OECD Information Technology Outlook

ICTs AND THE INFORMATION ECONOMY

OECD

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Head of Publications Service,
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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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FOREWORD

The *Information Technology Outlook* 2002 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 sixth 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 developments in selected areas of information technology and a description of IT policy directions.

Building on the 2000 edition, the 2002 edition further extends 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 increasingly important software sector. The next three chapters describe the growing use of electronic commerce, rapidly evolving developments in the provision and use of ICT skills and the diffusion of ICTs and the digital divide. The last two chapters examine selected technological developments that will shape ICT exploitation and socio-economic impacts in the medium term and provide an overview of IT policies in OECD countries. Detailed statistical tables are provided in Annex 2. 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* 2002 was prepared by: Graham Vickery, Vladimir López-Bassols, Catalina Martinez, Pierre Montagnier and Elizabeth Muller of the OECD's Information, Computer and Communications Policy Division; Alessandra Colecchia, Elena Anton-Zabalza and Andrew Devlin of the Economic Analysis and Statistics Division (Chapter 4); and John Houghton (consultant). It benefited from valuable contributions from Delegates to the ICCP Committee's Working Party on the Information Economy, under the chairmanship of Mr. 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.

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HIGHLIGHTS

ICTs play a strong and increasing role in the world economy

ICTs play an increasingly important role in the economy.

Information and communications technologies (ICTs) are increasingly ubiquitous and firms, industries and countries are reaping greater benefits from their ongoing investments in ICTs and the more widespread use of the Internet. This is true despite considerable changes in the economic landscape since the 2000 edition of the IT Outlook and questions about the existence of a "new", knowledge-based economy, in light of the recent sharp decline in technology stocks and the slump in the ICT equipment industry.

ICTs account for a large share of investment and contribute significantly to output and productivity growth.

During the late 1990s, ICTs accounted for a large and growing share of investment and contributed significantly to output growth, particularly in the United States, Australia and Finland. The diffusion of ICTs throughout the economy has enhanced economic efficiency and substantially boosted productivity growth and the ICT-producing and ICT-using sectors have accounted for the bulk of overall productivity growth in a wide range of OECD countries.

Despite current cyclical difficulties, trend growth of the ICT sector remains strong…

Since late 2000, however, the world ICT equipment industry has faced a severe downturn, although there are signs of an upturn on the horizon, as OECD economies begin to recover and demand and investment slowly pick up. Despite the short-term turbulence, prospects for the industry remain strong, as new products and services such as broadband continue to drive demand from firms, households and governments. In most OECD countries, the ICT sector accounts for a growing share of production, value added, employment and trade, owing to sustained price declines and continuing technological developments and venture capital investment in ICT firms.

… and the overall market for ICT goods and services continues to grow.

In the OECD area, ICT intensity (total ICT markets/GDP) increased, driven by strong growth in telecommunications services, to an average 8.3% in 2001 for goods and services combined. Software still represents less than 10% of the total ICT market, but is growing fastest, at almost 16% a year since 1992. Growth in non-member countries has been even more dynamic, and markets such as China and Brazil are now among the world's ten largest.

ICT producers are an essential part of the current trend towards globalisation of economic activity

The ICT sector is highly globalised in an increasingly globalised world economy…

The ICT sector is highly and increasingly globalised. Trade in ICT goods has grown at almost double the rate of trade in total goods, with exports of ICT equipment equivalent to well over 5% of GDP in a few OECD countries and trade in IT services growing faster than trade in equipment. Both are growing at much higher rates than GDP.

... with intra-firm trade playing an ever larger role.

As cross-border investment increases, intra-firm trade is beginning to dominate trade, with ICT producers in the lead. US data show that ICT products represent over one-quarter of all imports of related parties and one-fifth of exports, shares higher than those of ICT products in total trade. Over two-thirds of all US ICT imports and one-third of US ICT exports are related party trade. Sales of ICT products by foreign-owned affiliates operating in the United States are of the same order of magnitude as imports of ICT products by related parties, and overseas sales by US foreign affiliates are approximately three times exports of ICT products by US related parties.

The focus of international investment in ICTs is shifting from manufacturing towards services.

Foreign investment in the ICT sector is strong, and the focus of new international investment in ICTs is shifting from manufacturing to services activities. This trend is likely to continue as services undergo greater domestic deregulation and competition, as trade liberalisation continues and as marketed services take a larger part in economic activity. As deregulation has created new markets, telecommunication services have been at the forefront of investment and M&A activities. Owing, for example, to the large future cost of third-generation mobile networks and the substantial investments required in broadband, significant consolidation is likely. This will be tempered, however, by regulatory demands for competition and choice in national markets.

Mergers, acquisitions and strategic alliances focus on R&D and technology access.

Technology-oriented M&As and strategic alliances in the ICT-producing sector are being propelled by rapid technological change, as product life cycles become shorter and new markets open up for innovative products and services. Through M&As and alliances, ICT-sector firms are likely to continue to seek ways to exploit emerging technologies (*e.g.* in IP networking, radio and optical communications, broadband applications) and bring them rapidly to market. However, the sector has felt the impact of the business cycle, with significant reductions in the level of FDI, M&As and strategic alliances likely in 2002 and beyond. Despite the recent slowdown, the ICT sector's underlying structure and dynamics will ensure that it continues to play a leading role in industrial globalisation.

Strong growth in the software sector is due to its increasingly crucial role in the ICT sector and the economy

Software is one of the most rapidly growing and evolving sectors in OECD countries.

Dynamic growth and the impact of software investment on firm-level and economy-wide productivity and competitiveness underpin policy interest in the software sector. It is among the most rapidly growing sectors in OECD countries, with strong increases in value added, employment and R&D investment. Both packaged software and software-related services have a growing share in overall ICT markets. World packaged software markets were estimated at USD 196 billion in 2001, 95% of which in OECD countries. Businesses across all sectors of the economy increasingly invest in software, and the nominal share of software in business sector gross fixed capital formation has increased constantly since 1990. At the end of the 1990s, it reached 13.6% and 11.9% for the United States and Finland, respectively. At the same time, market structures in the software sector have changed rapidly, owing to technical innovation and the emergence of new product segments, and new firm entry, alliances, M&As and fierce competition among incumbent firms.

Many competing forces are thus shaping the software sector. The crucial importance of integration, interconnection and software product compatibility will test the rival approaches to software development and exploitation: open and proprietary source code software. Network computing and the ubiquity of the Internet are driving new software supply strategies by application service providers, reinforced by outsourcing-driven business strategies adopted by user firms of all sizes.

Software that underpins network integration, interconnection and compatibility will be essential…

Innovation is a particularly important driver of change, and software firms are the most R&D-intensive of ICT firms, important recipients of venture capital (up to 20% of total technology venture capital in the United States, over 30% in Europe) and increasingly active in patenting. In the United States, for example, the number of software-related patents has grown much faster than total patents granted and now account for between 4% and 10% of all patents, depending on how they are counted.

… and software-related patenting is increasing rapidly.

Trade in software goods and services is growing strongly but is difficult to measure, partly owing to the increasing diversity of delivery channels. The value of software goods traded on physical supports gives an indication of cross-border sales of software goods. Ireland and the United States accounted for more than 55% of OECD exports of software goods in 2000. Ireland has become the European manufacturing and distribution centre for the software of many of the world's top software vendors, accounting for over 40% of all packaged software and 60% of all business software sold in Europe. In 2000, Ireland also ranked first in the value of software services exports (mostly computer and information services) (USD 5.48 billion, followed by the United States with USD 4.9 billion) and in terms of the national share of software in total services exports (33%). Software trade is significantly underestimated because it is usually based on the value of physical supports (CD-ROM, diskettes) rather than content and is often bundled with computer hardware, while digitally delivered software is not measured in trade statistics. On the services and intangibles side, software and copyright trade are poorly measured.

Trade in software is dynamic but difficult to measure.

Electronic commerce is growing, but is still in its infancy, especially among consumers

Electronic commerce has the potential to alter economic activity and the social environment. In the aftermath of the "dot com" crash, many start-ups that sold and/or purchased exclusively on line have disappeared, and growth in electronic commerce transactions has been less spectacular than predicted. Nevertheless, the volume of electronic transactions is growing and the Internet is increasingly used as a transaction channel, particularly for purchases.

Electronic commerce has the potential to transform economic activity, but transactions are taking off more slowly than predicted.

Recent official surveys show that while Internet and electronic commerce transactions are rising fast, they still play a small role. In the few countries that currently measure the value of Internet or electronic sales, total Internet sales in 2000 ranged between 0.4% and 1.8% of total sales. Electronic sales (including those over all computer-mediated networks) were over 10% in Sweden. In most countries, sales via electronic data interchange (EDI) are at least twice sales via the Internet. Use of the Internet to carry out transactions varies according to whether the business is a customer or supplier, with purchasing more common than selling.

However, electronic transactions are growing, the Internet is increasingly used for purchase and EDI remains important.

Internet transactions remain concentrated in a few sectors and the relation between Internet use and firm size is complex.

Internet sales and purchases tend to be concentrated in a few sectors. The nature and type of transactions that typically take place in these sectors strongly determine the characteristics of Internet transactions. Available statistics show that Internet sales are mainly domestic or regional. Results for eight EU countries show that European companies have a high propensity to sell over the Internet to locations within Europe. The relation between Internet use and firm size is complex, and industry-specific factors play a considerable role. Smaller Internet-using businesses have roughly the same propensity to sell over the Internet as larger ones in Australia, Denmark and Sweden. However, use of the Internet for purchases seems to be more sensitive to firm size in all countries. Businesses that do not conduct transactions electronically perceive electronic commerce as ill-suited to the nature of their business. Other reasons vary. While Canadian firms seem to prefer to maintain their current business model, the major concerns in Europe relate to security in handling payments, uncertainty over contracts and an insufficient customer base.

Business-to-consumer Internet sales remain low with lack of consumer interest a common reason.

Business-to-consumer Internet sales have not taken off. The share of Internet users buying over the Internet and the volume of transactions remain quite low and vary widely across countries. Computer products, clothing and digitised products such as music, books and software often constitute the major sources of Internet sales to consumers. However, the best-selling products vary, reflecting the nature of the product and consumer tastes and habits. For consumers, the main reasons for not purchasing over the Internet are "lack of interest or no use for the Internet" and cost of access.

The need for ICT skills at all levels of competence is of continuing concern

The demand for ICT skills continues to grow, creating concerns about possible labour shortages and gaps in worker skills.

Given their role in the current transformation of advanced economies, ICTs offer the promise of new business and employment opportunities along with higher productivity gains, but also make new demands on skills. OECD countries are confronted with the dual challenge of ensuring that the growth of new industries and activities is not stifled by labour bottlenecks and skill mismatches and that their population is equipped to master the basic ICT skills which these transformations require. Despite recent claims of a widespread ICT worker shortage, the analysis suggests that although there is indeed some evidence of tightness in labour markets for particular categories of such workers, the main issue of concern for policy makers and firms should be the gap between the current skills of some IT workers and those sought by firms.

Governments, firms and educational institutions in OECD countries are taking measures to meet changing skill demands in the IT workforce.

Both short- and long-term private-sector strategies can be implemented to address the rapidly changing skill requirements for ICT jobs. OECD firms appear to be taking similar measures, but they also emphasise the need for better data to measure the IT workforce and for new kinds of partnerships. It is broadly agreed that all stakeholders have a role in implementing short-term solutions and in facilitating development of longer-term strategies. Various supply- and demand-side measures are being deployed. On the supply side, these include providing more information to students, developing stronger IT skills in secondary schools, assisting in teacher training, making IT careers more attractive (in particular to under-represented groups such as women), ensuring better integration of educational programmes with "real world" problems, helping workers maintain up-to-date skills. On the demand and user side, these include better use by employers of the existing workforce (both in terms of recruitment and retention), more information on skill needs and opportunities (including new pathways to IT jobs), adequate training programmes for various categories of workers (including unemployed and older workers) and governments taking a lead role as employers of IT workers.

Immigration is one means of increasing the short-term supply of IT workers. Many countries favour this solution, but immigration alone cannot address the need for cyclical adjustments to the labour market, and, by dampening wage growth, it can send conflicting signals to firms, workers and students.

Immigration is only one tool to increase short-term supply and must be part of a broader policy framework.

Reducing the digital divide among and within countries is another pressing issue

Differences in access to ICTs, such as computers and the Internet, create a "digital divide" between those able to benefit from opportunities provided by ICTs and those who cannot. Access to and development of the information and communication resources that these technologies enable is increasingly viewed as crucial for economic and social development. Network economics mean that the more the participants in ICTs the greater the value to all.

Differences in access to ICTs create a "digital divide".

There are considerable differences in the diffusion and use of ICTs and electronic commerce across, and within, OECD countries. Differences may create new kinds of social divides and accentuate existing divides relating to income, education, age, family type and sub-national regions. There are particularly striking differences by household income and education in household PC and Internet access, but these are greatly influenced by other access factors, particularly whether individuals also have access in the workplace.

Household digital divides exist by income, education, age, family type, sub-national region.

The digital divide may be said to be growing, as the access gap between those with the highest and lowest levels of ICT access is increasing. Conversely, the digital divide may be said to be shrinking, as rates of growth are much faster for lagging groups. Common measures of distributional inequalities such as Gini coefficients also show the digital divide to be shrinking.

The shape of the digital divide is changing.

Differences in diffusion may also be creating new kinds of business divides. Sector-specific factors and firm size have an important influence on the uptake and use of ICT, and the regional concentration of particular kinds of firms and industries accentuates these divides. Government use of ICT is also increasingly important in OECD countries. As e-government is more widely implemented, it may both provide incentives to increase ICT use by citizens and businesses and accentuate existing digital differences.

Different kinds of firms have different rates of ICT use and e-government will affect the divide.

These issues are affected by the rapid evolution of ICT technologies

As computing power increases, unit price and size decrease and communication capabilities expand. These trends are likely to have widespread impacts, increasing ICT ubiquity and possible associated benefits, such as productivity growth. More devices will be fitted with computing and communication capabilities that will provide new functionalities for users. There will be more communication channels, and people will increasingly communicate with each other and with applications, while applications will increasingly communicate directly.

New computing potential and communication channels are being developed and are proliferating.

Many new technologies are being developed…

Efficient and more effective information exchange is a major aim of information technology (IT) innovation. The development and rapid diffusion of new communications technologies and channels are altering communications structures and providing possibilities for further economic and social gains through greater networking. The Internet is a vital infrastructure for communication, collaboration and information sharing and contributes to efficiency improvements and productivity gains. Updating capacity and other constraints in its architecture while retaining its open and relatively simple architecture will provide additional benefits.

… shifting the focus from a centralised to a decentralised model of information exchange.

With increasingly ubiquitous computing power and communications capacity, the dominant model of information exchange is shifting from a centralised and hierarchical model to one that is decentralised, horizontal and more equally distributed and democratic. Open source, Internet protocol version 6 (IPv6), wireless and peer-to-peer are examples of different aspects of the shift in the structure and nature of information exchange. The potential for encouraging decentralised information flows is just beginning to be realised and has already profoundly affected established structures.

New technologies present new policy challenges.

The development of new technologies is driven by the interplay of technological potential, commercial exploitation and socio-economic acceptance. The challenge for government is to foster innovation and technological development while attending to equity considerations (*e.g.* digital divide issues related to new technologies) and potential problem areas (*e.g.* system security, privacy and trust issues). Technological developments are moving rapidly and it is not easy to anticipate future policy impacts in detail.

OECD governments are addressing ICT issues through a wide variety of policies

OECD countries increasingly have broad action plans for the information society.

Almost all OECD countries have well-developed and clearly enunciated broad strategies and action plans for IT and an overarching policy approach to the information society. These usually cover technology development, technology diffusion, improving the IT environment and the global diffusion and distribution of ICTs. Policies to encourage broadband infrastructure investment and use are receiving more and more attention. The potential cost-effectiveness of public-private partnerships in promoting the development and use of ICTs is increasingly recognised.

Governments are implementing policies to facilitate the supply of skills…

OECD governments recognise the importance of a skilled workforce, and are increasingly taking policy measures to support the efforts of business. While professional ICT skills are important for growth of industry in general, they are also increasingly needed throughout the economy. ICT skills have become a new type of "general" skill, like literacy or numeracy. Governments are implementing an array of policies targeting different segments of the population in order to promote basic and advanced ICT skills. Some government policies do not specifically target the development of IT skills but imply the need for them (*e.g.* e-learning, on-line job searching).

Main OECD country IT policy areas

General policies
ICT policy environment and broad policy visions

Technology development
R&D programmes

Technology diffusion
Diffusion to individuals and households
Diffusion to businesses
Government services online
SMEs
Demonstrate benefits of ICT use

IT environment
Electronic settlement, authentication and security
Intellectual property rights

Globalisation
International co-operation

Source: OECD.

... and to overcome the digital divide.

Governments are also searching for ways to overcome the digital divide in order to spread more widely the potentially positive benefits of ICT use and digital opportunities. Fostering a healthy and pro-competitive ICT environment will enable ICT goods and services supply at competitive prices and quality. General and specific policies may be needed to target more specific goals and socio-economic groups that may be lagging. International initiatives will help countries to learn from the experience of others.

Chapter 1

ICTS AND THEIR ROLE IN THE ECONOMY

This issue of the *Information Technology Outlook* suggests, on the basis of recent evidence and analysis, that something new is indeed taking place in the structure of OECD economies and that it is this transformation, driven and facilitated by information and communication technologies (ICTs), which has contributed to the high growth recorded in several OECD countries during the second half of the 1990s (OECD, 2001*a*). In many respects, Solow's paradox is being resolved. In addition to the surge in investment, ICT also appears to have brought other, more qualitative, economic benefits, like valuable networks between suppliers and more choice for consumers, notably thanks to the Internet. ICT has spurred innovation in services, has improved the efficiency of manufacturing and design, while making inventories and overheads more manageable. It has been a catalyst of change in business, improving work organisation, and helping firms to reduce routine transaction costs and rationalise their supply chains. Crucially, ICT, particularly when combined with skill upgrading and organisational change, seems to have facilitated productivity-enhancing changes within firms, in both new and traditional industries. Such benefits are long-term in their effects, and will continue to develop, even given the difficulties and challenges that the industry faces today.

However the economic landscape has changed considerably since the 2000 edition of the OECD *Information Technology Outlook*: the Internet bubble burst, the US economy entered a recession, ICT firms worldwide have faced the difficult consequences of a sharp economic downturn. Although most of the "irrational exuberance" of the "dot com" era has dissipated and we now know that the effects of ICT must be put in the context of other major inventions of the past, it would indeed be wrong to conclude that there was nothing particularly exceptional about the recent US experience and experience in a number of other countries and that the "new economy" was in fact a myth (OECD, 2001*b*). This chapter examines developments in the ICT-producing sector, as well as the growing role of ICT diffusion and investment across the whole of the economy. It looks first at the role of ICT investment in growth as well as the importance of ICT-producing and ICT-using sectors for economic performance in terms of growth and productivity. Next, it discusses developments in the ICT-producing sector, including the recent downturn, but also ongoing structural changes. Finally, it presents data on ICT markets. An appendix provides a firm-level view of the top ICT firms.

ICTs and their contribution to growth and economic performance

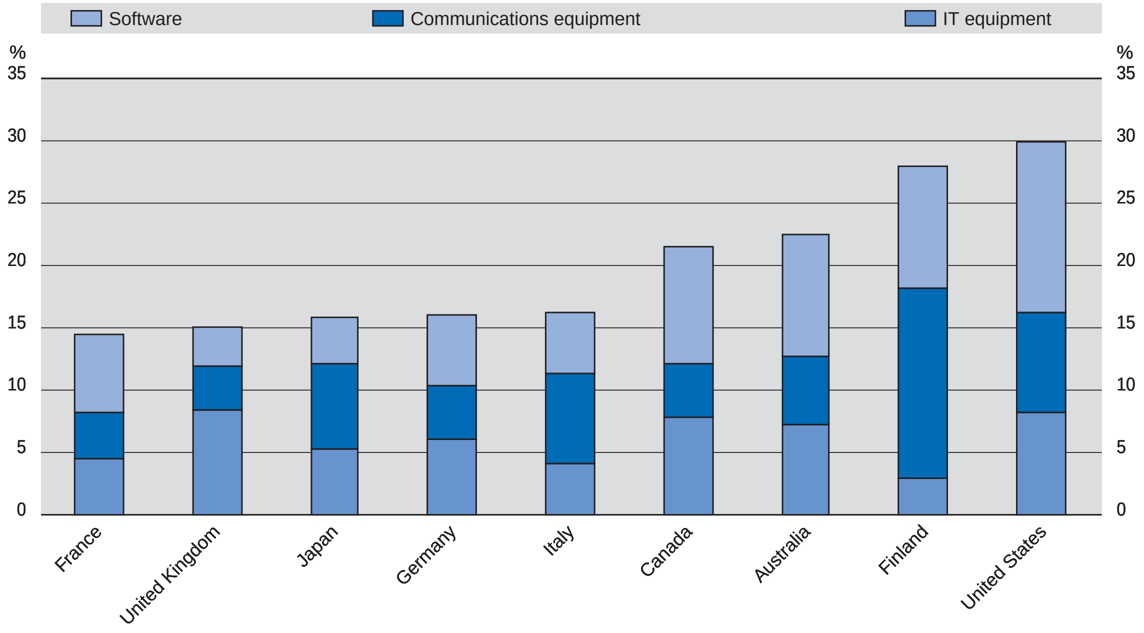
This section examines the growing importance of ICTs at both aggregate and firm level. It presents recent evidence of the growing share of ICT in investment in OECD countries, as well as the contributions of ICT-producing and ICT-using sectors to economic growth and performance.

ICT *investment*

ICTs have an increasing share in all investment across the economy, owing to rapid price declines and growing demand for ICT applications. In a group of nine OECD countries (the G7 countries plus Australia and Finland), ICT investment rose from less than 15% of total non-residential investment in the business sector in the early 1980s to between 15% and 30% in 2000 (Figure 1). Investment in hardware has typically increased at the most rapid rate, but software investment has also experienced fast growth

Figure 1. **Share of ICT investment in total non-residential investment, 2000**

Percentages



Note: 1999 for Finland, Italy and Japan.
Source: Colecchia and Schreyer (2001).

from a small base. During the 1990s, and despite different positions in the business cycles, the growth of investment has increasingly been driven by ICT investment, particularly in the United States, Australia and Finland (Colecchia and Schreyer, 2001).

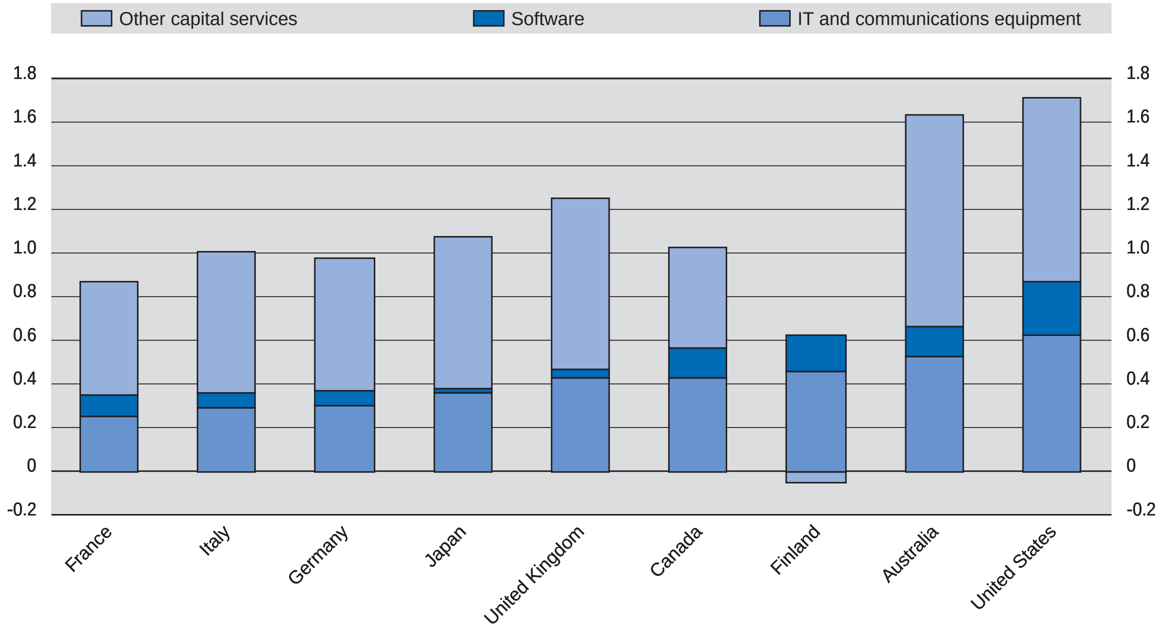
While ICT investment accelerated in most OECD countries, the pace and impact on growth differed widely. ICT investment accounted for between 0.22 and 0.46 percentage points of growth in GDP per capita over the 1985-90 period. Over the 1995-99 period, this contribution increased to between 0.35 and 0.87 percentage points a year, with the United States, Australia and Finland receiving the largest boost (Figure 2). The contribution of ICT investment to GDP per capita in France, Italy, Germany and Japan increased only marginally, and accounted for less than 0.40 percentage points of total growth in the 1995-99 period. In the 1995-2000 period, software capital accumulation accounted for at least one-fifth of the overall contribution of ICT capital to output growth. This holds across all OECD countries for which software data are available, with the exception of Japan and the United Kingdom. These observations confirm that the United States is not alone in experiencing the growth effects of ICT.

ICT *diffusion and its contribution to aggregate growth*

There has been continuing debate regarding the relative importance of diffusion and use *versus* production of ICTs in improved economic performance. Increasing firm-level evidence suggests that effective diffusion and use of these technologies are key factors in broad-based growth, particularly when combined with effective human resource strategies involving education and training and organisational change. There is also increasing evidence that the effective use of ICT is contributing positively to growth at the sectoral level. Recent studies (Pilat and Lee, 2001; Van Ark, 2001) have attempted to quantify the contribution of ICT-producing and ICT-using sectors to aggregate GDP and productivity growth during the 1990s.

Figure 2. **Percentage point contribution of ICT and other capital services to output growth, 1995-2000**

Business sector, harmonised price index



Note: 1995-99 for Australia, Finland, Italy and Japan.
Source: Colecchia and Schreyer (2001).

Figure 3 shows the contributions of ICT-producing, ICT-using and other sectors to GDP growth between 1995 and 1999 in the G7 countries as well as Denmark, Finland and the Netherlands. The data confirm that the contribution from ICT sectors was highest in the United States (mainly owing to ICT-using sectors) and Finland (mainly owing to ICT-producing sectors). Even in Japan and Italy, which experienced relatively slow GDP growth, the contribution of ICT-producing and ICT-using sectors was still significant, exceeding 50%. When compared with the period 1990-95, the contributions from both the ICT-producing and ICT-using sectors to the acceleration of GDP growth during the second half of the decade were particularly high in Finland, followed by the Netherlands and the United States.

If ICTs are indeed contributing to the shift in our economies towards higher sustainable growth paths, one would expect them to be playing an important role in the recent acceleration of productivity growth. During the period 1995-99, for all ten countries examined, labour productivity growth in the ICT-producing sector was substantially higher than in the rest of the economy. Overall, as Figure 4 shows, ICT-producing and ICT-using industries contributed in an important way to the growth of total labour productivity across the economy during the second half of the 1990s, particularly in Finland and the United States.

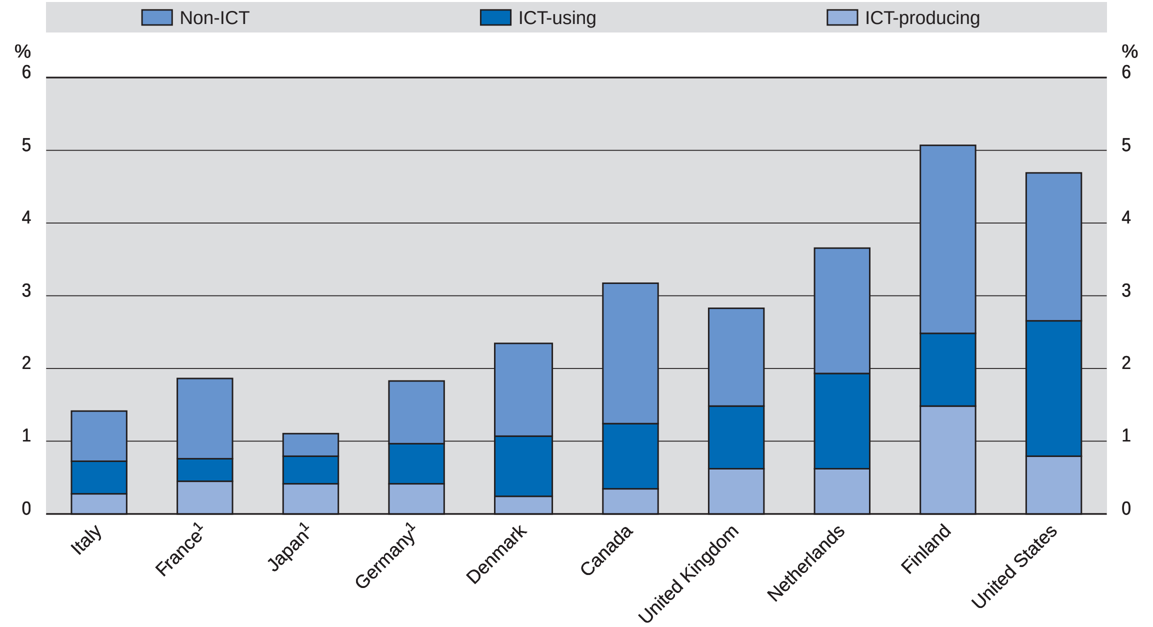
These results support the view that countries can reap benefits (in terms of economic growth) from different ICT-related strategies: fostering a strong ICT-producing sector (*e.g.* Finland) or successfully harnessing the benefits of ICT usage in other sectors of the economy (*e.g.* United States, Denmark).

The ICT-producing sector

This section discusses trends in the ICT-producing sector. As already noted, the ICT sector contributes directly to growth, but also provides goods and services that improve the functioning of other economic sectors.

Figure 3. **Contribution of ICT-producing and ICT-using sectors to GDP growth in selected OECD countries, 1995-99**

Percentages

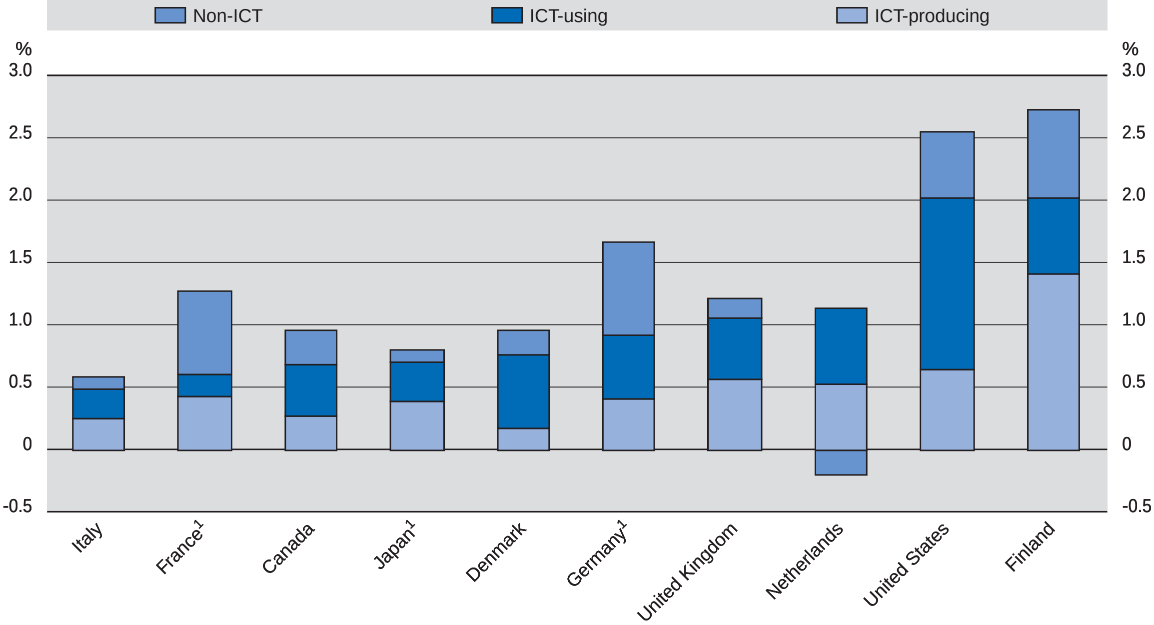


1. Data for 1995-98.

Source: Van Ark (2001).

Figure 4. **Contribution of ICT-producing and ICT-using sectors to labour productivity growth in selected OECD countries, 1995-99**

Percentages



1. Data for 1995-98.

Source: Van Ark (2001).

Recent developments in the ICT *industry*

Several factors have contributed to modify the short-term economic landscape for the ICT industry. The economic slowdown which began in the United States has since spread to Europe and other parts of the world. Several factors have contributed to the current slump in the industry:

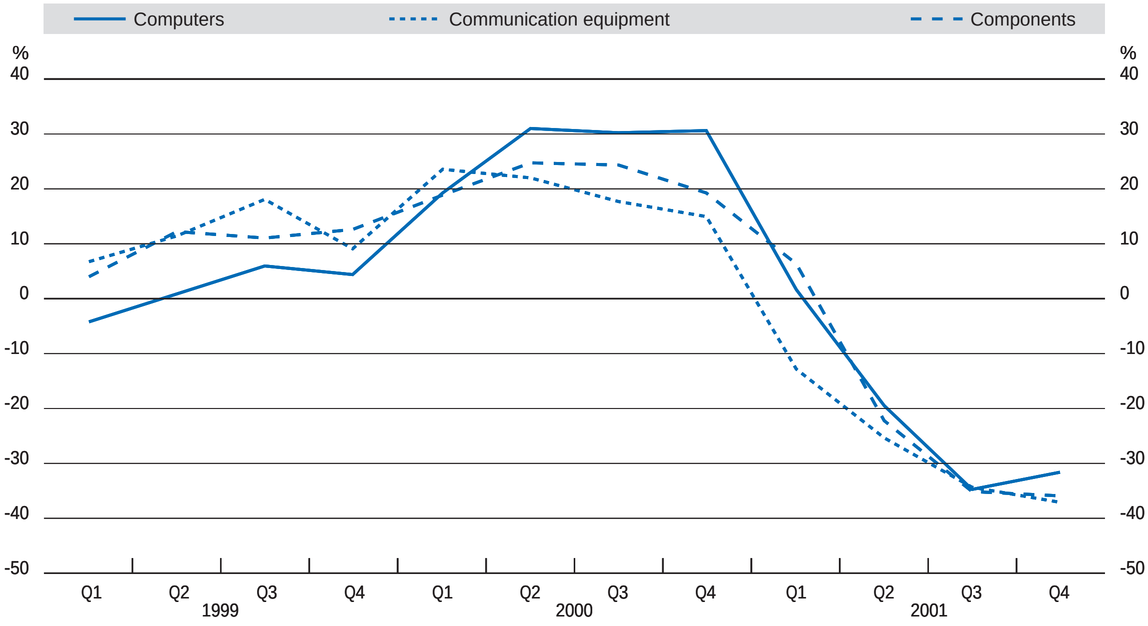
- Over-investment by firms, including in excess telecommunications capacity.
- The correction in high-technology stock markets, the collapse of equity values and the ensuing reverse "wealth effect" for consumers.[1] This has created a difficult climate for new firms seeking financing and uncertainties for those seeking to launch initial public offerings (IPOs).
- Saturation in certain markets, such as consumer PCs in the United States and mobile phones in some European countries.
- On the supply side, more efficient production methods have resulted in lower inventory buffers, while on the demand side, firms accelerated write-offs to maintain profits. As the economy started to slow, vendors were forced to slash margins to maintain sales (price wars), while purchasing firms deferred investments and cancelled orders.

Data from the United States show that shipments in the three main ICT equipment areas (computers, communication and components) increased rapidly during 1999 and reached growth of more than 20% over the previous year in the second quarter of 2000 (Figure 5). Growth in communication equipment began to slow in early 2000, followed by computers, then components later in the year. Since the beginning of 2001, growth has been negative for all three categories, although the decline in computer shipments slowed in the last quarter of 2001.

Semiconductor vendors also experienced the deterioration: as orders evaporated, inventories swelled, and prices dropped without any immediate effects on demand. In early 2001, PC demand collapsed. Subsequently, market demand for each of the major hardware segments deteriorated steadily.

Figure 5. **Quarterly ICT shipments in the United States, 1999-2001**

Year-on-year growth, percentages



Source: OECD, based on US Bureau of the Census, February 2002.

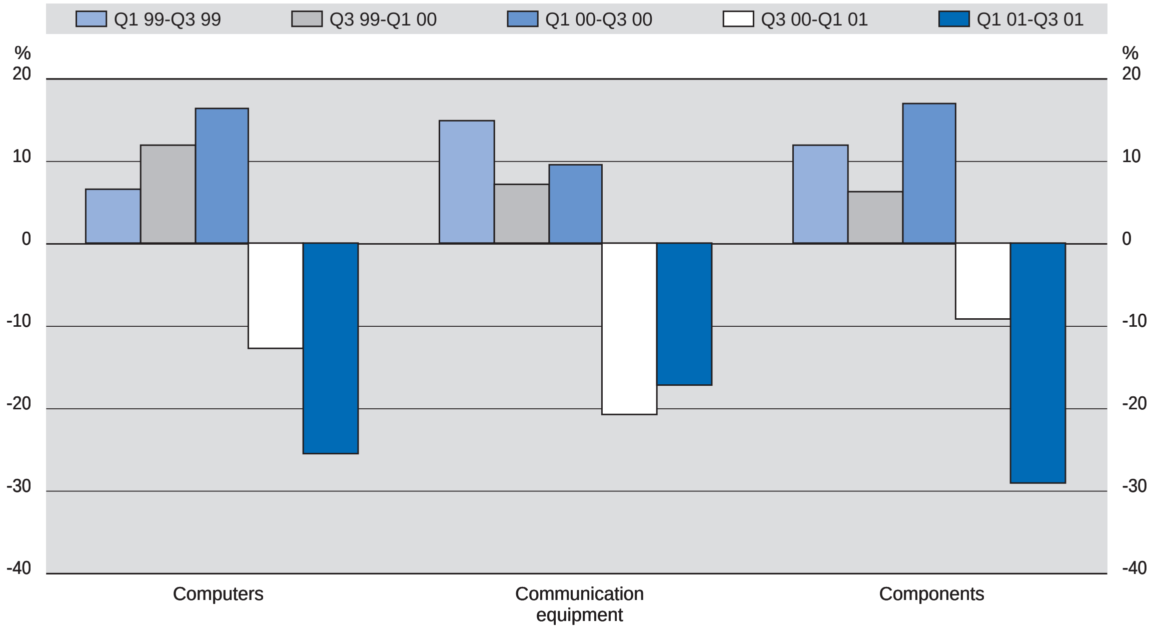
During the second half of the 1990s, capital was heavily invested in network and equipment and the number of operators increased. As a result, equipment manufacturers initially saw their revenues boom. The growth strategy followed by these firms (*i.e.* Lucent, Nortel, Cisco, Siemens) during this period was mainly oriented towards external acquisitions. When the Internet bubble burst, the cost of those acquisitions had heavy financial implications. In addition, the operators, the main clients of equipment manufacturers, suddenly slashed orders. Furthermore, some markets where heavy investment had taken place, such as mobile telephony, started to reach maturity. As a result, telecommunication manufacturers (infrastructure and handsets) faced a sudden downturn, and their semiconductor orders followed suit. The semiconductor industry was then faced with a demand-induced downturn due not only to the telecommunications market but also to the hardware market. For the first time, the PC market (in the United States, Germany and the United Kingdom) decreased in terms of shipments during the second quarter of 2001, albeit very slightly.

Figure 6 illustrates the sharp drop in orders during the fourth quarter of 2000 and the first quarter of 2001 for all three categories of ICT goods in the United States, which was followed by a steeper decline during the second and third quarters of 2001.

Outside the United States, data on semiconductor markets show that shipments had been increasing at an accelerating pace in the four main regions (Americas, Europe, Japan and Asia-Pacific) since early 1998 to reach more than 50% year-on-year growth in June 2000. This was followed by slowing growth during the second half of 2000 and a decline in the value of orders during the first three quarters of 2001. World-wide, the value of orders in August 2001 was similar to that of three years earlier at USD 9.4 billion, compared to a peak of more than USD 21 billion in September 2000. The recent decline has been less sharp in Japan and the Asia-Pacific region, which now account for more than half of all orders (Semiconductor Industry Association, 2001*a*).

Figure 6. **Quarterly ICT shipments in the United States**

Growth over six-month period, percentages



Source: OECD based on US Bureau of the Census, January 2002.

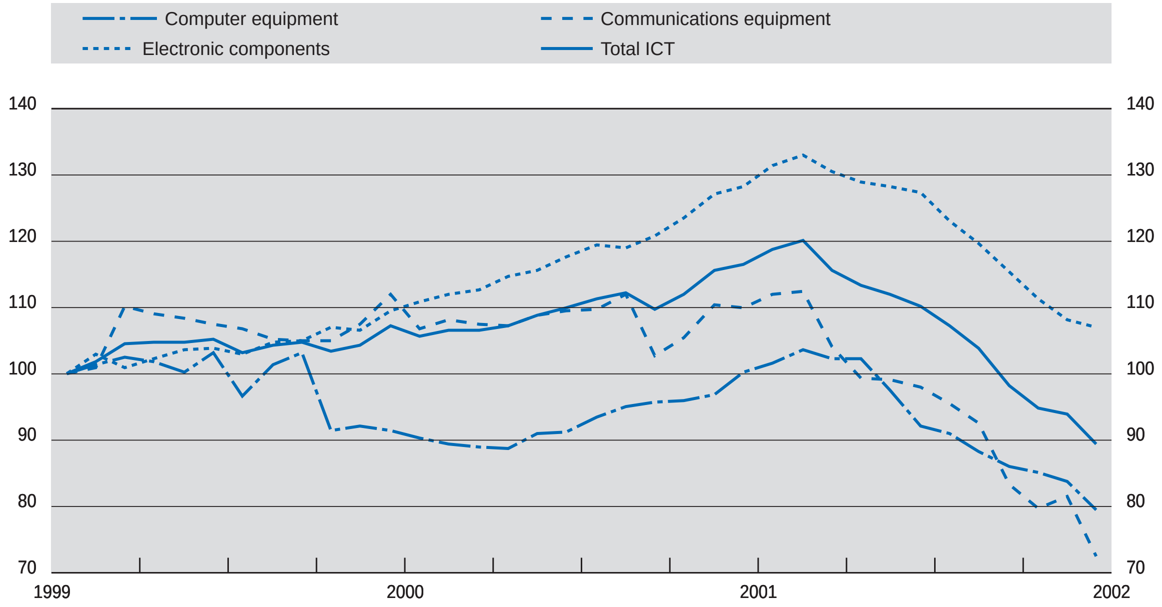
When can we expect an upturn?

Given the overall economic uncertainty, it is difficult to predict when a full recovery in ICT demand will occur. As of late 2001, consumer demand was still high in the United States and Europe, despite the events of 11 September. Also as of late 2001 and early 2002, business demand for ICTs in the United States has remained high by historical standards. Overall, the sharp declines in nominal terms on the supply side only took output back to historically high levels of a few years earlier. Most analysts had forecast some uncertainty during the first half of 2002, which should gradually dissipate as business confidence improves, the effects of monetary loosening are felt, and, in some countries, those of fiscal stimulus, which already supports aggregate demand. Other positive factors will contribute to the recovery within the sector: ICTs enable firms to operate more efficiently and control costs, and this becomes a vital competitive advantage during a period of economic turmoil. Among recent positive developments, stocks of ICT goods had been significantly reduced by late 2001 compared to the first quarter of the year in the United States, for both telecommunications equipment and electronic components (Figure 7). In the case of computers, inventories had already been on a steadily declining trend since early 1996 owing to rationalisations in the ICT industry which have improved ordering and manufacturing systems, thereby minimising the risk of inventory overhangs.

In the United States, the ratio of inventories to shipments for computer and electronic products (a broader category which does not include electronic components) declined steadily during 1999 and most of 2000, then increased rapidly during 2001 as the abrupt fall in shipments outpaced the ensuing decline in inventories (Figure 8). After reaching a peak in August 2001, this ratio was on a sharply declining trend during the fourth quarter of 2001, suggesting improving conditions for the industry.

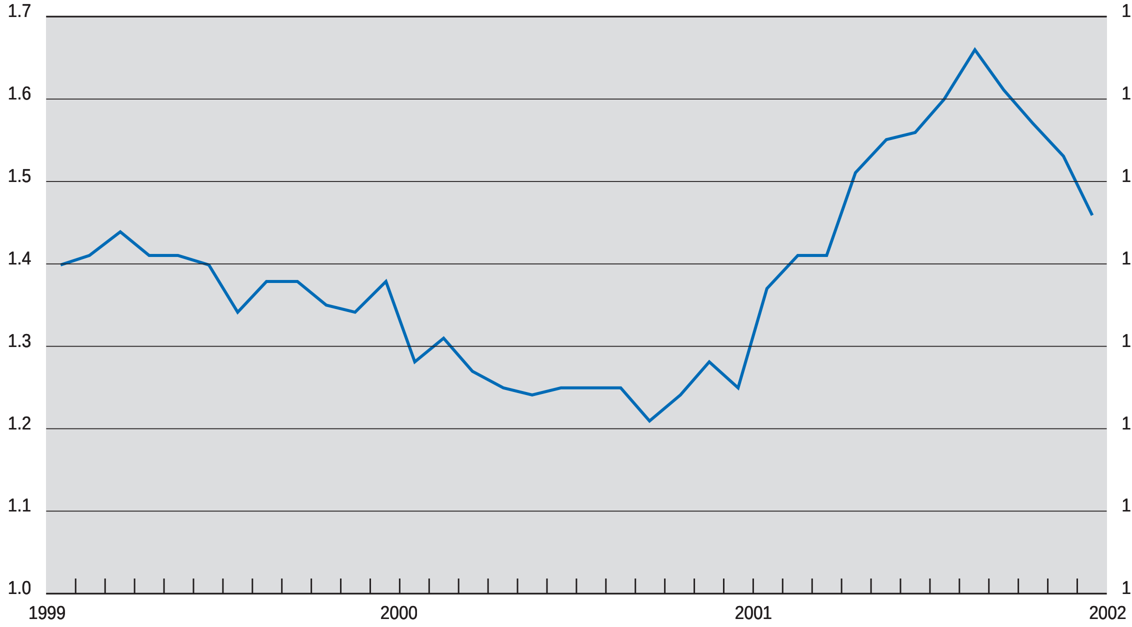
Although many firms have succeeded in cutting costs (some through layoffs), there is still a risk that sales growth will not pick up until late 2002 and that margins will be further squeezed. Most analysts suggested that hardware sales would remain slow following the sharp slowdown in many segments

Figure 7. **Monthly inventories of ICT goods in the United States, 1999-2001**
Index: January 1999 = 100 (seasonally adjusted)



Source: OECD based on US Bureau of the Census, February 2002.

Figure 8. **Monthly inventory-to-shipments ratio for computer and electronic products in the United States, January 1999 to December 2001**



Source: US Bureau of the Census, January 2002.

in 2001, although software sales grew moderately; the outlook, for example, for electronic components in 2002 is for moderate growth from 2001 (IDC, 2001; Forrester Research, 2001; Semiconductor Industry Association, 2001*b*).

Ongoing structural change of the ICT *sector*

Despite the cyclical downturn, longer-term prospects for the industry remain solid since, based on past experience, new products and services will drive demand from businesses, households and governments. This section examines the main economic variables relating to the ICT supply side (production, value added, employment, trade) and some of the main drivers behind the long-term growth of the industry (R&D expenditures, price declines, patents, venture capital). The analysis covers the 1990s, with the focus on the second half, and in particular on the most recent data available (1998-2000). When possible, official OECD definitions of the ICT sector are used (see Annex 1: Methodology; and OECD, 2000).

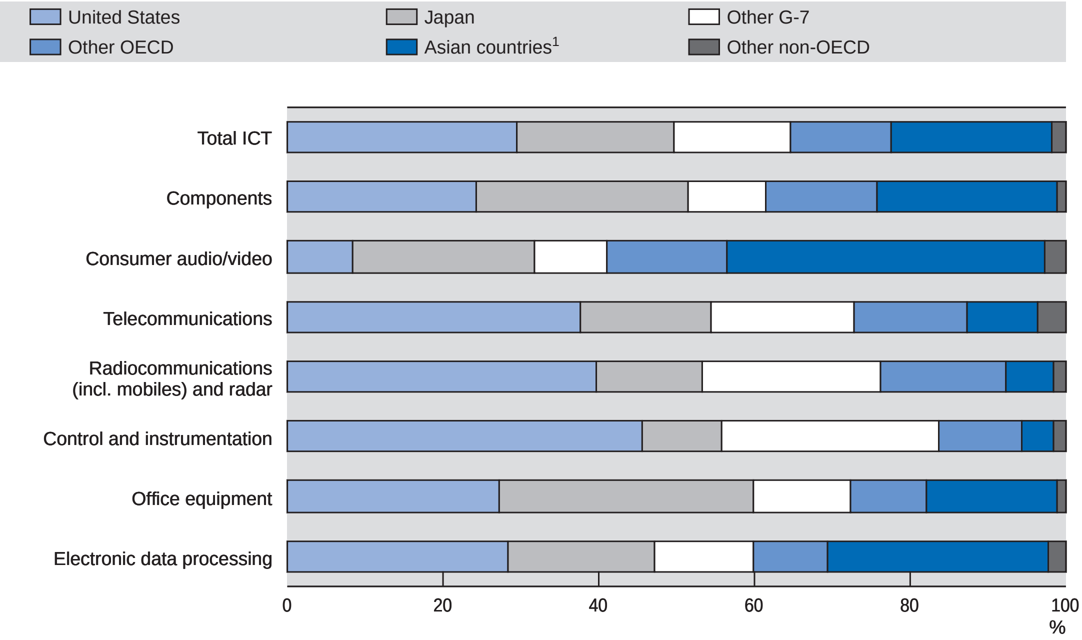
Production

Between 1995 and 1999, the production of ICT goods in the OECD area increased slightly in value at a compound growth rate (CAGR) of 1.4% in nominal terms, mainly owing to radio communication, mobile and telecommunication equipment [data from Reed Electronics Research (2001); ICT goods comprise EDP equipment, office equipment, control and instrumentation, radio communications, including mobiles, and radar, telecommunications, consumer and components: growth in real terms would show faster gains owing to price declines in these market segments]. Countries experiencing strong growth included Denmark, Finland and Sweden, and, to a lesser extent, the United Kingdom, Korea and Ireland (see Annex Table 1.1). Ireland is also the only OECD country to have enjoyed very strong growth in production during the last half of the decade, owing mainly to EDP (electronic data processing equipment) and components (CAGR of 6.1% and 7.5% respectively). On the other hand, at the OECD level as well as in individual countries, consumer electronics and office equipment have been declining slightly.

Mirroring the situation in the OECD countries, production in the Asian countries grew at more than six times the pace in OECD countries (CAGR of 8.7%) and was mainly concentrated in EDP, consumer electronics and components. The Philippines, China, Malaysia and Chinese Taipei grew most rapidly mainly owing to components and EDP, as well as consumer electronics for China. China alone accounted for around one-fifth of the production of consumer electronics in 1999, against less than 10% in 1995.[2] As a result, the Asian countries had around 21% of global ICT goods production in 1999, against only 15.6% in 1995 and 10.4% in 1990.

The United States remains the world's largest ICT producer (29.5%), with a specialisation in EDP and radio- and telecommunication. Japan remains the second largest ICT producer (20%) and the first for consumer electronics and components. However, its relative share in global ICT strongly declined during the 1990s, especially sharply in the second half of the decade, mainly to the benefit of other Asian countries, especially China and Chinese Taipei for EDP (see Chapter 2). The situation in Europe has been more contrasted, with some of the Nordic countries specialising in communication equipment and Ireland in EDP and components. During the 1990s, ICT production increased relatively more in components, EDP and radio and mobile communication, mainly to the detriment of consumer electronics, and to a lesser extent, office equipment (Figure 9).

Figure 9. **World ICT-sector production by region, 1999**



1. Includes China, Chinese Taipei, Hong Kong (China), India, Indonesia, Malaysia, Philippines, Singapore and Thailand.
Source: OECD estimates, based on Reed Electronics Research (2001).

Value added

In the second half of the 1990s, the share of the ICT sector in value added increased in OECD countries, mainly owing to the strong growth of ICT services. There are exceptions, such as Finland, where the ICT manufacturing sector more than doubled, owing to the importance of the telecommunication equipment manufacturer, Nokia.

On average, the ICT sector contributed around 9.5% of business sector GDP in 1999, against only 8% in 1995. The share varies from 4% to more than 16% (Figure 10*a*). Austria and Greece are the only countries for which the share of the ICT sector (in terms of value added) did not increase during the period 1995-99. In both cases, the ICT manufacturing sector saw its relative share remain stable, while the share of the ICT services sector decreased slightly.

Ireland has the largest ICT-producing sector relative to GDP and is the only OECD country in which ICT manufacturing activities are mainly oriented towards computer and related equipment (more than 50%) (Figure 10*b*). Along with Finland and Korea, Ireland is also the only OECD country for which the ICT manufacturing sector is larger than the ICT services sector. This was also the case in Japan in 1995 but the situation has changed owing to strong growth in the telecommunication services sector.

In most countries the relative share of the ICT manufacturing sector increased slightly, and particularly in Finland, Ireland, Korea, the United States and Mexico. Almost one-fifth of the Finnish and the Irish manufacturing industry output came from ICT-producing industries in 1999, compared with around 13.0 and 12.5% in the United States and Japan respectively. Hungary experienced the fastest growth in its ICT-manufacturing sector (relative to other manufacturing activities), and in 1999 its share was comparable to that of the United Kingdom.

In most cases, the ICT services sector accounts for more than two-thirds of the overall ICT sector in terms of value added (Figure 10*c*). In about half of the OECD countries for which data are available, ICT services industries accounted for between 9% and 11% of business services value added. The share is highest in Ireland, where in 1999 almost 15% of business services value added originated from ICT services, mainly owing to the large share of the computer and related services industry. Sweden and the United Kingdom are also highly specialised in ICT services industries, ahead of France, the United States and Canada. Hungary and the Czech Republic, with the highest relative share of telecommunication services, are reaping the benefits of liberalisation reforms in the mid-1990s, which have resulted in more dynamic growth relative to other services sectors.

Employment

In 1999, the 22 OECD countries for which data are available employed more than 15 million persons in the ICT sector or around 6.1% of total employment in the business sector. The United States accounted for around one-third of total OECD ICT sector employment, the European Union for around 35% and Japan for 17%; the G7 countries alone accounted for over three-quarters of the total.

In 1999, the size of the ICT sector represented between 3% and over 9.5% of total business sector employment. Only a handful of OECD countries (Hungary, Japan, Mexico, Korea) employed more people in ICT manufacturing activities than in ICT services, and in more than three-fifths of countries, more than seven out of ten ICT employees worked in services activities.

In all OECD countries except Korea, the Czech Republic and Spain, employment in the ICT sector increased in relative terms between 1995 and 1999, most notably in the Netherlands, the United Kingdom, Finland and the United States.

Between 1995 and 1999 in almost all the OECD countries, the share of employment in ICT manufacturing activities (as a percentage of total manufacturing employment) remained stable, owing to a slight decrease in overall OECD manufacturing employment. In Ireland, Finland, Korea and Hungary, it increased significantly since 1995. Except for Finland, these countries also had the largest computer equipment sector, in terms of ICT manufacturing employment.

Unlike ICT manufacturing activities, ICT services had a phase of relative expansion during the second half of the 1990s, adding more than 2 million jobs at the OECD level. The Netherlands, Finland, Denmark, the United Kingdom and the United States had a significant increase in the relative share of ICT services in overall services (Figure 11). Together, these countries contributed almost three-quarters of the growth in ICT services employment in the OECD area.

Figure 10*a*. **Share of ICT value added in business sector value added, 1995 and 1999**

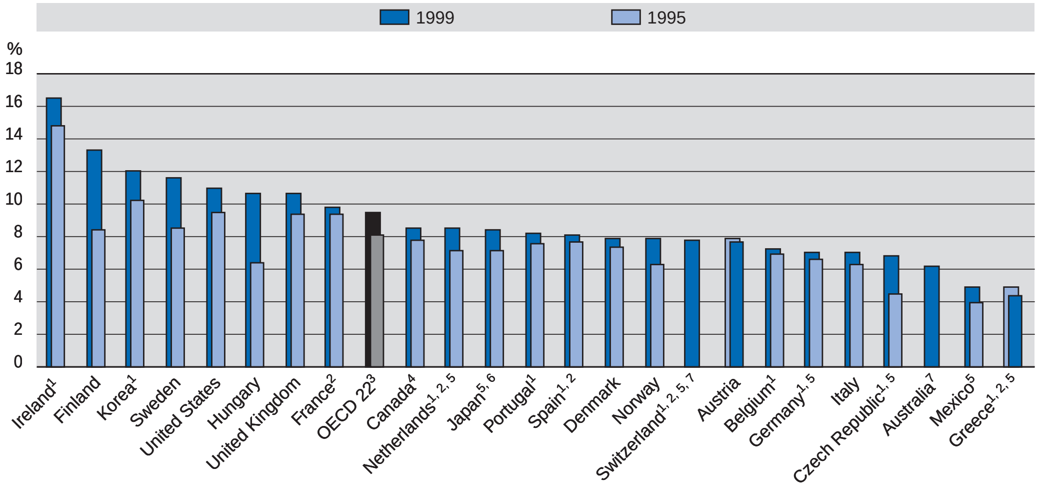


Figure 10*b*. **Share of ICT manufacturing in total manufacturing value added, 1999**

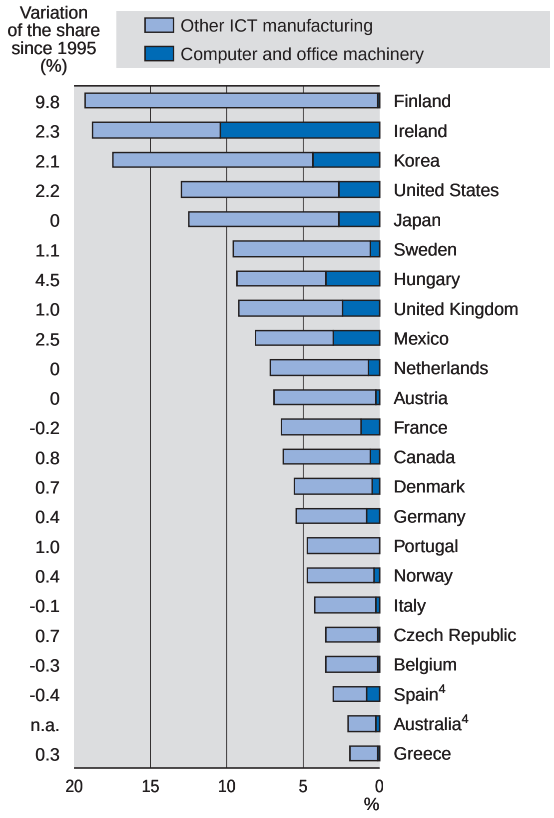
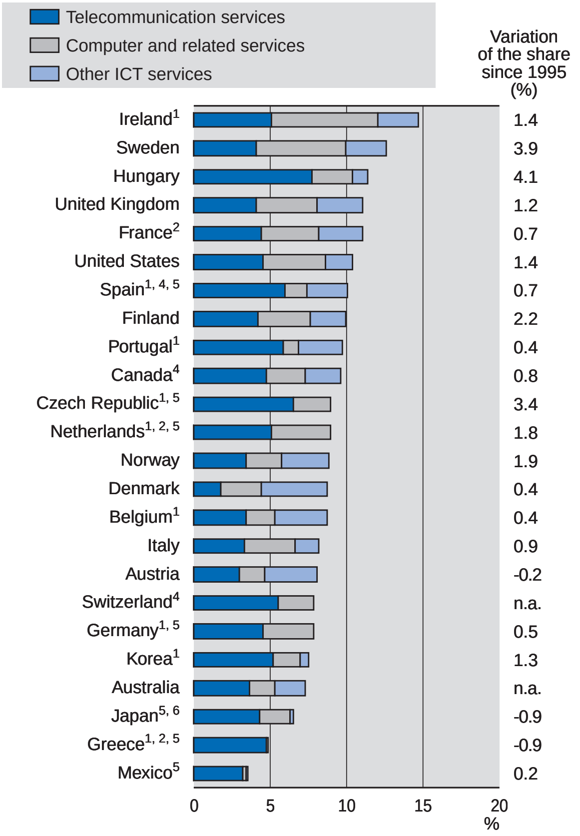


Figure 10*c*. **Share of ICT services in total business services value added, 1999**[8]



1. Rental of ICT goods (7123) is not available.
2. Postal services included with telecommunications services.
3. Austria and Switzerland missing.
4. 1998 instead of 1999.
5. ICT wholesale (5150) is not available.
6. Includes only part of computer-related activities (72).
7. 1995 not available.
8. "Other ICT services" is the sum of 5150 and 7123.

Source: OECD estimates, based on national sources; STAN and National Accounts databases, November 2001.

Figure 11*a*. **Share of ICT employment in business sector employment, 1995 and 1999**

Percentages

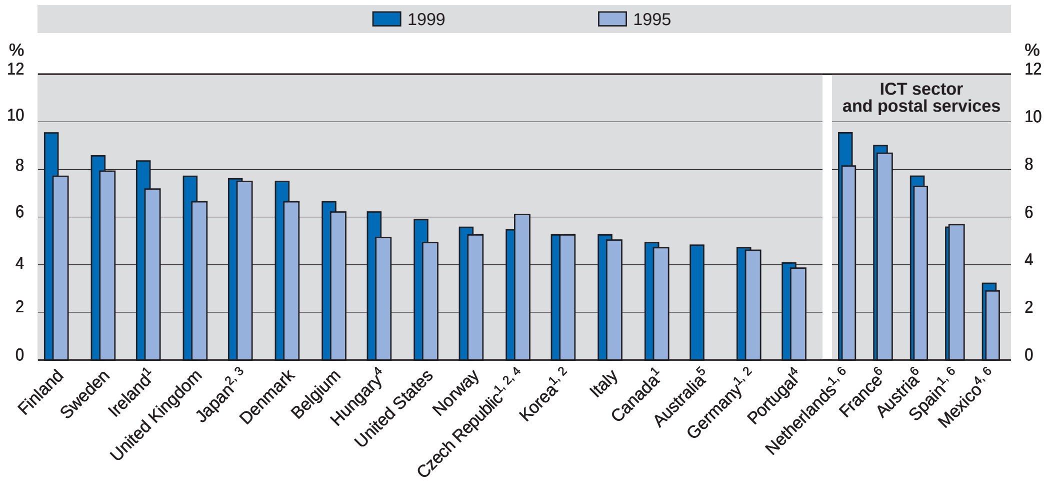


Figure 11*b*. **Share of ICT manufacturing in manufacturing employment, 1999**

Percentages

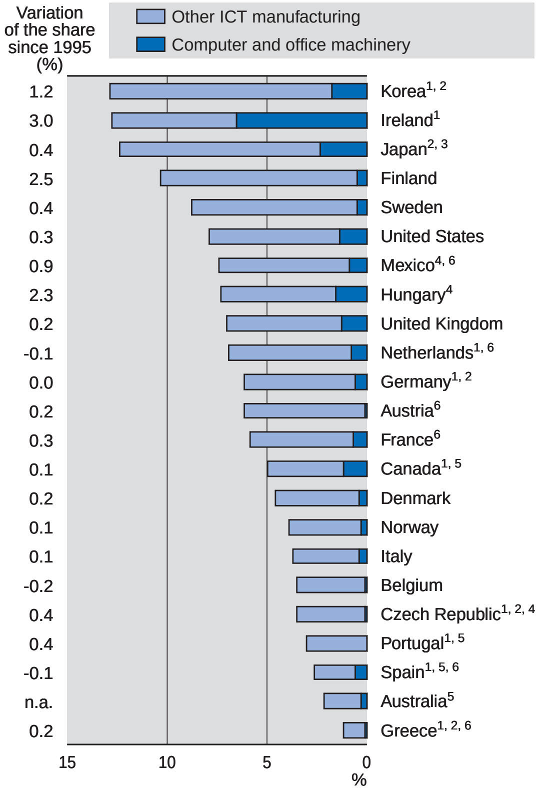
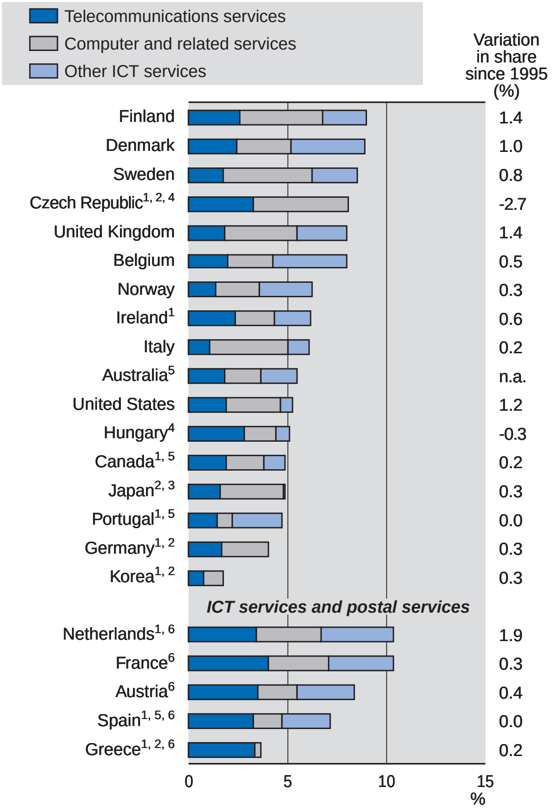


Figure 11*c*. **Share of ICT services in market services employment, 1999**[7]

Percentages



1. Rental of ICT goods (7123) not available.
2. ICT wholesale (5150) not available.
3. ICT services include market research and public opinion polling.
4. Based on employee figures.
5. 1998 instead of 1999.
6. ICT services include postal services.
7. "Other ICT services" is the sum of 5150 and 7123.

Source: OECD estimates, based on national sources; STAN and National Accounts databases, November 2001.

There is currently some debate over the extent to which a large ICT-producing sector contributes positively to growth (OECD, 2001*b*). In terms of the broader growth picture across the economy, few OECD countries – the United States, Canada, Australia, Ireland and Norway – increased trend growth in the 1990s compared with the 1980s both in GDP per capita and in adjusted multifactor productivity (MFP), and all but Australia had a relatively large ICT sector (in terms of value added and employment). In countries that have seen a slowdown in trend GDP and a deceleration in adjusted MFP growth, the picture is more mixed, with some countries having large ICT sectors, while others did not.[3]

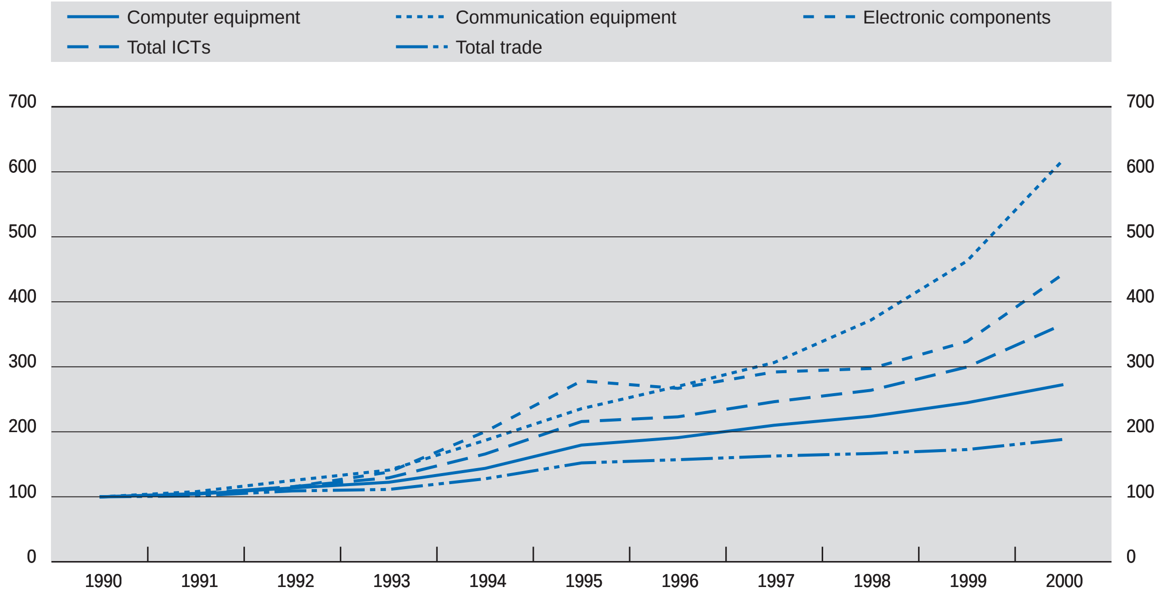
Trade

The following section examines the main trends in ICT trade, while Chapter 2 examines this topic in more detail and provides additional insights into the extent and nature of globalisation in the ICT-producing sector. For the purposes of this analysis, ICT products are divided into four main segments: computer equipment, communication equipment, electronic components and software products (see Annex 1: Methodology). Owing to the use of different classification systems, software and hardware products are treated separately. The recent downturn is not yet evident in ICT trade data, with 2000 being the most recent year for which complete data are available. Nonetheless, preliminary data suggest that during 2001, the regions and countries that experienced the strongest export declines were also those that traded intensely in ICT goods (WTO, 2002).

OECD trade in ICT goods (excluding software) grew rapidly during the 1990s, through to 2000. In 1990, ICT goods accounted for 6.5% of OECD merchandise trade; by 2000 they accounted for almost 13%.[4] In 1990, ICT goods trade (defined as the average of imports and exports) was worth almost USD 160 billion. By 2000, it had reached almost USD 580 billion. Over that period, ICT goods exports increased from USD 154 billion to USD 559 billion, and imports increased from USD 162 billion to USD 602 billion (see Annex Table 1.2). Trade in ICT goods grew 13.8% a year over the period 1990-2000, compared to growth of 6.5% a year in total merchandise trade (Figure 12).

Figure 12. **OECD trade in ICT goods, 1990-2000**

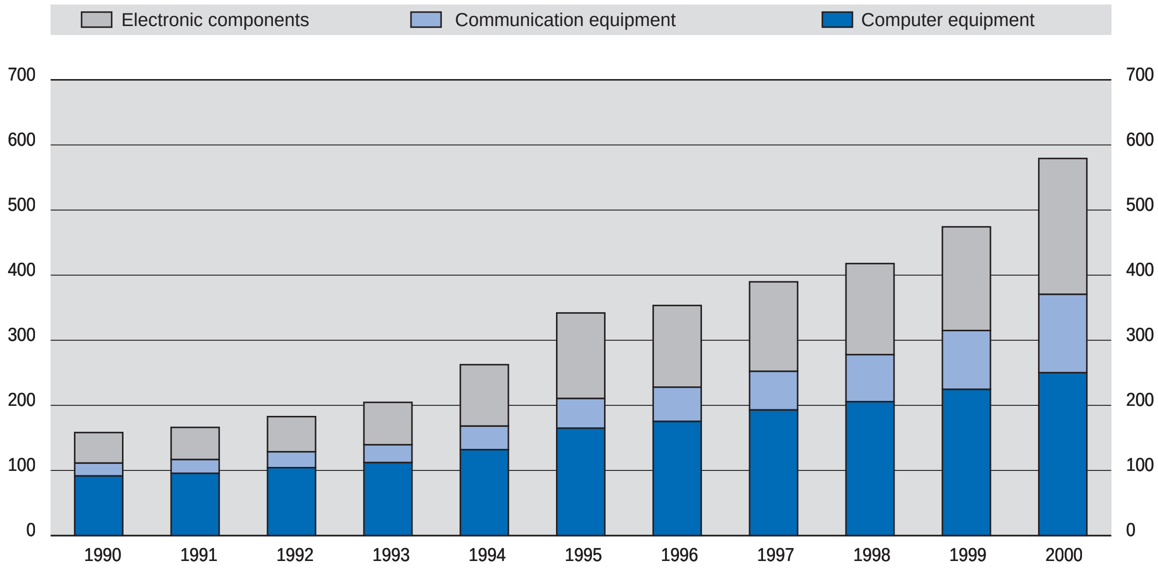
Index 1990 = 100



Source: OECD, ITS database, January 2002.

Figure 13. **Composition of OECD trade in ICT goods, 1990-2000**

Billions of current USD



Source: OECD, ITS database, January 2002.

The largest segment of ICT goods trade is computer equipment, which accounted for 43% of the total in 2000, down from 58% in 1990 (Figure 13). Electronic components accounted for 36% of total ICT goods trade in 2000 and communication equipment for 21%, up from 30% and 12%, respectively. The fastest growing segment is communication equipment, trade in which increased by 20% a year over the period 1990-2000. Trade in electronic components increased by 16.1% a year, and trade in computer equipment by 10.5% a year.[5]

- Computer equipment

Trade in computer equipment increased steadily throughout the 1990s. OECD exports of computer equipment rose from USD 86 billion in 1990 to USD 219 billion in 2000, or by 9.8% a year (see Annex Table 1.3) while computer equipment imports rose from USD 98 billion to USD 282 billion, or by 11.2% a year (Table 1). In EU countries, computer equipment exports and imports have grown at a similar

Table 1. **Computer equipment trade, 1990-2000**

Value in millions of current USD and growth in percentages

	Exports				Imports			
	1990	1995	2000	Average annual growth	1990	1995	2000	Average annual growth
United States	23 005	34 476	54 685	9.0	23 414	57 375	87 463	14.1
Japan	18 854	29 521	27 558	3.9	4 996	15 364	26 509	18.2
EU	40 119	66 460	94 131	8.9	57 876	87 684	127 160	8.2
Other OECD	3 822	14 376	42 655	27.3	11 620	24 687	41 249	13.5
Total OECD	85 800	144 832	219 159	9.8	97 905	185 109	282 381	11.2

Notes: Luxembourg not included. 1990 data do not include Belgium, the Czech Republic, Hungary, Korea, Poland and the Slovak Republic. 1999 instead of 2000 for Greece and the Slovak Republic.

Source: OECD, ITS database, January 2002.

rate (between 8% and 9% a year between 1990 and 2000). Computer equipment imports into the United States and Japan have grown much faster than their exports from these countries, while exports from other OECD countries have grown much faster than imports.

The United States and Japan are still the leading exporters of computer equipment, but their share of total OECD exports is falling. Exports of computer equipment from other OECD countries represent a rising share. In 2000, the United States accounted for one-quarter of total OECD exports of computer equipment, Japan for 13%, the European Union 43% and other OECD countries for the remaining 20%. Other leading exporters of computer equipment in 2000 included the Netherlands and the United Kingdom (around USD 20 billion each), Korea (USD 19 billion), Ireland (USD 17 billion), Germany (USD 15 billion), Mexico (USD 11 billion) and France (USD 9 billion).

The United States is also a major import market for computer equipment (31% of imports in 2000); as are the European Union and other OECD countries. Japan accounts for a relatively smaller share of computer imports at just 9% of the total in 2000. Nevertheless, imports of computer equipment into Japan increased by more than 18% a year between 1990 and 2000. Other major import markets for computer equipment in 2000 included Germany and the United Kingdom (around USD 26 billion), the Netherlands (USD 23 billion), France (USD 14 billion), Canada (USD 11 billion) and Ireland (USD 10 billion).

Ireland's role in assembly and re-export is evident from its USD 10 billion in imports and USD 17 billion in exports of computer equipment in 2000. Ireland's exports of computer equipment have increased by 14.5% a year since 1990. Mexico also stands out in terms of assembly and re-export. Its imports of computer equipment increased by 25% a year between 1990 and 2000, from USD 560 million to USD 5.2 billion, while its exports increased from just USD 450 million to more than USD 11 billion, or by 38% a year.

- Communication equipment

Communication equipment is the fastest growing segment. Exports of communication equipment from OECD countries increased by almost 20% a year, from USD 21 billion in 1990 to USD 126 billion in 2000. Imports of communication equipment into OECD countries increased by 21% a year over the same period, from USD 18 billion to USD 116 billion (Table 2).

In 2000, EU countries accounted for 55% of OECD country exports of communication equipment, the United States for 16.4%, Japan for 6.4% and other OECD countries for the remaining 22.1% (see Annex Table 1.4). Japan's share of communication equipment exports declined rapidly, while that of other OECD countries has increased. Communication equipment exports from Japan have grown relatively slowly since 1990 (3.7% a year), while exports from the United States increased by 18% a year, exports from European Union countries rose by 22% a year and those from other OECD countries advanced by 31% a year.

Table 2. **Communication equipment trade, 1990-2000**

Value in millions of current USD and growth in percentages

	Exports				Imports			
	1990	1995	2000	Average annual growth	1990	1995	2000	Average annual growth
United States	4 063	10 933	20 680	17.7	6 016	10 649	34 652	19.1
Japan	5 614	6 904	8 106	3.7	805	3 023	5 165	20.4
EU	9 541	26 440	69 179	21.9	8 022	18 194	52 017	20.6
Other	1 854	6 931	27 871	31.1	2 964	8 559	23 988	23.3
Total OECD	21 071	51 207	125 837	19.6	17 807	40 425	115 822	20.6

Notes: Luxembourg not included. 1990 data do not include Belgium, the Czech Republic, Hungary, Korea, Poland and the Slovak Republic. 1999 instead of 2000 for Greece and the Slovak Republic.

Source: OECD, ITS database, January 2002.

In 2000, EU countries accounted for 45% of OECD country imports of communication equipment, the United States accounted for 30%, Japan for less than 5% and other OECD countries for the remaining 21%. Import shares for the major groupings were stable throughout the last decade. Imports of communication equipment into OECD countries have grown strongly since 1990, by around 20% a year into the United States, the European Union and Japan.

After the United States, leading exporters of communication equipment in 2000 included the United Kingdom (USD 14.0 billion), Germany (USD 11.5 billion), Canada (USD 10.4 billion), Sweden (USD 10.2 billion) and France (almost USD 10 billion). Sweden and Finland (with Ericsson and Nokia) are much larger exporters of communication equipment than they are importers. The United States accounts for almost 30% of OECD communication equipment imports at almost USD 35 billion in 2000. Other markets for communication equipment imports are small in comparison. They include the United Kingdom (USD 12.7 billion), Germany (USD 7.6 billion), the Netherlands (5.8 billion), Canada (USD 5.5 billion) and Japan, France and Italy (around USD 5 billion each). Mexico's trade in communication equipment is also significant, with exports growing from just USD 24 million in 1990 to more than USD 8 billion in 2000. Ireland too has experienced very strong growth in its trade in communication equipment, with exports increasing from USD 211 million in 1990 to USD 2.8 billion in 2000.

- Electronic components

Trade in electronic components has also grown rapidly; faster than trade in computer equipment and almost as fast as trade in communication equipment. Exports of electronic components from OECD countries increased from USD 48 billion in 1990 to USD 214 billion in 2000, or by 16% a year. Over the same period, imports of electronic components into OECD countries increased from USD 47 billion to USD 204 billion, or by 16% a year (Table 3).

Table 3. **Electronic component trade, 1990-2000**
Value in millions of current USD and growth in percentages

	Exports				Imports			
	1990	1995	2000	Average annual growth	1990	1995	2000	Average annual growth
United States	13 826	27 668	70 001	17.6	15 653	44 283	56 190	13.6
Japan	14 678	43 270	50 348	13.1	3 585	12 592	20 970	19.3
EU	16 330	36 393	55 972	13.4	21 776	44 810	69 070	12.2
Other	2 753	26 045	35 712	29.2	5 491	26 931	57 366	26.4
Total OECD	47 587	133 376	213 658	16.2	46 505	128 615	203 596	15.9

Notes: Luxembourg not included. 1990 data do not include Belgium, the Czech Republic, Hungary, Korea, Poland and the Slovak Republic. 1999 instead of 2000 for Greece and the Slovak Republic.
Source: OECD, ITS database, January 2002.

Exports of electronic components from the United States increased by 18% a year over the decade 1990 to 2000, while those from both Japan and the European Union increased by 13% a year, and those from other OECD countries by 29% a year (see Annex Table 1.5). Imports of electronic components into other OECD countries also increased rapidly (26% a year), while those into Japan increased by 19% a year, and those into the United States by 14% a year. Imports of electronic components into the European Union increased at the more modest rate of a little over 12% a year.

In 2000, the United States accounted for 33% of total OECD electronic component exports, Japan and the European Union for around 25% each and the other OECD countries for the remaining 17%. The United States' share of exports rose over the decade to 2000, while the shares of the European Union and Japan fell. EU countries accounted for the largest share (34%) of OECD electronic component imports in 2000, the United States was a close second (28%), Japan accounted for just 10% and other

OECD countries for the remaining 28%. Japan and other OECD countries account for a larger share of electronic component imports than they did in 1990, while the shares of the European Union and the United States have fallen.

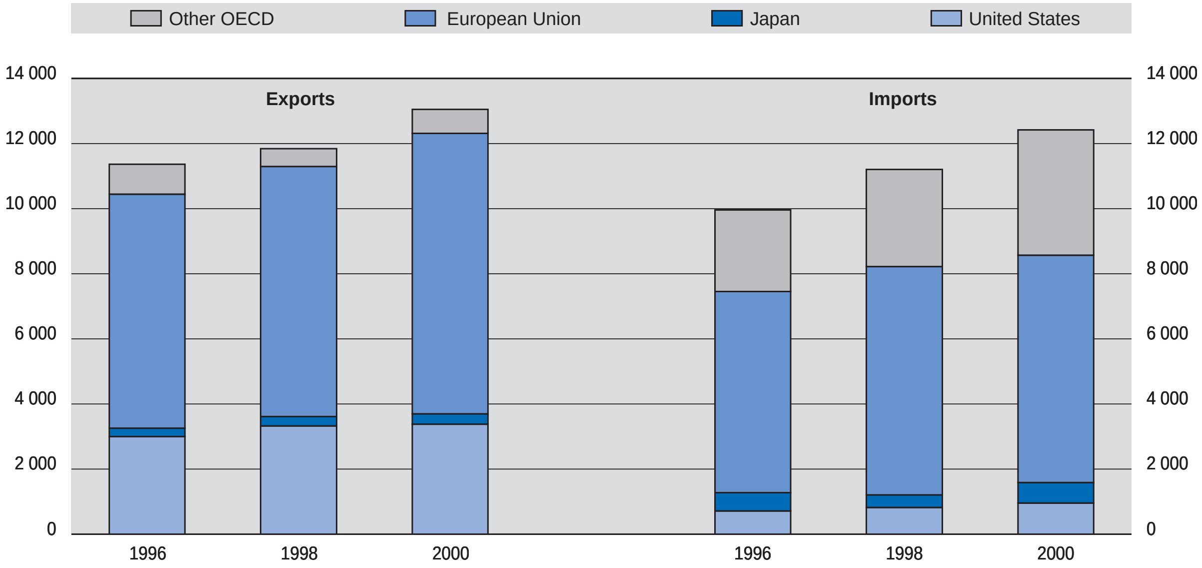
After the United States and Japan, Korea (USD 21 billion), Germany (USD 14.7 billion), France (USD 8.6 billion) and the United Kingdom (USD 8.2 billion) are the leading exporters of electronic components although the Netherlands (USD 6.3 billion), Ireland (USD 4.6 billion) and Mexico (USD 3.7 billion) are also significant exporters. These same countries are also major importers of electronic components, evidence of significant intra-firm and intra-industry trade in electronics. Korea imported USD 17.5 billion of electronic components in 2000, Mexico USD 12.9 billion and Ireland USD 3.8 billion.

- Software products

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 for software (*e.g.* magnetic discs, tapes and other recorded media). This approach has clear limitations. First, as border valuations are based on physical support media, the value of software traded is significantly understated. Second, the bundling of software with hardware leads to significant mismeasurement (likely overstating equipment trade and understating software trade). Third, trade statistics do not measure the value of copyrighted works sold in foreign markets (*i.e.* the "gold master" problem). Fourth, trade statistics do not measure the value of software electronically transmitted across borders. Nevertheless, trade statistics do give some indication of the relative size and geographical distribution of cross-border sales of software products (see Annex 1: Methodology).

Software products remain a relatively small share of ICT trade. Total OECD exports of software products were worth USD 13 billion in 2000, and total imports were worth USD 12 billion (Figure 14). Exports of software products from OECD countries increased at an annual average of 3.5% between 1996 and 2000, while imports of software products into OECD countries increased at an annual average of 5.7% (Table 4).

Figure 14. **OECD trade in software products, 1996-2000**
Millions of USD



Source: OECD, ITS database, January 2002.

Table 4. **Software products trade, 1996-2000**

Value in millions of current USD and growth in percentages

	Exports				Imports			
	1996	1998	2000	Average annual growth	1996	1998	2000	Average annual growth
United States	3 002	3 325	3 382	3.0	714	822	956	7.6
Japan	254	292	317	5.7	560	385	629	3.0
EU	7 188	7 681	8 618	4.6	6 185	7 014	6 984	3.1
Other	920	549	734	–5.5	2 501	2 987	3 850	11.4
Total OECD	11 363	11 847	13 051	3.5	9 959	11 208	12 418	5.7

Notes: Luxembourg not included. 1990 data do not include Belgium, the Czech Republic, Hungary, Korea, Poland and the Slovak Republic. 1999 instead of 2000 for Greece and the Slovak Republic.

Source: OECD, ITS database, January 2002.

In 2000, EU countries accounted for 66% of all OECD exports of software products, the United States for 26%, Japan for just 2.4% and other OECD countries for the remaining 5.6% (see Annex Table 1.6). Software product imports are more evenly distributed. EU countries accounted for 56% of total OECD imports in 2000, the United States for 8%, Japan for 5% and the other OECD countries for the remaining 31%.

The leading exporters of software products are Ireland and the United States (Table 5). Ireland exported USD 3.8 billion in 2000, or almost 30% of total OECD exports of software products. The United States exported USD 3.4 billion, or around 26% of the OECD total. Except for the Netherlands, no other country exported more than USD 1 billion. However, the United Kingdom (USD 895 million) was also a major exporter.

Table 5. **Software products: leading exporting and importing countries, 2000**

Value in millions of current USD and share in percentages

Exports	USD millions	Share (%)	Imports	USD millions	Share (%)
Ireland	3 819	29	United Kingdom	1 592	13
United States	3 382	26	Canada	1 054	8
Netherlands	1 079	8	Germany	988	8
United Kingdom	895	7	France	959	8
Austria	780	6	United States	956	8
Germany	702	5	Switzerland	823	7
France	483	4	Italy	815	7
Japan	317	2	Japan	629	5
Belgium	308	2	Netherlands	567	5
Canada	241	2	Korea	527	4
OECD	13 051	100	OECD	12 418	100
EU	8 618	66	EU	6 984	56

Notes: 1999 data for Greece and the Slovak Republic. OECD and EU are partial totals from available data.

Source: OECD, ITS database, January 2002.

The United Kingdom was the leading import market for software products in 2000; at USD 1.6 billion or 13% of OECD total. Canada (USD 1 billion), Germany (USD 988 million), France (USD 959 million), the United States (USD 956 million) and Switzerland (USD 823 million) were the other major import markets for software products in 2000.

- Services

Because of their intangible nature and the increasing complexity of delivery mechanisms, trade in services is more difficult to quantify. Moreover, there is greater variation among countries in the collection of services trade data in terms both of definitions used and of the quality and coverage of collections.[6] Nevertheless, it is clear that trade in ICT-related services is significant and growing.

Communications services exports from OECD countries were worth around USD 23 billion in 2000, while imports of communications services cost OECD countries more than USD 26 billion (Table 6). OECD exports of computer and information services were worth around USD 29 billion, while imports cost almost USD 20 billion. Over the period 1995-2000, OECD-area communications services exports increased by 33%, while imports increased by 18%. Computer and information services exports increased by 173% over the same period, while imports increased by 146%.

The United States was the leading exporter *and* importer of communications services; USD 4.1 and USD 5.8 billion, respectively (see Annex Table 1.7). The United States accounted for 18% of OECD exports of communications services, and 22% of imports. Other major exporters of communications services included the United Kingdom (USD 2.5 billion), Belgium-Luxembourg (USD 1.9 billion), Germany and the Netherlands (USD 1.4 billion), and France and Italy (around USD 1.3 billion). Other major importers of communications services included: Germany (USD 3.2 billion), the United Kingdom (USD 2.3 billion), Italy (USD 1.9 billion), Netherlands (USD 1.4 billion), Canada (USD 1.3 billion), and Japan and France (around USD 1.1 billion). The top ten exporters account for 75% of all OECD exports of communications services, and the top ten importers for 78% of imports.

Table 6. **Trade in ICT services, 2000**

Value in millions of current USD

	Communication services		Computer and information services	
	Imports	Exports	Imports	Exports
Australia	1 095	819	261	421
Austria	425	472	212	135
Belgium-Luxembourg	958	1 861	1 320	1 721
Canada	1 254	1 215	791	1 345
Czech Republic	46	215	83	95
Finland	270	203	281	181
France	1 143	1 322	742	807
Germany	3 150	1 436	4 836	3 716
Greece	288	257	157	89
Hungary	76	69	127	122
Iceland	2	10	2	31
Ireland	342	328	275	5 479
Italy	1 935	1 274	926	448
Japan	1 150	821	3 066	1 569
Korea	623	387	92	11
Mexico	366	1 213	. .	. .
Netherlands	1 426	1 426	1 187	1 152
New Zealand	198	181	100	79
Norway	169	286	243	92
Poland	423	234	218	60
Portugal	158	176	160	75
Slovak Republic	26	52	56	52
Spain	743	668	1 226	2 041
Sweden	792	644	1 067	1 191
Switzerland	858	891	. .	. .
United Kingdom	2 310	2 505	1 150	3 684
United States	5 800	4 090	1 040	4 900
OECD	26 022	23 055	19 617	29 495
EU	13 938	12 572	13 538	20 718

Source: OECD/Eurostat (2001), *Statistics on International Trade in Services*; IMF, Balance of Payments, January 2002.

In 2000, Ireland, with its very large software industry, was the leading exporter of computer and information services, which were worth over USD 5.4 billion, or almost one and-a-half times the value of its software products exports. The United States (USD 4.9 billion), Germany (USD 3.7 billion), the United Kingdom (USD 3.7 billion), Spain (USD 2.0 billion), Belgium-Luxembourg (USD 1.7 billion) and Japan (USD 1.6 billion) were the other leading exporters of computer and information services. The top ten exporters of computer and information services accounted for over 90% of OECD exports. Germany was the leading importer of computer and information services, which were worth USD 4.8 billion in 2000. Other leading importers included Japan (USD 3.1 billion), Belgium-Luxembourg (USD 1.3 billion), Spain (USD 1.2 billion) and the United Kingdom (USD 1.1 billion). The top ten importing countries accounted for almost 85% of total OECD imports of these services.

Industry trends and drivers

This section examines four important drivers which have contributed to innovation in the ICT sector in the last years and are expected to continue to do so: R&D expenditure, price declines, patents and venture capital investments.

Research and development

ICT industries invest very heavily in R&D in order to create increasingly complex products. The pace of innovation and competitive pressure in ICT industries also force firms to maintain their R&D efforts. Anecdotal evidence suggests that despite the economic downturn, R&D expenditures by ICT firms have not declined significantly in recent months (see the appendix to this chapter). Firms continue to value R&D as a necessary investment for building long-term innovative capacity and competitiveness. In 1999, the ICT sector accounted for more than one-quarter of total business R&D expenditures in most OECD countries, and more than half in Finland, Korea and Ireland (Figure 15). In the 1990s, in countries for which R&D data are available for both ICT manufacturing and services industries, R&D expenditures expanded more rapidly in ICT services industries than in ICT manufacturing.

A sectoral breakdown of average R&D intensity (R&D expenditure over total sales) in the world's top 135 ICT firms (see the appendix to this chapter), reveals that firms in the software and IT services sector have the highest R&D intensity, at over 17% in 2000. Firms in the IT and communications equipment sector have relatively high R&D intensity (12-15%), while firms in electronic components have a low intensity (less than 8%). Telecommunication services firms have the lowest R&D intensity of these six ICT segments (Figure 16).

Price declines

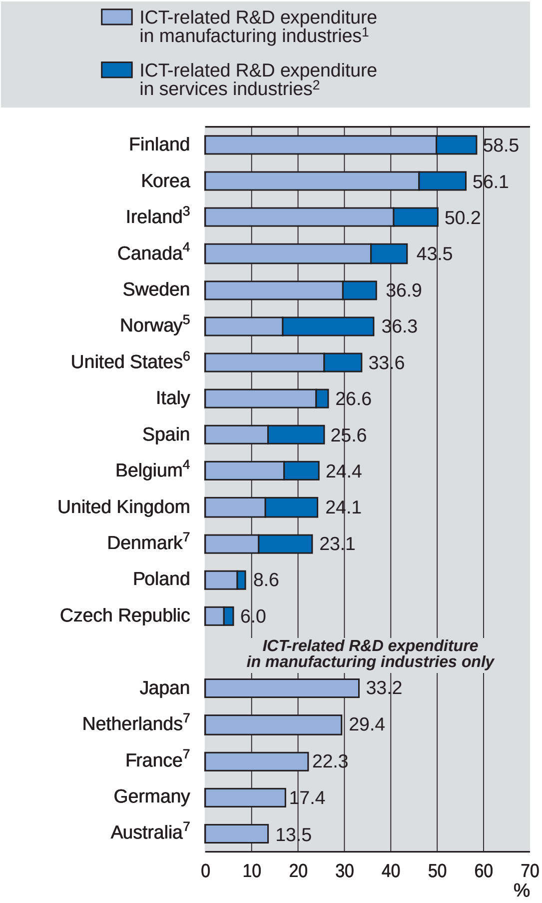
The evolution of prices for ICT goods and services during the last decade (and in the most recent years) has been somewhat contrasted. Price declines have been rapid and sustained in hardware (PCs and peripherals), and the incorporation in some countries of quality changes into computer price indices (hedonic deflators) has led to an even steeper decline of these indices. Figure 17 compares consumer price indices in the United States for three broad ICT categories during the last four years: PCs and peripherals, computer software and accessories and computer information processing services. The decline in software has been much slower, and prices remained relatively constant or even increased slightly in computer services. Price indices of computer goods and services for France, the Netherlands and Denmark suggest similar trends (Figures 18-20).

ICT *patents*

Just as R&D expenditures (input indicator) in the ICT sector continue to grow in relative importance, ICT-related patents (output indicator) also account for an increasing share of overall

Figure 15. **R&D expenditure in selected ICT industries, 1999 or latest available year**

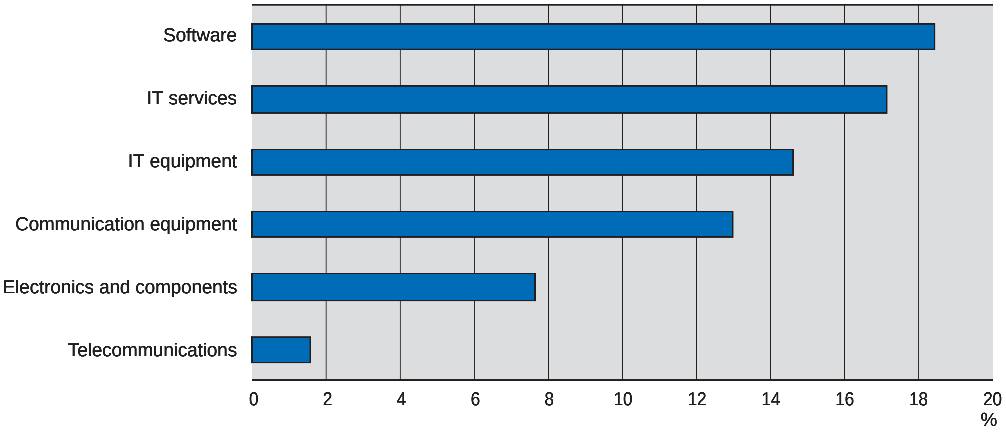
As a percentage of business enterprise sector R&D expenditure



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. 1997 instead of 1999.
4. 2000 instead of 1999.
5. 1998 for manufacturing industries and 1997 for services industries instead of 1999.
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 about 97-98% of division 64 total.
7. 1998 instead of 1999.

