound equipment operators
462	Telegraph operators
463	Radio and telegraph operators
523	Telephone fitters
524	Cable jointers, lines repairers
525	Radio, TV and video engineers

ICT occupations are defined as including: *i*) ICT/computing occupations; *ii*) electronic/electrical occupations; and *iii*) telelecommunications and broadcasting occupations not elsewhere specified. The decision to include electrical occupations with electronic occupations throughout was guided by the fact that there are many occupational categories where the two types of occupation cannot be distinguished. Furthermore, this category also includes many higher level telecommunications occupations which cannot be separately identified.
Source: Mason *et al.*, 2002.

StatLink: http://dx.doi.org/10.1787/020645676022

Table C.6.18. **ICT occupations in the United States, based on the Occupational Classification from the 1980 Census**

IT/computing	
64	Computer systems analysts and scientists
65	Operations and systems researchers and analysts
229	Computer programmers
233	Tool programmers, numerical control
304	Supervisors, computer equipment operators
308	Computer operators
309	Peripheral equipment operators
385	Data entry keyers
525	Data processing equipment repairers
Electronic/electrical	
55	Engineers, electrical and electronic
213	Electrical and electronic technicians
523	Electronic repairers, communications and industrial equipment
533	Miscellaneous electrical and electronic equipment repairers
575	Electricians
576	Electrician apprentices
577	Electrical power installers and repairers
683	Electrical/electronic equipment assemblers
Telecommunications and broadcasting equipment related occupations (nes)	
228	Broadcast equipment operators
348	Telephone operators
353	Communications equipment operators nec
527	Telephone line installers and repairers
529	Telephone installers and repairers

ICT occupations are defined as including: *i*) ICT/computing occupations; *ii*) electronic/electrical occupations; and *iii*) telelecommunications and broadcasting occupations not elsewhere specified. The decision to include electrical occupations with electronic occupations throughout was guided by the fact that there are many occupational categories where the two types of occupation cannot be distinguished. Furthermore, this category also includes many higher level telecommunications occupations which cannot be separately identified.
Source: Mason *et al.*, 2002.

StatLink: http://dx.doi.org/10.1787/366240148246

Table C.6.19. **IT-related occupations: US Department of Commerce**

IT-related occupations	
High skill level	
Engineering managers	Computer and information systems managers
Computer and information scientists, research	Computer programmers
Computer software engineers, applications	Computer software engineers, systems software
Computer support specialists	Computer systems analysts
Database administrators	Network and computer systems administrators
Network systems and data communication analysts	Computer hardware engineers
Electrical engineers	
Electrical and electronic engineering technicians	Electronics engineers, except computer
Moderate skill level	
Computer, automated teller, and office machine repairers	Data entry keyers
Electromechanical equipment assemblers	Electrical power line installers and repairers
Electrical power line installers and repairers	Semiconductor processors
Telecommunications line installers and repairers	Telecommunications equipment installers and repairers, except line installers
Electrical and electronics repairers, commercial and industrial	
Low skill level	
Communications equipment operators	Computer operators
Billing and posting clerks and machine operators	Other office machine operators

Source: US Department of Commerce, 2003a.

StatLink: http://dx.doi.org/10.1787/722742184887

Table C.6.20. **Definition of ITEC (information technology, electronics, and communication technology) occupations**

UK SOC 90 Code	Occupational category	ISCO 88	Occupational category
126	Computer systems and data processing managers	213	Computing professionals
212	Electrical engineers	214	Architects, engineers and related professionals
213	Electronic engineers	311	Physical and engineering science technicians
214	Software engineers	312	Computer associated professionals
302	Electrical / electronic technicians	313	Optical and electronic equipment operators
320	Computer analysts, programmers	724	Electrical and electronic equipment mechanics and fitters
523	Telephone fitters		
524	Cable jointers, line repairers		
525	Radio, TV and video engineers		
526	Computer engineers		

Source: Millar, 2001a.

StatLink: http://dx.doi.org/10.1787/128033303007

Table C.6.21. **Classification of IT occupations**

	3-digit ISCO88
Knowledge workers Engineers and applied and social scientists	• Physical, mathematical and engineering science professionals (**211**, **212**, **214**) • Life science and health professionals (221, 222, 223) • Teaching professionals (231) • Other professionals (**241**, **242**, 244, 247) • Physical and engineering science associate professionals (311, **313**, 314, 315) • Life science and health associate professionals (321, 322, 323) • Other associate professionals (**341**, **342**)
Computer specialists	• Computing professionals (**213**) • Computer associate professionals (**312**)
Managerial workers	• Legislators and senior officials (111, 114) • Corporate managers (**121**, **122**, **123**) • Manager of small enterprises (131)
Data workers	• Teaching professionals (232, 233, 234, 235) • Other professional (**243**) • Teaching associate professionals (331, 332, 333, 334) • Other associate professionals (**343**, 344) • Office clerks (**411**, **412**, 413, 414, 419) • Customer service clerks (421, 422)
Service workers	• Other professionals (245, 246) • Other associate professionals (345, 346, 347, 348) • Personal and protective service workers (511, 512, 513, 514, 515, 516) • Models, sales persons and demonstrators (521, 522) • Sales and services elementary occupations (911, 912, 913, 914, 915, 916)
Goods producing workers	• Skilled agricultural and fishery workers (611, 612, 613, 614, 615) • Extraction and building trade workers (711, 712, 713, 714) • Metal, machinery and related trades workers (721, 722, 723, **724**) • Precision, handicraft, printing and related trades workers (731, 732, 733, 734) • Other craft and related trades workers (741, 742, 743, 744) • Stationary plant, and related operators (811, 812, 813, 814, 815, 816, 817) • Machine operators and assemblers (821, 822, 823, 824, 825, 826, 827, 828, 829) • Drivers and mobile plant operators (831, 832, 833, 834) • Agricultural, fishery and related labourers (921) • Labourers in mining, construction, manufacturing and transport (931, 932, 933)

Note: Occupations in bold are included in this chapter's broad definition of ICT-skilled employment; the main overlap occurs within the first three categories of workers.
Source: Arnal *et al.* (2001), based on Lavoie and Roy (1998).

StatLink: http://dx.doi.org/10.1787/523781745077

OECD PUBLICATIONS, 2, rue André-Pascal, 75775 PARIS CEDEX 16
PRINTED IN FRANCE
(93 2004 02 1 P) ISBN 92-64-01685-6 – No. 53625 2004