Source: OECD (2001*c*).

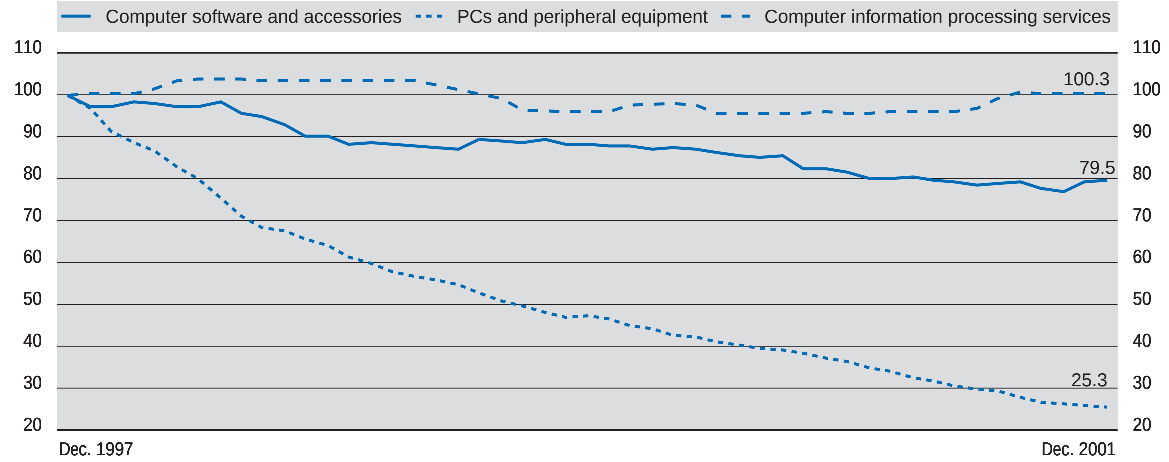
Figure 16. **Average R&D intensity in top ICT firms by sector, 2000**



Source: OECD, based on a sample of the top 135 ICT firms.

Figure 17. **US consumer price index for ICT goods and services, 1997-2001**

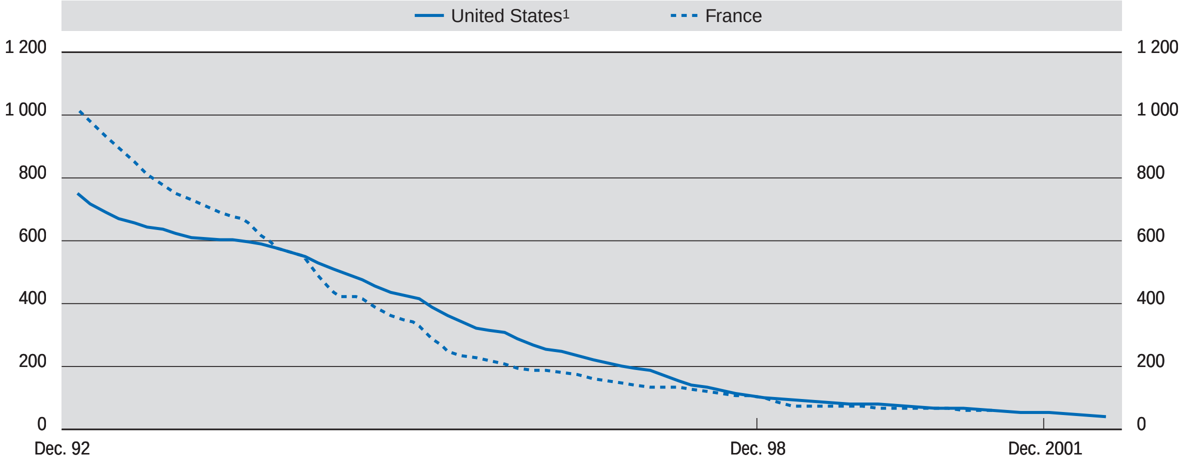
Index: December 1997 = 100, not seasonally adjusted



Source: US Bureau of Labor Statistics, January 2002.

Figure 18. **PC producer price index, France and United States**[1]

December 1998 = 100



1. For United States, workstations are included.

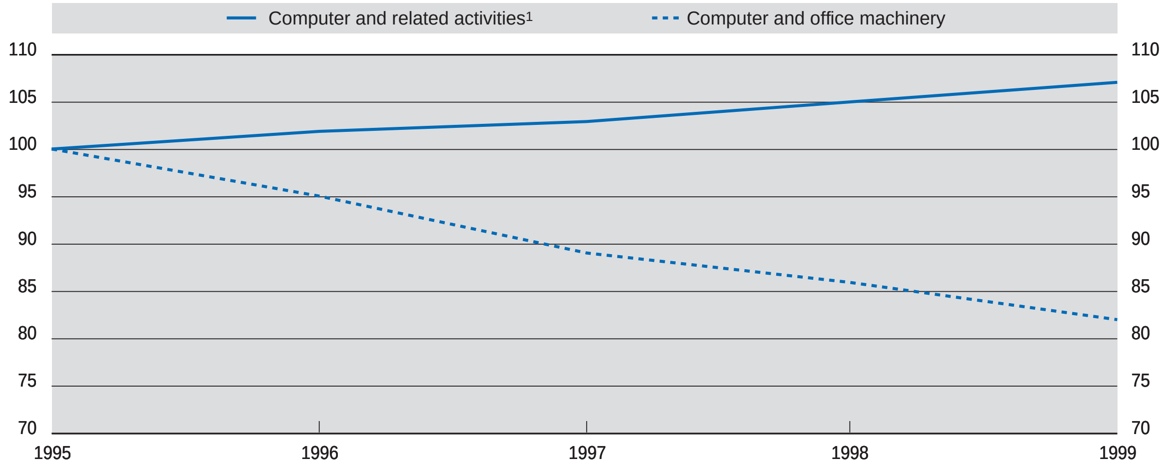
Source: OECD, based on data from INSEE and US Bureau of Labor Statistics.

patenting activity. In the OECD area, ICT patents grew during 1990-98 at a CAGR of 10.2%, twice the rate of total patent applications. In 1998, almost 17 patent applications out of 100 related to the ICT field, against only 11 in 1990 (Figure 21).

ICT patents grew relatively more quickly in the European Union than in the United States and Japan. Growth was highest in Finland, Sweden and Denmark, at a CAGR of more than 27% between 1990 and 1998. However, in 1998 the share of ICT patents in total patent applications was higher in the United States and Japan than in the EU, as had already been the case in 1990.

Figure 19. **Prices of selected ICT goods and services, the Netherlands, 1995-99**

December 1995 = 100

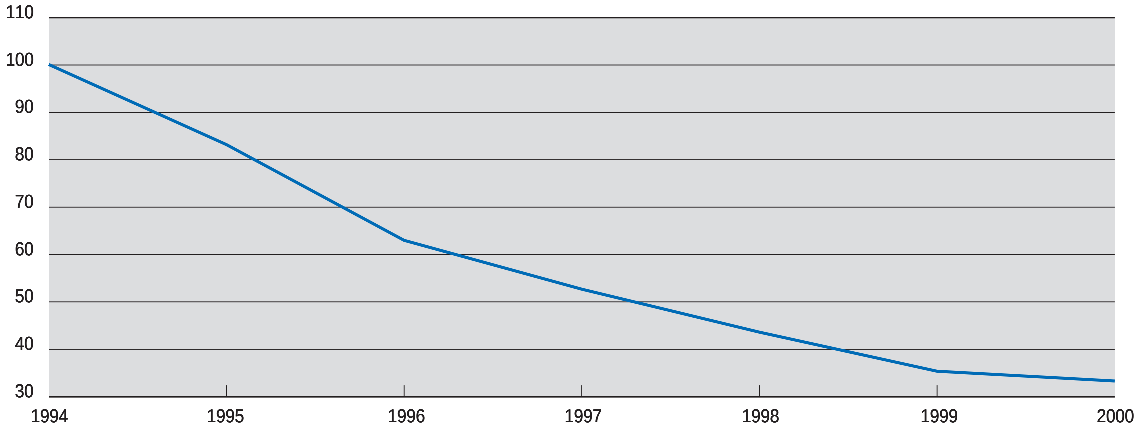


1. Includes both software and computer services.

Source: Statistics Netherlands (2001).

Figure 20. **Consumer price index for PCs and accessories, Denmark, 1994-2000**

1994 = 100



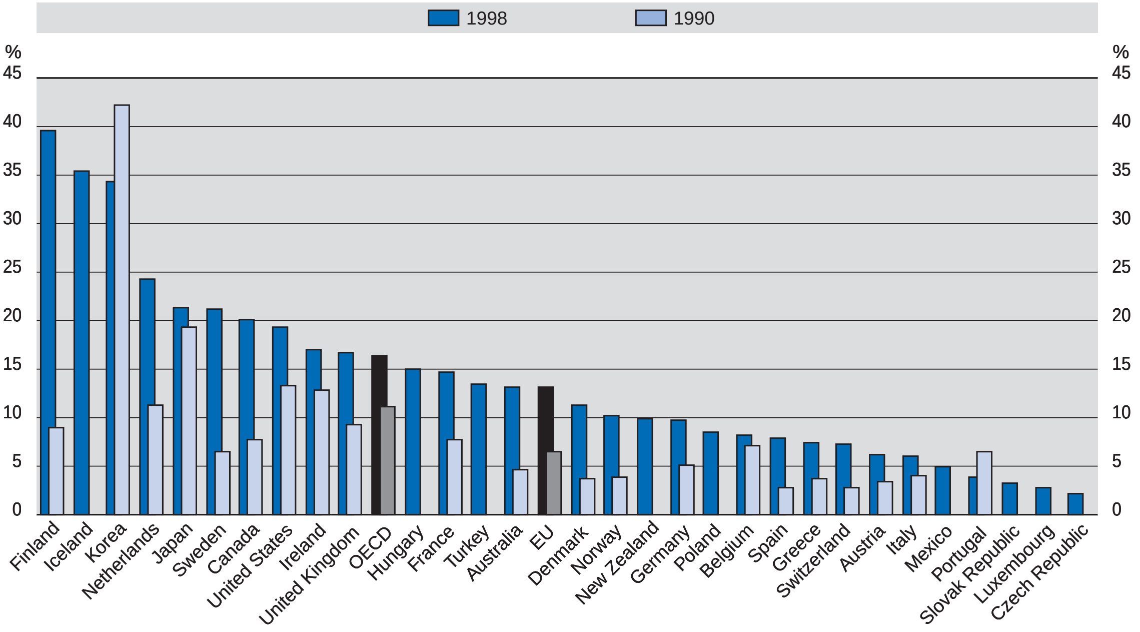
Source: Statistics Denmark (2001).

Countries with relatively higher R&D expenditures in ICT also tend to have higher relative ICT patenting (Finland, Korea). Some countries have a high relative specialisation in terms of ICT patenting, and they are often also important ICT producers (Sweden, Korea, Finland). On the other hand, Ireland or Hungary seem to be less engaged in innovative activities in the ICT field (in terms of patenting), despite the significant part of their economic activity in this field.

Venture capital

On average across OECD countries,[7] venture capital invested in the ICT sector during the second half of the 1990s, accounted for less than 0.25% of GDP, but this varied significantly across countries

Figure 21. **ICT[1] patents as a percentage of total national patents filed at the European Patent Office (EPO), for priority years 1990 and 1998**



1. International Patent Classification classes: G06 (computing, calculating, counting devices), G11 (information storage equipment) and H04 (electrical communication systems).

Source: OECD Patent Database, March 2002.

(Figure 22). However the ICT sector attracted much interest among venture capitalists during the second half of the 1990s, and, as a result, the funds raised increased strongly. The share in 19 OECD countries was multiplied on average by a factor of more than 12 between 1995 and 1999, with about two-thirds of the funds to the IT field and the rest to communications.

The ICT sector attracts more than one-third of the total venture capital in the OECD area, and around one-fifth in the European Union. Ireland is the only European country in which the ICT sector attracts more than half of all venture capital, of which three-quarters went to the IT field (Figure 23). Korea is one of the countries in which at least 40% of total venture capital is concentrated in the ICT field, far above G7 countries such as the United Kingdom, Germany or Japan.

A more detailed analysis of the US data (with a slightly different definition of the ICT sector) shows the vitality of the country's venture capital financing system and the ICT sector. In 2000, total venture capital in the United States reached a record USD 103 billion, a 73.5% rise over the previous year. Figure 24 shows the strong growth of venture capital investments in each of the four main ICT-related industries, which accounted for a total of USD 40.4 billion in 2000 (compared to USD 21.3 billion the previous year). In addition to these industries, a further USD 47.9 billion was invested in 2000 in various other "Internet-specific" firms.

Using a different breakdown, Figure 25 shows Internet-related firms as the main beneficiaries of venture capital investment in the United States: these firms accounted for three-quarters of all investments in 2000, with e-commerce and content accounting for a full third.[8] Preliminary data suggest that the decline throughout successive quarters during 2000 continued until the third quarter of 2001, with a significant pickup in the final quarter of that year, particularly in the software sector (PricewaterhouseCoopers, 2002).

Figure 22. **Venture capital in the ICT sector as a percentage of GDP, 1995-2000**

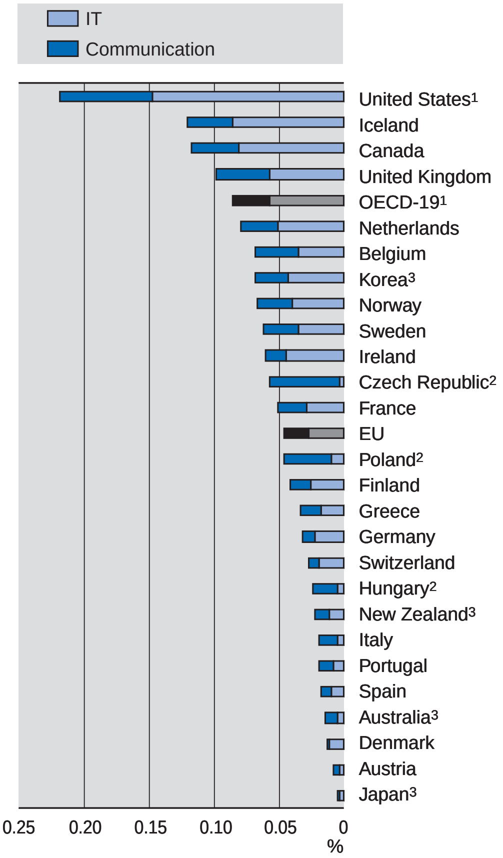
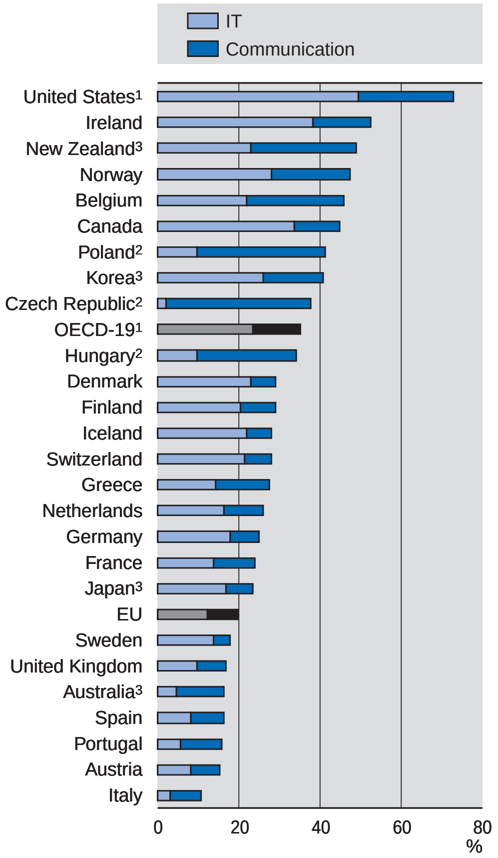


Figure 23. **Percentage share of the ICT sector in total venture capital, 1995-2000**



1. 1995-1999.
2. 1998-2000.
3. 1995-1998.

Source: OECD estimates based on data from EVCA (Europe); NVCA (United States); CVCA (Canada); Asian Venture Capital Journal (*The 2000 Guide to Venture Capital in Asia*). Data compiled in November 2001.

The growing role of ICTs across the economy

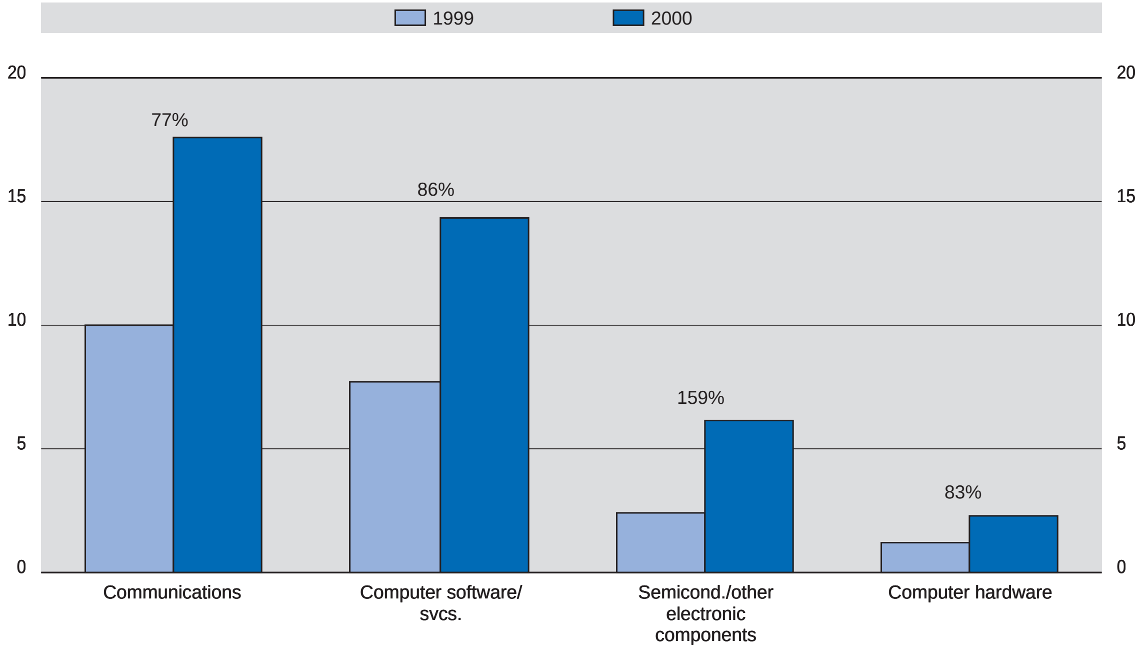
This section looks at ICT markets in OECD and selected non-member countries. It provides data on total ICT markets, then focuses on four main segments: hardware (and semiconductors), packaged software, IT services and telecommunications.

ICT *markets*

Overview

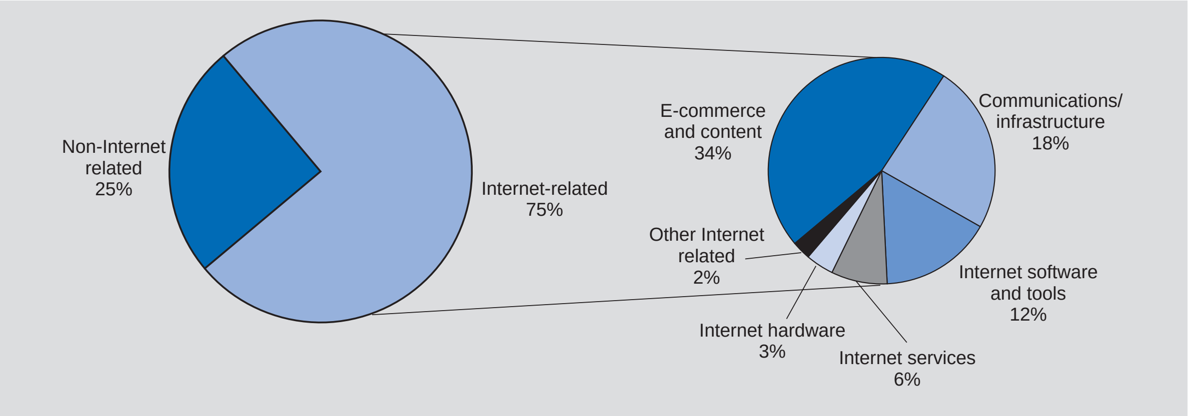
ICT markets in the OECD area continued to grow strongly in the second half of the 1990s, averaging 6.3% a year between 1995 and 2001 in nominal terms (Figure 26). The United States experienced the fastest growth during 1995-98 (8.9% a year), while all other OECD regions had their strongest growth in 1998-2000 (6.8% in the EU, 12.1% in Japan and 9.8% in the other OECD countries). Between 2000 and 2001, growth slowed considerably in all OECD regions, averaging only 3.4%. OECD countries represent the largest market in the world by far, although their share has declined steadily from 92%

Figure 24. **Venture capital investments in ICT industries in the United States, 1999-2000**
Value in billions of USD and annual growth in percentages



Source: NVCA, January 2001.

Figure 25. **US venture capital investments in 2000, by type**
Percentages

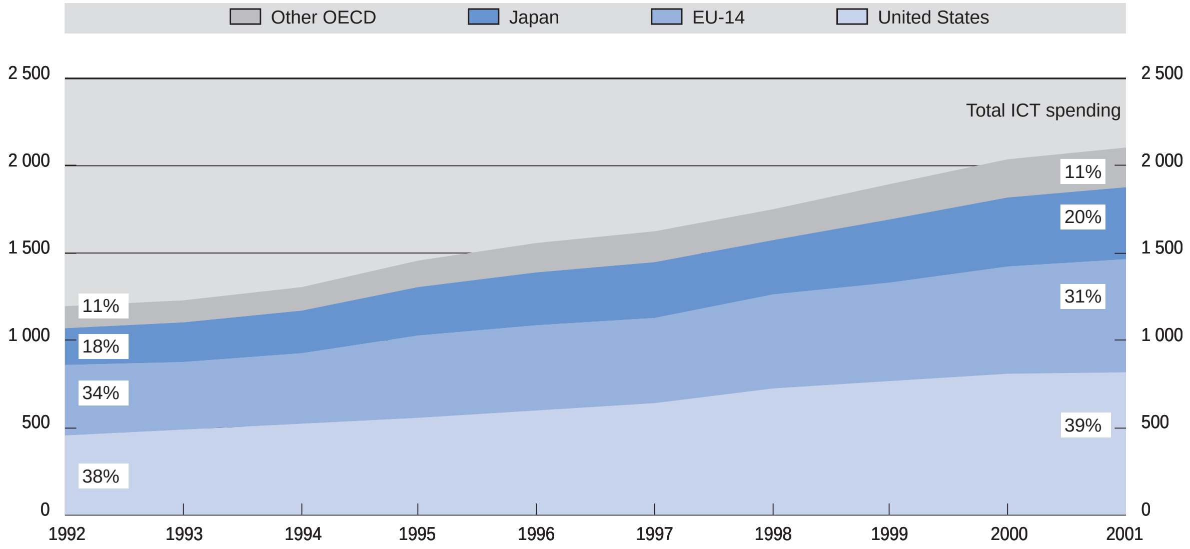


Source: NVCA, January 2001.

in 1992 to 87% in 2001. Within the OECD area, the United States accounts for around 40% of the ICT market, the EU for 30% and Japan for close to 20%. Note that the data in this section are in nominal terms, and data in volume terms could show a somewhat different picture, reflecting particularly rapid price declines in hardware.

Figure 26. **OECD ICT spending by region/country, 1992-2001**

Value in billions of current USD



Source: OECD, based on World Information Technology and Services Alliance (WITSA)/International Data Corporation (IDC), 2002.

In terms of ICT intensity (ICT market/GDP), the OECD area averaged 8.3% in 2001, compared to less than 6% in 1992 (Figure 27). In 2001, New Zealand took first place in the OECD area in terms of ICT intensity (14.7%), owing to the strong contribution of telecommunications. Sweden ranked second (12%) mostly owing to the importance of ICT services. Growth has been strong throughout the OECD region with 17 out of 28 countries having an ICT intensity greater than 8% in 2001, compared to only ten in 1999.

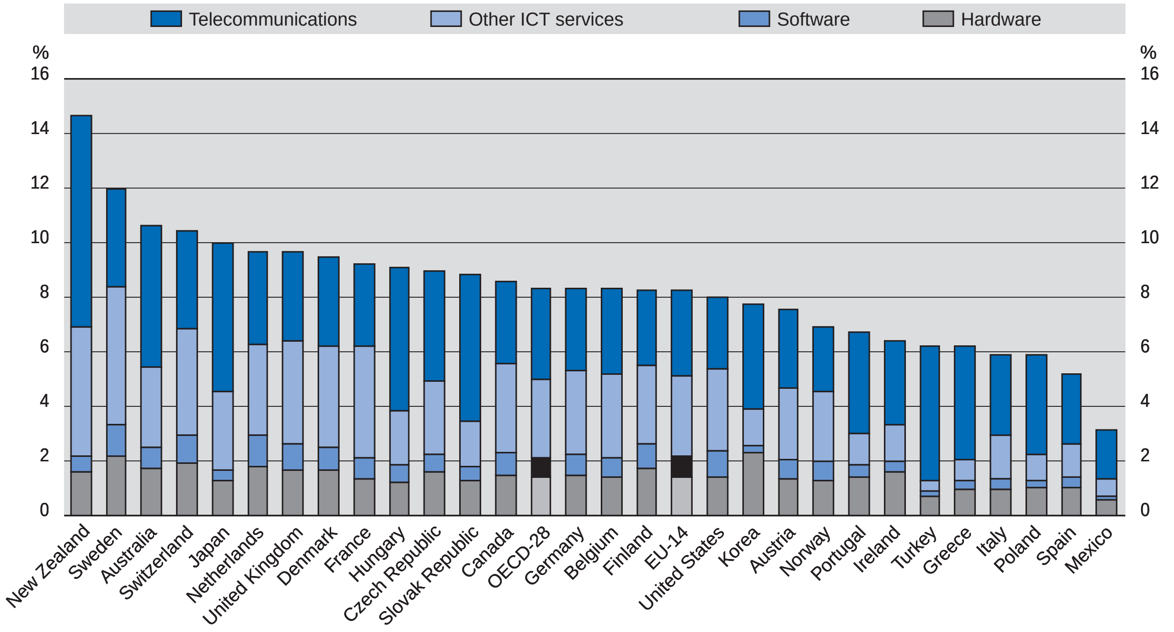
In terms of market segments within the OECD area, telecommunications accounts for the largest share (almost 40%) followed by IT services (around 35%), hardware (16.7%) and software (8.8%) (Figure 28). Countries differ markedly: in the United States, France and Sweden, IT (hardware, software, services) accounted for more than two-thirds of all ICT spending, while southern and eastern European countries spent a significantly higher share on telecommunications. Telecommunications accounted for over 60% of all ICT spending in the Slovak Republic, Poland and Greece. In Hungary, Poland, Portugal, Japan, Greece and the Czech Republic, countries that experienced the fastest ICT intensity growth during the 1990s, telecommunication expenditure accounted for most of the growth. Slower overall ICT market growth in 2001 was mainly due to the decline in the OECD hardware market (–10.9% over 2000), particularly in the United States (–17.8% over the previous year).

Hardware and semiconductors

- Hardware

The United States has been a strong driver of growth in the hardware market, with a nominal CAGR of almost 8% *versus* only 5.7% for the OECD as a whole (Figure 29). This is despite a nominal decline in 2000 and 2001 (hardware spending in volume terms continued to grow in 2000 due to price declines in this segment). Overall, the US share has remained stable at around 40%. By way of contrast, Japan, the second largest market by size, has experienced below-average growth (less than 2% a year). In most European countries, hardware has grown more slowly than the OECD average. Growth has been more vigorous in smaller markets such as Greece, Ireland, Portugal and Poland. Korea was also among the most dynamic countries, with a CAGR higher than that of the United States, and is now the eighth largest hardware market in the OECD area.

Figure 27. **ICT intensity[1] in OECD countries,[2] 2001**

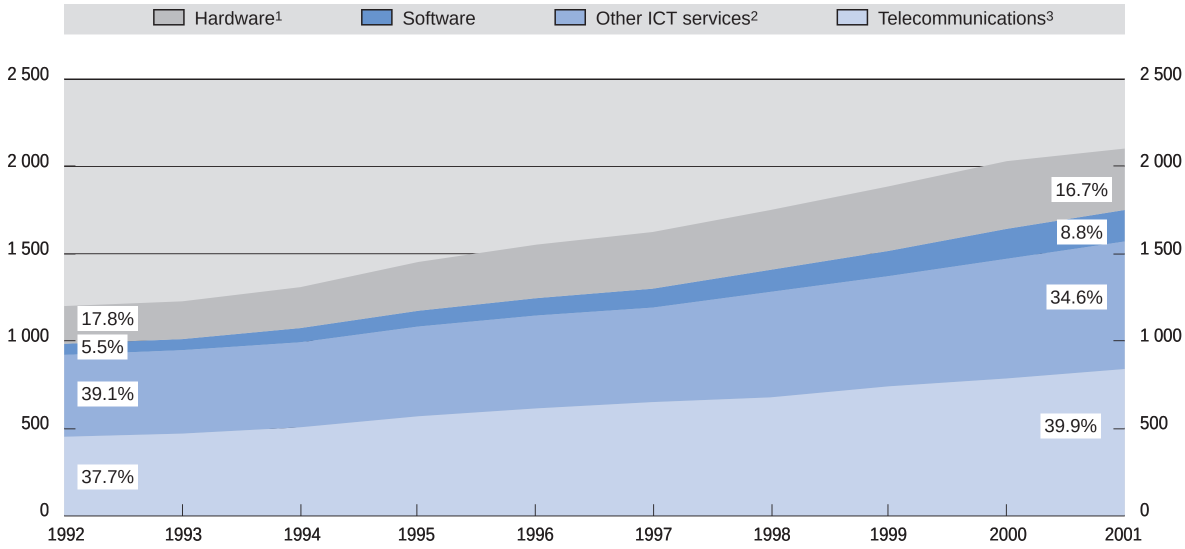


1. ICT intensity is defined as ICT markets/GDP.
2. EU-14 excludes Luxembourg. OECD-28 excludes Luxembourg and Iceland.

Source: OECD, based on World Information Technology and Services Alliance (WITSA)/International Data Corporation (IDC), 2002.

Figure 28. **OECD ICT spending by segment, 1992-2001**

Billions of current USD

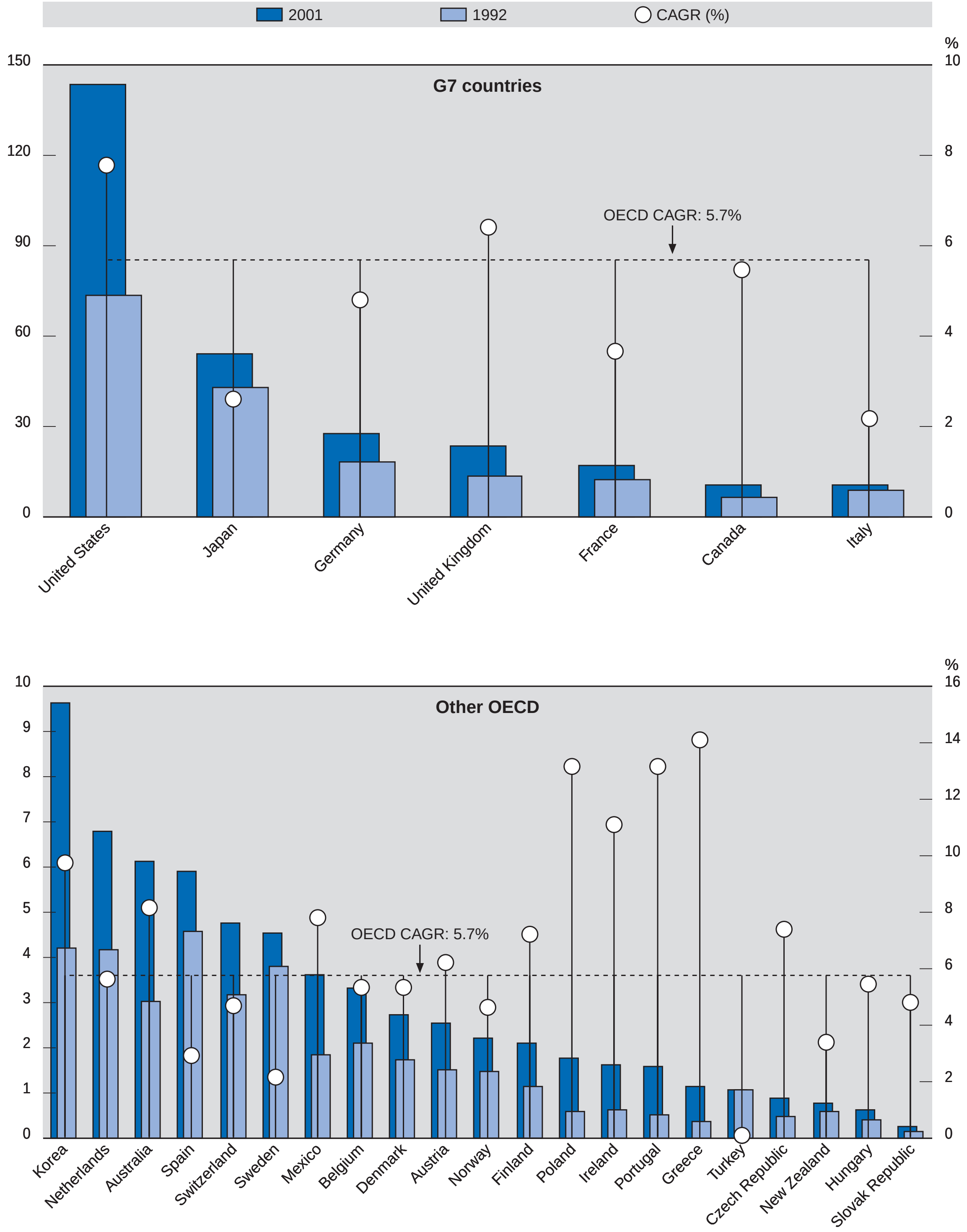


1. Includes other office equipment.
2. Includes internal spending.
3. Includes telecommunication services and telecommunication equipment.

Source: OECD, based on World Information Technology and Services Alliance (WITSA)/International Data Corporation (IDC), 2002.

Figure 29. **OECD hardware markets by country, 1992 and 2001**

Value in billions of USD and nominal growth in percentages



Source: OECD based on World Information Technology and Services Alliance (WITSA)/International Data Corporation (IDC), 2002.

The installed PC base (per inhabitant) continues to increase significantly across OECD countries, almost quadrupling between 1992 and 2001 (Figure 30). Growth of the installed base has been particularly strong in some of the smaller OECD economies (*e.g.* Poland, Greece, Turkey), as well as in Japan and Korea (more than 19% a year). There is a large disparity among countries in terms of the distribution of the PC installed base across the various sectors of use (businesses, government, households and educational institutions). In 2001, businesses and government accounted for around one-half of the total PC installed base in more than half of all OECD countries, ranging from more than three-quarters of all PCs in eastern Europe, to less than one-third in the Netherlands.

- Semiconductors

From its beginning in the 1950s, the semiconductor industry has undergone economic cycles, usually of four years' duration. However, the 1990s were somewhat atypical. After a first pause in 1996, and a second in 1998, 2001 is likely to witness the strongest decrease in value (a drop of 31.2%), owing to a strong inventory correction in some end markets combined with significantly weakening demand throughout all regions (particularly in the United States).

Between 1990 and 2001, the world semiconductor market grew at a CAGR of 9.6%, albeit unevenly across regions (Figure 31). In 1990, Japan had the largest share (almost 40%), followed by the Americas (less than 30%) and Europe (around 20%). Both Japan and the Americas have seen their shares drop, mainly to the benefit of other Asia-Pacific countries, which now account for 28% of world orders against less than 14% in 1990. This reflects the progressive shift of the Asian semiconductor and electronic components industries away from Japan and towards other countries, notably China.[9] Europe's share has remained relatively stable.

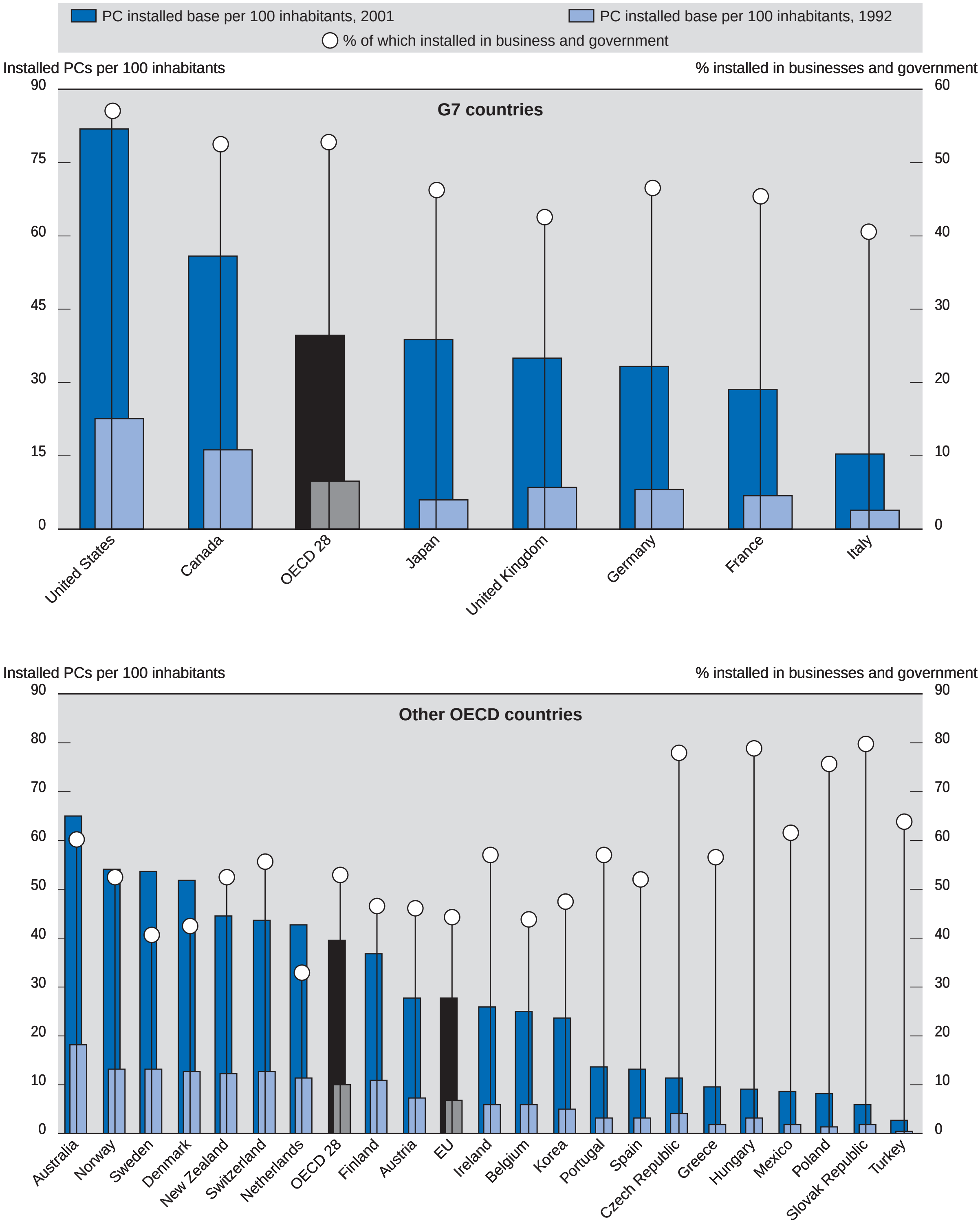
Table 7 shows the source of semiconductor shipments for the main regions as well as the world total. The United States is an increasingly important supplier for all regions, accounting in 2000 for one-fifth of shipments to Japan, around one-half to Asia-Pacific and Europe and 70% to the US market. Japanese firms have lost ground in all markets, particularly in the Asia-Pacific region (21.6% in 2000 versus 34.9% five years earlier) and the United States (their share has dropped to almost half of its 1995 value).

This decade of growth has mainly benefited microprocessors, sales of which increased at a CAGR of 14.8% between 1990 and 2001 (Figure 32). At the beginning of the decade, less than USD 2 out of USD 10 spent on semiconductors went to microprocessors, by 1998 the ratio was close to USD 4 out of USD 10, but it then decreased to USD 3 out of USD 10 by the end of the decade. Memories went through an overproduction crisis in the middle of the decade, but, on average, their relative share remained stable at between one-fifth and one-quarter of the market.[10] Other categories, discrete in particular, lost share, with the noticeable exception of ASICS (devices dedicated to specific applications), which experienced a slight increase between 1991 and 2001, from 14.9% to 16.4% of the market. Although usually aimed at a limited market, the growth of ASICS reflects the diffusion of semiconductors to various broader fields of application.

In terms of end markets, at world level, telecommunications is the segment that has grown most rapidly, reaching second place in terms of consumption of semiconductors, behind computers (Figure 33). This reflects the strong growth of Internet infrastructure (in particular xDSL equipment) and mobile devices. The share of consumer electronics has declined steadily although recent growth in the game console, DVD and digital set-top box markets should contribute to a recovery (J.P. Morgan Securities, 2001).

The relative importance of computers as the segment of final destination has declined in all regions since 1998-99 although it is still the main end market in all regions (Figure 34). Growth in the telecommunication end market picked up first in Europe (in 1992-93) and only in the second half of the decade in other regions. Japan is the only region in which consumer electronics accounted for a sizeable share, at around 30% in 2001, while in Europe and the Americas, the share was below 10%. Automobiles have become an increasingly important sector of final use for semiconductors in Europe but still accounted for only an estimated 12% of the market in 2001.

Figure 30. **PC installed base per 100 inhabitants and share in businesses and government in the OECD area,[1] 1992 and 2001**

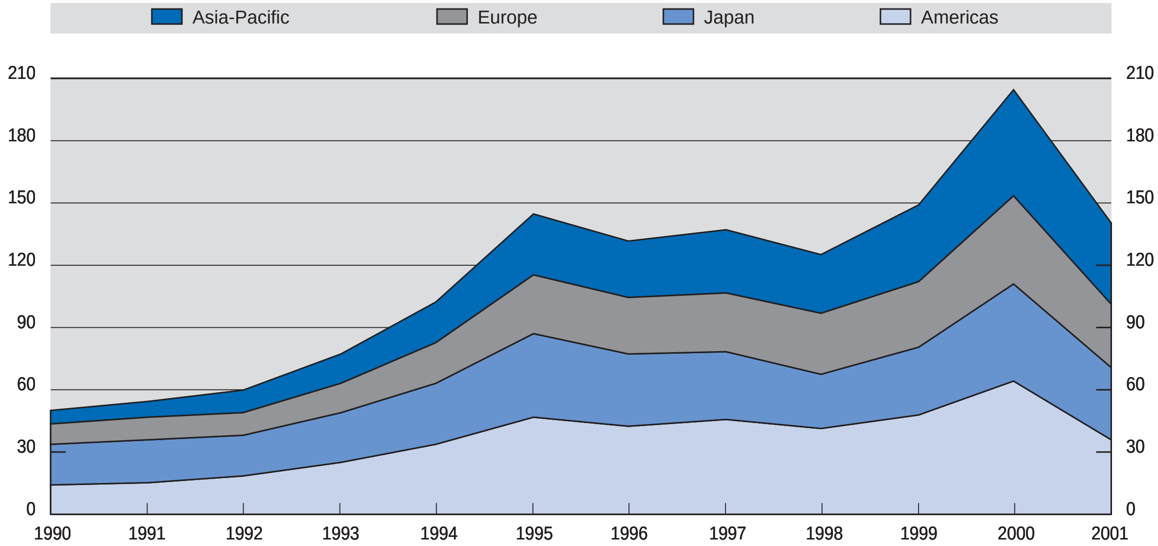


1. Total PC installed base divided by total population.

Source: OECD, based on World Information Technology and Services Alliance (WITSA)/International Data Corporation (IDC), 2002.

Figure 31. **World semiconductor market by region, 1990-2001**[1]

Billions of USD



1. Data for 2001 are an autumn 2001 projection.

Source: World Semiconductor Trade Statistics (WSTS).

Table 7. **World semiconductor market shares by region, 1995 and 2000**

Percentages of regional market

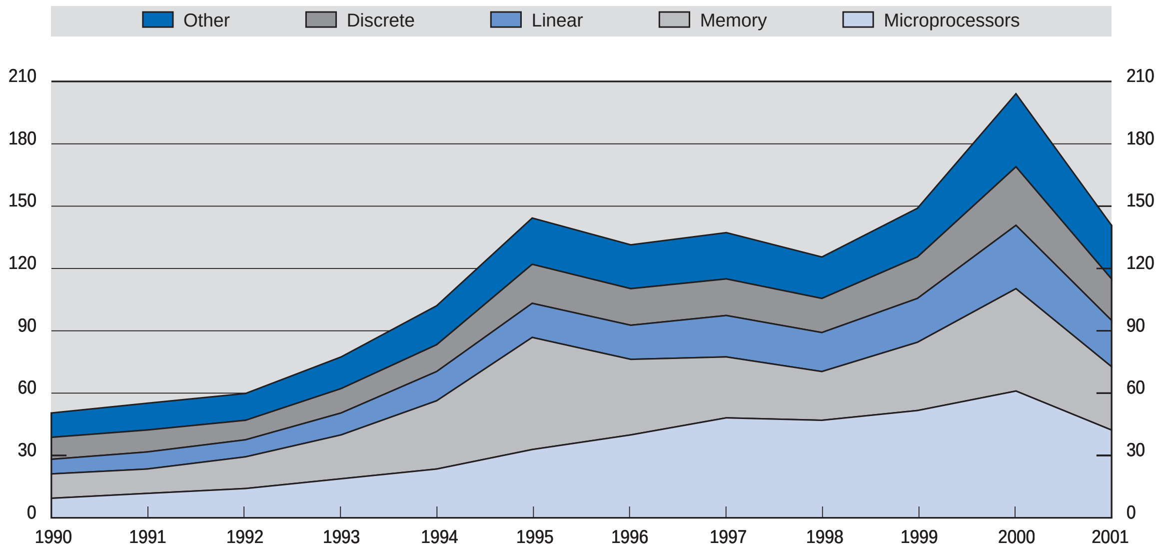
Market	Base country					
	1995			2000		
	Americas	Japan	Other	Americas	Japan	Other
Americas	61.3	22.6	16.1	70.2	11.6	18.2
Europe	47.1	18.0	34.9	55.0	13.8	31.2
Japan	17.9	76.0	6.1	20.4	70.3	9.3
Asia-Pacific	33.6	34.9	31.5	47.3	21.6	31.1
Total	40.9	38.9	20.2	49.9	28.3	21.8

Source: WSTS, 2001.

Packaged software

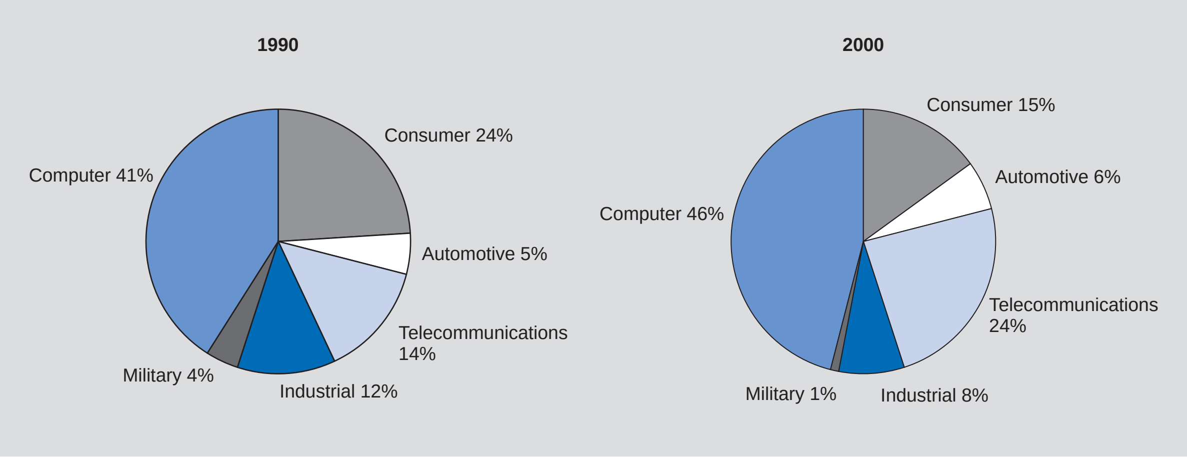
Packaged software has been the most rapidly growing ICT segment in OECD countries, with a CAGR of 12.3% between 1992 and 2001 (Figure 35). By 2001, packaged software accounted on average for around 8.8% of ICT spending for OECD countries, against only 5.5% nine years earlier. However, if the OECD as a whole maintains a relatively stable share of the world market, the United States is clearly, as for hardware, the main driver, having continued to increase its share from 43.6% to 49.2% between 1992 and 2001. The US market in 2001 was about 1.5 times larger than that of all the other G7 countries combined. Among these countries, the Canadian market was also very dynamic, displaying the second highest CAGR among the G7 countries (13.7%). Japan was the second largest market in the OECD area until 1997, when it was overtaken by Germany. Most of the smaller markets (less than USD 1 billion in 2001) experienced above-average growth rates during the 1990s (Poland, Portugal, Ireland, the Czech Republic, Hungary, Greece, Turkey, the Slovak Republic).

Figure 32. **World semiconductor market by segment, 1990-2001**[1]
Billions of USD



1. 2001 is a ST Microelectronics June 2001 forecast, based on WSTS figures.
Source: WSTS and ST Microelectronics.

Figure 33. **World semiconductor market by application (end markets), 1990 and 2000**



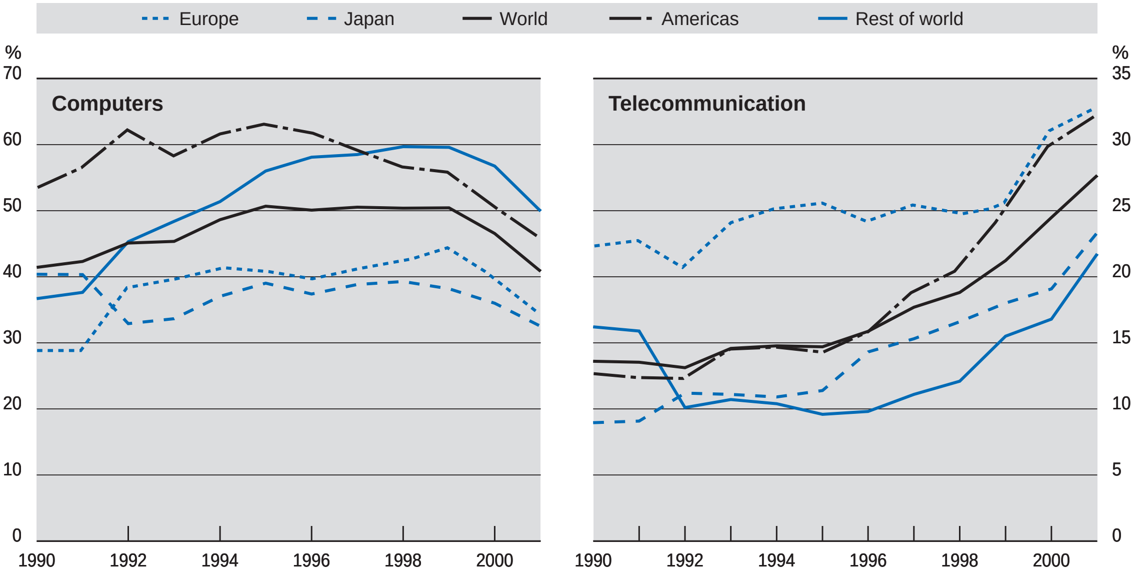
Source: OECD based on WSTS, 2001.

IT *services*

IT services are, on average, the least dynamic ICT market segment in the OECD area, with a CAGR of only 5.0% between 1992 and 2001 (Figure 36). As for packaged software, the United States has been a strong driver during the 1990s increasing its share in world markets from 36.6% to 39.8%. France and Sweden are the only countries to devote more than 40 per cent of their total ICT expenditures to IT services. In countries in the Asia-Pacific region, the situation has been contrasted: Korea and New Zealand experienced quite dynamic growth in the 1990s, while growth rates in Japan and Australia were among the lowest.

Figure 34. **Main semiconductor end markets, 1990-2001**[1]

Percentages of regional market



1. 2001 data are June 2001 forecasts by ST Microelectronics based on WSTS figures.
2. Until 1994, South America is included under "Rest of World". Since then, it is included in "Americas".

Source: WSTS and ST Microelectronics.

Telecommunications

In 2001, out of USD 10 spent in the OECD-area ICT market, almost USD 4 went to telecommunications (including equipment and services). Market liberalisation was the main underlying factor in this market's development during the 1990s. New technologies and new services, and the advent of a commercial Internet, also contributed to an increase in the demand for most types of telecommunication goods and services.

Extremely rapid growth between 1992 and 2001 in Hungary, the Czech Republic, the Slovak Republic and Poland reflects the joint effects of economic development and basic infrastructure investment as well as anticipated or on-going liberalisation. For similar reasons, Portugal, Greece and Turkey also experienced strong growth in their telecommunications market during the period (Figure 37).

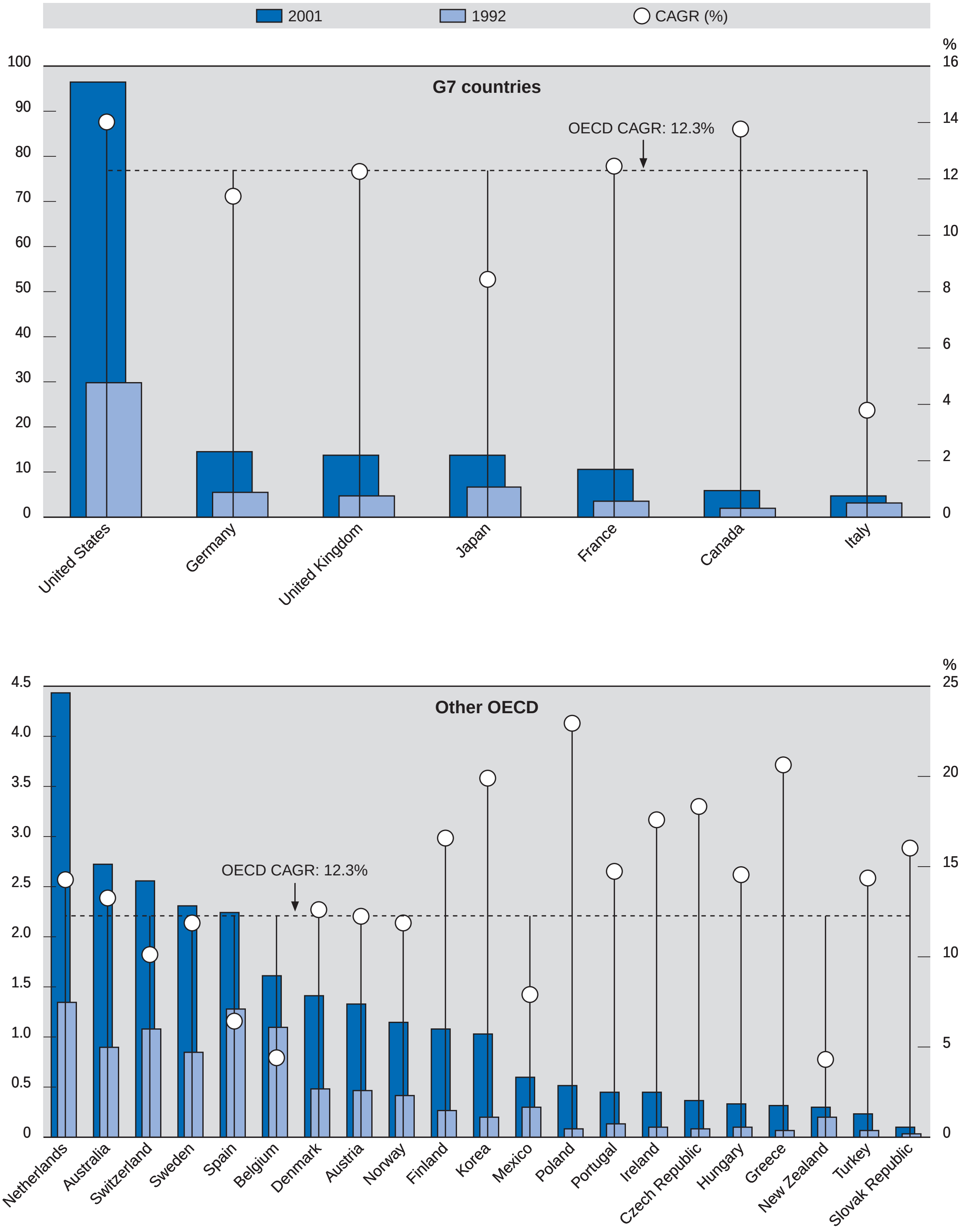
Among the G7 countries, growth in Japan was particularly resilient, mainly owing to the expansion of the mobile telecommunication market. As a result, the market more than tripled in value during the period, and in 2001 Japan accounted for over one-quarter of the overall OECD telecommunication market, second only to the United States which had almost one-third.

Korea, Finland and Ireland also saw their communication market grow at an above-average pace, Ireland mainly owing to the effects of liberalisation and the others mainly owing to the expansion of mobile services (Finland), and Internet access equipment (Korea).

ICT *markets in non-member countries*

Although OECD countries remained by far the world's main ICT market with more than 87% of the total in 2001, non-member countries significantly increased their share from 8% in 1992. Outside the OECD area, ICT expenditures grew at a rate almost double that of the OECD countries: 12.9% CAGR between 1992 and 2001 *versus* 6.5% for the OECD region. China, India and Brazil were among the

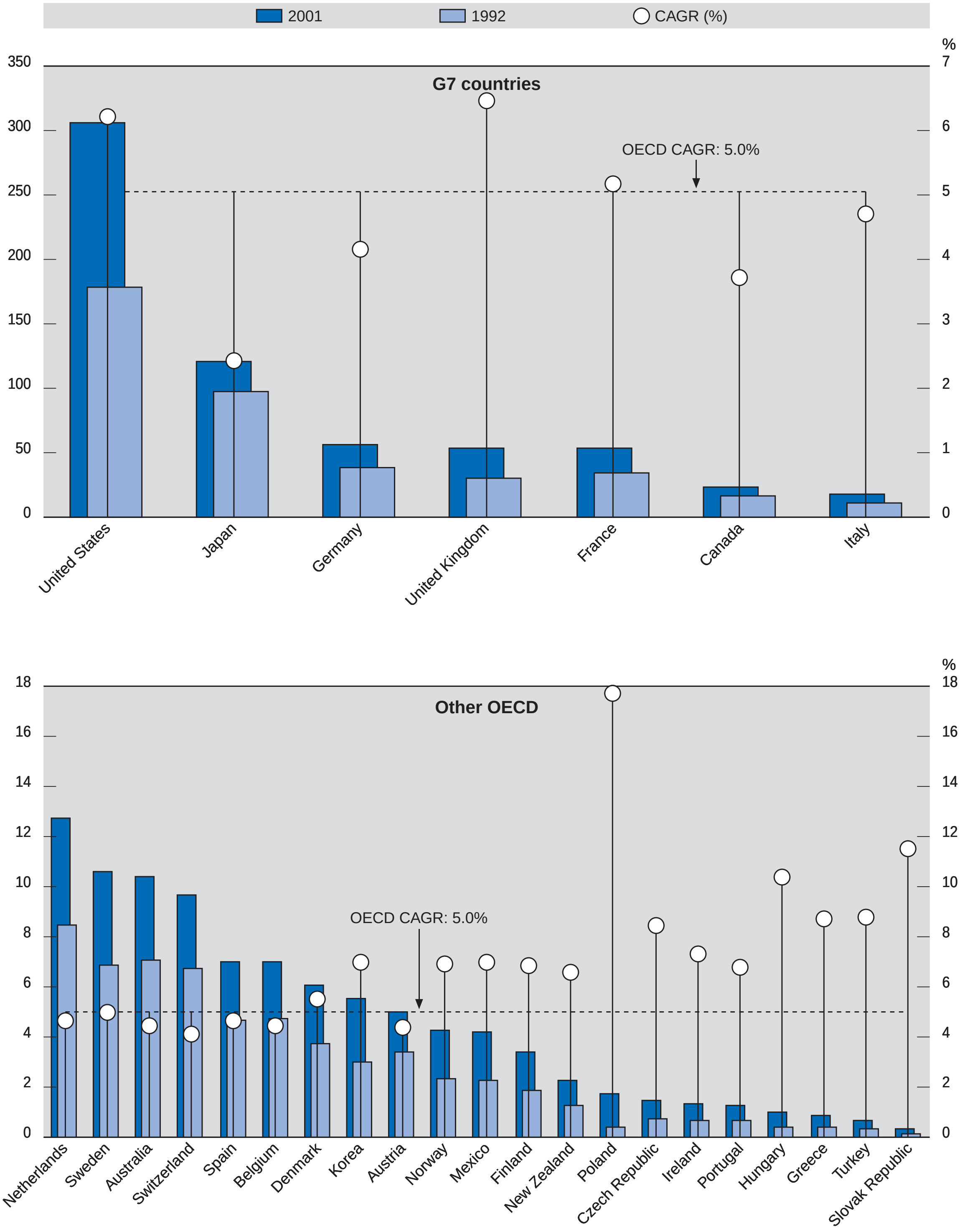
Figure 35. **OECD packaged software markets by country, 1992-2001**
Value in billions of USD and growth in percentages



Source: OECD, based on World Information Technology and Services Alliance (WITSA)/International Data Corporation (IDC), 2002.

Figure 36. **OECD IT services markets by country, 1992-2001**

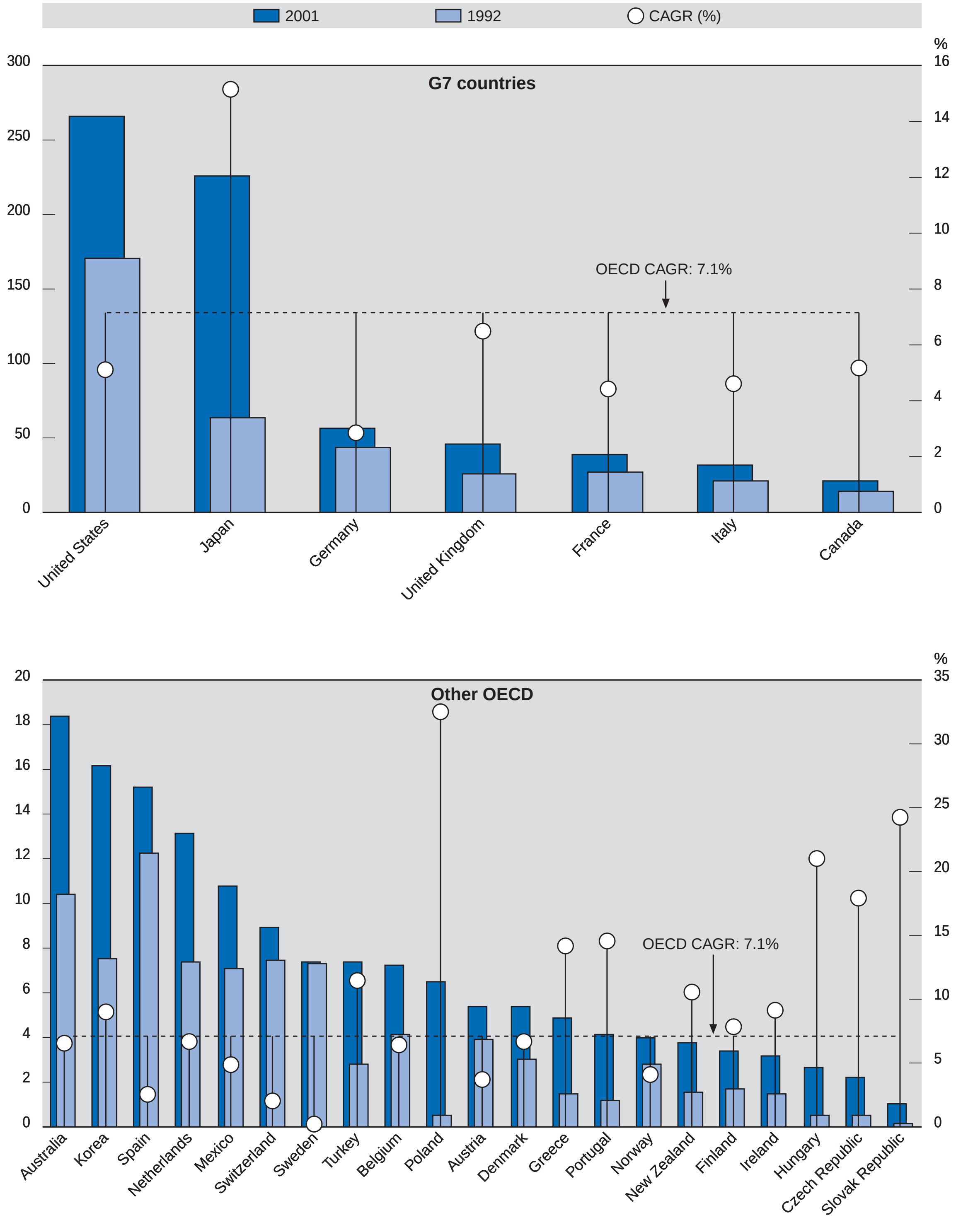
Value in billions of USD and growth in percentages



Source: OECD, based on World Information Technology and Services Alliance (WITSA)/International Data Corporation (IDC), 2002.

Figure 37. **OECD telecommunication markets by country, 1992-2001**

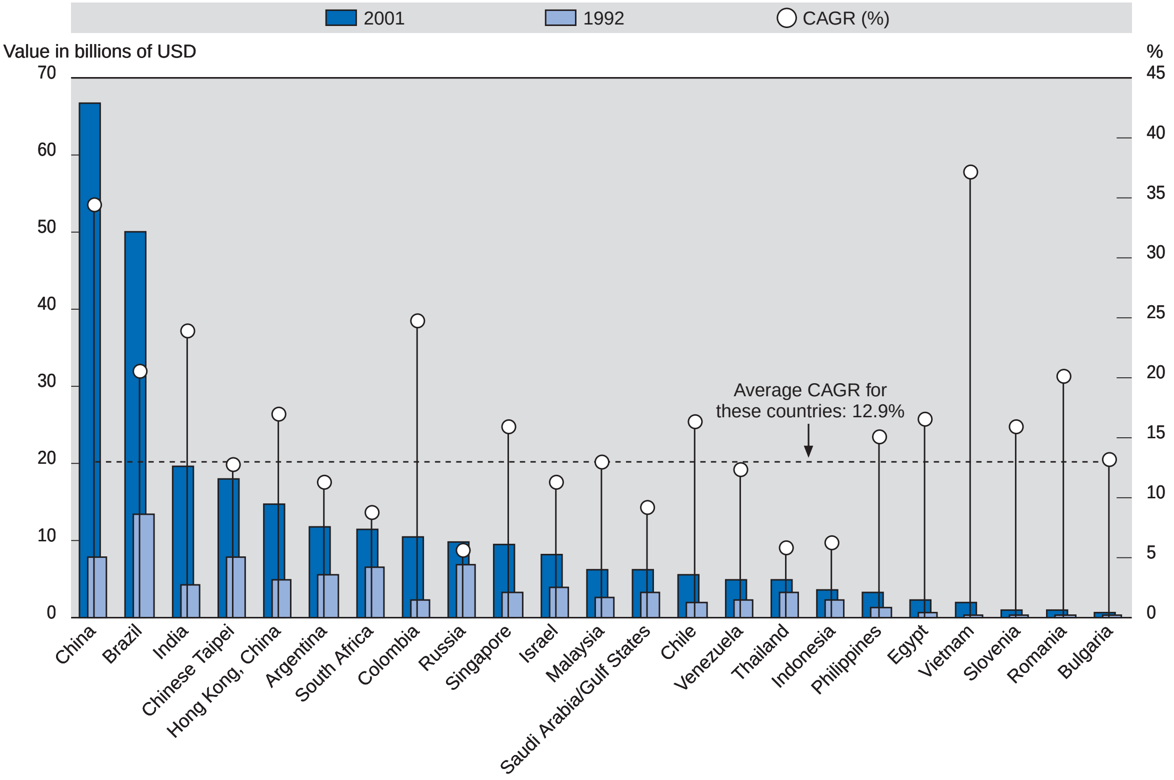
Value in billions of USD and growth in percentages



Source: OECD, based on World Information Technology and Services Alliance (WITSA)/International Data Corporation (IDC), 2002.

Figure 38. **ICT markets in selected non-member countries, 1992 and 2001**

Value in billions of USD and growth rate in percentages



Source: OECD calculations, based on World Information Technology and Services Alliance (WITSA)/International Data Corporation (IDC), 2002.

countries with the most rapid growth, averaging between 20% and 35% a year over the period. As a result, those three countries saw their combined share of the world market more than double, from 2.0% in 1992 to 5.6% in 2001 (Figure 38).

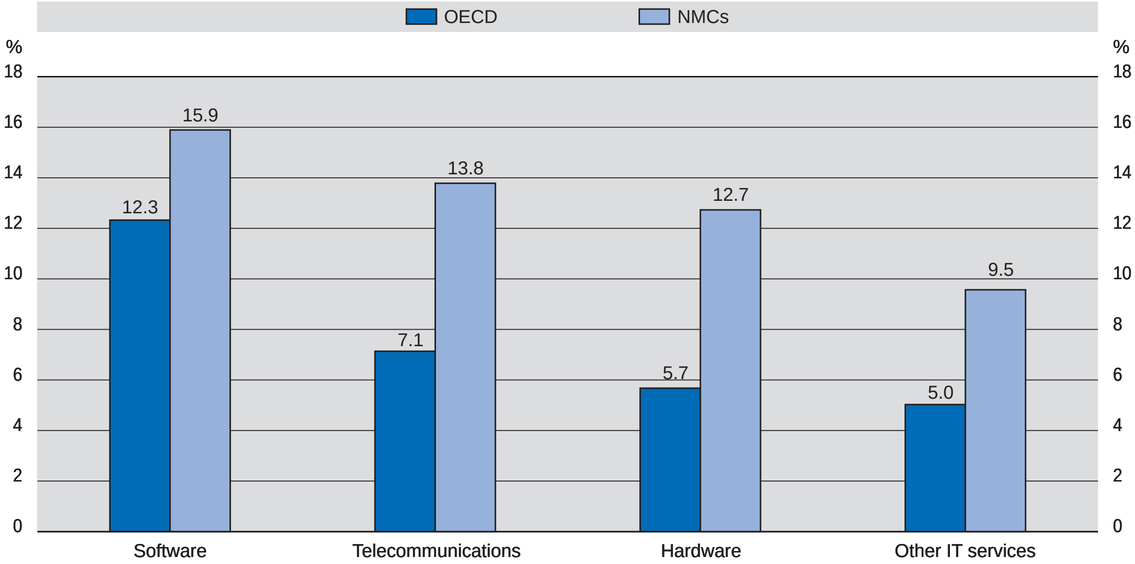
China ranked as the world's sixth largest ICT market in 2001, while Brazil ranked eighth (ahead of Australia). Brazil was not the only country in the region experiencing rapid growth: all South American countries had annual growth rates exceeding 8%. Colombia was the world's third most rapidly growing ICT market, after Vietnam and China, and in 2001 its size was comparable to that of Poland or Finland.

As in OECD countries, software was the fastest growing segment in nominal terms in the 1990s (15.9% CAGR between 1992 and 2001), followed by telecommunications, hardware, and finally, IT services (Figure 39). However, it should be noted that price declines have been much smaller in software than in hardware, and growth in volume terms is much more comparable between hardware and other ICT market segments.

In most of these countries, telecommunication markets have been the main driving force behind the growth in ICT markets in nominal terms; they contributed on average around two-thirds of growth during the period 1992-2001. This is particularly true in South America and also, to a lesser extent, in Asia. Hardware generally ranks second by order of importance as a contributor to ICT market growth in nominal terms. Other ICT services and software have generally only contributed modestly to growth during the period, less than 15% on average. Taken together, these two components accounted in 2001 for just over 17% of the overall ICT market in non-member countries, compared to more than 43% in the OECD area, an indication of the overall lower share of services within these economies (Figure 40).

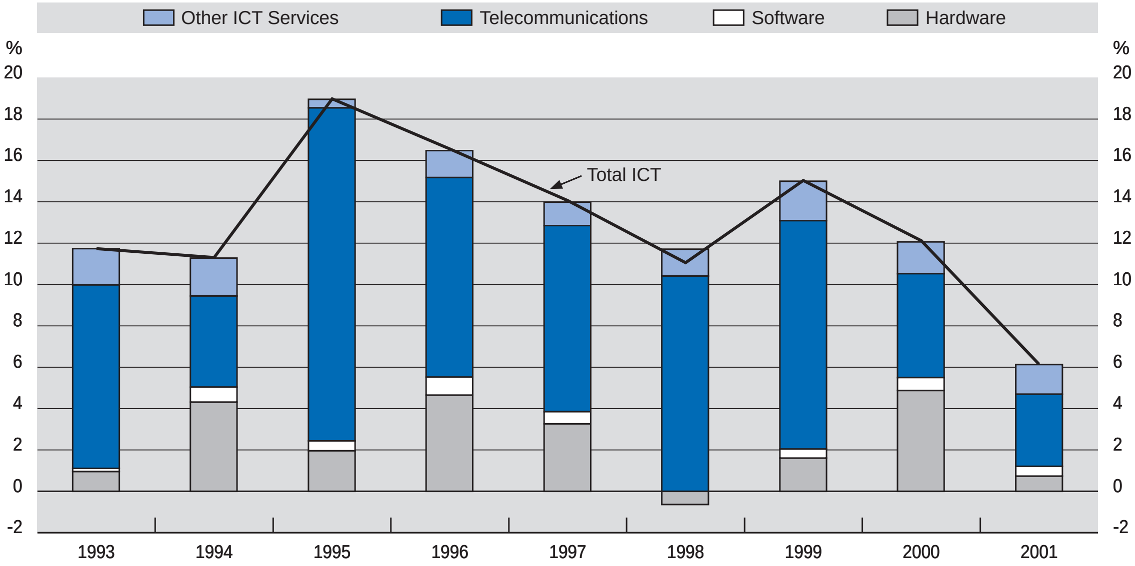
Figure 39. **ICT market growth by main segment and region, CAGR 1992-2001**

Percentages



Source: OECD calculations, based on World Information Technology and Services Alliance (WITSA)/International Data Corporation (IDC), 2002.

Figure 40. **Contribution by segment to non-member countries[1] ICT market growth, 1993-2001**



1. See Figure 38 for list of countries included.
Source: OECD calculations, based on World Information Technology and Services Alliance (WITSA)/International Data Corporation (IDC), 2002.

Conclusion

In conclusion, the impacts of ICTs are being strongly felt throughout the economy. ICTs are increasingly ubiquitous and firms, industries and countries are reaping ever more benefits from their ongoing investments in ICTs and the more widespread use of the Internet. This is true despite considerable changes in the economic landscape since the 2000 edition of the IT *Outlook*. Detailed evidence shows that during the late 1990s, ICTs accounted for a large and growing share of investment and contributed significantly to output growth, particularly in the United States, Australia and Finland.

The diffusion of ICTs throughout the economy has enhanced economic efficiency and substantially boosted productivity growth. The ICT-producing and ICT-using sectors have accounted for the bulk of overall productivity growth in a wide range of OECD countries. The most recent analysis from the United States shows that non-farm business productivity growth remained positive for most of 2001, even while total output was declining, and that this positive productivity performance continued in the first quarter of 2002, an indication that continuing investments in ICTs are resulting in increasing economic benefits (US Department of Commerce, 2002). It is probably still too early to clearly understand and measure how returns to ICT investment, at both firm-level and in aggregate terms, differ from those derived from other types of investment. In other words, many crucial questions remain, such as the extent to which investments in ICT have a substantially higher impact on productivity growth than other types of investments, the extent to which there are differences across countries in these relationships, and the interplay between the impact of ICTs across the economy and the performance of the ICT industry.

The long-term prospects of the ICT industry remain solid. ICTs continue to play an increasingly important role in the growth and performance of advanced economies, and the demand for products and services will return to an upward trend. Firms investing in ICTs will continue to benefit from the increasing integration of network technologies and the efficiencies made possible by moving a wider range of business processes on line. Technological advances will allow price/performance ratios of ICT equipment to decline further in the foreseeable future, thus ensuring that the substitution of this type of capital for other types of inputs will continue. Thus, the contribution of ICTs to the economy as a whole can be expected to grow, despite the short-term turbulence which reminds us that, contrary to some claims, the business cycle has far from disappeared. Having witnessed how the ICT sector was affected by (and itself contributed to) the current economic downturn, there is strong reason to believe that it will have a significant role to play in the next recovery.

Appendix

ICT FIRMS

This appendix describes the business activities of top ICT firms. ICT firms are ranked according to their total revenue for the most recent financial year ending on, or before, 30 September 2001. They are classified by ICT industry sectors according to their official industry classification or, where it appears reasonable to do so, according to the ICT market segment from which they derived their largest share of ICT related revenues. The analysis covers the top 50 firms (all ICT sectors), and the top 10 firms in each of the six major ICT industry sectors – communication equipment and systems, electronics and components, IT equipment and systems, IT services, software and telecommunications, followed by a selection of Internet-related firms (see Box A1.1). However, many large ICT firms are active in a number of sectors (for example, large Japanese and European firms have several ICT activities) and allocating firms to a single ICT sector can be misleading. Furthermore, there are changes in the composition of firm activities over time, as equipment firms shift into services and vice-versa (see Box A1.2).

Among the top 250 ICT firms (ranked by revenue), 89 (36%) are electronics and components manufacturers, 48 (19%) are IT equipment and systems producers, 35 (14%) are IT services providers, 30 (12%) are telecommunication services providers, 26 (10%) are software publishers and 22 (9%) are communication equipment and systems producers. In terms of location, 150 (60%) are based in the United States and 42 (17%) are based in Japan. After that, no country has more than ten. There are eight based in the United Kingdom and in France, seven in Canada, six in Chinese Taipei, five in Germany and the Netherlands, three in Korea, two in Denmark, Israel, Singapore, Sweden and Switzerland and one in Australia, Bermuda, Finland, Italy, Mexico and Spain.

Box A1.1. **Methodology used for identifying ICT firms**

A variety of sources were used to identify the top 250 ICT firms. These include the *Financial Times* 500, the United Kingdom Department of Trade and Industry's R&D scoreboard, *Business Week*'s Information Technology 100, *Software Magazine*'s Software 500, Soft*Letter's Software 100, the *Washington Post*'s Top Information Technology Companies, Forbes 500 largest private companies, NetValley's Computer Industry Top 100 and a number of other Internet listings (including Yahoo!Finance and Wall Street Research Net). Having identified the candidates for a top 250 listing, details were sourced from the latest annual reports, either from the Securities Exchange Commission 10K forms or directly from annual reports. Each of the top 250 firms was classified by ICT industry sector, *i.e.* 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 have been classified according to their official industry classification (US SIC), and where it was not possible, or relevant, they have been classified according to their main ICT-related activity (on the basis of revenue derived from that activity). This necessarily involves a degree of judgement, and some may disagree with the categorisation. Nevertheless, a consistent and workable framework was established.

The top 250 are ranked by total revenue in the most recent financial year ending prior to 30 September 2001. In each case, company name, country, industry, revenue, employment, R&D expenditure, net income and market capitalisation are reported. All items are taken from the most recent annual reports, except market capitalisation, which is that reported by Wall Street Research Net on 12 October 2001. In the absence of set criteria to identify Internet firms, the top 25 Internet-related firms were identified from the Wall Street Research Net's Internet Investment Network listings of Internet-related companies listed on the New York stock exchange in October 2001, and they are ranked by market capitalisation.

The top 50 ICT firms

During 2000-01, the top 50 ICT firms generated total revenues of USD 1.8 trillion, employed more than 6.4 million people worldwide, spent more than USD 90 billion on R&D, earned net income of some USD 125 billion and had a market capitalisation in October 2001 of around USD 2.5 trillion. These top 50 firms have grown significantly. Although data are incomplete, total top 50 firms' revenue appears to have increased by around 30% between 1998 and 2001, the number of employees by 17%, R&D expenditures by 14% and net income by around 50%.

The top 10 firms accounted for 39% of top 50 revenue, 41% of top 50 employment, 33% of top 50 R&D expenditure, 37% of top 50 net income and 30% of top 50 market capitalisation. Reflecting the dynamism of the ICT sector, the top 10 firms have under-performed the top 50 over the last two years, with some of the smaller firms growing faster than the largest. For example, top 10 firms' revenue grew by 14% between 1998 and 2001, while top 50 firms' revenue increased by 29%. Similarly, top 10 employment grew by 6.6% compared to 17%, top 10 R&D expenditure grew by 3% compared to 14% and top 10 income grew by 27% compared to 50%.

Top 50 ICT firms by sector

Fifteen of the top 50 ICT firms were telecommunication services providers, 14 were electronics and components manufacturers, eight were IT equipment and systems producers, seven were communication equipment and systems producers, five were IT services providers and one was a software publisher (*i.e.* Microsoft) (Table A1.1). Telecommunication services providers accounted for 31% of the top 50 revenue in 2000-01 (USD 556 billion), electronics and component manufacturers accounted for 28% (USD 499 billion), IT equipment and systems producers for 22% (USD 386 billion), communication equipment and systems producers for 12% (USD 204 billion), IT services providers for 6% (USD 105 billion) and software publishers for just 1% (Figure A1.1). Sector shares of employment were similar, except that electronics and components manufacturers accounted for a slightly larger share of employment, and IT and communication equipment and systems producers for a correspondingly smaller share.

There are gaps in the data for IT services and software firms. In spite of this, it is evident that the top 50 firms in the IT services and software sectors are growing faster than firms in other sectors of the ICT industry. Microsoft (the only software publisher in the top 50) increased its revenue by 65% between 1998 and 2000-01, employment by 63%, R&D expenditure by 47% and net income by 64%. The four IT services firms for which complete data are available (PricewaterhouseCoopers being new) increased their revenues by 47%. ICT equipment and systems producers among the top 50 had somewhat lower growth. Communication equipment and systems producers increased their aggregate revenues by 45% between 1998 and 2000-01, IT equipment and systems producers increased theirs by 29% and electronics and component manufacturers increased theirs by 13%.

While data are incomplete, equipment manufacturers clearly spend more than services providers on R&D. Moreover, communication equipment and systems firms among the top 50 appear to be more R&D-intensive than their counterparts in electronics and components or IT equipment and systems. Communication equipment and systems producers spent around 13% of revenue on R&D during 2000-01, compared to the electronics and components manufacturers' 6.4% and the IT equipment and systems producers' 5.6%. Market capitalisation is more evenly distributed across the sectors, but it is clear that communication equipment and systems producers and service providers enjoy a somewhat higher level of market capitalisation, relative to revenue, than firms in other IT sectors.

Top 50 ICT firms by country

Most of the top 50 ICT firms are based in the United States or Japan (Figure A1.2). The 26 firms based in the United States accounted for 47% of total top 50 revenue in 2000-01 (USD 834 billion), 41% of employment (2.7 million), 39% of R&D expenditure (USD 35 billion), 60% of net income and 65% of total market capitalisation. The 12 top 50 firms based in Japan accounted for 31% of total revenue (USD 557 billion), 29% of employment (1.9 million), 34% of R&D expenditure (USD 31 billion), just 5% of net income (USD 5.8 billion) and 13% of market capitalisation. Germany, France and the United Kingdom each have two firms in the top 50, and the Netherlands, Canada, Sweden, Finland, Italy and Spain each have one.

Data are incomplete, but US-based companies among the top 50 appear to be growing faster than those based in Japan. They increased their total revenues by 36% between 1998 and 2000-01 compared to 19% for companies based in Japan, increased employment by 25% compared to 7% and increased their aggregate net income by 56% compared to a decrease of 35% for Japan. The top 50 ICT firms based outside the United States and Japan increased their aggregate revenues by 28%, employment by 18% and net income by 72%. Finland (Nokia) and Canada (Nortel) were the stellar performers, with revenues growing by 90% and 80%, respectively.

The R&D intensity of the top 50 ICT firms is relatively high, at 5% of revenue in 2000-01. Some strong R&D performers stand out, but overall R&D intensity varies little among countries. Top 50 IT firms based in the United States spent around 4.2% of their revenues on R&D, those based in Japan around 5.5% and those in other countries an average of around 6%.

Table A1.1. **Top 50 ICT firms**

USD millions and number employed

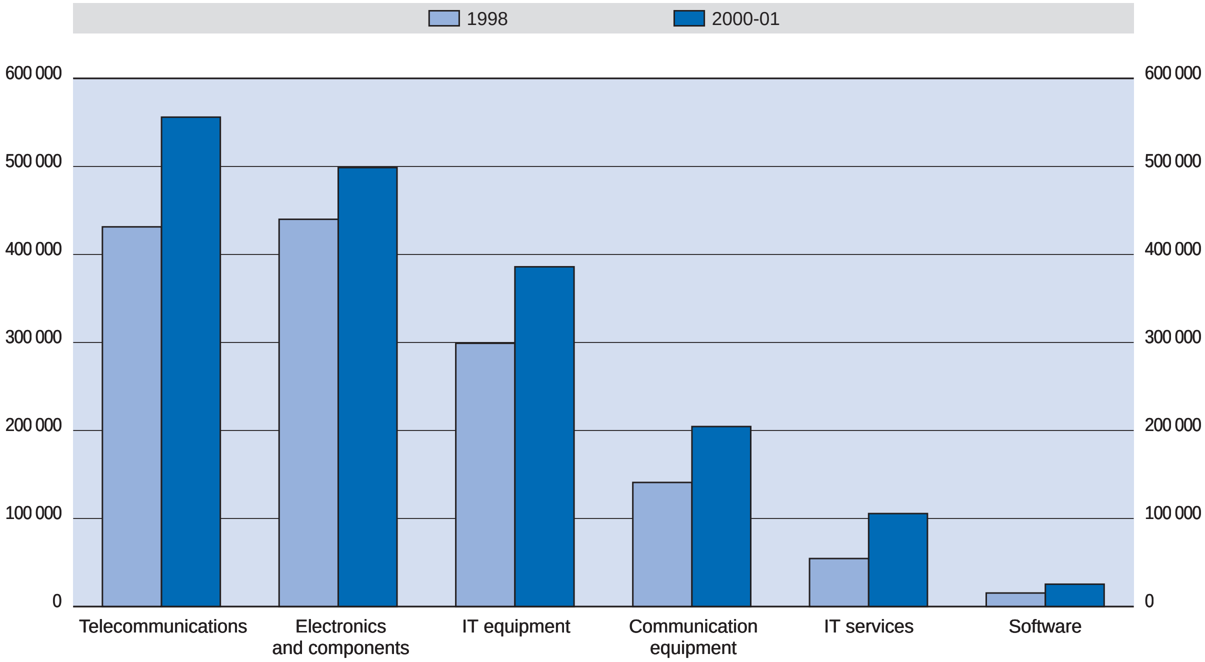
Company		Industry	Revenue 1998	Revenue 2001	Employed 1998	Employed 2001	R&D 1998	R&D 2001	Net income 1998	Net income 2001	Market cap 2001
NTT	Japan	Telecoms	78 099	92 679	226 000	224 000	2 806	3 178	5 835	–603	71 200
IBM	United States	IT equipment	81 667	88 396	291 067	316 303	5 046	5 151	6 328	8 093	168 900
Hitachi	Japan	Electronics	64 305	71 158	331 494	323 827	4 825	3 870	27	151	25 600
Siemens	Germany	Electronics	66 896	70 964	416 000	447 000	4 839	5 328	1 511	11 539	38 600
AT&T	United States	Telecoms	51 319	65 981	107 800	166 000	550	402	7 487	4 277	69 300
Matsushita Electric	Japan	Electronics	60 285	64 916	276 000	290 448	4 667	4 670	715	887	25 500
Verizon Communications	United States	Telecoms	57 075	64 707	255 000	260 000	. .	. .	4 980	11 797	146 600
Sony	Japan	Electronics	51 178	59 467	173 000	189 700	3 089	3 505	1 682	1 084	033 500
Toshiba	Japan	IT equipment	41 704	55 194	186 000	188 042	2 467	3 041	112	892	21 929
SBC Communications	United States	Telecoms	46 241	51 476	200 380	220 090	. .	. .	7 690	7 967	157 700
Fujitsu	Japan	IT equipment	40 057	50 863	180 000	188 042	3 018	3 741	–104	79	29 946
NEC	Japan	IT equipment	37 976	50 171	152 450	149 931	3 045	3 199	316	525	30 983
Hewlett-Packard	United States	IT equipment	38 419	48 782	124 600	88 500	2 380	2 646	2 945	3 697	33 000
Compaq Computer	United States	IT equipment	31 169	42 383	90 000	70 100	1 353	1 469	–2 743	569	16 100
Worldcom	United States	Telecoms	17 617	39 090	20 300	59 000	3 725	. .	–2 506	4 238	40 600
Mitsubishi Electric	Japan	Electronics	29 043	38 297	115 206	116 715	1 393	1 731	–758	1 157	13 673
Deutsche Telekom	Germany	Telecoms	38 957	37 021	197 000	170 000	692	667	2 314	6 698	71 200
Philips Electronics	Netherlands	Electronics	33 915	34 956	252 680	231 161	2 280	2 553	6 740	8 863	28 400
Lucent Technologies	United States	Com equipment	24 367	33 813	153 000	126 000	3 655	4 024	1 065	1 219	22 000
Intel	United States	Electronics	26 273	33 726	64 500	86 100	2 509	3 897	6 068	10 535	155 000
Dell Computer	United States	IT equipment	18 243	31 888	24 400	40 000	272	482	1 460	2 177	60 600
Motorola	United States	Com equipment	29 398	30 931	133 000	121 000	3 209	4 440	–962	817	37 300
Ingram Micro	United States	Services	22 034	30 715	. .	16 500	. .	. .	245	226	1 910
France Telecom	France	Telecoms	26 851	30 480	156 600	188 866	801	428	2 373	3 313	40 500
Nortel Networks	Canada	Com equipment	16 857	30 275	75 050	94 500	2 532	4 005	–1 282	–3 407	17 500
Ericsson	Sweden	Com equipment	23 209	29 931	101 485	105 129	3 527	4 587	1 641	2 300	32 300
Alcatel	France	Com equipment	23 671	28 992	118 272	131 598	2 014	2 610	2 605	1 222	85 800
Nokia	Finland	Com equipment	14 838	28 039	41 091	58 708	1 387	2 385	1 280	3 635	89 200
Telecom Italia/ Olivetti	Italy	Telecoms	. .	27 799	. .	120 973	. .	138	. .	–868	15 643
BT	United Kingdom	Telecoms	25 597	27 486	124 700	132 000	444	552	4 883	3 018	59 017
Bell South	United States	Telecoms	20 561	26 151	81 000	103 900	. .	. .	3 527	4 220	77 000
Canon	Japan	Electronics	21 593	25 794	79 799	86 673	1 719	1 729	837	1 244	32 629
Telefonica	Spain	Telecoms	16 141	25 783	64 100	145 730	80	101	1 349	2 267	52 100
Microsoft	United States	Software	15 262	25 296	29 159	47 600	2 970	4 380	4 490	7 346	299 900
Sprint (consolidated)	United States	Telecoms	17 144	23 613	. .	84 100	179	. .	190	505	49 900
Cisco Systems	United States	Com equipment	8 489	22 293	15 000	38 000	1 663	3 922	1 331	–1 014	111 100
PWC	United States	Services	. .	21 500	. .	150 000	. .	. .	. .	. .	Private
Tech Data	United States	Services	7 056	20 428	8 240	10 500	. .	. .	90	178	2 280
EDS	United States	Services	17 243	19 227	120 000	122 000	43	24	743	1 413	27 500
Xerox	United States	Electronics	19 593	18 701	94 600	92 500	1 035	1 044	273	–257	5 650
Sun Microsystems	United States	IT equipment	9 862	18 250	26 300	43 300	1 029	2 016	755	927	29 400
Sanyo Electric	Japan	Electronics	16 474	17 914	. .	83 519	920	885	. .	193	6 960
3M	United States	Electronics	15 094	16 724	70 549	75 026	648	727	1 213	1 857	40 100
Qwest	United States	Telecoms	12 395	16 610	8 700	67 000	. .	. .	1 508	–81	30 700
Sharp	Japan	Electronics	15 812	16 495	48 820	49 748	1 285	1 096	45	250	13 456
Emerson Electric	United States	Electronics	13 447	15 545	116 900	123 400	491	594	1 229	1 422	20 200
Solectron	United States	Electronics	6 102	14 137	37 936	65 270	31	57	251	497	8 480
DDI	Japan	Telecoms	9 738	13 571	2 927	7 361	37	73	165	–93	18 342
Cable and Wireless	United Kingdom	Telecoms	13 599	13 513	46 550	54 919	. .	18	2 160	5 469	12 200
Accenture	United States	Services	8 307	13 500	65 134	71 300	. .	. .	. .	1 650	11 000

Notes: Verizon Communications results for 1998 are a consolidation of Bell Atlantic and GTE, Compaq and Hewlett-Packard results are pre-merger, Olivetti and Telecom Italia are consolidated, and Accenture results for 1998 relate to Andersen Consulting.

Source: OECD, compiled from annual reports and SEC filings.

Figure A1.1. **Top 50 ICT firms revenue by sector**

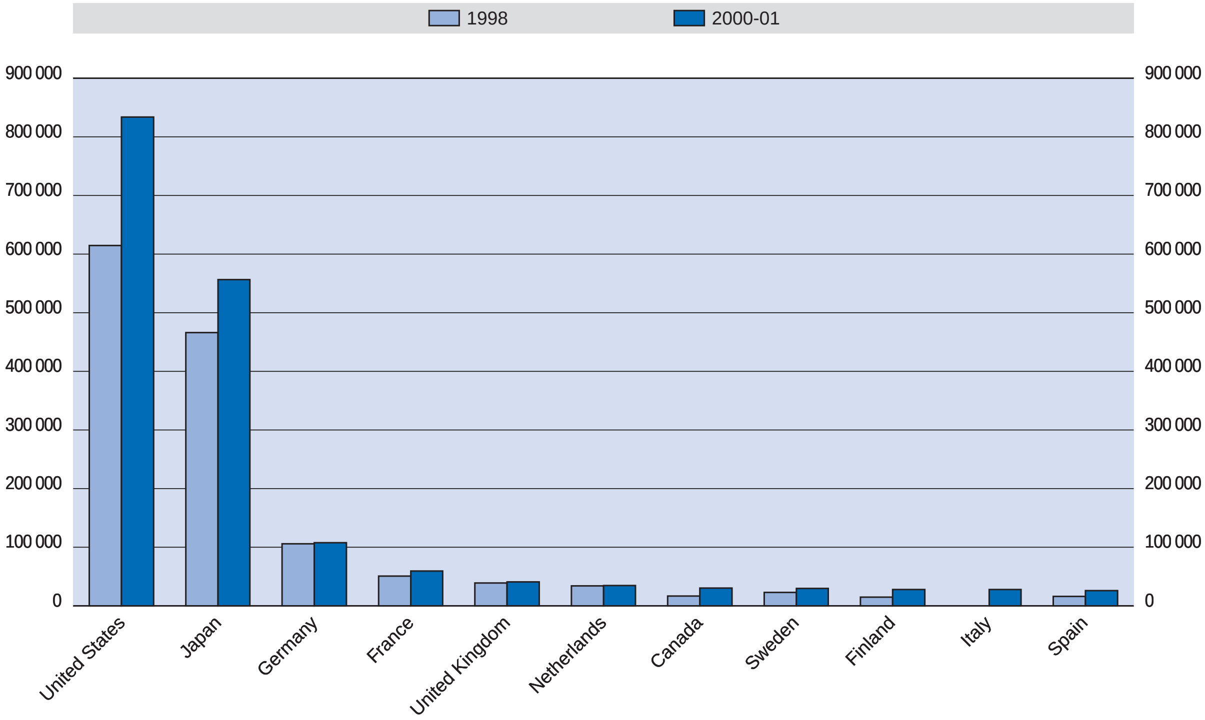
USD billions



Source: OECD, compiled from annual reports and SEC filings. See Box A1.1 for details.

Figure A1.2. **Top 50 ICT firms revenue by country**

USD billions



Source: OECD, compiled from annual reports and SEC filings.

The differences between firms based in the United States and in Japan are likely to reflect a range of structural factors and sectoral differences. For example, the top 50 firms based in Japan are somewhat larger than those based in the United States. Average per company revenue of the Japan-based firms was USD 46.4 billion, compared to an average of USD 32 billion for those based in the United States. While 24% of the top 50 IT firms are based in Japan, they account for 31% of total top 50 revenue and 29% of employment. While 52% of the top 50 IT firms are based in the United States, they account for 47% of total revenue and 41% of employment. Seven (58%) of the 12 top 50 firms based in Japan are electronics and components manufacturers, three (25%) are IT equipment and systems producers and the other two (17%) are telecommunication services providers. By contrast, only five (19%) of the 26 top 50 firms based in the United States are electronics and components manufacturers and a further five are IT equipment and systems producers. Finally, 13 (50%) of the 26 top 50 firms based in the United States are services firms – seven in telecommunication services, five in IT services and one in software.

The top 10 ICT firms in each sector

Because the top 50 group is dominated by large equipment manufacturers, it does not reveal much about major players in specific ICT industry sectors. This section explores the top 10 firms in each sector – communication equipment and systems, IT equipment and systems, electronics and components, IT services, software and telecommunication services.

The communication equipment and systems top 10

The top 10 communication equipment and systems firms generated a combined revenue of USD 226 billion during 2000-01, employed 770 578 people worldwide, spent USD 28 billion on R&D, earned USD 4.5 billion in net income and had a combined market capitalisation of USD 432 billion. Seven were in the top 50 IT firms in 2001 (Table A1.2). Between 1998 and 2000-01, the top 10 communication equipment and systems firms enjoyed a 44% increase in revenue and a more modest increase of around 14% in the number of employees. However, net income fell by around 34%. Communication equipment manufacturing is R&D-intensive. Between 1998 and 2000-01, the top 10 communication equipment and systems firms increased their R&D expenditure by 48%, spending the equivalent of 12% of revenue on R&D. Five of the top 10 communication equipment and systems firms are based in the United States, but no other country has more than one – with Canada, Sweden, France, Finland and the United Kingdom all represented.

Table A1.2. **Top 10 communication equipment and systems firms**

USD millions and number employed

Company		Revenue 1998	Revenue 2001	Employed 1998	Employed 2001	R&D 1998	R&D 2001	Net income 1998	Net income 2001	Market cap 2001
Lucent Technologies	United States	24 367	33 813	153 000	126 000	3 655	4 024	1 065	1 219	22 000
Motorola	United States	29 398	30 931	133 000	121 000	3 209	4 440	–962	817	37 300
Nortel Networks	Canada	16 857	30 275	75 050	94 500	2 532	4 005	–1 282	–3 407	17 500
Ericsson	Sweden	23 209	29 931	101 485	105 129	3 527	4 587	1 641	2 300	32 300
Alcatel	France	23 671	28 992	118 272	131 598	2 014	2 610	2 605	1 222	85 800
Nokia	Finland	14 838	28 039	41 091	58 708	1 387	2 385	1 280	3 635	89 200
Cisco Systems	United States	8 489	22 293	15 000	38 000	1 663	3 922	1 331	–1 014	111 100
Marconi	United Kingdom	6 353	10 522	36 838	56 000	411	1 014	689	–640	28 903
Avaya	United States	7 754	7 680	. .	31 000	302	690	43	–375	2 900
Tellabs	United States	1 706	3 387	5 000	8 643	224	415	392	731	5 340

Source: OECD, compiled from annual reports and SEC filings.

The electronics and components top 10

Electronics and components firms include a range of large conglomerate producers of ICT-related electronics and components. The top 10 firms generated a combined revenue of USD 436 billion during 2000-01, employed almost 2 million people worldwide, spent USD 29 billion on R&D, earned more than USD 35 billion net income and had a combined market capitalisation of USD 366 billion (Table A1.3). All were in the top 50 IT firms in 2001. Between 1998 and 2000-01, the top 10 electronics and components firms increased their combined revenues by 12% and employment by just 3.4%, while doubling net income. R&D expenditure amounted to 6.7% of revenue from sales. Six of the top 10 electronics and components firms are based in Japan, two in the United States, one in Germany and in the Netherlands.

Table A1.3. **Top 10 electronics and components firms**

USD millions and number employed

Company		Revenue 1998	Revenue 2001	Employed 1998	Employed 2001	R&D 1998	R&D 2001	Net income 1998	Net income 2001	Market cap 2001
Hitachi	Japan	64 305	71 158	331 494	323 827	4 825	3 870	27	150	25 600
Siemens	Germany	66 896	70 964	416 000	447 000	4 839	5 328	1 511	11 539	38 600
Matsushita Electric	Japan	60 285	64 916	276 000	290 448	4 667	4 670	715	887	25 500
Sony	Japan	51 178	59 467	173 000	189 700	3 089	3 505	1 682	1 084	33 500
Mitsubishi Electric	Japan	29 043	38 297	115 206	116 715	1 393	1 731	–758	1 157	13 673
Philips Electronics	Netherlands	33 915	34 956	252 680	231 161	2 280	2 553	6 740	8 863	28 400
Intel	United States	26 273	33 726	64 500	86 100	2 509	3 897	6 068	10 535	155 000
Canon	Japan	21 593	25 794	79 799	86 673	1 719	1 729	837	1 243	32 629
Xerox	United States	19 593	18 701	94 600	92 500	1 035	1 044	273	–257	5 650
Sanyo Electric	Japan	16 474	17 914	. .	83 519	920	885	. .	193	6 960

Source: OECD, compiled from annual reports and SEC filings.

The IT *equipment and systems top* 10

The top 10 IT equipment and systems firms generated a combined revenue of USD 404 billion during 2000-01, employed 1.3 million people worldwide, spent almost USD 23 billion on R&D, earned USD 19 billion net income and had a combined market capitalisation of USD 420 billion (Table A1.4). Eight were in the top 50 IT firms in 2001. With the recently announced merger of Hewlett-Packard and Compaq Computer (ranked fifth and sixth, respectively), the leading IT equipment and systems firms will further consolidate. Between 1998 and 2000-01, the top 10 IT equipment and systems firms increased their combined revenues by 30% and employment by just 2%, while enjoying an 88% increase in net income. R&D expenditure amounted to 5.6% of revenue from sales. Seven of the top 10 IT equipment and systems firms are based in the United States and the other three in Japan.

Table A1.4. **Top 10 IT equipment and systems firms**

USD millions and number employed

Company		Revenue 1998	Revenue 2001	Employed 1998	Employed 2001	R&D 1998	R&D 2001	Net income 1998	Net income 2001	Market cap 2001
IBM	United States	81 667	88 396	291 067	316 303	5 046	5 151	6 328	8 093	168 900
Toshiba	Japan	41 704	55 194	186 000	188 042	2 467	3 041	112	892	21 929
Fujitsu	Japan	40 057	50 863	180 000	188 042	3 018	3 741	–104	79	29 946
NEC	Japan	37 976	50 171	152 450	149 931	3 045	3 199	316	525	30 983
Hewlett-Packard	United States	38 419	48 782	124 600	88 500	2 380	2 646	2 945	3 697	33 000
Compaq Computer	United States	31 169	42 383	90 000	70 100	1 353	1 469	–2 743	569	16 100
Dell Computer	United States	18 243	31 888	24 400	40 000	272	482	1 460	2 177	60 600
Sun Microsystems	United States	9 862	18 250	26 300	43 300	1 029	2 016	755	927	29 400
Gateway	United States	7 703	9 601	. .	24 600	70	90	346	242	1 620
EMC	United States	5 436	8 873	9 400	24 100	393	781	654	1 782	27 100

Source: OECD, compiled from annual reports and SEC filings.

The IT *services top* 10

IT services firms tend to be smaller than manufacturing firms. The top 10 IT services firms generated combined revenue of USD 142 billion during 2000-01, employed around 570 000 people worldwide, earned around USD 5.2 billion net income and had a combined market capitalisation of USD 101 billion (Table A1.5). Five were in

Table A1.5. **Top 10 IT services firms**

USD millions and number employed

Company		Revenue 1998	Revenue 2001	Employed 1998	Employed 2001	R&D 1998	R&D 2001	Net income 1998	Net income 2001	Market cap 2001
Ingram Micro	United States	22 034	30 715	. .	16 500	. .	. .	245	226	1 910
PricewaterhouseCoopers	United States	. .	21 500	. .	150 000	. .	. .	. .	. .	Private
Tech Data	United States	7 056	20 428	8 240	10 500	. .	. .	89	178	2 280
EDS	United States	17 243	19 227	120 000	122 000	43	24	743	1 413	27 500
Accenture	United States	8 307	13 500	65 134	71 300	. .	. .	. .	1 650	11 000
CSC	United States	8 111	10 524	45 000	68 000	. .	. .	355	233	5 670
ADP	United States	4 926	7 018	34 000	41 000	416	467	608	925	31 000
Unisys	United States	7 244	6 885	33 200	36 900	308	334	376	225	2 640
Cap Gemini Ernst and Young	France/United States	4 397	6 398	34 606	50 249	. .	. .	195	398	18 675
SAIC	United States	. .	5 900	. .	. .	. .	. .	. .	. .	Private

Source: OECD, compiled from annual reports and SEC filings.

the top 50 IT firms in 2001. Two of the IT services top 10 are private firms. Data relating to the IT services top 10 are limited, but they appear to be enjoying rapid growth. Between 1998 and 2000-01, the top 10 IT services firms for which complete data are available increased their combined revenues by 45%, employment by 18% and net income by 38%. Two are primarily distribution firms, while the others are IT services and consulting firms. At least nine of the top 10 IT services firms are based in the United States, and Cap Gemini Ernst and Young is French/US.

The software top 10

The top 10 software firms generated a combined revenue of USD 60 billion during 2000-01, employed 220 000 people worldwide, earned around USD 10.5 billion net income and had a combined market capitalisation of USD 477 billion (Table A1.6). Only one, Microsoft, was in the top 50 IT firms in 2001. The top 10 software firms are experiencing rapid growth. Between 1998 and 2000-01, they increased their combined revenues and employment by 47% and net income by 35%. Data are incomplete, but the top 10 appear to be R&D-intensive; the eight top 10 software firms for which data are available increased their R&D expenditures by 60% between 1998 and 2000-01, and by the end of the period R&D expenditures were equivalent to 15% of revenue from sales. Eight of the top 10 software firms are based in the United States, one (SAP) in Germany and one (Softbank) in Japan.

Table A1.6. **Top 10 software firms**

USD millions and number employed

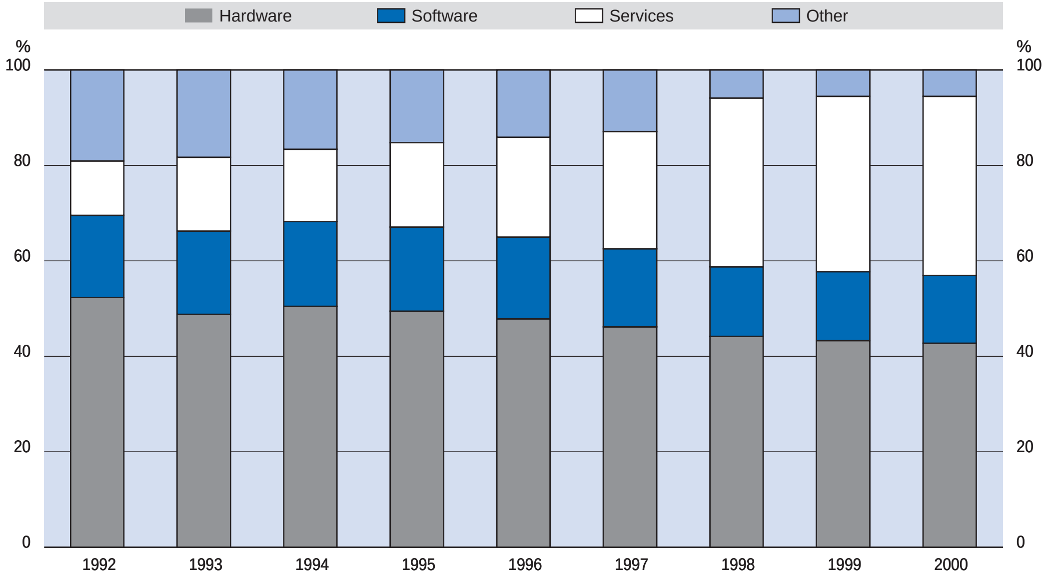
Company		Revenue 1998	Revenue 2001	Employed 1998	Employed 2001	R&D 1998	R&D 2001	Net income 1998	Net income 2001	Market cap 2001
Microsoft	United States	15 262	25 296	29 159	47 600	2 970	4 380	4 490	7 346	299 900
Oracle	United States	7 144	10 860	36 802	42 927	810	1 139	814	2 561	80 000
SAP	Germany	4 806	5 783	19 308	23 700	597	923	587	585	37 500
Computer Associates	United States	4 206	4 918	11 400	18 200	325	1 110	1 169	–591	16 700
Softbank	Japan	3 922	3 925	1 002	7 219	. .	. .	79	78	11 660
Compuware	United States	1 139	2 010	10 016	13 220	77	116	194	119	3 430
Siebel Systems	United States	418	1 795	1 450	7 389	. .	. .	42	222	8 600
Peoplesoft	United States	1 475	1 737	7 032	8 019	270	329	140	146	7 750
BMC Software	United States	985	1 504	3 604	7 330	164	235	189	42	3 640
Electronic Arts	United States	909	1 322	. .	3 500	146	389	73	–11	7 430

Source: OECD, compiled from annual reports and SEC filings.

Box A1.2. **The shift to services: the case of IBM**

Few companies better illustrate the shift towards IT services than IBM. Between 1992 and 2000, IBM's total revenue increased from USD 64.5 billion to USD 88.4 billion, at a compound annual growth rate (CAGR) of 4.0% (Figure A1.3). Over the same period, IBM's services revenue increased from USD 7.4 billion to more than USD 33 billion, at a CAGR of 20.6%.

Figure A1.3. **IBM's revenues by market segment, 1992 to 2000**



In 1992, services generated just over 11% of IBM's total revenue. By 2000, this had increased to almost 38%. Over the eight years to 2000, IBM's total revenue increased by USD 24 billion, while services revenues increased by almost USD 26 billion. Services have not only driven revenue growth, but have more than compensated for declines elsewhere. Quarterly results through 2001 suggested that IBM's annual services revenues would exceed hardware revenues in 2001, making IBM a services and solutions firm rather than a computer manufacturer. Similar shifts are seen in the operations of many firms that were predominantly hardware providers (for example Hewlett-Packard, Sun), and now provide services bundled with goods, or in many cases stand-alone IT or software-related services.

Source: OECD, compiled from IBM's SEC filings, 1997 to 2001.

The telecommunications top 10

Telecommunications firms are among the largest. The top 10 telecommunications firms generated combined revenue of USD 463 billion during 2000-01, employed more than 1.6 million people worldwide, earned USD 44 billion net income and had a combined market capitalisation approaching USD 750 billion (Table A1.7). All ten were in the top 50 IT firms in 2001. The top 10 are experiencing solid growth, but are not growing as fast as the top software and services firms. Between 1998 and 2000, the telecommunications top 10 increased their combined revenues by 28%,

Table A1.7. **Top 10 telecommunications firms**

USD millions and number employed

Company		Revenue 1998	Revenue 2001	Employed 1998	Employed 2001	R&D 1998	R&D 2001	Net income 1998	Net income 2001	Market cap 2001
NTT	Japan	78 099	92 679	226 000	224 000	2 806	3 178	5 835	–603	71 200
AT&T	United States	51 319	65 981	107 800	166 000	550	402	7 487	4 277	69 300
Verizon Communications	United States	57 075	64 707	255 000	260 000	. .	. .	4 980	11 797	146 600
SBC Communications	United States	46 241	51 476	200 380	220 090	. .	. .	7 690	7 967	157 700
Worldcom	United States	17 617	39 090	20 300	59 000	3 725	. .	–2 506	4 238	40 600
Deutsche Telekom	Germany	38 957	37 021	197 000	170 000	692	667	2 314	6 698	71 200
France Telecom	France	26 851	30 480	156 600	188 866	801	428	2 373	3 313	40 500
Telecom Italia/Olivetti	Italy	. .	27 799	. .	120 973	. .	138	. .	–868	15 643
BT	United Kingdom	25 597	27 486	124 700	132 000	444	552	4 883	3 018	59 017
Bell South	United States	20 561	26 151	81 000	103 900	. .	. .	3 527	4 220	77 000

Source: OECD, compiled from annual reports and SEC filings.

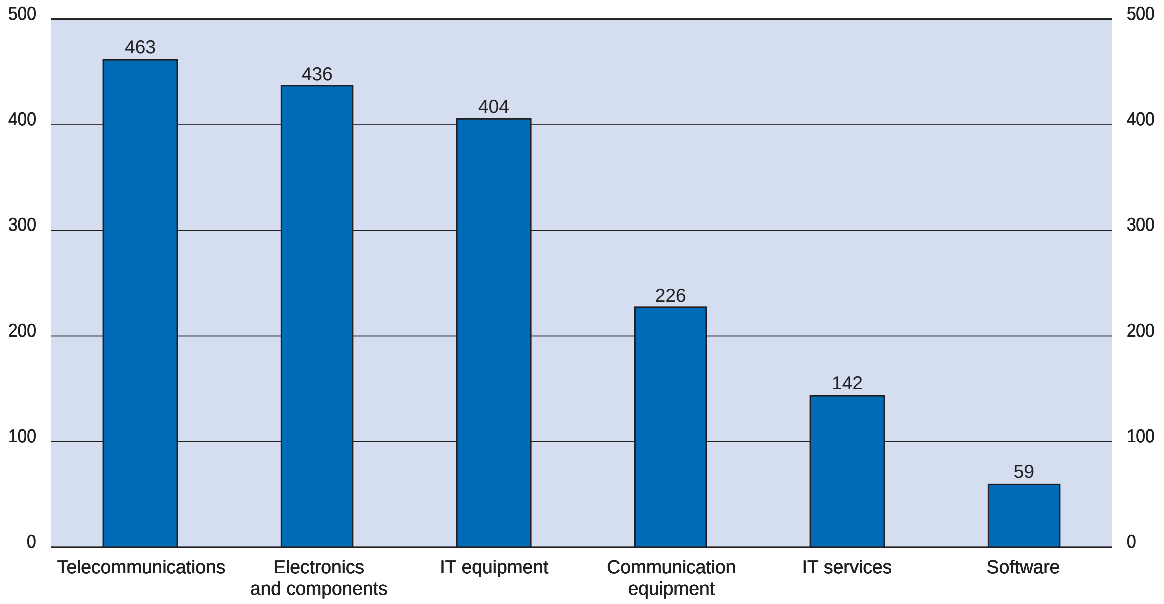
employment by 11% and net income by around 23%. Five of the top 10 telecommunications firms are based in the United States, and one in Japan, Germany, France, Italy and the United Kingdom. Details of the leading telecommunications firms can be found in OECD *Communications Outlook* 2001.

ICT *sector comparisons*

Figure A1.4 shows the relative size of the top 10 firms in each sector. Telecommunications, electronics and components and IT equipment and systems firms tend to be larger than the leading IT services and software firms. During 2000-01, the top 10 telecommunications firms generated USD 463 billion in revenues, the top 10 electronics

Figure A1.4. **Relative size of ICT top 10s**

Revenue, USD billions



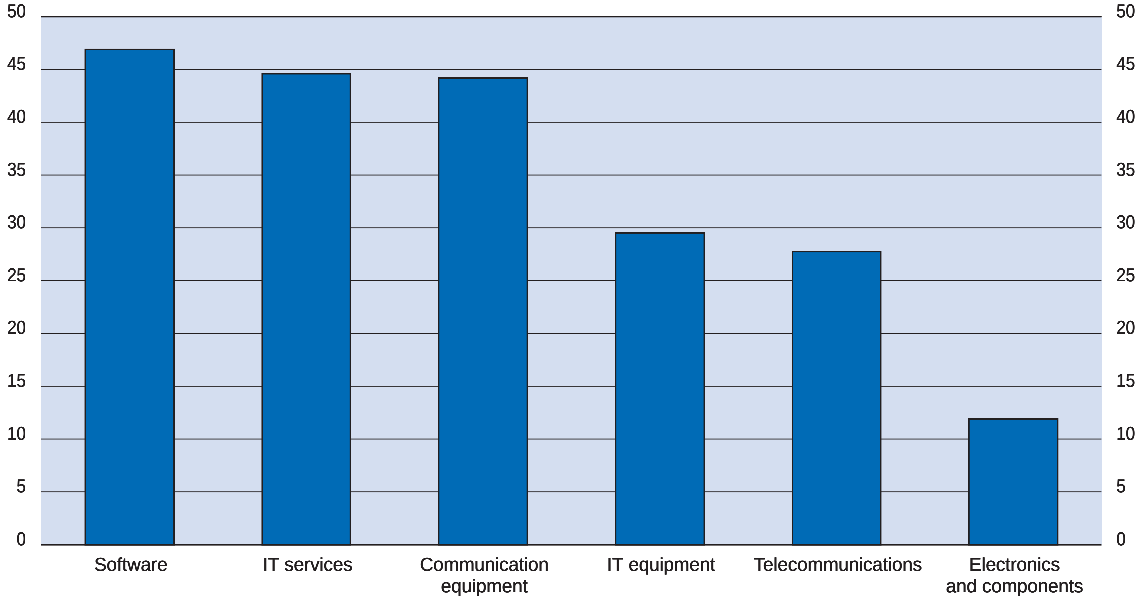
Source: OECD, compiled from annual reports and SEC filings.

and components firms USD 436 billion, the top 10 IT equipment and systems firms USD 404 billion, the top 10 communication equipment and systems firms USD 226 billion, the top 10 IT services firms USD 142 billion and the top 10 software firms USD 59 billion.

However, a ranking by revenue growth shows the reverse order (Figure A1.5). Between 1998 and 2000-01, the top 10 software, IT services and communication equipment and systems firms increased revenues much faster than the top 10 firms in other sectors – by 47%, 45% and 44%, respectively. The top 10 IT equipment and systems and telecommunications firms increased their revenues by 30% and 28%, respectively. In contrast, the top 10 firms in electronics and components increased their revenues by 12%. What is perhaps most striking is that all these growth rates are high. Clearly, leading firms in all sectors of the ICT industry have been experiencing rapid growth in recent years.

Figure A1.5. **Revenue growth of top 10 firms, 1998-2001**

Percentages



Source: OECD, compiled from annual reports and SEC filings.

Detailed descriptions of the activities of each of the firms in the top 10 industry groupings can be found in Table A1.10. Although this section focuses on the top firms (which are often large ones), small firms and networks of SMEs also play an important role in ICT innovation (see Box A1.3).

Internet firms

The analysis of the top ICT firms above is based on a ranking by revenue, but many Internet firms are relatively small, and some have expenditures and costs far outweighing income. They are, however, important to the development of the ICT sector. There are as yet no set criteria by which to identify Internet firms. Some are IT firms, but many are not. This section describes a group of 25 Internet firms, ranked by US market capitalisation. This description is based on the Wall Street Research listing of Internet firms listed on the New York stock exchange in October 2001. As such, it presents a snapshot of US-based Internet firms, but it is neither definitive nor comprehensive.

In October 2001, the top 25 US-based Internet firms from this listing had a combined market capitalisation of USD 331 billion. Just one of these firms (Cisco Systems) appears in the top 50 IT firms, and a further three (Broadcom, Juniper Networks and I2 Technologies) appear in the top 250 IT firms ranked by revenue. During 2000-01 they had revenues worth a combined USD 47 billion, more than USD 38 billion (82%) of which was earned by the top 10 firms. As one would expect, revenue growth over the period 1998-2001 was rapid (Table A1.8). One of the top 25 Internet

Box A1.3. **Large and small firms: outsourcing, networking and changing growth models**

Large firms play key roles shaping the broad structure of economies. They lead small firms in all measures of technology use, including ICTs and the Internet, efficiency and productivity, although the extent and impacts of use of ICTs depend on sectoral factors, with manufacturing, wholesale and retail trade and business services more likely to use ICTs.

In recent years outsourcing (purchasing from outside vendors intermediate components and production-related services previously produced in-house) has increased more rapidly than industrial production, particularly in growing industries such as electronics and electrical engineering. Reasons include a tendency of companies to concentrate on their core competencies, and pressures to reduce costs and use specialised vendors more efficiently. Specialised producers can provide intermediate goods at lower cost and offer a wider choice of innovative products due to larger production volumes and the positive effects of competition. On the other hand, outsourcing may reduce in-house knowledge creation and innovative activity. Furthermore, outsourcing involves transaction costs in negotiation, co-ordination and monitoring.

Nokia is one example of increasing co-operation with outside suppliers. Rather than produce everything, it is strengthening vertical relations and permanent partnerships. In the 1980s inter-firm co-operation was mostly traditional subcontracting to stabilise manufacturing capacity over business cycles. In the 1990s outsourcing became a permanent mode for manufacturing accessories, and manufacturing partnerships were gradually expanded to other areas to reorganise supply chains and use assembler services. Now these relationships encompass R&D subcontracting, and are moving towards R&D partnerships.

Extensive orchestration of the supply chain has helped gain competitive advantage and produce mutual benefits to both partners in sales growth and geographical expansion. Usually suppliers and key customers have common teams that meet frequently to solve problems, exchange information about strategies, future technologies and products, with suppliers involved in the very early planning phases. Some suppliers have also internationalised, and established R&D units abroad to offer global services to other customers.

Co-operation has encouraged joint learning on technologies, market development and market requirements. This has enabled some smaller subcontractors to grow rapidly to reach size and scale requirements of large partners. A continuing challenge to increased networking in small open economies is size differences between suppliers and customers, and the ability of small and medium-sized component and services companies to deliver large volumes required by the key customer. Furthermore, large firms are decreasing the number of direct suppliers, to reduce the complexity of relationships, and encourage common systems and components along supply chains.

Partnerships with reasonable shared risk appear to be the most rewarding business relations. However, close co-operation can bring difficulties. For example, in demand-pull sourcing the entire supply chain needs the same real-time information about expected demand changes to reduce instability. Second, dependence on a single customer may constitute a high long run risk. The third possible drawback of networking is where patents, copyrights and trademarks from R&D co-operation are left to the partner, limiting utilisation of the results of co-operation. Finally, just-in-time strategies can lead fluctuations in demand to cause immediate impacts at the beginning of the production chain.

Sources: Pajarinen, M. (2001), *Make or buy – Outsourcing in Finnish industry*, ETLA, The Research Institute of the Finnish Economy, Helsinki; Ali-Yrkkö, J. (2001), "The role of Nokia in the Finnish Economy", *The Finnish Economy and Society*, 1/2001.

firms is a recent start-up (Hotel Reservation), but the remaining 24 increased their combined revenues from USD 13.5 billion in 1998 to USD 46.6 billion in 2001 – a 247% increase. Unfortunately, the net income realised by these leading Internet firms deteriorated even more spectacularly, falling from a combined profit of USD 1.1 billion in 1998 to a combined loss of USD 28 billion in 2001. Verisign Software contributed no less than USD 15 billion to this combined loss, with WebMD contributing a further USD 4 billion, I2 Technologies USD 3 billion, and Amazon, Broadcom and Cisco Systems each contributing more than USD 1 billion. No fewer than 19 of the top 25 Internet firms made a loss in 2001, whereas 15 showed losses in 1998.

Table A1.8. **Top 25 Internet firms, 2001**

USD millions and percentage change

Company	Activity	Revenue 1998	Revenue 2001	Change %	Net income 1998	Net income 2001	Market cap 2001
AOL Time Warner	ISP/Content	2 600	7 703	196	92	1 152	142 175
Cisco	Communication equipment	8 489	22 293	163	1 331	–1 014	111 100
E Bay	Online trading	47	582	1 129	2	85	16 833
Verisign	Authentication	39	815	1 990	–20	–15 205	9 147
Broadcom	Communication equipment	203	1 181	482	36	–1 576	6 726
Checkpoint Software	Security software	142	544	283	70	313	5 984
Yahoo!	ISP/Portal	203	969	377	26	–110	5 820
Juniper Networks	Communication equipment	4	1 031	27 032	–31	142	4 777
Terra Networks	ISP	14	290	1 925	–4	–524	3 541
Amazon	Online store	610	2 978	388	–125	–1 178	2 507
Earthlink	ISP	176	1 135	545	–60	–368	2 301
E Trade	Online trading	285	2 202	672	–1	19	2 136
I2 Technologies	E-business software	362	1 295	258	20	–3 118	2 073
Ticketmaster	Online booking	28	471	1 582	–17	–199	1 838
Hotel Reservation	Online booking	. .	438	. .	. .	14	1 755
Tibco Software	E-business software	53	330	524	–13	–26	1 491
Expedia	Online travel booking	39	222	474	–20	–78	1 487
Quest Software	E-business software	35	230	561	2	–43	1 315
WebMD	Portal (Medical)	49	713	1 362	–57	–3 997	1 219
Openwave Sys	ISP/Software	2	465	21 050	–11	–690	1 191
Research In Motion	Communication equipment	23	271	1 059	0	–3	1 174
Sycamore Networks	Communication equipment	11	375	3 216	–20	–180	1 149
Liberate Technologies	TV Software	17	60	249	–33	–296	1 136
Vignette Corp	E-business software	16	408	2 419	–26	–811	1 121
Webex	Online exchange	3	52	1 892	–14	–65	1 101

Note: Ranked by market capitalisation on 12 October 2001.
Source: OECD, US-based Internet firms compiled from Wall Street Research Net (WSRN)'s Internet Investing Network.

The activities of this group of Internet firms are very heterogeneous (Table A1.9). These firms can be broadly grouped into four categories: six provide communication equipment and software, seven provide some form of on-line retail, reservation or trading service, six provide software for authentication, security and other e-business applications, and six provide ISP and portal and related content services. According to the detailed US SIC code, seven of the top 25 Internet firms report packaged software (SIC 7372) as their primary business, two report computer systems design (SIC 7373), two report computer peripheral equipment manufacturing (SIC 3577) and two report business services (SIC 7389). The remaining firms all report different primary business activities. These include: book publishing and printing (SIC 2731), telephone and telegraph apparatus manufacturing (SIC 3661), semiconductor manufacturing (SIC 3674), travel agency (SIC 4724), communications services (SIC 4899), security brokers and dealers (SIC 6211), hotels and motels (SIC 7011), computer programming services (SIC 7371), computer processing services (SIC 7374), information retrieval services (SIC 7375), motion picture and video tape production (SIC 7812) and amusement and recreation services (SIC 7999). This list clearly shows the diversity of Internet activities and of the backgrounds of "Internet" firms, hence the difficulty in unambiguously identifying and tracking them.

Table A1.9. **Top 25 Internet firms by industry and activity**

Company	Primary SIC	Description of the firm's activities
AOL Time Warner	7812	An Internet-powered media and communications company, whose industry-leading businesses include interactive services, cable systems, publishing, music, cable networks and filmed entertainment.
Cisco	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.
E-Bay	7389	Pioneer of online personal trading by developing a Web-based community in which buyers and sellers are brought together to buy and sell almost anything. It also engages in the traditional auction business and in online payment processing.
Verisign	7371	Provider of Internet-based trust services, including authentication, validation and payment, needed by Web sites, enterprises, e-commerce service providers, and individuals to conduct trusted and secure e-commerce and communications over IP networks.
Broadcom	3674	The leading provider of highly integrated silicon solutions that enable broadband digital transmission of voice, video and data to and throughout the home and within the business enterprise.
Checkpoint Software	7372	Develops markets and supports Internet security solutions for enterprise networks and service providers including Virtual Private Networks (VPNs), firewalls, intranet and extranet security.
Yahoo!	7373	Global Internet communications, commerce and media company that offers a comprehensive branded network of services to more than 120 million users each month worldwide.
Juniper Networks	3577	A provider of Internet infrastructure solutions that enable Internet service providers and other telecommunications service providers to meet the demands resulting from the rapid growth of the Internet.
Terra Networks	7375	Provides Internet access and local-language interactive content and services to Spanish- and Portuguese-speaking residential and small office/home office (SOHO) customers.
Amazon	2731	World's leading online retailer. Company directly offers for sale millions of distinct items in categories such as books, music, DVDs, videos, toys, electronics, software, video games and home improvement products.
Earthlink	7372	Internet service provider that focuses on providing access, information, assistance and services to its members to encourage their introduction to the Internet and to provide them with a satisfying user experience.
E Trade	6211	Provider of online personal financial services offering value-added investing, banking, research and educational tools, premium customer service and a proprietary Stateless Architecture infrastructure to its customers.
I2 Technologies	7372	A leading global provider of intelligent e-business solutions that help enterprises optimise business processes both internally and among trading partners.
Ticketmaster	7999	Leading provider of automated ticketing services worldwide. Provides local city guides, local advertising, live event ticketing, merchandise, electronic coupons and other transactions on the Internet.
Hotel Reservation	7011	A leading consolidator of hotel and other lodging accommodations. Contracts with lodging properties for volume purchases and guaranteed availability of rooms at wholesale prices and sells these rooms to consumers at discounts.
Tibco Software	7373	Provider of e-business infrastructure software products that enable business-to-business, business-to-consumer and business-to-employee solutions.
Expedia	4724	A provider of branded online travel services for leisure and small business travellers. Their Web site *www.expedia.com* offers one-stop travel shopping and reservation services, giving reliable real-time access to a variety of travel information.
Quest Software	7372	Provides application and information availability software solutions that enhance the performance and reliability of an organisation's e-business packaged and custom applications and enable the delivery of information across the entire enterprise.
WebMD	7374	Provides a range of web-based transaction and information services and technology solutions or participants across the continuum of healthcare, including physicians, patients and suppliers. Products assist in reducing the cost of healthcare.
Openwave Sys	7372	A provider of Internet-based communication infrastructure software and applications.
Research In Motion	4899	Develops, manufactures and supplies radios and other network access devices for use in wireless data communications systems.
Sycamore Networks	3661	Provider of optical networking products that enable telecommunications service providers to quickly and cost-effectively transform the capacity created by their fibre optic networks into useable bandwidth for the deployment of high-speed data services.
Liberate Technologies	7372	Provider of standards-based software platforms for delivering enhanced content and services to television viewers and consumers around the world.
Vignette Corp	7372	Provider of e-Business application software products and services. Solutions are designed to enable businesses to build successful and sustainable online businesses.
Webex	7389	Develops and markets services that allow end-users to conduct meetings and share software applications, documents, presentations and other content on the Internet using a standard web browser.

Source: US-based Internet firms from Wall Street Research Net (WSRN)'s Internet Investing Network. See *www.Internetstocklist.com*

Table A1.10. **Primary SIC and activity description of the top 10 ICT firms by sector**

Company	Primary SIC	Description of the firm's activities
Communication equipment and systems		
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.
Motorola	3663	Provider of integrated communications solutions and embedded electronic solutions such as: software-enhanced wireless telephone radio and satellite communications; embedded semiconductor products and embedded electronic systems.
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.
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.
Alcatel	3669	Provider of communications equipment including ADSL equipment, terrestrial and submarine optical networks, public switching, fixed wireless access and intelligent networks.
Nokia	4813	Supplier of data, video and voice network solutions, mobile and fixed access solutions, and broadband and IP network solutions. It also manufactures mobile phones and is a pioneer in digital multimedia terminals for digital TV and interactive services.
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.
Marconi	. .	UK-based communication equipment firm.
Avaya	3661	A provider of communications systems and software for enterprises, including businesses, government agencies and other organisations.
Tellabs	3661	Developer, manufacturer and marketer of voice-quality enhancement products for wireless, satellite-based, cable communication, and wireline telecommunications systems. Company's products are sold in domestic and international marketplaces.
Electronics		
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.
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.
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.
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.
Mitsubishi Electric	. .	Large conglomerate electronics firms.
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.
Xerox	3861	Provides solutions to help customers manage documents whether on paper, electronically or online. Offers hardware, software services and solutions for small businesses, global enterprises or home offices.
Sanyo Electric	3663	Manufactures and distributes consumer and commercial electronics, including multimedia and telecommunication products such as information and communication equipment, home appliances, industrial and commercial equipment, electronic devices and batteries.

Table A1.10. **Primary SIC and activity description of the top 10 ICT firms by sector** (*cont.*)

Company	Primary SIC	Description of the firm's activities
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.
Toshiba	. .	Major producer of IT and office equipment.
Fujitsu	. .	Major producer of a range of IT, communications and related equipment, systems and services.
NEC	3571	Provider of Internet solutions, dedicated to meeting the specialised needs of its customers in the key computer, network and electron device fields through its three market-focused in-house companies: NEC Solutions, NEC Networks and NEC Electron Devices.
Hewlett-Packard	3571	Global provider of computing and imaging solutions and services for business and home. The Company's operations are organised into four major businesses: Imaging and Printing, Computing Systems, Information Technology Services, and Measurement Systems.
Compaq Computer	3571	Designs, develops, manufactures and markets hardware, software, solutions and services, including fault-tolerant business-critical solutions, networking and communication products, desktop and portable products and consumer PCs.
Dell Computer	3571	World's largest direct computer systems company. 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.
Gateway	3571	Major PC manufacturer that has a company-owned retail network and focuses on providing complete technology solutions for its clients, including financing, Internet service, a personalised Internet portal, peripherals and software, and service.
EMC	3572	Designs, manufactures, markets and supports a wide range of hardware and software and provides services for the storage, management, protection and sharing of electronic information.
IT services		
Ingram Micro	5045	Wholesale distributor of computer-based technology products and services worldwide. It markets computer hardware, networking equipment and software products to more than 140 000 reseller customers in more than 130 countries.
Pricewaterhouse-Coopers	. .	Major international technology and business consulting firm.
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.
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.
Accenture	. .	Technology consulting and services.
CSC	7373	One of the world leaders in the information technology (IT) services industry. Its services, both US federal and global commercial, include outsourcing system integration and IT and management consulting and other professional services.
ADP	7374	Provides computerised transaction processing, data communication and information services. Major services include payroll and human resources information management, benefits administration and time and labour management.
Unisys	7373	Worldwide information services and technology company; provides services, systems and solutions, its Unisys e-@ction Solutions, that help customers apply information technology to seize opportunities and overcome the challenges of the Internet economy.
CapGemini Ernst and Young	. .	Combined software, services and consulting business.
SAIC	. .	Former defence contractor that now takes on wider outsourcing and services contracts, especially for government clients.

Table A1.10. **Primary SIC and activity description of the top 10 ICT firms by sector** (*cont.*)

Company	Primary SIC	Description of the firm's activities
Software		
Microsoft	7372	Develops, manufactures, licenses and supports a wide range of software products for a multitude of computing devices. Software includes scalable operating systems for servers. Online efforts include the MSN network.
Oracle	7372	A world supplier of software for information management. Company develops, manufactures, markets and distributes computer software that is categorised as systems software and Internet business applications software that help manage and grow company business.
SAP	7372	International developer and supplier of integrated business software designed to provide cost-effective comprehensive solutions for businesses. It designs, develops, markets and supports client/server and mainframe standard business application software.
Computer Associates	7372	A leading e-business software company. Company's solutions address all aspects of e-business process management, information management and infrastructure management in six focus areas.
Softbank	. .	Software producer based in Japan.
Compuware	7372	Provides software products and professional services designed to increase the productivity of the information technology departments of businesses worldwide.
Siebel Systems	7372	Provider of enterprise-class sales, marketing and customer service information software systems. It designs, develops and markets Siebel Enterprise Applications, a leading Internet-enabled, object oriented client/server application software product.
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.
BMC Software	7372	An independent systems software vendor, delivering comprehensive enterprise management. Provides solutions to enhance the performance of customers' applications to help them better manage their businesses.
Electronic Arts	7372	Creates, markets and distributes interactive entertainment software for a variety of hardware platforms.

Source: Wall Street Research Net's Internet Investing Network, October 2001, and other sources.

NOTES

1. Internet stocks were the first to be hit during the dramatic stock market correction in 2000: the NASDAQ index lost more than two-thirds of its value between March 2000 and April 2001.
2. Japanese and Korean consumer electronics firms, which had previously focused on domestic production, have progressively delocalised part of their production to other Asian countries, notably China. A recent illustration is provided by Matsushita, which, in order to strengthen price competitiveness both in its national market and abroad, was planning in October 2001 to move its DVD player manufacturing facilities to China (*www.digitimes.com*, 3 October 2001).
3. For those countries that have both data sets, MFP growth in the most recent period (1995-99) is positively and weakly correlated with the share of the ICT sector in business value added, but the correlation is not significant. Similar patterns apply for ICT manufacturing, where Australia and Norway (and Denmark) have relatively small ICT sectors and relatively good adjusted MFP growth; the correlation is again positive but not significant (OECD, 2001*b*).
4. Analysis in this section is based on data from the OECD ITS database (International Trade Services) in January 2002. The data are complete for all OECD countries except: the Czech Republic (data from 1994), Hungary (from 1992), Korea (from 1994), and the Slovak Republic (from 1997). Luxembourg is not included. Data for 2000 are incomplete and 1999 data were used for Greece and the Slovak Republic.
5. As Chapter 2 shows, foreign trade is only one dimension of globalisation: it is estimated that in 1998, sales by foreign affiliates of US IT firms were almost twice as large as total exports of IT goods and services by firms based in the United States (US Department of Commerce, 2002).
6. ICT-related services include communications services and computer and information services (see Annex 1: Methodology).
7. Averages over the period 1995-2000 are used since the value of venture capital investments displays strong annual fluctuations, so shares can change significantly between years.
8. A different source (PricewaterhouseCoopers, 2001) estimates an even higher share for Internet-related venture capital investments in the United States during 2000, at around 83%.
9. According to the Statistics Bureau of China, the electronics and information manufacturing industry has become the largest component of the Chinese industry in 2000, with output growing at an annual average rate of about 32% over the last ten years, compared to only 14% for the industry as a whole (KISDI, 2001).
10. The average price of a 16-Megabyte DRAM fell between June 2000 and 2001 from USD 20 to USD 4. On average, selling prices are now below production costs.

REFERENCES

Colecchia, A. and P. Schreyer (2001),
"ICT Investment and Economic Growth in the 1990s: Is the United States a Unique Case? A Comparative Study of Nine OECD Countries", STI Working Paper 2001/7, OECD, Paris; *www.oecd.org/sti*

Forrester Research (2001),
"Tech Recovery in 2003: A Different Beast", Forrester Brief, 24 October.

International Data Corporation (IDC) (2001),
"IT Industry Headed for Gradual Recovery in 2002, Led by Software and Services", Press Release, 13 November. *www.idc.com/ITOver/press/G111301pr.stm*

International Data Corporation (IDC) (2002),
"Economic Recovery to Drive IT Market Rebound in 2002", Press Release, 1 May.

J.P. Morgan Securities (2001),
Industry Analysis – European Semiconductors: A Foggy Road to Recovery, November, London.

Korea Information Society Development Institute (KISDI) (2001),
Review of the Development and Reforms of the Telecommunication Sector in China, mimeo, September.

OECD (2000),
Measuring the ICT Sector, Paris.

OECD (2001*a*),
Science, Technology and Industry Outlook – Drivers of Growth: Information Technology, Innovation and Entrepreneurship, Paris.

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

OECD (2001*c*),
OECD Science, Technology and Industry Scoreboard – Towards A Knowledge-Based Economy, Paris.

Pilat, D. and F.C. Lee (2001),
"Productivity Growth in ICT-Producing and ICT-using Industries: A Source of Growth Differentials in the OECD?", STI Working Paper 2001/4, OECD, Paris. *www.oecd.org/sti/*

PricewaterhouseCoopers (2001),
"MoneyTree Survey – Full Year 2000 and Q1 2001 Results". *www.pwcmoneytree.com/index.asp*

PricewaterhouseCoopers (2002),
"MoneyTree Survey – Q4 2001 Highlights". *www.pwcmoneytree.com*

Reed Electronics Research (2001),
Yearbook of World Electronics Data 2001, Vol. 1-2, Sutton, United Kingdom.

Semiconductor Industry Association (SIA) (2001*a*),
"Global Billings Report History". *www.sia-online.org*

Semiconductor Industry Association (SIA) (2001*b*),
"Semiconductor Forecast Summary: 2001-2004", November. *www.sia-online.org*

Statistics Denmark (2001),
Information Society Denmark – A Statistical Mosaic, Copenhagen.

Statistics Netherlands (2001),
De Digitale Economie 2001, Voorburg/Heerlen.

United States Department of Commerce (2002),
Digital Economy 2002, Economics and Statistics Administration, February. *www.esa.doc.gov/508/esa/DIGITALECONOMY2002.htm*

Van Ark, B. (2001),
"The Renewal of the Old Economy: An International Comparative Perspective", STI Working Paper 2001/5, OECD, Paris. *www.oecd.org/sti*

World Information Technology and Services Alliance (WITSA)/International Data Corporation (IDC) (2002),
Digital Planet 2002.

World Trade Organization (WTO) (2002),
"Trade to Pick Up Slightly in 2002 After Sharp Drop in 2001", Press Release, 2 May. *www.wto.org/english/news_e/pres02_e/pr288_e.htm*

Chapter 2

GLOBALISATION OF THE ICT SECTOR

ICT firms are a dynamic and leading part of the wider globalisation of industry. Industrial globalisation refers to an evolving pattern of cross-border collaboration for product development, investment, production, sourcing, marketing and trade. It is the result of firms' strategies to exploit their competitive advantages at international level, locate in final markets and take advantage of favourable production factors and infrastructures. New trends and combinations of trade, investment and inter-firm collaboration are changing the pattern and scope of business and expanding the presence and increasing the influence of foreign companies in national economies. These international activities enable firms to exploit their technological and organisational advantages, reduce business costs, enter new markets and spread risks.

Underlying the international expansion of firms, and in part driven by it, are technological advances, especially in information and communication technologies (ICT), the liberalisation of markets and increased mobility of capital and other production factors. Globalisation is fundamentally firm-driven. In the past, international strategies were based on exports or multi-domestic operations. These have given way to strategies based on a mix of cross-border operations, including exports and sourcing, foreign investment and international alliances. Globalisation thus has three main routes: international trade, foreign direct investment (FDI) and various kinds of international alliances, collaboration and co-operation.

On any measure, the world economy is rapidly globalising. Between 1990 and 2000, OECD merchandise trade grew by 7.6% a year, significantly faster than gross domestic product (GDP). Trade in services grew faster still. Worldwide, FDI inflows reached USD 1.3 trillion in 2000, and accounted for 20% of global gross domestic capital formation, compared with 2% 20 years earlier (UNCTAD, 2001). Gross product associated with international production and foreign affiliate sales worldwide increased faster than GDP and global exports, respectively, and sales by foreign affiliates – worth USD 15.7 trillion in 1999, compared with USD 3 trillion in 1980 – were twice as high as global exports. The gross product associated with international production is about one-tenth of global GDP, compared with one-twentieth in 1982. The number of transnational parent firms in 15 developed countries increased from around 7 000 at the end of the 1960s to 40 000 at the end of the 1990s (UNCTAD, 2001).

This chapter examines the globalisation of the ICT-producing sector. Drawing on official industry and trade sources, it looks at quantitative indicators of the globalisation of ICT industries and markets. This leads to a brief exploration of some of the issues involved in the globalisation of the ICT sector and possible implications for the further development of the sector.[1]

Globalisation of the ICT sector

This section presents a variety of quantitative indicators of the globalisation of the ICT-producing sector in order to highlight major trends and developments. It demonstrates that the ICT sector has been, and remains, at the forefront of industrial globalisation.

Trade

Over the last 20 years or so, 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 global sourcing (*i.e.* international purchasing of intermediate 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 the globalisation of the ICT sector.[2]

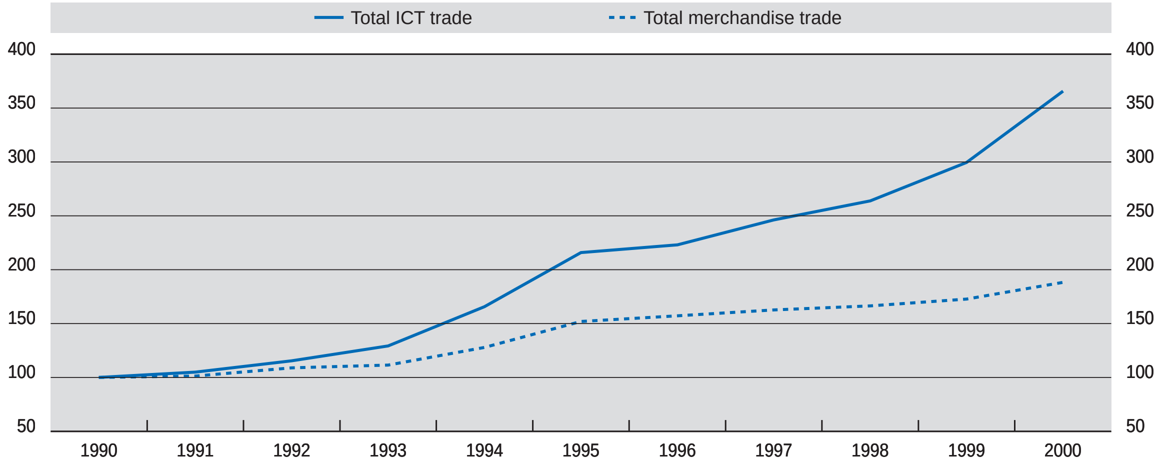
ICT *trade is growing faster than total trade*

In the past decade, trade in high-technology industries has accelerated, and their share in total OECD trade has increased. At the end of the 1990s, high-technology industries accounted for 25% of OECD manufacturing trade, compared with 18% in 1990 (OECD, 2001*c*). The three industries with the highest growth rates were pharmaceuticals, radio, television and communication equipment and computers. Six of the seven fastest-growing manufactures in world trade over the period 1980-95 were types of ICT equipment. The top four accounted for one-third of the value of dynamic exports in 1995 and for 37% of the growth in value since 1980 (UNCTAD, 1999, p. 229).

In 1990, ICT products (including computer and communication equipment and electronic components – see Annex 1 for definitions) accounted for 6.5% of OECD merchandise trade. By 2000, they accounted for more than 12%.[3] Trade in ICT products showed a compound annual growth rate of 13.8% a year over the period 1990-2000, compared with growth of 6.5% in total merchandise trade (Figure 1). Trade in software products has also grown, from USD 10.7 billion in 1996 to USD 12.7 billion in 2000. Exports of software products from OECD countries increased at a compound annual rate of 3.5% between 1996 and 2000, while imports of software products into OECD countries increased at 5.7%. The value of software royalties received and paid by countries is another indicator of the magnitude of software trade. Information available for the United States shows that the inflow of software royalties into the United States tripled between 1992 and 1998 from USD 1.1 billion to USD 3.2 billion (OECD, 2001*d*; see also Chapter 3). Similarly, software royalty and license fee payments into Australia doubled from AUD 172 million in 1993-94 to AUD 346 million in 2000-01 (Houghton, 2001).[4]

Figure 1. **OECD trade: total and ICT products, 1990-2000**

Index 1990 = 100



Note: OECD total does not include Luxembourg. 1990 data do not include Belgium, the Czech Republic, Hungary, Korea, Poland and the Slovak Republic. Based on 1999 instead of 2000 data for Greece and the Slovak Republic.

Source: OECD, ITS database, January 2002.

Trade in ICT-related services also appears to be growing faster than total trade in services. OECD trade in combined communications and computer and information services increased from around USD 29 billion in 1995 to more than USD 49 billion in 2000, and their combined share of total services trade increased from 3.1% to 4.3%. ICT products clearly account for an increasing share of OECD merchandise trade and, despite limited data, it seems that trade in software and in ICT-related services represents an increasing share of total services trade. In that sense, the ICT sector is globalising faster than many other sectors.

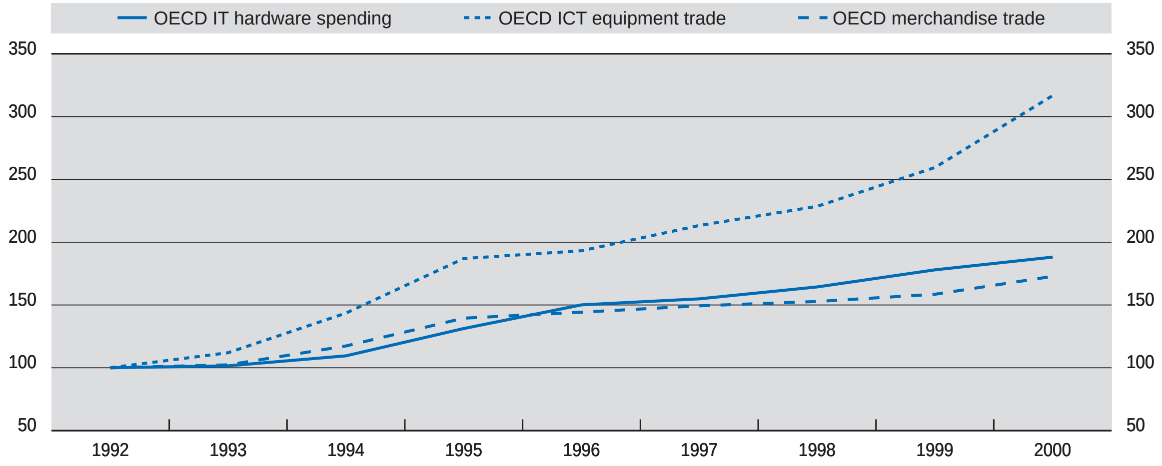
ICT *trade is growing faster than sales*

ICT trade grew faster than ICT spending in the 1990s. Not only is the ICT sector highly globalised relative to other sectors, a comparison of national data on ICT spending by category with ICT-related trade data suggests that it is also becoming increasingly globalised.

Spending on information technology (IT) hardware in OECD countries increased from USD 193 billion in 1992 to USD 362 billion in 2000, or by a compound annual rate of 8.2% (Figure 2). World spending on IT hardware increased by 8.8% a year over the same period. In comparison, OECD trade in ICT equipment (computer and communication equipment and electronic components) increased by a compound annual rate of 15.5%. Between 1992 and 2000, OECD ICT equipment trade increased by 159%, OECD spending on ICT hardware increased by 88%, and world spending on ICT hardware increased by 96%.

Figure 2. **Spending on ICT hardware and trade, 1992-2000**

Index 1992 = 100



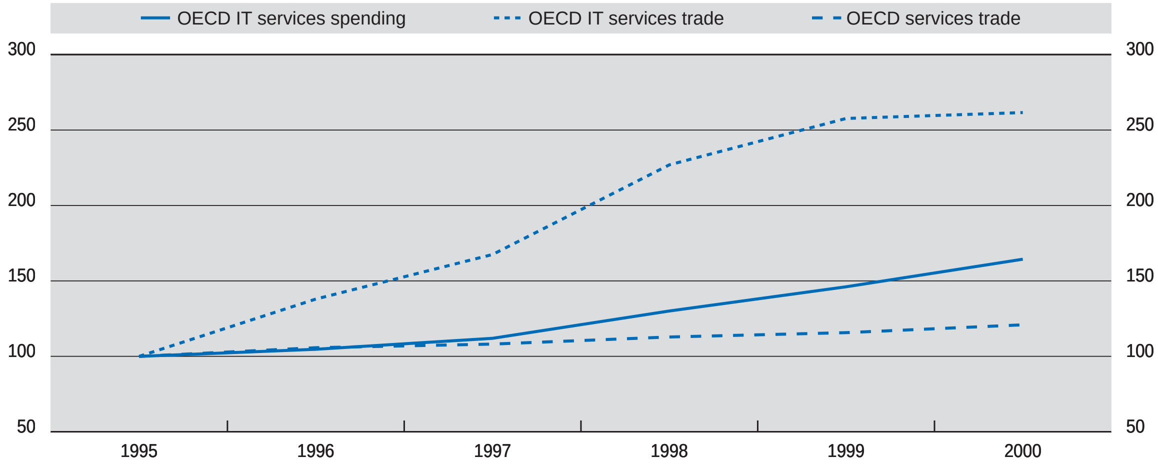
Note: IDC spending data do not include Luxembourg and Iceland. IT hardware does not include office equipment. OECD 1990 trade data do not include Belgium, the Czech Republic, Hungary, Korea, Poland and the Slovak Republic. Based on 1999 instead of 2000 for Greece and the Slovak Republic.

Source: OECD, ITS database, January 2002; IDC.

Spending on IT services in OECD countries increased from USD 227 billion in 1995 to USD 372 billion in 2000, or by a compound annual rate of 10.4% (Figure 3). World spending on IT services increased by a compound annual rate of 10.7% over the period. By comparison, OECD trade in computer and information services increased from USD 9.4 billion in 1995 to USD 24.5 billion in 2000, or by a compound annual rate of 21%. Between 1995 and 2000, OECD trade in computer and information services increased by 158%, OECD spending on IT services by 64% and world spending on IT services by 66%. Clearly, IT-related trade is growing faster than IT spending, an indication that the IT sector is becoming increasingly globalised.

Figure 3. **Spending on IT services and trade, 1995-2000**

Index 1995 = 100



Note: IDC spending data do not include Luxembourg and Iceland. IT services does not include internal spending. OECD 1990 trade data do not include Belgium, the Czech Republic, Hungary, Korea, Poland and the Slovak Republic. Based on 1999 instead of 2000 for Greece and the Slovak Republic.

Source: OECD/Eurostat (2001); IDC.

ICT *trade is growing faster than production*

Reed Electronics Research publishes data on world production and trade in ICT goods. In Europe, overall electronics trade increased at a compound annual rate of 9.4% between 1992 and 1999, while European production of electronics increased by 4.2%. Similarly, Asia-Pacific trade in electronics increased by a compound annual rate of 10.8% and regional production by 6.5% (Reed Electronics Research, various years). In both Europe and the Asia-Pacific region, ICT trade is growing faster than ICT production (see Annex Table 2.1).

Specialisation in ICT *production*

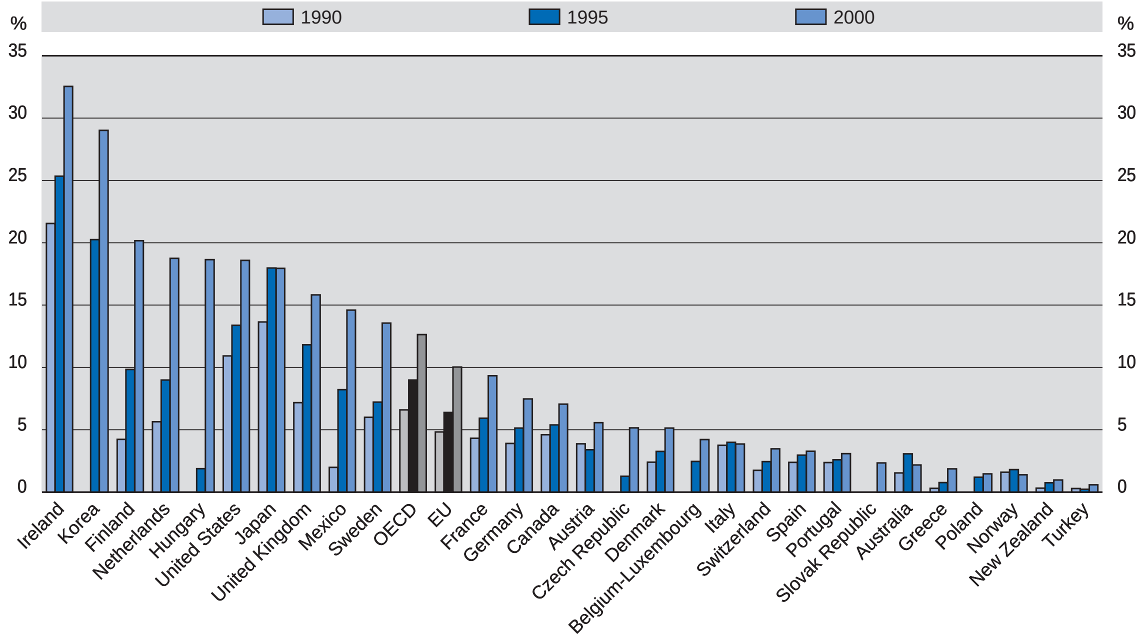
Rationalisation of production at world level might be expected to lead to countries becoming more specialised in the production of a smaller and more defined range of products and services, *i.e.* globalisation and specialisation would go hand in hand. The share of manufactured exports accounted for by ICTs is one indicator of the level of specialisation in ICT production.

Countries vary significantly in this respect. Throughout the 1990s, ICT equipment's share of total merchandise trade was highest in Ireland, with ICTs accounting for 22% of trade in 1990 and 32% in 2000. Iceland has been at the opposite end of the scale, with ICTs accounting for 0.06% of trade in 1990 and 0.08% in 2000 (Figure 4). Generally, OECD countries that specialised in ICT manufacture at the end of the decade also did at the beginning. However, rankings and levels have changed. Mexico, Greece (albeit from a very low base), Finland and the Netherlands most rapidly increased their level of specialisation in ICT manufacturing. Italy was the only country whose level of ICTs in exports was lower in 2000 than in 1990, although Australia and Japan had lower levels of ICTs in total exports in 2000 than in 1995.

Perhaps a more direct indicator of specialisation and the globalisation of a country's ICT manufacturing sector is the ratio of ICT exports to GDP, which indicates how important those exports are in the industrial structure. Again, Ireland's economy is strongly oriented to ICT production for export, with ICT equipment exports equivalent to 26% of GDP in 2000 (Figure 5), followed by Hungary (11.5%),

Figure 4. **Share of ICTs in total merchandise exports, 1990-2000**

Percentages

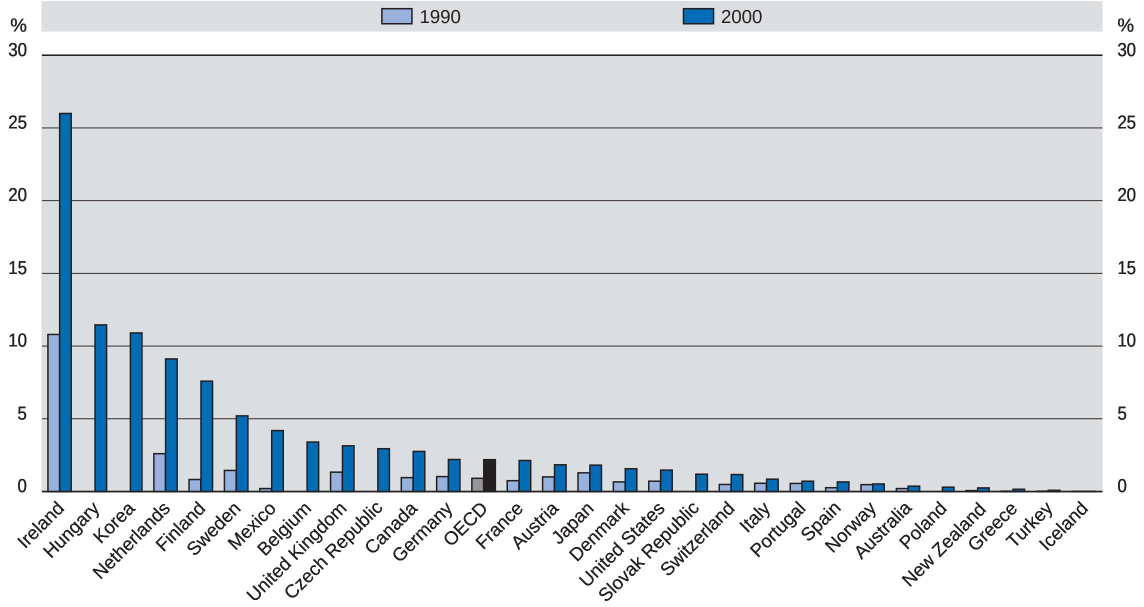


Note: OECD 1990 trade data do not include Belgium, the Czech Republic, Hungary, Korea, Poland and the Slovak Republic. Based on 1999 instead of 2000 for Greece and the Slovak Republic.

Source: OECD, ITS database, January 2002.

Figure 5. **ICT equipment exports as a share of GDP, 1990-2000**

Percentages



Note: OECD 1990 trade data do not include Belgium, the Czech Republic, Hungary, Korea, Poland and the Slovak Republic. Based on 1999 instead of 2000 for Greece and the Slovak Republic.

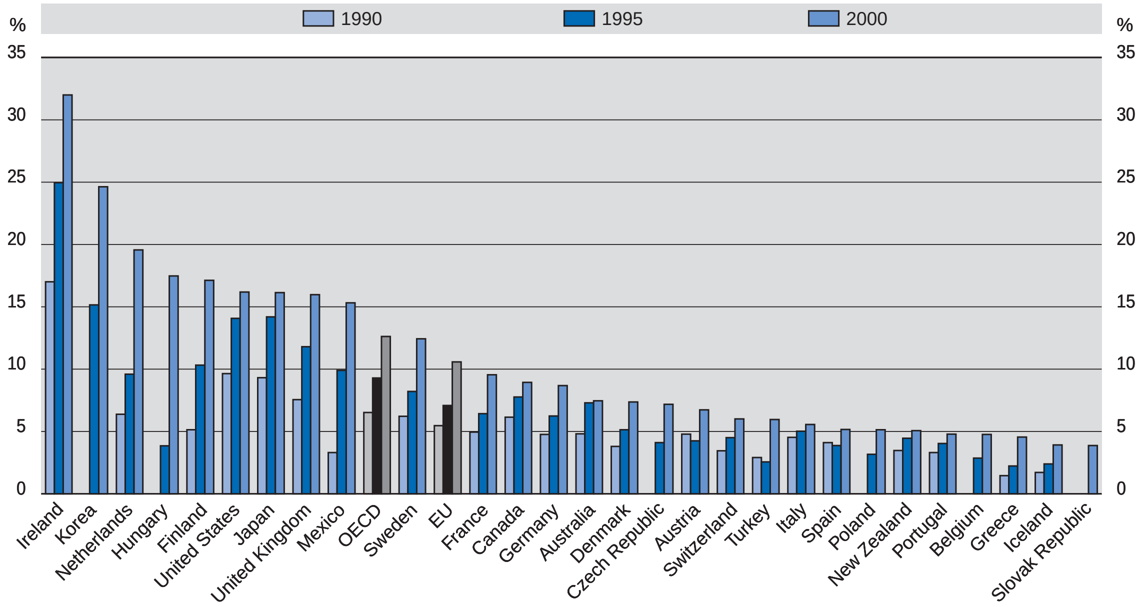
Source: OECD, ITS database, January 2002.

Korea (10.9%) and the Netherlands (9.1%). These countries also had the highest ratio of trade in ICT equipment (defined as the average of ICT equipment imports and exports) to GDP. Interestingly, the countries that were already the most specialised increased their ratio of ICT equipment exports to GDP faster than others (*i.e.* they became increasingly specialised). Mexico recorded the fastest growth in the ratio over the period 1990-2000. Finland, Sweden and the Netherlands also experienced rapid growth.

An examination of the share of ICT trade (defined as the average of ICT imports and ICT exports) in total manufacturing trade emphasises specialisation in ICT production for export by focusing on intra-industry and intra-firm trade (Figure 6). Again, Ireland had the highest share of ICTs in total merchandise trade in 2000, at 32%. It is clear that some of the more specialised producers of ICT equipment for export in the early 1990s increased their levels of specialisation more rapidly than others (*e.g.* Ireland, the Netherlands, Hungary, Finland, Mexico and Sweden).

Figure 6. **ICT equipment trade as a share of total trade, 1990-2000**

Percentages



Note: OECD 1990 trade data do not include Belgium, the Czech Republic, Hungary, Korea, Poland and the Slovak Republic. Based on 1999 instead of 2000 for Greece and the Slovak Republic.

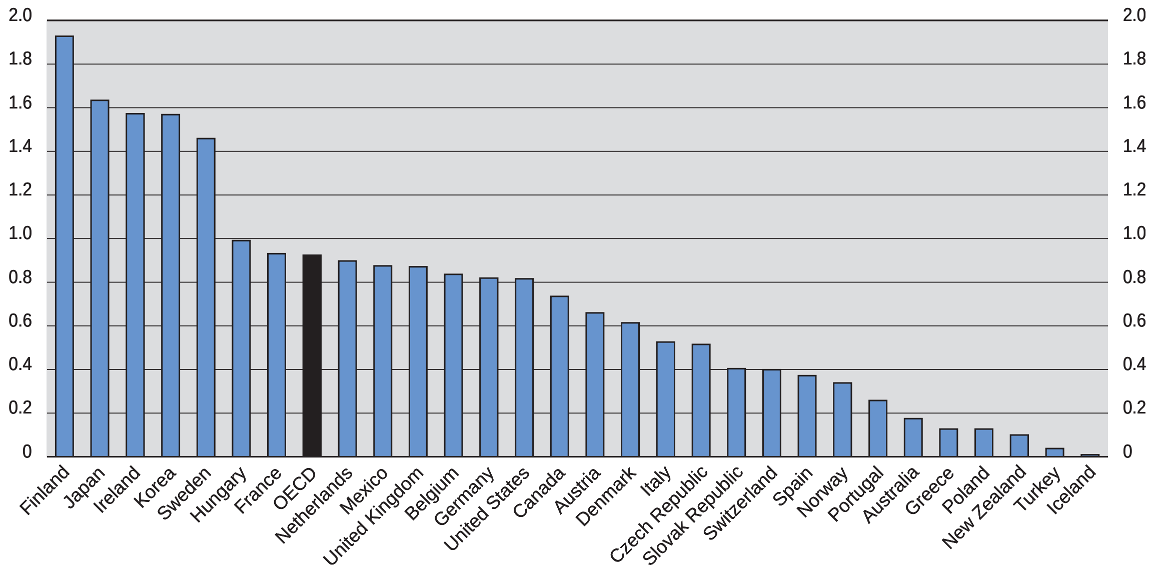
Source: OECD ITS database, January 2002.

Indicators of ICT *trade performance*

The ratio of exports to imports is an indicator of how well a country is performing as a producer and exporter. A ratio of more than one indicates a surplus of exports over imports, and a ratio of less than one a deficit. In 2000, Finland, Japan, Ireland, Korea and Sweden had surpluses of ICT equipment exports over imports (see Figure 7). All other OECD countries had an export/import ratio of less than one.

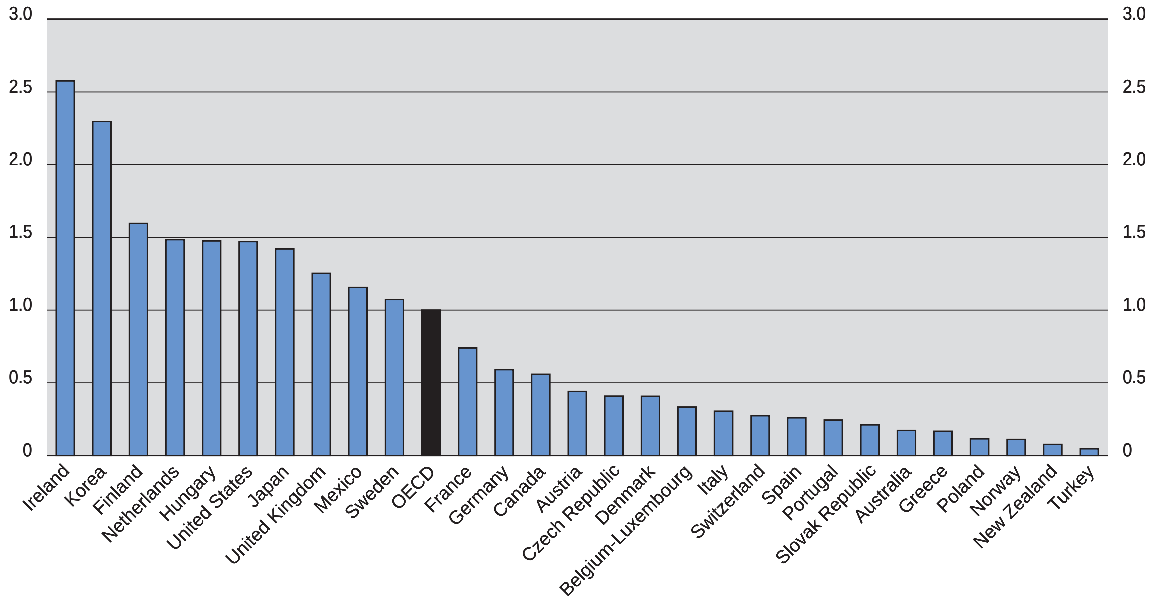
Another way to look at specialisation in ICT equipment manufacture for trade is to calculate an index of "revealed comparative advantage" to see whether an industry performs better or worse in each country than the average across the OECD.[5] Such an indicator shows that ten OECD countries had a comparative advantage in ICT manufacturing in 2000: Ireland, Korea, Finland, the Netherlands, Hungary, the United States, Japan, the United Kingdom, Mexico and Sweden (see Figure 8). Ireland (2.58) and Korea (2.30) had the greatest advantage in ICT manufacturing, with the other eight countries having indexes ranging from 1.07 (Sweden) to 1.60 (Finland). There have been some interesting changes in the

Figure 7. **Export/Import ratio for ICT equipment, 2000**



Source: OECD, based on ITS database, January 2002.

Figure 8. **Revealed comparative advantage in ICT equipment, 2000**



Source: OECD, based on ITS database, January 2002.

index of comparative advantage during the last decade. Mexico, Greece and Finland have experienced large increases since 1990, with the largest percentage increase in Finland. Ireland and Japan have suffered the largest declines, with the largest percentage falls in Italy, Portugal, Norway and Japan.

Intra-industry trade

Traditional economic theory suggests that trade is based on factor endowment and comparative advantage, with countries specialising in producing those things for which they possess relatively abundant factors and comparative advantage and trading them for products of different industries. Recently, however, developed countries have increasingly traded products of the same industries. Intra-industry trade tends to enhance the gains from trade through specialisation in a limited number of products within any particular industry, through better exploitation of economies of scale and sourcing and intra-firm exchange of products (Ruffin, 1999). Intra-industry trade is a consequence of the global rationalisation of production (*i.e.* globalisation).

The most widely used measure of intra-industry trade is the Grubel-Lloyd Index (Grubel and Lloyd, 1975). The index represents the fraction of total trade in the industry accounted for by intra-industry trade, expressed as a percentage (Annex Table 2.2).[6] The closer the values of imports and exports the higher the index. Because the ICT equipment 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, which are especially noticeable where trade is either very large (*e.g.* United States) or very small (*e.g.* Iceland). Nevertheless, it does reveal something about the globalisation of the ICT sector.

In general, the ICT equipment-producing sector appears to be becoming more specialised, with higher levels of intra-industry trade at the end of the 1990s than at the beginning. For most OECD countries, the level of intra-industry trade increased during the 1990s, although in a few cases it was lower in 2000 than in the mid 1990s.

Intra-firm trade

Intra-firm trade consists of cross-border transactions between affiliated units of multinational companies (MNCs). The level and growth of intra-firm trade as a share of total trade reflects the search by MNCs for greater efficiency and the consequent rationalisation of production at global level. High and increasing levels of intra-firm trade are an indicator of globalisation.

The United States is one of the few countries to report intra-firm trade in any detail. In 2000, intra-firm trade accounted for 47% of the total value of merchandise imports into the United States and 32% of the value of merchandise exports (see Annex Table 2.3). Figure 9 shows that total US cross-border and intra-firm services sales rose over the 1990s. The ratio of goods traded by related parties varies from highs of 74% for US imports from Japan and 42% of exports to Canada, to lows of 16% for imports from Argentina and 11% for exports to Korea.

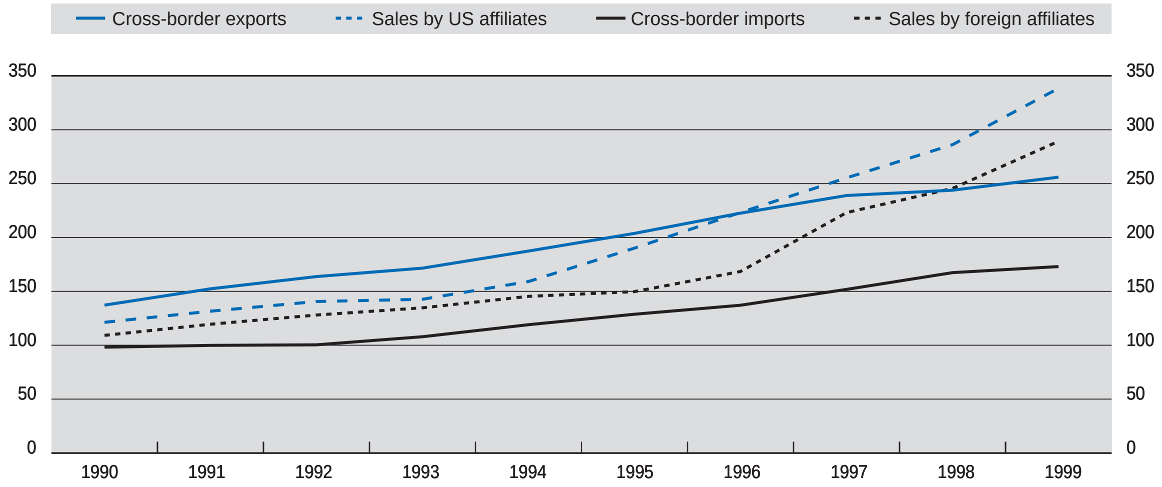
Limited data are available on intra-firm trade in the ICT sector. US data on ICT products and services trade between related parties show that the ICT sector is characterised by relatively high levels of intra-firm trade (Table 1). Clearly, intra-firm trade is becoming increasingly significant, and ICT producers are at the forefront. Intra-firm trade in all ICT goods industries accounts for a larger share of US imports than it does of exports.

Foreign direct investment

In recent years, trade has become less important as an avenue for globalisation as a new and evolving pattern of cross-border business activity is emerging. Recent modes of globalisation include FDI,[7] cross-border mergers and acquisitions (M&As)[8] and strategic alliances.[9] Each plays an important part in the increasing globalisation of production. The remainder of this chapter explores each of these forms of internationalisation and examines the resulting activities of foreign affiliates in host economies.

Figure 9. **US cross-border and intra-firm services sales, 1990-99**

USD billions



Source: Mann and Borga (2001).

Table 1. **US intra-firm trade by industry, 2000**

USD millions and percentage shares

	US imports			US exports		
	Total imports	Related party trade	Share	Total exports	Related party trade	Share
All industries	1 205 339	563 084	46.7	779 624	245 863	31.5
Computer equipment	68 542	46 603	68.0	44 247	17 581	39.7
Communication equipment	30 998	21 293	68.7	18 965	5 184	27.3
Audio and video equipment	28 701	20 522	71.5	4 165	1 476	35.4
Electronic components	98 157	63 133	64.3	65 180	25 751	39.5
Magnetic and optical media	2 762	1 631	59.1	1 717	724	42.2
ICT products	229 160	153 182	66.8	134 274	50 716	37.8
ICT share of total	19.0	27.2	. .	17.2	20.6	. .

Note: ICT sector based on 4-digit NAICS.

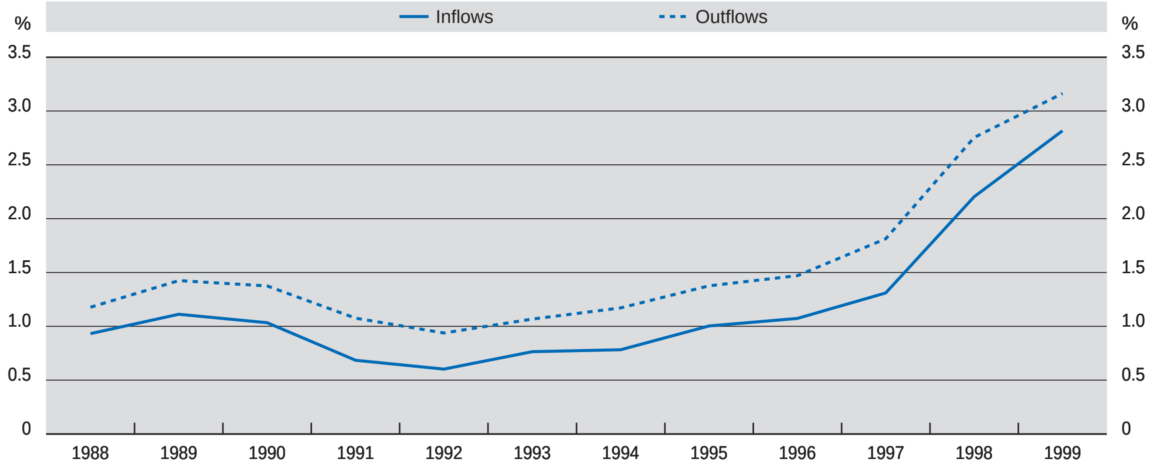
Source: US Department of Commerce, June 2001.

FDI has played a fundamental role in furthering international economic integration and has been a driving force behind world economic restructuring over the past 15 years. World FDI inflows, which accounted for 2.3% of global gross domestic capital formation in 1980, reached almost 20% in 2000 (see Annex Table 2.4). As many as 65 countries had compound annual growth in FDI of 30% or more between 1986 and 2000, and a further 29 had rates of 20% or more. In 2000, world FDI inflows reached USD 1.3 trillion, up from USD 202 billion in 1990. World FDI inflows rose more rapidly between 1990 and 2000 (20% compound annual growth) than GDP (4%), domestic investment (3.7%), licensing payments (9%) and trade (5%) (UNCTAD, 2001).

FDI inflows to OECD countries grew from USD 138 billion in 1988 to USD 684 billion in 1999, and outflows rose from USD 175 billion to USD 768 billion (Figure 10). FDI inflows accounted for 0.93% of OECD GDP in 1988 and outflows for 1.18%, compared with 2.8% and 3.2%, respectively, in 1999. Hence, FDI has grown more quickly than GDP both worldwide and among OECD countries, with particularly high rates of growth in the latter halves of the 1980s and 1990s.

Figure 10. **Inward and outward FDI flows: OECD total, 1988-99**

Percentages of GDP



Source: OECD (2000).

Limited data are available on FDI by industry. However, over the period 1988-97, world FDI stocks in ICT equipment manufacturing grew by a compound annual rate of 10% and computer and related services stocks by 16% (UNCTAD, 1999) (see Annex Table 2.5). Individual country FDI flows for a single industry sector are subject to wide variations. Nevertheless, there is a general pattern of growth in direct investment in computer and office machinery manufacturing, particularly in inward flows (see Annex Table 2.6). In 1999, FDI in this industry accounted for almost 6% of all foreign investment flowing into the United States. The ICT manufacturing sector received 12% of all foreign investment in the United Kingdom, almost 9% in Finland and 8% in Mexico. Also in 1999, 4.1% of all investment flowing out of the United States went to this industry as did 6.1% from the Netherlands and 4.3% from Sweden.

More limited data are available for telecommunications. They are more difficult to interpret because of the very large, one-off investment flows that accompany carrier privatisation and the introduction of competition in telecommunication services (see Annex Table 2.7). Apart from the general trend towards increased direct investment in the sector, the most evident features are specific national deals and activities. There were high levels of overseas investment from carriers based in the United States during the 1990s, strong outward investment from Spain (*e.g.* Telefonica), overseas expansion of activities of carriers based in the United Kingdom and, more recently, investments out of Sweden. In Spain, outward direct investment in telecommunications has accounted on average for almost 15% of all direct investment abroad since the mid-1990s (almost 40% in 1994). In 1999, telecommunications accounted for 17% of all outward investment from Germany, 12% from Spain and Denmark, 8.7% from Italy, 5.0% from Sweden and 3.3% from the Netherlands. The impact of these investments can be seen in the international activities of affiliates (see the following section). Box 1 looks at the share of ICTs in FDI to China.

Affiliate activities

International production by MNCs now spans virtually all countries, sectors and economic activities. By 2000, there were an estimated 63 000 parent firms with some 820 000 foreign affiliates. The gross product of all MNC systems together (including parent firms) was estimated at USD 8 trillion in 1997, approximately 25% of the world's GDP. World sales of foreign affiliates were around double global exports in 1999, compared to approximate parity 20 years earlier, and global gross product

Box 1. ICTs in the evolving profile of FDI in China

China's portfolio of FDI has evolved over the past two decades. Inflows concentrated in labour-intensive industries in the 1980s and moved towards capital-intensive ones in the early 1990s. In recent years, technology-intensive industries have been attracting an increasing share. The old image of a China at a relatively low level of the value chain is giving way to that of a rising competitive location for the technology-intensive activities of multinational corporations.

Nearly 400 of the Fortune 500 firms have invested in over 2 000 projects in China. The world's leading manufacturers of computers, electronics, telecommunication equipment, pharmaceuticals, petrochemicals and power-generating equipment have extended their production networks there. More recently, R&D activities have emerged as a bright spot for FDI, with over 100 R&D centres established by MNCs. Microsoft, Motorola, GE, JVC, Lucent-Bell, Samsung, Nortel, IBM, Intel, Ericsson, Nokia, Panasonic, Mitsubishi, AT&T and Siemens all have R&D facilities in China. Motorola, for example, has established R&D centres, with a USD 200 million investment and 650 research personnel. Microsoft invested USD 80 million in a Chinese research institute and has announced the investment of a further USD 50 million to create a Microsoft Asian Technology Centre in Shanghai. The need to adapt technology to the huge local market has been one of the push factors. The availability of extensive hard and soft R&D infrastructure (particularly well-educated and hardworking researchers at low costs, including many graduates returning from abroad) is the main pull factor. In addition, the government has introduced policy measures to reform the national science and technology system and promote self-sustained and market-oriented research institutions. As a result, Chinese R&D institutions actively seek partnerships with MNCs.

Exports of high-technology products from China by ownership of production, 1996-2000

	Total USD millions	SOEs (%)	Affiliates (%)
1996	7 681	39	59
1997	16 310	. .	. .
1998	20 251	25	74
1999	24 704	23	76
2000	37 040	18	81

Note: SOEs = state-owned enterprises.
Source: UNCTAD (2001), p. 26.

The prominence of FDI in technology-intensive industries is also evident in China's foreign trade (see table). Exports of new high-technology products by foreign affiliates increased from USD 4.5 billion in 1996 to USD 29.8 billion in 2000. They accounted for 25% of total exports by foreign affiliates, and 81% of the country's total exports in high-technology products. Since the second half of the 1990s, China has significantly reduced its imports of complete sets of advanced equipment and is now relying more and more on FDI to acquire foreign technology. In fact, FDI has become the engine of growth of China's high-technology exports and an essential means of inward technology transfer.

Source: UNCTAD (2001).

attributed to foreign affiliates was around 10% of global GDP, compared to 5% in 1982 (see Annex Table 2.8). Moreover, global sales and gross product associated with international production have increased faster than global exports and GDP, by 3.2 percentage points and 4.1 percentage points, respectively, during the period 1982-99. Global sales of foreign affiliates are now worth more than twice the value of world exports of goods and services (UNCTAD, 2000, 2001).

The ICT sector is a significant part of this process. In 1999, 21 of the top 100 MNCs were in the ICT sector, 18 in electronics and related manufacturing and three in telecommunications. They held foreign assets worth in excess of USD 500 billion, recorded foreign affiliate sales in excess of USD 450 billion and employed almost 3.9 million worldwide, more than 1.5 million of whom were employed by their foreign affiliates. These 21 ICT firms account for around 30% of the total assets and employment of the top 100 MNCs, and about one-fifth of their sales.

ICT *sector affiliate activities in* OECD *countries*

Data on affiliate activities in OECD countries are limited (see Annex Tables 2.9-2.14). However, these data indicate that a significant and growing number of affiliated enterprises operate in the ICT sector. During the 1990s, there was more growth in equipment manufacturing in communication than in IT, as the deregulation of telecommunications services has reduced national monopsony purchasing. For example, the number of majority-owned communication equipment manufacturing enterprises operating in Canada increased from 39 in 1990 to 57 in 1998. Similarly, the number of majority-owned affiliate communication equipment manufacturing enterprises increased from 1990 to 1998 in Italy, Norway, Sweden, the United Kingdom and the United States. Employment in these foreign affiliates is also high. In 1998, more than 61 000 were employed in ICT equipment manufacturing affiliates in France, 34 000 in Germany, 24 600 in Ireland, almost 47 000 in Italy, and 134 000 in the United Kingdom.

Value added and exports generated by ICT equipment manufacturing affiliates have also been increasing. In 1998, their value added reached USD 4.5 billion in France, USD 5 billion in Ireland and almost USD 11 billion in the United Kingdom. They exported for USD 12.6 billion from France, more than USD 2 billion from the Netherlands, USD 950 million from Finland and USD 500 million from Sweden.

ICT equipment manufacturing affiliates also contribute significantly to R&D expenditure. In 1998, they spent USD 500 million on R&D in Canada, more than USD 1 billion in France, USD 120 million in Ireland, more than USD 400 million in the United Kingdom and USD 3.3 billion in the United States. The share of foreign affiliates in industrial R&D varies widely across countries, ranging from less than 2% in Japan to over 68% in Ireland and 70% in Hungary. At over 30%, the share of R&D conducted by foreign affiliates is also high in Spain, the Netherlands, the United Kingdom, Canada, Australia and the Czech Republic. The differences primarily reflect the contribution of foreign affiliates to industrial activity. For instance, the share of foreign affiliates in manufacturing production is high in Ireland and low in Japan. The share of foreign affiliates in R&D also reflects the size of their R&D effort relative to that of domestic firms. In Ireland, for example, foreign affiliates carry out relatively more R&D than national firms. In Japan, the opposite is true (OECD, 2001*c*, p. 102).

Affiliate activities in the United States

The United States provides detailed data on the activities of affiliates. This section explores that data to develop a picture of the extent and nature of ICT sector affiliate activities in a large OECD economy (Table 2). In 1998, foreign affiliates in all industries accounted for 22% of all goods exports from the United States and 32% of all imports. ICT-sector foreign affiliates operating in the United States accounted for 8% of all foreign affiliate employment in the United States, 7% of affiliate sales, 8% of affiliate gross product and 10% of affiliate exports. Finally, 46% of the computer and electronic products affiliate sales in the United States were sold by affiliates of Japanese firms and 33% by affiliates of European firms (see Annex Table 2.15).

Among affiliates of US firms operating abroad in the ICT sector (Table 3), those manufacturing electronic and electrical equipment overseas accounted for the largest shares of ICT sector affiliate sales in 1998 (30%) and of employment (46%). Those manufacturing computer and office equipment accounted for 29% of the sector's affiliate sales and 15% of employment. Those providing telecommunication services accounted for 20% of both affiliate sales and employment, while those providing computer and data processing services represented 19% and employed 15%.

In 1998, sales by US affiliates in Europe accounted for 54% of worldwide affiliate sales in all industry sectors, and those in Japan for just 7% (see Annex Table 2.16). ICT sector affiliates' sales (USD 185 billion) accounted for 14% of the total in Europe in all sectors and 16% in Japan (USD 30 billion), with 50% of all ICT affiliate sales in Europe and just 8% in Japan. In Europe, computer

Table 2. **ICT-sector foreign affiliates operating in the United States, 1998**

USD millions and thousands of affiliates and employees

	Affiliates ('000)	Employees ('000)	Payment to employees	Total assets	Sales	Gross product	Exports of affiliates	Imports by affiliates
All industries	9 738	5 633	260 661	3 525 885	1 881 865	418 138	150 836	289 679
Manufacturing	2 944	2 540	134 886	878 864	834 396	224 372	87 581	126 924
Computers and electronic products	353	283	16 091	81 604	97 391	19 402	14 306	26 771
Computers and peripheral equipment	74	36	1 926	9 869	17 303	1 552	1 489	. .
Communications equipment	54	85	4 818	23 760	26 685	5 169	4 514	5 906
Semiconductors and other electronics	112	72	3 712	19 708	20 718	5 273	3 145	5 402
Magnetic and optical media	12	. .	. .	. .	2 887	. .	313	386
ICT share of manufacturing	12	11	12	9	12	9	16	21
ICT services	248	156	9 602	72 287	39 678	14 738	141	151
Software publishers	46	14	1 019	7 921	4 635	2 919	31	. .
Telecommunications	55	86	4 583	52 099	24 123	7 184	1	. .
Information and data processing	39	18	1 062	3 452	3 439	1 588	2	0
Computer systems design services	108	39	2 938	8 815	7 481	3 047	107	151
Total ICT sector	601	439	25 693	153 891	137 069	34 140	14 447	26 922
ICT share of total	6	8	10	4	7	8	10	9

. . No data available or suppressed for reasons of confidentiality.

Source: US Department of Commerce, 2001.

Table 3. **Foreign affiliates of US firms, 1998**

USD millions, number of affiliates and thousands of employees

	Affiliates	Assets	Sales	Net income	Payment to employees	Employees
All industries	23 744	4 000 842	2 443 350	155 292	271 386	8 388
Computer and office equipment	173	71 682	105 968	5 737	9 303	262
Electronic and other electric equipment	933	90 176	110 418	3 231	14 733	782
Household appliances	65	. .	. .	. .	1 800	96
Audio/video and communication equipment	111	20 191	26 713	594	. .	. .
Electronic components and accessories	519	46 017	58 052	1 745	6 944	398
Electronic and other electric equipment	238	. .	. .	. .	. .	. .
Computer and data processing services	844	70 672	70 671	4 097	15 610	250
Computer processing and data services	131	11 540	10 818	440	3 637	68
Information retrieval services	48	665	1 027	–18	277	5
Computer related services, n.e.c.	665	58 468	58 826	3 675	11 696	177
Communication	295	166 555	82 535	3 213	15 011	399
Telephone and telegraph communications	183	135 858	72 350	3 686	12 788	333
Other communications services	112	30 698	10 185	–473	2 223	66
Total ICT sector	2 245	399 085	369 592	16 278	54 657	1 692

. . No data available or suppressed for reasons of confidentiality.

Source: US Department of Commerce, 2001.

and office equipment accounted for 32% of sales, computer and data processing services for 22% and communication services for 21%, very similar to the worldwide breakdown (Table 3). By contrast, in Japan, computer and office equipment accounted for less than 4% of US ICT affiliate sales, computer and data processing services for 56% and communication services for just 8%.

Table 4 shows exports and imports to and from US-based multinational parents and their affiliates. Close to 70% of parents' ICT products and services exports during 1998 went to their affiliates abroad. US-based multinational computer and office equipment manufacturers shipped 93% of their exports to

Table 4. **US exports and imports associated with US parents and their affiliates, 1998**

USD millions and percentage shares

	US exports			US imports		
	Total by parents	To affiliates	Share	Total to parents	By affiliates	Share
All industries	438 293	217 153	49.5	355 976	187 610	52.7
Computer and office equipment	36 965	34 273	92.7	30 938	28 401	91.8
Audio, video and communication equipment	21 821	10 388	47.6	15 663	7 193	45.9
Computer and data processing services	4 655	. .	. .	. .	. .	. .
Communication services	2 247	469	20.9	. .	60	. .
ICT sector[1]	65 688	45 130	68.7	46 601	35 654	76.5

1. Partial total.

Source: US Department of Commerce, 2001.

overseas affiliates. US-based multinational audio, video and communication equipment manufacturers shipped close to 50% of their exports to affiliates. For their part, overseas affiliates supply a significant proportion of their US-based parent imports. In 1998, 77% of US-based multinational parent imports in the ICT sector came from their overseas affiliates. Intra-firm trade was particularly significant among computer and office equipment manufacturers, with overseas affiliates supplying more than 90% of US-based parent imports, almost the same share as for exports from parents to affiliates.

Affiliate activities in Sweden

Sweden also provides detailed data on the activities of affiliates. This section explores these data in order to develop a picture of the extent and nature of ICT sector affiliate activities in a much smaller country. Table 5 shows the number of affiliates of foreign-owned enterprises operating in Sweden in 2000. The ICT sector represented 20% of all enterprises and employed 14% of all employees (see Annex Table 2.17). The largest employers among foreign affiliates operating in Sweden in 2000 were in software consultancy. In the same year, 95% of all foreign affiliates operating in Sweden's ICT sector were service providers, 63% were in wholesale activities and 29% in computer services. Just 5% were in manufacturing. Table 6 shows the countries of origin of foreign-owned enterprises in Sweden's ICT sector.

Affiliates of Swedish ICT sector firms operating abroad employed a total of 210 557 in 1999, of whom 77 462 were abroad and 133 095 in Sweden (see Annex Table 2.18). Those employed by Swedish affiliates abroad in the ICT sector accounted for almost 13% of those employed by Swedish affiliates in all industries. Not surprisingly, communication equipment manufacturing was a major activity of Swedish affiliates abroad, employing more than 8% of Sweden's total affiliate employment abroad.

Table 5. **Foreign-owned enterprises in Sweden's ICT sector, 2000**

Numbers and percentage shares

	Enterprises	Employment
Equipment manufacturing	53	15 876
Wholesale	680	25 252
Computer and related services	309	18 242
Renting office machinery	9	133
Telecommunication services	35	3 301
Total ICT sector	1 086	62 804
ICT sector share	20	14
All industries	5 519	446 893

Source: ITPS (2001).

Table 6. **Country of origin of foreign-owned enterprises in Sweden's ICT sector, 2000**

Numbers and percentage shares

	ICT sector		Share (%)	
	Enterprises	Employment	Enterprises	Employment
United States	236	17 301	22	28
United Kingdom	104	6 157	10	10
Switzerland	53	5 807	5	9
Finland	114	5 460	10	9
France	50	5 199	5	8
Netherlands	81	4 397	7	7
Germany	118	3 372	11	5
Norway	101	3 335	9	5
Japan	36	2 079	3	3
Denmark	81	1 779	7	3
Top ten	974	54 886	90	87
Other countries	112	7 918	10	13
Total	1 086	62 804	100	100

Source: ITPS (2001).

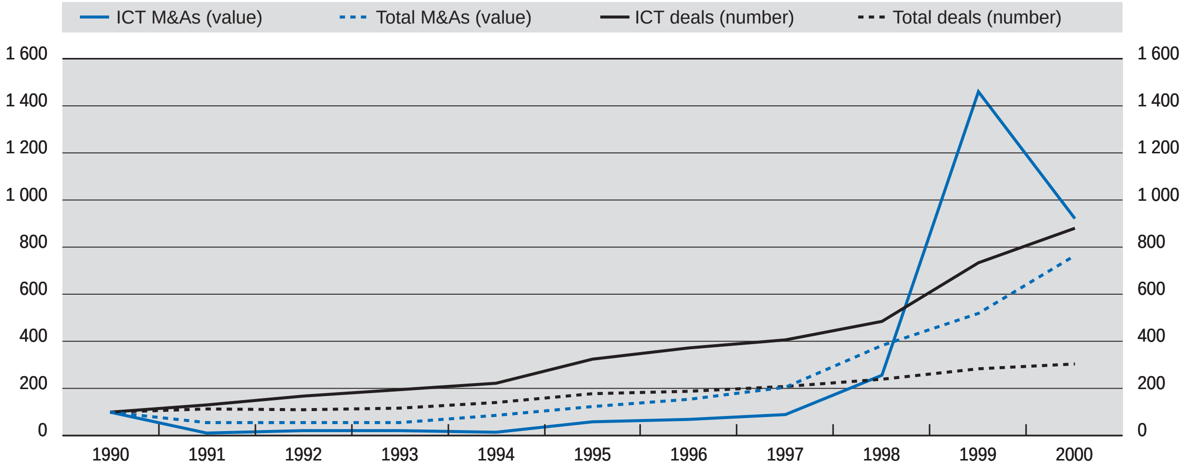
Mergers and acquisitions

Cross-border M&As are now the most common form of FDI. It is generally held that scale, speed and technological and regulatory change are among the principal motivations for M&As. M&As allow rapid entry into a market. Scale is often sought as a means of spreading the costs and risks associated with large R&D investments and rapid technological change, while speed of entry suits industries where technological change is rapid and product life cycles short. Such motivations are present in the ICT sector.

Between 1990 and 2000, cross-border M&As increased at a compound annual rate of 23% worldwide on a value basis.[10] The upsurge in both deal value and number of deals was especially significant after the mid-1990s (Figure 11). Large-scale cross-border M&As account for the bulk of the increase in the value of cross-border M&As. Cross-border M&As now account for around 90% of total FDI inflows in value.

Figure 11. **ICT and total M&As, 1990-2000**

Index 1990 = 100



Source: Thomson Financial, 2001.

M&A activity in the ICT sector has increased faster than average over the last decade.[11] Deal value increased by a compound annual rate of 25% between 1990 and 2000, with almost as large an increase in the number of deals (see Annex Table 2.19). In 2000, ICT sector M&A deal value reached USD 245 billion, up from USD 27 billion in 1990. Over the decade, the number of (completed) ICT sector cross-border M&As rose from 86 to 756. The ICT sector increased its share of deals and deal value from around 3.5% in the early 1990s to 21% of deal value and 10% of total deals in 2000. Because of very large deals in telecommunications, the ICT sector accounted for 49% of the value of all cross-border M&As worldwide in 1999. Over the period 1990-2000, the ICT sector accounted for 22% of the value of all cross-border M&A deals worldwide and 7% of the deals completed. This clearly suggests a larger than average deal value and higher than average M&A activity in the sector (see Annex Table 2.20).

ICT M&As *by industry*

As targets of M&As, ICT services firms are both the main focus of activity and the fastest-growing area (see Annex Tables 2.21-2.23). There has also been considerable and strongly growing M&A activity in electronic component and other equipment manufacturing and communication equipment manufacturing. As acquirers, ICT services firms, especially telecommunications services firms, are both the most active (in value terms) and the fastest growing group. In fact, the deregulation of telecommunications, privatisation of infrastructure and the mobile revolution have driven much of the activity in ICT sector cross-border M&As since the mid-1990s.

Some interesting features emerge from these broad trends. For example, electronic component and other equipment manufacturing activities represented 45% of all ICT manufacturing inflows in 2000 but only accounted for 11% of all ICT manufacturing M&A outflows. Conversely, communication equipment manufacturers accounted for 83% of M&A outflows and 37% of inflows in 2000. However, vertical M&As do not appear to be a major feature of ICT manufacturing M&A activities. There are some signs of acquisitions of component manufacturers by communication equipment manufacturers, but many acquisitions of component manufacturers appear to be by non-specialised ICT producers (conglomerates). Large deals create volatility in the data, but it seems that non-primary ICT firms are more often acquirers than targets. This suggests that there is a greater tendency for firms operating around the edges of the ICT sector, as non-specialist ICT producers, to buy into the ICT sector, than there is for ICT firms to buy out, as one would expect for a high-growth sector.

Horizontal M&As accounted for 49% of the value of all deals in the ICT sector over the period 1990-2000, ranging from a low of 25% in 1995 to a high of 92% in 1999 (Figure 12). Since 1998, they have accounted for 60-90% of all ICT-related M&As by value, owing, in part, to a few very large deals, notably in telecommunications. Nevertheless, they accounted for 41% of all deals in the sector over the period 1990-2000, with a low of 34% in 1997 and a high of 51% in 1999. This suggests that scale, technology access and risk spreading may be significant drivers of M&A activity in the sector.

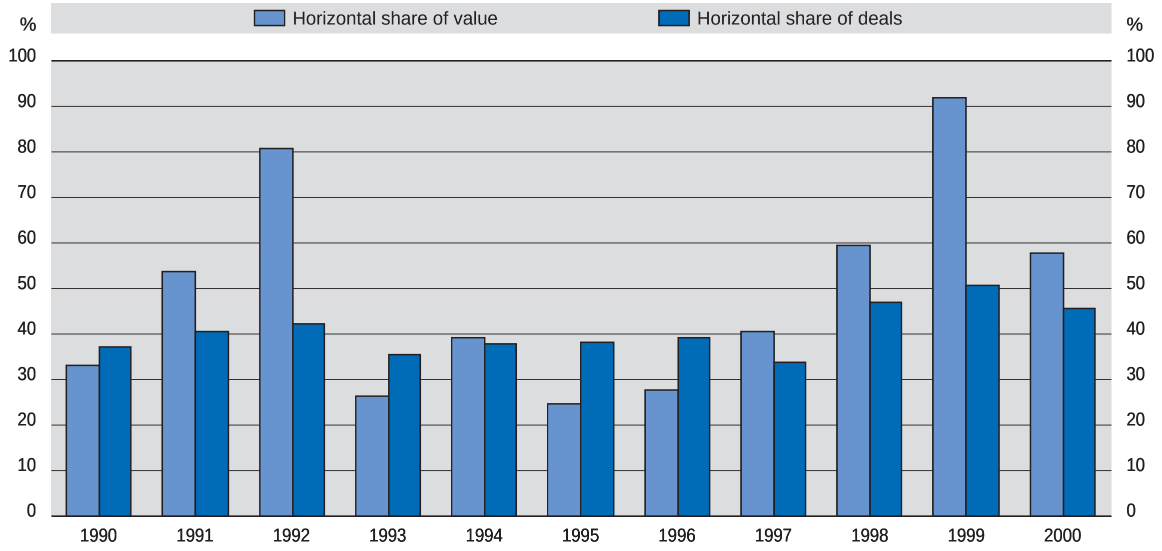
ICT M&As *by country*

In terms of outflows (see Annex Table 2.24), OECD countries accounted for more than 96% of total world ICT sector M&A outflows over the period 1990-2000. The United States, the United Kingdom and France accounted for 67%, while Japan accounted for a surprisingly modest 2.3%. Germany accounted for 7%; Canada, 6.3%; Spain, 4%; the Netherlands, 3.1%; and Australia, 1.2%.

Large deals by Nokia (Finland) and France Telecom and Vivendi (France) in 2000 and Mannesmann and Deutsche Telekom (Germany) and Vodafone (United Kingdom) in 1999 have driven rapid growth in ICT M&A outflows. M&A outflows from the United States, while strong throughout, have grown less quickly than those from other countries (14% compound annual growth, compared to 25% for the OECD as a whole). Only Korea and Japan had lower ICT-related M&A outflows in 2000 than in 1990, although outflows from Japan were substantial in 2000, and high relative to the decade average.

ICT-related M&A inflows are somewhat more evenly distributed (see Annex Table 2.25). OECD country inflows have grown faster than outflows over the period, at a compound annual rate of 27%. Over

Figure 12. **Share of horizontal M&As in the ICT sector, 1990-2000**
Percentages



Source: Thomson Financial, 2001.

the period 1990-2000, the United States and Germany were each the target of 28% of ICT M&A inflows, partly owing to the Vodafone/Mannesmann deal in 1999 in the latter case, and the United Kingdom received 16% of ICT M&A inflows. Again, major deals shape the overall picture.

Major deals by industry

Telecommunication services assets have been major targets of cross-border M&As in the ICT sector over the last decade and have involved some very large deals. M&As targeting telecommunications between 1990 and 2000 were valued at USD 510 billion, with no fewer than 41 deals worth more than USD 1 billion. Computer and related services assets were the second largest target of cross-border M&As in the sector, with 1 248 deals worth USD 88 billion. Communications equipment, computer and office equipment, and electronic equipment and component manufacturing assets were each the target of cross-border M&As valued at between USD 25 billion and USD 40 billion.

During the period 1990-2000, the top 20 cross-border M&A deals targeting *communications equipment manufacturing* were valued at USD 29.5 billion and accounted for 3.7% of the total value of M&As in the ICT sector. Each of the top seven deals was worth more than USD 1 billion (see Annex Table 2.26). The largest M&A deal was worth USD 7 billion. Announced in February 2000, it involved Alcatel of France acquiring 100% of Newbridge Networks of Canada in a stock swap deal which focused on networking technologies and products. Alcatel, in various national guises, was the acquirer in six of the top 20 acquisitions in communication equipment manufacturing, including the top four, worth a total of USD 19.5 billion. All were horizontal deals, three were 100% acquisitions and all but one were majority acquisitions.

Of the top 20 deals targeting communication equipment manufacturing, 13 were horizontal deals; in three cases, the acquiring firms were in the telecommunications services industry (vertical acquisitions), in three cases the acquiring firms were in non-ICT industries and in one case the acquiring firm was in the electronic equipment and component manufacturing industry. In only one of these top 20 deals was the acquirer from a non-OECD country (ECI Telecom Ltd., Israel, which acquired Telematics International Inc. of the United States in 1993 for USD 279 million), and in only three cases was the target in a non-OECD country (Exalink Ltd., Israel; NGI, Brazil; and VTR Hipercable, Chile).

The top 20 deals targeting *computer and office equipment manufacturing* were valued at almost USD 25 billion, around 3% of the total value of M&As in the ICT sector over the period 1990-2000. The largest deal was the 1998 acquisition of Bay Networks of the United States by Nortel Networks of Canada for a little under USD 9.3 billion (see Annex Table 2.27). Although not listed as a horizontal deal, it clearly involves two major communication equipment manufacturers. It can, perhaps, be characterised as an example of the convergence of computer and communication networking and the need for communication equipment manufacturers to acquire capabilities in IP networking. In 14 of the top 20 deals, the target firm was located in the United States. These deals involved acquiring firms based in Canada, the United Kingdom, Japan, Korea, Belgium, Germany and Macau (China). In many cases, access to technology was a significant driver. Only three of the top 20 were listed as horizontal deals.

The top 20 deals targeting *electronic equipment and components manufacturing* were valued at a total of USD 30 billion, and accounted for 3.7% of the value of all deals in the ICT sector. The largest was the acquisition in 2000 of Alteon WebSystems of the United States by Nortel Networks of Canada in a stock swap worth USD 7 billion (see Annex Table 2.28). Alteon WebSystems was a provider of Internet infrastructure solutions and is another example of Nortel developing its IP capabilities through acquisition. Interestingly, at least four of the targeted firms were working on optical fibre and/or opto-electronic equipment and systems. Only four of the top 20 were horizontal deals, but six involved acquiring firms from communication equipment manufacturing and one from computer and office equipment manufacturing, suggesting the presence of vertical deals.

The top 20 deals targeting *computer and related services* were valued at USD 47.7 billion, 6% of total M&A activity by value in the ICT sector. The largest deal was the acquisition in 2000 of Lycos Inc. of the United States, an Internet Web portal, by Terra Networks (Telefonica) of Spain for USD 6.2 billion in a stock swap transaction (see Annex Table 2.29). The second largest deal, in which NTT Communications of Japan acquired Verio of the United States, was worth USD 5.7 billion. M&As targeting the computer services industry have been both common and relatively large, with 1 248 deals over the decade worth almost USD 88 billion. All of the top 20 deals were worth more than USD 1 billion. Seven of the top 20 were horizontal deals; four telecommunication services firms acquired assets in computer and related services, often relating to Internet service provider (ISP) and other Internet activities; and four involved communication equipment manufacturers seeking vertical integration. In only one deal, where the acquiring nation was listed as Bermuda, was the target or the acquirer outside the OECD.

The top 20 deals targeting *telecommunication services* were worth a total of USD 440 billion, 55% of the value of all M&As in the ICT sector. The largest deal was the 1999 acquisition of Mannesmann of Germany by Vodafone of the United Kingdom for USD 203 billion (see Annex Table 2.30). M&As in the telecommunications industry are large: eight of the top 20 deals were worth more than USD 10 billion and 41 were worth more than USD 1 billion. Vodafone of the United Kingdom was the acquirer in three of the top five, worth a combined USD 277 billion in 1999 and 2000. At least seven of the top 20 deals in telecommunications targeted mobile network operators, and 16 were horizontal deals. Among the acquiring firms in the top 20 deals in telecommunications, only Global Crossing of Bermuda was based outside the OECD area. Significant acquisitions in South America (notably by Telefonica of Spain) meant that six of the top 20 targeted assets outside the OECD.

Deals targeting ICT *wholesaling* were generally smaller, worth a total of USD 4.7 billion and accounting for less than 1% of all deals in the ICT sector. Nevertheless, the acquisition of STC (United Kingdom) by Nortel of Canada in 1990 was valued at USD 2.6 billion (see Annex Table 2.31). The largest deal targeting ICT wholesaling during 2000 was worth just USD 26 million.

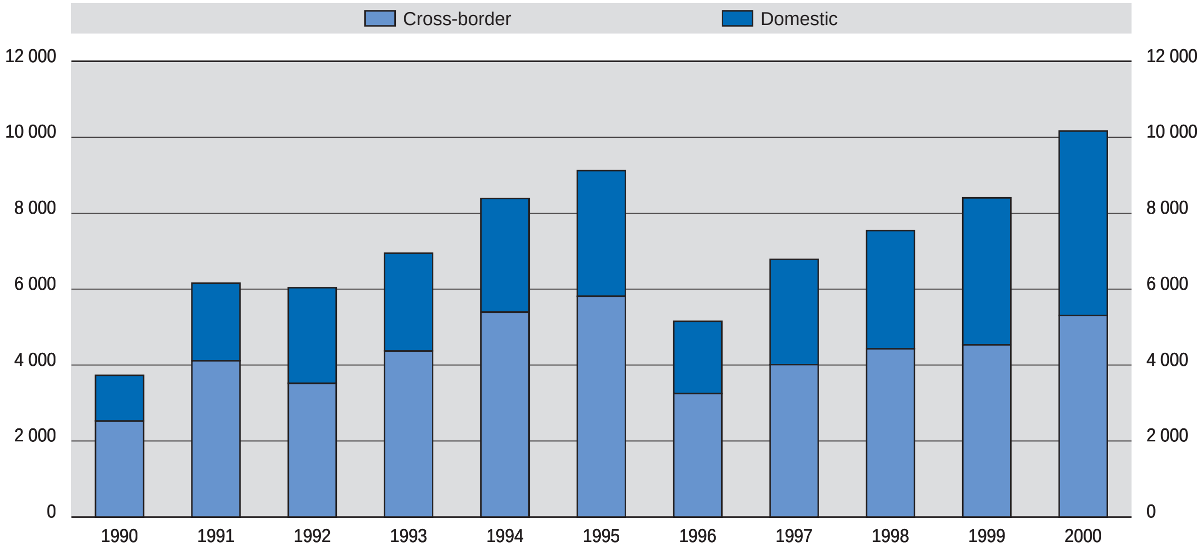
Deals targeting the ICT-related *media and content industries* were valued at USD 76 billion and accounted for more than 9% of the value of cross-border M&As in the ICT sector. They included some large deals, with the top seven worth more than USD 1.5 billion and the largest (the acquisition of Seagram of Canada by Vivendi of France in June 2000) worth more than USD 40 billion (see Annex Table 2.32).

Strategic alliances

As firms restructure, there has been a significant increase in strategic alliances.[12] Cross-border strategic alliances accounted for 60% of all alliances that took place between 1990 and 2000 (Figure 13). They numbered 2 531 in 1990 and 4 532 in 1999. For smaller countries (*e.g.* Iceland, Belgium, Luxembourg, Austria), international alliances have been more numerous than alliances among domestic firms, accounting for over 90% of all their deals. The United States accounted for about two-thirds of all strategic alliances in the 1990s, half of them with foreign partners.

Figure 13. **Share of domestic and cross-border strategic alliances, 1990-2000**

Number of deals



Source: Thomson Financial, 2001.

Between 1990 and 2000, 6% of cross-border alliances were in the ICT sector (see Annex Table 2.33). Out of a total of 2 765, 2 335 were completed and the remaining 430 were pending or terminated. While a relatively small share of the total, ICT sector cross-border alliances have been growing faster than total alliances, with a compound annual growth rate of 12% compared to 8%, a further indication that the ICT sector is rapidly globalising.

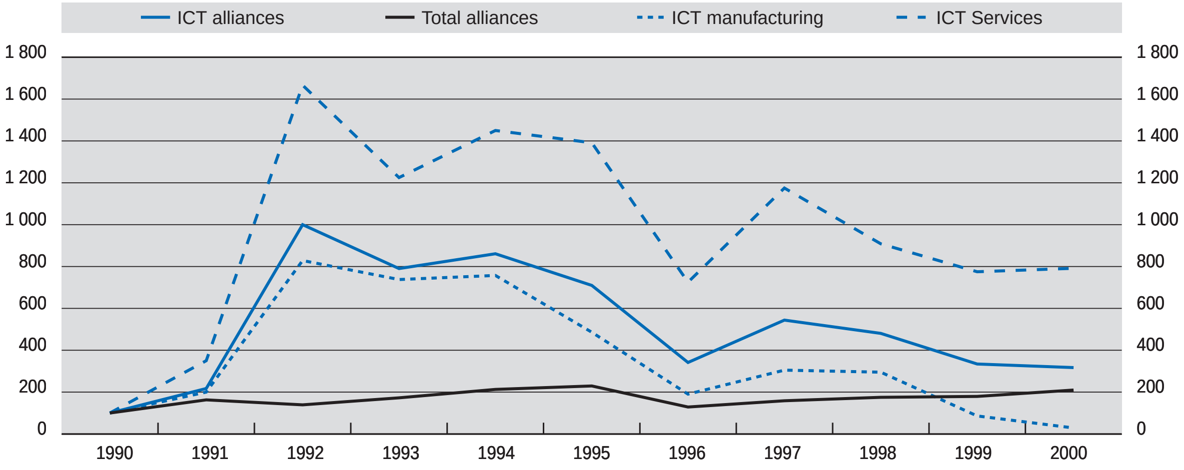
ICT *cross-border alliances by industry*

Between 1990 and 2000, 54% of ICT sector cross-border alliances targeted ICT services activities, 36% targeted ICT manufacturing and the remaining 10% targeted media and other activities (Figure 14). ICT sector cross-border alliances focused primarily on computer services (32%), telecommunication services (12%) and ICT wholesaling activities (10%). Among ICT manufacturing industries, more than 15% of all ICT sector cross-border alliances between 1990 and 2000 focused primarily on electronic components and parts manufacturing activities, almost 13% on communication equipment manufacturing and 8% on computer and office machinery manufacturing.

Over the period 1990-2000, the most obvious trend is a shift away from ICT manufacturing activities to ICT services. Manufacturing activities were the primary focus of more than 50% of all cross-border alliances in 1990 but of less than 5% in 2000, while services were the primary focus of 29% in 1990 and of 73% in 2000,

Figure 14. **Cross-border strategic alliances, 1990-2000**

Index 1990 = 100



Source: Thomson Financial, 2001.

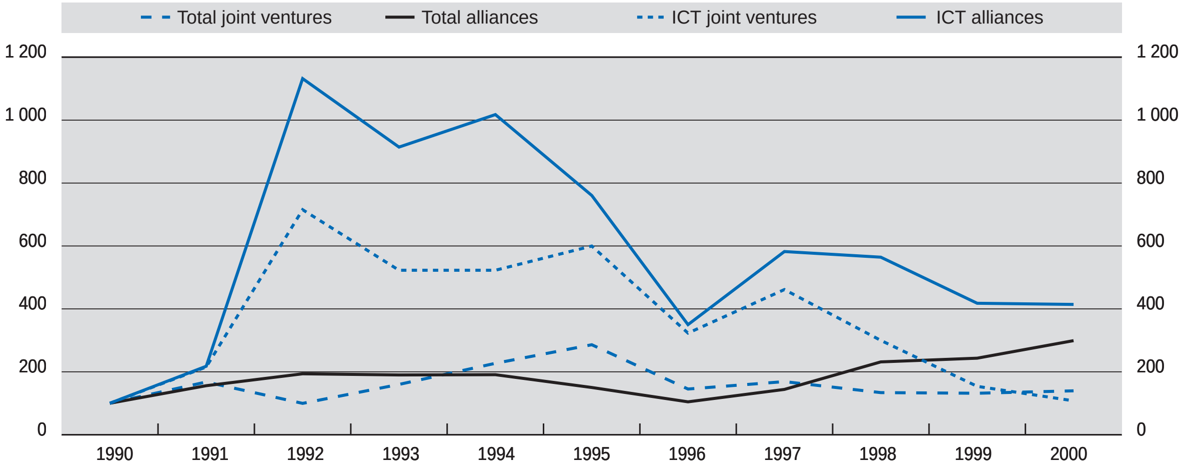
increasing at a compound annual rate of 23% over the period. The alliances focused on computer services increased at a compound annual rate of 25%, compared to 18% for telecommunications and 15% for wholesale activities, while those in all areas of ICT manufacturing declined.

The nature of cross-border alliances in the ICT *sector*

Across all industries, joint ventures accounted for 55% of all cross-border alliances over the period 1990-2000 (Figure 15), but for only a little over 22% in the ICT sector. In 1990, joint ventures accounted for 32% of all cross-border alliances in the ICT sector, but by 2000, their share had fallen to just

Figure 15. **Cross-border joint ventures and alliances, 1990-2000**

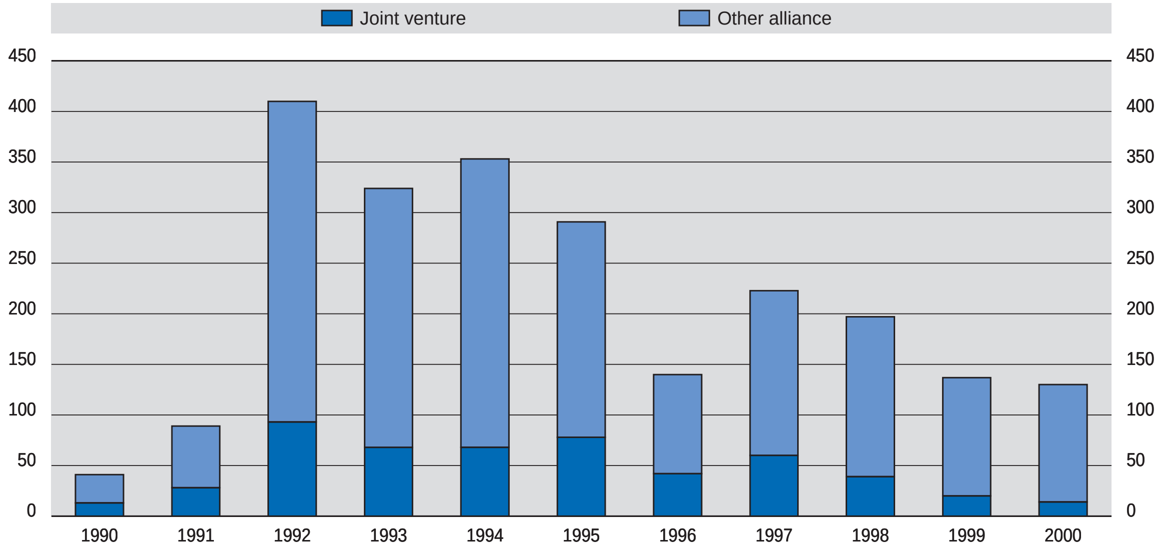
Index 1990 = 100



Source: Thomson Financial, 2001.

Figure 16. **Share of joint venture and other alliances in ICT sector, 1990-2000**

Number of deals



Source: Thomson Financial, 2001.

11% (see Annex Table 2.34). Interestingly, there is little difference between the shares of agreements focused on manufacturing and on services in joint ventures and other ICT sector alliances over the last decade (Figure 16). Manufacturing activities were the focus of 36% of agreements and services activities the focus of a little over 50% whether they were joint ventures or other forms of alliance.

Purpose of cross-border alliances in the ICT *sector*

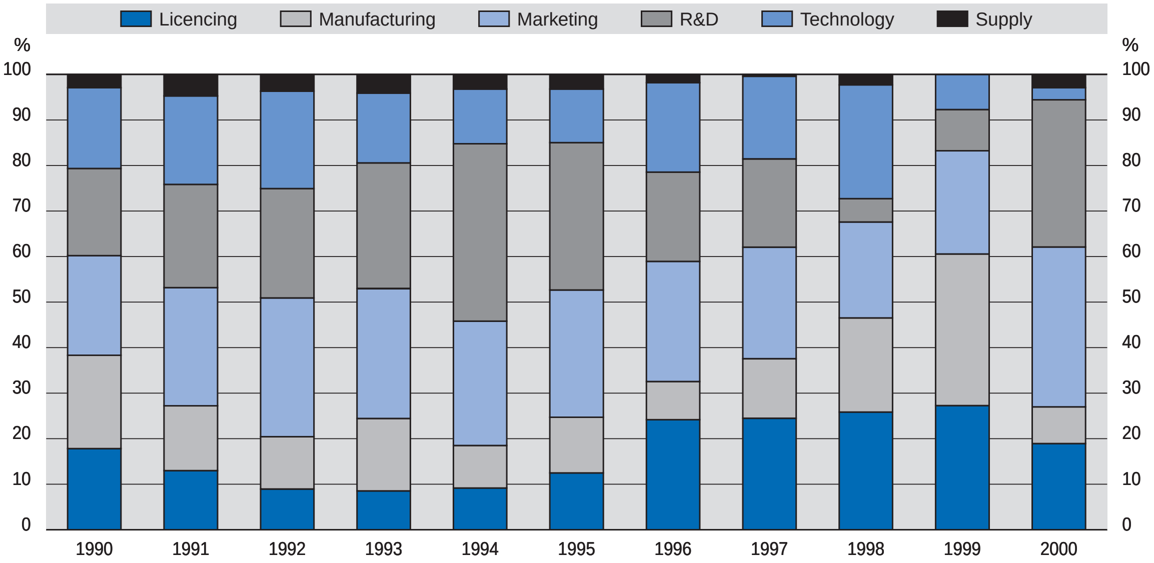
Technology is the main driver of cross-border alliances in the ICT sector (see Annex Table 2.35). R&D was the focus of 36% of all cross-border alliances over the period 1990-2000, compared to 23% for technology transfer and 19% for technology licensing. It was cited as the primary focus of just 13% of cross-border alliances across all industries.

Together, R&D, technology transfer and licensing have been the primary focus of 1 807 cross-border alliances in the ICT sector since 1990 or 78% of a total of 2 335 (Figure 17).[13] Marketing was also an important focus, with more than 880 deals, while manufacturing was less important, with 430. Perhaps curiously, given the level of intra-industry trade in ICT equipment, supply has not been a major focus of cross-border alliances. This may reflect the relatively low and declining share of manufacturing-oriented alliances and the level of direct investment and sales through affiliates in the sector.

Of the 834 ICT sector cross-border alliances focused on R&D between 1990 and 2000, only 116 were joint ventures (see Annex Table 2.36). By industry, the largest number of R&D alliances were in computer and related services (296); 186 were in electronic equipment and component manufacturing, 128 in communication equipment manufacturing, 101 in computer and office equipment manufacturing and 44 in telecommunication services. Overall, 50% of the sector's cross-border R&D alliances have been in ICT equipment manufacturing and 43% in services.

Curiously, there were many more cross-border R&D alliances early in the decade, with almost 87% established between 1990 and 1995 (90% of those in manufacturing and 84% of those in services). Cross-border R&D alliances peaked in the years 1992-95, perhaps owing to expansion after the downturn of 1991-92 as firms looked for a technological "leg up". In 1994, 58% of all cross-border alliances focused on R&D[14] but in 1999, this was the declared focus of just 4.4%. Firms may feel less need to push the technology boundaries during boom sales years.

Figure 17. **Purpose of ICT sector cross-border alliances, 1990-2000**



Source: Thomson Financial, 2001.

The country focus of ICT *sector cross-border alliances*

The United States has been a party to 66% of the cross-border alliances in the ICT sector over the last decade (Figure 18). In 72% of these, it was the principal nation of the alliance. Its involvement in these alliances is somewhat higher than the average across all sectors (60%). Japan was a party to 32% and less than half the number involving the United States; it was the primary nation of the alliance in just 39%. Involvement in ICT sector cross-border alliances then tails off very quickly.

Only the United States, France and Finland are cited as the principal nation of the alliance in more than 50% of their cross-border alliances (see Annex Table 2.37). Australia, Sweden the United Kingdom and Canada are the principal nation in more than 40% of their cross-border alliances. The main secondary countries have been New Zealand, Italy and Luxembourg, followed by Hungary, Belgium, Ireland and Spain.

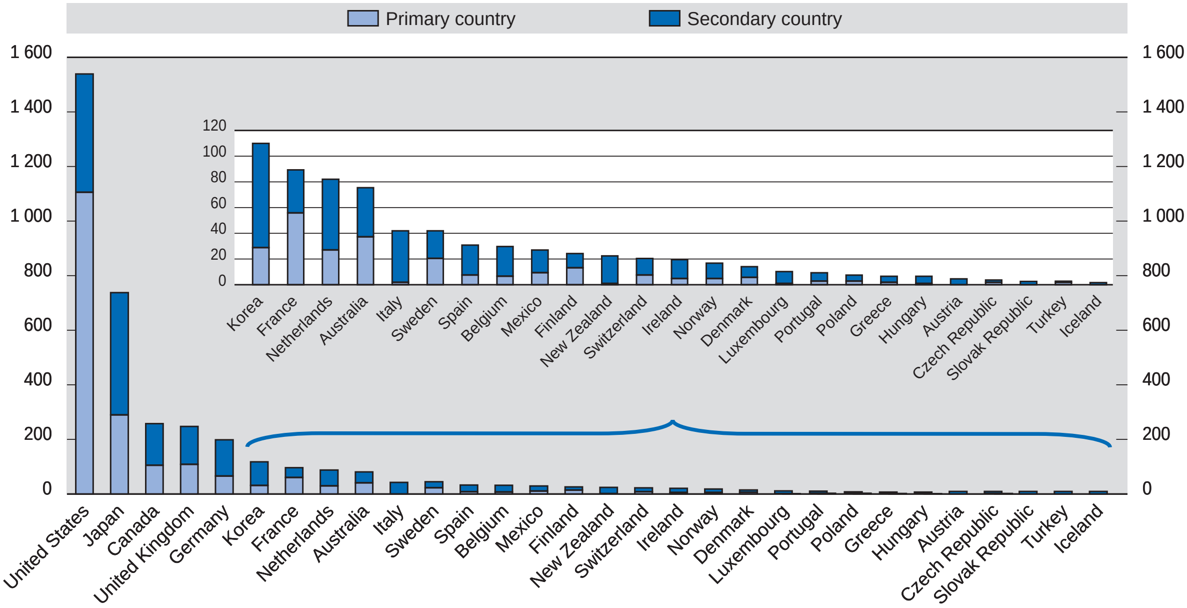
Conclusion

The ICT sector is highly and increasingly globalised and, in many respects, a leading example of industrial globalisation. While the different segments of the ICT sector vary, owing to different regulatory and market imperatives, the ICT sector overall reveals some of the key drivers and core characteristics of industrial globalisation.

ICT trade is very dynamic, with trade in ICT goods growing at almost double the rate of all goods; trade in ICT services is growing faster than trade in ICT goods. In terms of investment, there has been a major shift away from globalised manufacturing activities towards globalising services activities. As services become the focus of deregulation and trade liberalisation and marketed services a larger part of economic activity in most economies, this trend seems likely to continue. In recent years, telecommunication services have been at the forefront of investment and M&A activities as deregulation creates new markets. The focus on mobile communications is likely to continue, owing to the recent loss of share value and the large future cost of rolling out third-generation mobile networks. One can expect to see significant consolidation, tempered to some degree by regulatory demands for competition and real choices in national markets.

Figure 18. **ICT sector cross-border alliances, 1990-2000**

Number of deals



Source: Thomson Financial, 2001.

The globalisation of all parts of the ICT-producing sector is also being propelled by rapid technological change, which makes product life cycles ever shorter and opens up new markets for innovative products and services. The importance of R&D and various forms of technology development and access is clearly evident in the sector's M&As and strategic alliances. ICT-sector firms are likely to continue to seek ways of embracing emerging technologies (*e.g.* in IP networking, radio and optical communications) and bringing them rapidly to market, be it through M&As or alliances.

The impact of the business cycle on the level of activity in FDI, M&As and strategic alliances is clear. The boom years of the 1990s were a period of rapid globalisation. The recent "tech wreck" and the international economic downturn are likely to have a significant impact on these forms of globalising activity in the ICT sector in 2002 and beyond. Despite the tendency in the ICT sector for those left standing to pick up international assets while they are relatively cheap, there is likely to be a reduction in the levels of FDI, M&A and alliance activity over the next few years. Whatever happens, it seems likely that its underlying structure and dynamics will ensure that the ICT sector will remain at the forefront of industrial globalisation.

NOTES

1. This chapter focuses on what is happening rather than why. Management and policy implications are not analysed in depth, as there is an extensive literature on these aspects of globalisation.
2. In a recent study (OECD, 2001*a*), the OECD made a first attempt to focus on the trade and investment dimensions of the new economy. The study concluded that, in trade terms, the ICT sector expanded the most over the last decade, and that the ICT share in trade in goods and services has continuously increased. Further, while trying to gauge the effects on global trade of the dissemination of ICTs, it concluded that countries with the highest ICT expenditure are more open and have increased their participation in global trade more rapidly. While showing significant disparities among ICT trade actors – from country to country and from business to business – the study revealed that the emerging economies are often achieving better trade results in ICT than in other sectors.
3. Analysis in this section is based on data in the OECD ITS (International Trade Statistics) database in January 2002. The data are complete for all OECD countries except the Czech Republic (data from 1994), Hungary (from 1992), Korea (from 1994), and the Slovak Republic (from 1997). Luxembourg is not included. Data for 2000 are incomplete and 1999 data are used for Greece and the Slovak Republic.
4. Neither trade in software products nor cross-border payments for software royalties and license fees fully capture the extent of software-related trade. Digital delivery of software is significant and growing. Unfortunately, it is also very difficult to measure. However, software is the main product in digital delivery. In 1999, the value of on line software sales was estimated at USD 1.24 billion, of which around 6.5% were delivered on line (OECD, 2001*d*).
5. Revealed comparative advantage is calculated as the ratio of the share of ICT equipment exports in total merchandise exports for each country to the share of OECD ICT exports in total OECD merchandise exports. A value greater than 1 indicates a comparative advantage, and a value less than 1 a comparative disadvantage.
6. For an industry "i" with exports Xi and imports Mi the index is $GLI = [1 - |Mi - Xi|/(Mi + Xi)]$.
7. FDI is defined as an investment by an entity based in another country involving a long-term relationship, interest and management control.
8. M&As take place when operating enterprises merge with or acquire control of the whole or part of the business of other enterprises. Cross-border M&As are undertaken between firms of different national origin or home countries. M&As allow firms quick entry into a specific market through the acquisition of production facilities and intangible assets.
9. Strategic alliances may involve equity participation, but contrary to M&As, investment is typically not a significant factor. There are two kinds of strategic alliance. Joint ventures, in which a new jointly funded and controlled entity is created; and other alliances, in which no new entity is created. 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. Their flexibility allows firms to respond to changing market conditions effectively, without changes in the ownership structure of participating firms. See OECD (2001*b*), p. 14.
10. This analysis of cross-border M&As is based on Thomson Financial data and includes deals between entities based in different economies (cross-border) and declared completed or unconditional. They are recorded as occurring in the year of announcement and defined as deals involving the acquisition of more than 10% equity. Not all deal values are recorded, and not all deals are reported. Consequently, these data are no more than a guide to M&A activity.
11. There are three types of ICT sector M&As: *i*) the primary activity of the acquirer is in the ICT sector; *ii*) the primary activity of the target in the ICT sector; and *iii*) ICTs are not the primary activity of either acquirer or target, but are among the activities of the wider corporate entity. ICT industries include: ICT equipment manufacturing (office and computer equipment, communication equipment, and electronic equipment and components); ICT-related services (computer and related services, telecommunication services, and wholesale activities); and ICT media (principally broadcasting and content industries).

12. This analysis is based on strategic alliances listed in the Thomson Financial database, is presented in terms of the year of announcement and includes completed deals.
13. Some cross-border alliances have more than one focus and some do not record a focus. R&D, technology transfer and licensing account for 56% of the total number of cross-border alliances that registered the focus or foci of the alliance.
14. Percentages do not sum to 100 because some alliances indicate more than one purpose.

REFERENCES

Grubel, H.G. and P.J. Lloyd (1975),
Intra-Industry Trade: The Theory and Measurement of International Trade in Differentiated Products, Wiley, New York.

Houghton, J.W. (2001),
"Australian ICT Trade Update 2001", Centre for Strategic Economic Studies, Victoria University, Melbourne (*www.cfses.com*).

Mann, M.A. and M. Borga (2001),
"US International Services: Cross-border Trade in 2000 and Sales Through Affiliates in 1999", US Department of Commerce, November 2001. *www.bea.doc.gov/bea/*ARTICLES/2001/11*November/*1101*IntlServ.pdf*

OECD (2000),
International Direct Investment Statistics Yearbook 2000, Paris.

OECD (2001*a*),
"Measuring the New Economy: Trade and Investment Dimensions", TD/TC/WP(2001)23/FINAL, Paris.

OECD (2001*b*),
New Patterns of Industrial Globalisation: Cross-border Mergers and Acquisitions and Strategic Alliances, Paris.

OECD (2001*c*),
Science, Technology and Industry Scoreboard 2001: *Towards a Knowledge-based Economy*, Paris.

OECD (2001*d*),
The Software Sector: Growth, Structure and Policy Issues, DSTI *Working Paper*, forthcoming.

OECD/Eurostat (2001),
Statistics on International Trade in Services, Paris.

Reed Electronics Research (various years),
Yearbook of World Electronics Data, Reed Elsevier, London.

Ruffin, R.J. (1999),
"The Nature and Significance of Intra-industry Trade", *Economic and Financial Review*, Federal Reserve of Dallas.

Thomson Financial (2001).

UNCTAD (various years),
World Investment Report.

Yoshino, M.Y. (1995),
Strategic Alliances: An Entrepreneurial Approach to Globalisation, Harvard University Press, Cambridge, Massachusetts.

Chapter 3

THE SOFTWARE SECTOR

The software industry is at the heart of information technologies and is closely linked to the computer and communications industries both technologically and through the activities of firms. It has been of growing policy interest since its emergence as an independent economic activity. It is increasingly important for driving the information economy and a key component of investment. The impacts of software are pervasive owing to the constant innovations that underpin the increasing spread of information and communication technologies (ICTs) and the Internet throughout the economy and society. In the knowledge-based economy, "the creation of wealth becomes synonymous with creating products and services with large software content" (Hagel and Armstrong, 1997).

The evolution of the software sector rests on the complementarities between software and hardware. Software programmes require the support of hardware, and hardware usually relies on software to be functional. Software production entails high sunk costs for development and testing ("first copy" costs) prior to launching the product. However, once products are developed, replication costs are minimal, thereby generating large economies of scale. In addition, owing to network effects on the demand side, the value of a software programme increases with the rise in the number of users running it. Thus, users can exchange information with other users running compatible programmes and software developers and hardware manufacturers have incentives to develop products for common platforms.

The combination of economies of scale on the supply side and network effects on the demand side can lead to the establishment of *de facto* standards. In dynamic software markets, technological innovation constantly challenges leaders, and network effects may accelerate the advent of new standards and the displacement of old ones, in a process frequently referred to as "creative destruction" (Schumpeter, 1950).

This chapter describes the latest developments, on both the supply and the demand side, in this rapidly growing and fiercely competitive industry. It highlights methodological problems which point to areas requiring further research. It first describes growth trends and shows how the software sector has grown in terms of most economic variables in the last few years and how software R&D and investment have spread throughout the economy. It then turns to international trade and foreign direct investment (FDI) in software. The next two sections look at packaged software markets, from the geographical point of view in the section on domestic markets and from the product point of view in the section on product categories for packaged software. A section on industry structure concludes the chapter.

Growth trends

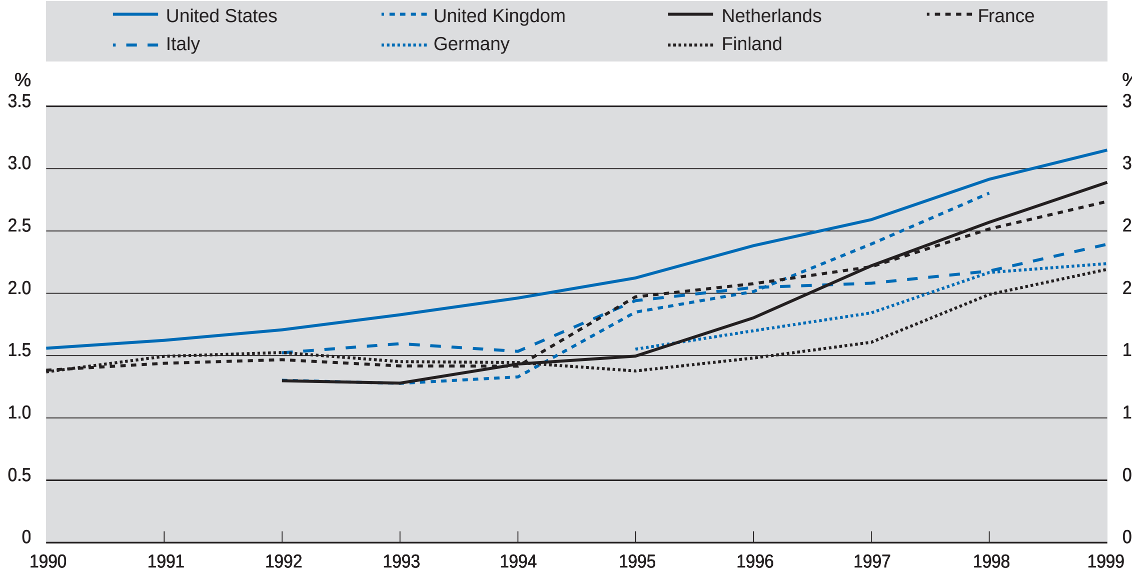
The software sector is one of the most rapidly growing sectors in OECD countries, with a relatively strong performance across all economic variables. The sector contributes directly to economic performance because of its dynamism, and software applications help boost growth across the whole economy through their use in an ever-expanding array of applications. Rapid growth in the sector is evident in terms of value added, employment, wages, R&D intensity, patents and investment. These are described in more detail below.

Value added

Over the last decade, the software sector has been one of the areas of the economy experiencing the highest growth rates. Value added has increased at a faster pace than in any other ICT sector. Nominal value added in the broadly defined software sector represents around 1% to 3% of business sector value added in OECD countries.[1] This relatively small share has been increasing regularly (Figure 1).

Figure 1. **Nominal value added of computer and related activities in selected OECD countries, 1990-99**

As a share of total business sector value added



Source: OECD, based on data from the STAN database, *Services Statistics on Value Added and Employment, 2000 Edition* (ISIC 72), and US Department of Commerce (SIC 737 less 7377).

Growth has been highest in the Netherlands, where value added in the broadly defined software sector more than doubled its share of total business sector value added, from 1.3% in 1992 to 2.9% in 1999, and in the United States where the share increased from 1.6% to 3.1% (see Annex Table 3.1). All countries for which detailed time series data are available (Figure 1) had a share above 2% in 1999 and showed considerable growth (see Annex Table 3.2).

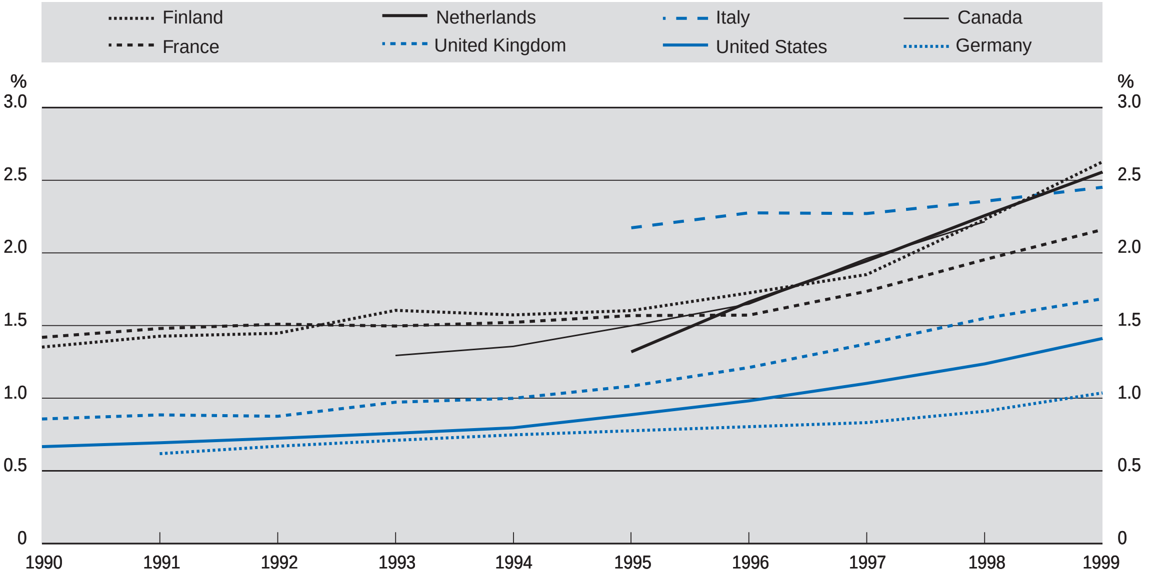
Value added per employee in the industry is generally higher than the average for the whole business sector, reflecting the sector's high productivity. New technologies and new organisational approaches may further raise its productivity. However, more work is required to improve the measurement of productivity.[2]

Employment

The broadly defined software sector (computer and related activities) accounts for 1% to 2.6% of total business sector employment[3] (see Annex Table 3.3). The shares of the Netherlands, Finland and Italy are all relatively close (around 2.5% in 1999). Growth rates have been high in the past decade, especially in Canada, Finland and the Netherlands (Figure 2).

Figure 2. **Employment in computer and related activities in selected OECD countries, 1990-99**

As a share of total business sector employment



Source: OECD, based on data from STAN database, *Services Statistics on Value Added and Employment*, *2000 Edition* (ISIC 72), US Department of Commerce (SIC 737 less 7377).

Between January 1990 and January 2001, slightly more than 1.2 million jobs were created in the United States in the broadly defined software sector, which now accounts for more than 1.9% of total private employment (US Department of Commerce, 2002) (see Annex Table 3.4). Packaged software and computer programming services accounted for more than 40% of these jobs. Employment in Internet-related computer services was the segment with the highest growth, with an average annual growth rate of 34% between 1995 and 2000 for information retrieval services (US SIC 7375), compared to around 14% for the narrowly defined software sector (computer programming services and packaged software), according to the US Bureau of Labor Statistics.

Information from other countries confirms these trends. In France, the number of employees in computer and related activities increased by more than 160 000 between 1981 and 1998. By the end of 1998, one employee in ten in professional services worked in computer and related activities (*i.e.* the broadly defined software sector (INSEE, 2000). In Canada, employment (excluding self-employment) in software and computer services showed similarly high growth rates, increasing between 1993 and 1997 at a compound annual growth rate almost ten times that of total employment (Statistics Canada).

Although software sector employment has been growing rapidly, jobs in the software sector alone are only part of the contribution of software activities to total employment. In the United States, all employment in computer and related services accounted for only 1% of total employment in 1998 (including the public sector), whereas the share of computer-related occupations in the economy was around 2%. As a result, as much as 76% of computer-related occupations were in other industries.[4] Likewise, in France, all employment in computer and related activities was 1% of total private employment in 1997, whereas all computer-related occupations[5] amounted to 1.4% of employment in the whole economy, *i.e.* 66% were employed in other industries (Lerenard and Tanay, 1998).

Wages

Wages and salaries in the software sector are relatively higher and growing more rapidly than the overall average for the economy, indicating among other things a high share of employees with tertiary-level education. In the United States, wages in the broadly defined software sector have been around twice as high and have grown twice as fast the national average for all private industries during the 1990s. Within the sector, packaged software experienced the highest growth rates, with a compound annual growth rate of 9.5% compared to 7.8% for the whole sector between 1992 and 2000.

Prices

One of the most striking phenomena of the ICT equipment industry has been the rapid decline in computer prices per unit of computing power. However, services have resisted better, among other things owing to the high wage content in their total price.[6] Recent data on hedonic consumer price indices[7] for various information technology (IT) goods and services in the United States show that computer software and related accessories have seen a modest decline in prices since the end of 1997, in contrast with the rapid decline in prices of PCs and peripheral equipment (see Chapter 1, Figure 18).

R&D in the software sector

Like the rest of the ICT industry, the software sector invests heavily in R&D. Earlier analysis indicates that the software sector tends to be the main R&D performer (for a discussion on measurement issues for R&D in services, including software consultancy and supply, see Young, 1996). Computer and related activities (ISIC 72) account for between 2% and 16% of total gross business expenditure on R&D (BERD) across OECD countries (see Annex Table 3.5), ranging from more than 10% in Australia, Denmark, Norway, Iceland and Greece, to less than 2% in Germany, where, however, the level of BERD in computer and related activities is one of the highest in the OECD area.[8] In some countries, a significant share of BERD in this sector is funded by government (see Annex Table 3.6).

The United States has the highest business R&D in computer and related activities, with almost USD 14 billion in purchasing power parity (PPP) in 1997, more than ten times the amount spent by the next two spenders in the OECD area at the time, Japan and the United Kingdom. Canada, Germany, France and Australia are also among the top spenders.

Software R&D throughout the economy

An alternative way of measuring R&D intensity in software is to look at R&D expenditures on software across all sectors of the economy.[9] Software R&D is also performed outside the broadly defined software sector, and if this is not taken into account, the overall importance of R&D related to software will be underestimated.

Information from a number of national surveys confirms the relevance of software-related R&D in other industries, although the lack of official data prevents a comprehensive cross-country analysis. At the beginning of the 1990s, about 40% of services firms in Japan and Italy undertook some form of IT R&D, about three-quarters of all R&D reported by "other services industries" was computer-related in Denmark, and over half of all R&D in the services industries was software-related in Canada (Young, 1996). In 1998, almost one-quarter of BERD in the Netherlands could be labelled software R&D (Statistics Netherlands, 2000, cited in Khan, 2001).

Software patents

Information on the number of patents granted in the United States provides an indication of the spectacular increase in patented software inventions in the last few years. The heterogeneity of patent regimes across countries, the changes in the definition of what can be patented in individual countries and the lack of a widely acknowledged classification of software patents and sources of data on patent counts hamper empirical analysis of the impacts of patenting on software innovation.[10]

There are two ways to measure the number of "software patents" granted in the United States, although they should only be considered as proxies owing to the current lack of more precise classifications. One is the number of patents originally classified[11] in a selection of software-related patent classes, more precisely computer graphics processing and data processing (US patent classes 345 and 700-707 and 716-717).[12] The second is the number of patents that include the word "software" in the description[13] (see Annex Tables 3.7 and 3.8).

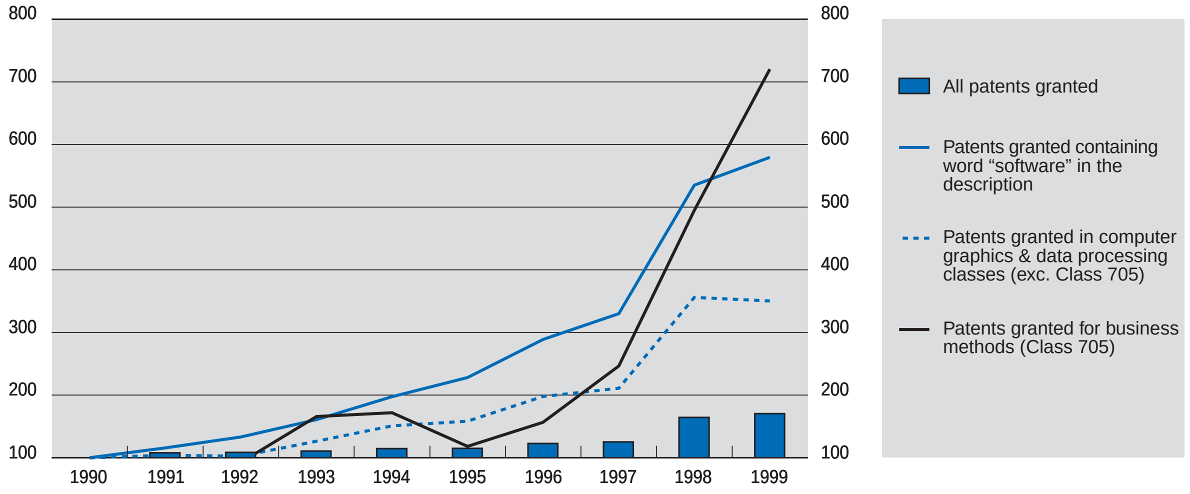
The number of patents granted in the United States under the software-related patent classes mentioned above almost tripled in the 1990s, from less than 2 000 in 1990 to more than 6 000 in 1999, or from 2% to 4% of all patents granted. This selection includes US patent class 705, also known as business methods, which has become an area of vigorous debate owing to the increasing number of patent applications for software-based business methods, mainly relating to electronic commerce. Examples of such patents are the British Telecom patent on hyperlinks, the Amazon patent on its One Click shopping system and the Priceline patent on reverse auctions.

On the other hand, the number of patents including the word "software" in the patent description was over four times higher in 1999 than in 1990, increasing from over 3 000 in 1990 to more than 17 000 in 1999 (10% of the total number of patents granted in 1999, compared to only 3% in 1990). However, as the subject matter of such a patent might not be a software invention, this second indicator should be only considered as a proxy. A search for the number of patents granted to a selection of firms among the largest software vendors worldwide (see Annex Table 3.9) shows that 89% of the patents granted to Oracle, 85% of the patents granted to Novell and 64% of the patents granted to Microsoft in 1999 included the word software in the description.

Overall, these measures show that, in the United States, the number of software-related patents has grown at a much faster pace than the total number of patents granted. The total number of patents granted had a compound annual growth rate (CAGR) of only 6% between 1990 and 1999, but the number of patents originally classified in these software-related patent classes has had a CAGR of 16% (15% if patents for business methods are excluded), while the number of patents granted with the word "software" in their description grew at a CAGR as high as 22% (Figure 3).

Figure 3. **Patents granted in the United States, 1990-99**

Index 1990 = 100



Note: US Patent Class 705 is also known as "business methods". USPTO patent counts by class only take into account the original classification of each patent in order to avoid double counting. These patent counts cover all patent documents, including utility, design, plant and reissue patents, as well as statutory invention registrations and defensive publications.

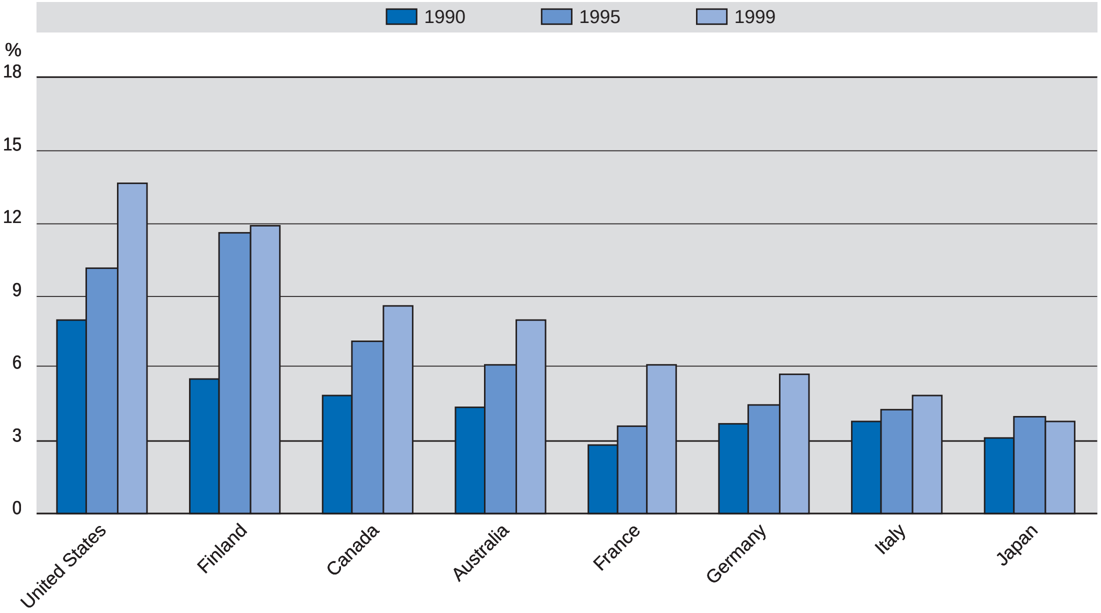
Source: US Patent and Trademark Office (USPTO), "Patent Counts by Class by Year: January 1977-December 1999" (April 2000); and USPTO Full Text Database for number of patents with the word "software" in the description.

Software as an intangible investment

Software has been the most dynamic component of ICT investment in overall investment growth, and hence in GDP growth, in OECD countries in the 1990s.[14]

The nominal share of software in business sector gross fixed capital formation, as reported in the National Accounts, has increased constantly since 1990, and in 1999 reached levels as high as 13.6% and 11.9% for the United States and Finland, respectively. Canada and Australia present a more modest share of around 9%, followed by France, Germany, Italy and Japan with shares below 6% (Figure 4).

Figure 4. **Share of software in business sector nominal gross fixed capital formation**



Note: Only "made to order" software is included for Japan.
Source: Colecchia and Schreyer, 2001.

International trade and foreign direct investment

International trade

International trade in software goods and services is growing rapidly but is difficult to measure, among other things owing to the increasing diversity of delivery channels (OECD, 1998, 2000*a*). The value of software goods trade has been significantly underestimated in border valuations because, in most countries, it is based on the value of physical supports (CD-ROM, diskettes) rather than of content.

The potential for significant mismeasurement is further increased by the bundling of software with computer hardware. Moreover, trade statistics do not measure the value of copyrights sold in foreign markets, although a substantial amount of international software trade involves licenses to use software in foreign countries, or the value of software electronically transmitted to and then subsequently sold by a foreign affiliate of a company or digitally delivered directly to final consumers. This last point is part of a larger problem related to the transition to the electronic distribution of intangible goods, since measuring and valuing domestic and international transactions involving intangible goods (*e.g.* software) are much harder than measuring those involving physically delivered tangible goods. Finally, software-related services trade is identified and measured poorly and is often not distinguished from other services.[15]

Statistics on software traded on physical supports (diskettes, CD-ROMs and other media) give an indication of the relative size and geographical distribution of cross-border sales of software goods. International trade of media for reproducing phenomena other than sound or image (predominantly software) is a relatively small percentage of all exports, varying between less than 0.1% and 0.4% for all OECD countries except Ireland (over 5% in 2000). Imports of these software-related media represent up to 1% of all goods imports. All OECD countries except Ireland, the United States, Austria and the Netherlands were net importers of software traded in physical supports in the period 1997-2000. The OECD was a net exporter overall, mainly because of the strong performance of Ireland and the United States, which have accounted for more than 55% of OECD exports in software goods in the period.

In Ireland, according to official Irish sources, more than 60% of the production of software was exported in 2000. That year, however, foreign firms based in Ireland accounted for about 90% of software exports.[16] Ireland appears to have become the manufacturing and distribution centre of the software sold by many of the world's top software vendors, particularly for Europe.[17] Over 40% of all packaged software (and 60% of all business software) sold in Europe is produced in Ireland.[18] More broadly, a significant share of EU exports correspond to software products produced by local affiliates of US-based firms.

Finally, although software-related services trade is also identified and measured poorly, Ireland also ranked first in terms of value of exported computer and information services in 2000 (USD 5.48 billion, followed by the United States with USD 4.9 billion) and in terms of the national share of total services exported (32.6%), followed by Sweden (5.9%) (see Annex Table 3.10). As for computer services alone, the item in computer and information services most closely linked to software-related services, Ireland also ranked first in terms of exports in 2000 (USD 5.48 billion)[19] followed by Germany (USD 3.71 billion) among countries for which such information was available.

In 2000, the United Kingdom and Spain ranked third and fourth, respectively, among net exporters of computer and information services in value terms, after Ireland and the United States. Germany, the third largest exporter, was a net importer in 2000, with imports valued at USD 4.47 billion. With imports valued at USD 3.07 billion, Japan was also a net importer. Imports and exports of computer and information services accounted for less than 5% of the total value of imports and exports of services in Germany and Japan. Available information on computer services shows that trade in computer and information services is largely trade in computer services in most OECD countries, except for Spain where information services account for more than two-thirds of trade in computer and information services.

The value of software royalties received and paid by a country is another indicator of the magnitude of its software trade. Information available for the United States shows that the inflow of software royalties more than tripled between 1992 and 2000, from USD 1.1 billion to USD 3.9 billion, considerably above the level of software royalties paid by the United States in other countries, a reflection of its position as the world's largest producer of software (US Department of Commerce, 2000*a*, 2001).

Digital delivery

Digital delivery has a potentially large impact on the patterns of international trade and investment. Software ranks first in terms of on-line sales by type of product and digital delivery, with potentially major effects on conventionally measured trade in software. In 1999, the value of software on-line sales was estimated at USD 1.24 billion, of which 6.5% was delivered on line. Books ranked second, followed by music, which ranked second in terms of digital delivery (Forrester Research, cited in Goldman Sachs, 2000). Electronic distribution of software and of other digitisable products is expected to grow as technologies and bandwidth improve.

Digital delivery can take several forms. Using e-mail, files can be transferred from one computer to another over the Internet. In centralised downloading, files are made available to a number of users on a server; for example, a file may be made available on the Internet for the general public to download (using FTP, HTTP, etc.). In peer-to-peer downloading (also called file swapping), one of the most recent developments, a computer links directly to another and can download a file from the linked computer's hard drive (OECD, 1999).

Foreign direct investment

FDI is growing rapidly and is an important means of enabling the software industry to enter foreign markets and, in some cases, to access human resources abroad. A picture of its importance can be obtained from data on the activities of foreign affiliates of software firms (defined as those classified under computer and related activities, ISIC 72), as detailed data on FDI flows are generally not available for the software sector.

Affiliates of US companies abroad account for a very significant share of computer and related activities in the rest of the world, with total turnover equivalent to around one-half of the total world packaged software market in 1998. Their turnover has increased rapidly in the last decade and was approximately four times higher in 1998 than in 1993 (see Annex Table 3.11). US affiliates have increasingly turned towards Asian countries, in particular Japan, whose relative share has doubled in terms of turnover, employment and employee compensation. Although there are no detailed data available for India, it has been a dynamic exporter of customised software products. While some of its exports are due to US and other foreign affiliates, most are due to extensive outsourcing to Indian software firms to gain access to skilled software professionals (see in particular OECD, 2000*a*, Chapter 6).

Europe remains the main region for US software sector investment, although its share in terms of turnover decreased between 1993 and 1998 from 67% to 58%. According to the Irish National Software Directorate, seven out of the ten of the world's biggest independent software companies (Microsoft, Computer Associates, Oracle, Informix, Novell, SAP and Symantec) had a local production establishment in Ireland in 1997.[20] In 2000, foreign companies accounted for more than 86% of software sector revenues, although they represented only 15% of the total number of software companies in Ireland.[21] Ireland's success in attracting software investment has been largely driven by low corporate taxes, good IT infrastructure and other factors, such as a large pool of skilled, English-speaking labour.

During the 1990s, European firms accounted for by far the most FDI in computer and related activities in the United States in terms of employment and turnover (see Annex Table 3.12). Nonetheless, with the exception of the United Kingdom, Europe's share of affiliate activity in the United States has declined, while foreign affiliates from Japan and Canada have significantly increased their activities. Overall, turnover of foreign affiliates in the United States almost doubled between 1990 and 1996. Detailed official data on inward investment is also available for Sweden, where software consultancy and supply (NACE 72.2, equivalent to ISIC 72.20) concentrates more than 81% of foreign-owned enterprises providing computer and related services (see Annex Table 3.13). In Sweden, the United States and the United Kingdom account for around 40% of foreign software sector employment in the broadly defined software sector (NACE 72, equivalent to ISIC 72), while Finland and France accounted for almost 15% each.

Domestic markets

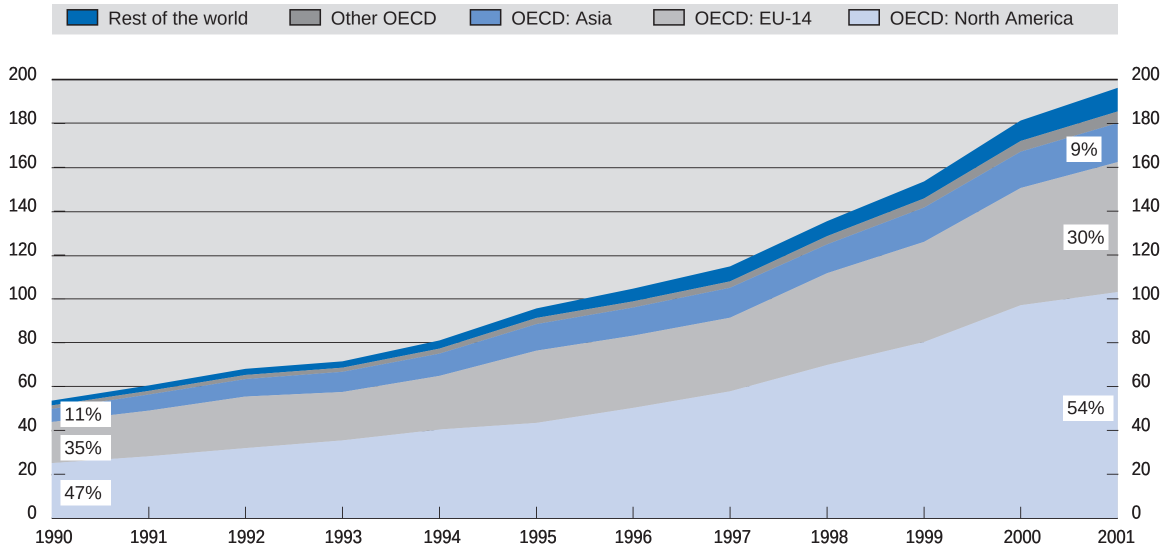
National markets for software are growing rapidly, matching supply. Analysis of these markets provides further information on the development of the software industry. Market data are available for packaged software and total IT services. According to International Data Corporation (IDC) data, around three-quarters of expenditures on IT services are devoted to professional services, with the remaining quarter going to support services. However, as it is not possible to separate software-related professional services from total IT services, most information on domestic markets in this chapter refers to packaged software.

The combined size of domestic markets for packaged software and total IT services, as a share of GDP, differs considerably across OECD countries and remains relatively modest in most, ranging in 2001 from 6.2% in Sweden to 0.6% in Turkey. In 2001, the average share in GDP of the domestic markets for packaged software and IT services in OECD countries was 3.6%, with Sweden and New Zealand ranking first, with shares above 5%. The ranking changes, however, when looking at packaged software alone, as the two countries with the largest packaged software markets as a share of GDP are the Netherlands and Sweden, both slightly above 1%.

The world packaged software market was estimated at USD 196 billion in 2001 (see Annex Table 3.14). The bulk of world packaged software sales remains highly concentrated within OECD countries (95%). North America increased its share to 54% during the 1990s, with the United States accounting for almost 50% against 44% in 1990. In contrast, EU countries and Japan saw their share decline, slightly for the former and more significantly for the latter, from 35% to 30% (Figure 5).

Figure 5. **Geographical breakdown of packaged software markets, 1990-2001**

Billion current USD

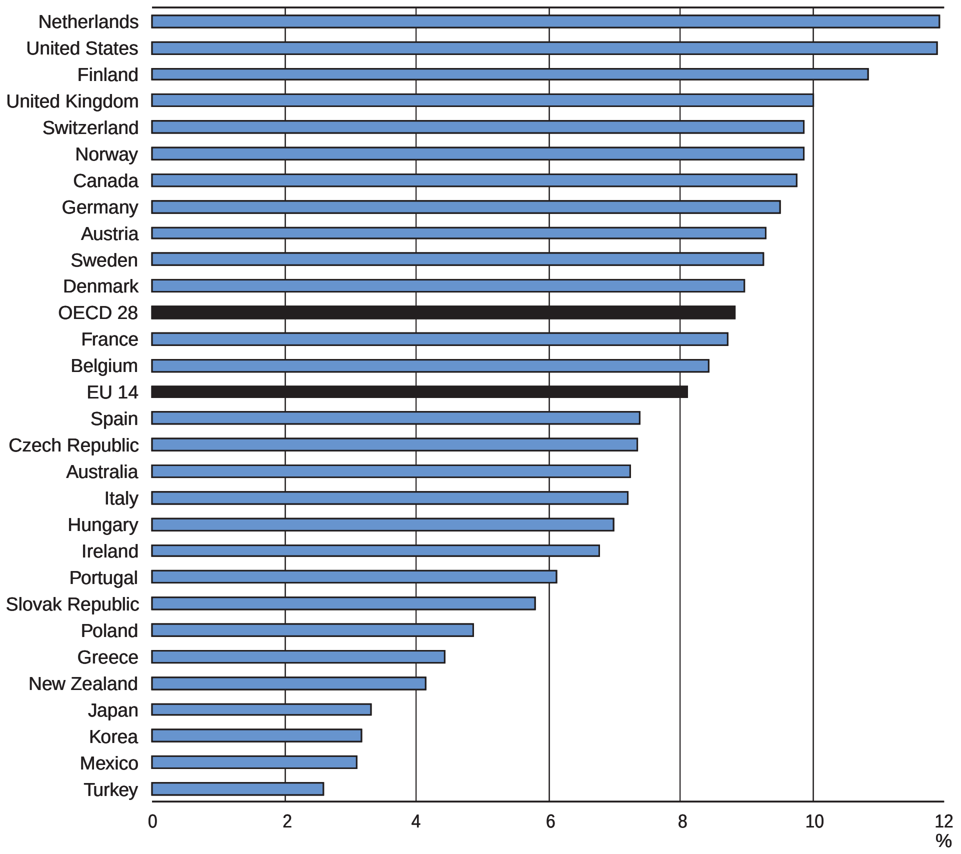


Note: OECD North America includes Canada, Mexico and United States. OECD Asia includes Australia, Japan, Korea and New Zealand. Other OECD include the Czech Republic, Hungary, Norway, Poland, the Slovak Republic, Switzerland and Turkey.
Source: OECD, based on data from WITSA/IDC.

Packaged software has continued to increase its relative importance with respect to the total OECD ICT market, although there is a wide dispersion across countries. On average in 2001, less than USD 9 out of USD 100 spent on ICT went towards packaged software (compared to 5.5% in 1992). This ratio varied from more than 10% in the Netherlands, the United States, Finland and the United Kingdom to less than 5% in Poland, Greece, New Zealand, Japan, Korea, Mexico and Turkey (Figure 6). In terms of dynamics, the Netherlands, Finland and Canada grew most rapidly between 1992 and 2001, with the relative importance of software within the ICT markets almost doubling. Countries which already in 1992 had a high propensity to spend ICT funds on software increased that propensity in 2001. Among the G7 countries, only Italy saw the relative share of software decline slightly between 1992 and 2001; Japan is the least specialised, although the share of software in ICT spending increased slightly during the 1990s.

Figure 6. **Packaged software as a share of total ICT markets, 2001**

Percentages



Source: OECD, based on IDC data.

Packaged software

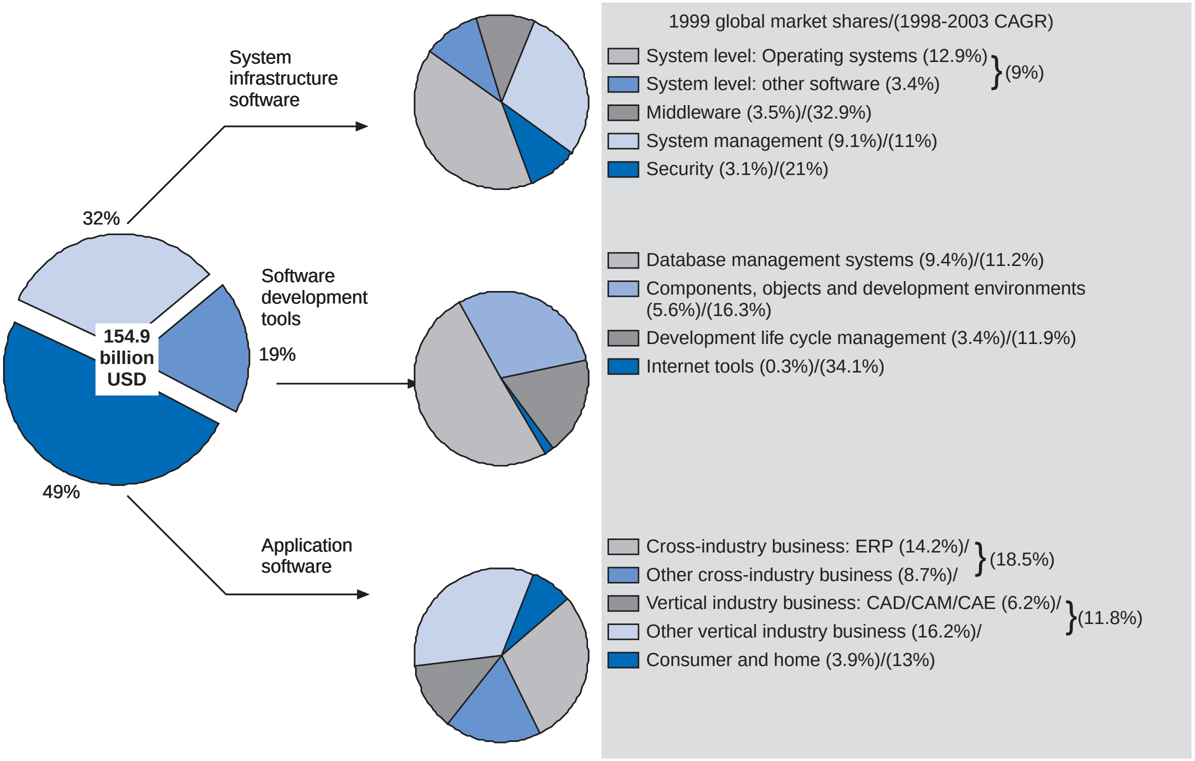
This section describes product categories for packaged software based on demand-side information (IDC, as reported in US Department of Commerce, 2000*b*). In 1999, applications software accounted for about half of the market for packaged software worldwide, with 32% for system infrastructure software and 19% for software development tools, according to IDC (Figure 7).

Applications software

Applications software, the largest segment of the packaged software market, consists of computer programmes that enable users to perform specific activities. It can be broken down by user type into business and consumer/home applications. Business applications can be further divided into cross-industry applications, for activities related to a particular business function, and vertical industry applications, for activities inherent to a particular industry.

Enterprise Resource Planning (ERP) software[22] takes the lion's share of revenues in the cross-industry business applications software segment, with 14.2% of the world market for packaged software in 1999 (the highest market share for a single type of product, followed by operating systems in the systems infrastructure segment, with 12.9%). Accounting, human resource management or word processing are other office activities that can be performed by cross-industry business applications

Figure 7. **World packaged software market by segments, 1999**



Note: Estimated market shares based on data from IDC.
Source: OECD, based on IDC and US Department of Commerce, 2000*b*.

software. Microsoft's Office Suite products (including word processor, spreadsheet, database, personal calendar and e-mail) are considered to be business applications, although they can also be used at home, and their market share is therefore included in the 8.7% held by other (non-ERP) cross-industry business software. According to IDC, cross-industry business applications software is expected to grow at an annual rate of 18.5% between 1998 and 2003.

Vertical industry applications are software for performing activities in specific industries. The most popular products in this segment are for computer-aided manufacturing (CAM), computer-aided design (CAD) and computer-aided engineering (CAE), with a combined share of 6.2% of the world packaged software market in 1999. According to IDC, vertical industry business applications software is expected to grow at an annual rate of 11.8% between 1998 and 2003.

Consumer and home applications software has the smallest market share (3.9%) of packaged software within applications software, although it is expected to grow strongly between 1998 and 2003 (a 13% annual growth rate, according to IDC) owing to increased household computer and Internet access and use. This segment includes applications to enable users to perform non-business activities at home, such as education, personal creativity, personal finance, word processing (excluding Microsoft Word or any other software intended for commercial use) or games (excluding proprietary platform games such as Nintendo, Sega or Sony Playstation).

System infrastructure software

System infrastructure software, the world's second largest market segment for packaged software in 1999, consists of computer programmes that deal with the internal operations of a computer. It acts as an intermediary between applications software and the system's hardware components. This segment can be broken down into system level, middleware, system management and security.

System-level software includes programmes such as operating systems and networking software. In 1999, operating systems had the highest share of the overall packaged software market for this segment (12.9%). This subsegment is expected to grow at an annual rate of 9% between 1998 and 2003.

Middleware is software that enables shared use of computing resources across heterogeneous systems. After Internet tools, it is expected to be the segment with the highest annual growth rate (32.9%) between 1998 and 2003. According to the US Department of Commerce (2000*b*), much of this growth is due to programmes integrating software applications, in particular e-commerce applications.

The growing number of attacks on computer systems is drawing more attention to the issue of information security. The number of incidents reported has risen enormously in the past few years. In 2000 and 2001, reported incidents grew by 121% and 142%, respectively.[23] The security software segment comprises firewall, encryption and antivirus software. It currently has a small share of the overall packaged software market (3.1% in 1999), but it is projected to have the highest growth rate (21% between 1998 and 2003) after Internet tools and middleware.

Software development tools

Software development tools account for the smallest market share of the three segments, with around one-fifth of the world market for packaged software in 1999. The segment is divided into: *i*) database management system tools; *ii*) components, objects and development environments (CODE), which are used to write code for software programmes; *iii*) development life cycle management (DLM) to support the software development process; and *iv*) Internet tools.

With 9.4%, database management systems, used to manipulate information in databases, has the largest share of the overall packaged software market within this segment. For the other software development tools, growth will be driven by the increasing demand for Internet-related software, in particular owing to the need to provide Internet access to databases.

Finally, although still small, Internet tools are projected to have the highest growth rates of all software types considered, with a projected annual growth rate of 34.1% between 1998 and 2003. Growth in this area should be driven by increasing business demand for e-commerce solutions and overall very rapid growth of Internet use for a widening range of other applications.

Open source

Open source software refers to software whose source code is publicly available.[24] While open source has been around since the early development of the computer industry, the communication possibilities made possible by the Internet has significantly boosted open source development. Open source software is covered more extensively in Chapter 7.

Industry structure

Technical innovation, new entrants, alliances, mergers and acquisitions (M&As) and fierce competition are characteristics of the software sector that lead to rapidly changing market structures. This section focuses on firm-level developments, particularly on leading firms, strategic alliances, M&As, new entrants and global market concentration.

Leading vendors worldwide

Leadership tends to be a short-term phenomenon in software markets. Changes in top positions can be illustrated by looking at the different products that have dominated software markets in the past. For example, no product had more than 12 years with at least 25% of the market in the following market segments for PC software: word processors, spreadsheets, databases, personal finance and operating systems. The product which was a leader longest is DBASE, a database application software produced by Ashton-Tate, which maintained its leadership from 1981 to 1993 (see Annex Table 3.15).

However, for the first time in the history of the software industry, a single company, Microsoft, leads in most of the selected market segments for PC software. Network effects derived from the fact that it is the leader in several related markets may help extend its leadership.

Besides changes in leading positions, the growth in revenues of top companies is striking. A comparison of the revenues obtained by the top ten vendors of PC applications software in 1983 (USD 355 million) and in 2000 (USD 30.8 billion) (Softletter, 2001) reflects the spectacular growth of the industry (see Annex Table 3.16).

Software Magazine's ranking of the world's top software and related services suppliers provides a good illustration of the market structure of the software sector. In 2000, the top 20 software and services vendors accounted for more than one-third of total sales of packaged software and IT services. The fierce competition and constant technological innovation that characterise the industry can also be illustrated by the different positions held by current leading firms in previous rankings. However, despite considerable churning at the top, three of the current leading software vendors have been among the top five from 1996: IBM, Microsoft and Oracle.

Table 1 lists the top 20 software vendors in 2000, their software-related revenue (licenses and services), their main corporate industrial activity and their primary software business. As regards main industrial activity, they can be broken down into independent software vendors, hardware manufacturers and consulting firms.

Table 2 shows 1999 revenues broken down by license (*e.g.* packaged software) and services. Independent software vendors and hardware manufacturers are active in both segments; consulting firms only provide services. The top ten firms by license revenue concentrate 34% of the value of the world's packaged software sales, as estimated by IDC. On the other hand, the top ten firms by services revenue account for only 10% of the overall market for IT services. The market for IT services is thus less concentrated and enjoys higher revenues than the market for packaged software, with total market size of IT services more than five times the market for packaged software.

Independent software vendors

Independent software vendors are companies whose primary activity is the development and supply of software. Examples include the companies listed in Table 1 whose primary business falls under US SIC 7371 (computer programming services) or 7372 (packaged software), such as Microsoft, Oracle and Computer Associates.

In 1999, Microsoft ranked first in terms of packaged software sales (license revenue), at almost twice the revenues of IBM (Table 2). Microsoft has a strong presence in all packaged software market segments: in system infrastructure software with the Windows operating system, in business applications software with its Office Suite and in software development tools with Visual Basic.

Other independent software vendors hold top positions in packaged software market sub-segments but are also active in other software market segments, such as Computer Associates in system management software, the German-based SAP AG in enterprise resource management (ERP) and Oracle in databases.

Independent software vendors often provide both packaged and customised software. However, owing to lack of information, it is not possible to distinguish between these two types of revenues.

Hardware manufacturers

Hardware manufacturers have long been at the top of the ranking of software vendors. From the early 1960s, computer manufacturers supplied software together with hardware. Some was system infrastructure software, and some was applications software designed for the specific requirements of large customers installing computer systems.

Table 1. **Top 20 software vendors, 2000**

Ranking 2000	Company	Software and services revenue (USD millions)	US SIC	Primary software business
1	IBM Corp.	45 750.0	3570	Middleware, connectivity, application servers, Web servers, operating system
2	Microsoft Corp.[1]	23 845.0	7372	Desktop applications, operating system
3	PricewaterhouseCoopers[2]	21 500.0	–	IT services, sourcing, consulting
4	EDS	19 227.0	7370	IT services, sourcing, consulting
5	Oracle Corp.[1]	10 745.1	7372	Databases
6	Hewlett-Packard Co.[3]	10 397.0	3570	Infrastructure and systems management, middleware, connectivity, operating system
7	Accenture	10 276.0	7389	IT services, sourcing, consulting
8	Cap Gemini Ernst and Young[4]	8 064.4	7371	IT services, sourcing, consulting
9	Compaq Computer Corp.[3]	7 352.0	3570	IT services, sourcing, consulting, operating system
10	Unisys Corp.[3]	5 843.2	7373	Infrastructure and systems management, middleware, storage management
11	SAP AG	5 797.0	7372	ERP
12	Computer Associates International Inc.[5]	5 515.0	7372	Management of Infrastructure, performance, assets, systems
13	Hitachi Ltd.[6]	5 300.0	3570	Management of Infrastructure, performance, asset, systems
14	Sun Microsystems Inc.[1, 3]	4 668.9	3571	Application development and testing tools, middleware, connectivity, servers, operating system
15	NCR Corp.	3 010.0	7374	Data warehouses, query tools, OLAP
16	Compuware Corp.	2 077.6	7372	Application development, testing and lifecycle tools
17	Siebel Systems Inc.[7]	1 795.4	7372	CRM
18	PeopleSoft Inc.	1 736.5	7372	ERP
19	SunGard Data Systems Inc.	1 660.7	7374	Financial application
20	Fiserv Inc.	1 653.6	7374	ASP, MSP

Note: The ranking is based on total worldwide software/services revenue, which comprises license revenue, maintenance and support, training and software-related services revenue. Suppliers are not ranked on their total corporate revenue, since many have other lines of business, such as hardware or entertainment/gaming software. When possible, revenues are based on the calendar year so that all firms are measured over the same four quarters. Financial information was gathered from *Software Magazine's* vendor survey, public documents, press releases, SEC filings and industry analysts. Official US SIC classifications from EDGAR (*www.edgar-online.com*), except for privately owned companies (*e.g.* PricewaterhouseCoopers). Primary software business as reported by *Software Magazine*.

1. Calendar year revenue annualised from quarterly filings. Fiscal year ends 30 June 2000.
2. Revenue reflects fiscal year ending 30 June 2000.
3. Total software/services revenue includes estimated software revenue, based on 1999 estimates by IDC.
4. Revenue is pro forma, includes Ernst and Young.
5. Revenue is pro forma, pro rata, as the company has changed its business model and the way it reports revenue.
6. Revenue reflects fiscal year ending 31 March 2001.
7. Revenue restated to reflect acquisitions.

Source: OECD, based on *Software Magazine* (2001), "2001 Software 500", June.

System infrastructure software was included in the price of the hardware ("bundled") and not invoiced separately, while applications software was usually the object of a turnkey contract. Some manufacturers also designed custom software as part of their time-sharing services. But the ancillary status of software as a sales support for hardware evolved over the 1960s and 1970s, particularly from 1969, when the US Department of Justice required IBM to invoice its hardware and software separately. This arrangement, by which hardware manufacturers supplied software separately ("unbundled"), is regarded as having founded the software market and thereby the software industry (OECD, 1985).

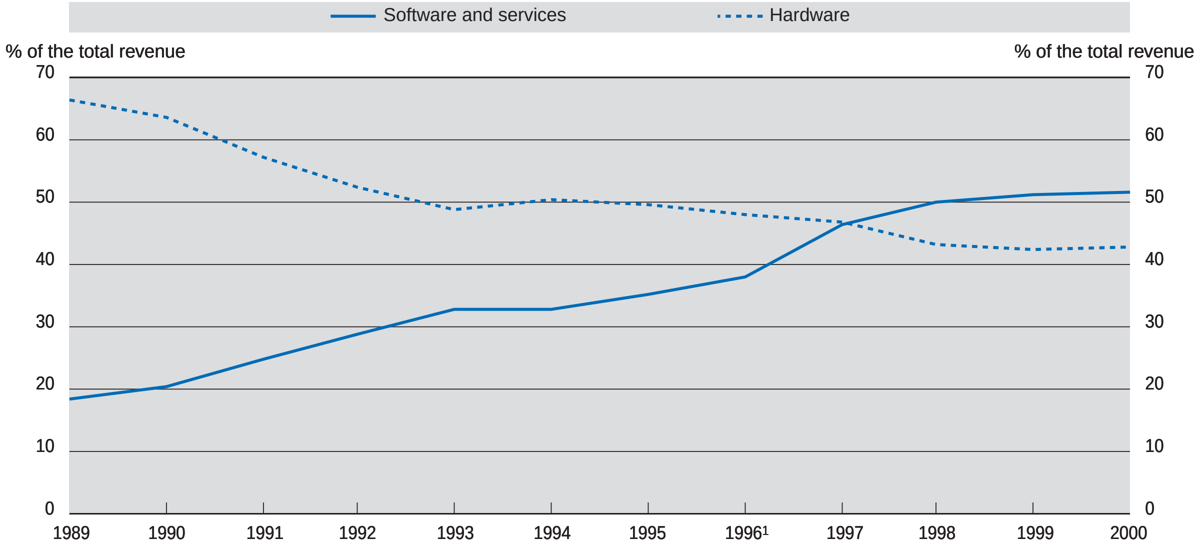
IBM is the only hardware manufacturer that has remained a leading software vendor since then, a position consolidated in 1995 with its acquisition of Lotus. The increasing importance of its software products and services sales is reflected in the fact that software-related revenue surpassed hardware sales in 1997 and continues to grow (Figure 8).

Table 2. **Leading vendors worldwide by license and service revenues, 1999**

Top ten by software license			Top ten by service revenue		
1999 overall ranking	Company	License revenue (USD millions)	1999 overall ranking	Company	Service revenue (USD millions)
2	Microsoft Corp.	21 591	1	IBM Corp.	32 200
1	IBM Corp.	12 700	3	PricewaterhouseCoopers	17 300
8	Computer Associates International Inc.	4 962	5	Andersen Consulting LLP	8 941
4	Oracle Corp.	3 873	7	Compaq Computer Corp.	6 623
6	Hewlett-Packard Company	2 542	6	Hewlett-Packard Company	6 192
10	SAP AG	1 946	4	Oracle Corp.	5 455
11	Sun Microsystems Inc.	1 302	10	SAP AG	3 125
20	Unisys Corp.	1 207	12	Bull Worldwide Information Systems	2 790
7	Compaq Computer Corp.	1 156	14	Ernst and Young LLP	2 000
19	Novell Inc.	1 092	11	Sun Microsystems Inc.	1 935
	Top ten total	**52 371**		**Top ten total**	**86 562**

Note: Software license revenue estimates provided by IDC for Hewlett-Packard Company, Unisys Corp. and Compaq Computer Corp.
Source: *Software Magazine*, 2000.

Figure 8. **Share of software and services in IBM revenue, 1989-2000**



Note: Break in series in 1996.
Source: OECD, based on annual reports.

Consulting firms

Consulting firms have been ranked among the top positions since 1999, owing to a change in *Software Magazine*'s definition of "software vendor" to reflect the software industry's shift to a services-based business model. In that year, *Software Magazine* added revenues from training and software-related services to the revenues used to build the ranking of top software vendors; it had previously counted only license fees and revenues from product maintenance and support.

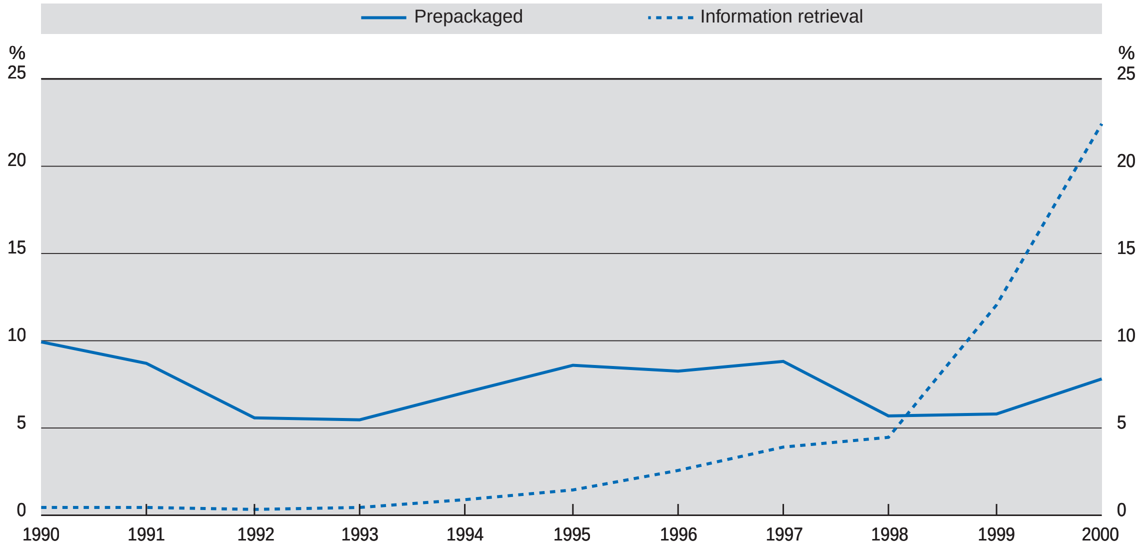
The success of IT consulting services began in the 1980s, mainly owing to the popularisation of automated internal processing, which required re-engineering, for example ERP systems. Companies such as EDS, Cambridge Technology Partners, Cap Gemini Sogeti and the Big Five accounting firms led sales at the time.

The last few years have seen a major reorganisation in the largest traditional accountancy and consulting firms, in an effort to adapt to, and profit from, new Internet-related business models. The increasing need to make e-business methods profitable has fostered the application of traditional management consulting services to IT applications. Recent strategic alliances between traditional consulting firms and software producers have helped configure these new business models. Examples are the acquisition of the consulting arm of Ernst and Young by Cap Gemini Sogeti, and Cisco Systems' alliances with KPMG Consulting and Cap Gemini Sogeti. Three of the Big Five accountancy and consulting firms are now among the world's top 10 software vendors: PricewaterhouseCoopers, Accenture (formerly Andersen Consulting) and Cap Gemini Ernst and Young (Table 1).

Strategic alliances

Software is becoming one of the most popular areas for strategic alliances, whether or not the partners belong to the software sector. Strategic alliances are commonly seen as a way to gain access to needed complementary capabilities. This explains why companies outside the software sector enter into software-related alliances. The number of software-related strategic alliances has increased strongly in the last few years. In particular, strategic alliances to provide information retrieval services (which mainly cover Internet-related activities) represented around one-third of all strategic alliances in 2000. Figure 9 shows the share of alliances mainly concerned with packaged software and information retrieval services, the software-related areas with the highest number of strategic alliances as a percentage of all announced strategic alliances between 1990 and 2000.

Figure 9. **Share of selected software-related strategic alliances in all announced alliances, 1990-2000**



Note: The selected software-related strategic alliances comprise those mainly concerned with packaged software (US SIC 7372) or information retrieval services (US SIC 7375).

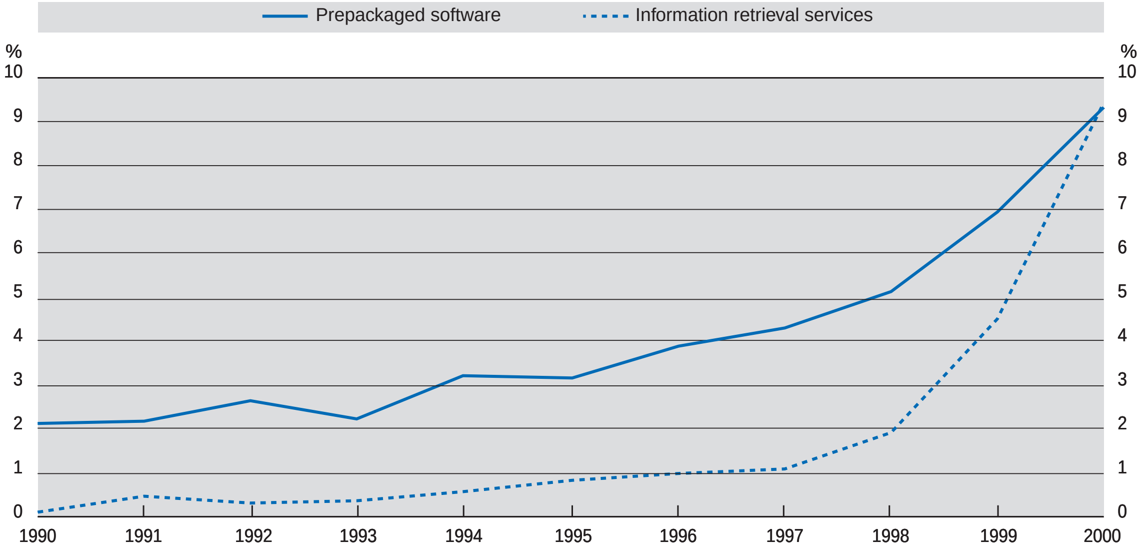
Source: OECD, based on Thomson Financial.

Mergers and acquisitions

Software companies are very active in mergers and acquisitions. Growth by acquisition is a common strategy in the software industry: according to *Software Magazine*, 36% of the top 500 software vendors acquired at least one company during 2000. Software developers and suppliers are among the most common targets for cross-sectoral M&As, with financial institutions and telecommunications companies among the top acquirers. Within the broadly defined software sector, M&As between software developers and providers of computer-related services are relatively frequent (OECD, 2001).

Figure 10 shows that, as for strategic alliances, packaged software and information retrieval services are also the software-related areas with the highest number of M&As as a percentage of all completed M&As between 1990 and 2000. Overall, as many as 10% of all completed M&As in 2000 involved providers of packaged software, and another 10% involved firms providing information retrieval services.

Figure 10. **Share of selected software-related M&As in all completed M&As, 1990-2000**

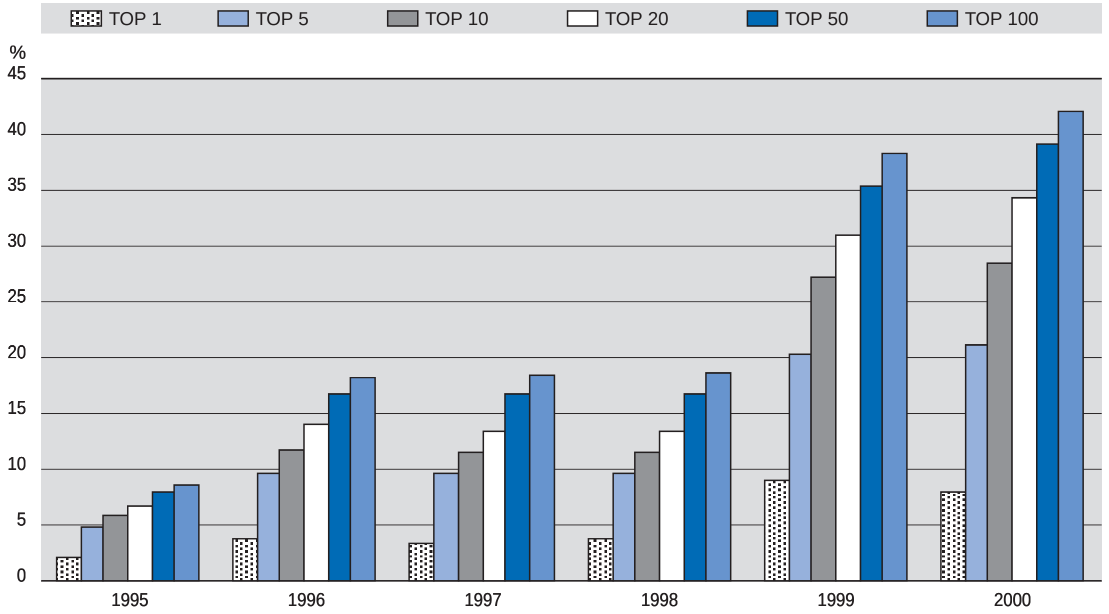


Note: The selected software-related M&As comprise deals for which the primary activity of the target or the acquirer is packaged software (US SIC 7372) or information retrieval services (US SIC 7375).
Source: OECD, based on Thomson Financial.

Supply-side concentration

The market share of the world's top software vendors has increased regularly (Figure 11). However, a closer look shows that much of this is due to changes in the definition of software vendors and the reclassification of very large firms. The substantial increase in concentration ratios between 1995 and 1996 was largely due to the reclassification of IBM as a software vendor after its acquisition of Lotus in 1995. While IBM was not among the top 100 software vendors in 1995, it ranked first in 1996. In addition, the inclusion of revenue from training and software-related services in total software and services revenues since 1999 not only increased the range of software-related revenues considered to determine the ranking, but also added two of the world's largest consulting and accountancy firms to the top 100 software vendors in 2000: PricewaterhouseCoopers in third place and Cap Gemini Ernst and Young in eighth. In 2000, although the share of the top vendor (IBM) declined slightly, concentration ratios for the top 5, top 10, top 20, top 50 and top 100 software firms all increased (see Annex Table 3.17).

Figure 11. **Share of top software and services vendors on world markets, 1995-2000**



Note: Break in series in 1999. Software and services revenues until 1998 only include license fees and revenues from product maintenance and support. Revenue from professional services/consulting, custom programming, training and hardware sales was excluded. In 1999, revenue from training and software-related services was added.

Source: OECD, based on data from *Software Magazine* and WITSA/IDC.

Recent data show that while the industry leader significantly increased its share between 1997 and 2000 in the United Kingdom, its share has remained stable over the period both in Germany and Italy, and has decreased in both France and Spain (see Annex Table 3.18). Concentration ratios in the software industry should nevertheless be treated with caution, as they may be affected by changes in the definition of software markets and software vendors.

New *entrants*

In spite of a few large players, the software sector is relatively fragmented and remains much less concentrated than computer hardware, for example. Some commentators suggest that the predominance of a fringe of small companies in the industry will be reinforced by the move to component-based software development, which will lead to greater specialisation and foster the creation of strategic alliances and further globalisation of software supply (Nowak and Grantham, 2000). On the other hand, network effects may lead to increasing consolidation; despite high entry rates, large established firms tend to acquire successful start-ups to acquire new technologies or reach new markets. New entrants are nevertheless an important driver of competition in software and services markets, where close to 40% of the top 500 vendors in 1999 were founded after 1990.[25]

A large part of this new fringe consists of start-ups born from partnerships between entrepreneurs and venture capitalists. Both private and public investment is increasing, with funds coming from public sector grants, public-private partnerships and business incubators (often working in conjunction with state and regional funds) as well as private venture capitalists. In addition to financial resources, external support is also essential, including access to low-cost infrastructure, adequate management skills and knowledge and marketing resources.

The share of software in technology venture capital investments has remained relatively constant in the last few years in both the United States (around one-sixth) and Europe (around 30%), although these ratios are not directly comparable owing to methodological differences in surveys (Table 3).

Table 3. **European and US software venture capital investments,[1] 1996-2001**

	1996	1997	1998	1999	2000	2001
United States						
Software (USD millions)	1 736	2 932	3 675	8 311	16 978	6 851
As a percentage of total technology	18.0	20.4	19.2	15.8	17.0	18.8
Europe						
Software (USD millions)	. .	. .	. .	2 247	3 819	. .
As a percentage of total technology	. .	. .	. .	30.9	31.3	. .

1. Amounts may be not comparable owing to methodological differences across regions.
Source: OECD, adapted from PricewaterhouseCoopers (2002 for the United States and 2001 for Europe).

However, total European technology venture capital investments are only a fraction of those in the United States, which may help explain why Europe and the rest of the world lag the United States in software industry developments.

Conclusion

The software sector will continue to undergo dynamic change, driven by innovation and business strategies. Provision of software applications services is one emerging trend already evident in the appearance of some of the world's largest consulting firms among software vendors; it will be reinforced if outsourcing continues to gain acceptance. The Internet and the move to network computing will facilitate this type of software supply which now focuses on certain software segment applications (e-mail and ERP) and may extend to all kinds of e-commerce and specialised software services. Application service providers (ASPs) include new entrants such as Verio, as well as established software vendors (Oracle, Sun Microsystems, IBM) that are facing competition from new entrants in this emerging market segment (US Department of Commerce, 2000*b*).

The rivalry between open and proprietary source code software will intensify, with most of the large software vendors already supporting the open source movement. This may become one of the drivers of changes in market structure.

Integration and greater compatibility of software products are crucial in a world where interconnection, e-commerce and automation of business functions are increasingly important. Open standards and the open source movement may help to meet this need. On the other hand, new business models, such as software outsourcing to ASPs, may help small and medium-sized enterprises keep pace with the constant technological changes that characterise the software industry, without incurring substantial sunk costs. Software companies will have to take these new trends in software development and supply into account.

NOTES

1. The broadly defined software sector comprises computer and related activities (ISIC 72). For countries for which information is available, value added of the narrowly defined software sector (software consultancy and supply: ISIC 7220) represents a large share of the value added of computer and related activities (ISIC 72), ranging in 1998 from 86% for Sweden to 44% for France.
2. As improved data become available, cross-country value added per employee trends and comparisons for the sector could be explored in more detail.
3. As in the case of value added, core software activities (software consultancy and supply: ISIC 7220) represent a large share of total employment in computer and related activities, ranging from 84% for Sweden to 41% for France in 1998.
4. According to US Bureau of Labor Statistics data. Computer related occupations are considered to be engineering, natural science and computer and information system managers, database administrators, systems analysts, computer programmers, computer engineers, computer support specialists, all other computer scientists, data entry keyers and computer operators.
5. "Informaticiens", *i.e.* computer engineers and computer technicians, excluding maintenance.
6. The estimation of price indices for rapidly evolving ICT products is very difficult. Quality improvements in software are even more difficult to measure than in hardware. For recent work on this issue, see Colecchia and Schreyer (2001).
7. Colecchia and Schreyer (2001) give a brief description of deflation methods applied to ICT assets across selected countries, including the United States.
8. Data on business enterprise expenditure on R&D (BERD) include both costs of in-house production financed by own funds and the purchase of R&D from third parties.
9. Since the 1993 edition of the OECD statistical guidelines (*Frascati Manual*), a software development project is classified as R&D if its completion is dependent on the development of a scientific and/or technological advance, and the aim of the project is resolution of a scientific and/or technological uncertainty on a systematic basis. As a result, software-related activities of a routine nature, or technical problems which have been overcome in previous projects, are not considered to be R&D. It is also worth noting that R&D expenditures also include software activities undertaken as part of an overall R&D project (Young, 1996).
10. One of the main difficulties for counting software patents is that patent classes tend to be broken down by technological fields and that software inventions may cover several. Ongoing work at the OECD aims at identifying international patent classes related to e-commerce, ICT (hardware and software) and biotechnology.
11. Each patent is assigned a single original patent classification by the US Patent and Trademark Office (USPTO), and often several other cross-reference classifications. Counting patents by their original classification prevents double counting.
12. The USPTO does not provide information on the number of patents originally classified under patent classes 703, 716 and 717. See USPTO, 2000.
13. Searching for the word software in the patent claim instead of the patent description provides lower figures for software-related patents.
14. The system of National Accounts 1993 (SNA 93) stipulated that software purchases by firms, subject to certain conditions, should be considered as investment. Previously, software expenditures were accounted as gross fixed capital formation when integrated into purchases of hardware, and as intermediate consumption otherwise (OECD, 2000*b*; Colecchia and Schreyer, 2001). Khan (2001) provides a comparison of information from private sources and national accounts on investment in software. According to SNA 93, software only qualifies as an intangible investment if not bundled with hardware (when it is counted as a tangible asset under "machinery and equipment"), if it is used for more than one year and if its cost exceeds a certain threshold. Otherwise it is counted as intermediate consumption. Countries have only recently started to apply this new system and several measurement and methodological differences need to be addressed before proper

international comparisons can be made, in particular: *i)* the interpretation of what should be treated as software; *ii)* the valuation of own-account software; and *iii)* the choice of appropriate deflators to measure investments in real terms. For an analysis of the contribution of software expenditures to output growth, see Colecchia and Schreyer (2001).

15. OECD (1998) illustrates some of these problems: "If a company sells a software application and manuals abroad directly, the operation can be recorded as exports of goods. If it sells them to a computer company which loads them on its computers before export, they will be included in the value of the computers that are exported. If instead a copy of the software is sold to a foreign firm which pays royalties to make further use of it, this operation will appear in the balance of payments as an export of business services. To complicate the matter further, if a company opens a branch abroad, the income accruing from software sales will be recorded as the income of the branch and will be a component in its profits. When these are remitted to the home country, they will appear in the balance of payments as *investment income*."
16. Enterprise Ireland Software Industry Statistics for 1993-2000, at: *www.nsd.ie/htm/ssii/stat.htm* (viewed in January 2002).
17. "The Irish software industry – a European success story" at *www.techwatch.ie/fea/1998_314.htm* (viewed in May 2001).
18. "Ireland, the software capital of Europe" at *www.enterprise-ireland.ie/connect-profiles.asp?sectorid=19* (viewed in January 2002).
19. Computer services accounted for 100% of computer and information services trade in Ireland, 1998-2000. Information services trade alone was below the statistical significance threshold (conversation with experts from the Irish Central Statistical Office, 14 February 2002).
20. "Ireland as an offshore software location" at *www.nsd.ie/inflitof.htm* (viewed in April 1999).
21. Enterprise Ireland Software Industry Statistics for 1993-2000, at: *www.nsd.ie/htm/ssii/stat.htm* (viewed in January 2002).
22. ERP software consists of cross-industry applications that automate firms' business processes. Common applications include human resources, manufacturing and financial management (US Department of Commerce, 2000*b*).
23. CERT Coordination Centre, *www.cert.org/stats/cert_stats.html* (viewed in May 2002). CERT/CC defines an incident as "the act of violating an explicit or implied security policy" and includes in this definition: *i)* attempts (failed or successful) to gain unauthorised access to a system or its data; *ii)* unwanted disruption or denial of service; *iii)* unauthorised use of a system for the processing or storage of data; *iv)* changes to system hardware or software characteristics without the owner's knowledge, instruction or consent.
24. For a more specific definition, see DiBona *et al.*, 1999, Appendix B, The Open Source Definition, Version 1.0.
25. "In like a legacy, out like an e-business" at *www.softwaremag.com* (viewed in May 2001).

REFERENCES

CBS/Statistics Netherlands (2000),
R&D en software-onderzoek bij bedrijven in Nederland, CBS/Statistics Netherlands, Voorburg.

Colecchia, A. and P. Schreyer (2001),
"ICT investment and economic growth in the 1990s: is the United States a unique case? A comparative study of nine OECD countries", OECD STI Working Papers 2001/7.

C. DiBona, S. Ockman and M. Stone (1999),
Open Sources, O'Reilly.

Goldman Sachs (2000),
"Internet Global", 6 October 2000.

Hagel, J. and A.G. Armstrong (1997),
Net Gain, Harvard Business School Press.

INSEE (2000),
L'emploi dans les services marchands, Paris.

Khan, M. (2001),
"Investment in Knowledge", OECD STI *Review*, No. 27.

Lerenard, A. and A. Tanay (1998),
L'emploi dans le secteur des technologies de l'information et des télécommunications, *Premières Informations et Premières Synthèses*, DARES, ministère de l'Emploi et de la Solidarité.

Nowak, M.J. and C.E. Grantham (2000),
"The Virtual Incubator: Managing Human Capital in the Software Industry", *Research Policy*, 29.

OECD (1985),
Software: An Emerging Industry, OECD, Paris.

OECD (1998),
Measuring Electronic Commerce: International Trade in Software, OECD, Paris.

OECD (1999),
"Electronic Commerce: Case Studies on the 'Downloadable' Digital Products", internal working document.

OECD (2000*a*),
Information Technology Outlook 2000, Paris.

OECD (2000*b*),
"Software in the National Accounts: Recent Developments", STD/NA(2000)37.

OECD (2001),
New Patterns of Industrial Globalisation: Cross-Border M&As and Alliances, Paris.

PricewaterhouseCoopers (2001),
Money for Growth: the European Technology Investment Report.

PricewaterhouseCoopers (2002),
MoneyTree Survey 1995-2000.

Schumpeter, J.A. (1950),
Capitalism, Socialism and Democracy, Harper.

Softletter (2001),
The 2001 Softletter 100. *www.softletter.com*

US Department of Commerce (2000*a*),
Digital Economy 2000, Washington, DC.

US Department of Commerce (2000*b*),
US Industry and Trade Outlook 2000, Washington, DC.

US Department of Commerce (2001),
Survey of Current Business, December 2001 issue, US International Services, Washington.

US Department of Commerce (2002),
Digital Economy 2002, Washington, DC.

US Patent and Trademark Office (2000),
"Patent Counts by Class by Year: January 1977-December 1999", Washington, DC, April.

Young, A. (1996),
Measuring R&D in Services, STI Working Paper, OCDE/GD(96)132.

Chapter 4

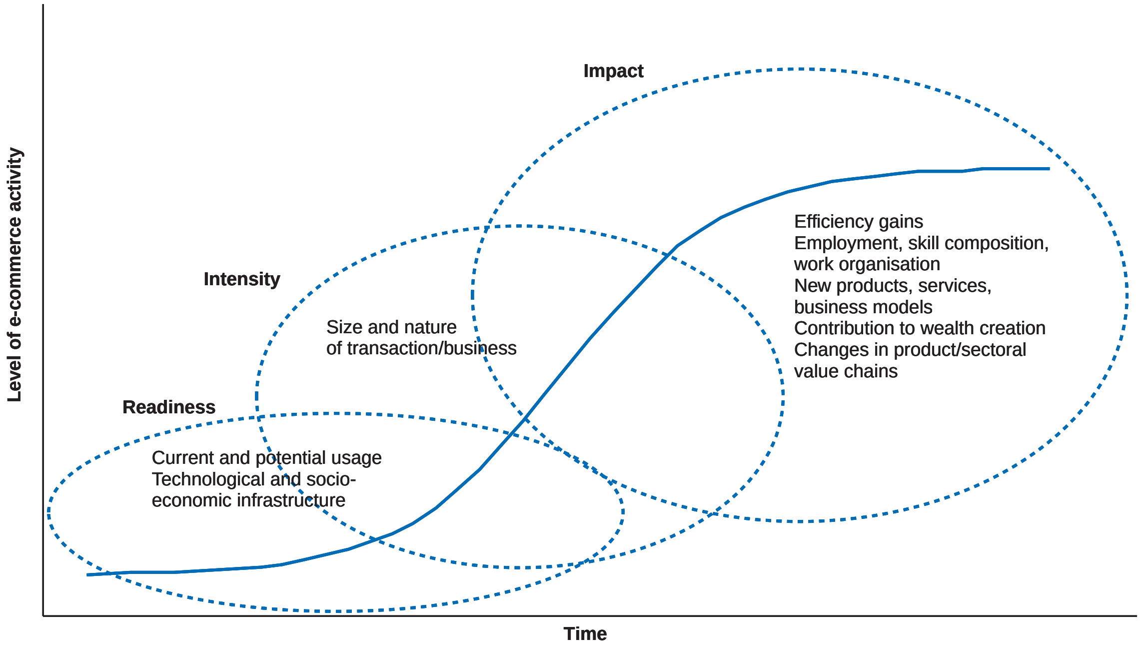
E-COMMERCE INTENSITY

Introduction

Electronic commerce has the potential to alter economic activity and the surrounding social environment. This will require new frameworks for conducting business and create new challenges for policy makers. To focus the policy debate, especially in the light of the recent exuberance and subsequent crash in the market value of "dot com" firms, reliable electronic commerce metrics are needed to track developments in this medium and understand its impact on our economies and societies.[1]

Figure 1 gives a useful representation of needs with respect to electronic commerce metrics in the three areas of the S-shaped diffusion path of new technologies.[2] At an initial stage, information on enabling factors and barriers to electronic commerce is needed (*e-readiness* indicators); at a more mature stage, information on the intensity of electronic commerce is needed to enable policy makers to address imbalances (*e-intensity* indicators); at an even later stage, information that makes it possible to measure the impact of electronic commerce on the economy and society is needed (*e-impact* indicators).

Figure 1. **User needs for e-commerce indicators**



Source: OECD (1999), based on Industry Canada.

The degree of *e-readiness* requires indicators that reflect the country's socio-economic and technological infrastructure and its use. Particularly important are indicators that express the potential for readiness, *i.e.* the propensity of individuals, businesses or governments to transact or carry out business electronically (*e.g.* indicators of credit card use, indicators of the barriers or the perceived benefits to electronic commerce). E-*intensity* indicators give information on the size, growth and nature of electronic commerce transactions/business. It is important to know: for what component of a transaction electronic commerce is used (*e.g.* information gathering, purchase, sale, payment) or in what business function; who are the actors involved in the transaction/business and what are their socio-economic characteristics; what are the products and services involved; and whether the transaction is domestic, international, urban or rural. The *e-impact* indicators would focus on the value added generated by the use of electronic business processes, such as the impact on production processes and business models, on the workplace and more generally on society.

This chapter focuses on *e-intensity* indicators, in particular on the use of the Internet to purchase and sell, as well as on the nature and volume of electronic commerce transactions. In the aftermath of the "dot com" crash, many "virtual" start-ups that sold and/or purchased exclusively on line have disappeared. Overall, the growth of electronic commerce transactions has been less spectacular than some consultants had predicted. On the other hand, newly available official statistics show that, while still small, the volume of electronic transactions is growing and that the Internet is increasingly being used as a channel for transactions, especially purchases.

The chapter begins by defining what is meant by electronic commerce transactions and by highlighting some of the relevant measurement issues. Available and comparable official statistics for measuring electronic transactions are still limited. This chapter uses the few high-quality indicators available to capture the nature and volume of electronic commerce transactions and identify common trends across countries, sectors and firm size. Finally, it exploits existing surveys to discuss some of the benefits of and barriers to electronic commerce transactions as perceived by businesses and individuals.

Defining and measuring electronic commerce transactions

The need for statistics that measure the level, growth and composition of e-commerce has fuelled the increase in e-consultants who provide many kinds of "e-estimates" that cannot be easily compared. Despite very recent efforts by national statistical offices, internationally comparable statistics measuring the level, growth and composition of electronic commerce transactions are not yet available. Comparisons are hampered by the use of different definitions across countries as well as by differences in survey coverage. The United States, for example, does not produce economy-wide estimates and uses a broad definition that includes sales over "Internet, extranet, electronic data interchange (EDI)[3] or other on-line systems". France currently only published estimates of Web retail sales. Figures for the Nordic countries refer to sales via a Web page and do not cover the financial sector. Australia and Canada have similar definitions and coverage of Internet transactions.

To improve the comparability of estimates of electronic commerce transactions, OECD Member countries endorsed, in April 2000, two definitions of electronic transactions (electronic orders), based on narrower and broader definitions of the communications infrastructure. According to the OECD definitions, the method by which the order is placed or received, not the payment or the channel of delivery, determines whether the transaction is an Internet transaction (conducted over the Internet) or an electronic transaction (conducted over computer-mediated networks). In 2001, the OECD developed guidelines for interpreting the definitions of electronic commerce and encouraged Member countries to take such guidelines into account when developing their questionnaires (Table 1).

The OECD definitions of electronic commerce transactions, as well as a list of core electronic commerce indicators that Member countries seek to measure on an internationally comparable basis, have been incorporated into the OECD model questionnaire on ICT usage in businesses.[4] This chapter makes an attempt to exploit some of the most recent official statistics. Given that efforts to harmonise

Table 1. **OECD definitions of electronic commerce transactions and proposed guidelines for their interpretation**

E-commerce transactions	OECD definitions	Guidelines for the interpretation of the definitions (WPIIS proposal April 2001)
BROAD definition	An **electronic transaction** is the sale or purchase of goods or services, whether between businesses, households, individuals, governments, and other public or private organisations, conducted over **computer-mediated networks.** The goods and services are ordered over those networks, but the payment and the ultimate delivery of the good or service may be conducted on or off line.	**Include:** orders received or placed on any on line application used in automated transactions such as Internet applications, EDI, Minitel or interactive telephone systems.
NARROW definition	An **Internet transaction** is the sale or purchase of goods or services, whether between businesses, households, individuals, governments, other public or private organisations, conducted over the **Internet.** The goods and services are ordered over the Internet, but the payment and the ultimate delivery of the good or service may be conducted on or off line.	**Include:** orders received or placed on any Internet application used in automated transactions such as Web pages, extranets and other applications that run over the Internet, such as EDI over the Internet, Minitel over the Internet, or over any other Web-enabled application regardless of how the Web is accessed (*e.g.* through a mobile or a TV set, etc.). **Exclude:** orders received or placed by telephone, facsimile or conventional e-mail.

Source: OECD.

these statistics are very recent, that in some countries the surveys have been carried out for the first time and that there exist differences in collection vehicles, international comparisons of electronic commerce transactions should be interpreted with caution (see Box 1).

The use of the Internet in transaction-related business processes

A pattern that emerges from the available surveys is that different applications (*e.g.* Web, extranet, EDI) are used for different business processes. One implication is that there will be a different degree of substitutability among electronic commerce technologies. The use of Internet-based applications, for example, has emerged in every country as a medium for sharing information and for marketing; the introduction of low-cost Internet applications for procurement, however, promotes the use of the Internet for purchasing. The rate of diffusion of Internet applications across countries will thus differ and will depend on the prior use of alternative technologies/applications to perform the same business functions and on the cost of switching to the Internet.

The Internet is still mostly used by enterprises to provide and access information (marketing, information search). In some countries a large proportion of businesses using the Internet also use it to carry out financial transactions (*e.g.* 84% in Finland, 70% in Denmark and 36% in Australia). However, the Internet is still rarely used to carry out transactions (sending and receiving orders).

The International Benchmarking Study[5] (Department of Trade and Industry – DTI, 2000) contains information on the use of different applications for ordering goods from suppliers or accepting orders from customers (e-mail, Web site/Internet, extranet or EDI). Of the four applications considered, e-mail is generally the one most used for receiving orders on line, while extranets are least used.[6] For the eight countries covered in the report, 9% of businesses[7] on average allowed their customers to use an extranet to order on line, compared with 20% for EDI, 65% for the Web and 74% for e-mail. EDI orders were highest in France (31%) and lowest in Sweden (10%). E-mail was least popular for on-line orders in France (51%) and most popular in Italy (85%). In the case of purchases, Web applications are used more frequently than e-mail orders.

Box 1. Measuring electronic commerce transactions

Although OECD Member countries have agreed on two definitions of electronic commerce transactions and on some general guidelines for their interpretation, several issues remain open and will continue to be discussed. The definitions and guidelines will be reviewed in light of their statistical feasibility. Some of the issues still to be debated relate to definitional issues and some to the typical structure of Member countries' data collection programmes. They include:

- How to measure electronic commerce transactions in the financial sector. Ideally, one would collect only the value of fees on those transactions. Some countries avoid the problem by not surveying the sector (*e.g.* the Nordic countries), but this poses a problem of differences in survey coverage.
- Assuming that organisations will not necessarily know the value of electronic commerce transactions undertaken on their behalf, how to capture this information. For example, the Canadian 2000 survey excludes sales of the organisation's goods and services by agents as well as those for which the respondent is an agent.
- What income concept to use to produce an indicator of electronic commerce sales as a ratio of total sales, *e.g.* operating revenue, turnover, sales? Should it vary according to the sector for which transactions are measured?

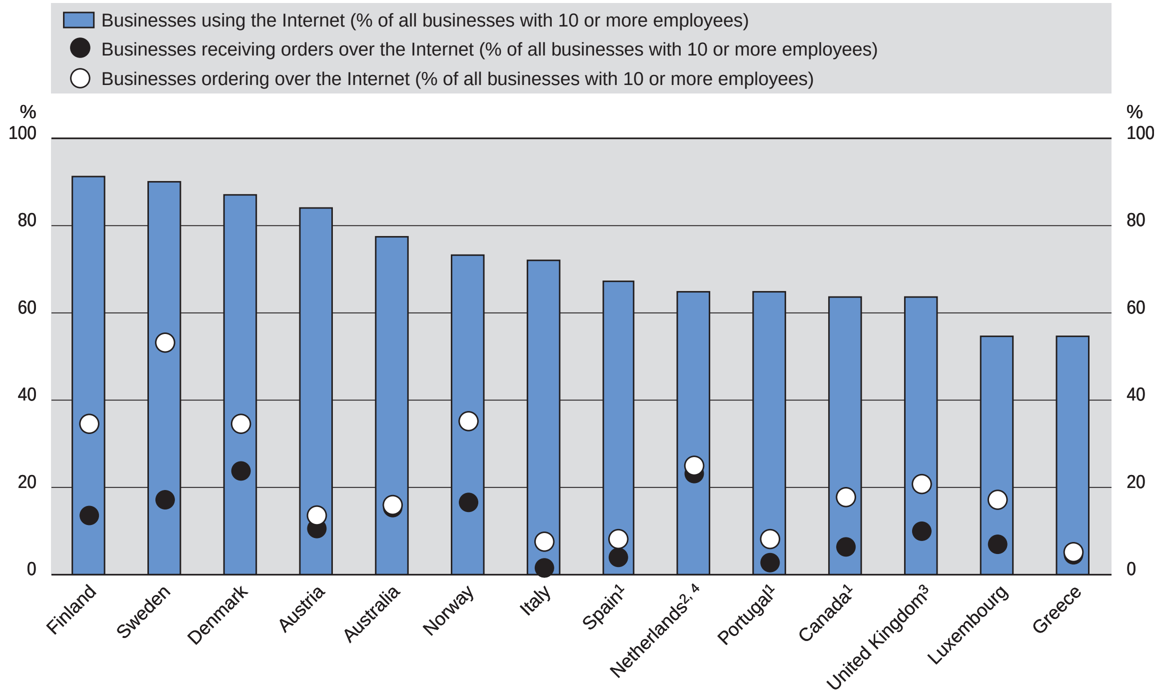
Examples of issues relating to the structure of countries' data collection programmes are:

- Relatively few businesses or households may currently engage in electronic commerce, so the absolute numbers appearing in samples of businesses or households are likely to be small.
- Some key industries may consist of a small number of businesses, making it difficult to publish statistics that do not disclose confidential information.
- Recently, many businesses have entered and exited electronic commerce activities and changed the nature of those activities relatively quickly when looked at in the light of the rate at which governments update the business registers from which they draw their samples.
- Many electronic commerce transactions of interest occur within businesses, but data collection programmes typically focus on transactions between and not within businesses.
- Survey vehicles differ in coverage (sector and firm sampling) as well as in timing. Some business surveys are based on enterprises, some on establishments (this adds the problem of double counting the value of transactions when calculating a total). Values of purchases measured from household surveys raise the problem that the person interviewed responds on behalf of other individuals in the household. Even purchases measured by surveys of individuals require the choice of a common reference period for the transaction.

National statistical surveys of business enterprises provide information on the extent to which the Internet is used to carry out transactions. Although rising fast, this use of the Internet remains limited and varies according to the business's position in the value chain (customer or supplier). For 15 countries for which both Internet purchasing and Internet sales data are available, purchasing is more common than selling (Figure 2). With the exception of Greece and Luxembourg, 60-90% of businesses with more than ten employees reported using the Internet. However, only one in eight on average reported making Internet sales. Internet purchases were more common, but still approximately only one business in five ordered over the Internet. On average, twice as many businesses use Internet commerce for purchases as for sales.

The more intensive use of the Internet for purchases than for sales is not surprising. Purchasing/ procurement is an area which firms often do not consider strategic, and the use of common packaged software applications is widespread, especially for procurement of indirect inputs (office supplies, computer equipment, etc.), *i.e.* those for which the requirements are fairly standard across sectors. In this case, the incentive for firms to engage in Internet procurement may be the number of their suppliers that already use the technology. Sales, instead, are much more differentiated across sectors. Packaged solutions need to be industry-specific or customised, and firms tend to perceive the selling function as a strategic business process around which they build their competitive position.

Figure 2. **Proportion of businesses with ten or more employees using the Internet for purchasing and selling, 2000**



Note: The results of the Eurostat survey are based on a selection of industries that changes slightly across countries. The main sectors covered are manufacturing, wholesale and retail trade, hotels and restaurants, transport, storage and communications, financial intermediation, real estate, renting and business activities. The surveys of Denmark, Italy, Finland and Norway do not cover financial intermediation; those of Denmark, the Netherlands, Finland, the United Kingdom and Norway also cover construction; Denmark and Norway also survey personal services.

1. All businesses.
2. Use, orders received and made refer to Internet and other computer mediated networks.
3. Orders received and made over the Internet and other computer mediated networks.
4. Expectations for the year 2001 measured in 1999.

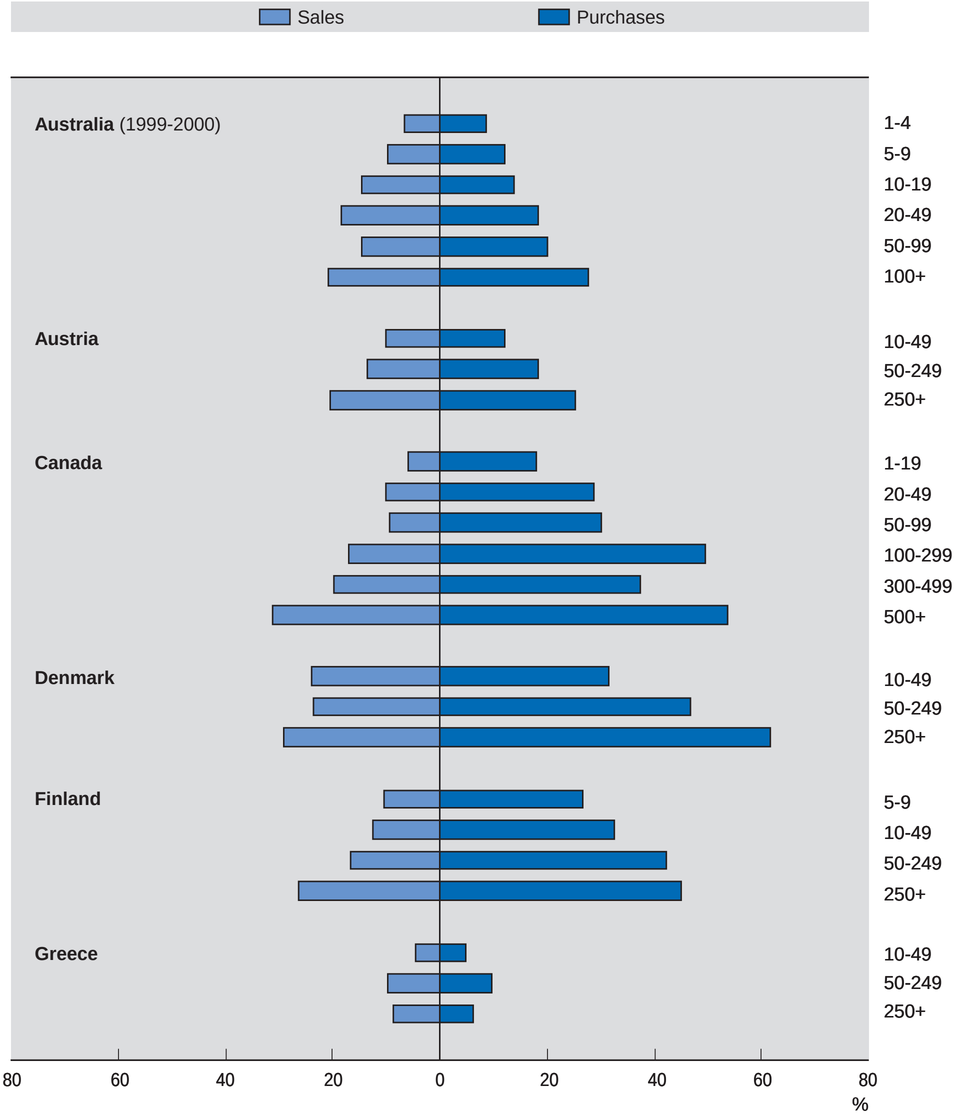
Source: OECD, ICT database and, Eurostat, *E-commerce Pilot Survey,* December 2001.

Data broken down by class size show that smaller businesses that use the Internet appear to have roughly the same propensity to sell over the Internet as larger ones in Australia, Denmark and Sweden (Figure 3). Use of the Internet for purchases seems to be more sensitive to firm size across all countries. However, the relation between Internet use and size is a complex one. Not only is business size industry-specific, *i.e.* what may be a small enterprise in one industry might be a large one in another, but also Internet use for transactions is industry-specific.

Figure 4 shows the propensity of businesses to carry out Internet purchases across selected sectors in six OECD countries. This propensity is higher in services than in manufacturing, and financial services, business services and wholesale trade are generally the most intensive users. Internet orders are most popular in the finance and insurance industry in Sweden and the United Kingdom, and the business services[8] industry also has high rates of Internet commerce. In Denmark and Finland, the business services industry reported approximately every second order to be an Internet order. In Canada and Australia, the propensity to buy over the Internet seems to be more equally distributed across sectors. In Canada, the industries with the highest percentage of businesses purchasing over the Internet in 2000 were information and cultural industries (53%), private educational services (41%) and professional, scientific and technical services (41%). In Australia, Internet procurement in 1999-2000 was most common in the electricity, gas and water supply and communication services industries (38% and 29% of Internet users, respectively).

Figure 3. **Internet and electronic purchases and sales by enterprise size class, 2000**

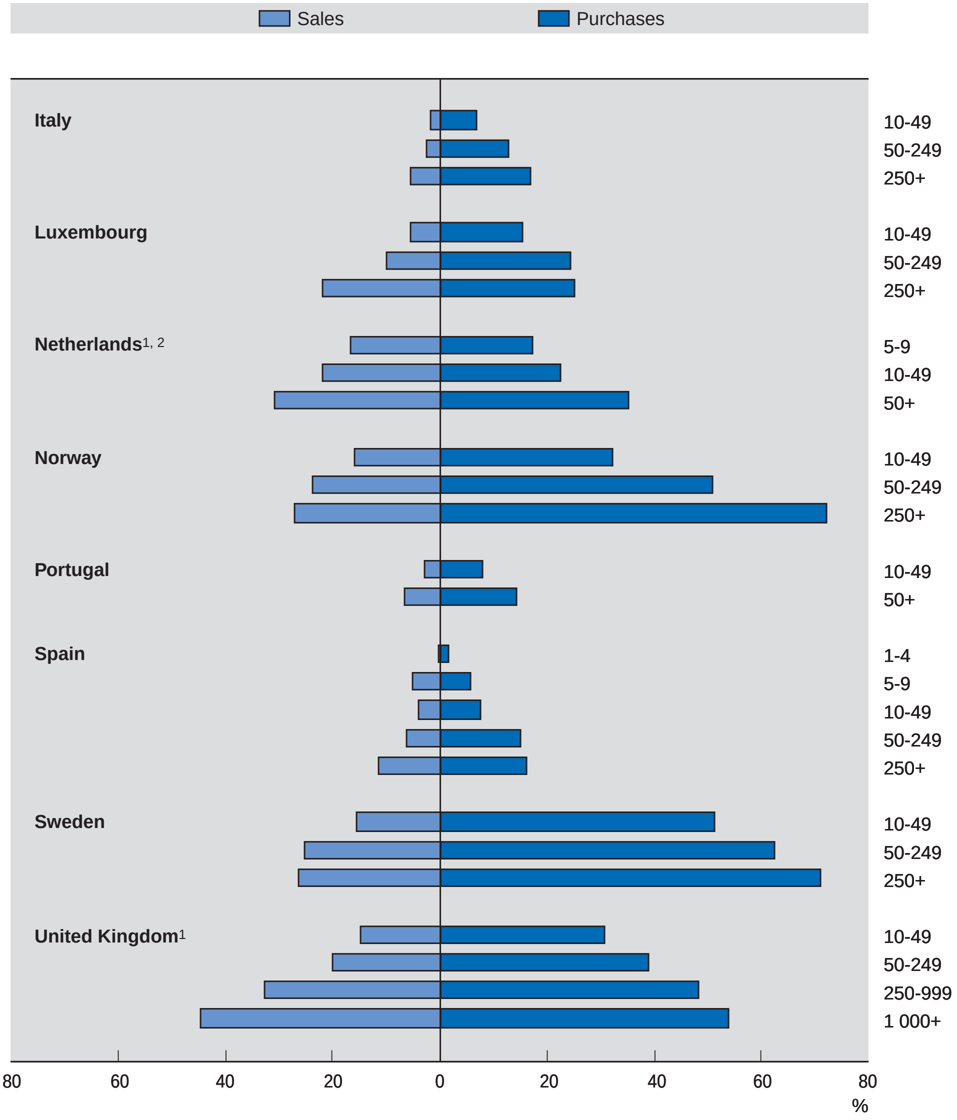
Percentage of all businesses in each class size



While selling goods and services over the Internet offers the potential to reach new markets at lower cost, cost reduction is the main motivation for purchasing on line. Choosing from the most efficient suppliers, better managing inventories, receiving products on line are all potential sources of cost efficiencies. However, the greatest efficiency gains from electronic commerce transactions are expected to come from the integrated use of new information technologies along businesses value chains. Measures of the integration of the technology with business practices and the associated impact on firms' productivity are difficult to obtain. One way is to gather qualitative information with the aid of case studies (see Box 2); another is to develop metrics of electronic business processes, measure them in enterprise surveys and link the information with statistics of performance and productivity at firm level. Some statistical surveys on the use of ICT technologies in enterprises do collect information on selected transaction-related electronic business processes.

Figure 3. **Internet and electronic purchases and sales by enterprise size class, 2000** *(cont.)*

Percentage of all businesses in each class size



1. Orders received or made over the Internet and other computer mediated networks.
2. Expectations for the year 2001 measured in 1999.

Source: OECD, ICT database, and Eurostat, *E-commerce Pilot Survey*, December 2001.

Table 2 shows data on the use of Web, Internet or computer network applications in selected transaction-related business processes. Firms mainly use the Internet or the Web for marketing purposes and, to a limited extent, to sell on line; however, among firms that use the Internet, only a few distribute goods and services on line or offer interactive electronic payment capability. An analysis of the use of computer networks in US manufacturing plants in mid-2000 revealed that the integration of transaction-related business processes via the use of Internet applications is still very limited. Some plants that do not accept on-line orders accept on-line payments, while some plants that reported no on-line orders provided on-line customer support. About 34% of manufacturing plants reported having purchased on line, while only 9% paid on line. Although firms may not pay on line for security reasons, 29% of those that did, did not purchase on line (US Department of Commerce, 2001).

Figure 4. **Businesses ordering over the Internet by industry, 2000**

Percentage of businesses with ten or more employees in each industry

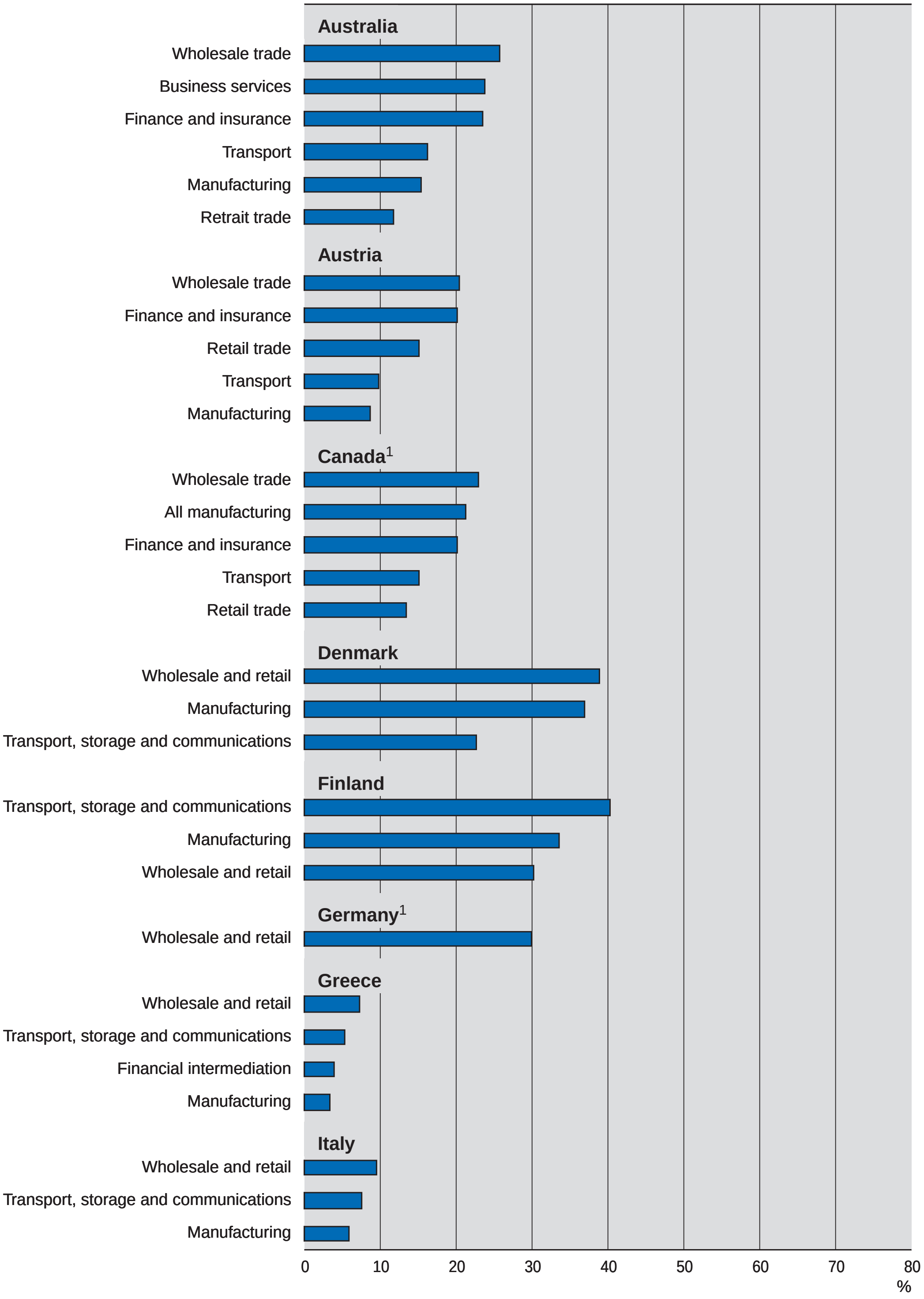
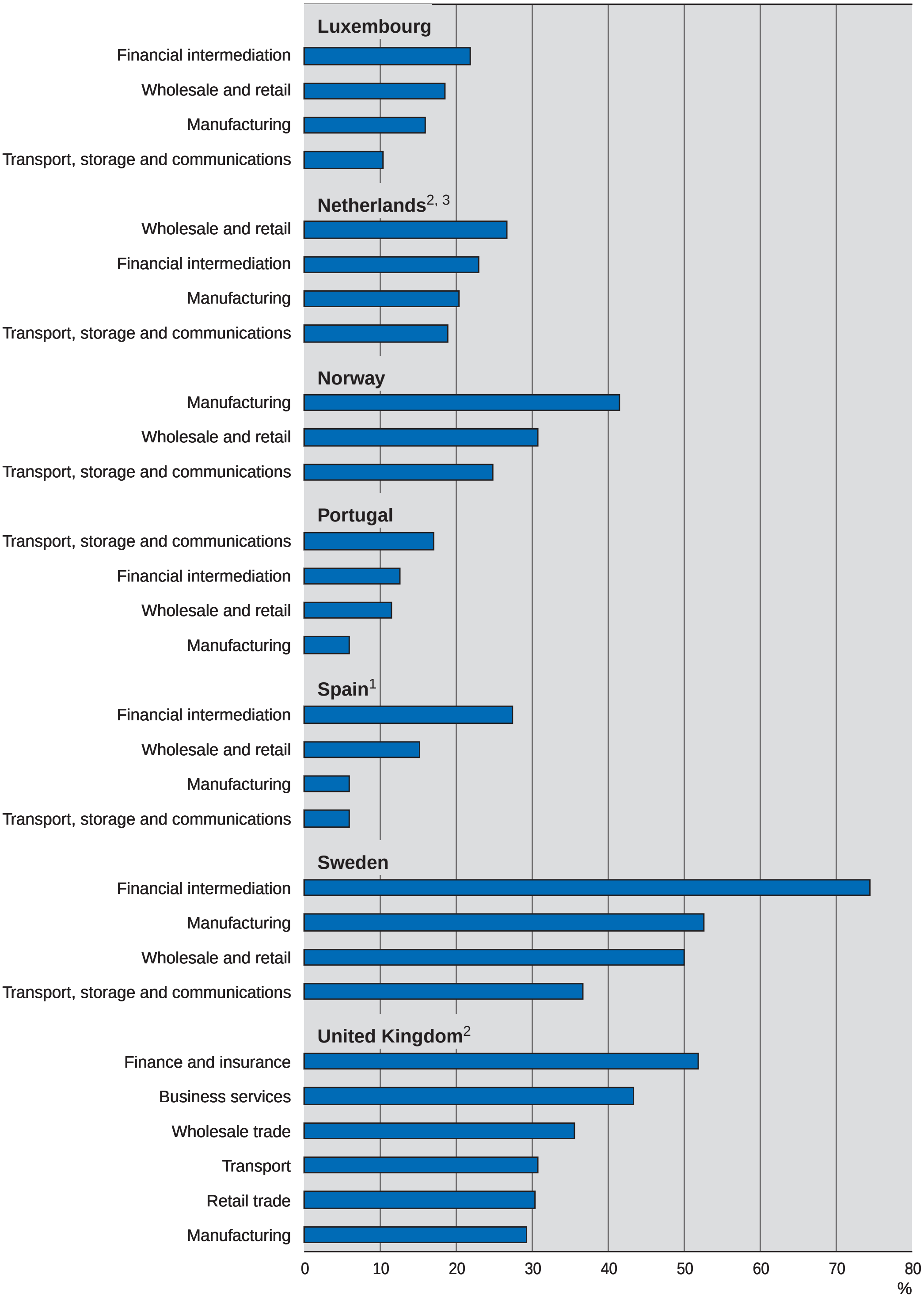


Figure 4. **Businesses ordering over the Internet by industry, 2000** *(cont.)*

Percentage of businesses with ten or more employees in each industry



1. All businesses.
2. Internet and other computer-mediated networks.
3. Expectations for the year 2001 measured in 1999.

Source: OECD, ICT database and Eurostat, *E-commerce Pilot Survey*, December 2001.

Box 2. Results from the OECD Electronic Commerce Business Impacts Project (EBIP)*

What is more important, the "commerce" factor or the "e" factor? Successful e-commerce strategies are led more by commercial than by technological considerations. E-commerce is part of much larger business and economic transformations, and successful application and use are usually embedded in broader strategies to respond to business challenges. Nevertheless, e-commerce is a major business innovation that all firms will have to adopt, and successful firms have coherent overall business strategies with a major emphasis on the development of both e-commerce and IT skills.

Why do firms engage in e-commerce and what is going on line? Motivations to apply e-commerce are high where ICT investment is already large and risk is low. Most firms want to reduce costs, increase the speed and reliability of transactions, improve management capabilities, develop or improve collaboration, create interdependencies, manage customer relations better and create more added value. Firms are cautious about putting important things on the Web; when they do, they protect their transactions and advantages: advertising catalogues, information services are overwhelmingly on the WWW, but transactions (ordering, billing and payment, finance) are on EDI, EDI over the Internet or extranets. There has been only partial migration from EDI to Web-based systems, for example for ordering, and many firms are still slow to move from their established closed systems.

What are the impacts on firms? Most firms consider that e-commerce facilitates the management of business relationships and that e-commerce tools lower the costs of reaching new customers and suppliers. There are considerable differences by sector and firm size. Product innovations are more common among firms with intangible products and assets (mainly services firms); process innovations are more frequently implemented by large firms. Market expansion and segmentation are more common for firms with intangible products and assets, and small firms benefit from Internet-based expansion strategies, as they use e-commerce to make themselves known and explore new markets to a greater extent than large firms.

Almost one-third of firms reported positive measurable impacts on turnover and on profitability, and none reported decreases. However, well over half of firms were unable to report on impacts or indicated that the question was not applicable. The share of firms reporting employment impacts was lower, and more firms reported positive than negative employment impacts. However, many firms reported upskilling and changes in the composition of the workforce. A crucial emerging issue is the organisation of firms to use their human resources and other assets more effectively to achieve business goals. Overall, the impacts of e-commerce are hard to quantify, suggesting that it is too soon to measure impacts or that firms are unable to identify separately effects solely due to e-commerce.

What are the impacts on market structure and competition? Many types of markets may become more open and efficient, with obvious benefits to producers and consumers. E-commerce results in a greater mix of direct and intermediated sales, helping customers to bypass traditional intermediaries (disintermediation) and facilitating new intermediaries (reintermediation). E-commerce may provide new avenues for firms to create new dominant positions or perpetuate existing ones. Incumbent firms and their established business models are surviving, and e-commerce is not significantly altering the established basis of market power. Very few interviewed firms saw e-commerce destabilising existing commercial relations. Overall, "first mover" advantages by new firms have not been as clear as earlier thought. Established firms and industries are benefiting from e-commerce, and small firms may not be advantaged.

What policy issues are important? Firms identified competence factors (general education, specific IT/e-business skills) as being crucial to their involvement in e-commerce activities. Other factors consistently mentioned were costs, including, but not limited to, technology. According to firms, in the area of confidence and trust, problems relate mostly to clarification, enforcement and cross-border interoperability of existing legal frameworks rather than the need for new ones. Overall, several broad areas where the scope for government policy action is greatest were identified: skills and competencies, infrastructure (pricing, broadband) and market structure/competition areas, with continuing concern for small firm issues.

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* The OECD Electronic Commerce Business Impacts Project (EBIP) was undertaken under the aegis of the Working Party on the Information Economy (WPIE). It aimed to improve comparability of firm-level case studies across sectors and countries through the use of a common analytical framework and an interview reporting instrument. The project focused on e-commerce and Internet applications by proactive firms in established industries, mainly in business-to-business e-commerce. It was launched in late 1999 with ten countries participating: Canada, France, Italy, Korea, Mexico, the Netherlands, Norway, Spain, Sweden and the United Kingdom, with Portugal joining subsequently. The studies were mainly undertaken during the second half of 2000 and early 2001. The final report draws on a database of 217 reporting firms, and 30 sector reports across 14 broad sectors in both physical and intangible products in the 11 participating countries.

Source: See OECD (2002), *Electronic Commerce Business Impacts Project: Synthesis Report*, forthcoming.

Table 2. **Business processes related to selling activities over the Web, the Internet and computer-mediated networks, 2000**

Business processes via:	AUT	DNK	FIN	GRC	ITA	LUX	NOR	POR	SPA	SWE	NLD
	Web page										
	Enterprises with Internet (%)										Enterprises with computer mediated networks (%)
Sales	12.9	27.6	15.1	9.1	2.3	12.6	23.2	4.9	6.3	19.3	36.4
Delivery of digitised products	1.0	7.7		2.0	0.4	3.1	6.0	1.0	2.1	4.3	
Receiving on-line payments	3.0	8.1	2.4	2.5	0.9	4.5	5.5	1.5	1.6	4.3	16.1

Business processes via:	AUS	CAN	USA
	Web page		Computer networks
	Enterprises with home page (%)		Manufacturing plants with computer (%)
Marketing	79.0		
Sales	14.0		31.0
After sales services	11.0		19.2
Delivery of digitised products	4.0	13.0	
Receiving on-line payments	2.0	8.0	11.1

Source: OECD, ICT Database and Eurostat, *E-commerce Pilot Survey*, December 2001.

Volume and nature of e-commerce transactions

Electronic and Internet transactions: still very small but growing

The number of secure servers, one indicator of a country's infrastructure for Internet commerce, is often used as a proxy for countries' propensity to carry out Internet transactions.[9] The United States accounted for about 65% of the OECD total of secure servers in July 2001; the United Kingdom was second with 6%. In July 2001, Iceland and the United States recorded the most intensive use, with 328 and 315 secure servers per million inhabitants, respectively. Other countries above the OECD average of 119 per million inhabitants were New Zealand (203), Canada (197), Australia (193), Switzerland (191), Luxembourg (155) and Sweden (142). Available statistics from business surveys show that the proportion of Web sites with secure capabilities is much lower than the number of businesses actually selling on line. In Australia, only 6% of businesses' homepages allowed for secure transactions in 1999-2000, while 14% of businesses with Web sites offered on-line ordering. In Canada, the percentage of secure Web sites in 2000 was three times higher.

For the few countries that currently measure the value of Internet or electronic sales, total Internet sales in 2000 ranged between 0.4% and 1.8% of total sales; electronic sales (including those over all computer-mediated networks) were over 10% in Sweden (Figure 5). Sales via EDI are generally higher than sales via the Internet, with almost all countries reporting EDI sales to be at least twice as high as Internet sales. Scandinavian countries reported being the biggest users of the Internet and e-commerce.

These relatively low shares indicate that the uptake of e-commerce is still very low and that there is considerable scope for growth. On the other hand, there are already signs that the volume of transactions may tend to be concentrated in a few sectors or firms. The US Bureau of the Census noted that in 1999 on-line sales of manufacturing plants were concentrated in five of the 21 subsectors. On-line

Figure 5. **Broad and narrow official estimates of electronic commerce sales[1] in 2000**

Percentage of total sales or revenues

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	Web commerce	Internet commerce	Electronic commerce
Business sector[2]	**2.0%** Sweden	**1.8%** United Kingdom **1.4%** Spain **1.0%** Austria **0.6%** Norway **0.5%** Luxembourg **0.40%** Portugal **0.40%** Canada **0.7%** Australia (2000-2001)	**13.3%** Sweden **8.1%** Norway **5.2%** United Kingdom **4%** Spain **2.5%** Austria **1.8%** Portugal **0.5%** Luxembourg
Business sector (excluding financial sector)	**0.90%** Denmark **0.70%** Finland	**0.94%** United Kingdom **0.4%** Italy	**9.1%** Finland **5.95%** United Kingdom **5.7%** Denmark **1.1%** Italy
Retail sector	**0.10%** (France, 1999)	**1.04%** United Kingdom **0.40%** Canada **0.2%** Austria	**1.39%** United Kingdom **1.2%** (USA, 4th Q 2001) **1.09%** (USA, 4th Q 2000) **0.2%** Austria

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1. See Table 1 for a discussion of these definitions.
2. Data for Austria, Italy, Luxembourg, Portugal, Spain and Sweden exclude the NACE activity F (construction).

Source: OECD, ICT database and Eurostat, *E-commerce Pilot Survey*, December 2001.

purchases were even more concentrated. Two subsectors accounted for more than half of all on-line purchases in manufacturing in 1999. Transportation equipment was first, accounting for almost half of total manufacturing on-line purchases (USD 112 billion) in 1999 (US Department of Commerce, 2001).

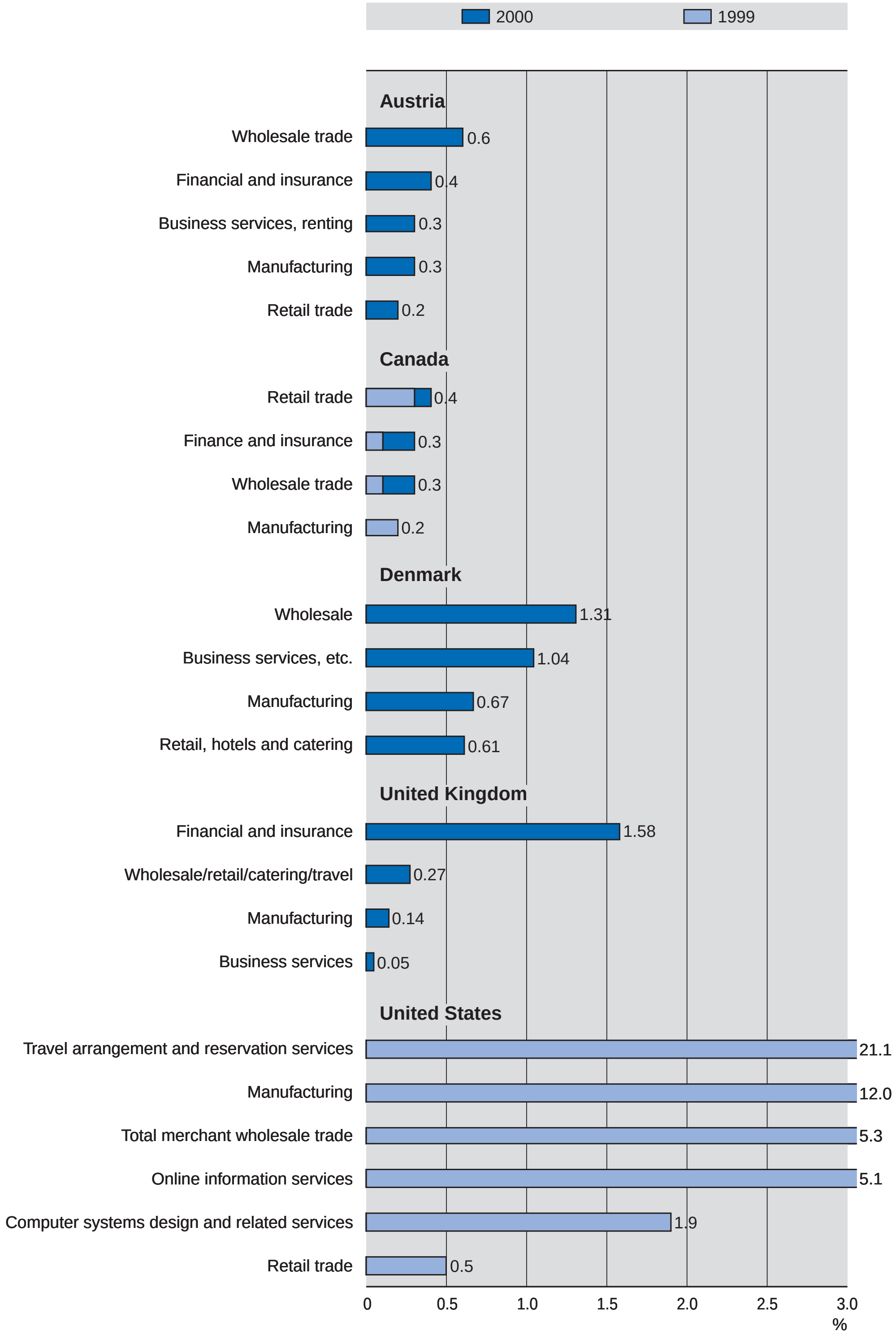
Figure 6 shows electronic commerce sales by industry. In the United States, the figures refer to sales over all computer-mediated networks and reach a 20% penetration rate in travel and reservation services. Elsewhere, however, penetration rates of Internet sales are generally rather low and vary across sectors. In Denmark, Internet sales are concentrated in the wholesale and retail trade sectors, which account for 58% of the total. Statistics Canada has carried out two consecutive economy-wide surveys of electronic commerce. For those enterprises included in the sample in both 1999 and 2000, for every two that started to sell on line in 1999, five stopped doing so in 2000. As a result, although Internet sales by private sector firms grew by 73% in one year, the number of enterprises selling on line declined from 10% in 1999 to 6% in 2000. However, there was an increase in both the volume of purchases and the number of private-sector firms buying on line over the two-year period.

Business-to-consumer Internet transactions … still very small

Although transactions among businesses represent the bulk of electronic commerce, most attention has focused on business-to-consumer Internet sales. Since household expenditure in OECD countries typically accounts for over half of total domestic demand, this is not surprising. Moreover, the growing interest of policy makers in issues such as consumer trust and privacy protection in the on-line environment has raised demand for indicators of consumers' on-line transactions. Table 3 summarises some of the few available indicators based on official statistics.

Figure 6. **Internet or electronic commerce sales by industry**[1]

Percentage of total industry sales



1. Internet sales for Austria, Canada, Denmark and the United Kingdom. A broader definition has been used for the United States figures, which represent sales over the Internet and other computer-mediated networks.

Source: OECD, ICT database and Eurostat, *E-commerce Pilot Survey*, December 2001.

Table 3. **Indicators of consumers' transactions over the Internet in selected OECD countries, 2000**

	Number of individuals purchasing over the Internet[1]		Volume of Internet retail transactions		
	Share of total	Share of Internet users	USD millions	Share of retail sales	Share of business-to-consumer in total Internet commerce
Australia	7.1	15.0			
Austria[2]			59.1	0.2	6.95
Canada	12.3	24.0	599.2	0.4	20.0
Denmark[3]	18.0	29.0			12.15
Finland	9.1	16.8			29
France			162.4	0.1	
Italy	1.1	5.9			
Korea[4]	8.1	15.3			
Luxembourg[2]					31.28
Norway					12.51
Portugal[2]					4.80
Singapore					1.26
Sweden	29.2	42.5			15.59
Turkey[5]	0.4	4.6			
United Kingdom[6]	14.9	33.0	2 686.5	1.04	17.48
United States	14.1	30.0	27 287.0	0.89	

1. Age cut-off: 16 years and older except for Canada and Finland (15+), Italy (11+), Korea (6+) and Australia and Turkey (18+).
2. Sales of computer-mediated networks.
3. First quarter 2001 for the number of individuals purchasing over the Internet.
4. Third quarter 2001.
5. Individuals belonging to households in urban areas.
6. Last quarter 2000 for the number of individuals purchasing over the Internet.

Source: OECD, ICT database, and Eurostat, *E-commerce Pilot Survey*, December 2001.

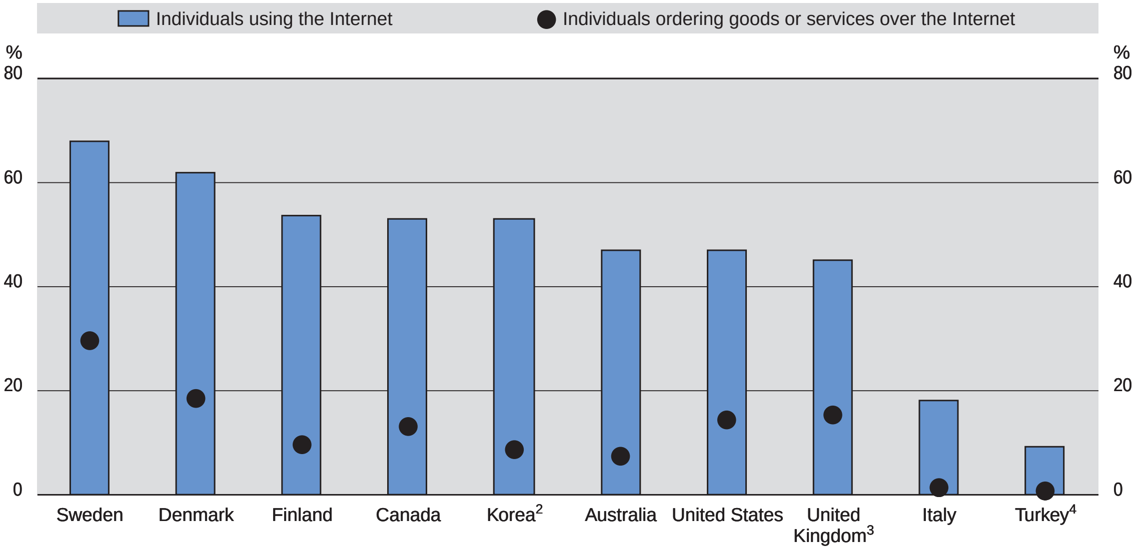
The share of Internet users buying over the Internet is generally quite low and varies widely. It is highest in Sweden, where 43% of individuals using the Internet ordered products in 2000, followed by the United Kingdom (33%) and the United States (30%). With about one in seven Internet users purchasing goods over the Internet in Finland and Australia, there is still a potential for a marked increase in Internet sales, especially since approximately one out of two households in those countries had access to a computer in 2000 (Figure 7).

A growing minority of consumers use on-line banking. Fewer than three in ten regular Internet household users in Canada reported having carried out financial transactions over the Internet in 1999. In Australia, only 13% of all adults paid bills or transferred funds via the Internet in 1999-2000. In Australia at present, Internet banking is less popular than paying bills or transferring funds using other electronic means; for example, 49% of all Australian adults reported using the telephone to pay bills or transfer funds electronically and two out of three reported using EFTPOS[10] for these purposes.

Some countries have started to collect statistics on the proportion or volume of business-to-consumer Internet transactions (Figure 8). Generally, less than 30% of Internet sales are to households, although the share varies considerably, ranging from an estimated almost 30% in Finland (Statistics Finland, 2001*a*) to only a little over 1% in Singapore in 2000 (Infocomm Development Authority, 2000). In the United Kingdom, most Internet sales to households are accounted for by the financial sector; if sales of the financial sector are excluded, household Internet sales drop from 0.36% to 0.1%. In Canada, the finance and insurance sector only accounted for 8% of total business-to-consumer transactions in 2000. Retail enterprises had the largest volume of transactions to consumers (30%), followed by wholesale trade (19%) and transportation and warehousing (13%). Manufacturing enterprises had the largest share of business-to-business Internet transactions (22%).

Because it is difficult to estimate business-to-consumer electronic transactions, retail transactions over the Internet are often used as proxies. Interestingly, the 2000 Canadian e-commerce survey, which produces estimates of Internet business-to-consumer transactions across all sectors of the economy,

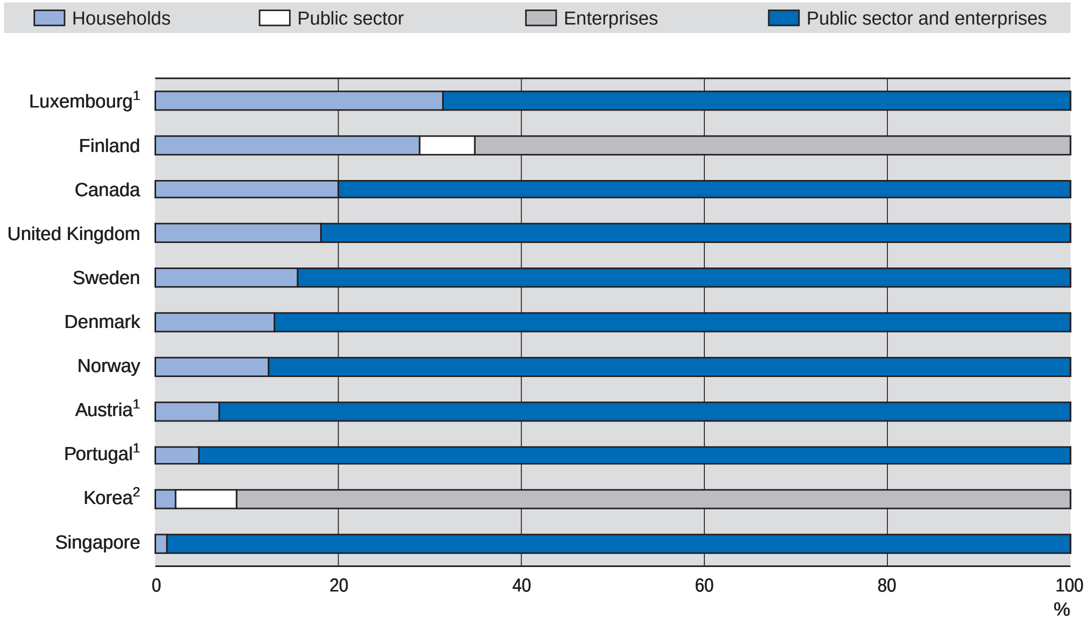
Figure 7. **Percentage of individuals using and ordering goods and services over the Internet, 2000**[1]



1. Age cut-off: 16 years and older except for Canada and Finland (15+), Italy (11+), Korea (6+) and Australia and Turkey (18+).
2. Third quarter 2001.
3. Last quarter 2000.
4. Individuals belonging to households in urban areas.

Source: OECD (2001a).

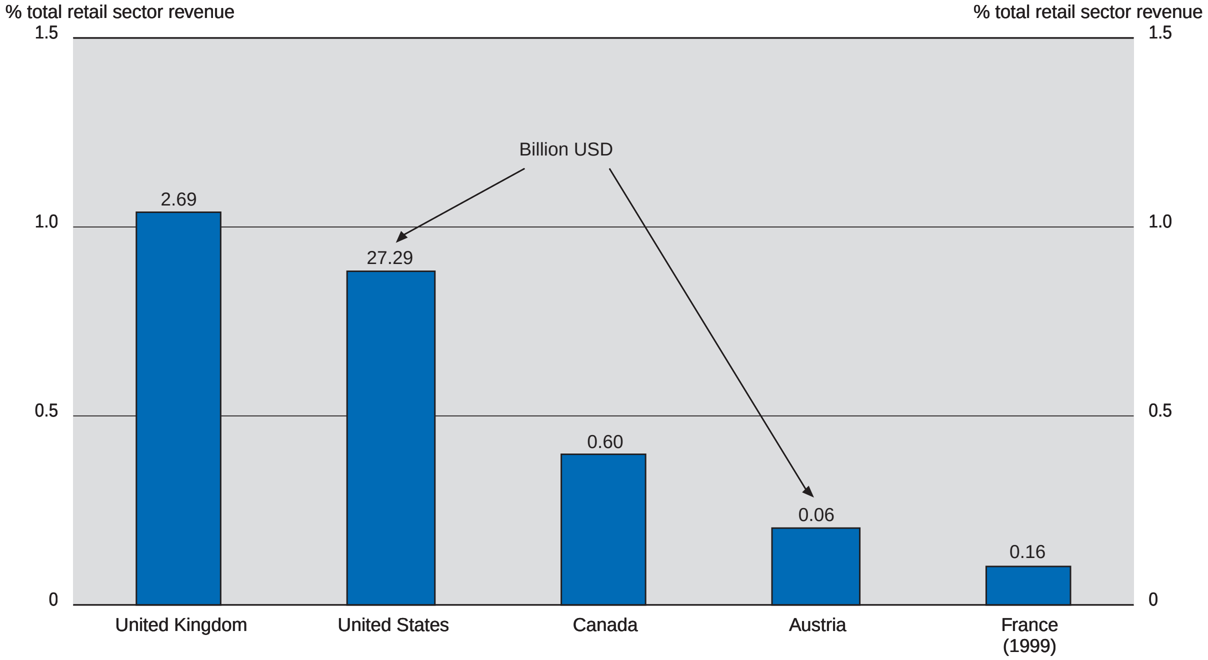
Figure 8. **Share of Internet sales by type of customer, 2000**



1. E-commerce sales.
2. Data for the second quarter of 2001.

Source: OECD, ICT database and Eurostat, *E-commerce Pilot Survey*, December 2001.

Figure 9. **Value of Internet sales as a proportion of total revenue or sales of the retail sector, 2000**

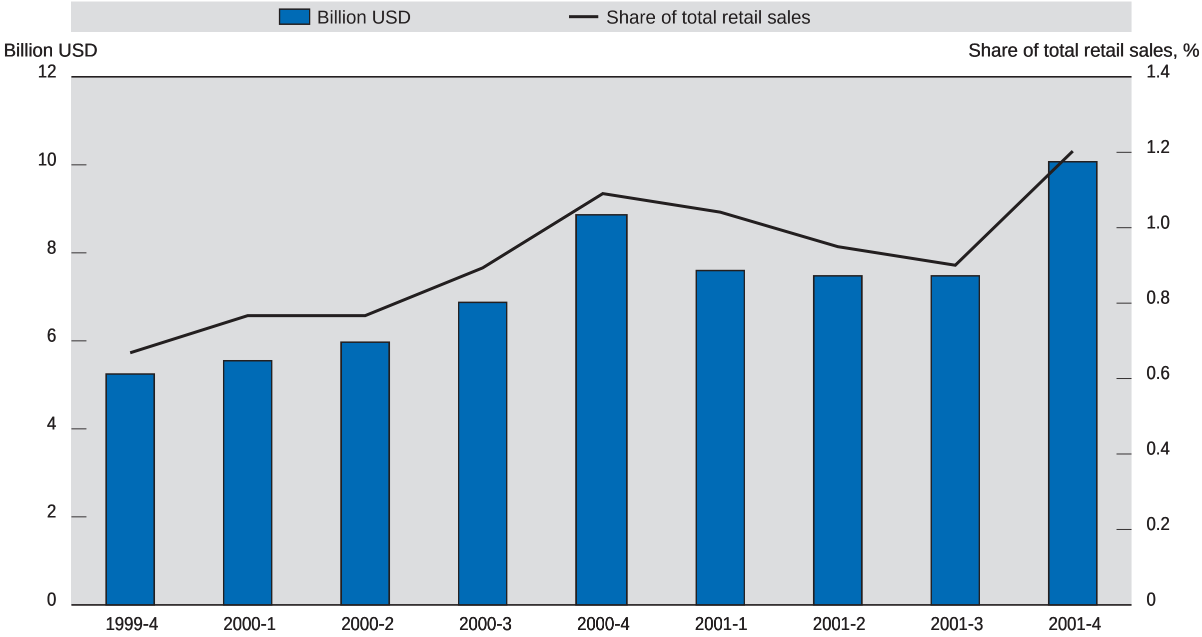


Source: OECD, ICT database and Eurostat, *E-commerce Pilot Survey*, December 2001.

shows that only about half of Internet retail sales go to consumers. Internet retail sales are still a very small share of total retail trade sales, ranging from 0.1% in France to just over 1% in the United Kingdom (Figure 9). Retail sales in Canada doubled from 1999 to 2000, with the average value of an Internet sale remaining relatively unchanged at CAD 121 (USD 75) (Statistics Canada, 2001*b*). The US Department of Commerce has published data on quarterly on-line retail sales since the last quarter of 1999 (Figure 10). Internet retail trade has been growing rapidly both in volume terms and as a share of total retail trade over the 1999-2000 period; its share increased from 0.67% in the fourth quarter of 1999 to 1.09% in the fourth quarter 2000. In 2001, there was a slowdown in the rate of growth of quarterly Internet retail sales year on year, and they now account for about 1% of total retail sales. The total annual value of on-line retail sales (USD 32.6 billion for 2001) should be considered as a lower bound, as certain categories that are included in other surveys, such as on-line travel services, financial brokers and dealers and ticket sales agencies, are excluded.

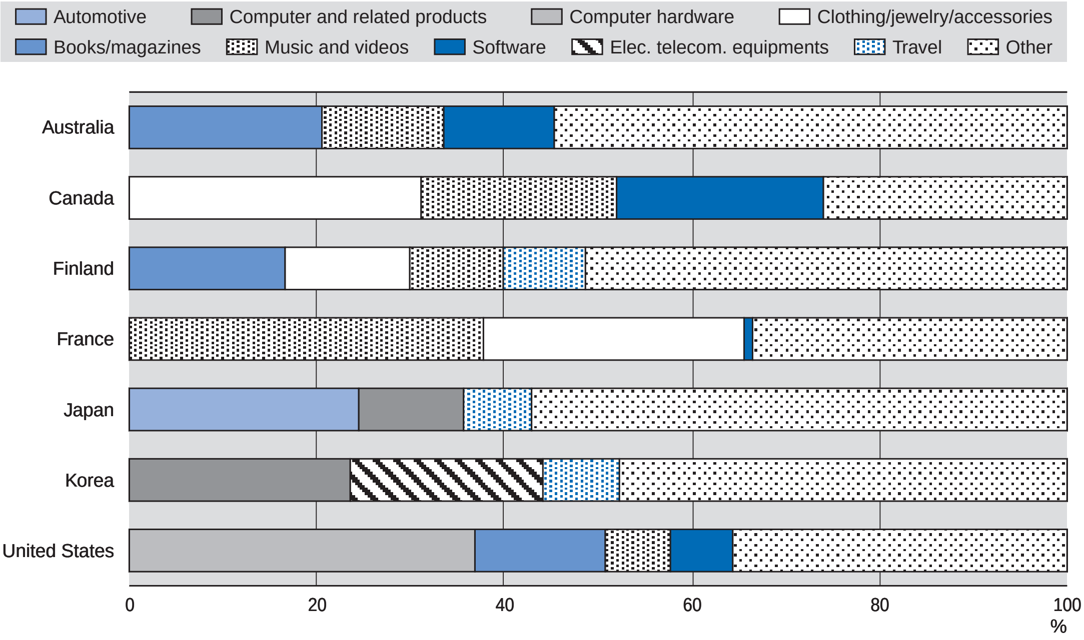
The products that sell the best over the Internet are not necessarily the same across countries (Figure 11), since they reflect not only the nature of the product – digitised products such as music, books and software are easier to sell and distribute over the Internet – but also consumer tastes and habits. Computer products represent the biggest shares in the United States, Japan and Korea. The Korean national statistical office reported that for the third year in a row, computers and computer-related appliances were the most popular on-line purchases, followed by home appliances and electronic telecommunication equipment. In France, clothing accounts for about 30% of consumer purchases over the Internet. Statistics Canada (2001*b*) reported that 40% of households regularly used the Internet from home. In 2000 e-commerce households favoured buying clothing, jewellery and accessories; however, in the previous year, computer software was the most popular on-line purchase. Digitised products such as music, computer software, books and magazines also represent a relatively important source of revenue. In France, CDs and DVDs were the top-selling items over the Internet and represented almost 40% of the total value of Internet sales in 1999. In the Netherlands in 2000, CDs

Figure 10. **Quarterly retail electronic commerce sales in the United States, 1999-2001**



Source: US Department of Commerce, Bureau of the Census, *www.census.gov/mrts/www/current.html*, December 2001.

Figure 11. **Consumers' Internet purchases by product**



Source: Household surveys for Australia (Australian Bureau of Statistics, 2001) and Canada (Statistics Canada, 2000); survey of business-to-consumer sales in cybershopping malls for Korea (Korea National Statistical Office, 2001); net commerce survey for Finland (Statistics Finland, 2001*b*); retail trade survey for France (INSEE, 2000) and the United States (US Bureau of the Census, 1999, only electronic shopping and mail order houses); market research survey for Japan (Electronic Commerce Promotion Council of Japan – ECOM, 2001.

made up 23% and DVDs a further 4% of Internet sales (*De digitale economie* 2001). In Australia, three digitised products (books, music and computer software) accounted for 45% of household spending over the Internet.

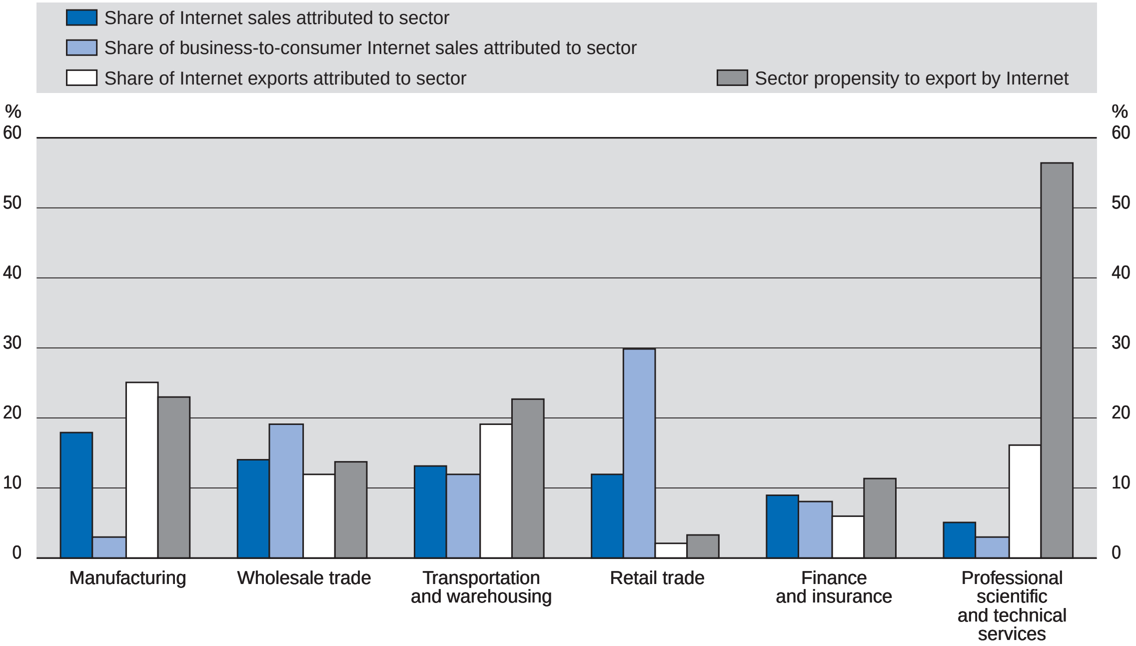
Internet transactions are mainly domestic

The Internet has the potential to help enlarge existing markets by cutting through many of the distribution and marketing barriers that prevent firms from gaining access to foreign markets. Internet-based electronic commerce can also create new opportunities for trade by changing the delivery modes for digitised goods and services. The best example is electronic software distribution (ESD), *i.e.* the transmission of software over the Internet. Other services, from financial services to education to medical services, all have the potential to become more globally traded.

Statistical offices have started to collect statistics on the share of firms' turnover originating from sales abroad. These statistics are hard to collect at this stage, mainly because the volume of the sales abroad may not yet be statistically significant. It is also difficult to identify where buyers and sellers are physically located. In Australia, 90% of businesses with a Web site have a site only hosted in Australia; 5% have a site hosted only overseas and the remaining 5% have a site hosted both in Australia and overseas (Australian Bureau of Statistics, 2000).

Available statistics show that Internet sales are mainly domestic. To understand why, it is necessary to break down sales by industry, destination and type of customer (business or household). Canadian data can be broken down in terms of sales by industry and destination and sales by industry and customer (Figure 12). Professional, scientific and technical services were most likely to have Internet sales to customers outside Canada, with 56% of the total value of their Internet sales abroad. Other industries with more than 50% of the value of Internet sales to customers abroad were the accommodation and food services industry and the arts, entertainment and recreation industry. While

Figure 12. **Distribution of Internet sales, business-to-consumer Internet sales and Internet exports by selected industries in Canada, 2000**



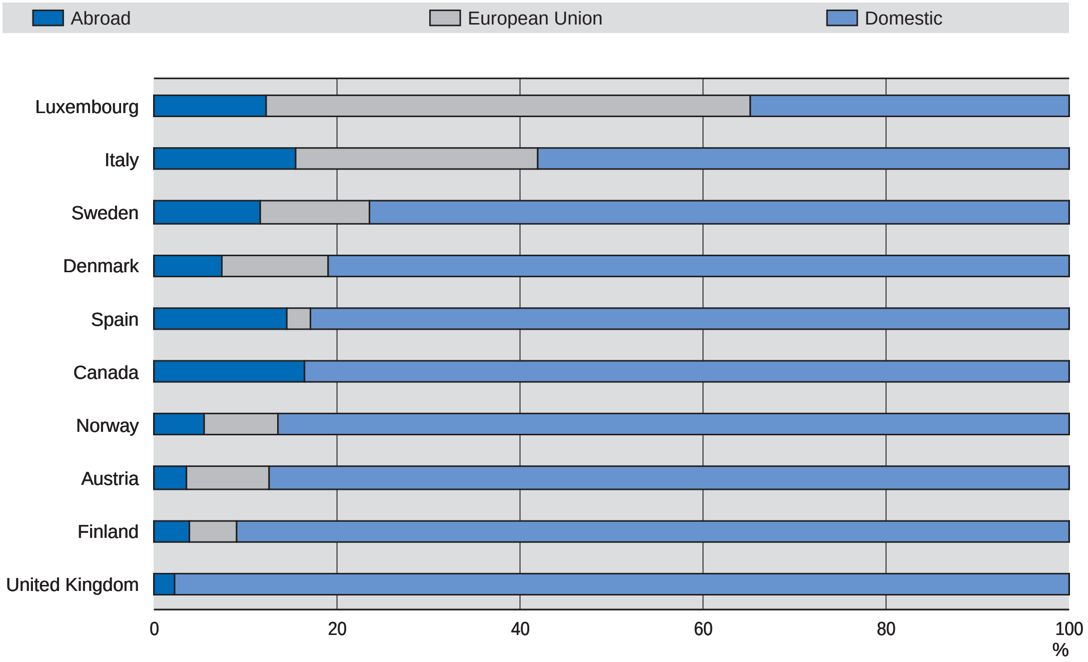
Note: Percentages do not sum to 100 as not all industries are shown.
Source: G. Peterson (2001).

these services sectors have the highest propensity to sell abroad, four sectors – manufacturing, transport, wholesale trade and retail trade – accounted for 60% of total Internet sales in Canada in 2000. In sum, 16.6% of total Internet sales are to customers outside Canada, but their industry composition is highly skewed. Wholesale trade and retail trade account for over a quarter of Internet sales, but their propensity to export is rather low, at 13.6% and 3.2% of all sales, respectively.

In Eurostat's *E-commerce Pilot Survey*, sales abroad are broken down by destination within and outside Europe (Figure 13). Initial results for nine European countries indicate that European companies mainly sell over the Internet to locations within rather than outside Europe. This may partly reflect the overall (intra-Europe) tendency of European trade. In Austria, Denmark and Finland, the share of exports to Europe to total exports of goods is between 55% and 63%. This roughly coincides with the ratio of intra-European Internet exports to total exports in Finland (56%) and Denmark (63%), while it is a little higher for Austria (73%). The share of international Internet sales is particularly small in the United Kingdom, at only 0.05% of total sales in the sectors surveyed; the air transport industry has the highest propensity to export, with 0.7% of total sales (ONS, 2001).

The available data do not allow for breaking Internet exports down by type of customer in order to know whether business-to-consumer Internet transactions are more "international" in nature than business-to-business transactions. It is also difficult for consumers to know where a firm or a Web site is physically located, or whether a firm's location and that of its Web site coincide. Moreover, even if business-to-consumer transactions have a higher propensity to be "international", Internet sales in volume terms are more likely to be domestic, owing to the weight of business-to-business transactions. Statistics on international Internet purchases drawn from household surveys or surveys of individuals might help but rarely exist as yet. In Australia, 50% of adults purchasing over the Internet buy only from Australian Web sites, 32% only from overseas Web sites and 18% from both. Singapore reports that business-to-consumer sales are dominated by overseas customers, with particularly large shares of customers in Malaysia, Thailand, Japan and the United States (Infocomm Development Authority, 2000).

Figure 13. **Share of Internet sales in domestic and international markets, 2000**



Source: OECD, ICT database and Eurostat, *E-commerce Pilot Survey*, December 2001.

Drivers and inhibitors of electronic commerce transactions

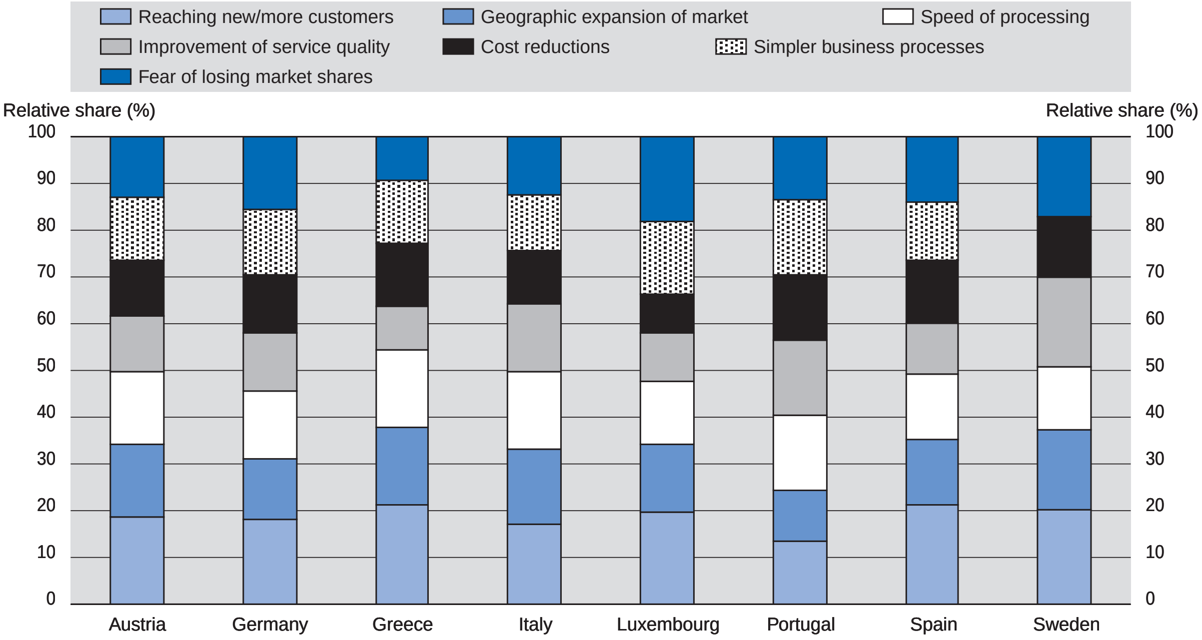
Surveys by national statistical offices do not usually collect information on perceived benefits of or obstacles to the use of technologies, since such information is largely qualitative. However, owing to policy interest in electronic commerce, several surveys of business enterprises have attempted to collect information on the drivers and inhibitors to buying and selling on line. Issues of interpretation, differences in the formulation of questions and the use of qualitative response scales make international comparisons in this area particularly difficult.

One source of differences in countries' implementation of electronic commerce as well as in the impact of electronic transactions on business performance and productivity is the extent to which firms strategically incorporate the technology into their business processes. Firms carrying out transactions on line may seek greater efficiency, or speed, in their business processes or production-related efficiency, *i.e.* reduction of transaction costs or of the costs of intermediate inputs, by reaching more efficient suppliers. Other firms may adopt e-commerce technologies to develop new business practices and change their way of interacting in the marketplace, while still others implement e-commerce technologies as a result of pressures from customers and suppliers or to remain competitive.

A number of studies or survey results on perceived motivations or benefits mention company image, satisfaction of customer demand and improved customer service among the main reasons for adopting e-commerce (*e.g.* DTI, 2000; INSEE, 2001). Another significant factor driving the uptake of electronic commerce is the behaviour of competitors and the fear of losing market share. French retailers cited "because you have to be on the Web" as a primary driver of e-commerce.

Figure 14 shows the relative importance of various drivers of electronic commerce. Motivation factors are grouped into three classes: innovation, efficiency and external pressure. The innovation factors include reaching new/more customers and geographical market expansion. These two factors account for about 30% of motivation factors. Efficiency measures include speed of processing, improvement in service

Figure 14. **Relative business motivation factors for Internet commerce, 2000**



Source: OECD, based on Eurostat, *E-commerce Pilot Survey*, December 2001.

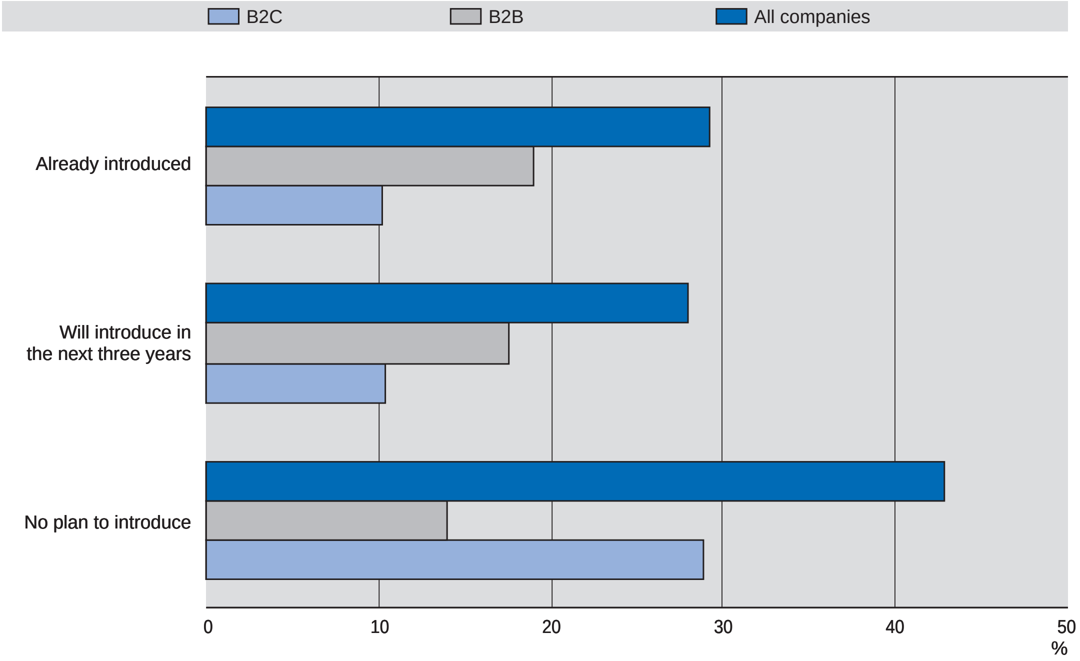
quality, simplification of tasks, cost reductions and simpler business processes. These factors account for about 50% of motivation factors. Fear of losing market share accounts for at most 20%. Reaching new/more customers is the factor generally regarded as the leading motivation factor.

Drivers of electronic commerce transactions can also be explored in terms of the target market. Factors affecting growth in business-to-consumer transactions differ significantly from those affecting business-to-business electronic transactions. The use of electronic commerce technologies in business-to-business relationships has resulted in considerable efficiency gains through cost cutting and rationalisation of business processes. Successful business-to-consumer models, instead, have often created new products or value (*e.g.* convenience, customisation). Cost reductions obtained by reaching more efficient suppliers or better managing inventories are easier to quantify than the perceived benefits of experimenting with new business models in the business-to-consumer arena.

It is not very surprising that Japanese businesses reported business-to-business electronic commerce transactions as far more appealing and lucrative for the near future than business-to-consumer ones. Approximately three in four businesses reported already conducting or intending to conduct business-to-business electronic transactions in the next three years. Only 28% of businesses expressed no intention of carrying out such transactions. In comparison, approximately four in ten Japanese businesses said that they were either already conducting or expected to conduct electronic transactions with consumers in the next three years (Figure 15); the rest (58.5%) expressed no intention of introducing business-to-consumer applications (Japanese Cabinet Office, 2001).

Statistical surveys can also be used to measure barriers to electronic commerce transactions. The barriers and policy issues of concern differ, depending on whether the transactions involved are business-to-business or business-to-consumer. For the former, existing transaction models or tight links with customers and suppliers along the value chain may discourage businesses from introducing new models. There may also be questions of the security or reliability of complex systems that can link all

Figure 15. **Percentage of enterprises introducing business-to-business and business-to-consumer e-commerce in Japan**



Source: Japanese Cabinet Office, 2001.

customers and suppliers. Business-to-consumer transactions, instead, are typically hampered by concerns about security of payment, the possibility of redress in the on-line environment or privacy of personal data. Other factors that have considerable impact on the development of on-line consumer transactions are ease and cost of access, convenience of shopping on line and the appeal of customisation.

Given the preponderance of business-to-business transactions, business surveys are probably a good source of indicators on the relevant barriers (Figures 16-18). Indicators from surveys of households and individuals can capture reasons why customers do not buy on line.

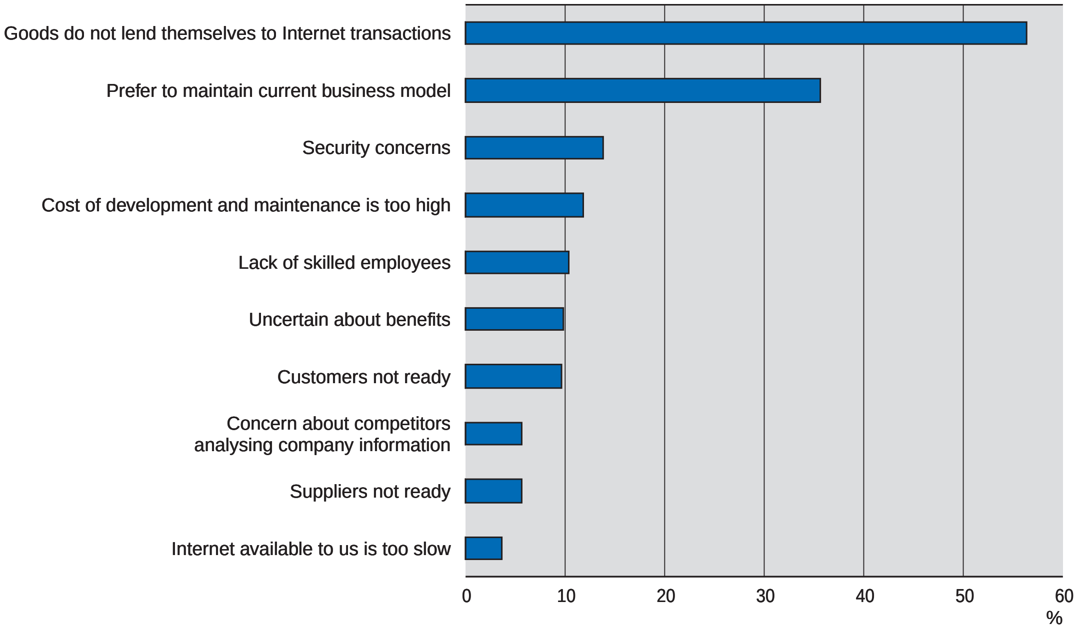
For countries for which data are available, the leading reason cited by businesses for not conducting transactions electronically was a view that electronic commerce was not suited to the nature of their business. In Canada, among businesses that did not buy or sell over the Internet, 56% believed that their goods or services did not lend themselves to Internet transactions; 36% preferred to maintain their current business model. Smaller shares of these enterprises felt that security was a concern (14%) or that the cost of development and maintenance was too high (12%) (Statistics Canada, 2001*a*). In the Nordic countries and in Austria, instead, issues of major significance are security of payments, uncertainty in contracts and insufficient customer base. Security issues regarding handling of payments are not surprising given the very small percentage of sites that ensure secure transactions.

Issues of system security and reliability are a major concern in Japan. Businesses were specifically asked about viruses. Just under one in every two Japanese businesses rated viruses as the major reason for not using the Internet (Tachibana, 2000).

The absence of recognition of on-line signatures may also act as a barrier to transactions between two parties. It appears that by 2000 most Member countries had laws in place that recognise electronic signatures for domestic business-to-business or business-to-consumer transactions. Regulations on signatures related to international on-line transactions are still being drafted in many countries (OECD, 2001*b*). While electronic signatures are only just starting to be recognised legally, their

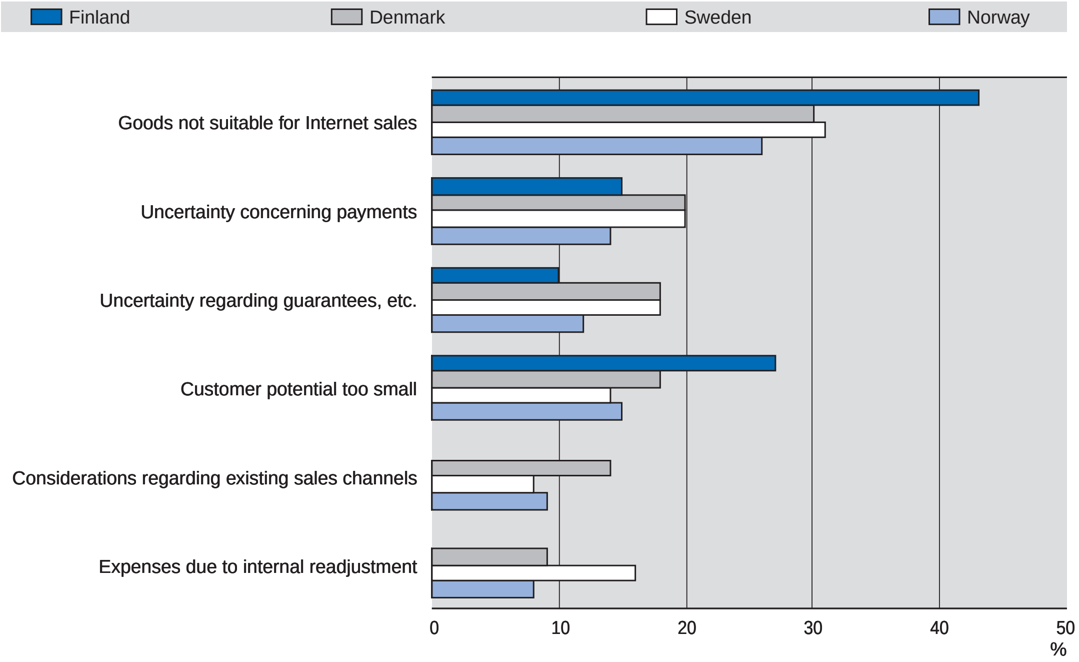
Figure 16. **Perceived barriers to buying and selling over the Internet in Canada, 2000**

Percentage of businesses that did not buy or sell on line



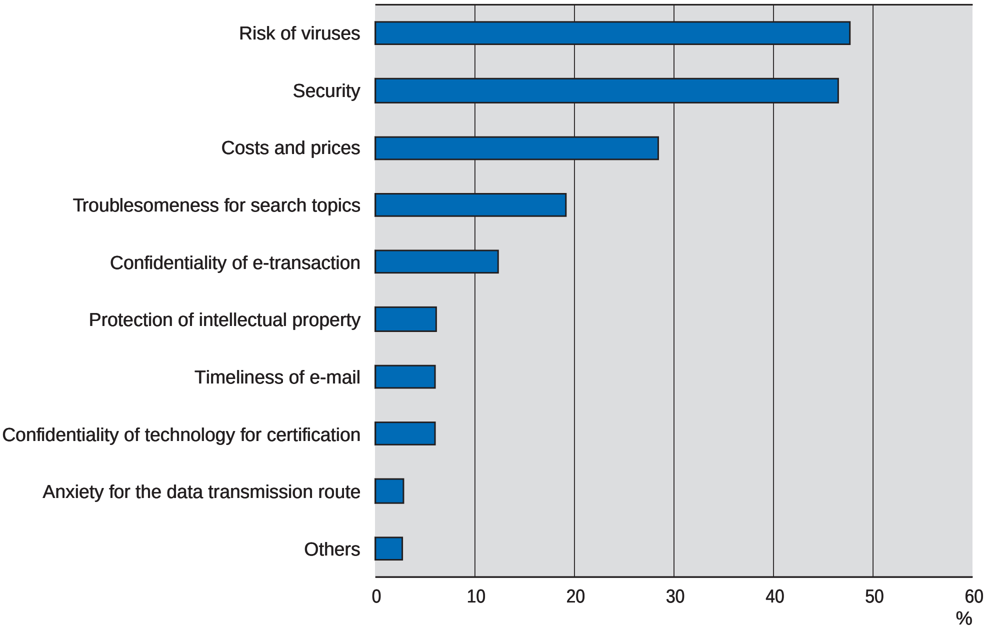
Source: Statistics Canada, 2001*a*.

Figure 17. **Barriers to e-commerce in Nordic countries**



Source: Statistics Denmark *et al.*, *The Use of ICT in Nordic Enterprises*, 1999/2000.

Figure 18. **Barriers[1] to Internet and ICT use in Japan**



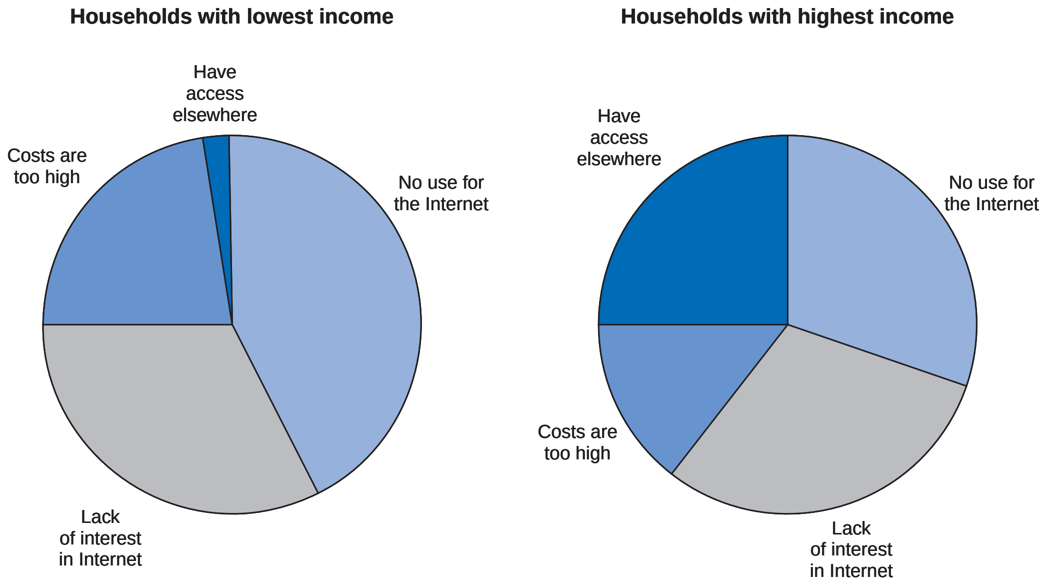
1. Businesses with 100 or more employees. Businesses were asked to choose the three biggest barriers.
Source: Tachibana (2000).

progressive implementation could have a significant influence on the volume of future international electronic commerce transactions.

As in the case of businesses, for which a major reason not to sell on line is that the nature of their products is not suited to it, lack of interest seems to be why most individuals do not use the Internet. A large share of individuals in Australia, Turkey and the United States cited "lack of interest or no use for the Internet" as a reason for not having Internet access at home. For individuals as for businesses, security issues are a significant barrier. In Australia, 29% of individuals cited security as the primary reason for not making a purchase over the Internet. Singapore users cited fear of fraud as the leading reason (Infocomm Development Authority of Singapore).

For consumers, another significant barrier appears to be cost of access. Australia reported on barriers to Internet access for households by income (Figure 19), and it appears that high Internet costs are a significant reason for not using the Internet in both low-income and high-income households. Unsurprisingly, cost was a more important factor in lower income households (Australian Bureau of Statistics, 2001*a*). The major difference between low-income and high-income households was that the latter could gain access to the Internet from locations other than the home.

Figure 19. **Australian household Internet access barriers and income level**



Source: Australian Bureau of Statistics, *Household Use of Information Technology*, 2001.

Conclusion

This chapter draws on some of the most recent official statistics on the nature and volume of electronic commerce transactions. Coverage will be extended to additional countries as data become available. This will help to identify more clearly some of the trends that appear to be emerging. Given that efforts to harmonise these statistics are very recent, that in some countries such surveys have been carried out for the first time and that there exist differences in collection instruments, international comparisons of electronic commerce transactions should be interpreted with caution. Nevertheless, the available indicators point to common patterns:

– Although rising fast, use of the Internet to carry out transactions remains limited and varies according to the position of the business in the value chain (customer or supplier). For 15 countries with data available on Internet purchases and Internet sales, purchasing is more common than selling.

– Smaller businesses that use the Internet appear to have roughly the same propensity to sell over the Internet as larger ones in Australia, Denmark and Sweden. Use of the Internet for purchases seems to be more sensitive to firm size across all countries. However, the relation between Internet use and size is a complex one. Not only is business size industry-specific – a small enterprise in one industry might be a large one in another – Internet use for transactions is also industry-specific.

– Internet and electronic commerce transactions are still relatively small. For the few countries that currently measure the value of Internet or electronic sales, total Internet sales in 2000 ranged between 0.4% and 1.8% of total sales. Electronic sales (including those over all computer-mediated networks) were over 10% in Sweden. Sales via EDI are generally higher than sales via the Internet, with almost all countries reporting EDI sales to be at least twice as high as Internet sales.

– There is evidence that Internet sales and purchases tend to be concentrated in a few sectors. Hence, at this stage, the characteristics of Internet transactions, whether for example they occur mostly within businesses or are mostly domestic, are strongly determined by the nature and type of transactions that typically take place in those sectors.

– Although most policy attention has focused on business-to-consumer Internet sales, these do not seem to have taken off. In general, the share of Internet users buying over the Internet and the volume of transactions are still quite low and vary widely across countries.

– The best-selling products over the Internet are not necessarily the same across countries, since they reflect not only the nature of the product but also consumer tastes and habits. Nevertheless, computer products, clothing and digitised products such as music, books and software often constitute the major sources of Internet sales to consumers.

– Available statistics show that Internet sales are mainly domestic. Results for eight EU countries indicate that European companies have a higher propensity to sell over the Internet to locations within Europe. This seems to reflect regional trade patterns.

– The main reason why businesses are not conducting transactions electronically is a perception that electronic commerce is not suited to the nature of their business. Other reasons vary. While Canadian firms seem to prefer to maintain their current business model, the major concerns in Europe relate to security in handling payments, uncertainty over contracts and an insufficient customer base. For consumers, the main reasons not to use the Internet are "lack of interest or no use for the Internet" and cost of access and use.

NOTES

1. Because of the high policy interest in electronic commerce and the mandate given by OECD Ministers (Ottawa, 1998) to "compile definitions of electronic commerce that are policy relevant and statistically feasible", the OECD Working Party on Indicators for the Information Society (WPIIS) has devoted much attention to the measurement of electronic commerce. In particular, WPIIS has worked on the development of a framework for user needs and priorities, definitions and statistical measurement of core electronic commerce indicators, OECD internal working document.
2. The S-curve is used here as a synthetic expositional device. In fact, the sequence readiness-intensity-impact is a static image of a more dynamic interaction between user needs and measurement "possibilities". There are many S curves and countries are on different points of the many curves with respect to both e-commerce developments and user needs for indicators. The curve illustrates different stages of OECD methodological work in this area. While this is by no means the only approach to the development of indicators, it has proved to be a good approach for setting priorities in the development of internationally comparable statistical surveys.
3. EDI transmits information from one computer to another without creating the need to re-enter or scan the information. EDI does not including faxing as this requires the receiver of the information to re-enter or scan the data before using it electronically.
4. After two years of sharing experience and testing, a model questionnaire on ICT usage in the business enterprise sector was approved at the meeting of the Working Party on Indicators for the Information Society (WPIIS) in April 2001. The questionnaire is intended to provide guidance to OECD Member countries for measuring indicators of ICT, Internet use and electronic commerce; it is composed of separate, self-contained modules to ensure flexibility and adaptability to a rapidly changing environment. While the use of "core" modules allows measurement on an internationally comparable basis, additional modules can be added to respond to evolving or country-specific policy needs in this area. The OECD definitions and the model questionnaire have been used as a basis for the development of the Eurostat Pilot Survey on E-commerce as well as other e-commerce surveys in OECD Member countries.
5. The study was conducted by a market research company for the UK Department of Trade and Industry, and covered all G7 countries plus Sweden. It collected information on the types of business processes performed electronically.
6. Note that some of those in the Internet group also use one or more of the other technologies. The extranet category, for example, only includes those that use the extranet to take orders and do *not* use the Internet for taking orders.
7. All business respondents are weighted by number of employees.
8. The business services industry is based on International Standard Industrial Classification (ISIC), Rev. 3. ISIC business services industry codes 72-74 include computer and related activities, research and development, legal activities, advertising activities and architectural, engineering and other technical activities.
9. This indicator, based on Netcraft's Secure Socket Layer (SSL) surveys, measures the number of servers with a secure software commonly used for purchasing goods and services or transmitting privileged information over the Internet. Over the period 1998-2000, there was an increase of 470% in the number of secure servers in OECD countries.
10. Electronic funds transfer at point of sale.

REFERENCES

Australian Bureau of Statistics (2000),
"Business Use of Information Technology December 2000", 8129, ABS, Canberra. *www.abs.gov.au*

Australian Bureau of Statistics (2001*a*),
"Household Use of Information Technology November 2000", 8147, ABS, Canberra. *www.abs.gov.au*

Australian Bureau of Statistics (2001*b*),
"Household Use of Information Technology 2000", 8146, ABS, Canberra. *www.abs.gov.au*

Electronic Promotion Council of Japan (ECOM) (2001),
Market Survey of Electronic Commerce 2000 *in Japan*, September, ECOM, Tokyo.

Department of Trade and Industry (DTI) (2001),
"International Benchmarking Study 2000", *www.dti.gov.uk*

Dickinson, P. and J. Ellison (1999),
"Plugging In: The Increase of Household Internet Use Continues into 1999", Connectedness Series, Statistics Canada, Ottawa, *www.statcan.ca*

Eurostat (2001),
"The European Community Survey on E-commerce: First Results", *Information Newsletter*, No. 1, July, Eurostat, Luxembourg.

Gault, F. (2000),
"The Canadian Landscape of E-commerce", paper presented at the National Policy Research Conference, 1 December.

Infocomm Development Authority of Singapore (2000),
"Survey on E-commerce 2000, Executive Summary", IDA, Singapore.

INSEE (2001),
"Retailers' first steps on the Internet", No. 771, April, INSEE, Paris, *www.insee.fr*

Japanese Cabinet Office (2001),
"Questionnaire on Corporate Activities", *www.cao.go.jp*

Korea National Statistical Office (2001),
"Cyber Shopping Mall Survey", August, *www.nso.go.kr*

Korea National Statistical Office (2002),
"E-commerce Transactions in the Second Quarter of 2001", February, *www.nso.go.kr*

OECD (1999),
"Defining and Measuring Electronic Commerce: A Status Report", DSTI/ICCP/IIS(99)4/FINAL.

OECD (2000),
Information Technology Outlook 2000, OECD, Paris.

OECD (2001*a*),
Science, Technology and Industry Scoreboard. Towards A Knowledge Based Economy, OECD, Paris.

OECD (2001*b*),
"Progress achieved by the OECD Member Countries in the Furtherance of the Ottawa Declaration on Authentication for Electronic Commerce", forthcoming.

Office of National Statistics (ONS) (2001),
"E-commerce Inquiry to Business 2000", ONS, London.

Peterson, G. (2001),
"Electronic Commerce and Technology Use", Statistics Canada Connectedness Series, No. 5, September.

Statistik Austria (2001),
Europäische Piloterhebung über E-commerce 2000/2001, Statistik Austria, Vienna.

Statistics Canada (1999),
Information and Communications Technologies and Electronic Commerce in Canadian Industry, Statistics Canada, Ottawa.

Statistics Canada (2001*a*),
The Daily, April, Statistics Canada, Ottawa.

Statistics Canada (2001*b*),
The Daily, October, Statistics Canada, Ottawa.

Statistics Denmark *et al.* (2000),
"Use of ICT in Nordic Enterprises 1999/2000", Statistics Norway, Kongsvinger, *www.ssb.no*

Statistics Finland (2001*a*),
Internet Use and E-commerce in Enterprises 2001, Statistics Finland, Helsinki.

Statistics Finland (2001*b*),
On the road of the Finnish Information Society III 2001.

Statistics Netherlands (2001),
De digitale economie 2001, CBS, Voorburg.

Tachibana, T. (2000),
"The Survey on ICT Usage and E-commerce on Business in Japan", paper presented at the Voorburg Group on Services Statistics meeting, Madrid, 18-22 September.

US Department of Commerce (2001),
"E-Stats", *www.census.gov/estats*

Chapter 5

ICT SKILLS AND EMPLOYMENT

ICT skills and employment continue to be major issues, owing to growth and change in the numbers and characteristics of ICT workers and concerns about possible skill mismatches in ICT-related jobs (OECD, 2000*a*).[1] As ICT employment continues to expand, broad trends are transforming OECD economies and the workforce: the process of globalisation and economic integration has strengthened, and structural changes have shifted economic activity (and employment) towards services. Demographic and educational trends (such as ageing populations and rising overall attainment levels) are substantially altering the size and composition of the workforce. Apart from these general trends affecting IT work and IT workers, the rapid growth of new segments of the ICT sector, such as the Internet, e-commerce and IT services, has created new types of jobs requiring new skills (OECD, 1999).

It is useful to distinguish the characteristics of different IT skill sets. A simple categorisation is:

– Professional IT skills: ability to use advanced IT tools and/or to develop, repair and create them.[2]

– Applied IT skills: ability to apply simple IT tools in general workplace settings (in non-IT jobs).

– Basic IT skills or "IT literacy": ability to use IT for basic tasks and as a tool for learning.

This chapter focuses on the IT workforce, or those with professional IT skills, and the growing demand for these skills across the economy. It examines the following related questions. Why are IT skills important? Where are IT workers employed? How are firms coping with skill mismatches and tight labour markets? Does immigration play a significant role? It then turns to the issue of IT skills. What are the skill requirements for IT jobs? Can certification schemes help signal IT skills to employers? How is the supply of potential IT workers evolving? It next addresses the roles for different stakeholders when faced with changing skill requirements. What are the relative incentives and barriers for upgrading skills? How might the various economic actors respond if IT skills become a new category of "general" skill?

Knowledge, skills and IT

As OECD economies continue to move towards "knowledge-based societies", the role of knowledge workers and information workers becomes increasingly crucial (OECD, 2001*a*). In the 1990s, knowledge workers (including computer workers, along with engineers and applied and social scientists) were the fastest-growing occupational category in the United States and the EU area (Figure 1). Although the links to aggregate growth are difficult to quantify (see Box 1), firm-level evidence suggests a positive association between productivity gains and use of knowledge workers. The sustained growth of new ICT industries and the diffusion of ICTs throughout all sectors have created new skill requirements. However, despite the importance of these new skills, there are great conceptual and practical difficulties in attempting to define and measure skills, particularly in fast-moving areas based on information technology.

On a basic level, skills refer to the ability to perform tasks, while occupations refer to jobs or work requiring given sets of skills (see OECD, 1998; Advisory Council on Science and Technology – ACST, 2000). Skills are important for:

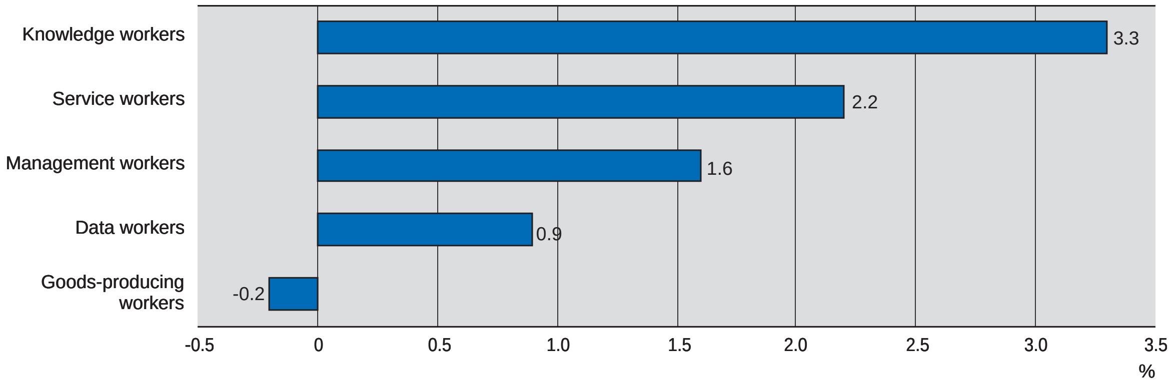
– Individuals: in terms of compensation, employability, personal development.

– Firms: as they allow increases in productivity, competitiveness, adaptability.

– Countries and regions: as determinants of economic growth and social cohesion.

Figure 1. **Employment growth in EU countries and the United States, by occupational group, 1992-99**

Average annual percentage change



Note: See OECD (2001*a*) for a complete breakdown by occupational categories.
Source: OECD (2001*b*).

Box 1. Human capital, labour and growth

Skills and human capital are increasingly regarded as major factors in development and growth. A broad consensus is emerging that there is a positive association between investment in human capital and economic growth (Ahn and Hemmings, 2000; Temple, 2000; OECD, 1998, 2001*c*). Micro-level studies using regressions on earnings find that schooling often has a significant impact, although it may also act as a signalling/screening/credential device.

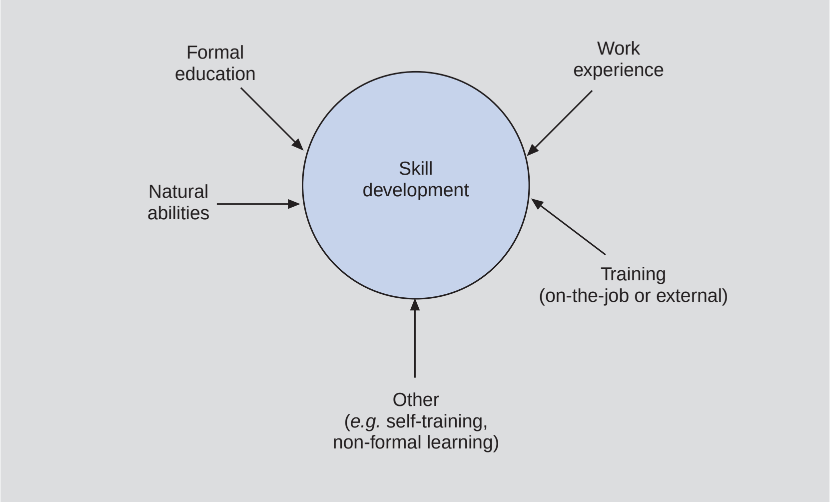
Recent analysis of the determinants of economic growth across OECD countries reveals that labour utilisation plays an important role and that strong productivity performance at sectoral level tends to correlate with a general upskilling of the workforce (Scarpetta *et al.*, 2000). In many OECD countries, structural changes have led to higher overall labour utilisation in a context of more productive use of factor inputs. There is still a potential for higher levels of labour utilisation, particularly in continental Europe where employment rates are low, especially among youths, prime-age women and older workers. Labour productivity growth was estimated to account for at least half of the recent GDP per capita growth in most OECD countries.

Compositional changes in the quality of labour input can be measured using educational attainment as a proxy for skills. Scarpetta *et al.* (2000) found a positive effect from labour composition (skill upgrading) in all countries but Germany for the 1985-98 period. In countries such as the United States, Australia and the Netherlands, skill upgrading seems to have played a modest role, while in others (including most European countries) its role appears to have been more significant. In most OECD countries, there is a general tendency to skill-biased employment growth.

Although there is growing agreement on the importance of skills *per se* as a key driver of economic growth and the spread of the knowledge economy, there is far less consensus on which competencies and skills make the difference (OECD, 2001*d*). Since skills cannot be easily measured, different proxies are used to capture observable characteristics, such as educational attainment on the supply side and occupations on the demand side. As Figure 2 shows, skills are acquired through a variety of channels.

By its nature, IT work requires individuals to master codified and tacit knowledge and technical and abstract concepts, which are acquired through various formal (education) and non-formal (work experience) channels. Even for non-IT workers, ICTs are affecting the skills required and the nature and organisation of work (US Council on Competitiveness, 1998; International Labour Organization – ILO, 2001). Overall, the rapid growth of ICT industries and the wide diffusion of ICTs are radically changing skill sets and occupations, and it is important to gain a better understanding of the employment

Figure 2. **How skills are acquired**



Source: OECD.

patterns of this new IT workforce, including new types of compensation, new types of jobs and new motivations. The recent debate on the supply and demand of IT skills (and possible "gaps") must be examined in the context of earlier (and more general) concerns about "skill shortages" (Massé *et al.*, 1998) and the effects of skill-biased technological change on employment and wages (OECD, 1996; Katz, 1999; Acemoglu, 2000).

Measuring the IT workforce

Industry-based data can provide information on the relative importance of IT-producing sectors in national economies, but are insufficient to capture the true size and nature of the IT workforce. First, not all workers in these industries perform IT-related tasks: many are involved in marketing, sales and various other activities that are not strictly IT-related. Conversely, many IT workers are employed in sectors other than those producing ICT goods and services: the business and financial service sectors are important employers of IT workers. It is therefore necessary to use other ways of measuring the size and composition of the IT workforce, such as occupational data.

For the United States, Table 1 shows the most recent available data for the entire IT workforce, which reached more than 6.5 million in 2000. Almost 60% of these workers were employed in high-skill IT occupations (as determined by educational attainment), one-quarter in medium-skill jobs, and the remaining one-fifth in low-skill occupations.

The Information Technology Association of America (ITAA) estimates that in 2001 about 10.4 million workers were employed in ICT-related jobs in the United States (all sectors) (ITAA, 2001). Others (US National Research Council – NRC, 2001) have questioned this figure owing to the small sample size, the low response rate,[3] and possible ambiguities in the survey interview questions used to identify IT workers. Nonetheless, this figure may be considered an upper bound for a broad definition of those using IT as a main component of their work. The US Bureau of Labor Statistics estimates that the number of "core" IT workers will grow from 2.2 million in 1998 to 3.9 million in 2008.[4] Additionally, the United States will need to replace 306 000 workers who leave these occupations permanently. Accordingly, the United States could require an average of about 201 800 new IT workers a year to fill jobs in these occupations. As can be seen, measuring with any precision the size of the IT workforce is a challenging task.

Table 1. **Employment in IT-related occupations by skill level in the United States, 2000**

Thousands

Occupation	Employment
High skill	
Computer support specialists	523
Computer software engineers, applications	375
Computer systems analysts	463
Computer programmers	531
Computer software engineers, systems software	265
Computer and information systems managers	283
Network and computer systems administrators	234
Engineering managers	242
Electrical and electronic engineering technicians	245
Network systems and data communications analysts	119
Database administrators	108
Electrical engineers	162
Electronics engineers, except computer	124
Computer hardware engineers	64
Computer and information scientists, research	26
Medium skill	
Data entry keyers	459
Electrical and electronic equipment assemblers	367
Telecommunications line installers and repairers	168
Computer, ATM, and office machine repairers	142
Electrical power-line installers and repairers	96
Telecommunications equipment installers and repairers, exc. line installers	192
Electrical and electronics repairers, commercial and industrial equipment	82
Semiconductor processors	67
Electromechanical equipment assemblers	73
Low skill	
Billing and posting clerks and machine operators	492
Switchboard operators, including answering service	243
Mail clerks and mail machine operators except postal service	182
Computer operators	186
Office machine operators, except computers	86
Telephone operators	52
Total IT occupations	6 652

Source: US Department of Commerce (US DOC) (2002), based on Bureau of Labor Statistics (US BLS), Occupational Employment Statistics (OES) (2002).

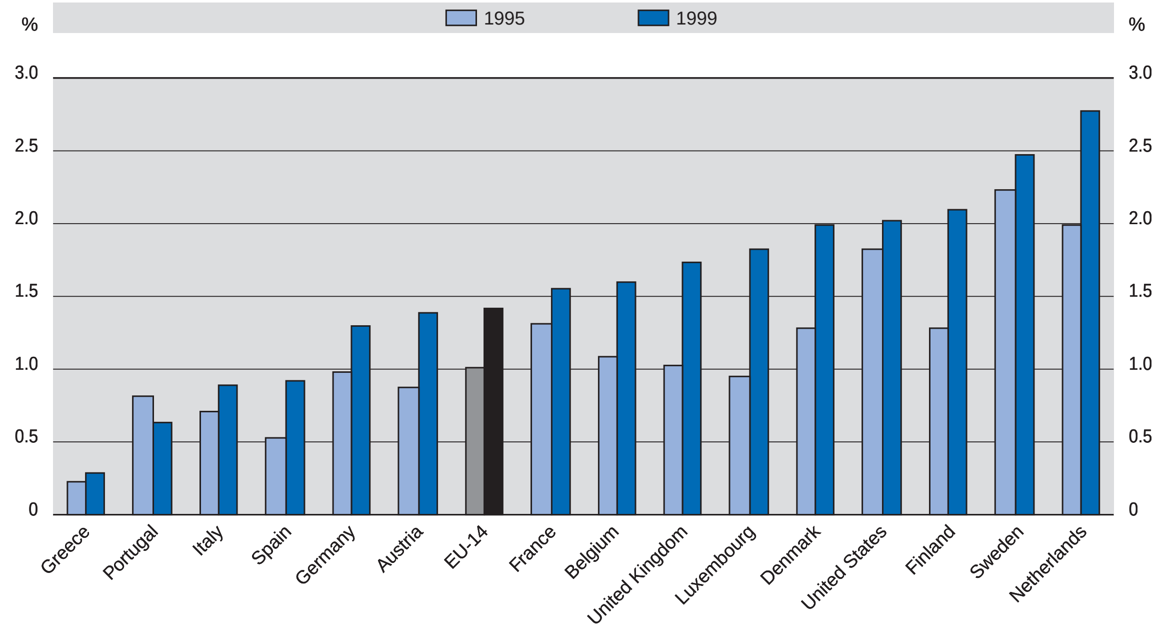
Analysis of occupational data by sector of employment shows that in the United States in 2000, almost two-thirds of all high-skilled IT workers (as defined in Table 1) were employed in sectors other than computer and data processing services (US BLS, 2002). The US Department of Commerce estimates that by 2008, in addition to computer-related services, the following industries will employ more than 100 000 IT workers each: wholesale trade, management and public relations, personnel supply services and education (US DOC, 2000*a*).

For the United Kingdom, the most recent analysis of labour force statistics (Institute for Employment Studies – IES, 2002) estimates that in 2000, the number of IT jobs (in both IT-producing and IT-using industries) was between 1.1 million and 1.3 million, including 940 000 in "core" ICT occupations. Of these, just under half were employed in ICT-producing industries.

In Italy, a study conducted by the IT industry association (ASSINFORM *et al.*, 2000) estimated the number of ICT workers at around 890 000 in 1999.[5] It also estimated that a further 122 000 workers had (non-professional) IT skills.

In Denmark, an analysis of labour force data at the end of 1998 estimated that there were 92 900 ICT workers, 60 600 of whom were classified as "primary" IT workers. Of these, 72% were employed in

Figure 3. **Computer workers[1] as a percentage of total employment in selected OECD countries/regions, 1995 and 1999**



Note: 1995 data estimated for EU-14. 1997 instead of 1995 for Finland and Sweden.
1. For Europe, computer workers include ISCO-88 categories 213 and 312; for the United States, CPS categories 64, 65, 229, 308 and 309.
Source: OECD estimates based on data from the European Labour Force Survey (Eurostat) and US Bureau of Labor Statistics.

manufacturing, trade, hotel and restaurant services and business services, while almost 40% of the "secondary" ICT workers were employed in manufacturing, electricity, gas and water supply (Statistics Denmark, 2001).

Figure 3 shows the share of computer workers[6] in total employment, which increased steadily during the second half of the 1990s throughout the OECD area (except for a slight decline in Portugal).

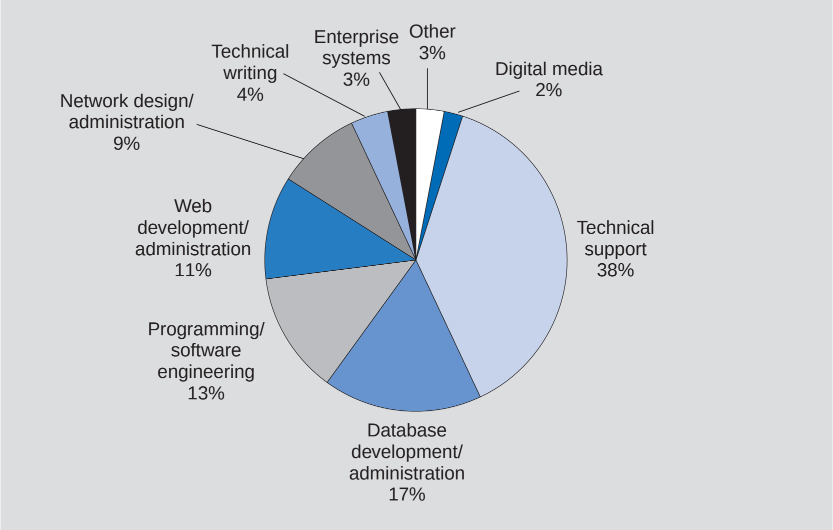
At sub-national level, a recent EU-funded study identified various European regions with a high level of ICT intensity in terms of employment (ISCO occupational categories 213, 312 and 313). In 1999, the Stockholm (Sweden), Paris (France), Utrecht (Netherlands), and Uusimaa (Finland) regions had over 4% of total employment in ICT occupations (Emergence, 2001).

Shortages of IT workers? Data and analysis

A labour shortage is usually defined as a persistent shortfall in the supply of qualified personnel at the prevailing wage or salary level. Needless to say, this is often very difficult to quantify. Various private firms and industry associations have produced estimates of jobs required and potential gaps. Many observers have questioned such estimates for the United States while agreeing that there is convincing evidence of tightness in some parts of the IT labour market, particularly in certain new software-related professions (US NRC, 2001; US DOC, 2000*b*; Weinstein, 1999; Matloff 1998).

The ITAA estimates a "skills gap" of around 425 000 workers in the United States in 2001, or 4% of the IT workforce (ITAA, 2001). Given the methodology used, these figures must be interpreted with care,[7] but they do indicate the extent to which specific IT jobs (and related skills) are associated with particularly high demand and continuing concerns regarding supply. The main areas are technical support, database development and administration, programming and software engineering (Figure 4).

Figure 4. **Distribution of estimated "IT worker gap" in the United States by activity, 2000**



Source: ITAA (2000).

The International Data Corporation (IDC) estimates a demand for 11.2 million IT workers in Europe in 2001, three-quarters of whom with "high-level" (professional) skills (European Information Technology Observatory – EITO, 2001). In addition, IDC forecasts a demand for 3.9 million workers with "e-business" skills (a combination of technical and business/management skills). This total of more than 15 million workers is then compared to the estimated number of currently available workers, to obtain an estimate of unfilled vacancies (Table 2). IDC expects the demand for IT workers to continue growing rapidly to 13 million workers with IT skills and 6.3 million with e-business skills in 2003. It is worth noting that, according to this estimate, the locus of the problem in the next few years will not be an insufficient supply of qualified IT workers, but a mismatch due to a growing demand for e-business employees, *i.e.* those with strong knowledge of IT applications, but not IT professionals *per se*. In October 1999, the German IT industry association (BITKOM) estimated a need for 75 000 jobs in Germany, for the IT-producing industries only (Klotz, 2000).

Table 2. **Estimated unfilled vacancies in IT and e-business in Europe, 2001 and 2003**

Millions

	2001	2003
IT	1.36	1.69
E-business	0.87	1.98
Total	2.23	3.67

Source: EITO (2001).

Examining the evidence

Discussion of IT worker shortages must keep in mind that "economic theory suggests that skill shortages and surpluses are a permanent feature of decentralised labour markets. Hence, at any point in time, labour market economists examining the data will find evidence of occupational imbalances" (Roy *et al.*, 1996, in Stager, 1999), but there will be market responses. Shortages are conceptually difficult to measure; some possible indicators of a tight labour market are strong employment growth, high employment rates for recent graduates, low unemployment rates, strong rise in vacancies[8] and upward pressure on wages and compensation. Various recent studies have examined the evidence for the United States and concluded that claims of a severe across-the-board shortage are unsubstantiated (US NRC, 2001; US Department of Commerce – DOC, 2000*b*; US National Science Foundation – NSF, 2000*a*; Ellis and Lowell, 1999*a*, 1999*b*, 1999*c*, 1999*d*). In addition, the current economic slowdown in the United States and other OECD economies should contribute to ease tensions in the IT labour market as firms adjust to the cycle and reduce staff numbers.[9]

In the *United States*, employment growth is strong and unemployment rates in IT professions remain very low. Earnings continue to increase, but not at a rate consistent with a shortage (except for specific categories of workers in high demand). A factor that may contribute to this wage moderation is the increasing number of foreign workers admitted under the H-1B programme (see the section on foreign workers below). Admittedly, data on wages do not adequately describe compensation trends, as different forms of compensation, such as bonuses, profit-sharing schemes and stock options, are increasingly used to attract top workers. Nonetheless, wages are still an important indicator of labour market conditions, as these other forms of compensation usually only concern a small share of all IT workers, and the recent plunge of technology-related stock prices has made many of these schemes much less appealing to workers.

On the supply side, many countries appear to have had an upturn in the number of IT-related degrees granted, along with increasing student participation in IT courses, regardless of the field of study (see the section on higher education below).

Overall, although there is high demand in new and rapidly expanding areas, it is not possible to conclude that a severe shortage of IT workers exists across all categories of IT jobs. A distinction should be made between a shortage of IT workers, for which there is little or no aggregate evidence, and a gap between the current skills of IT workers and those sought by firms, for which some anecdotal evidence exists (such as employer surveys). Analysis of the data reveals that indicators of labour market tightness may mask many other problems related to labour market imperfections which are exacerbated by the highly specialised nature of IT jobs. Employers seek specific combinations of (IT and other) skill sets which may not be readily found in many otherwise qualified job seekers. Other problems include inadequate recruitment practices, uncertainty related to temporary work and differences in remuneration (*e.g.* for IT teachers). Even the growing demand for Internet-related skills may mask a polarisation between highly sought "next-generation" skills (*e.g.* design and management of secure high-speed networks, e-business integration) and the skills needed to perform increasingly routine tasks such as Web site authoring and maintenance (Institute for the Management of Information Systems, 2001).

In the *United Kingdom*, a survey on skills shortages revealed that the hardest to fill vacancies were for jobs in crafts (mechanic, carpenter, plumber, electrician) and sales/marketing, ahead of IT staff (Wilson, 2000).

In *Australia*, somewhat outdated figures suggest a tight labour market for IT workers (NOIE, 1998). Relevant indicators include strong employment growth (15% between 1996-98 compared to 10% for all professionals and 2.6% for all occupations), low unemployment rates (2.7% in August 1998 compared to 3.8% for all professionals) and a sharp increase in published vacancies. Employment prospects for computer science and engineering graduates were also more favourable than for all graduates, although lower than in the late 1980s. Trends in earnings are inconclusive: the ratio of earnings of IT workers to all occupations has remained relatively stable throughout the 1990s, with short peaks following cyclical trends. More recent data suggest that in early 2001, the number of ICT-related vacancies declined continuously (as measured by vacancies posted on on-line recruiting sites) (Department of Employment, Workplace Relations and Small Business – DEWRSB, 2001).

In *Canada*, wage and other data suggest that there is no severe shortage, but that certain skills are in high demand (both technical and business/personal skills) (Gingras and Roy, 1998; ACST, 2000). An analysis of labour force survey data predicted that "there should not be an emerging problem of shortage over the next five to seven years" but also acknowledged the need to improve occupational data and knowledge of current skill requirements at a finer level of disaggregation (Stager, 1999).

In *France*, professionals ("*cadres*") in the computer services sector continue to enjoy strong employment growth: 41 590 new jobs (+10%) were created between 1999 and 2000 and 37 410 (+14.6 %) between 2000 and 2001. This accounts for almost one-quarter of all new professional jobs and more than one-third of all those in service sectors. More than half of the new jobs went to recent graduates. Employment growth has remained strong in communication equipment but much more modest (and even negative during 2000/2001) in IT manufacturing activities. Altogether, growth in ICT jobs is slowing down from previous years but remains strong (APEC, 2001; APEC, 2002). Although the ratio of job offers to job seekers in computer-related occupations increased rapidly between 1996 and 1998 (to twice the average for all occupations), there appears to be a slowdown since early 1999 (ministère du Travail, 2000).

Enterprise responses to labour market conditions

Employers can opt for either internal or external strategies to address tightness in the labour market[10] (Table 3). Internal strategies imply using the existing workforce in more effective and productive ways. External strategies imply expanding the pool of potential employees and either attracting new recruits or using external workers. A distinction should also be made between short-term solutions which firms can adopt to address immediate labour requirements and longer-term remedies related to changes in supply. Within medium-/long-term solutions, firms can also focus on two complementary aspects: retaining their current workforce or attracting new skilled workers.

Table 3. **Firm strategies for coping with skills shortages**

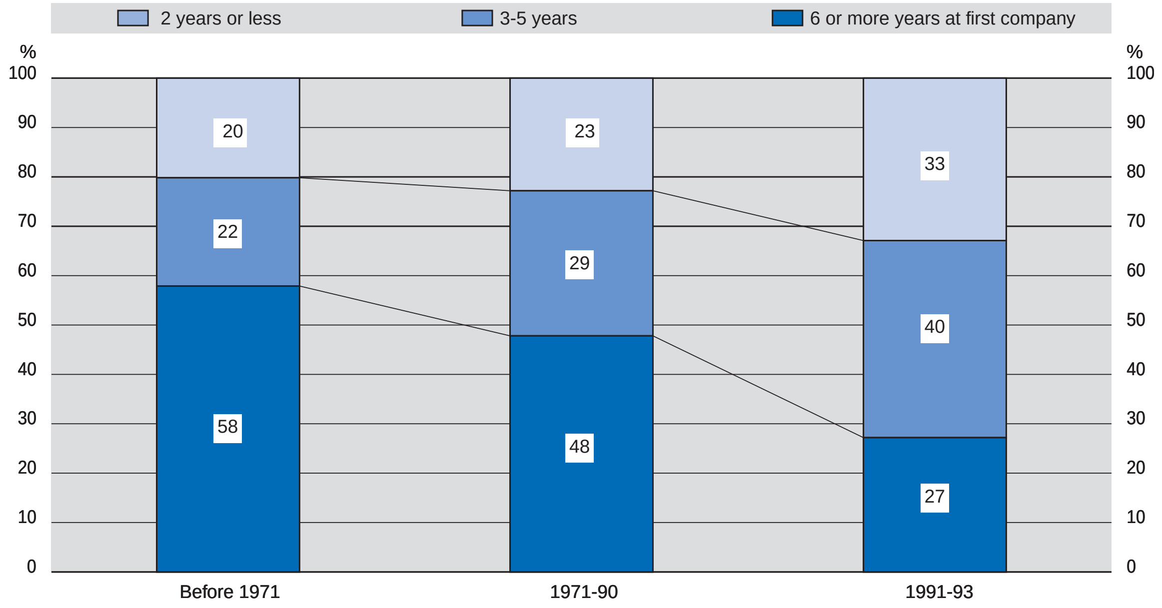
	Short-term	Medium-/long-term
Internal strategies	Train (or retrain) existing staff	Train (or retrain) existing staff
	Overtime	Changes in management practices and workplace organisation
	Increase wages or other forms of compensation (profit-sharing, stock options) to retain current skilled workers	
	Offer better non-wage benefits (flexible work schedule, holidays, health benefits and services) to retain workers	
External strategies	Outsourcing	Outsourcing Increase compensation and non-wage benefits to attract workers, either unemployed or employed by other firms
	Hire foreign workers (either offshore or immigrants)	Expand scope of recruiting: use private recruitment firms, campus recruiting, Internet recruiting
	Temporarily hire less skilled workers	Work with educational institutions to identify and build skills for the future

Source: OECD.

Firms adopt different strategies, depending on costs and benefits, which differ according to the type of skills required (US DOC, 1999; Wilson, 2000; ASSINFORM *et al.*, 2000). For example, the demand for technical support specialists (the category identified in the ITAA survey as the one for which the most unfilled vacancies exist) might be better addressed through outsourcing, than the demand for database specialists (which could be addressed through training). The ITAA study finds that in the United States, outsourcing is the strategy most commonly used by firms to fill vacant IT positions (ITAA, 2000). Another recent US study argues that although firms face important human resource challenges with respect to supply (due to lags in labour market adjustments), the most critical of these stem from managing workers inside companies, including reducing turnover and improving recruitment practices (Cappelli, 2000).

Turnover rates of IT workers in the United States have been particularly high, especially for younger workers (US NRC, 2001). On the one hand, if turnover is indeed high, this may have adverse effects on the willingness of firms to train. On the other hand, rapid turnover may also have positive spillovers, as

Figure 5. **Expected duration with first employer by year of graduation**



Source: McKinsey, in Business 2.0 (2000).

workers learn a variety of new (and marketable) skills when moving to different jobs. The evidence of rapid turnover must be examined in the context of the changing expectations of recent graduates and their desire to build experience by moving from job to job. Various McKinsey surveys of computer science and engineering graduates in the United States show that in the early 1990s fewer than one-third expected to stay more than six years with their first employer, compared to almost one-half of those graduating in the 1970s and 1980s (Figure 5) and almost two-thirds of those graduating earlier. Among more recent graduates (1994-96), 47% expected to spend less than two years with their first employer (Business 2.0, 2000).

The supply of IT workers

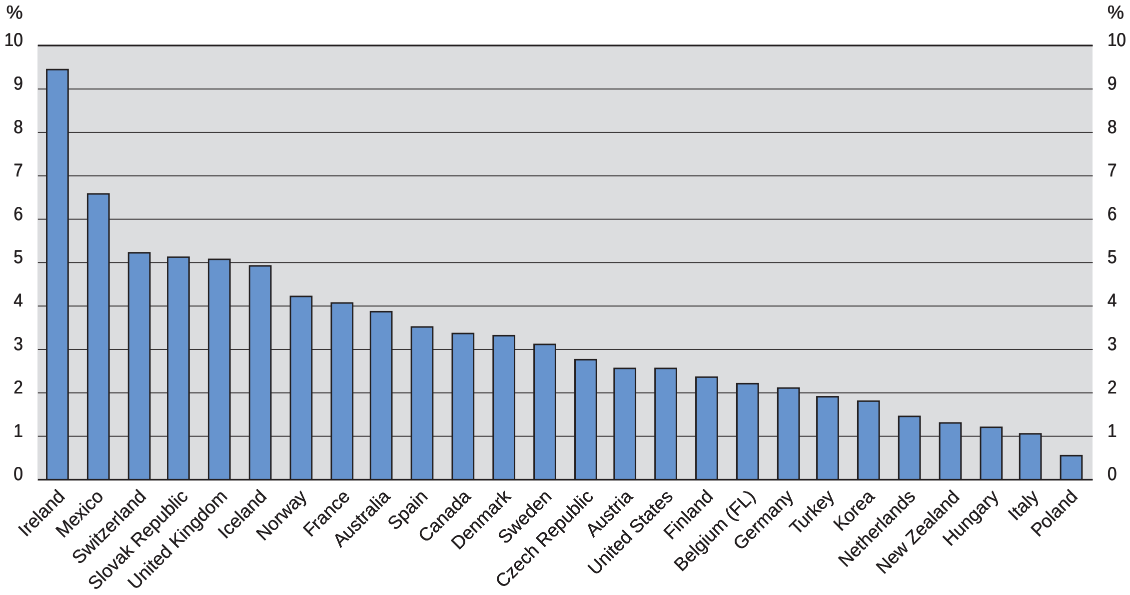
Higher education

The main source of IT workers continues to be tertiary-level education. Data from the US Current Population Survey (CPS) show that 60.2% of all computer programmers held a bachelor's degree or higher in 2000, while an additional 11% held an associate's degree. In the case of computer systems analysts, the figures were 69.8% and 9.1%, respectively. Figure 6 shows the ratio of computer science tertiary-level graduates to those in other fields of study, which averaged 2.9% in the OECD area in 1999. Data from the US Department of Education show that in 1997-98 computer and information sciences accounted for 2.4% of all bachelor's and master's degrees granted, up from 2.2% in the mid-1990s, but a full percentage point lower than in the late 1980s (National Center for Education Statistics – NCES, 2001).

There is recent evidence of sustained increases in the supply of IT graduates. The Taulbee Survey covers PhD-granting departments of computer science and computer engineering in the United States and Canada (Computing Reasearch Association – CRA, 2000 and 2001) and provides data broken down by type of degree.[11] Results from the latest survey show that the number of bachelor's degrees awarded was projected to grow from around 8 000 in 1997 to almost 16 000 (estimated) in 2001. There has also been significant growth in the number of master's degrees, with a 19% increase between 1999 and 2000. On the other hand, there has been an observable slowdown in the growth of PhDs since the mid-1990s,

Figure 6. **Computing in tertiary education in OECD countries, 1999**

Tertiary-level graduates in computing as a percentage of all fields of study



Source: OECD Education Database, May 2001.

partly owing to changes in the labour market as job prospects are currently very positive for holders of master's degrees. In the United Kingdom, the number of graduates in computer science has increased by 25% since 1995 and is currently just over 10 000 (IES, 2002). If other ICT-related fields are included (*i.e.* mathematics, electrical and electronic engineering, etc.), the figure reaches 65 000.

Although post-secondary education is the main supplier of workers entering IT jobs, graduates in computer science and engineering are only a part of all individuals eventually pursuing IT careers. US data for 1997 reveal that among "core" IT workers, 46% had IT degrees (BA or higher, including minors or second majors), 14% engineering (other than computer), 26% science and maths and 6% business (US DOC, 1999).

In the United Kingdom, the share of IT workers with an IT degree increased slightly from 33% in 1994 to 37% in 1998. Among ICT workers, software engineers have, on average, the highest academic degrees: in 2000 almost 60% held a first degree or higher (IES, 2002). However, two-thirds of IT workers do not have IT degrees, and two-thirds of IT graduates do not work in IT jobs (AISS/ITNTO, 1999). Similar results from Statistics Denmark (2001) confirm that there is no systematic link between ICT education and ICT occupations: almost half of those employed in ICT jobs do not have formal ICT education degrees. Likewise, more than half of those with formal ICT education work in non-ICT jobs.

As Box 2 shows, women are usually underrepresented, even when compared to other science and engineering fields. By enhancing the attractiveness of this career, governments and firms could help to expand the pool of potential IT workers.

Private sector certification

In the last few years, there has been a strong increase in the number of technical credentials granted by companies, business associations and commercial IT bodies. Table 4 shows that by early 2000, Cisco, Microsoft, Novell and other firms or private bodies had awarded more than 1.8 million credentials[12] certifying IT skills to individuals.

Box 2. IT degrees and gender

Data on tertiary-level graduates highlight a gender imbalance: computing continues to be a field of tertiary-level study that attracts a disproportionate share of men. In 1999, in four-fifths of OECD countries, men accounted for over 80% of tertiary-level computing degrees.

A UK study estimates that in 1997 women accounted for only 17% of entrants to computer science higher education courses, compared to 53% for all fields of study (IES, 2002).

In the United States in 1997-98, women accounted for only 26.7% of bachelor's degrees in computer and information sciences and 29.0% of all master's degrees (NCES, 2001). Between 1980 and 1997, one-quarter of all graduate students in computer science in the United States were women, compared to one-third for all science and engineering fields (NSF, 2000*b*).

In Sweden, of the 43 000 graduates from higher education IT programmes from 1977/78 to 1998/99, just over a quarter were women. For the latest year available, the share was 28% after a decline during the mid-1990s (Swedish Ministry of Industry, Employment and Communications, 2000).

In Norway, the Norwegian University of Science and Technology (NTNU) introduced in 1997 a special quota system for women in computer technology studies. The project soon produced positive results. In the first two years, the percentage of female students increased to more than 30%. In addition, the Government has carried into effect several initiatives to increase the number of female pupils and students taking up IT and technology-related skills. Finally "ICT Norway", the largest IT-organisation in Norway initiated in 2002 a special mentor-program to increase the number of women in the IT-sector, titled "OD@".

Table 4. **Worldwide commercial IT certifications, early 2000**

	Certifications
Microsoft Certified Professional (MCP)	457 603
Microsoft Certified Solutions Developer (MCSD)	23 785
Microsoft Certified Systems Engineer (MCSE)	231 180
Other Microsoft Certified Professional Programmes	176 028
Certified Cisco Design Associate (CCDA)	4 000
Other Cisco certifications	31 000
Certified Novell Engineer (CNE)	175 000
Certified Novell Administrator (CNA)	370 000
Other Novell Certifications	18 300
Oracle (all certifications)	24 000
CISSP (Certified Info Systems Security Professional)	1 500
CCA (Citrix Certified Associate)	8 000
A+ (Computer Tech Industry Associate)	180 000
Institute for Certification of Computing Professionals	50 000
Natl. Assoc. of Communication Systems Engineers (all Certif.)	18 000
Others (Baan, Sybase, SAP, Adobe, etc.)	43 778
Total	1 812 174

Source: Adelman (2000) and 21st Century Workforce Commission (2000).

There is still insufficient information on the exact role played by such certification programmes in terms of IT employment. Analysis of recent vacancy data underscores the growing role of these tools (and provides an interesting corollary to IT worker shortage estimates based on vacancies). Around one in seven positions advertised in the United States was found to require a commercial certification (Adelman, 2000). Further analysis could include identifying the types of workers undergoing certification and examining the incentives for workers (or firms) to pay for such programmes. These programmes should also be linked to broader attempts to recognise, certify and accredit different forms of non-formal learning.[13]

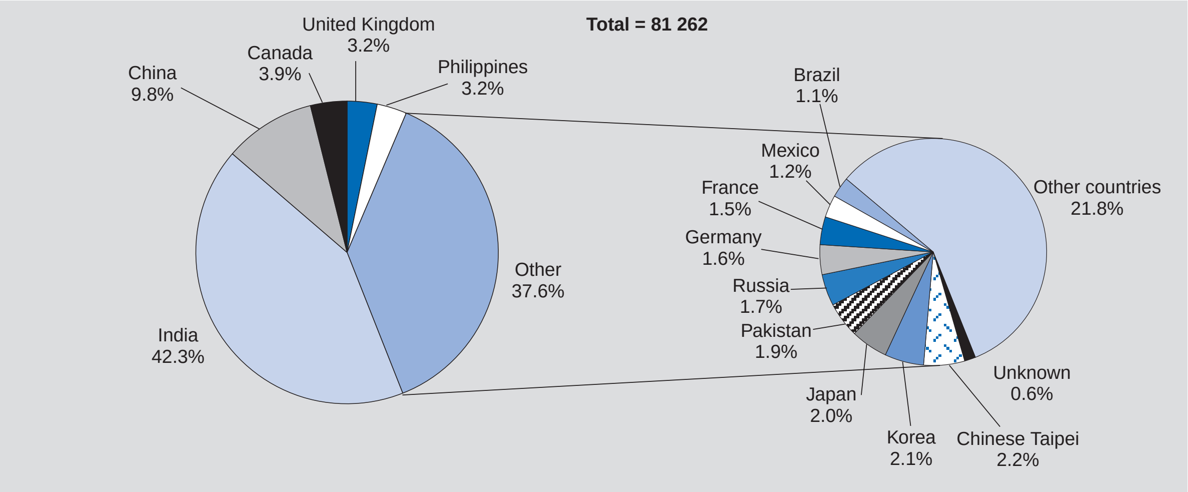
Foreign workers

Foreign workers are an important source of labour and play an increasingly important role in the context of tight national labour markets for IT specialists. The two main categories are immigrants (both temporary and permanent) and offshore workers.[14] Although foreigners can help alleviate problems related to strong labour demand during economic upturns, immigration alone cannot resolve the need for cyclical adjustments to the labour market (OECD 2001*e*). In the case of occupations or skills in high demand (such as ICT), five main types of measures are being taken to facilitate the admission of foreign specialists:

- Relaxing quantitative constraints (*e.g.* United States).
- Setting up special inward migration programmes for occupations with shortages (*e.g.* Germany, Canada, Australia).
- Facilitating recruitment conditions or procedures and relaxing criteria for issuing employment visas for highly skilled workers (*e.g.* Australia, Canada, France, Japan, New Zealand, Norway, United Kingdom).
- Increasing non-wage incentives for skilled foreign workers (*e.g.* Australia).
- Allowing foreign students to change status at the end of their studies (*e.g.* Germany, Switzerland, Australia, United States).

In the United States, the H-1B visa programme aims to attract skilled non-immigrant workers. Although the programme is not restricted to IT workers, more than half of the petitions currently granted are issued to workers in computer-related occupations (US INS, 2000*a*).[15] The number of such visas has increased from 65 000 a year before 1998, to 115 000 and then to 195 000 (from FY2001 to 2003). These temporary visas are valid for six years, and must be renewed after the first three. Although there are no country quotas under this programme, recent data show that about half of all visas are granted to workers from India, followed by China and Canada (Figure 7 and Appendix Table A5.1). It is estimated that the current H-1B population in the United States is around 425 000 and that about one-quarter of

Figure 7. **Geographical distribution of H-1B petitions approved by the INS between October 1999 and February 2000, by country of origin**



Source: US INS (2000*a*).

these visa holders have changed from foreign student status (F visa) (Lowell, 2000). Foreign-born individuals (both temporary and permanent immigrants) account for about 17% of the US IT workforce, compared to 10% for the overall population (US NRC, 2001).

Table 5 presents recent data on the firms employing workers with H-1B visas and shows that, in addition to the largest hardware and software companies, firms with strong ties to India such as Syntel Inc., Wipro Ltd. and Tata Consultancy Services are among the main recruiters.[16]

Table 5. **Leading employers of H-1B visa holders, petitions approved by the INS between October 1999 and February 2000**

Company	Number
Motorola	618
Oracle Corp.	455
Cisco Systems Inc.	398
Mastech (iGATE Capital)	389
Intel Corp.	367
Microsoft Corp.	362
Rapidigm	357
Syntel Inc.	337
Wipro Ltd	327
Tata Consultancy Services	320

Source: US INS (2000*b*).

Box 3 describes several programmes for foreign ICT workers in OECD countries.[17]

What attracts new IT workers?

Smaller and younger companies are becoming increasingly attractive to young graduates. According to a McKinsey survey in the United States, more than two-thirds get their first job with a large company (more than 1 000 employees), but small firms (fewer than 500 employees) are preferred once employees move to a second job.

New non-standard forms of compensation such as stock options and performance-related bonuses are strong incentives for talented workers (Hoch *et al.*, 2000). Given high turnover rates, firms are often willing to offer high non-standard compensation packages to retain and attract the most skilled workers (Table 6). Although earnings through such schemes have been growing at a much faster rate than wages, these incentives only appear to benefit a small proportion of all IT workers.

Given the relative job security and job opportunities that they enjoy, IT workers can often afford to ask for other benefits besides, or in addition to, financial compensation. An international survey of software firms identifies individual workplace styles as strong incentives for workers seeking jobs (Hoch *et al.*, 2000). A McKinsey survey highlights other non-monetary incentives that prospective employees value highly: autonomy, lifestyle, company culture, geographic location (Business 2.0, 2000). Some observers have even argued that a new class of "digital nomads" is emerging: highly skilled and mobile workers with little or no attachment to firms or countries (Makimoto and Manners, 1997).

Defining and identifying IT skill requirements

Surveys from countries such as the United States (US NRC, 2001; ITAA, 2000), Canada (ACST, 2000; Sangster, 1999), Ireland (ISC, 2000*a* and 2000*b*; Forfás, 2000*a* and 2000*b*), the Netherlands (Ministry of Economic Affairs/Ministry of Education, Culture and Science, 2000) and the United Kingdom (AISS/ITNTO,

Box 3. Foreign ICT worker programmes in various OECD countries

Germany

In August 2000, Germany launched a "Green Card" programme that allows for 20 000 temporary visas to be issued to computer specialists from outside western Europe. An analysis of the data[1] for the first 8.5 months of the programme shows that the main source of workers are eastern European countries (around 40%), followed by India and Pakistan (about one-fifth). Most are men (88%) and are hired from abroad (about 85%), except for North Africans, who are predominantly hired after study in Germany. Although there are two criteria for eligibility – educational attainment and income – the former is determining in almost 90% of cases. Around two-thirds of these workers are employed in small firms (fewer than 100 employees). By mid-April 2001, only one-third of the 20 000 cards had been allotted.

Canada

In terms of IT workers, Canada faces both immigration and emigration issues. Despite a perceived gap in employment opportunities and income tax differentials, there seems to be no evidence of an increasing "brain drain" towards the United States. The net effect is in fact estimated to be positive, as a growing number of foreign workers are moving to Canada (Helliwell, 1999). A recent study of Asian computer professionals hired by Canadian firms shows that effective recruitment and retention strategies are needed, given the global nature of competition for skilled workers (CPRN, 2001).

Australia/New Zealand

In Australia, 3 200 temporary immigrant visas were granted in 1997-98 to IT professionals (18% of all skilled temporary nominations) (NOIE, 1998). If IT workers meet the test-points criteria, they are eligible under the Independent and Skilled Australian-linked categories: in 1997-98, 613 computer professionals entered under the Independent category compared to 180 under the Skilled Australian-linked category. According to the Department for Immigration and Multicultural Affairs (DIMA), the number of IT professionals entering Australia has increased markedly since 1997: 7 000 IT managers, computing professionals, and computer support technicians entered Australia and 4 200 departed, resulting in a net gain of 2 800 IT workers (DIMA, October 2000). The New Zealand Immigration Service recently announced that it would start pilot testing on-line applications for visas and permits in order to attract IT talent.[2]

United Kingdom

Of the 42 000 work permits granted in 1999 to non-EU nationals, 2 000 went to immigrants employed in ICT occupations. Of these, two-thirds were from India, and the remainder were mainly from English-speaking countries (IES, 2002). A "fast-track" work permit system has since been implemented to speed up the recruitment of foreign workers by companies experiencing skills shortages. In addition, certain ICT occupations have been added to the "shortage occupation list", and other measures have been taken to attract workers from Asia and Eastern Europe, as well as extending the period of stay from four to five years (OECD, 2001*f*).

Norway

In March 2001, the Norwegian government launched a programme to amend regulations to simplify the recruitment of skilled workers and specialists from countries outside the EEA area. With the amended regulations, the processing time of applications will be reduced, and a non-EEA citizen will be able to obtain a work permit more rapidly than before. The regulations will enter into force from January 2002.

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1. Data on Green Cards were kindly provided to the OECD by the German Ministry of Employment.
2. As part of the recently disclosed New Zealand E-commerce Strategy, see *www.ecommerce-summit.govt.nz/minister/index.html*

Source: OECD and other sources as cited.

Table 6. **Annual growth in compensation for workers in software firms in the United States, 1997-99**

	Base salary (%)	Cash awards (%)	Long-term incentives (%)	Total compensation (%)	Number of incumbents (1999)
Technical staff	5.12	15.85	36.79	7.15	35 022
Managerial jobs	6.76	32.28	95.77	24.95	5 339

Source: Executive Alliance in US NRC (2001).

1999; Hendry 1999; DfEE 2000*a* and 2000*b*) concur with the finding that IT firms tend to seek a combination of three main types of skills:[18]

- Technical skills: primarily IT, but also quantitative analysis/data modelling, digital media, technical writing, etc.
- Business/management skills: in particular marketing, strategy and business writing.
- Personal skills: communication, leadership, teamwork, problem-solving ability.

Along with the emergence of new occupations, new jobs are appearing which require hybrid skills (Ducatel and Burgelman, 2000). Content industries are an example of activities where interdisciplinary work calls for a combination of creative and technical skills, as well as business abilities.

Data based on industrial and occupational classifications do not provide sufficient information on the specific skills of the IT workforce. Given that IT workers undertake a wide range of activities that fall under different occupational categories (not always IT-related), more detailed tools are needed to identify IT jobs and the specific skills required. The appendix to this chapter contains a detailed list of IT-related occupations from the US Northwest Center for Emerging Technologies (NWCET), divided into eight clusters. These standards cover technical skills, employability skills and basic knowledge requirements for each IT career cluster. Each cluster has a range of jobs at various levels.

In the United Kingdom, a Skills Framework for the Information Age (SFIA) along similar lines has been developed by a consortium of public and private bodies. It is constructed as a two-dimensional matrix with skills and responsibility levels as the axes. One axis divides ICT activities into skills grouped into subcategories or "business roles". Subcategories are then grouped into six work areas: strategy and planning, management and administration, development and implementation, service delivery, sales and marketing and use. The other axis defines the level of responsibility and accountability exercised by ICT workers and users. Each of seven levels, from new entrant to strategist, is defined in terms of autonomy, influence, complexity and business skills. A skills/levels matrix can then be used to show which skills are relevant at which levels (ITNTO, 2000). This system is intended as a diagnostic tool to assist employers in determining more precisely and systematically the skill content of current jobs and new skill requirements. It is also meant to help firms to develop training, recruitment and outsourcing policies. The framework is designed in such a way as to be compatible with detailed competence descriptions and other schemes, such as the IT National Occupational Standards, the British Computer Society's Industry Structure Model 3 (ISM3.2) and the NWCET system.

Policy options and action

Firm responses

There is a need to balance costs and benefits for both firms and employees as training generates increased wages for workers, but also increased productivity for firms, especially if introduced in connection with changes in work organisation (OECD, 1996; OECD, 1998; Bresnahan *et al.*, 1999). High turnover rates might act as a strong disincentive for firms to invest in generic (not company-specific) skills (IT or other), especially given the rapid pace of change in the industry. On the other hand, the availability of training can be an additional incentive for a worker to accept a job within that firm.[19] In the case of IT training, there is reason to believe that workers will be willing to share some of the costs of training aimed at building and updating highly marketable skills. Many firms have opted for a combination of on-the-job and training outside of normal working hours.[20]

Firms are also establishing closer links with educational institutions, both through in-house programmes (apprenticeships)[21] as well as through involvement in formal education (both direct support in terms of equipment and/or human resources and co-operation in designing curricula and academic programmes). Finally, employers can contribute by clarifying which attributes they consider to be essential for IT jobs and which ones are merely desirable (US NRC, 2001).

Industry associations also play an important role in helping identify skill needs of firms. They can act as a bridge with educational institutions and facilitate structured assessment programmes at industry-wide level. Two examples previously mentioned are the NWCET and SFIA skill-setting exercises in which industry associations have played a significant role. The Council of European Professional Informatics Societies (CEPIS) has developed a similar set of standard statements of attributes and skills for ICT jobs (CEPIS, 2001). Given rapid changes in the industry, certification can help firms to identify workers with the latest skills quickly. In Australia, the Industry IT&T Skills Taskforce has played an important role in relaying concerns from private firms to policy makers. In Canada, the sector councils (*e.g.* Software Human Resources Council) play a key role, including surveying sectoral skills needs, establishing occupational/skill standards and developing education and training programmes (ACTS, 2000). In the United States, the ITAA has launched a series of Workforce Development Initiatives, including organising nation-wide and regional conferences, implementing a programme to engage IT employers in the "School-to-Careers" programme, launching a national internship programme targeting minority students and assisting in the development of an IT career cluster model (ITAA, 2000). The World Information Technology and Services Alliance (WITSA), a federation of national industry associations, has recently compiled an extensive inventory of studies and actions undertaken by governments, firms and other stakeholders (WITSA, 2001).

Incentives and barriers

A range of stakeholders are involved in building IT skills, with different incentive structures (costs and benefits) resulting in a variety of human capital investment strategies. Table 7 provides a general framework relating to the main questions: who pays for what and who can expect to appropriate the benefits, keeping in mind that private and social rates of return do not always converge (OECD, 1998). Although there is strong evidence that secondary education yields important social rates of return (strengthening the case for government support), the evidence for tertiary education and training seems to suggest greater relative private rates of return to individuals. This is particularly the case for IT training and work; given the backdrop of favourable employment opportunities and increasing compensation, this supports arguments favouring cost sharing. Although no analysis has been done specifically on IT workers, studies on the broader group of scientists and engineers and other categories of "knowledge workers" suggest that important spillovers exist and that government policy should focus on increasing the supply of such workers instead of targeting demand (Romer, 2000).

The complexity of linkages reinforces the need to develop a systemic approach to addressing the various relevant parties: schools and higher education institutions, private firms, government and individuals. Workers and graduates need information on which skills are in demand, as well as on where and how to obtain them. Policy makers require better measurement tools and continuous monitoring, not only of employment and skills, but also of related data such as compensation, mobility and immigration. Firms seek clearer signals on the supply of skilled workers while working out new ways of communicating their changing requirements in a more efficient and timely way to the educational system.

Table 7. **Assessing costs and benefits of human capital investment**

	Individuals		Enterprises		Government/society	
	Costs	Benefits	Costs	Benefits	Costs	Benefits
Compulsory education	Tuition fees and other educational costs	Future productive and social capabilities and better quality of life	Some direct financial contributions	Improved skills, cognitive and behavioural attributes of workers	Direct outlays	Higher skill levels, social cohesion, growth and tax returns
Post-compulsory and higher education	Tuition fees, other educational costs and foregone earnings while studying	Skills/ qualifications leading to higher earnings, employability and quality of life	Direct financial contributions	Improved skills, cognitive and behavioural attributes of workers	Direct outlays on educational institutions, transfers to students	Higher skill levels, social cohesion, economic growth and tax returns
Enterprise training	Zero to full cost depending on terms of contract	Studies suggest positive impact on wages, job tenure and productivity	Direct outlays, wages paid and some training levies	Enterprise-specific knowledge with improvements in productivity	Zero to full subsidy	Higher skill levels, social cohesion, economic growth and tax returns
Informal learning	Opportunity time costs and direct financial costs	Economic and non-economic gains depending on qualifications earned	Cost of lost production time due to learning	Enterprise-specific knowledge with improvements in productivity	No cost	Economic and social spin-offs

Source: OECD (1998).

Other stakeholders

Australia, Canada, Ireland, the Netherlands, Sweden, the United Kingdom and the United States have set up task forces to examine skills issues and suggest urgent action. The mandate of these bodies is often much broader than the narrow question of IT skills (both professional and basic) and often includes recommendations for related areas of policy making. In order for these to be effective, programmes aimed at building IT skills will need to be well integrated into the educational, employment and other social and economic policy frameworks (Netherlands Ministry of Economic Affairs/Ministry of Education, Culture and Science, 2000).

Governments

A wide range of policy recommendations and actions which countries consider relevant when addressing the challenge of building ICT skills for the future are presented in Chapter 8.[22] Reviews of skill requirements in various OECD countries all point towards the need for a strong co-ordinating role by governments in addressing the relevant issues. Through the use of both direct and indirect measures, governments can play a leading role in setting priorities and leveraging the action of other stakeholders. Table 8 summarises some of the main issues and policy areas for governments.

Chapter 8 provides a comprehensive listing of various policies undertaken by OECD governments to promote ICT skills. The following is a brief presentation of some promising examples.

In Australia, the government and the private sector are in the process of setting up an IT&T Skills Exchange. The Exchange will be a privately incorporated body driven by industry needs, focused on

Table 8. **ICT skills: issues and actions**

	Skills formation (which skills?)	Skills acquisition/renewal (when and where?)	Main issues	Areas for government action
Professional ICT skills	Skills required to develop, use or service ICTs professionally	Post-secondary education, IT vendor certification	– Balance specialist ICT skills with other more generic skills – High mobility – Recognise non-formal qualifications	– Improve attractiveness of ICT careers – Assist in providing labour market information – Examine options for using foreign labour
Applied ICT skills	Ability to use ICTs in non-ICT jobs	Post-compulsory education, workplace training	– Importance of integrating ICT into a sector/profession	– Help identify emerging ICT skill requirements for non-ICT jobs – Provide incentives for firms to train workers
Basic ICT skills	Strong life-long learning skills: fluency to use ICT for learning, working, recreation	Learning context: schools (children), training (adults) [at work, formal courses, informal exposure]	– Develop common standards – Build core ICT competencies in curricula – Enhance teacher skills	– Promote ICT skills as important "generic" skills for life-long learning – Facilitate roll-out of ICTs in schools – Promote ICT skills among teachers

Source: OECD based on Multimedia Victoria (2000).

providing just-in-time training and complementing the public education and training infrastructure. The projects undertaken by the Exchange will involve three areas:

- A survey of industry demand for IT&T skills, administered to around 3 000 businesses Australia-wide.
- A survey of the current enrolment and completion rates of public and private education suppliers to determine the supply of IT&T skills in Australia.
- A systematic analysis of the survey outcomes to determine the economic implications of any shortfalls.

The Ignite Careers Web site (*www.ignite.net.au/*), jointly managed by the Commonwealth, state and territory governments and the Industry IT&T Taskforce, provides information on IT courses and financial assistance and has three parts: programmes, apprenticeships and careers. It also links to skill shortage lists compiled at national and regional level by the Department of Employment, Workplace Relations and Small Business. Regional authorities such as the state governments of Victoria, New South Wales and Queensland have been very active in recognising the importance of building a strong ICT skills base to strengthen both traditional and emerging industries (*e.g.* Multimedia Victoria, 2000). The Asia-Pacific Economic Cooperation (APEC) Telecommunications and Information Working Group announced an initiative to address e-commerce skills gaps in the region and define standards. Australia will be leading this activity, which also includes China, the Philippines and Indonesia (NOIE, 2001).

A study of skill requirements in the Canadian ICT sector (Denton and Pereboom, 1999) highlights the success of the "O-Vitesse" programme which provides university-level training to engineers, mathematicians and other qualified professionals in fields relevant to software development. The programme, which runs as a partnership between government, industry and educational institutions, was originally created by the National Research Council Canada and is now being privatised. A report prepared by the Canadian Expert Panel on Skills for the Advisory Council on Science and Technology calls for new decision-making structures, such as an executive agency that could be federally funded and private sector-led, working at national, regional and local level to integrate skills and enterprise development strategies (ACST, 2000).

The Swedish government has collaborated with industry through a national IT training programme (SwIT). Government Bill 1997/98:1 allocated some SEK 1.3 billion to cover the costs of training courses, administration, evaluation and assessment, as well as unemployment training grants. This programme, which ran from 1998 to March 2000, provided training for 11 700 persons, mainly unemployed, and focused on women, immigrants and the occupationally disabled. The average training period was 25 weeks. An initial evaluation of the programme indicated that 62% of those who participated were subsequently employed and 2% were pursuing higher education degrees. The results also indicated that SMEs found the programme to be very useful, valuing the close contact between the training organisation and local business communities.

Educational institutions

Higher education institutions are facing the challenge of having to respond quickly in a rapidly moving area. The two main concerns regarding IT students are: *i*) ensuring that graduates have acquired the right balance of theoretical and more applied skills; and *ii*) incorporating the teaching of business/ management skills and "soft" skills into technical degrees. To address the first goal, educational institutions must ensure that students are exposed to real-life situations and problems. In many countries, the importance of apprenticeships (or "co-ops") and other programmes where students gain on-the-job experience has been growing through partnerships with business. New forms of industry/ academia collaborations should also be encouraged to attract qualified teaching staff, given the salary differentials which often discourage computer science graduates from following academic careers. In terms of revising IT curricula, educational institutions are responding to concerns voiced by industry groups that many IT-related occupations require a broad range of often non-technical skills. Many business schools have begun to introduce innovative e-business programmes that combine technical and business skills.[23]

It is also important that existing educational institutions recognise the growing role of other actors such as private training firms and vendors, and engage in new partnerships to collaborate on issues of common concern such as developing and reviewing certification programmes.

Individuals

Clearly, individuals themselves have strong incentives to upgrade their skills although they often lack information on how to do so. Students can benefit from better information on labour market prospects and clearer information on educational pathways to IT careers. Apprenticeship and other learning-at-work programmes contribute to raising students' awareness of industry's concerns, work methods and challenges. For workers, various reports stress the importance of self-training and the need for better information on the possibilities of retraining into IT jobs.

IT *skills for all?*

There is a growing recognition that the digital revolution has brought about the need for digital literacy, or widespread basic IT skills. In order to avoid digital exclusion, countries must ensure that IT skills are integrated into the concept of lifelong learning. All stakeholders agree on the need for an early introduction of students to computers and other new technologies (OECD, 2000*b*). Investments in technologies (hardware and software) must be accompanied by an adequate supply of qualified instructors able to teach these new skills, as well as innovative curricula which take into account the possibilities (and limitations) of the new technologies. Other possible actions include enhancing the opportunities for computer science graduates wanting to be teachers, strengthening the teaching of mathematics and other sciences and encouraging post-secondary students to take basic IT courses regardless of their main field of study.[24] A wide range of OECD work has already addressed these issues and a detailed analysis falls outside the scope of this study.

Table 9. **Examples of PCs/Internet for employees programmes in various firms**

Firm	Number of employees	Offer	Cost
Ford	360 000 employees	Computer, colour printer, Internet access	USD 5/month (3 years)
Delta	72 000 employees	Computer, printer, Internet access	USD 12/month (36 months)
American Airlines	100 000 + employees	PC, printer, Internet access	USD 12/month (3 years)
Intel	70 000 employees	Pentium III package (incl. Internet access)	
General Motors/ Daimler-Chrysler	300 000 employees	Internet access (through AOL)	USD 3/month for standard access; USD 5/month for AOL-TV (interactive TV)

Source: OECD, based on various published sources.

Outside of the academic realm, a variety of different approaches to enhancing access to ICTs are emerging (such as the current debate on narrowing different "digital divides"). Some firms have chosen measures to enhance their workers' access to IT: low-cost PC programmes including Internet access have been recently launched by various large US firms (Table 9). It is unclear whether firms in some European countries will be able to implement similar programmes, given current taxation restrictions and the lack of widespread unmetered Internet access (OECD, 2001*g*).

Labour unions have also been active. In 1997, the Swedish Trade Union Confederation (LO) launched its home PC package programme for workers in order to help them master the IT skills needed in their work. The offer consists of a PC, a printer, Internet access and basic software on a 36-month lease contract. Currently, more than 56 000 families (or more than one in every 40 affiliated) have signed on (*www.lo.se*). In the United States, the AFL-CIO is developing a range of initiatives such as offering low-price union-built PCs for its members while the site Workingfamilies.com offers low-cost Internet access.

Conclusion

The preceding analysis of the IT workforce highlights the need to differentiate issues relating to the IT workforce (those with professional IT skills) from those relating to more applied IT skills across the economy and basic IT skills. With respect to claims of IT worker shortages, the evidence is not conclusive, but a gap does appear to exist between the skills sought by employers and those found in the workforce, mainly because of rapidly changing skill requirements. Both short- and long-term strategies can be pursued to address these new skill requirements, and most studies of OECD countries point to the need for similar measures that emphasise the need for better data and for government-industry partnerships. Policy makers and industry agree that all stakeholders have a role in implementing short-term solutions and in facilitating mechanisms for devising longer-term strategies.

In order to ensure that the IT workforce is equipped with appropriate skills sets, various measures on the supply and demand sides can be used:

- On the supply side: providing more information to students, developing stronger IT skills in secondary schools, assisting in teacher training, making IT careers more attractive (in particular to under-represented groups such as women), ensuring better integration of educational programmes with "real world" problems, helping workers maintain up-to-date skills.
- On the demand and user side: better use by employers of the existing workforce (in terms both of recruitment and retention), more information on skill needs and opportunities (including pathways to IT jobs), adequate training programmes for various categories of workers (including unemployed and older workers) and government taking a lead role as model users.

Messages are more mixed in terms of immigration policy. Most countries seem to favour expanding the short-term supply of IT workers through the use of foreign labour, but some observers point to the risks of such solutions. Even temporary increases in supply (such as short-term immigration) can put downward pressure on wages, which in the medium term might discourage more students from pursuing careers in this field and send conflicting signals to current IT workers and firms.[25]

There are strong reasons to believe that as IT continues to diffuse throughout the economy, basic IT skills are becoming a new category of "general" competency, like numeracy or literacy skills.[26] IT skills not only increase the earnings potential of information workers, they are becoming necessary for a broad range of activities. Therefore, in addition to creating a larger and more skilled IT workforce, the focus should also be on building IT skills for all. Many countries have already formulated the explicit goal of achieving in the near future IT literacy for all students completing secondary education. To be effective, however, these programmes must be well integrated into broader policy frameworks such as those aimed at strengthening educational systems, promoting lifelong learning and facilitating workforce upskilling.

Appendix

NWCET INFORMATION TECHNOLOGY SKILL STANDARDS

The Northwest Center for Emerging Technology (NWCET) (State of Washington, United States) has developed a list of IT skills standards based on eight career clusters. The standards enumerate technical skills, employability skills and foundation knowledge requirements for each cluster. The following table presents examples for the "digital media" and "network design and administration" clusters.

Career cluster	Representative job titles	Sample critical work function	Sample key activity	Sample performance indicator	Sample technical knowledge	Sample employability skills
Digital media	Animator, 2D/3D artist, media specialist	Produce visual and functional design	Determine media types and delivery platform	Chosen media elements and delivery platform support project goals	Knowledge of media types and capabilities	Ability to present technical information
Network design and administration	Network technician, network engineer	Perform monitoring and management	Monitor and report component security and connectivity problems	System is closely monitored and outages are reported in a timely manner	Knowledge of network architecture, topology, hardware and software	Ability to interpret and evaluate data

Source: NWCET in ITAA (2000).

The following table presents the job titles for each of the eight career clusters:

Database administration and development
- Data administrator
- Data analyst
- Data architect
- Data management associate
- Data modeler
- Data modelling specialist
- Database administration associate
- Database administrator
- Database analyst
- Database developer
- Database manager
- Database modeler
- Database security expert
- Decision Support Services (DSS)
- Knowledge architect
- Senior database administrator
- Systems analyst
- Tester

Digital media
- 2D/3D artist
- Animator
- Audio/video engineer
- Designer
- Media specialist
- Media/instructional designer
- Multimedia author
- Multimedia authoring specialist
- Multimedia developer
- Multimedia specialist
- Producer
- Production assistant
- Programmer
- Streaming media specialist
- Virtual reality specialist
- Web designer
- Web producer
- Web specialist

Enterprise systems analysis and integration
- Application integrator
- Business continuity analyst
- Cross-enterprise integrator
- Data systems designer
- Data systems manager
- Data warehouse designer
- E-business specialist

Electronic transactions implementer
Information systems architect
Information systems planner
Systems analyst
Systems integrator

Network design and administration

Communications analyst
Data communications analyst
Information systems operator
Information technology engineer
Network administrator
Network analyst
Network architect
Network engineer
Network manager
Network operations analyst
Network security analyst
Network specialist
Network technician
Network transport administrator
PC support specialist
PC network engineer
Systems administrator
Systems engineer
Technical support specialist
User support specialist

Programming/software engineering

Applications analyst
Applications engineer
Business analyst
Computer engineer
Data modeler
Operating system designer/engineer
Operating system programmer/analyst
Programme manager
Programmer/analyst
Project lead
Software applications specialist
Software architect
Software design engineer
Software design engineer and tester
Software development engineer
Software QA specialist
Software tester
Systems analyst
Systems administrator
Test engineer
Tester

Technical support

Analyst
Call centre support representative
Content manager
Customer liaison
Customer service representative
Customer support professional
Help desk specialist
Help desk technician
Senior systems analyst
Systems analyst
Technical account manager
Technical support engineer
Technical support representative
Testing engineer

Technical writing

Desktop publisher
Document specialist
Editor
Electronic publications specialist
Electronic publisher
Instructional designer
Online publisher
Technical communicator
Technical editor
Technical publications manager
Technical writer

Web development and administration

Web administrator
Web architect
Web designer
Web page developer
Web site developer
Web specialist
Webmaster

Source: NWCET in ITAA (2000).

Table A5.1. **H-1 visas granted in the United States by country of origin, 1989-99**

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
India	2 144	2 697	4 102	5 552	7 606	11 301	15 528	19 203	31 686	40 247	55 047
United Kingdom	6 663	7 174	8 794	6 726	3 993	4 230	4 771	5 601	6 928	6 343	6 665
China	837	610	1 145	894	1 031	1 256	1 887	2 330	3 214	3 883	5 779
Japan	3 678	3 791	5 167	2 767	2 152	2 217	2 070	2 411	2 929	2 878	3 339
Philippines	6 055	7 302	7 221	7 550	7 596	8 753	10 026	4 601	2 685	2 758	3 065
France	2 318	2 293	2 413	1 686	870	1 003	1 216	1 463	1 894	2 110	2 633
Germany	1 798	1 637	1 888	1 501	1 012	1 092	1 484	1 518	2 088	2 242	2 451
Mexico	2 951	3 727	3 227	2 488	1 307	1 147	1 451	1 909	2 785	2 320	2 419
Australia	872	827	1 102	990	863	1 050	1 042	1 123	1 438	1 666	1 651
Russia	2 256	3 709	3 942	1 651	1 892	1 245	1 196	1 255	1 357	1 395	1 619
Other	19 248	24 906	20 324	19 862	13 884	15 990	18 422	18 658	23 604	25 536	32 027
Total	48 820	58 673	59 325	51 667	42 206	49 284	59 093	60 072	80 608	91 378	116 695

Source: Lowell (2000).

NOTES

1. In this chapter, the terms IT and ICT are used interchangeably. Although the discussion most often refers to the "IT workforce" and IT workers, the data usually include telecommunication jobs to the extent that they relate to the IT infrastructure.
2. Even within ICT jobs, a distinction must be made between: routine technical work (sales, support, basic Web development), which is often tied to vendor products, subject to rapid obsolescence and the need for frequent training; the implementation of business applications (ICT business analysts); and "high-level" ICT roles (programmers, systems engineers/analysts).
3. Responses were received from 532 firms in a sample of 1 493.
4. This includes the following IT occupations: computer programmers, computer engineers, computer systems analysts, database administrators, computer support specialists and all other computer scientists.
5. This figure is an overestimate of the actual number of ICT workers since it includes all employment in ICT-producing industries, as well as ICT jobs in other sectors.
6. For Europe, computer workers include ISCO-88 categories 213 and 312; for the United States, CPS categories 64, 65, 229, 308 and 309.
7. The ITAA study calculates the "skills gap" as follows: current demand (vacancies) times percentage of applicants that employers deem qualified to fill a specific job.
8. Vacancy rates are a useful but imperfect indicator of tightness in the labour market. Vacancies are to be expected in high-growth industries and occupations and can also mask inadequate recruitment practices (US DOC, 1999). In addition, various firms may advertise openings for a same (IT services) contract which they all expect to win, resulting in multiple counting of individual jobs.
9. It is estimated that in March 2001, almost 10% of layoffs in the United States took place in Internet-related firms (Industry Standard, 2001; US Bureau of Labor Statistics, 2001).
10. Internal and external strategies are sometimes also referred to as functional and numerical, respectively (OECD, 1996).
11. The institutions covered in the survey usually award about one-third of all bachelor's degrees in these fields in the United States.
12. This does not provide an estimate of the number of persons with credentials since individuals often possess more than one. It is estimated that there are more than 37 000 Microsoft Certified individuals in the United Kingdom and Ireland (Department for Education and Employment, 2000*a*).
13. Countries such as the Netherlands have recognised the need to facilitate certification mechanisms, including recognition of non-formal learning (Duvekot, 2000).
14. To address the lack of reliable data on the use of offshore workers and the international relocation of employment, the UK Institute of Employment Studies (IES) is co-ordinating the EU-funded EMERGENCE project (*www.emergence.nu*) which attempts to gather statistical evidence on international outsourcing activities.
15. The H1 visa programme was created in the 1960s to attract skilled non-immigrant workers to the United States. Following the Immigration Nursing Relief Act of 1989, H-1A visas were granted to registered nurses. Since 1995, this programme has been discontinued and all H1 visas are now H-1B (speciality worker). Numerical caps to the H-1B programme were first set by the US Congress in the early 1990s.
16. For more on the Indian software industry and its links to the United States see OECD, 2000*a*, Chapter 6. Immigration policies of host countries have a strong impact on education policy in home countries of IT workers such as India. Given the strong (and growing) demand for Indian IT professionals, the Indian government recently announced a decision to double the capacity of engineering colleges and to set up a task force on human resources development in IT [*www.wired.com/news/business/*0,1367,39902,00.*html*]
17. See OECD (2001*a*) Annex 5.D for more detailed country-specific criteria and conditions for admission and DIMA (2001) for a comparison of policies relating to ICT skills for temporary business entry and students in various OECD and non-member countries.

18. In several non-English-speaking countries, foreign language skills were often cited as an important asset for IT workers given the predominance of English as a technical language.
19. Autor (2000) argues that temporary help firms have an incentive to provide free general skills training given that their main role (and business) is to gather and sell information about worker "quality" to employers (screening).
20. The American Society for Training and Development (ASTD) estimates that between 11% and 13% of training expenditures in the United States are currently allocated to IT training, including training for both IT employees and for other categories of workers (21st Century Workforce Commission, 2000). Statistics Finland estimated that in Finland in 1997, in all occupations at least one-third of employees had received employer-arranged computer training in the previous two years (Statistics Finland, 1999).
21. An oft-cited example is Nortel Networks' co-op programme in Canada and the United States aimed at both high school and university students.
22. Button *et al.* (2000) provides a short overview of IT policies in various OECD and non-member economies relating to workforce and skill development.
23. See for example *www.dmsoz.org/Business/E-Commerce/Education/Degree_Programs/* for a list of e-commerce degree programmes offered at various institutions across OECD countries. Oglivie (2000) presents an overview of research and course offerings related to e-commerce in Canadian universities.
24. By late 2001, the European/International Computer Driving Licence (ECDL/ICDL) programme had already exceeded the mark of 1.5 million persons certified with basic IT skills. At that time, there were over 10 000 test centres world-wide issuing such certification (*www.ecdl.com*).
25. While some observers point to the risk for developing countries of losing valuable human resources ("brain drain"), in India and other Asian countries, a new view is that scientists and engineers working overseas may represent a "brain bank" that can be drawn upon to encourage innovative development at home (OECD, 2000*c*).
26. At their April 2001 meeting, OECD Education Ministers acknowledged the importance of developing ICT skills as a general competence, within the theme of fostering "Competencies for the Knowledge Society" (OECD, 2001*d*).

REFERENCES

21st Century Workforce Commission (2000),
"A Nation of Opportunity: Building America's 21st Century Workforce", *www.workforce21.org/finalreport.htm*

Acemoglu, D. (2000),
"Technical Change, Inequality and the Labor Market", NBER Working Paper No. 7800, July, *www.nber.org/papers/w7800*

Adelman, C. (2000),
"A Parallel Universe Expanded: Certification in the Information Technology Guild", revised version of article first appearing in *Change*, Vol. 32, No. 3, May-June, *www.aahe.org/change/paralleluniverse.htm*

Advisory Council on Science and Technology (Canada) (ACST) (2000),
"Stepping Up: Skills and Opportunities in the Knowledge Economy, Report of the Expert Panel on Skills", *acst-ccst.gc.ca/acst/skills/home_e.html*

Ahn, S. and P. Hemmings (2000),
"Policy Influences of Economic Growth in OECD Countries: An Evaluation of the Evidence", OECD Economics Department Working Papers No. 246, June, *www.oecd.org/eco/eco*

Alliance for Information Systems Skills/IT National Training Organisation (AISS/ITNTO) (United Kingdom) (ITNTO) (1999),
Skills 99, Report for the Department of Trade and Industry and the Department for Education and Employment (United Kingdom).

ASSINFORM/Netconsulting/ESDW-UNIMIB (2000),
"Rapporto 2000 sull'Occupazione nel settore dell'Informatica e delle Telecommunicazioni in Italia", *www.assinform.it/aree_sx/pubblicazioni/index_rapporto_occupazione2000a.htm*

Association pour l'emploi des cadres (APEC) (2001),
"Panel Entreprises Apec: Emploi Cadre – Bilan 2000, Perspectives 2001", *www.apec.asso.fr/*

Autor, D.H. (2000),
"Why Do Temporary Help Firms Provide Free General Skills Training?", NBER Working Paper No. W7637, April, papers.nber.org/papers/W7637

Bresnahan, T.F., E. Brynjolfsson and L.M. Hitt (1999),
"Information Technology and Recent Changes in Work Organization Increase the Demand for Skilled Labor", February, Stanford University.

Business 2.0 (2000),
"Talent Crunch", 10 October.

Button K., K. Cox, R. Stough and S. Taylor (2000),
"Comparative Analysis of International Policy and Practice for High-Technology Workforce Development", Mason Enterprise Center, School of Public Policy, George Mason University, May, *www.workforce21.org/comparative_analysis.htm*

Canadian Policy Research Networks (CPRN) (2001),
"Economic Migrants in a Global Labour Market: A Report on the Recruitment and Retention of Asian Computer Professionals by Canadian High-tech Firms", CPRN Discussion Paper No. W 13, July, *www.cprn.org*

Cappelli, P. (2000),
"Is There a Shortage of Information Technology Workers?", Wharton School, University of Pennsylvania, report prepared for McKinsey and Co., June.

Computing Research Association (CRA) (2000),
"1998-1999 Taulbee Survey", "Computing Research News", Vol. 12, No. 2, March, *www.cra.org/CRN/online.html*

Computing Research Association (CRA) (2001),
"1999-2000 Taulbee Survey", "Computing Research News", Vol. 13, No. 2, March, *www.cra.org/CRN/online.html*

Council of European Professional Informatics Societies (CEPIS) (2001),
"European Informatics Skills Structure", *www.cepis.org/prof/eiss.htm*

Denton, T. and B. Pereboom (1999),
"Profile of the Information and Communications Technologies Sector", report prepared for the Expert Panel on Skills, *http://acst-ccst.gc.ca/skills*

Department of Employment, Workplace Relations and Small Business (DEWRSB) (Australia) (2001),
"Vacancy Report – April 2001", *www.dewrsb.gov.au/employment/publications/vacancyReport/*

Department of Immigration and Cultural Affairs (DIMA) (Australia) (2001),
"ICT in Focus: Immigration Initiatives for Australia's ICT Industry Innovation Action Plan", January, *www.dima.gov.au/ict/index.html*

Department for Education and Employment (DfEE) (United Kingdom) (2000*a*),
"Skills for the Information Age", Final Report from the Information Technology, Communications and Electronic Skills Strategy Group, *www.dfee.gov.uk/skillsforce/index.htm*

Department for Education and Employment (DfEE) (United Kingdom) (2000*b*),
"Skills for All: Proposals for a National Skills Agenda", Final Report of the National Skills Task Force, June, *www.dfee.gov.uk/skillsforce/index.htm*

Ducatel, K. and J.C. Burgelman (2000),
"ICTs and Employment in Europe: Outlook to 2010", paper presented at the EURO-CPR 2000 Conference, Venice, March.

Duvekot, R. (2000),
"Working and Learning Together: A Model for European Cooperation", Ministry of Economic Affairs of the Netherlands, paper presented for the Conference on "Identification, Assessment and Recognition of Non-Formal Learning: European Experiences and Solutions", Lillehammer, Norway, 15-16 May.

Ellis, R. and B.L. Lowell (1999*a*),
"Core Occupations of the US Information Technology Workforce", Report 1 of the Information Technology Workforce Data Project, United Engineering Foundation, November, *www.uefoundation.org/itworkfp.html*

Ellis, R. and B.L. Lowell (1999*b*),
"The Production of US Degrees in Information Technology Disciplines", Report 2 of the Information Technology Workforce Data Project, United Engineering Foundation, November, *www.uefoundation.org/itworkfp.html*

Ellis, R. and B.L. Lowell (1999*c*),
"Foreign Origin Persons in the US Information Technology Workforce", Report 3 of the Information Technology Workforce Data Project, United Engineering Foundation, November, *www.uefoundation.org/itworkfp.html*

Ellis, R. and B.L. Lowell (1999*d*),
"Assessing the Demand for Information Technology Workers", Report 4 of the Information Technology Workforce Data Project, United Engineering Foundation, November, *www.uefoundation.org/itworkfp.html*

EMERGENCE (2001),
"Where the Butterfly Alights: the Global Location of eWork", Press Release, *www.emergence.nu/news/balights.html*

European Information Technology Observatory (EITO) (2001),
EITO 2001, Frankfurt am Main.

Forfás (2000*a*),
"Second Report of the Expert Group on Future Skills Needs", *www.forfas.ie/publications/fskills_2.htm*

Forfás (2000*b*),
"Report on e-Business Skills", Expert Group on Future Skills Needs, *www.forfas.ie/publications/e-business_skills.htm*

Gingras, Y. and R. Roy (1998),
"Is there a Skills Gap in Canada?", Human Resources Development Canada, October.

Helliwell, J.F. (1999),
"Checking the Brain Drain: Evidence and Implications", report prepared for the Expert Panel on Skills, *http://acst-ccst.gc.ca/skills*

Hendry, C. (1999),
"Skills Task Force Research Paper No. 10: New Technology Industries", September, *www.dfee.gov.uk/skillsforce*

Hoch, D.J., C.R. Roeding, G. Purkert and S.K. Lindner (2000),
Secrets of Software Success: Management Insights from 100 Software Firms Around the World, Harvard Business School Press, Boston MA.

Industry Standard (2001),
"Putting Layoffs in Perspective", 23 April.

Information Technology Association of America (ITAA) (2000),
"Bridging the Gap: Information Technology Skills For A New Millennium", April, *www.itaa.org*

Information Technology Association of America (ITAA) (2001),
Where Can You Start? Building Better Information Technology Skills and Careers, Executive Summary, April.

Institute for Employment Studies (IES) (2002),
An Assessment of Skill Needs in Information and Communication Technology, report prepared for the ICT Skills Dialogue, United Kingdom.

Institute for the Management of Information Systems (IMIS) (2001),
"What Skills Shortages? 2001 IT Skills Trend Report", Discussion draft for IMIS and Computer Weekly 500 Club, Management Summary, August, *www.imis.org.uk/members/a_white/skills-shortage.pdf*

International Labour Organization (ILO) (2001),
World Employment Report 2001: Life At Work in the Information Economy, Geneva.

Ireland Information Society Commission (ISC) (2000*a*),
"IT Access for All", March, *www.infosocomm.ie*

Ireland Information Society Commission (ISC) (2000*b*),
"New Technology in Irish Business: Skills and Training (Business 3)", May, *www.infosocomm.ie*

IT National Training Organisation (United Kingdom) (ITNTO) (2000),
"Tracking the Skills for Prosperity", August, *www.sfia.org.uk/What_SFIA_is/sfiaintro_1_1.pdf*

Katz, L.F. (1999),
"Technological Change, Computerization and the Wage Structure", paper presented at the Conference on "Understanding the Digital Economy: Data, Tools and Research", Washington, DC, 25-26 May.

Klotz, U. (2000),
"Facts on the IT Labour Market", IBITS, April, *www.union-network.org/uniibits.nsf*

Lowell, B.L. (2000),
"H1-B Temporary Workers: Estimating the Population", Institute for the Study of International Migration, Georgetown University, April.

Makimoto, T. and D. Manners (1997),
Digital Nomad, John Wiley and Sons.

Massé, P., R. Roy and Y. Gingras (1998),
The Changing Skill Structure of Employment in Canada, R-99-7E, Human Resources Development Canada, November.

Matloff, N. (1998),
"Debunking the Myth of a Desperate Software Labor Shortage", University of California at Davis, Testimony to the US House Judiciary Committee – Subcommittee on Immigration, 21 April (updated October 2000), *www.heather.cs.ucdavis.edu/itaa.real.html*

Ministère du Travail – DARES (2000),
"Recruter en 1999, des difficultés plus ou moins vives suivant les métiers recherchés", Premières Synthèses, No. 22.1, June, *www.travail.gouv.fr*

Ministry of Economic Affairs/Ministry of Education, Culture and Science (Netherlands) (2000),
Competing with ICT Competencies: Know-how and Innovation for the Dutch Digital Delta, April.

Ministry of Industry, Employment and Communications (Sweden) (2000),
"The Development of IT Skills", No. 2000.076, December, *www.naring.regeringen.se/pressinfo/infomaterial/pdf/n2000_076en.pdf*

Multimedia Victoria (2000),
Skills × Knowledge = Growth, State Government of Victoria (Australia), October.

National Center for Education Statistics (United States) (NCES) (2001),
"Digest of Education Statistics", NCES-2001-034, *www.nces.ed.gov/pubs2001/digest/*

National Office for the Information Economy (Australia) (NOIE) (1998),
"Skills shortages in Australia's IT and T industries", *www.noie.gov.au/projects/ecommerce/skills/discpaper_dec98/skills.html*

National Office for the Information Economy (Australia) (NOIE) (2001),
"APEC TEL Aims to Remedy ICT Skills Shortage in Asia-Pacific Region", Press Release, 16 March.

OECD (1996),
Technology, Productivity and Job Creation, Vol. 2: *Analytical Report*, OECD, Paris.

OECD (1998),
Human Capital Investment: An International Comparison, Centre for Educational Research and Innovation, OECD, Paris.

OECD (1999),
The Economic and Social Impacts of Electronic Commerce, OECD, Paris.

OECD (2000*a*),
Information Technology Outlook 2000, OECD, Paris.

OECD (2000*b*),
Learning to Bridge the Digital Divide, Centre for Educational Research and Innovation (CERI), US National Center on Adult Literacy (NCAL), OECD, Paris.

OECD (2000*c*),
Proceedings of the "Joint German – OECD Conference on Benchmarking Industry-Science Relationships", held in Berlin 16-17 October 2000, Paris, *www.oecd.org/pdf/M00008000/M00008214.pdf*

OECD (2001*a*),
"Knowledge, Work Organisation and Economic Growth", DEELSA/ELSA(2001)2, mimeo.

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

OECD (2001*c*),
The Well-being of Nations: the Role of Human and Social Capital, Centre for Educational Research and Innovation (CERI), OECD, Paris.

OECD (2001*d*),
Education Policy Analysis 2001, OECD, Paris.

OECD (2001*e*),
Trends in International Migration – SOPEMI *Annual Report* 2000, OECD, Paris.

OECD (2001*f*),
"Foreign Workers: Overview and Challenges for OECD Countries", DEELSA/ELSA(2001)8, mimeo.

OECD (2001*g*),
Communications Outlook 2001, OECD, Paris.

Oglivie, K. (2000),
"Electronic Commerce in Canadian Universities", Report from the Talent Pool e-Team of The Canadian e-Business Opportunities Roundtable, November, *http://e-com.ic.gc.ca/eteam/*

Romer, P. (2000),
"Should the Government Subsidize Supply or Demand in the Market for Scientists and Engineers?", NBER Working Paper No. 7723, June, *www.nber.org/papers/w7723*

Roy R., H. Henson and C. Lavoie (1996),
A Primer on Skill Shortages in Canada, R096-8E, Human Resources Development Canada.

Sangster, D. (1999),
"Critical Skills in Five Canadian Industries: A Summary Report on Sectoral Interviews", report prepared for the Expert Panel on Skills, *http://acst-ccst.gc.ca/skills*

Scarpetta, S., A. Bassanini, D. Pilat, and P. Schreyer (2000),
"Economic Growth in the OECD Area: Recent Trends at the Aggregate and Sectoral Level", OECD Economics Department Working Papers No. 248, June, *www.oecd.org/eco/eco*

Stager, D. (1999),
"Labour Market Trends and Projections for Systems Analysts and Computer Programmers in Canada", RE-99-4E, Human Resources Development Canada, *www.hrdc-drhc.gc.ca/arb/publications/research/1999docs/abr-99-4e.shtml*

Statistics Denmark (2001),
Information Society Denmark – A Statistical Mosaic, Copenhagen.

Statistics Finland (1999),
On the Road to the Finnish Information Society II, Helsinki.

Temple, J. (2000),
"Growth Effects of Education and Social Capital in the OECD Countries", OECD Economics Department Working Papers No. 263, October, *www.oecd.org/eco/eco*

United States Bureau of Labor Statistics (BLS) (2001),
"Mass Layoff Statistics", March, *http://stats.bls.gov/mlshome.htm*

United States Bureau of Labor Statistics (BLS) (2002),
National Employment Matrix, February, *www.bls.gov/emp/home.htm*

United States Council on Competitiveness (1998),
"Winning the Skills Race", *www.compete.org*

United States Department of Commerce (DOC) (1999),
"The Digital Workforce: Building Infotech Skills at the Speed of Innovation", Technology Administration, Office of Technology Policy, June, *www.ta.doc.gov/otp/Reports.htm*

United States Department of Commerce (2000*a*),
The Digital Workforce: Update, Office of Technology Policy, August.

United States Department of Commerce (2000*b*),
"Digital Economy 2000", Economics and Statistics Administration, June, *www.esa.doc.gov/de2k.htm*

United States Department of Commerce (2002),
"Digital Economy 2002", Economics and Statistics Administration, February, *www.esa.doc.gov/508/esa/DIGITALECONOMY2002.htm*

United States Department of Commerce, US Department of Education, US Department of Labor, National Institute of Literacy, Small Business Administration (1999),
"21st Century Skills for 21st Century Jobs", January, *www.vpskillsummit.org*

United States Immigration and Naturalization Service (INS) (2000*a*),
"Characteristics of Specialty Occupation Workers (H-1B): October 1999 to February 2000", June, *www.ins.gov*

United States Immigration and Naturalization Service (INS) (2000*b*),
"Leading Employers of Specialty Occupation Workers (H-1B): October 1999 to February 2000", June, *www.ins.gov*

United States National Research Council (NRC) (2001),
Building a Workforce for the Information Economy, National Academy Press, Washington, DC, *www.books.nap.edu/html/building_workforce/*

United States National Science Foundation (NSF) (2000*a*),
Science and Engineering Indicators 2000, National Science Board, Arlington VA, *www.nsf.gov/sbe/srs/seind00/start.htm*

United States National Science Foundation (NSF) (2000*b*),
Women, Minorities and Persons with Disabilities in Science and Engineering 2000, Arlington, Virginia.

Weinstein, E. (1999),
"How and Why Government, Universities and Industry Create Domestic Labor Shortages of Scientists and High-Tech Workers", National Bureau of Economic Research (NBER), *http://nber.nber.org/~peat/PapersFolder/Papers/SG/NSF.html*

Wilson, R. (2000),
Skills Survey 2000, Institute of Directors (IoD), IoD Research Paper, London, November.

World Information Technology and Services Alliance (WITSA) (2001),
WITSA *Inventory on IT Skills and Workforce Initiatives*, Interim Compilation, 3 April.

Chapter 6

ICT DIFFUSION AND THE DIGITAL DIVIDE

The term "digital divide" is frequently used to describe the gap between individuals, households, businesses and geographical areas at different socio-economic levels, with regard to their opportunities to access and use information and communication technologies (ICTs) such as computers and the Internet. This gap varies significantly between advanced and developing economies, but also across the OECD area and within OECD countries.

This chapter examines relevant national and international data and addresses the digital divide between and within OECD countries. It does not address digital divide issues for developing economies or the North/South divide. It focuses on the following issues:

- What are the indicators of the digital divide?
- What does the digital divide look like? How is it captured in national statistics in terms of social, business and demographic characteristics?
- How rapidly is the divide changing and in what directions?

This chapter explores indicators of ICT access and use, the differences between leaders and laggards in terms of access and use and measures of changes in access. Chapter 7 addresses the development of alternative Internet access paths and Chapter 8 describes government policies to reduce the digital divide in OECD countries.

Indicators of ICT access and use

The ICTs most commonly considered when measuring the extent of the digital divide are telecommunications infrastructure, PCs and the Internet. This section summarises available indicators on infrastructure readiness, ICT penetration rate and ICT use.[1]

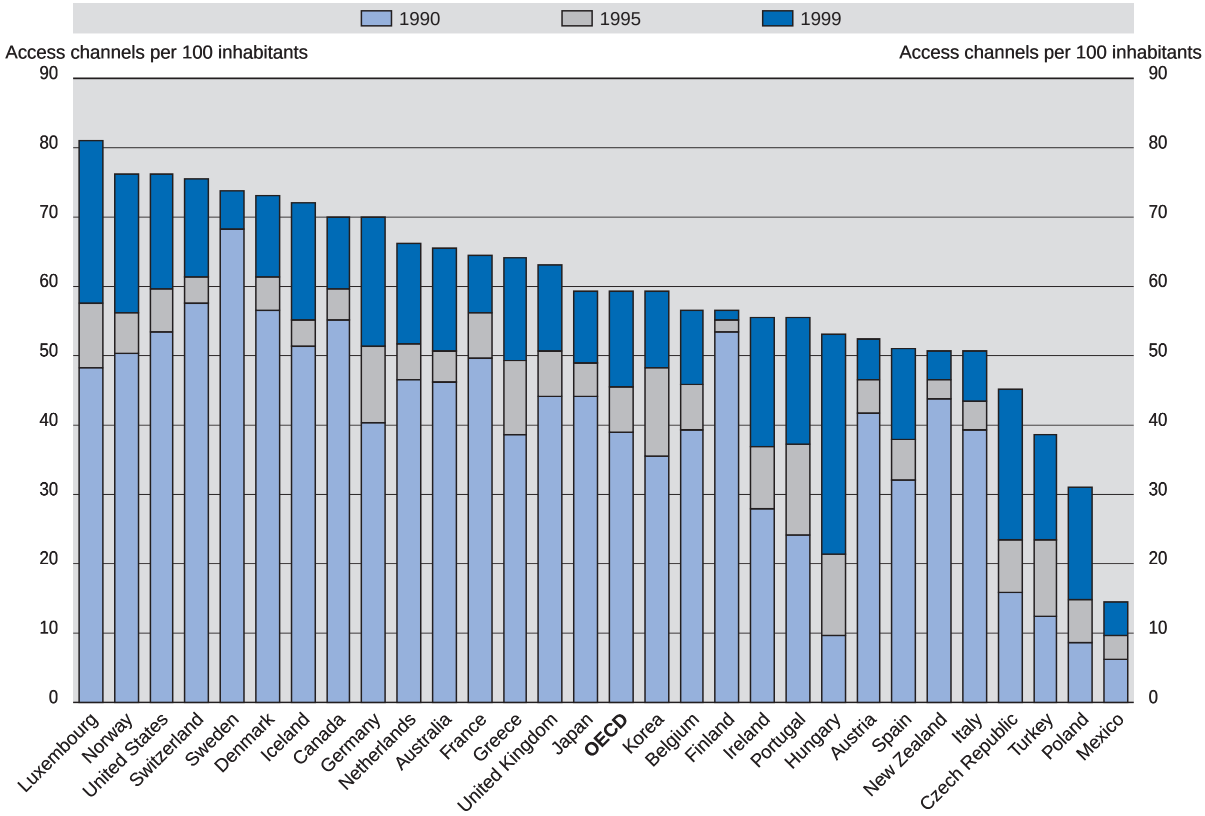
Infrastructure readiness

Infrastructure readiness indicators show the general extent of the digital divide between countries (see OECD, 2001*a*). The number of telecommunication access lines per 100 inhabitants is the leading indicator for the level of telecommunications service and a fundamental measure of the international digital divide. The number of Internet hosts is a good indicator of the relative development of Internet infrastructure. The number of secure servers is a key indicator for the development of electronic commerce.

Telecommunication access lines

Most OECD countries have a similar number of fixed telecommunication access lines (traditional access lines and ISDN lines) per 100 inhabitants. The OECD average is around 60 per 100 inhabitants (Figure 1). The appearance of ISDN channels is one reason why growth of fixed networks was slightly higher in the second half of the 1990s than in the first half. Fixed networks in countries that began the 1990s with low telecommunication penetration rates also grew significantly in the 1990s. The Czech Republic, Hungary, Poland and Turkey all increased their respective public switched telephone networks (PSTNs), with double-digit compound annual growth rates (CAGR).

Figure 1. **Fixed telecommunication access channels in OECD countries**
Per 100 inhabitants, 1990, 1995 and 1999



Source: OECD (2001*a*).

In the 1990s, the rise in wireless communication users far exceeded that for fixed network subscribers. While the average annual expansion for fixed networks over 1995-99 was just 4%, mobile networks grew at a CAGR of 49.1%. Taken together, the total number of fixed and mobile access paths in OECD countries stood at 933 million at the end of 1999 and surpassed 1 billion in 2000. Recent data from ITU (2002) show that access levels are similar for 1999 and 2001.

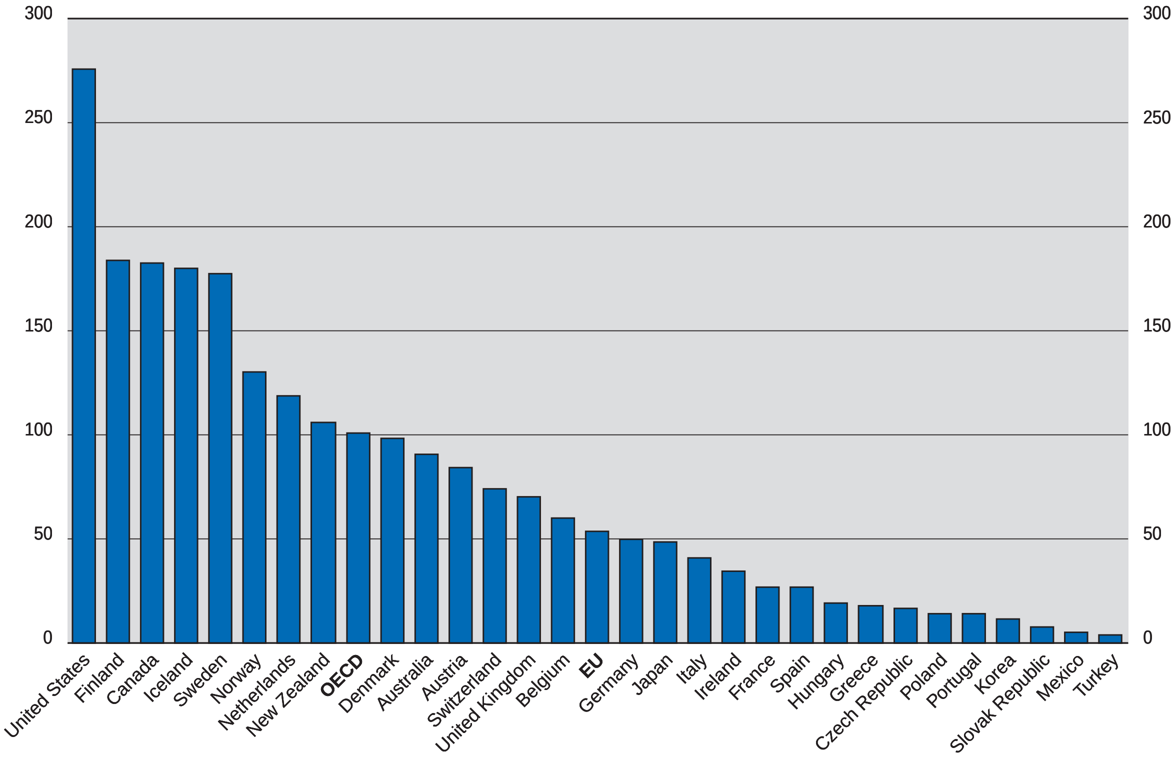
Internet hosts

The United States has by far the largest number of Internet hosts, with more than 75 million in July 2001, some 67% of all hosts in the OECD region. Japan has the second largest number, with 6.1 million (5.4% of the OECD total). Other OECD countries with more than a million hosts in July 2001 included Canada (5.6 million), the United Kingdom (4.1 million), Germany (4.1 million), Italy (2.3 million), the Netherlands (1.9 million), Australia (1.7 million), France (1.6 million), Sweden (1.6 million), and Spain (1.0 million).[2]

Between July 2000 and July 2001, the number of Internet hosts grew by 36.3% in the OECD area and by 58.8% in the European Union. Between 1999 and 2000, growth in hosts was fastest in countries with lower Internet host penetration (Italy, Mexico, Turkey), but from 2000 to 2001 these countries had substantially lower growth rates (with the exception of Poland, which had the highest growth rate). From 2000 to 2001, growth rates were higher in countries with medium to higher Internet host penetration (Sweden, Germany, Spain, Austria, Japan).

Figure 2. **Internet hosts in OECD countries per 1 000 inhabitants, July 2001**

gTLD adjusted



Source: OECD, from Netsizer (*www.netsizer.com*).

Hosts per 1 000 population gives a better indication of the relative intensity of development of the Internet infrastructure in various countries (Figure 2). The United States is far ahead of other OECD countries, with more than 273 hosts per 1 000 inhabitants in July 2001.

Secure servers

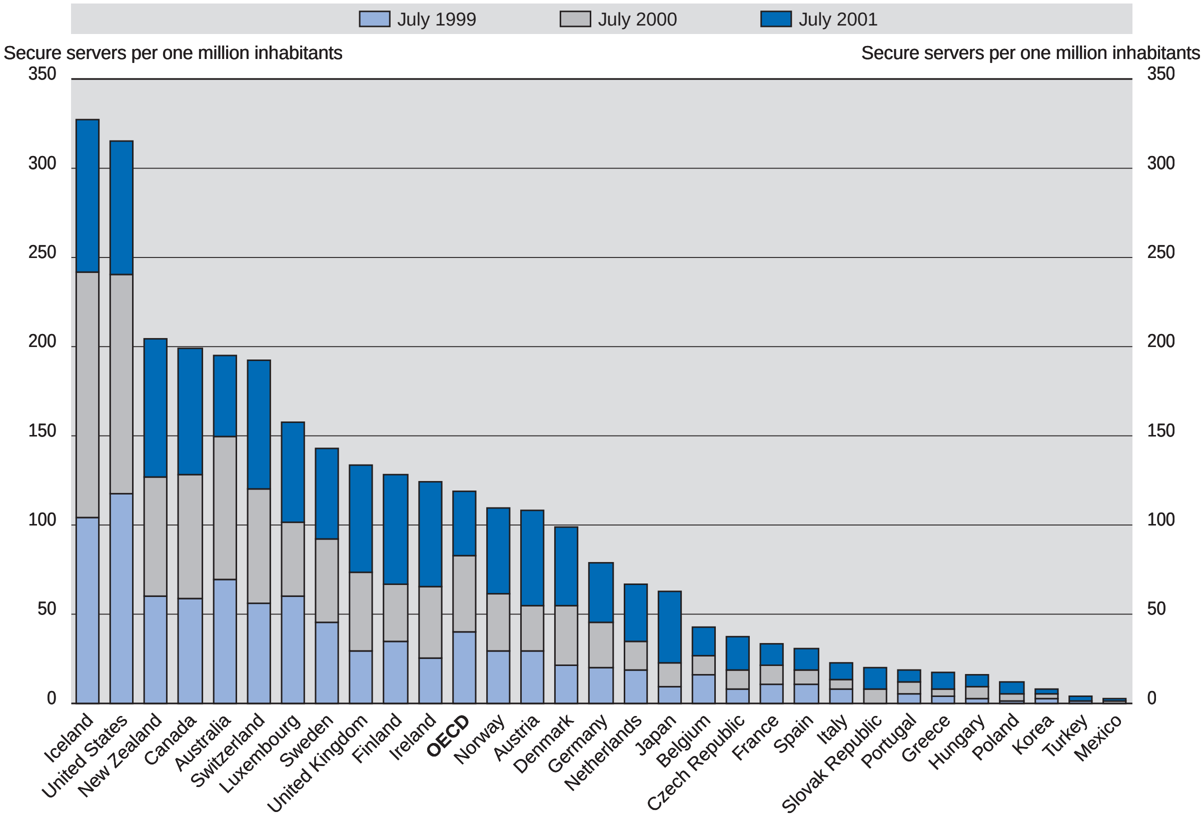
Electronic commerce requires secure ways of conducting buying and selling transactions over the Internet and other networks. Netcraft's Secure Socket Layer (SSL) surveys provide one of the best indicators of the growth and diffusion of e-commerce. The Netcraft survey can be used to explore the growth of e-commerce by country since it queries certificates to find the business address of the originator. The July 2000 survey showed that 95% of all secure servers were registered to addresses in OECD countries.

The United States is far ahead of other countries in developing secure (SSL) servers for e-commerce. In July 2001, the United States reported 86 025 secure servers with valid third-party certificates – almost 65% of all secure servers in the OECD area. Japan reported the second largest number with 7 952 secure servers, followed closely by the United Kingdom at 7 916 (both representing approximately 6% of the OECD total). Other countries with a high number of secure servers included Germany with 6 442, Canada with 6 050 and Australia with 3 704.

Over the two years to July 2001, there was a 300% increase in the number of secure servers in OECD countries, an indication of the rapid development of e-commerce infrastructure. Growth rates were high in countries with a relatively low base, such as Poland, Hungary, Turkey and Mexico. Growth was also high in some countries that already extensively use secure servers, such as Japan, the United Kingdom and Germany.

The number of secure servers per million inhabitants is an indicator of the relative intensity of use of e-commerce (OECD, 2001*a*). In July 2001, Iceland and the United States recorded the most intensive development of secure servers at more than 300 per million inhabitants (Figure 3). Other countries with more than 150 per million inhabitants were New Zealand (204), Canada (198), Australia (195), Switzerland (192), and Luxembourg (157).

Figure 3. **Secure servers per million inhabitants, July 2001**



Source: OECD (*www.oecd.org/sti/telecom*) based on Netcraft (*www.netcraft.com*).

ICT *penetration*

Rates of ICT access and use are among the most informative indicators of ICT penetration. However. care is needed when making cross-country comparisons owing to differences in the data collected. Access must be clearly distinguished from the extent and kind of use (see below). Access rates can differ widely among households and individuals, and comparable national sets of data for each of these variables and kinds of user are not available for all OECD countries.[3]

Access

Access to a personal computer in households has more than doubled in OECD countries since the mid-1990s. In Europe, Nordic countries are ahead of the Mediterranean countries and France, where the Minitel has certainly slowed uptake. In 2001 in most OECD countries, although access was still uneven, more than half of households had PC access (Figures 4 and 5).

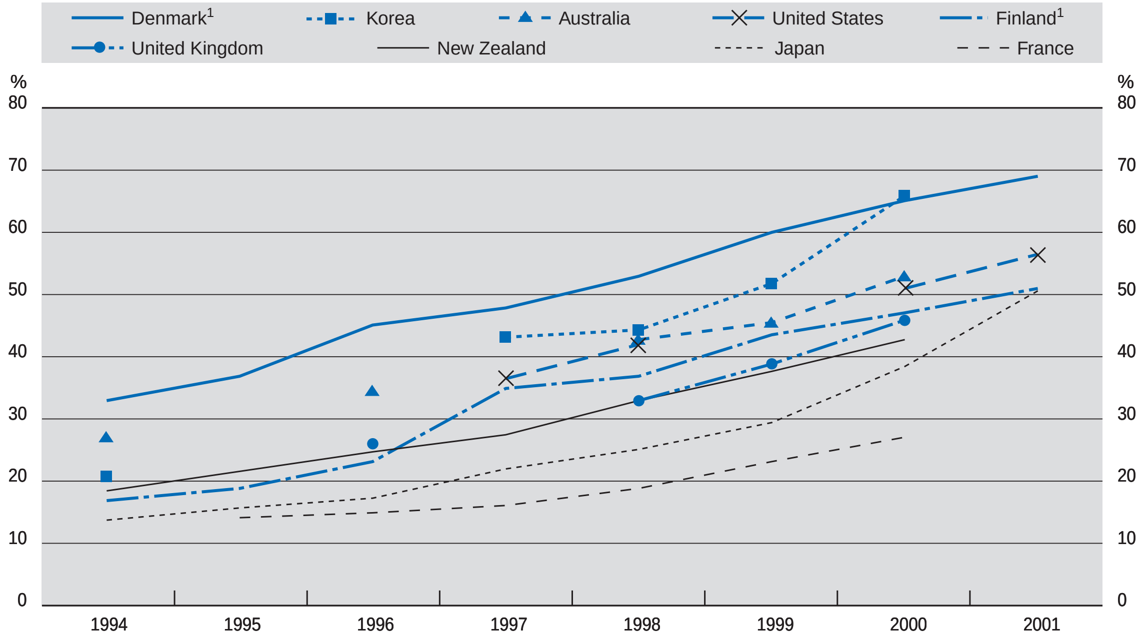
Although Internet access has lagged PC access, uptake by households has been extremely rapid and regular over the last five years (Figure 6). In four OECD countries, more than 40% of households had Internet access in 2000 (Figure 7), and in countries where the number is significantly lower, access is also rising rapidly. Box 1 highlights differences in ICT access in schools across OECD countries.

Access cost

Internet access prices strongly affect initial access, and metering practices affect the length of time users stay on line. Access prices differ greatly within OECD countries (Figure 8). Countries with lower access costs typically have a greater number of Internet hosts, and electronic commerce has developed rapidly in countries with unmetered access (OECD, 2001*c*).

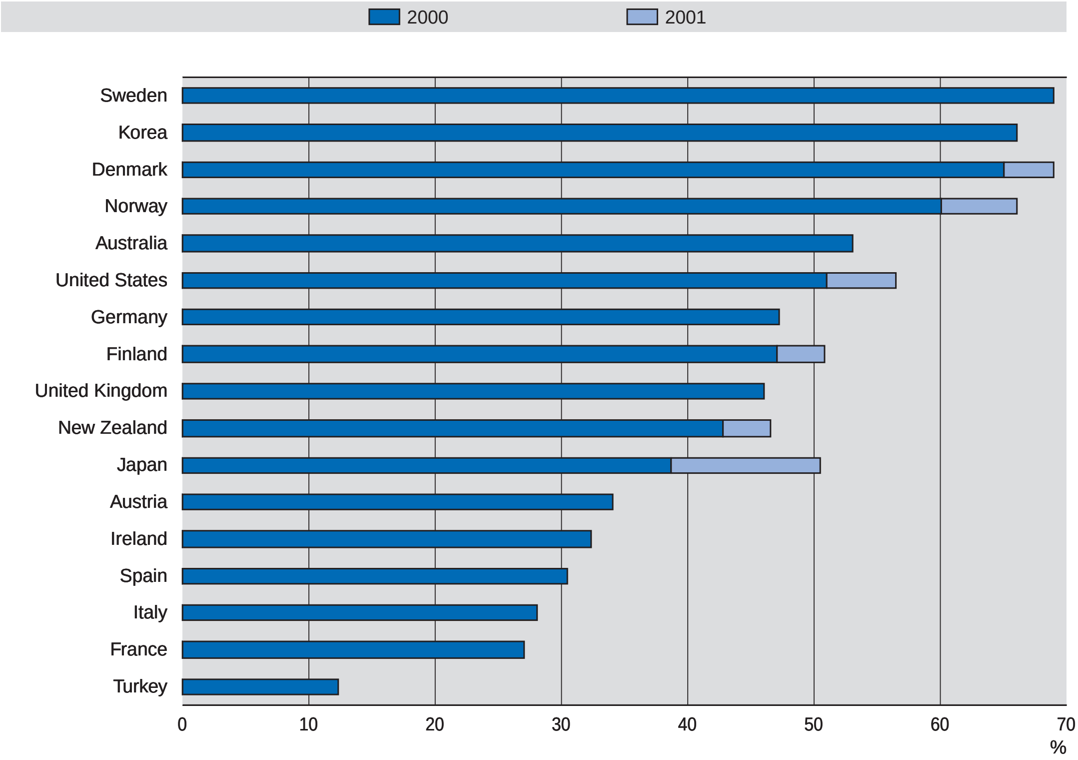
With regard to businesses, cost of investment can be a determinant of ICT access and use. In the 1990s, firms in the United States and Canada enjoyed considerably lower prices for ICT investment goods (OECD, 2001*c*, 2001*d*) than those in European countries and Japan. While prices in Canada were 10% higher than prices in the United States, prices elsewhere range from 30% to 75% higher than prices in the United States. The lower costs in the United States and Canada may have stimulated relatively more extensive business investment in both countries.

Figure 4. **Access to a home computer in selected OECD countries, 1994-2001**



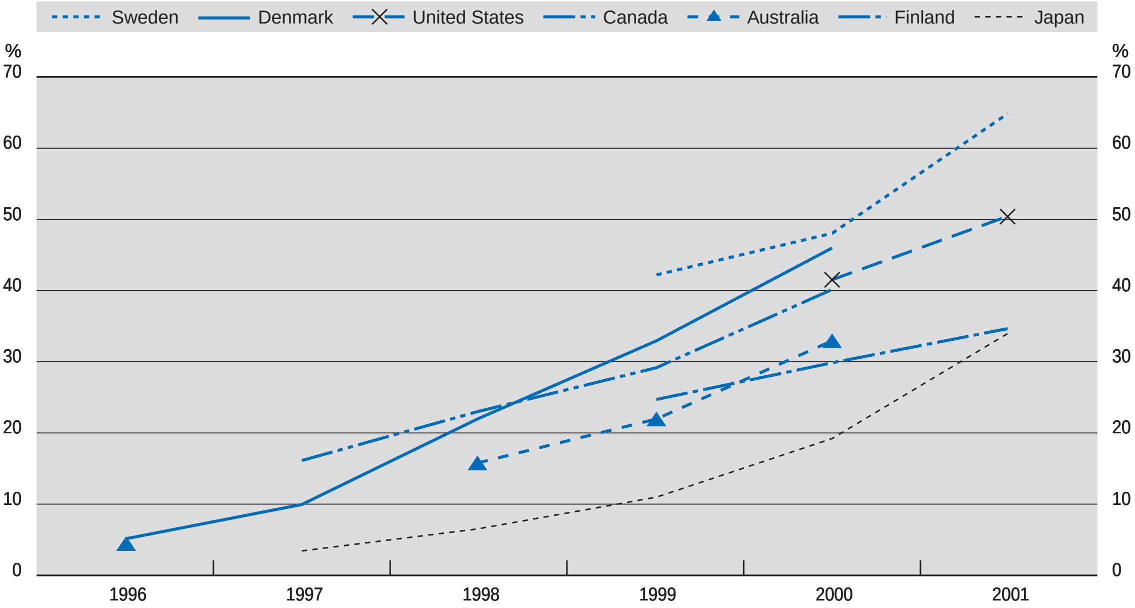
1. First quarter for 2001.
Source: OECD, based on ICT database and national sources. For further details, see Annex Table 6.1.

Figure 5. **Households with access to a home computer, 2000 and 2001**



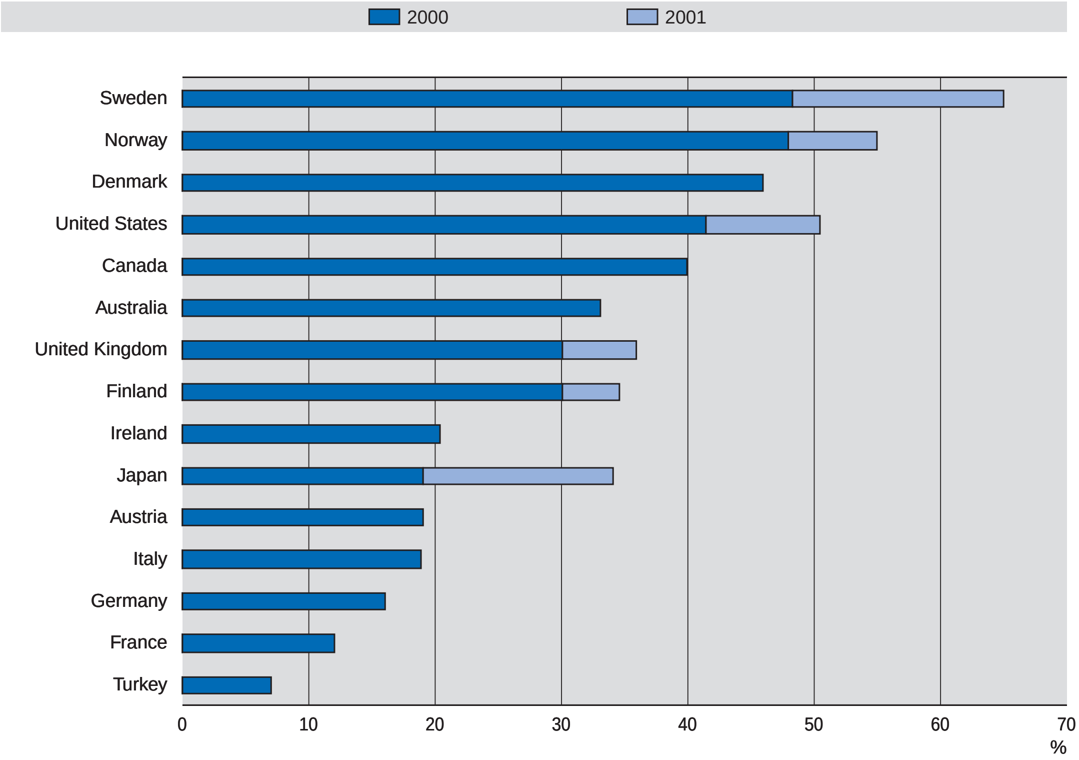
Source: OECD, based on ICT database and national sources. For further details, see Annex Table 6.1.

Figure 6. **Household access to Internet in selected OECD countries, 1996-2001**



Note: For Denmark, Internet access via a home computer; for other countries access via any device (computer, phone, TV, etc.).
Source: OECD, based on ICT database and national sources. For further details, see Annex Table 6.2.

Figure 7. **Households with access to Internet, 2000 and 2001**[1]



Note: For Denmark, Ireland and 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.)

1. 2001 for selected countries only.

Source: OECD, based on ICT database and national sources. For further details, see Annex Table 6.2.

Determinants of use

Various factors affect ICT use. As noted above, investment and access costs are important for households but there are other, more qualitative, hurdles to more widespread use. For PC use, for example, many say they "don't want" a PC. In Australia, two-thirds of households without a PC said that they had no need for or no interest in having one. Only one-quarter without a PC said that the costs were too high. For the Internet, lack of interest is generally ranked as the primary reason for non-use by households, while cost is generally ranked second (OECD ICT database). This holds true in Australia, France, the United Kingdom and the United States. Lack of a computer was also very important in France and the United Kingdom. In France, services being too complicated was also cited as important (SESSI, 2001) and in the United Kingdom lack of confidence and lack of skills were also important.

While access means that the technology is available, rate of use is lower than rate of access. Even when connected, not all those with access to technology actually use it. In the United States (in October 2000), only 76% of people who had Internet access at home actually used the Internet at home (US Department of Commerce, 2000*b*). Similarly, in Australia, Italy and Sweden more people have access to the Internet than use it (OECD ICT database).

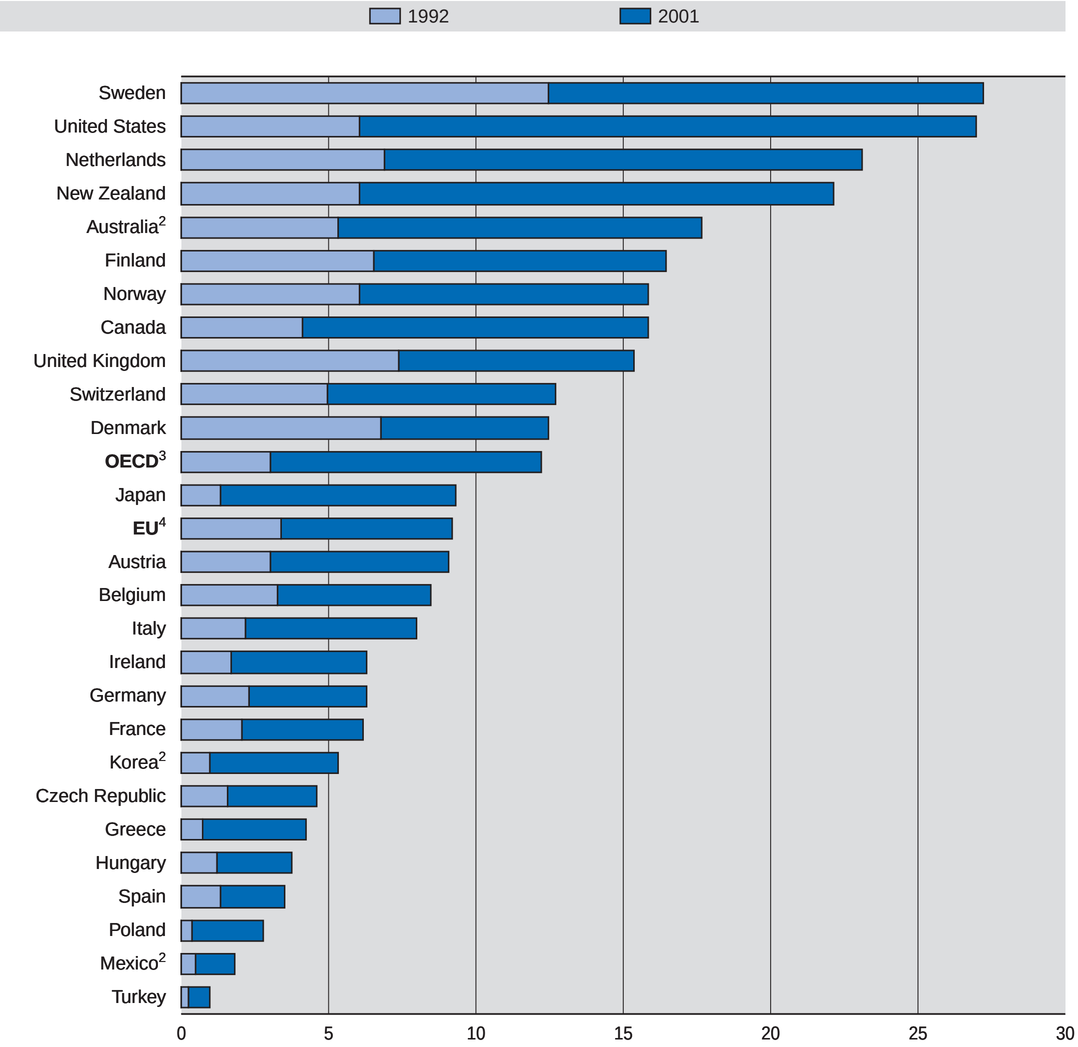
With regard to businesses, common obstacles to electronic commerce include strategic issues such as the belief that electronic commerce is not relevant or applicable, and lack of familiarity with new business models. Other obstacles include worries about security, cost, coverage and skills. For example, in Canada, the most common obstacle to electronic commerce (for both Internet users and

Box 1. ICT access in schools

Access to ICTs in schools and their use in education are viewed as extremely important for raising ICT awareness and developing and diffusing the ICT skill base (see Chapter 5 on ICT skills and Chapter 8 on policies). Information technology is now widespread in the education system in most OECD countries. The figure below shows the average number of PCs per 100 students in OECD countries in 1992 and 2001.

Diffusion of information technology in the education system, 1992-2001

Average number of PCs per 100 students[1]



1. Average number of PCs per 100 full-time enrolled students. For 2001, 1999 student figures were used.
2. 1993 instead of 1992.
3. Estimates for 1992. OECD excluding Portugal, the Slovak Republic and Luxembourg.
4. Estimates for 1992. EU excluding Portugal and Luxembourg.

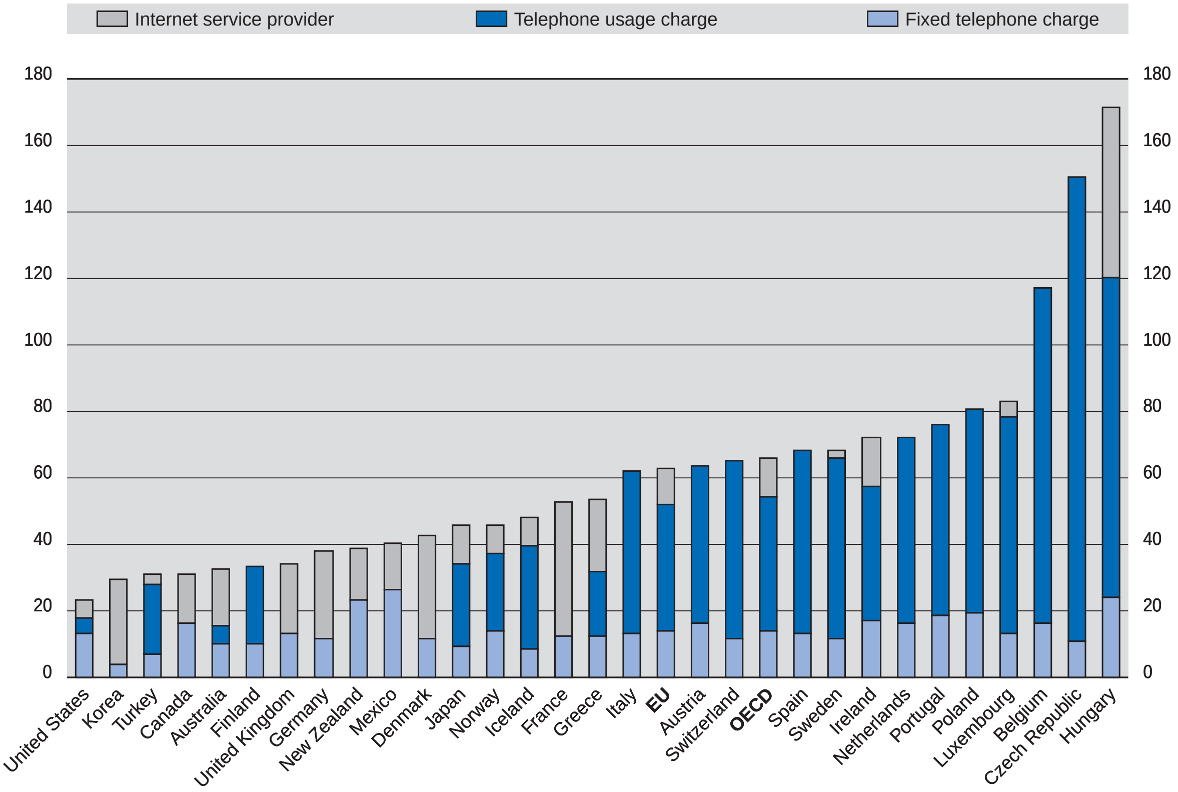
Source: OECD, based on World Information Technology and Services Alliance (WITSA)/International Data Corporation (IDC), 2002.

Box 1. ICT access in schools (*cont.*)

Internet access in schools is growing rapidly although it lags PC access. For example, the United States had a 35% public school penetration rate in 1994, which rose to 78% in 1997 and 98% in 2000 (NCES, 2001). In Japan, schools with access rose from 9.8% in 1997 to 57.4% in 2000 (Ministry of Education, 2000). Lower school levels lag higher ones. In France in 2001, all middle schools had either a multimedia room or a technology equipment room and 95% had both, but at the primary level 30% still had no Internet connection and 20% had only one machine connected.

Figure 8. **Internet access basket for 40 hours at peak times using discounted PSTN rates, August 2001**

USD, PPP, including VAT



Note: Internet access costs differ substantially among OECD countries, primarily owing to differences in variable telephone charges and the costs of Internet service providers. Previous OECD studies show that these differences are primarily due to the state of competition in different Member countries.

Source: OECD.

non-users) is that "goods do not lend themselves to electronic transactions". The share of this response ranged from 41% for public administration to 76% for health care and social assistance. The second most important barrier was "prefer to maintain current business model" (from 11% for public administration to 46% for retail trade). "Security concerns" had high priority for the public administration (27%,) and "cost of development and maintenance too high" and "lack of skilled employees" were also important barriers for many sectors (Statistics Canada, 2000).

Patterns of use

Major differences in patterns of use are evident in the large variations in frequency, location (home, workplace, public access), and purpose of use.

Frequency

Internet use has increased in terms of frequency of access and time spent on line as well as in the number of users. In Norway, only 20% of Internet users used Internet on a daily basis in 1996. In 2001, the number of daily users increased to 60% (Taylor Nelson Sofres Norway, 2002). In Finland, regular Internet use on a daily or weekly basis has increased, and the relative gap between daily and occasional use has narrowed as daily use has grown faster (Table 1). In Australia, regular and frequent use is also increasing as a share of on-line activities (Australian Bureau of Statistics), although in all countries, as in Italy (ISTAT, 2000), occasional use is still considerably higher than daily use.

Table 1. **Internet usage in Finland, 1996-2001**

Internet use…	% of population aged 15-75 October-November of each year, except for 2001, July-August					
	1996	1997	1998	1999	2000	2001
At least sometimes	19.6	29.0	38.5	50.6	75.8	86.0
At least once a week	10.9	18.4	28.1	38.3	60.6	68.4
Daily basis	4.5	8.1	13.2	17.4	34.0	41.9
Weekly from home	4.7	7.6	13.9	21.4	38.8	45.7
Weekly from workplace	5.3	8.1	13.2	17.4	29.1	36.5
Weekly from place of study	4.8	7.0	8.5	9.0	10.9	11.9
For other purposes besides e-mail	17.6	24.9	33.9	43.0	69.1	77.5

Source: Table 10.5, p. 245, of "Finnish Mass Media 2000", Statistics Finland (original source: Taloustutkimus, Internet Tracking), and updated for 2001 from Taloustutkimus Web site, Internet Tracking, *www.toy.fi/tuotteet/internet/inet5e.htm*, site visited 20 December 2001.

Location

Different locations of Internet use lead to different on-line activities, and there are many advantages to home access. In addition to being able to access information at any time day or night, a person may be less likely to access, for example, personal health information from a library or other public terminal than from home.

In the United States, use of all locations is rising. The share of people who use the Internet from both home and some other location is growing particularly rapidly, and use at work increases the propensity to use the Internet at home. In the United Kingdom, use at home has increased and exceeds use at work (Table 2). Italian data show that access only at home is highest, followed by access both at home and elsewhere. Access from only outside the home is lowest (ISTAT, 2001).

Purpose

In most countries, regular home users use the Internet most frequently for e-mail and information search. In Italy, for example, 63% of Internet users use it for e-mail, followed by information search (60%). Services, chat and shopping were considerably further behind (22.5%, 20%, and 6%, respectively). In the United Kingdom, uses other than e-mail are increasing significantly, and, as of July 2000, the Internet was used slightly more for finding information than for e-mail (70% and 69%, respectively). Purchases

Table 2. **Locations used by adults to access the Internet for personal use in the United Kingdom, July 2000 and 2001**

Places used to access the Internet	July 2000 (%)	July 2001 (%)
Respondent's own home	70	78
Another person's home	33	33
Respondent's workplace	32	36
A school, college, university or other educational institution	25	24
A public library	7	8
An Internet cafe or shop	6	8
A community or voluntary organisation	1	1
A government office	1	0
A post office[1]	–	0
Somewhere else	3	2

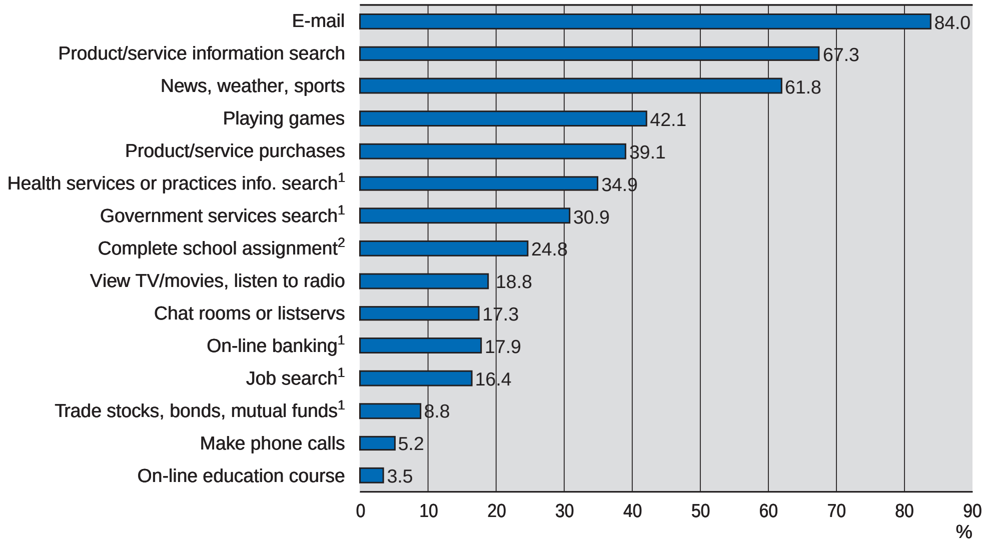
Note: Respondents may give more than one answer.

1. Post offices were not included in July 2000.

Source: UK National Statistics, July 2001.

Figure 9. **On-line activities of individuals, United States, 2001**

As a percentage of Internet users, persons aged 3+



1. For these on-line activities, only individuals aged 15 and over were surveyed.
2. All respondents were asked about this activity. If the response is restricted to individuals enrolled in school, the share of Internet users completing school assignments would increase to 77.5%.

Source: US Department of Commerce (2002), based on NTIA and ESA, US Department of Commerce, using US Bureau of the Census Current Population Survey Supplements.

and banking and investment accounted for 28% and 21%, respectively. In the United States, e-mail and information search remain the most common purposes by far, but other uses such as news, weather and sports are increasing (Figure 9). In Canada, one-third of regular home Internet use is for electronic banking. Use for formal education/training rose from 32% in 1999 to 47% in 2000. In Norway, while general information search and e-mail remain the most frequent uses, 59% of regular users pay their bills via the Internet (Taylor Nelson Sofres Norway 2002). In addition, studies show that Internet use is becoming more directed, and "open" or "aimless" Internet-surfing is decreasing as users gain experience in the use of the Internet (Ivar Frønes, Digitale skiller/Norwegian Gallup 2002).

In the 1998 survey on working conditions in France (Cezard and Vinck, 1998), 7% of wage earners used a PC at home (excluding laptops) for their professional activities, though there are considerable differences by profession. When laptops are included, the percentages are much higher (DARES, 1998).

Leaders and laggards: households and individuals

People have varying reasons for using ICTs. Those not using may not be able to afford access, they may not be able to benefit from ICTs (for example, if they are poorly educated or disabled), or they may have no interest in the Internet or not have been exposed to the benefits of ICTs. It is worth noting that use in the home is substantially influenced by use at work. This section examines differences in access and use of new ICTs according to various socio-economic indicators.

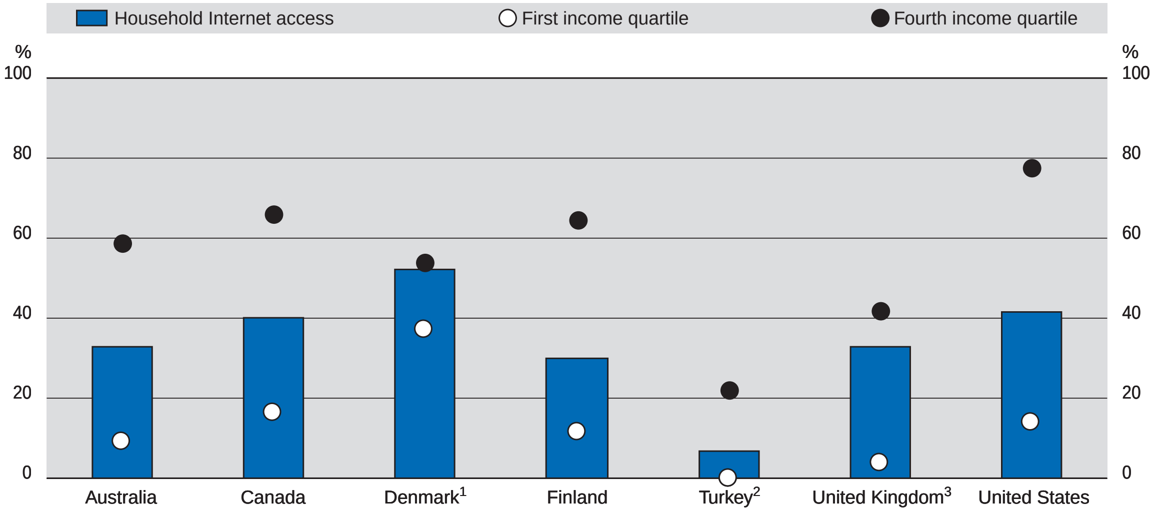
Income

Income is a strong determinant of household PC and Internet access in all countries for which information is available. High-income groups have more disposable income to spend on these technologies than lower income groups. Because of differences in the income brackets used in national statistics, most data across countries are not directly comparable, although distribution patterns are similar. In Australia (2000), for example, households in the highest income bracket had a PC penetration rate of 85% and an Internet penetration rate of 69%, while those in the lowest income bracket had a PC penetration rate of 24% and an Internet penetration rate of 10%. Annex Table 6.3 gives further details for nine OECD countries. Lower rates of Internet access, and larger relative differences between income groups suggest that in the early stages of new technology diffusion income distribution is an important determinant of diffusion. But it is also substantially influenced by use at work (see below).

It is impossible to make cross-country comparisons regarding the size of the income digital divide when countries provide data by different income brackets. However, seven OECD countries also provided data by income quartile for the year 2000 (Figure 10). The standard use of income quartile

Figure 10. **Internet home access among households by income level, 2000**

Percentages



Note: For Denmark and 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.). Household data may be different from quartile data.

1. First quarter 2001.
2. Households in urban areas only.
3. Last quarter 2000 for household Internet access, financial year 1999/2000 for quartile data.

Source: OECD 2001*b* and national sources. For details see Annex Table 6.4.

means that the data can be used for cross-country comparisons regarding the size of the digital divide in selected OECD countries.

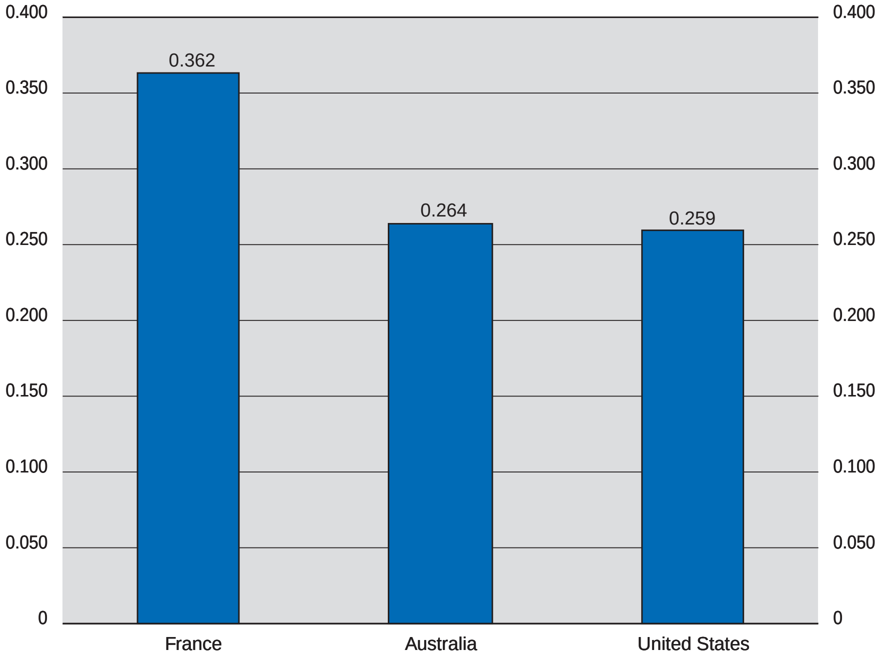
In frequency distributions, a commonly used statistical measure of inequality is the Gini coefficient (Kendall and Stuart, 1969). The Gini coefficient is widely used to measure inter-population inequality in income and wealth; it can also be used to measure the digital divide (US Department of Commerce, 2002). For household PC and Internet distributions, a Gini coefficient of "0" means that distribution among households is equal, a Gini coefficient of "1" means that one household, or one group of households, has all the access. With regard to the distribution of computers and the Internet by income, Gini coefficients typically vary between 0.200 and 0.500. Among OECD countries for which data are available, Canada and the United States have the most equally dispersed use of computers and the Internet. France and the United Kingdom have relatively greater differences. Figures 11 and 12 give the Gini coefficients for PC and Internet dispersion by income level in selected OECD countries.

Education

In general, the higher their level of education, the more likely individuals are to access and use ICTs both at home and at work. The US Department of Commerce (2000*b*) found this to be at least partly independent of income. For example, schoolteachers are highly educated and have high rates of ICT use, but are generally not included in high-income brackets. In Norway, the more highly educated (university degree or equivalent) use the Internet more frequently than other educational groups, and this helps explain why the lowest income group (which has a high share of students) has the highest Internet use.

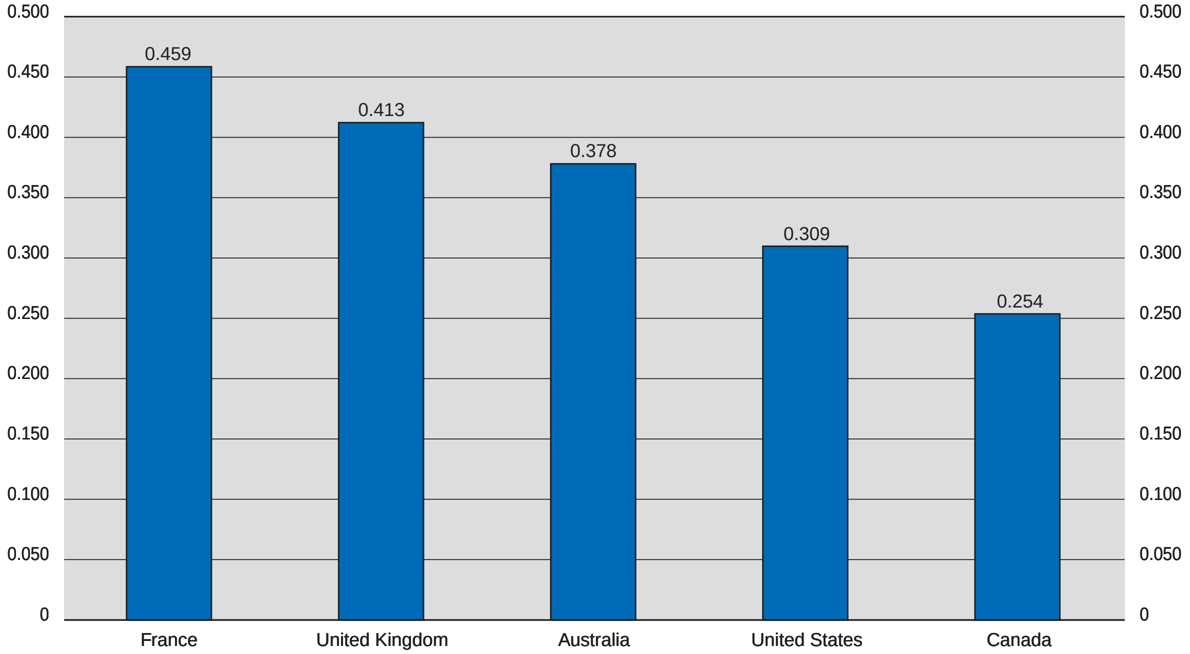
There are large differences in PC penetration between those with tertiary-level education and those at the lowest education levels (*i.e.* those lacking a high-school diploma or its equivalent). These differences vary from about a factor of two in the Netherlands to about a factor of six in the United States (OECD, 2000*c*). Although these differences have persisted over time, access by less educated groups is growing at more rapid rates albeit from a low base.

Figure 11. **Gini coefficients: distribution of computers by household income, 2000**



Source: OECD from national sources. For additional details, see Annex Table 6.5.

Figure 12. **Gini coefficients: distribution of Internet access by household income, 2000**



Source: OECD from national sources. For further details, see Annex Table 6.6.

Education is also reflected in Internet access patterns. Differences between those with tertiary-level education and those at the lowest education levels are large. In the early stages of diffusion, differences in access by educational attainment appear to be stronger for the Internet than for PCs. Differences vary by a factor of three in the Netherlands to a factor of over nine in the United States (according to the most recent data available; OECD, 2000*c*). Canada appears in an intermediate position, with differences varying by a factor of around seven. These differences have persisted over time (OECD, 2000*b*).

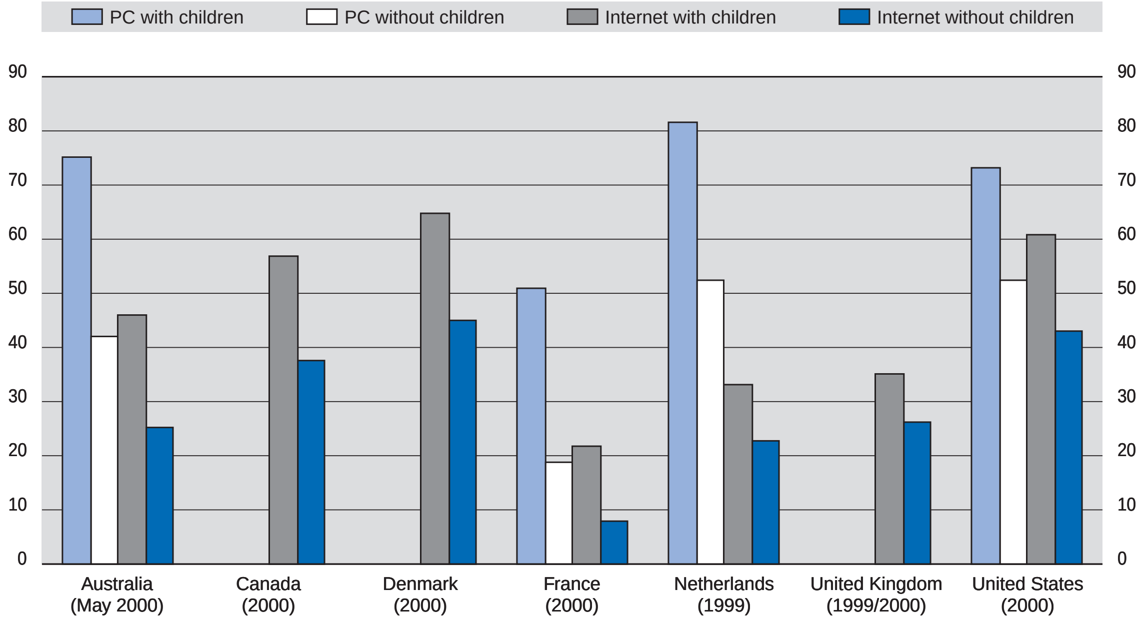
Household size and type

For the countries for which data are available, PC penetration appears to increase monotonically with household size and tends to be growing faster in larger households. Data for earlier years suggested that PC penetration rates increased until household size reached three to four people and then flattened out.[4]

Families with children have the highest PC and Internet access of all households.[5] Married couples with children under 18 are more likely to have a PC and Internet access than families with single heads of households or without children. Both of these types of households have approximately double the rate of PC and Internet use of singles or single person heads of household (Figure 13).

In the United States, data for 2001 show that married couples with children have the highest household penetration rates for both computers and the Internet, followed by family households without children. Male and female households with children have lower penetration levels, and non-family households have the lowest penetration (see Table 3).

Figure 13. **PC and Internet access by type of household**



Note: In France, data on households with children refer to those with two children. In the United Kingdom, data refer to households with two or more children.
Source: OECD from national sources.

Table 3. **Households with a PC and Internet access, United States, 2001**
Percentages

	PC	Internet
Married couple with child under 18	78.9	71.6
Family household without child	58.8	53.2
Male household with child under 18	55.1	44.9
Female household with child under 18	49.2	40.0
Non-family household	39.2	35.0

Source: US Department of Commerce (2002) on-line household supplement.

Age

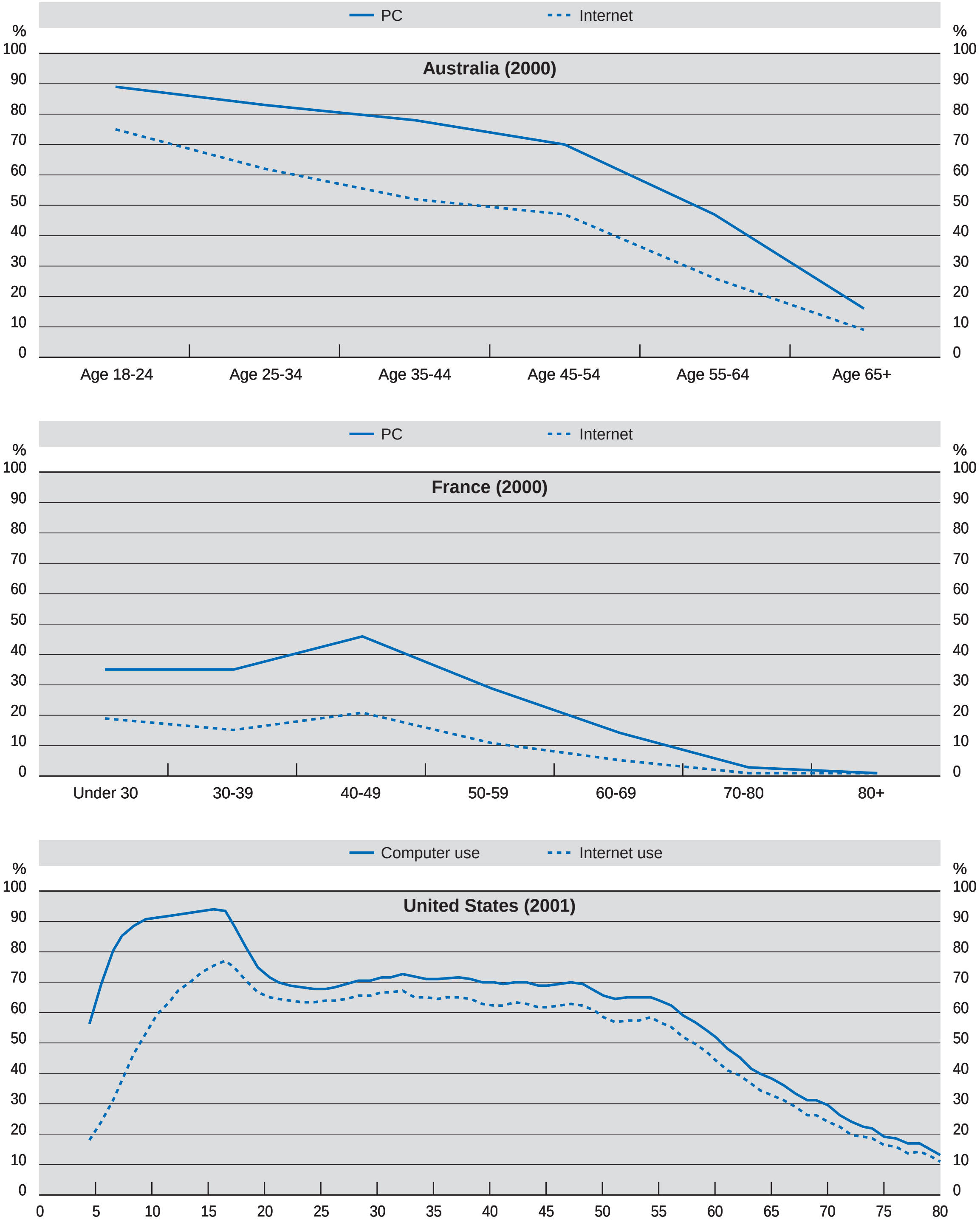
In general, older people have lower rates of access to PCs and the Internet than younger and middle-aged groups. Patterns of use by age are similar across countries; however, cross-country comparisons by age groups are imprecise because of the use of different age groups in various countries. Figure 14 shows diffusion rates for Australia, France and the United States, but similar patterns apply to Canada, Denmark, Japan, the Netherlands and the United Kingdom.

Australian surveys for three consecutive years (1998-2000) indicate that younger age groups go on line more rapidly once the technology has started to diffuse, and the relative advance in access by the youngest age group has grown rapidly (Australian Bureau of Statistics).

In France, nine people out of ten aged 65 or more do not expect to be connected in the coming years, either because they do not see the use, do not have a computer or assume that using the Internet is too complex (SESSI, 2001). Privacy concerns also tend to rise with age. In Norway, 70% have

Figure 14. **PC and Internet penetration rate by age**

Percentages



Note: Access in Australia and France. Use in the United States. Age of head of household in France, access from home. Age of individual in Australia and the United States, and includes adults accessing/using the Internet from any site.

Source: OECD from national sources.

access to the Internet at home or at work. Among those under 60 years of age, the figure is 80% (Taylor Nelson Sofres Norway, 2002). The disparity due by age may decrease as new generations of users reach retirement age.

Gender

The gender gap differs significantly among countries. In Japan, Internet access and use from home by men was approximately double that of women for all Internet-related activities, although women's rates of use were growing faster (Nikkei, 1999 and 2000). In the United Kingdom, the rate of Internet use by male adults was 52% in July 2000, compared with only 39% for female adults (UK National Statistics, September 2000).

In Norway, Internet access among males is higher than for females (Table 4), but the gender difference seems to decrease when the older age group is left out. It is primarily among the older age group that females are under-represented compared to males, and this to a large extent influences the female under-representation in general (Norwegian Gallup, 2002).

Table 4. **Internet and gender**

Percentages

	1998	1999	2000	2001
Australia				
Male	35	45	50	–
Female	28	37	43	–
Total	32	41	47	–
Norway				
Male	43	53	64	72
Female	33	42	54	65
Total	42	51	63	67
Sweden				
Male	32	–	67	–
Female	26	–	63	–
Total	29	–	65	–
United States				
Male	34	–	45	54
Female	31	–	44	54
Total	33	–	44	54

Note: Individual home access in Sweden, Internet use from any location in Australia and the United States.
Source: OECD from national sources.

Elsewhere, however, differences in the use of new technologies by gender appear to be quite small. In the United States by August 2000, women had closed the gap with men since the 1998 survey and individual Internet use rates were statistically identical; in 2001, gender differences were again insignificant (Table 4). There are, however, some persistent differences by age groups. Women from the age of 20 to 50 are more likely to use the Internet than males in the same age range. Men over the age of 60 are more likely to be Internet users than are women (US Department of Commerce, 2002).

The picture in Iceland, where ICT access rates are high, is similar. Women are ahead of or equal to men except in the older age groups. Frequency of use (men more frequent) and purpose of use (men more likely to purchase) differ considerably between women and men (Office of the Prime Minister, 2000). Swedish data suggest that some differences in Internet access may continue even when penetration levels are high (Table 4).

In 2001, computer use was higher in the United States for female heads of households with children than for male heads of household with children, but male heads of household had slightly higher rates of Internet access. Both were below average and considerably below rates for married couples with children, although use by female heads of household was growing relatively faster (US Department of Commerce, 2002). In the Netherlands, men living alone were much more likely to have Internet access at home than women living alone, although both were less likely than couples with children (Central Bureau of Statistics, 2000).

Disability

A number of visual, aural and physical impediments hinder the disabled from using ICTs. Adapting ICT tools to make them accessible to the disabled can be difficult, and special equipment may be needed. In addition, many Internet sites are inaccessible to the disabled; recent studies show that between 95% and 99% of Web sites are inaccessible to those with visual, hearing and/or mobility impairments.[6] For example, in the United States in 2000, people with a disability enjoyed about half the Internet access at home as those with no disability (21.6% *versus* 42.1%) (US Department of Commerce, 2000*b*).

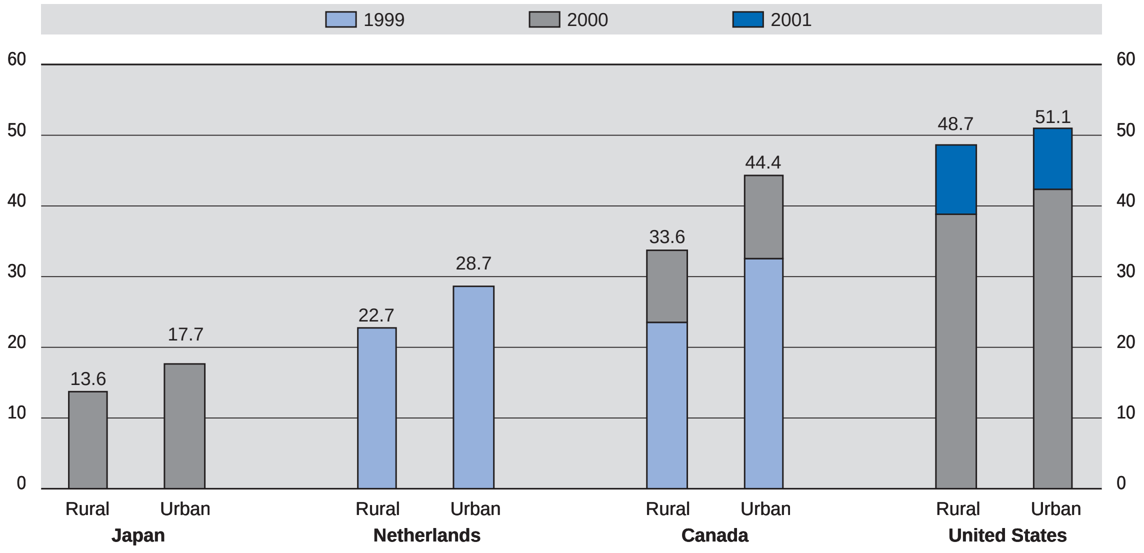
Location (*rural or urban*)

Analysis by geographical location shows considerable differences in access and use of PCs and particularly the Internet. The greater divide with regard to the Internet can be partially attributed to the fact that the Internet requires network infrastructure and services that PCs do not (OECD, 2000*a*).

Internet access in urban areas is everywhere greater than in rural and peripheral regions (Figure 15) and is especially high in main cities and highly industrialised and developed regions (Table 5). Two reasons are usually advanced for these differences: *i*) in rural areas, cost of access tends to be higher and quality of service lower, despite some countries' efforts to ensure standardised pricing and quality; *ii*) incomes tend to be lower in rural areas, and ICT costs are relatively higher for low-income groups. Moreover, members of households in urban areas are more likely to have occupations where computers and the Internet are part of their work environment. However, recent 2001 data from the United States shows that the gap has been closing rapidly, and rural areas are moving towards the national average.

Figure 15. **Urban homes are more connected than rural ones**

Internet access among rural and urban households



Note: For the Netherlands, "rural" is defined as a low degree of urbanisation, and "urban" a high degree. For Japan, "rural" is defined as "villages and towns" and "urban" as "cities". For both countries, the highest categories were not taken into account. For Canada, urban refers to the top 15 metropolitan areas and rural refers to other areas.

Source: OECD, based on national statistical sources.

Table 5. **Urban regions have better access than rural ones**
ICT equipment and Internet access in leading and lagging regions

		Leading regions	Lagging regions
Canada	2000	British Columbia, Ontario	Quebec, Saskatchewan, Newfoundland
France	1999	Paris region [for SME access] Paris region [Web]	South-east, West Centre
Italy	2000	North-east	South
Norway	1999	Oslo, counties with developed regional centres	Peripheral counties without developed centres

Source: OECD, based on national sources.

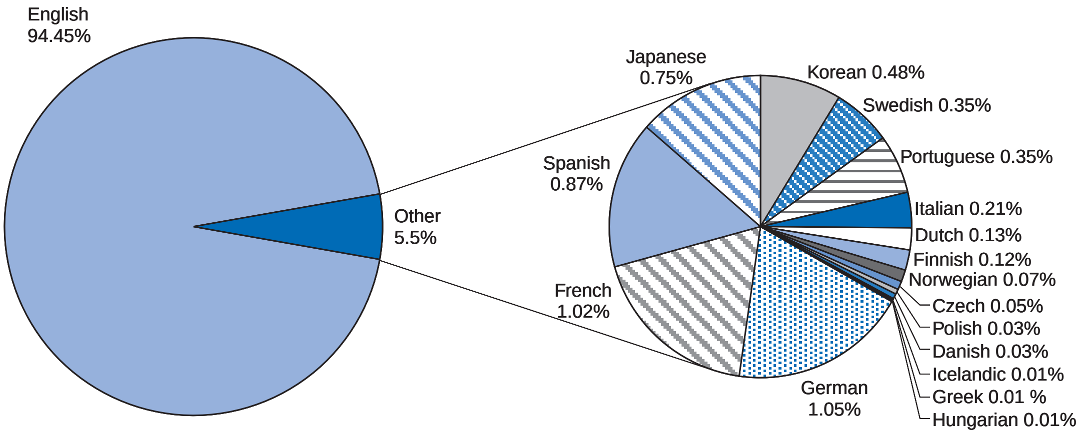
Leading regions tend to have higher concentrations of more technologically developed businesses and academic and research institutions which are likely to have high levels of uptake and use of new technologies. Firm size tends to be smaller in more remote areas, accentuating divides. Agglomeration effects, positive externalities and clustering of advanced firms reinforce divides.

In the Netherlands, however, while highly urbanised areas had lower penetration rates than moderately urbanised ones, the densest urban areas had appreciably lower rates of penetration than non-urban areas. The pattern has been similar in the United States, where recent data show that rural Internet use is approaching the US national average, but that Internet use in central cities lags other areas (US Department of Commerce, 2002). In the United States, the central cities frequently have lower average income and education levels.

Language

English is overwhelmingly the language of e-commerce. In July 2000, more than 94% of links (almost 2.9 million) to pages on secure servers were in English (Figure 16). The only other languages to account for more than 1% of detected links to secure servers were German (31 785 links) and French (30 954 links), although Spanish (26 512 links) and Japanese (22 852 links) came close. This suggests that individuals and businesses that are not proficient in English are at a considerable disadvantage with regard to commercial activities on the Internet.

Figure 16. **English is the main language of e-commerce**
Links to secure servers by language, July 2000



Source: Netcraft.

Employment status

The employed have the highest rates of access, followed by people in the workforce but currently unemployed (the Internet may be very useful for on-line job searches). People not in the labour force had far lower rates of access, perhaps because they include people taking care of the home and retirees who may not have been exposed to computers and the Internet at work or in an educational setting. For example, in Australia in 2000, the Internet was accessed by 56% of employed Australians, as compared to 40% of unemployed persons. Only 16% of those not in the labour force used the Internet.[7]

Use in the workplace

The most recent study in the United States shows that ICT use by individuals is strongly affected by use in the workplace. Not only are individuals who work in certain occupational areas more likely to use a computer and the Internet, but exposure in the workplace makes an individual substantially more likely to use a computer and the Internet at home. For example, 78% of households in which at least one family member uses a computer at work have a computer at home. In contrast, only 36% of households in which no family member uses a computer at work have a computer at home (US Department of Commerce, 2002). A similar pattern exists for Internet access (Table 6).

Table 6. **Use of a computer and the Internet at work affects use at home**

United States, 2001

	Percentage of US households with a computer (2001)	Percentage of US households with Internet access (2001)
Does any household member use at work?		
Yes	77.9	76.8
No	35.9	34.8

Source: US Department of Commerce, 2002.

A US Department of Commerce analysis of 2001 data suggests that the presence in a household of someone who uses the Internet on the job may be a key factor in whether a household has an Internet subscription. As Figure 17 shows, once the "use on the job" variable is factored in, the importance of income as a factor in Internet use is substantially diminished. This same pattern holds true for computers. This suggests that familiarity with the technology outside of the home helps to explain differences in technology adoption among various demographic groups.

How are access patterns changing?

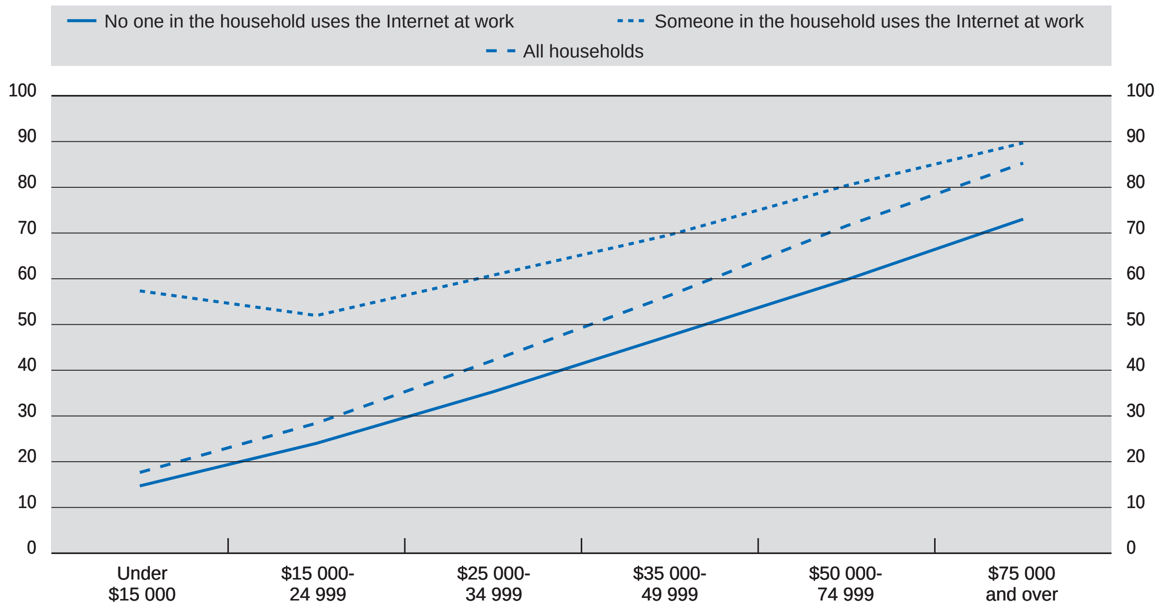
The digital divide may be said to be both growing and shrinking. When examined in terms of access gap (difference in absolute percentage points), the gap appears to be widening. When examined in terms of growth rate, the digital divide appears to be closing. Gini coefficients for PC and Internet access by income have been getting smaller in most OECD countries, suggesting that inequality is decreasing.

Access gap

The access gap is measured by the absolute difference between the percentage of access of two groups. This measure is used to see which groups are gaining the most new members relative to their group. If one looks at the access gap between different groups for PCs and the Internet from one year to the next, the digital divide in terms of income appears to be widening. The absolute percentage point increase in ICT users is greater for members of higher income brackets than for members of lower ones for both PCs and Internet access. For example, in 1997 the highest level income group in Canada had

Figure 17. **Household Internet access by family income, United States, 2001**

Percentage of all households



Source: US Department of Commerce, 2002, based on NTIA and ESA, US Department of Commerce and US Bureau of the Census Current Population Survey Supplements.

Internet access rates of 33% while the lowest income group had access rates of 6%, a difference of 27 percentage points. In 2000, the highest income group had Internet access rates of 65% while the lowest had rates of 17%, a difference of 48 percentage points. A comparison of the two years would suggest that by this measure, the digital divide is getting wider. Although income brackets differ among OECD countries and data are not directly comparable, other countries have similar patterns (see Annex Table 6.3).

Growth rate

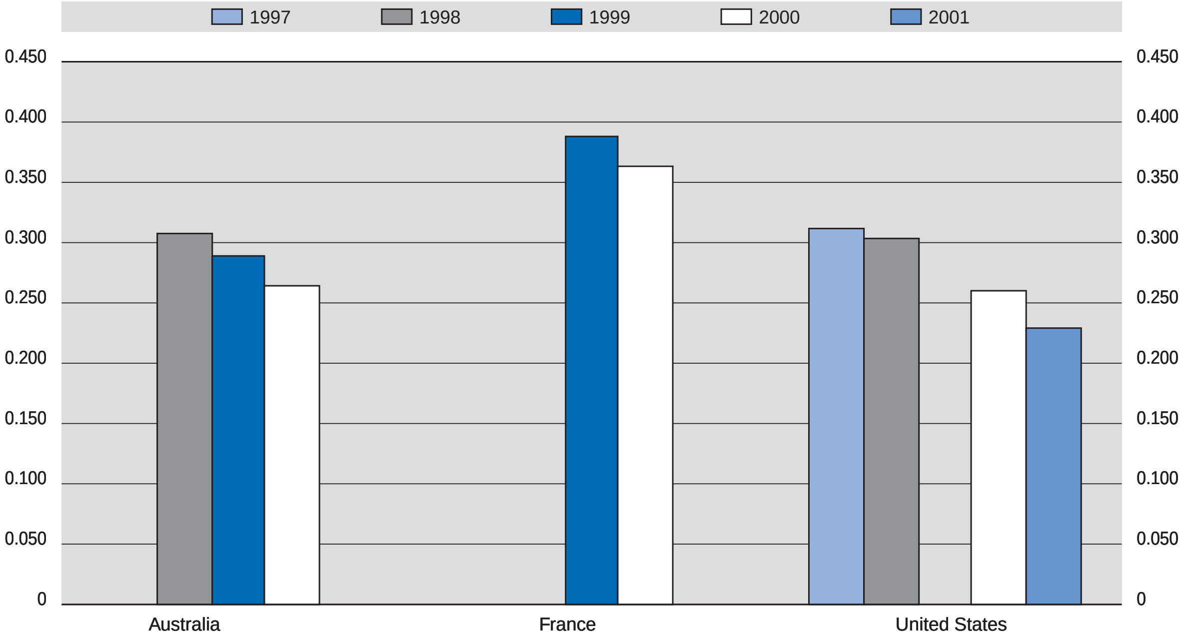
When considered in terms of growth rate, the digital divide appears to be getting smaller. Even as percentage point differences are widening, lagging groups are increasing their use of ICTs at a far faster rate than the highest income groups, particularly for the Internet. Internet access is growing faster than PC access, largely because the necessary infrastructure (PCs) is already in place.

Annual growth in penetration is greater for low-income groups than for high-income groups in almost all countries. Differences among low-income groups in different countries may be due to country-specific factors that determine rates of uptake in different income groups early in the diffusion of the Internet. In contrast to the general pattern, Internet penetration in the Netherlands was higher for the highest income group, which grew by 53% from 1998, compared to a growth rate of only 45% for the lowest income bracket. As income brackets differ across countries, data are not directly comparable. Annex Table 6.7 gives details of growth rates in nine OECD countries.

Gini coefficients

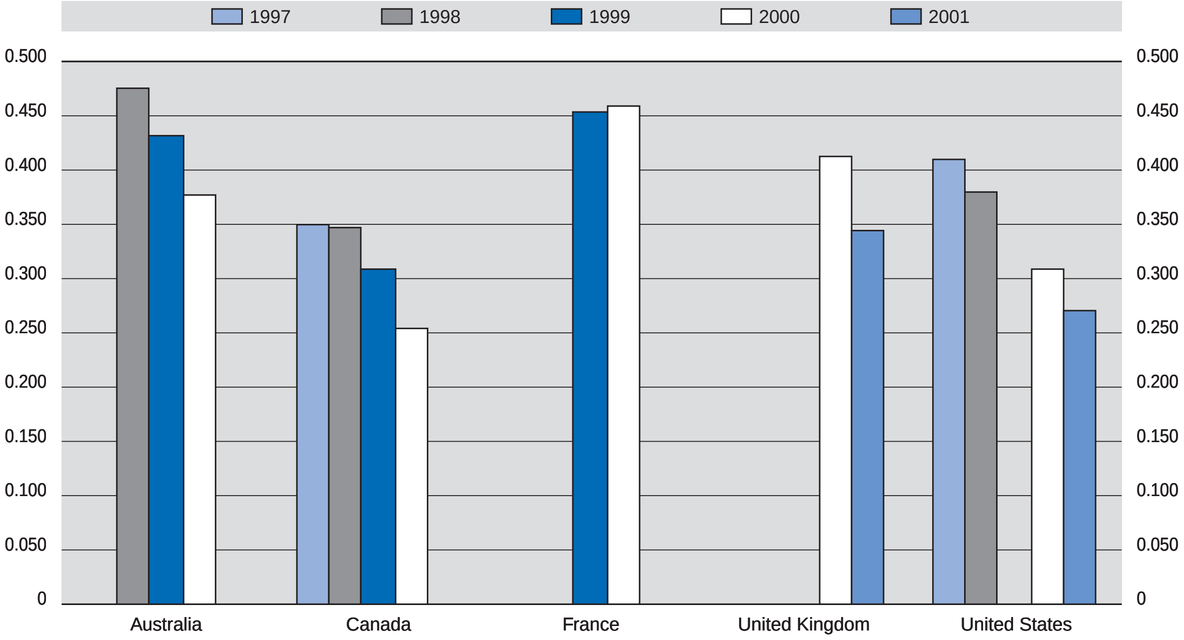
The Gini coefficients measuring differences in household access to PCs and the Internet by income bracket have been decreasing over time in almost all OECD countries for which data are available, suggesting that the digital divide is getting smaller (Figures 18 and 19). The only exception is France,

Figure 18. **Gini coefficients for household access to a computer by income**



Source: OECD, based on national sources. For further details, see Annex Table 6.5.

Figure 19. **Gini coefficients for household access to the Internet by income**



Source: OECD, based on national sources. For further details, see Annex Table 6.6.

where the Gini coefficient for Internet access by income did not decrease between 1999 and 2000. Decreasing Gini coefficients suggest that despite widespread differences in access, distribution is becoming more equal over time.

Leaders and laggards: business and government

The digital divide is not limited to households and individuals, but also affects businesses and the public sector.

Businesses

Most firms are now equipped with PCs (OECD, 2001*c*, 2001*d*), and the digital divide now largely concerns differences in Internet use. Patterns of Internet and e-commerce access and use by country, sector and firm size can help to understand how the information economy is evolving. Results of the Electronic Commerce Business Impacts Project (EBIP) (OECD, 2001*e*) clearly show that the Internet and related e-commerce strategies are transforming businesses, and that much of this transformation is in activities such as the preparation of transactions (advertising, catalogues, information services) and support (information management and market development) (OECD, 2001*f*, and Box 2 in Chapter 4).

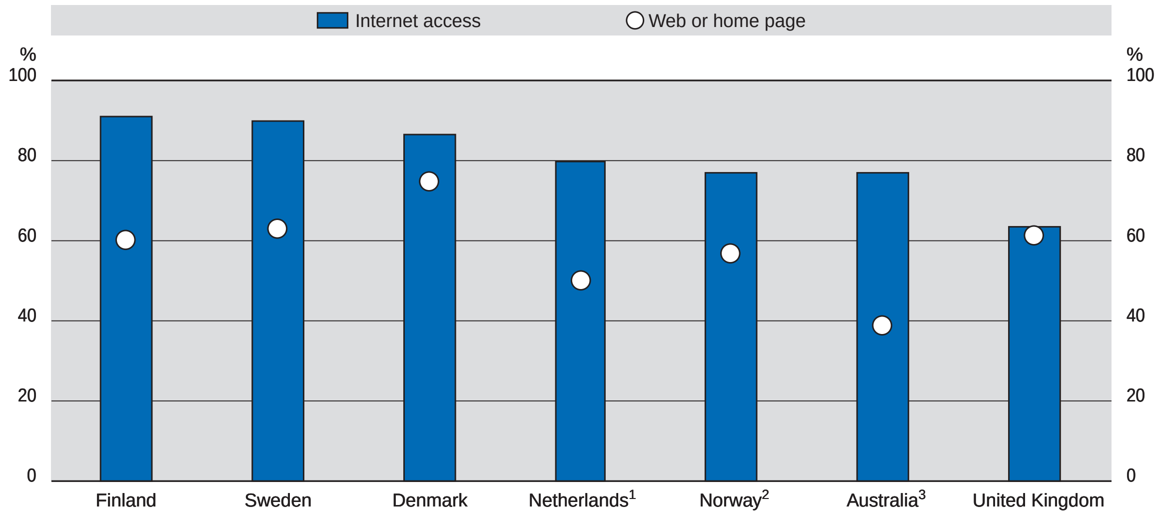
The share of businesses with their own Web site can also be used as an indicator of some aspects of the digital divide. Firms with Internet connections increasingly have their own Web site, and for firms with ten or more employees with an Internet connection, the share with a Web site was over 50% and reached almost 100% in the United Kingdom (Figure 20).

Industry sector

Internet access varies by sector; in most countries for which detailed data are available, the highest Internet penetration rates are in information-intensive services (business and property services, communications, finance and insurance). The lowest penetration rates are for transport and storage, retail trade and accommodation and food services (Figure 21).

Figure 20. **Businesses with Internet and Web sites, 2000**

Percentage of businesses with ten or more employees

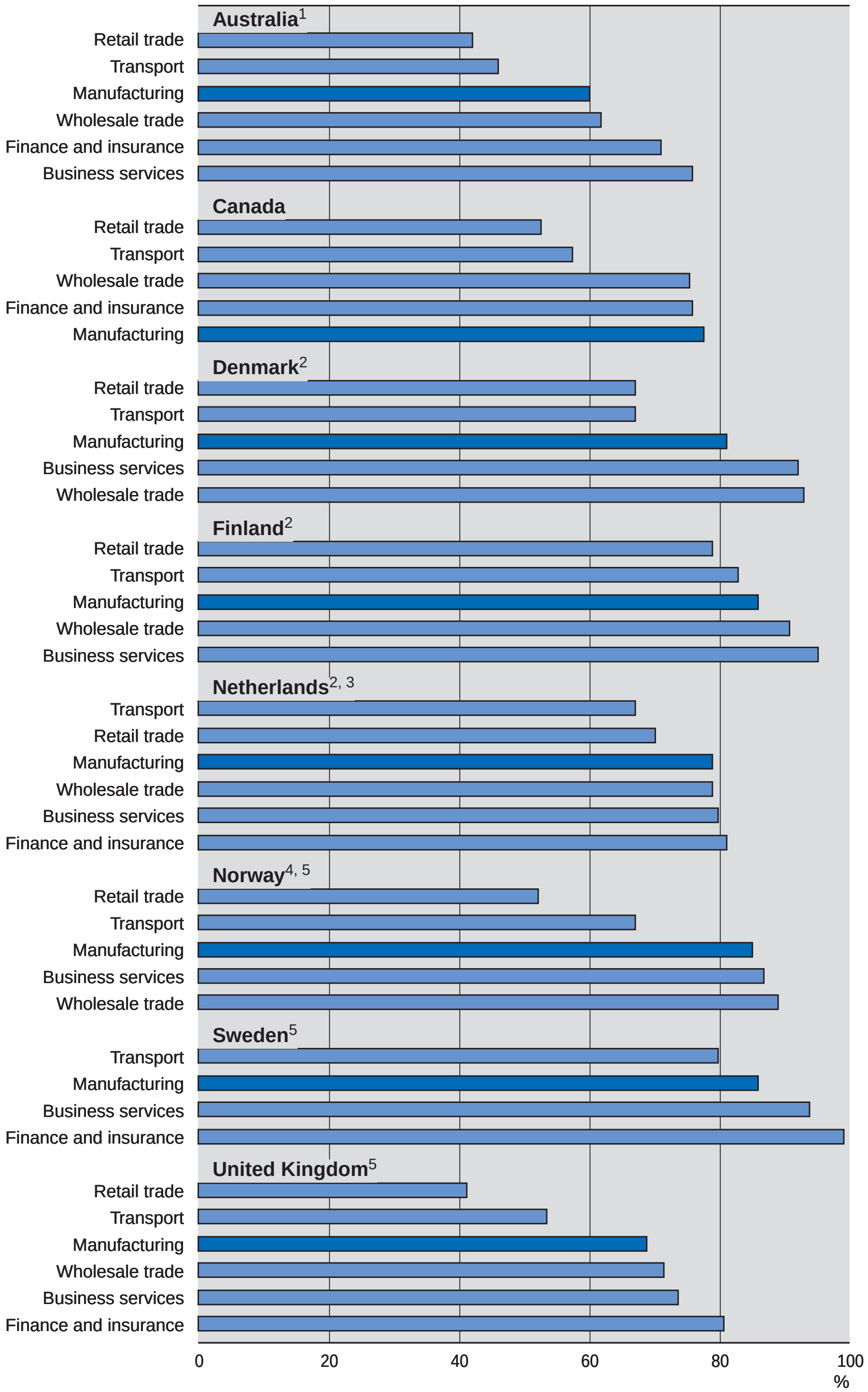


1. The Internet and other computer-mediated networks. Reference period, 1st quarter 2001.
2. Expectations for 2000.
3. 1999-2000.

Source: OECD (2001*b*).

Figure 21. **Internet penetration by industry, 2000**

Percentage of businesses using the Internet



1. 1999-2000.
2. All businesses with five or more employees.
3. The figure refers to the Internet and other computer-mediated networks. Expectations for 1st quarter 2001.
4. Expectations for 2000.
5. All businesses with ten or more employees.

Source: OECD (2001*b*).

Differences among industry sectors are more striking than differences in penetration rates in the same sector but in different countries. This suggests that the sectoral distribution of the business sector is an important determinant of national rates of uptake. Economies with larger shares of some services activities and more advanced ICT manufacturing will have higher rates of uptake, other things being equal.

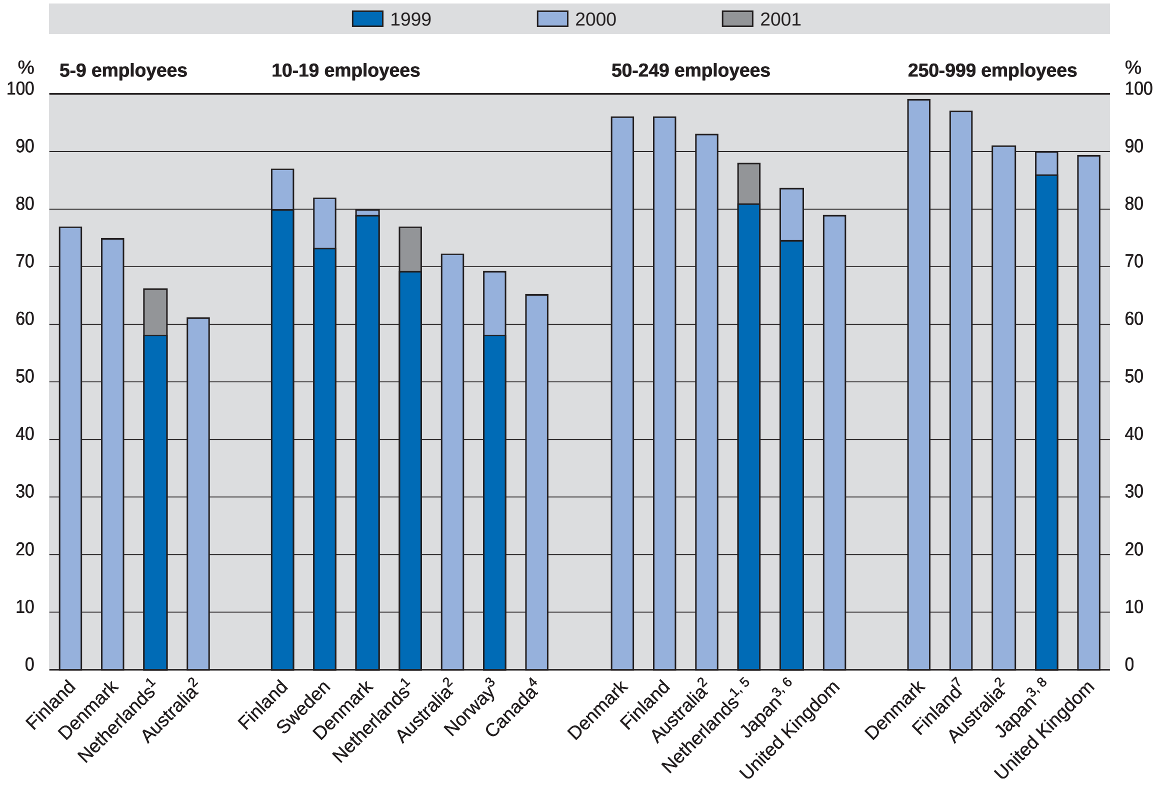
Firm size

In business, ICT penetration and Internet access are a function of firm size (see also Chapter 4). Smaller business units are less likely to have invested in new technologies or use the Internet. Figure 22 shows the pattern of Internet access by firm size for certain OECD countries. In 2000, 80-90% of businesses with more than ten employees had Internet access, while firms with fewer than ten employees had access rates of 50-75% depending on the country. Cross-country differences are higher for small firms than for larger ones.

Differences by firm size have tended to diminish over time, mainly owing to the almost complete rates of access for large business units. However, rates in larger units are still twice those of the smallest units. Larger units are more likely to undertake more complex and more advanced transaction and business processes than smaller ones.

Figure 22. **Internet access in the business sector by firm size**

Percentage of business using the Internet



1. Internet and other computer-mediated networks. Expectations for 1st quarter of 2001.
2. 1999-2000.
3. Expectations for 2000.
4. 1-19 employees.
5. 50-199 employees.
6. 100-299 employees.
7. 250 and more employees.
8. 300-499 employees.

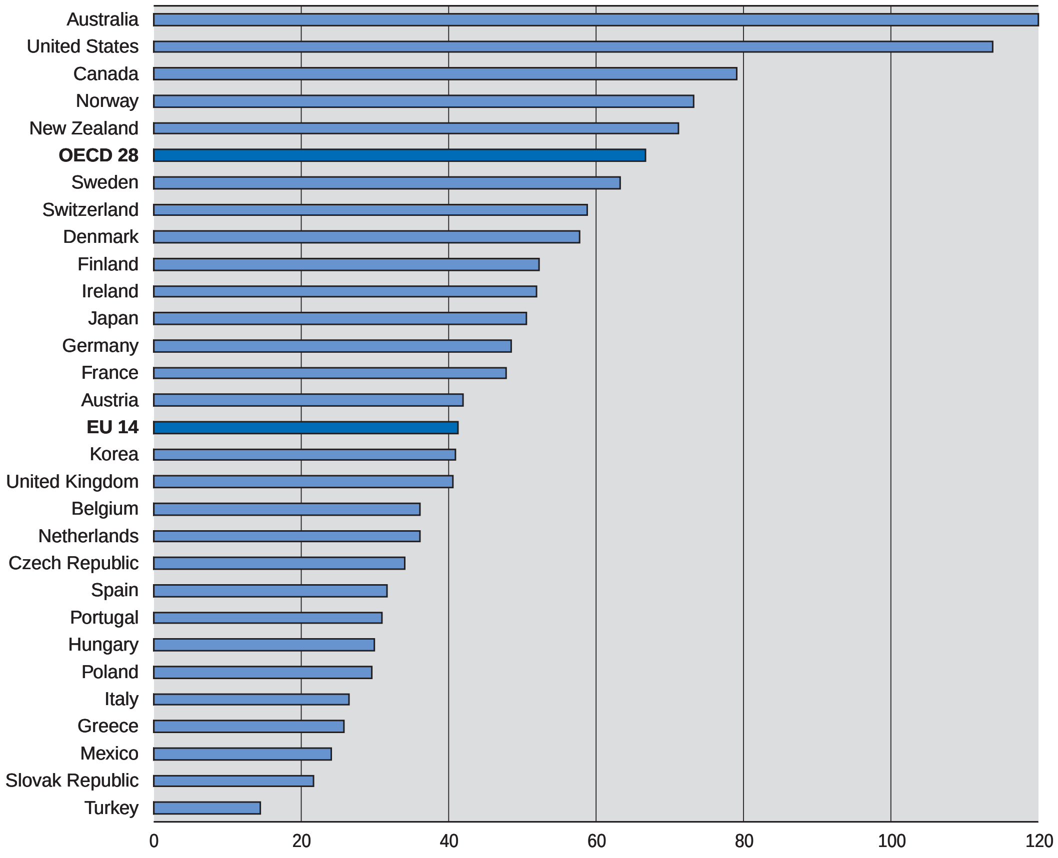
Source: OECD (2001*b*).

Differences by firm size are so important that, other things being equal, economies with large shares of small and very small businesses tend to have lower overall rates of uptake (OECD, 2000*a*).

Country

Diffusion of PCs and servers is widespread in firms and in public services. Between 1992 and 1999, the PC installed base in the working environment (businesses and government) more than tripled in OECD countries. During the second half of the decade, the average number of PCs per 100 white-collar workers increased very rapidly in most OECD countries, but countries differ considerably (Figure 23).

Figure 23. **PCs per 100 white collar workers,[1] 2000**



1. PC installed base in businesses and government, per 100 white-collar workers. Based on white collar workers. 1999 figures for Belgium, Denmark, France, Ireland, Turkey and the United Kingdom.

Source: OECD, based on data from IDC, Eurostat, US Bureau of Labor Statistics and International Labour Organization.

The development of e-government

The diffusion and use of ICTs affects not only households and businesses but also national and regional governments. Reflecting a cross-country digital divide, OECD countries differ in their use of ICTs and the provision of on-line information and services by government. In individual OECD countries e-government is seen as increasingly important, mirroring how national and local governments and public authorities are integrating and using ICTs to change the way they interact with citizens and economic actors.[8] However, provision of on-line government information and services will accentuate the digital divide and differences in uptake of ICTs in different socio-economic groups; it will also provide demonstration effects and incentives for citizens and businesses to go on line.

The benefits of on-line government activities include:

– *Improved government efficiency and transparency*, enabling administrative modernisation, restructuring and reform and encouraging good governance.[9]

– *Expanded provision of information and services*, enhanced delivery of services by providing better access and creating new information sources and services for citizens, businesses and other institutions.

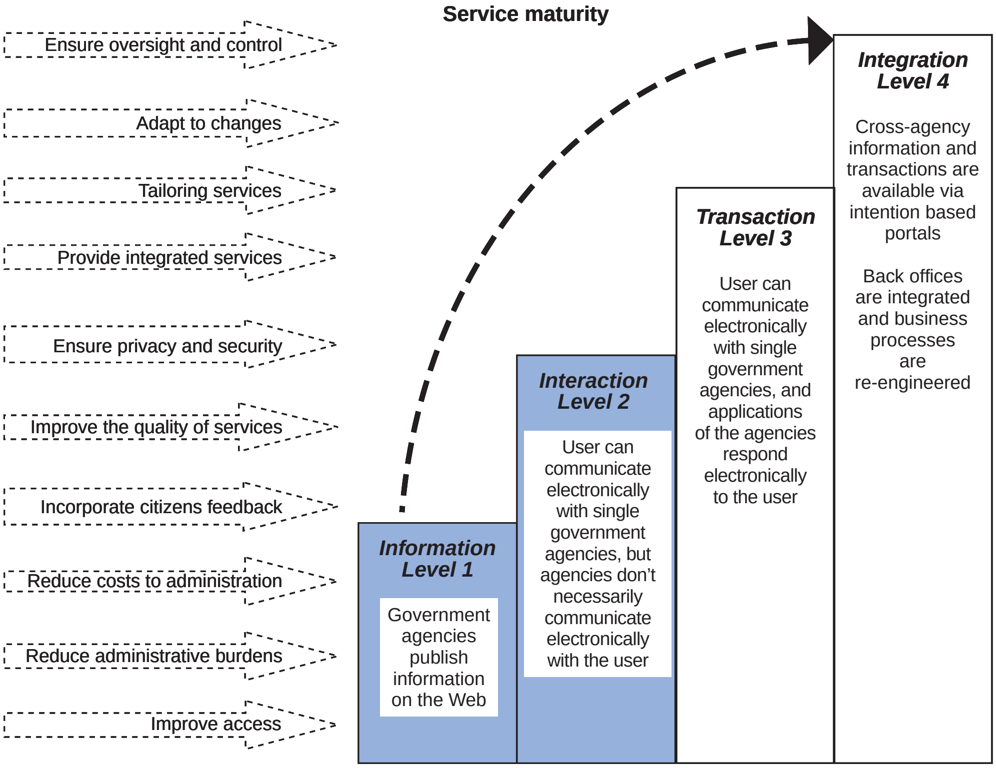
– *Enabling greater input into policy and political processes*, enhancing citizen input through on-line consultation and e-democracy approaches.

– *Demonstration effects*, to provide models for service delivery, spread awareness of the potential for on-line delivery and interaction, expand infrastructure provision and use (*e.g.* broadband) and provide incentives for content development in related areas.

Implementation of e-government will interact with and help to shape service delivery objectives, improve levels of service and lower some of the costs associated with delivering services of increasing complexity (Figure 24) (OECD, 2001*h*).

The transition to e-government may radically alter public administration and raises a host of ICT-related issues. These include changing the dimensions and reach of public authorities as they interact directly with citizens; changing the content and impact of delivering government services, health and education; issues related to data security, protection and privacy; and structural and skill issues related to ICT access, diffusion and use.

Figure 24. **E-government services and delivery objectives**



Source: OECD, based on OECD (2001*g*) and Robben (2001).

Measuring e-government

Surveys of various aspects of the supply, diffusion and use of ICTs, the Internet and e-commerce provide some insight into the supply and demand for e-government services, although there are no harmonised official statistics on e-government in OECD countries.

The potential for e-government: ICT *diffusion within government*

The simplest measure of the potential for e-government is the diffusion and use of ICTs in the public sector. Public administration has increased ICT use regularly over the last two decades. By the late 1990s, average ICT equipment per civil servant had increased significantly, mirroring the process at work in the whole economy. For example, in Finland between 1995 and 2000, the number of workstations per civil servant rose from 0.8 to 1.2, and in Japan between 1996 and 2000 PCs per central government employee rose from 0.7 to 1.3 (Tables 7 and 8).[10]

Table 7. **ICT use within government in Finland**

	End 1995	End 2000
Number of personal workstations	80 000	147 000
Share of laptops		10%
Multimedia capability (CD unit + sound)	5%	42%
Workstations per civil servant	0.8	1.2
Civil servant having access to Internet	36%	85%

Source: *On the Road to the Finnish Information Society* III, Statistics Finland, Helsinki 2001.

Table 8. **IT equipment installations[1] at national government level in Japan, 1999**

Units of equipment

	1995	2000
Supercomputers	65	86
Mainframes	1 320	1 584
Middle range[2]	4 207	3 835
Workstations	40 217	66 792
PC	312 889	763 670

1. Includes the number of units at national schools operated by the Ministry of Education.
2. Includes office computers and minicomputers.

Source: *Informatization White Paper*, JIPDEC, 1997 and 2001.

Interacting with users: government and the Internet

The extent of e-government applications depends on available infrastructure and the nature of the services involved. A recent survey[11] indicated that public services with simple procedures and centrally co-ordinated service provision, such as job search, income tax, VAT and customs declarations, were more likely to be available on line. Less likely were services involving more complex procedures needing co-ordination by local service providers, such as building permits and enrolment in higher education.

Relative use

Individual and business Internet users show significant interest in on-line government services, although use varies widely across countries and there is still very large potential for an increase in users in most countries. In Sweden in 1998, one individual Internet user in five accessed public service sites either from home or work, and in 2000 more than one-quarter of Internet users were communicating with public authorities via the Internet.[12] In Canada, about 13% were accessing government information in 1999, and 44% of regular home users searched for government information (Table 9) (Statistics Canada, 2001). In Australia in 2000, 10% of the adult population accessed government services via the Internet for private purposes (Table 10). Use of on-line government services is relatively high compared with other on-line activities; the share is generally higher than for shopping on line for products, and in Canada it is higher than e-banking for regular household users. Furthermore, a higher share of businesses than individuals use on-line government services. Internet access and use is widespread among firms, and around 45% of businesses with Internet access use it to interact with government (Table 11).

Services provided

Credit cards or bank account numbers are used to conduct e-government transactions over the Internet to pay city rates, driving licenses, garbage collection or traffic fines.[13] In Australia, services provided range from paying bills and providing on-line services involving taxation or employment to submission of tax returns and providing pension information (Table 10). The availability of on-line services still lags in many countries, hindering uptake. In Japan only 1% of citizen-related administrative procedures were available on line as of March 2000, although the ambitious 2001 E-Japan Programme aims at the creation of electronic local and central government by 2003, including digitisation of the administration and other public areas and electronic delivery of administrative information.[14]

Government on-line portals

Government on-line portals provide a range of information and services from a single entry point.[15] To overcome the dispersion and diversity of access points, many governments have action plans to

Table 9. **Households in Canada using the Internet from home, by purpose of use**

Percentage of all households

	1998	1999
All households		
Government information	8.2	12.7
E-banking	5.5	8
Regular home use by households		
E-banking	24.4	27.7
Government information	36.4	44.1

Source: *Plugging In: The Increase of Household Internet Use Continues into* 1999, *Connectedness Series,* Statistics Canada, 2000.

Table 10. **Adults accessing government services via the Internet in Australia for private purposes, 2000**

Adults accessing government services	
Percentage of all adults	9%
Government services accessed:	
Percentage of all adults accessing government services	
Pay bills	32
Submit tax returns	15
Tax information or services	32
Employment information or services	28
Pension or benefit information or services	7

Source: *Household Use of Information Technology* 2000, Australian Bureau of Statistics, Canberra, May 2001.

Table 11. **Importance of government services over the Internet in Australia…**

	1999-2000 (%)
Businesses with Internet access	28
Share of businesses with Internet access conducting selected Internet activities	
Accessing government services	44

Source: *Business Use of Information Technology* 1999-2000, Australian Bureau of Statistics, Canberra, December 2000.

… and in Finland

	2000 (%)
Businesses with Internet access[1]	84
Share of businesses with Internet use conducting selected Internet activities:	
Dealing with public authorities	45

1. Businesses with at least five employees.

Source: *Internet Use and E-commerce in Enterprises* 2001, Statistics Finland, Helsinki, 2001.

provide a single entry point for information and services over the next three to five years. Portals are already available in some countries which offer service pages to businesses and citizens (in Denmark and the United Kingdom, information is presented in a "life stages" format), as well as access to public sector documentation.[16]

Conclusion

Differences in access to ICTs such as computers and the Internet, create a "digital divide" between those that can benefit from the opportunities provided by ICTs and those that cannot. Access to and development of the information and communication resources that these technologies enable is increasingly viewed as crucial for economic and social development, and network economics mean that the more the participants in ICTs the greater the value to all.

Differences in diffusion and use of ICTs and electronic commerce may create new kinds of social divides and accentuate existing divides within countries related to income, education, age and family type and particular sub-national regions. It may also be creating new kinds of business divides, related to sectoral composition and firm size, as well as regional concentration of particular kinds of firms and industries.

This study finds that there are particularly striking differences in PC and Internet access by household income and education. The digital divide could be said to be growing as the access gap between those with the highest and lowest levels of ICT access increases. Conversely, the digital divide could also be said to be shrinking, as rates of growth are faster for lagging groups. There are also considerable differences by business sector and firm size, and government use of ICT is increasingly important in OECD countries.

NOTES

1. A project to explore the development of indicators for making compatible cross-country comparisons is under way, and Italy has been working with Canada, Finland, Germany and Norway on developing a Digital Divide Index that could be used to measure the extent of the digital divide across countries.

2. Hosts are located by their top level domain (TLD) addresses and generic top level domain (gTLD) addresses, which are distributed by country of location, as indicated in the Internet Protocol address. Data provided by Telcordia Technologies.

3. Statistical work is currently under way at the OECD to develop compatible cross-country definitions and guidelines for the collection of statistics on ICT use by business, households and government.

4. Information from Statistics Netherlands, Statistics Finland and INSEE France.

5. Information from Statistics Canada, INSEE France, Statistics Netherlands, Australian Bureau of Statistics, US Department of Commerce.

6. ZDNet, "Blind Spots", 9 April 2000.

7. In the 12 months leading up to and including February 2000, see *www.noie.gov.au*

8. The OECD has launched a comprehensive study of e-government and its impacts. See OECD (2001*g*).

9. See for example "Implementation Plan for the BundOnline 2005 e-government Initiative", Otto Schily, Federal Minister of the Interior, Germany, statement at the Federal Press Conference, 11 December 2001, available at: *www.bundonline2005.de/en/bilanz/umsetzung/data/statement.pdf* (viewed 14 January 2002).

10. Ratio for Japan includes national universities. Taken from "Number of Employees per PC in the Central Government (FY1996-2000)", Table 29, in Ministry of Public Management, Home Affairs, Posts and Telecommunications (2001).

11. Part of the e-Europe programme: "Summary Report: Web-based Survey on Electronic Public Services", Results of the first measurement, October 2001, European Commission and Cap Gemini Ernst and Young, available at: *http://europa.eu.int/information_society/eeurope/egovconf/documents/pdf/eeurope.pdf* (viewed 14 January 2002).

12. Statistics Sweden/Swedish Agency for Public Management, in "The Teldok Yearbook 2001", Chapter 2, available at: *www.teldok.org/tdy2001/view.htm*; and "IT at Home and in the Enterprise, A Statistical Description of Sweden", Statistics Sweden, 2001, available at: *www.scb.se/eng/publkat/transporter/it/it.pdf* (both viewed 16 January 2002).

13. See: "Government Online, An International Perspective, 2001 Benchmarking Research Study", Taylor Nelson Sofres. November 2001, available at: *www.sofres.com/etudes/pol/091101_egouv_uk_full.pdf* (viewed 14 January 2002).

14. See "Number of Administrative Procedures to which Citizens Can Apply", Table 31, in "IT Indicators in Japan, 2001", Statistics Bureau, Ministry of Public Management, Home Affairs, Posts and Telecommunications, available at: *www.stat.go.jp/english/data/it/zuhyou/e31.xls*; "e-Japan 2002 Program: Basic Guidelines Concerning the IT Priority Policies in FY2002", Prime Minister's Office, 26 June 2001, available at: *www.kantei.go.jp/foreign/it/network/0626_e.html* (both viewed 16 January 2002).

15. See "Global E-government Survey", World Market Research Center, September 2001, available at: *www.worldmarketsanalysis.com/pdf/e-govreport.pdf* (viewed 16 January 2002). See also "The Unexpected eEurope", Accenture, Paris, October 2001, available at: *www.accenture.com/eEurope2001* (viewed 14 January 2002).

16. See Chapter 8. For selected e-government Web sites see: *europa.eu.int/information_society/eeurope/egovconf/links/index_en.htm* (viewed 16 January 2002).

REFERENCES

Central Bureau of Statistics, Netherlands (2000, 2001),
POLS *Survey* 1999 and 2000.

Cézard, M. and L. Vinck (1998),
"En 1998, plus d'un salarié sur deux utilise l'informatique dans son travail", *Premières synthèses*, No. 53.2, December.

DARES, ministère de l'Emploi et de la Solidarité,
Enquête Conditions de travail de 1998, *premières synthèses*, Paris. Available at: *www.travail.gouv.fr/publications/p_detailPublication.asp?idTitre=316*

ISTAT (2000),
Official Sources for Data and Indicators on ICT *and Electronic Commerce*, July, Rome.

ISTAT (2001),
Annual Report 2001: *Data for Enterprises*, Rome.

International Telecommunication Union (ITU) (2002),
World Telecommunication Development Report 2002, March, Geneva.

Kendall, M.G. and A. Stuart (1966),
The Advanced Theory of Statistics, Charles Griffin, London.

Ministry of Education, Japan (2000),
Survey of current state of information education in public schools, years 1996-2000.

Ministry of Public Management, Home Affairs, Posts and Telecommunications (2001),
IT *Indicators in Japan*, 2001, Statistics Bureau, available at: *www.stat.go.jp/english/data/it/zuhyou/e29.xls* (viewed 16 January 2002).

National Center for Educational Statistics (NCES) (2001),
Internet Access in US *Public Schools and Classrooms*: 1994–2000, Washington, DC.

Nikkei Research (1999, 2000),
Home IT *study* 2000, available at: *www.nikkei-r.co.jp/mm/homepc/index2.htm*

OECD (2000*a*),
Information and Communication Technologies and Rural Development, OECD, Paris.

OECD (2000*b*),
Learning to Bridge the Digital Divide, OECD, Paris.

OECD (2000*c*),
"The Digital Divide: Diffusion and Use of ICTs", forthcoming, and OECD (2001), *Understanding the Digital Divide*, OECD, 2001, Paris.

OECD (2001*a*),
Communications Outlook 2001, OECD Paris.

OECD (2001*b*),
Science, Technology and Industry Scoreboard: Towards a Knowledge-based Economy, OECD, Paris.

OECD (2001*c*),
Science, Technology and Industry Outlook. Drivers of Growth: Information Technology, Innovation and Entrepreneurship, OECD, Paris.

OECD (2001*d*),
The New Economy: Beyond the Hype, Paris.

OECD (2001*e*),
"The Electronic Commerce Business Impacts Project (EBIP)", forthcoming.

OECD (2001*f*),
Business and Industry Policy Forum on the Internet and Business Performance, OECD, Paris.

OECD (2001*g*),
"Project on the Impact of e-Government", PUMA(2001)10/Rev2, available at: *www.oecd.org/oecd/pages/home/displaygeneral*/0,3380,EN-*home*-301-*nodirectorate-no-no-no*-11,FF.*html*

OECD (2001*h*),
"From In-line to On-line: Delivering Better Services", PUMA internal working document, December, OECD.

Office of the Prime Minister (Iceland) (2000),
Internet Survey, PricewaterhouseCoopers, October.

SESSI (2001),
"L'internet : les Français se hâtent lentement", ministère de l'Économie, des Finances et de l'Industrie DiGITIP, *Les 4 Pages des statistiques industrielles*, No. 152, August; also available at: *www.industrie.gouv.fr/biblioth/docu/4pages/pdf/4p152.pdf*

Statistics Canada (2000),
Information and Communications Technologies and Electronic Commerce in Canadian Industry, 1999, available at: *www.statcan.ca/english/research*/88F0006XIB/88F0006XIB00004.*pdf*

Statistics Canada (2001),
Changing our Ways: Why and How Canadians Use the Internet, Catalogue No. 56F0006XIE, available at: *www.statcan.ca/english*/IPS/Data/56F0006XIE.*htm*

Statistics Norway (2000),
"Use of ICT in Enterprises. Electronic Commerce 1999", available at: *www.ssb.no/iktbrukn_en/*

Swedish Institute for Transport and Communications Analysis (SIKA) (2000),
"*Informations- och kommunikationsteknik i Sverige*", En lägesanalys 2000, 2000:8, available at: *www.sika-institute.se/english_fr.html*

Taylor Nelson Sofres Norway (2002).

UK National Statistics (2000),
"Internet Access, 1st Quarter 2000", 10 July; "Internet Access", 26 September, available at: *www.statistics.gov.uk/pdfdir/inter*0700.*pdf* and *www.statistics.gov.uk/pdfdir/inter*0900.*pdf*

US Department of Commerce (2000*a*),
Digital Economy 2000, Washington DC, available at: *www.esa.doc.gov/de2k.htm*; see also US Department of Commerce (2002), *Digital Economy* 2002, Washington DC.

US Department of Commerce (2000*b*),
Falling through the Net: Towards Digital Inclusion, Washington, DC (Report IV) and "Falling through the Net I, II, III", available at: *www.digitaldivide.gov*

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*/508/*esa*/USE*conomy.htm*

World Information Technology and Services Alliance (WITSA)/International Data Corporation (IDC) (2002),
Digital Planet 2002: *The Global Information Economy*", Arlington, VA, available at: *www.witsa.org*

Chapter 7

TECHNOLOGY TRENDS IN THE ICT SECTOR

This chapter discusses IT-related developments, their impact on the economy and society and possible implications for governments.

Innovation is crucial to economic growth (OECD, 2001*a*). In the information and communication technology (ICT) sector, with its relatively short product and service cycles, innovation is very rapid. Among instances of such advances are the following:

- Rapidly increasing processor and memory performance (according to Moore's Law, the number of transistor circuits on a computer chip doubles every 18 months, increasing memory and processing power tenfold every five years).[1]
- Declining memory costs (the price of storing 1 megabit DRAM declined by a factor of 10 000 from the mid-1970s to the mid-1990s).
- Expanding communications capabilities (until recently, multiplexing, data compression and amplification tripled total bandwidth annually in the United States).

These advances improve computing capabilities, expand communication capacity and result in enhanced knowledge creation, greater access to information and knowledge and expanded capabilities for co-ordinating and applying information across a widening range of applications and uses.[2]

Rapid and ongoing innovation in ICT is the source of new products in both the ICT and other sectors and contributes significantly to future efficiency gains, productivity growth and related economic and social returns across the economy. ICTs are particularly important because of the positive network effects and externalities associated with their use. The greater the number of ICT users, the greater the benefits to all (Metcalfe's Law[3] states that the combined user value of the network increases with the square of the number of users). The rapid spread of ICTs throughout the world of work and society has made familiarity with and use of ICTs important to ensure the participation and inclusion of individuals and businesses. ICTs are increasingly vital in education, health and government services, all of which have public good characteristics and large externalities.[4]

The future impact of new technologies depends on their technological potential, the commercial exploitation of these technologies and their socio-economic acceptance and use. Because the final course of technological development depends on complex interactions among these three, intersecting factors, it is difficult to do more than summarise the potential of various technologies and point to the questions that they raise for government policy. In particular, the following discussion focuses on areas where the conditions for the development of competitive markets are changing and where established regulatory frameworks may require adjusting to new realities, for example in areas such as intellectual property protection, security and privacy.

Current technological trends

As computing power increases, unit price and size decrease and communication capabilities expand. These trends are likely to have widespread impacts:

- More devices are fitted with computing power and communication capabilities.

- Improved computing and communication capabilities and devices are allowing new functionalities.
- There are more channels of communication. People increasingly communicate with each other and with applications, and applications increasingly communicate directly.
- New kinds of communication channels are being developed.

Such trends are part of a shift away from using ICTs for their computational power and towards using them for audio-visual media and entertainment. Different combinations of trends manifest themselves in many new technologies. This section examines five innovations that are affecting the economy and society: ubiquitous computing, open source, IPv6, wireless communications and peer-to-peer exchange:

- Driven by rapid innovation, declining costs and decreasing unit size, computing capabilities are increasingly ubiquitous. Computing spreads throughout the economy and determines which benefits are reaped.
- Open source provides an alternative platform for software innovation which allows for the constant improvement of software. It is a positive force which affects the nature and direction of innovation in computing and the future development of the Internet and other software.
- The Internet is based on an open and relatively simple architecture and is a vital infrastructure for communication, collaboration and information sharing. It contributes to efficiency improvements and productivity gains. Updating elements of the Internet's architecture (Ipv6) will provide additional benefits in future.
- The development and rapid diffusion of new communications technologies has the potential to significantly increase the economic benefits of ICTs across society and diversify the nature of those benefits. New kinds of wireless communication are altering communications structures, providing possibilities for further economic and social gains, notably through greater network effects.
- Finally, efficient and more effective information exchange is a major aim of information technology (IT) innovation. With increasingly ubiquitous computing power and communications capacity, the dominant model of information exchange is shifting from a centralised and hierarchical model to one that is decentralised, horizontal and more equally distributed and democratic. Peer-to-peer is an important example of the shift in the structure and nature of information exchange. The potential of peer-to-peer to encourage decentralised information flows is only just beginning to be realised, and it has already profoundly affected established hierarchical structures.

Ubiquitous computing

Ubiquitous computing is not a specific technology, but a scenario in which computers become more numerous and fade into the background, providing information to human users and embedding intelligence and computing capabilities in seemingly ordinary everyday objects. The term was first coined by Mark Weiser who championed the concept at Xerox PARC (Weiser, 1991, 1993). It has since been extended, with terms such as pervasive and invisible computing (Norman, 1998), to describe the incorporation of information technology in many devices and applications (CSTB, 2001*a*). Computers are now not only on desktops and in handheld devices such as mobile phones, but are also in microwave ovens, antilock brakes and air bags. Such devices use integrated computing power for better performance without direct human intervention.

Some call ubiquitous computing the "third wave" of computing (Weiser, 1996). The first was mainframe computing (one computer, many people), the second personal computing (one person, one computer) and now ubiquitous computing (one person, many computers). Moore's Law has made continued reductions in the cost of computing capabilities possible, thereby allowing the production of relatively low-cost computing devices. Advances in storage, speech recognition and wired and wireless networking will further increase the capability of IT devices and their proliferation (Buderi, 2001).

Under a ubiquitous computing scenario, multiple computing devices delivering abundant computation and communication power can be connected, and computers are so ubiquitous that many are no longer thought of as computers. Developments in ubiquitous computing can take various forms; several examples are given below.

Achieving ubiquitous computing requires continuing research into a number of technologies that involve human-computer interaction and interfaces. To develop "humancentric" computing, it is necessary to identify research directions that may produce useful technologies. The aim of humancentric computing is to allow people to interact more naturally with progressively less intrusive technology. It includes new ways of communicating with computers, for example through speech, handwriting and visual signals. MIT's Project Oxygen is one humancentric computing project. It seeks to develop a platform that will respond to human needs, by using a microphone, speaker, view screen, camera and antenna to see and hear human input for broadband and narrowband communication.

Embedded tags allow small computer chips (or "tags") to be embedded in small devices, and use radio frequencies to communicate information stored on them. For example, an embedded tag can be used to call up information such as the price, history and ownership of a given object. Sensors added to these tags could allow the devices to take in information from their surroundings and use the information to react and respond (such as a heater which senses that one has left a room and sends a message to the controller which then shuts it off).

For example, the Active Badge system, deployed at Xerox PARC, AT&T, MIT Media Lab and a number of European universities, uses embedded tags and sensors in a personal badge to locate individuals within a building by determining the location of their Active Badge. These sensors make it possible to find the current location of a badge, provide information about other badges in the immediate area, notify a person through his/her badge in order to deliver a message, etc. When this system was initially tried at Olivetti Research Ltd, staff disliked the idea of being tracked. However, after a two-week period, the staff accepted the system and were willing to continue wearing badges (Want *et al.*, 1992).

Other small, powerful, inexpensive computing devices perform a variety of embedded functions in smart houses, smart offices, smart buildings, smart automobiles and on smart highways. For example, while a car is generally not thought of as a computer, cars built in 2001 had between 20 and 80 microprocessors controlling everything from running of the engine and the brake system to the deployment of airbags, control of windshield wipers, door locks and entertainment systems (CSTB, 2001*a*). The number of microprocessors is expected to grow dramatically as automobile manufacturers look for ways to translate electro-mechanical control systems into electronic ones. Future drivers will be informed about safety and maintenance and be able to get directions on demand to anywhere (including locations such as restaurants and parking spaces), as well as video or audio material.

In addition, many home-networking technologies are under development. For example, the MediaCup is a coffee cup augmented with computer technology embedded in the base (Beigl *et al.*, 2001). This cup uses integrated sensors to capture movement and temperature; it can beep if the coffee is too hot or send a signal to a coffee machine to brew more coffee when the cup is empty. In another example, Telia, the Swedish telephone company, is developing an electronic probe that can be used to identify the ingredients in prepared foods, for example to detect those that might cause allergies. The probe can also be used when preparing meals, downloading recipes from the Internet and offering guidance on the cooking process (TIME Europe, 2000).

In a further but different example of potential ubiquity, Tim Berners-Lee, the principal researcher behind the development of the original World Wide Web, and other researchers are combining tags and software agents or bots[5] in the development of a Semantic Web. Most of today's Web content is designed for people to read; computers are unable to interpret or manipulate the data. Based on eXtensible Markup Language (XML), the Semantic Web represents a technique for constructing Web content that is readable both by humans and by computer programmes. Bots will be able to access and interpret any information or data available on the Semantic Web. For example, a handheld agent could connect to the Web and check available appointment time and location for a prescribed doctor's visit (Berners-Lee *et al.*, 2001). However, there is some scepticism about this project.

Emerging issues

The growth of ubiquitous computing raises many issues of confidence and trust, including privacy, security, reliability, usability and safety (CSTB, 2001*a*). While such issues are not new, customer profiling, the possibility of permanent tracking and reliability issues have raised awareness of them. Consumers are concerned about who controls their information, how secure it is, who has access to it and how it may be used.

Ubiquitous computing presents new and vastly expanded ways of gathering information and thus raises new individual privacy issues. Some ubiquitous computing devices may be used to track people and monitor their activities without their knowledge. Privacy policy statements and third-party seals, which promise a certain level of privacy at a Web site, may be helpful for Web browsing but are not sufficient. Privacy issues in a ubiquitous computing environment include the kinds of data that may be collected (*e.g.* data about physical location and activities), how much might be collected (not only data that has been supplied, but also data that has been observed), and how it might be used (as a means of surveying and/or regulating everyday actions). For example, many automobiles are already equipped with devices that collect information about location and driving habits, such as driving speed, acceleration or engine speed. This information can be used to improve safety and analyse accidents; it could be used to learn whether an automobile was operated in an unsafe manner so as to disallow a claim (CSTB, 2001*a*). It could also be used to profile the drivers or to follow their movements.

The OECD Privacy Guidelines include eight basic principles that represent the international consensus on how to collect and process personal data.[6] These principles are based on openness, proportionality, awareness, choice, data security and customer access. In a ubiquitous computing environment, it is far easier to monitor individual activity than it is to apply these principles, as many different types of data are being collected, links may be made between different aspects of an individual's life and data may be associated with real identities. The many technological possibilities raise questions as to how policy can continue to ensure privacy in a ubiquitous computing environment. The approach taken by the OECD aims at helping to address this issue by promoting the implementation of a mix of solutions based on regulation and self-regulation, including privacy statements and trustmarks, as mentioned above, but also government oversight or use of privacy-enhancing technologies, and by fostering awareness of both privacy issues and solutions.

Security issues concern the level of protection of information from undesirable observation, alteration or use. They take as their basis an assumption that an unauthorised party is trying to access such information. It is particularly difficult to achieve high levels of security in ubiquitous computing environments because there are many more potential points of entry and intrusions at any individual node are harder to detect in widely dispersed systems. Network access policies and controls, enforcement of security policies, defence of critical infrastructure, prevention of attempts to deny service and energy security are areas that need to be continually reviewed and updated.

Reliability is the capacity of a system to perform over a given time. Low-power ubiquitous computing networks cannot be subjected to the same verification procedures as more traditional networks. Reliability may be harder to verify, and it is not clear how best to ensure it. Usability is the capacity of a device to meet user expectations. However, for ubiquitous computing, this takes on a slightly different appearance, as individuals should be less aware of the technology. Humancentric computing is addressing certain aspects of human-machine interaction, but this is a rapidly evolving area, and there may be, for example, unintended health or ergonomic issues related to the increased pervasiveness of computing power.

Computing devices are increasingly used in safety-critical systems to complement human action and minimise error. However, because machines also make errors and fail, this is a source of concern in a ubiquitous computing environment. For example, aircraft are highly automated, but accidents resulting from a pilot's confusion are generally blamed on pilot error rather than on system or automation design (Leveson *et al.*, 1997). Regarding the safety of automated systems, many risk and safety issues raise the question of government support for research in designing for safety and identifying features that lead to human error and of government participation in hazard analysis and system safety verification.

As ubiquitous computing develops, much research still needs to be done, and many paths to commercial exploitation and social acceptance are being explored and tested. Commercial interest is high, and government policies impinge on the development of ubiquitous computing in areas such as network regulation, R&D (in areas such as human-machine interaction), diffusion, government procurement for own use and standards and IPRs. These are in addition to issues of privacy, security and user and consumer safety, where public and commercial interests may not necessarily coincide. Regulatory frameworks are likely to require continuous review.

The ubiquity of computing devices also leads to new ways for humans to access the Internet. However uses are likely to be different (see Box 1).

Open source

Open source software (software whose source code is publicly available)[7] is likely to have major impacts on the software industry. With open source, anybody can modify or improve a computer programme's source code, and anyone using the modified software can benefit from the improvements. Many of the early protocols and software for the Internet were open source because the Internet was government-funded and sponsoring agencies encouraged sharing. Open source aided initial development of the Internet and contributed to the more general development of software. However, as the locus of innovation in Internet-related technology shifted to profit-minded corporations, proprietary source codes (protected by IPRs) gained share over open source.

The rapid spread of the Internet and the urgent need for interconnection and compatibility between different software and hardware platforms have reopened the debate over whether or not source codes should be proprietary. There is currently a move towards more widespread use and mainstream acceptance of open-source software. Examples of open source programmes with wide acceptance are Linux (see Box 2), Apache, Sendmail and Perl. Apache, an open source Web (http) server, has about 55% of the market for Web servers. Sendmail, an open source Internet mail transfer agent, currently handles about 80% of Internet mail traffic. Perl, an open source programming language that is used for system administration, is estimated to have 1 million users (Lerner and Tirole, 2000).

In addition, established ICT firms have started to adopt open source. For example, Apple is adopting an open source Unix system with its new Mac OS X. It has developed the Apple Public Source License, and has released a complete open source operating system, called Darwin. The Netscape open source license, Mozilla, was developed in 1998 to allow different standards for different parts of the code, and differentiates between repair and maintenance and new code.

However, commercial interests may feel open source is not a viable long-term business model. On the one hand, the decentralised organisation of open source projects means they cannot readily have narrowly strategic goal or product orientation (Lessig, 2001). Furthermore, vendors have had difficulty finding ways to develop viable business models for open source (Lerner *et al.*, 2000). Companies either give away the software and sell services and support; they may also charge for the software itself, for example in packaged, easy-to-use form. In contrast, the proprietary business model of Microsoft has proposed a "Shared Source Philosophy" under which Microsoft shares source code with customers and partners while maintaining all of the property rights.[8]

Open source has potentially positive impacts on innovation and competition. Open source projects help avoid unnecessary duplication, and, because advances are made available to all, new developments diffuse rapidly. Rapid diffusion of innovation and decentralised organisational models are important features of systems based on open source. For example, the open source Gnutella, which provides peer-to-peer file trading services similar to Napster, lends itself to ongoing modification to provide enhanced and widely available file exchange (see section on peer-to-peer).

Emerging issues

Open source software raises many policy issues, from government encouragement and support for software R&D, and government development and procurement for own use, through to standards and

Box 1. The development of alternative Internet access routes

Because of wide diffusion, low cost and ease and familiarity of use, interactive TV receivers and mobile telephones have great potential as alternative routes to the Internet. However, even with strong growth, the uses of alternative Internet access routes are likely to be different from those of the PC-Internet model, because of their different technical capabilities, commercial exploitation and social uses (Table 1).

Table 1. Capabilities of different access technologies

	Non-Internet communications			Alternative Internet access routes		Standard Internet access routes	
	Television	Post	Telephone	Mobile tel./Internet	Internet via TV	PC with narrowband	PC with broadband
Spoken correspondence	■	■	High	High	■	Limited	Limited
Written correspondence	■	High	■	Medium	Medium	High	High
Simple information gathering	Limited	Limited	Medium	Medium	Medium	High	High
Complex research	■	■	Limited	Limited	Limited	Medium	High
Simple business transactions	■	Limited	High	High	High	High	High
Complex business transactions	■	■	Limited	Medium	Medium	Medium	High
Job searches	■	Limited	Limited	Limited	Limited	High	High
Interactive job applications	■	■	■	■	■	Medium	High
Distance learning	Medium	Medium	■	■	■	Medium	High

■ Not readily available.

▒ Limited capabilities.

░ Medium capabilities.

□ High capabilities.

Source: OECD.

Mobile Internet users were estimated at over 21 million worldwide at the end of 2000: 81% in Japan (60% i-mode, 21% WAP); 12% in Korea (WAP); 5% in Europe (WAP); 1% in the United States (Palm) (Eurotechnology, 2000). Surveys suggest that messaging (e-mail, fax), location and miscellaneous services are most commonly used. Mobile phones have great potential because of wide diffusion, mobility and fast power-up; desktop computers have greater bandwidth capabilities, service variety and reliability. While there may be competition between mobile and PC Internet services, uses will also be complementary.

Hopes for mobile Internet are linked to the development of third-generation (3G) platforms, or IMT-2000, with frequencies around 2000 MHz. Although 3G is a possible route for broadband access, European consumers will have to wait three to four years for widespread, accessible services at convenient and affordable speeds, although the timetable may vary by a year or so in different OECD countries. While high-speed mobile access has advantages, it will significantly lag speeds over fixed networks in the immediate future (see OECD, 2001*d*).

There were 1.46 billion TV receivers worldwide in 1998, of which 637 million in OECD countries, mostly colour (ITU, 2000). A number of devices can be used to turn a television set into an Internet connection, but most of these devices have had little impact (*e.g.* WebTV). The most successful and widespread means of accessing the Internet through a television is via digital TV receivers. However, penetration levels are low; in mid-2000, 56 million households worldwide subscribed to digital television services. According to Strategy Analytics, penetration was highest in the United Kingdom, where 29% of homes had digital TV, followed by the United States (24%) and France and Spain (15%) (Strategy Analytics, 2000).

Box 1. **The development of alternative Internet access routes** (*cont.*)

Internet via TV has potential owing to the large installed base, ease of use, bandwidth capabilities via cable and low cost. However, there are difficulties. The PC-type keyboard, mouse, printer or other attachments are often not included in the service. Standard screens are not adapted for reading text over extended periods. Consumers may be unwilling to pay for interactive services, and service providers have focused on commercial sales and entertainment rather than Web services. Finally, desktop computers have far more network connections (246 million worldwide in 1999 *versus* 56 million digital TV subscriptions) and more complete services, and current Internet access tools are designed for PCs.

Digital TV is largely used for entertainment (sport, films), and many digital subscribers take no extra services. In Europe, of 12.2 million digital TV subscribers in 2000, less than one-half had e-mail and less than 10% had Web services (TV International, 2000). For UK users, the most popular functions are electronic programme guides (73%) and the favourites function (46%). The most popular on-line activity is downloading/playing games (44%), which is more than twice as popular as on-line shopping (18%). E-mail (13%), Internet browsing (9%) and banking (6%) are less used. The most common reasons for not using interactive digital TV were: services do not appeal and use of other Internet access routes (32% of subscribers in each case).

Alternative Internet access routes are expanding, but will be used differently from the PC-Internet model in the foreseeable future. Even with a dramatic increase in use of the most common alternative Internet services (e-mail, entertainment, news, location services), opportunities to access more complex services such as on-line education are limited, and such services may not be offered in the near future.

Box 2. **Linux**

Linux is a Unix-based operating system originally created in 1991 by Finnish graduate student Linus Torvalds. It has since been modified and improved by thousands of developers worldwide. It initially had a reputation for poor quality and difficulty of use and thus minimal success. However, as the code was developed, Linux gained a reputation for reliability superior to that of other operating systems. For this reason, Linux has been increasingly used for Internet servers, networked systems and other operations that require reliability. It can be downloaded directly from the Web at no cost or purchased at relatively low cost in commercial versions.

Linux property rights are held in the GNU General Public License, which states that its source code, and any modifications made and distributed, must remain free and available to the general public. The license, which applies to any programme including parts of another programme under the GNU General Public License, states that "any patent must be licensed for everyone's free use or not licensed at all".

Linux's market share for servers increased from 8% in 1997 to 27% in 2000 (Microsoft's share was 41% in 1999).* It is estimated that the largest hosting companies are Linux and Solaris (Netcraft, 2000). In 1999, Compaq was the leading Linux vendor, claiming 25% of all Linux server units, followed by IBM with 10%. On the other hand, Linux has a low share in the PC operating system market, estimated by IDC at only 4% of the 99 million operating systems shipped worldwide in 1999 (less than the Macintosh OS and far less than Windows), largely because of a lack of applications software and difficulty of use. However, the complexity of Linux OS makes support and training services a good business opportunity, and estimated growth rates for these services have been high.

The increasing demand for ubiquitous Internet connections may also help its installed base to grow if Linux continues to provide viable solutions for application devices connecting to the Internet.

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* IDC estimates, in "Software Survey". *The Economist*, 12 April 2001.

IPR issues. Receiving particular attention are the interrelationships between open and proprietary standards and between non-patented and patented software.

The Internet, the World Wide Web and related protocols were originally based on open standards and non-patented software which anyone could build on. As new capabilities are added to the Internet and new standards/protocols are introduced, researchers and standards bodies must address the issue of the incorporation of proprietary standards and patented software in Internet and WWW structures. While many of early Internet protocols/standards were developed with government funding and were in the public domain, government funding of software research is now relatively less important. The private sector is largely driving Internet-related and software innovation and recognises this as an important commercial resource, so that proprietary standards and IPR issues remain of ongoing importance.

For example, the standard-setting World Wide Web Consortium (W3C) has proposed a reasonable and non-discriminatory (RAND) licensing model, where not all Web licenses would be royalty-free. Thus proprietary code could become part of World Wide Web standards. While this is not new – the Internet Engineering Task Force (IETF) uses a similar licensing model[9] – the open source community is concerned about the possibility of having to pay to develop or use the Web and the risk that Web development will stagnate as a result.

More generally, this debate overlaps with that on the co-existence of open source and proprietary software code. Depending on the open source license, incorporation of open source code into proprietary software may be feasible. While some open source licenses (such as GPL) do not allow for combining with proprietary code, other licenses (such as BSD) do. Proprietary software can be incorporated into an open source project if the license permits (as with Mozilla). However, copyright and patent holders can prevent their code from being incorporated into open source, and the distributed nature of open source makes negotiating proprietary licenses (as is commonly done for proprietary software) difficult. Intellectual property rights thus pose major challenges for the future development of open source (Lessig, 2001). Property rights and standards crystallise the differences between the two philosophies on how to develop the Internet and the World Wide Web, public goods of enormous importance.

Finally, government funding of software R&D will continue to influence some aspects of software development, including open source. Choices within government are likely to be influential in the future development of open source, for example software procurement and development for government use take into account the potential benefits of sharing code and continually improving software.

IP*v*6

The Internet's architecture determines how different components of the networks that compose the Internet interrelate. The principles guiding the early builders of the Internet architecture have been described as follows (NRC, 2001*b*):

- *Hourglass architecture*. The Internet is designed to operate over different underlying communications technologies, including technologies yet to be introduced, and to support multiple and evolving applications and services.
- *End-to-end principle*. The network provides a communication fabric connecting the many devices at its ends but only offers a very basic level of service and data transport. The intelligence and information processing needed for applications is located in or close to devices attached to the edge of the network.
- *Scalability*. The Internet's design enables it to support a growing number of users and communications.
- *Distributed design and decentralised control*. Control of the network is largely distributed; no single entity controls the Internet.

The network is a vehicle for a vast array of client/server and peer-to-peer computing applications and electronic commerce. However, rapidly expanding use of the Internet threatens to overload its underlying protocols, and there has been increasing concern that growing demand will outstrip the number of Internet Protocol (IP) addresses.[10]

The IETF concerns itself with immediate technical challenges facing the Internet. In 1992, the IETF recognised the shortage of IP addresses and other technical development obstacles. The Internet Protocol next generation (IPng) project was started to resolve these issues and made recommendations in 1994. Subsequently, end-user organisations, standards groups and network vendors agreed on the IETF's Internet Protocol version 6 (IPv6) as the final IPng proposal. Until it has been completely adopted, IPv6 will work alongside the current IPv4.[11] IPv6 provides more addresses and takes into account performance, network route structure and management issues, scalability, ease of configuration, quality of service and security issues.

IPv6 dramatically increases the number of Internet addresses by using a 128-bit address space rather than the 32-bits of IPv4.[12] IPv6 provides enough addresses for foreseeable growth, including the proliferation of devices connecting to the Internet such as personal data assistants, mobile phones, set-top boxes and household appliances.

IPv6 allows for a flexible, scalable, open-ended and more efficient global network routing hierarchy. Additionally, IPv6 introduces advanced autoconfiguration features, allowing new devices to be added without reconfiguring the network. Computing stations will be able to configure their own addresses with the help of a local IPv6 router. This facilitates mobility, as devices will automatically receive a valid IP address that is independent of the location at which they connect to the network.

IPv6 uses flow labels to identify network streams of packets requiring special handling, and these labels could be used to give traffic flows a specific level of security, delay or cost. This new architecture paves the way for improved quality of service (QoS) for interoperable applications, such as real-time voice and video, where performance criteria such as available bandwidth and timing are not ensured.

IPv6 also incorporates low-level encryption and authentication features. The proprietary security extensions used for IPv4 have been less robust, largely owing to problems of interoperability. By incorporating security into the backbone of IPv6, these problems can be reduced. A standard header extension of IPv6 can be used to provide end-to-end encryption at the network layer. The header can be used directly between hosts, or in conjunction with a specialised security gateway that uses its own packet signing and encryption methods to add an additional level of security. An authentication header extension to IPv6 verifies that a data packet actually comes from the host indicated in its source address, thereby safeguarding against packets generated with forged source addresses.

Emerging issues

When and whether IPv6 will be deployed will depend on whether looming infrastructure shortages will outweigh the switching costs associated with the new technology. Switching from IPv4 to IPv6 requires expensive investment in infrastructure and new technology and few applications have been written for IPv6. There are, however, two sources of demand for IPv6. The first is the eventual lack of allocable addresses in high-use regions which would require the adoption of a larger capacity system. The second is adoption of IPv6 in regions with fewer IPv4 addresses and hence lower sunk costs and lower switching costs for moving to the new technology. North America has approximately 74% of IP addresses, Europe has 17% and the Asia-Pacific region has 9% (ZDNet, 2001); demand for IPv6 has so far been largely in Asia.

Owing to various quality and security advances associated with IPv6, some governments have chosen to boost the deployment of IPv6. For example, the European Commission has assigned a task force to investigate the transition to IPv6. The Japanese government has gone further, imposing a deadline of 2005 for upgrading all information technology sectors to IPv6 in order to stimulate application development and network upgrades.

Wireless

More devices are being fitted with wireless capabilities, and new wireless communication channels are being developed. Wireless devices are making it possible to connect anytime and anywhere to other users and other devices, and are part of the movement towards communications portability, along with mobile phones (see Box 1), handheld devices and laptop PCs. Wireless technologies are also a prerequisite for the development of ubiquitous computing. They can be used to extend traditional infrastructure in two ways: into areas where wires are a hindrance, such as many small appliances in a room, and into dispersed areas such as rural regions not served by traditional infrastructure. A number of examples of developments in wireless technologies are given below.

802.11

802.11 is an Ethernet standard based on radio signals that can be used for wireless networking. It was approved in 1997 and extended and updated in September 1999. There are a number of versions of 802.11 (also known as WiFi or wireless Ethernet) capable of speeds of up to 11 Mbps. 802.11*b* is the most common and works within a radius of 100 meters from a base station.[13] One base station can serve many users at the same time; this is particularly attractive for shared local networks as it avoids the cost of running wiring into every room. 802.11*b* has become the wireless standard for enterprise networking and is emerging as a *de facto* standard for all high-speed wireless connections to the Internet, particularly in the United States.[14] It is already available in certain airports, hotels and cafés, and there is high uptake by universities. An 802.11*b*-ready computer (with an antenna and a card) can connect easily in all of these areas with no individual charge. Internet service providers (ISPs), however, may be wary of attempts by customers to create community networks by putting 802.11*b* stations in/near public places. This may violate some customer agreements, which limit personal ISP accounts to individual users or households.

Another version of the 802.11 standard, 802.11*g*, attempts to boost speeds from 11 to 22 Mbps without altering other factors. 802.11*a* uses a higher-frequency 5 GHz band and has a greater bandwidth allotment; it can provide speeds of up to 54 Mbps. However, these versions are considerably more expensive than 802.11*b*, and while they may act as upgrades, they are unlikely to replace 802.11*b* as the most widely used in the near future. Obstacles to greater uptake of 802.11 include security issues (a major problem), congestion, interference and a lack of billing or roaming infrastructure.

B*luetooth*

Many discussions of wireless in Europe have focused on "Bluetooth" technology, an open standard for wireless networking.[15] Bluetooth is a short-range radio technology that allows devices within ten meters of each other to communicate wirelessly. The Bluetooth radio chip is one square centimetre in size and two millimetres thick, small enough to embed in small mobile phones, attach to clothing or embed in retail products. Because it only works at very short range and with narrowband capabilities of 1 Mbps, Bluetooth may be best used as a replacement technology which could also make possible new developments such as connected houses.

At USD 8-10 per chip, Bluetooth technology is far cheaper than many wireless devices, but it is still too expensive for low-cost applications. However, Cambridge Silicon Radio, the world's leading manufacturer of Bluetooth chips, has announced plans to have chips on sale at below USD 5 by 2003 (AP Informatique, 2001). As of late 2001, Bluetooth was used mostly in more expensive products such as mobile phones, laptop computers, printers and video cameras, but as the price comes down the technology may be integrated into less-expensive devices.

Advantages of Bluetooth compared to other wireless technologies include price and low power consumption, which make the technology ideal for mobile devices. However, compared to 802.11, Bluetooth speeds are very slow and the range is very short. This makes it a poorer choice for human networking (though these capabilities may be adequate for machine-to-machine communications). On the other hand, Bluetooth and 802.11*b* may be highly complementary, with Bluetooth linking consumer devices and 802.11 linking to the Internet. Obstacles to greater uptake include interoperability, interference with other radio signals and perceived security risks.

Satellite

Satellite transmission has been extremely successful in bringing television broadcasts to remote and developing areas. While there are hopes of using satellites to bring the Internet to such areas, various obstacles must be overcome. Common satellite broadcasting systems (such as television and radio) are one-way; a user receives a signal, but does not send information back. In contrast, the Internet is fundamentally two-way. One-way satellite television signals use distant geo-stationary satellites for transmission, but this gives a delayed and prohibitively slow signal for Internet signals. Another option, low Earth-orbit satellites, helps solve the problem of delay but raises others, such as coverage. A number of projects are under way to provide Internet access via low Earth-orbit satellites, but broadband services are not expected to be in place until at least 2004.[16] Current services are considerably slower, with maximum speeds of 400 kbps.

Spread spectrum

Spread spectrum radio (also called "wideband") uses intelligent receivers to enable radio signals to switch optimally without interference among frequencies, carriers and networks. Software-defined radio protocols regulate different signals with the end-to-end principle, just as Internet protocols govern the use of the Internet. Ultra-wideband (UWB) is one example of spread spectrum technology. It transmits information via extremely short pulses (half a billionth of a second). Because the pulses are so short, they do not interfere with receivers listening for transmissions, as these generally perceive the UWB signals as mere background noise. UWB would use extremely low-power radio pulses (50-70 millionths of a watt) extending from 1 to 4 Ghz, a large portion of the spectrum. The low power usage makes it ideal for battery-powered devices. In the United States, approval from the Federal Communications Commission was granted in early 2002. While this technology is in its infancy, some supporters believe that it has the potential to compete with both 802.11 and Bluetooth. The speed is currently 10 Mbps, which is comparable to that of 802.11, with a range of up to 50 meters. However, spread spectrum raises a number of policy and regulatory issues (see below).

Emerging issues

Apart from network security risks, congestion, interference and interoperability problems, a major issue for wireless is the deployment of spectrum to allow wireless adoption and applications. There is a limited amount of wireless broadcast spectrum – most commercial activity takes place between 30 MHz and 30 GHz. As a general rule, the lower the frequency, the better the signal penetrates obstacles and the farther it can travel, but higher frequencies are better suited for broadband. When many technologies use the same band for networking, there is risk of interference and degradation. For example, wireless technologies using the 900 MHz band risk interference from household microwave ovens. Such degradation is especially a problem for streaming video signals and could inhibit adoption.

National governments allocate bandwidth, licensing the use of specific parts of the spectrum in specific ways in specific geographic areas. These licenses generally go to the highest bidder, although in certain cases smaller companies are given an advantage. There is no international procedure for harmonisation of spectrum assignments, and spectrum may be used for different purposes in different countries. This can cause serious obstacles for companies trying to develop a multinational technology.

Governments are large users of spectrum. For example, in the United States, the federal government is the single largest user, using spectrum for law enforcement, air traffic control, national defence, weather services and environmental monitoring. Most governments do not concern themselves with interference within a privately held band; this is mostly left to trade groups. Bluetooth and 802.11*b* share the 2.4 GHz band and need to find ways to co-exist so they do not undermine each other.

The issue of spectrum assignment has been further complicated by technologies developed in the past few years, in particular spread spectrum radio (Lessig, 2001). Spread spectrum technologies undermine the current regulatory structure for spectrum allocation, as they do not use a definable band of spectrum but extend across a range of bands. While regulators do not want to stem new, innovative technologies, there is concern that widespread use of spread spectrum could create enough interference to hinder mission-critical applications such as air traffic control.

Security poses a particular problem for new, untested technologies, and security failures have occurred in many wireless technologies, including 802.11 and Bluetooth. Wireless networks are particularly hard to protect because connections are made through the air which is available to all.

Peer-to-peer

Peer-to-peer is a communication structure in which individuals interact directly, without going through a centralised system or hierarchy. It is an example of network power and commercial exploitation through decentralised information exchange as opposed to centralised information control. With peer-to-peer technology, users may share information, contribute to shared projects or transfer files (O'Reilly, 2001). Large numbers of users provide computing resources (disk space and processor time), creativity, administrative effort and even legal liability. Examples of peer-to-peer include file transfer, data caching, database generation, distributed computing and grid technology.

The original Internet design was peer-to-peer. Independent individuals connected to each another to share information, and any two nodes could send packets to one another. However, as the Internet became more popular, a shortage of IP addresses appeared and the need for network security increased. In the mid-1990s, dynamic IP addresses, network address translation (NAT) and firewalls were developed to address these problems, but they also made parts of the Internet harder to reach. Peer-to-peer applications such as file sharing and instant messaging need to work hard to circumvent these developments.[17] Peer-to-peer communication also declined because of the emergence of dominant Internet-based applications/services that mediate communications and Internet transactions (most people go to a Web site to locate and download files rather than use peer-to-peer techniques). However, peer-to-peer has recently been regaining popularity, most visibly through Napster and similar programmes (see Box 3).

Most current peer-to-peer applications are not 100% peer-to-peer, but hybrids that make some use of central servers, which can be used to ensure accountability and/or quality. For example, while instant messaging appears to be peer-to-peer, in fact a server facilitates communication between nodes.

Box 3. Napster

Napster was created in 1999 by 19-year old Shawn Fanning, and is the best-known example of peer-to-peer file transfer. It allows users to share MP3 files over the Internet. Users log on, and query the Napster server for a song or artist. The Napster server replies with a list of all relevant files currently available on other hard drives. The user then downloads directly from another user. The existence of the central server makes Napster a hybrid peer-to-peer application and more efficient than if it was purely peer-to-peer. The directory uses little bandwidth and file sharing takes place directly between users.

In late 1999, the Recording Industry Association of America (RIAA) filed a lawsuit against Napster for violating music copyright. In a preliminary injunction in July 2000, a US federal judge ruled that Napster must stop trading copyrighted works through the service. However, Napster appealed to a higher court, and the application continued to be used. Publicity stemming from the court case caused use of Napster to soar – an estimated 2.79 billion files were traded in February 2001. But in the same month a panel ruled that while the original injunction had been overly broad, Napster must block copyrighted material if the copyright holders identified it. Napster installed filters that slashed MP3 files available, and usage dropped dramatically. By May 2001, only 360 million files were being traded (Webnoize). A full trial is still ahead.

Since Napster has been restricted, projects such as the open source Gnutella are becoming more widely used. Unlike Napster, Gnutella does not have a central directory server – users connect directly to other nodes within the immediate vicinity and request a file. If the nearby nodes do not have the file, they ask the nodes in *their* immediate vicinity, and so on. When the file is found, it is routed back to the inquirer (Kan, 2001).

Other types of peer-to-peer application, distributed computing and grid technology, are recent decentralised applications that involve direct interaction. Distributed computing harnesses unused computer power to create a linked network of computers, multiplying computing power. Linked computer power is being used for cancer research, solving difficult mathematical problems and complicated modelling such as evolutionary research. Some large IT companies are developing this technology for business customers in order to avoid buying high-end mainframe computer systems. There are also applications in supply chain management and collaboration.

Grid technology goes one step beyond distributed computing, via an infrastructure for dynamic, co-ordinated multi-institutional resource sharing and problem solving. It was initially designed for advanced science and engineering projects but is now considered for business applications. A number of private and public sector efforts are under way. One example is the DataGrid project, funded by the European Union, which aims to be functional by 2005. Its goal is to further scientific exploration that requires intensive computation and analysis through the large-scale use of shared computational power and databases across widely distributed scientific communities.[18]

E*merging issues*

Peer-to-peer technologies raise important issues for IPR and copyright, trust, accountability, security and enforcement, largely owing to their structure, which does not use centralised servers. IPRs are designed to encourage innovation and promote social welfare by giving creators full exploitation and distribution rights for a defined period while divulging a certain amount of information on the protected product. The digital age challenges the established application of intellectual property, as technological innovation and new distribution channels have dramatically lowered the costs of replicating and distributing digital goods. With readily available tools anyone can copy and forward protected property, thus becoming an individual publisher of information they did not author. The reproduction and sharing of copyright-protected music files over Napster created extensive legal problems due to the difficulty of measuring and controlling flows of commercially valuable products.

Peer-to-peer raises a number of issues relating to the development and enforcement of many types of regulation (including intellectual property, on-line pornography, tax collection, etc.). Because individuals transfer files directly, central servers or regulators cannot control the information being sent. However, code can be used to help regulate peer-to-peer, as it can be embedded in the digital information that is shared. Some analysts argue that code is a more efficient means of protecting digital property than law, and that ideally the two should be combined to provide the right balance of protection (Lessig, 1999).

Trust in peer-to-peer is an ongoing issue. Users are unlikely to use peer-to-peer systems if they do not trust them, and users typically ask (Waldman *et al.*, 2001):

- Will this product really do what it says?
- Will the company sell my private information to other companies?
- Are my actions available for observers to see?

Peer-to-peer situations are especially challenging because users frequently use files or computations provided by (perhaps unknown) individuals who may be hard to contact later. In addition to building trust through information and reputation, there are a number of technical means of addressing these issues. For example, public key cryptography and digital signatures can be used to ensure that the person one contacts is the person he/she says he/she is, and that there is a way to contact that person if there is a problem. However, international harmonisation of Public Key Infrastructure has not yet been achieved (OECD, 1998).

Accountability in a network is important to ensure social responsibility. Peers can abuse the protocols and rules of a peer-to-peer system by (Dingledine *et al.*, 2001):

- Providing corrupted or low-quality information.
- Reneging on promises to store data.
- Going down during periods when they are needed.
- Claiming falsely that other peers have abused the system in these ways.

Restricting access and maintaining a reputation for every user are two methods of improving accountability. Future systems may be designed with incentives and controls to encourage proper behaviour.

Security poses additional challenges in a peer-to-peer situation, because common security tools such as firewalls are potential obstacles to peer-to-peer, and may be circumvented in order to use peer-to-peer applications, thus eliminating the most common form of protection. However, common security algorithms and protocols such as PKI can usually still be applied in peer-to-peer contexts, and security guarantees can be given. For example, Groove Networks is an Internet-based platform that delivers basic support for collaboration. It guarantees that strong security is always in force: all shared-space data are confidential, no group member can impersonate another group member or tamper with the contents of any group message, a lost message can be recovered from any member with assurance of its integrity and proof of its true originator and no non-member or former member who has been dismissed from the group can eavesdrop on or tamper with group communication (Udell *et al.*, 2001).

Conclusion

The development of new technologies is driven by the interplay of technological potential, commercial exploitation and socio-economic acceptance. Government policy touches in many ways on each of these areas (for a discussion of specific policies, see Chapter 8). The challenge for government is to foster innovation and technological development while paying attention to equity considerations (*e.g.* digital divide issues related to new technologies) and negative impacts (*e.g.* system vulnerability, illegal activities). Technological developments are moving very fast and it is difficult to anticipate future policy impacts in detail. Broad approaches to policies in emerging areas include:

- Technology-neutrality in legislation and regulation to avoid closing off promising options.
- Flexibility within broad regulatory frameworks and adaptation of current laws to a digital world.
- Involvement of all stakeholders in regulatory processes.
- Performance requirements rather than technical specifications when procuring new technologies.
- Increasingly looking to international co-operation to harmonise approaches to transborder issues.

Ubiquitous computing, open source software, IPv6, wireless and peer-to-peer are already affecting business and society by promising, and providing, new computing and networking capabilities. At the same time, these new technological trends raise important issues for example, for privacy, consumer protection and others areas of regulation and enforcement. Further technological developments will bring relevant policy issues to the fore, and governments may find it useful to apply broad policy approaches rather than focusing on specific technologies individually.

NOTES

1. Moore's Law states that the number of elements on a single integrated circuit doubles approximately every 18 months, owing to increased chip size and decreased transistor/element size, thus boosting speed and capability. It has roughly held true since the 1960s. Moore has been unwilling to extend the time scale too far into the future, and there are some indications that it may lose its relevance owing to lower physical size limits on electron-based technologies. Nonetheless, most experts believe that it will hold true for at least another five to ten years. Optical computing is likely to extend the horizon.
2. See Chapter 1 on the growth of the ICT supply side and capabilities and the impact of ICTs on the economy and society.
3. Metcalfe's Law predicts that the value of a network increases in proportion to the square of the number of people connected to the network (Metcalfe, 1995).
4. Details on the impact of the production, diffusion and use of ICTs can be found in Chapter 1. See also OECD, 2001*a*, 2001*b*, 2001*c*.
5. Software agents, or "bots", act on behalf of people looking for information, negotiating and aggregating different, dispersed services into larger co-ordinated actions. In future, they may be used to conduct searches, make reservations and compare alternatives. Bots already under development or available include applications to filter e-mail, phone calls and news alerts (see OECD, 2000).
6. The eight OECD privacy principles cover: collection limitation; data quality; purpose specification; use limitation; security safeguards; openness; individual participation and accountability.
7. For a more complete definition, see DiBona *et al.*, 1999, Appendix B, The Open Source Definition, Version 1.0.
8. In his remarks to the New York University Stern School of Business, Microsoft's Senior Vice President Craig Mundie stated that "A common trait of many of the companies that failed is that they gave away for free or at a loss the very thing they produced that was of greatest value – in the hope that somehow they'd make money selling something else" (Mundie, 2001).
9. The IETF's Internet Standards Process (Revision 3), RFC 2026, Section 10.3.2 states: "(C) Where the IESG knows of rights, or claimed rights under (A), the IETF Executive Director shall attempt to obtain from the claimant of such rights, a written assurance that upon approval by the IESG of the relevant Internet standards track specification(s), any party will be able to obtain the right to implement, use and distribute the technology or works when implementing, using or distributing technology based upon the specific specification(s) under openly specified, reasonable, non-discriminatory terms. The Working Group proposing the use of the technology with respect to which the proprietary rights are claimed may assist the IETF Executive Director in this effort." See *http://portal.etsi.org/directives/*
10. Internet protocols are standards governing the interchange of data and enable communication within and among networks. There is considerable lack of certainty about when/if current address space will run short. Only one-quarter of total addresses are observed to be in use; however, about half of these have been delegated to Internet service providers and other organisations (CSTB, 2001*b*).
11. IPv5 was experimental and was never used.
12. A 32-bit address space provides a theoretical limit of 232 unique addresses; 128 bits gives 2128 (CSTB, 2001*b*).
13. With a direct line of sight and directional dish antennae the signal can travel much farther.
14. HomeRF is a competing standard, also using the 2.4 GHz band. HomeRF is less expensive than 802.11, but is slower, with a maximum speed of 2 Mbps. Supporters maintain that HomeRF is better suited for home use because it is more resistant to interference from devices such as cordless phones and microwave ovens. It is also better suited for voice transmission. However, HomeRF has been losing market share.
15. Bluetooth was named after the 10th century Viking King Herald Bluetooth, who united Nordic nations under one religion.
16. Examples include Teledesic, Alcatel's SkyBridge and Hughes Space Way.
17. For example, port 80 is the port that HTTP traffic uses for browsing the Web. While firewalls may filter many types of traffic, they usually allow unrestricted access to port 80 in order to allow users to surf the Web at ease. Precisely because port 80 is less strictly controlled, most peer-to-peer applications have developed a way to use port 80 and circumvent network security policies.
18. See *www.eu-datagrid.org*

REFERENCES

AP Informatique (2001),
"Le prix des processeurs à la norme Bluetooth baissera en 2003", 15 September, available at: *www.ap-informatique.com*

Beigl, M., H.W. Gellersen and A. Schmidt (2001),
"MediaCups: Experience with Design and Use of Computer-Augmented Everyday Objects", *Computer Networks: Special Issue on Pervasive Computing*, Elsevier, forthcoming; available at: *http://mediacup.teco.edu/research/engl/research.html*

Berners-Lee, T., J. Hendler and O. Lassila (2001),
"The Semantic Web", *Scientific American*, May.

Boston Consulting Group (2000),
"Mobile Commerce: Winning the On-Air Consumer", available at: *www.bcg.com/media_center/media_press_release_subpage31.asp*

Bunderi, R. (2001),
"Computing Goes Everywhere", *Technology Review*, January/February.

Computer Science and Telecommunications Board (CSTB),
National Research Council (2001*a*), *Embedded Everywhere*, National Academy Press, Washington, DC.

Computer Science and Telecommunications Board (CSTB),
National Research Council (2001*b*), *The Internet's Coming of Age*, National Academy Press, Washington, DC.

DiBona, C., S. Ockman and M. Stone (1999),
Open Sources, O'Reilly and Associates, Cambridge.

Dingledine, R., M.J. Freedman and D. Molnar (2001),
"Accountability", in A. Oram (ed.) (2001), *Peer-to-Peer: Harnessing the Power of Disruptive Technologies*, O'Reilly and Associates, Cambridge.

Eurotechnology Japan (2000),
available at *www.eurotechnology.com/imode/*

Evans, P. and T. Wurster (2000),
Blown to Bits: How the Economics of Information Transform Strategy, Harvard Business School Press, Boston, Massachusetts.

IDC (2001),
"Teaching Penguins to Fly", IDC *Newsletter*, IT Forecaster, 13 February.

Kan, G. (2001),
"Gnutella", in A. Oram (ed.) (2001), *Peer-to-Peer: Harnessing the Power of Disruptive Technologies*, O'Reilly and Associates, Cambridge.

Lerner, J. and J. Tirole (2000),
"The Simple Economics of Open Source", NBER Working Paper 7600, National Bureau of Economic Research, Washington, DC.

Lessig, L. (1999),
Code and Other Laws of Cyberspace, Basic Books, New York.

Lessig, L. (2001),
The Future of Ideas: The Fate of the Commons in a Connected World, Random House, New York.

Leveson, N.G., J.D. Reese, S. Koga, L.D. Pinnel and S.D. Sandys (1997),
"Analyzing Requirements Specifications for Mode Confusion Errors", paper presented at the Workshop on Human Error, Safety, and System Development, Glasgow.

Metcalfe, R. (1995),
"From the Ether: A Network Becomes More Valuable as it Reaches More Users", *InfoWorld Magazine*, 2 October.

Mundie, C. (2001),
"The Commercial Software Model", prepared text of remarks by Craig Mundie, Microsoft Senior Vice President, at the New York University Stern School of Business, 3 May, available at: *www.microsoft.com/presspass/exec/craig/05-03sharedsource.asp*

Netcraft (2000),
"Netcraft Web Survey", March, available at: *www.netcraft.com/survey*

Newsbytes (2001),
"DoCoMo I-Mode Subscribers Top 30 Million Mark", A. Creed, 26 December, available at: *www.newsbytes.com*

Norman, D.A. (1998),
The Invisible Computer, MIT Press, Cambridge, Massachusetts.

OECD (1998),
Cryptography Policy: The Guidelines and the Issues, OECD, Paris.

OECD (2000),
OECD *Information Technology Outlook: ICTs, E-commerce and the Information Society*, OECD, Paris.

OECD (2001*a*),
Science, Technology and Industry Outlook, Drivers of Growth: Information Technology, Innovation and Entrepreneurship, OECD, Paris.

OECD (2001*b*),
"The New Economy: Beyond the Hype", OECD, Paris

OECD (2001*c*),
"The Electronic Commerce Business Impacts Project (EBIP)", forthcoming.

OECD (2001*d*),
"The Development of Broadband in OECD Countries", DSTI/ICCP/TISP(2001)2/FINAL.

Oftel (2000),
"Consumers' Use of Digital TV", Oftel Residential Survey, July 2000, available at: *www.oftel.gov.uk/research/digi0800.htm*

Oram, A. (ed.) (2001),
Peer-to-Peer: Harnessing the Power of Disruptive Technologies, O'Reilly and Associates, Cambridge.

Smetannikov, M., Interactive Week (2001),
"IPv6: So Far, Few Takers", 22 May, available at: *www.zdnet.com/zdnn*

Strategy Analytics (2000),
"Interactive Digital Television: World-wide Market Forecasts", available at: *www.strategyanalytics.com/press/PRDM21.htm*

Time Europe (2000),
"Not Very PC: A New Generation Is Moving Computing Power off the Desktop and into Everyday Items", 28 February, Vol. 155, No. 8.

TV International (2000),
"Europe's Digital TV Platforms Look beyond Interactivity to Commerce Riches", 2 October.

Udell, J.N. Asthagiri and W. Tuvell (2001),
"Security", in A. Oram (ed.) (2001), *Peer-to-Peer: Harnessing the Power of Disruptive Technologies*, O'Reilly and Associates, Cambridge.

Waldman, M., L.F. Cranor and A. Rubin (2001),
"Trust", in A. Oram (ed.) (2001), *Peer-to-Peer: Harnessing the Power of Disruptive Technologies*, O'Reilly and Associates, Cambridge.

Want, R., A. Hopper, V. Falcao and J. Gibbons (1992),
"The Active Badge Location System", Olivetti Research Ltd, Cambridge, available at: *www.ubiq.com/want/papers/ab-tois-jan92.pdf*

Weiser, M. (1991),
"The Computer for the Twenty-First Century", *Scientific American*, pp. 94-10, September.

Weiser, M. (1993),
"Some Computer Science Problems in Ubiquitous Computing", *Communications of the* ACM, July (reprinted as "Ubiquitous Computing", *Nikkei Electronics*, 6 December, pp. 137-143).

Weiser, M. (1996),
"Ubiquitous Computing" available at: *www.ubiq.com/hypertext/weiser/UbiHome.html*

Young, R. (1999),
"Giving it Away", in C. DiBona, S. Ockman and M. Stone (eds.), *Open Source*, O'Reilly and Associates, Cambridge.

Chapter 8

IT POLICIES

This chapter summarises information technology (IT) and related policies that affect the development, diffusion and use of IT in OECD countries.[1] First, an overview discusses responses to the IT Outlook policy questionnaire. The following sections explore areas of high current policy interest: ICT skills and the digital divide.

Overview of IT policies

Since the publication of the IT *Outlook* 2000, uptake and use of ICTs, and particularly the Internet, have continued to increase in OECD economies, although in 2001 and early 2002 nominal ICT investment expenditure declined and the rate of increase in the ICT capital stock slowed. OECD governments have adopted broad policy frameworks and detailed measures that encourage the development, diffusion and use of ICTs. Government policy has focused on ICTs not only because of the economic importance of the very dynamic ICT-producing sector itself, but also because of the wider impact of ICT investment and use on the economy and society. Areas of particular attention include:

- The impact of ICTs on firm-level competitiveness (OECD, 2002*a*).
- The potential for economy-wide output, employment and productivity gains, which are now being quantified (see Chapters 1 and 5 and OECD, 2001*a* and 2001*b*).
- Issues of social equality and the digital divide (see Chapter 6 and OECD, 2002*b*).
- The potential for improving government efficiency and the delivery of government services (see Chapter 6).

Almost all OECD countries have well-developed and clearly enunciated broad strategies and action plans for IT and an overarching policy approach to the information society. These usually cover technology development, technology diffusion, improving the IT environment and the global diffusion and distribution of ICTs with increasing accent on ICT demand and use. The potential cost-effectiveness of public-private partnerships in promoting the development and use of ICTs is also increasingly recognised.

Table 1 summarises the broad patterns of policies in 21 responding OECD countries. A brief discussion of the general policy areas follows.[2]

Policy environment and broad policy vision

The development of a broad IT policy vision has been an important feature of policy in almost all OECD countries. IT policy visions most commonly stress the importance of universal access to ICTs. In the European Union, the principal goal of the e-Europe initiative is an "Information Society for All", Mexico promotes greater access to new technologies and Switzerland emphasises "access for all" and "empowerment of all". Certain countries also stress broadband access: Norway has an Action Plan on Broadband Communication, and Canada plans to have broadband access available in all communities by 2004. Countries with less-developed ICT infrastructure and use emphasise the potential of ICTs for economic development. Poland anticipates that ICTs will help improve living standards and Hungary that the National Information Society Strategy could lead to a substantial improvement in the country's international ranking.

Table 1. **Summary of OECD country IT policy responses**

	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 co-operation	17
Trade and foreign direct investment	8

Note: Only policies listed in responses to the IT Outlook policy questionnaire are included. Other policies may also exist. The table does not suggest the relative importance of policies, either in terms of government direct expenditures, tax expenditures or their impact. The response from the European Commission is not included.

Source: OECD, based on responses from 21 OECD countries to the IT Outlook Policy Questionnaire.

In addition, a number of countries have ambitious plans to become world players in various aspects of IT and the knowledge economy and to improve their relative position. The Australian federal government wishes to "build a leading role for Australia in the global information economy". Canada has the goal of becoming "the world's most connected country … and one of the top five countries for research and development by 2010". Japan hopes to be "the world's most advanced IT nation within five years", and the United Kingdom is working to ensure its position as a "world leader in the knowledge economy revolution".

Technology development

OECD countries view technology development as important, but ICT-specific policies in this area are rarer than those for technology demand, diffusion and use. For technology development, OECD countries identify four policy areas: R&D, government procurement, ICT for government use and venture finance. They see government support for R&D as a means to spur innovation that will have large spillover effects. Many see partnerships between government research centres, universities, industry and the private sector as an important way to increase the efficiency and effectiveness of R&D and government support to R&D. Government procurement and development of ICTs for government use receive somewhat less attention but are considered important for improving the provision of government services (*e.g.* electronic identity cards, electronic signatures, customer-focused services, on-line procurement). Finally, a number of countries emphasise developing adequate venture finance systems, most often to support ICT innovation in SMEs.

R&D

Most OECD countries have programmes to promote R&D in the ICT sector, but these are often part of more general programmes. For example, Austria does not explicitly promote R&D on ICT, but the amount of general R&D support allocated to ICT-related industries increased by 37% from 1999 to 2000, much faster than overall business R&D funding. France raised by 50% funding for ICT in national science (*Fonds national de la science*) and technological research (*Fonds de la recherche technologique*) programmes in 2001.

Countries are also implementing programmes to strengthen R&D through universities and other educational and research institutions. Sweden has taken steps to foster co-operation between universities, industrial research institutes and businesses. Poland and Portugal stress the development/improvement of a high-speed computing and communications backbone for research institutions. Australia's Innovation Plan includes the establishment of an ICT Centre of Excellence to build a critical mass of first-class ICT research capability with high-quality ICT research skills at the postgraduate level and from overseas and to improve commercial exploitation of ICTs and develop ICT networks and clusters.

Various ICT R&D programmes mention specific technologies: development of telecommunications (Slovak Republic), digital television applications (Belgium), electronic support for health services (Greece), teaching technologies (Italy), information-related home electric appliances (Japan), software (Switzerland) and nanotechnologies (United States).

Government procurement

Government procurement programmes seek either to develop ICT supply capabilities and procure ICT goods at lower prices or to procure products on line to improve efficiency and transparency (e-procurement). Responding countries specifically mention procurement of ICT goods to develop industry capability and achieve lower prices for public sector IT purchases. Under the Procurement Act, Spain regulates government purchase of IT equipment, software and services. Since 1983 an inter-ministerial commission has overseen all aspects of government IT and computer-related purchases.

Among countries aiming to improve on-line government procurement, Italy has an e-procurement project for rationalising expenditure which covers central and regional government administration. Most responding countries have programmes to overcome legal and security obstacles to e-procurement systems, and pilot projects are under way in several countries.

Development of ICTs *for government use*

In the area of development for government use, most responding countries have programmes to develop secure electronic identity, which could be used for e-commerce and for health and other government service applications. Finland will introduce an electronic identity card so that people can do business with the civil service reliably and safely.

The development of electronic tax filing systems, especially for value-added tax, and better on-line technologies to serve citizens are also mentioned. In Greece, the Ministry of Finance and the General Secretariat of Information Systems have promoted the development of electronic exchange of receipts and, in particular, the electronic filing of value-added tax and personal tax statements.

Venture finance

Nine responding countries mention venture finance programmes, most commonly for funding of small and medium-sized enterprise (SMEs). Australia has initiatives to improve access to equity capital for developing ICT SMEs. The Korean government operates the IT Venture Investment Mart to match venture capital for promising ICT sector SMEs. In Mexico, the Foreign Commerce National Bank participates in risk capital funds for SMEs, and the Economic Secretary has developed commercial incubator organisations. In Belgium, the Walloon Region facilitates contacts between ICT companies and risk capital. Countries also help to match SMEs and research institutions/universities with investors. France has a programme to improve partnerships between public research institutions and enterprises through the sharing of information.

Technology diffusion

Technology diffusion receives most attention, particularly in terms of diffusion to individuals and households and to businesses, in order to increase ICT demand and use and spread network benefits and externalities more widely. There is also a push for uptake of e-commerce in businesses and for awareness and training programmes for SMEs. Programmes to demonstrate the benefits of IT use are also important. These mostly involve connecting the government administration and providing information on the benefits of IT use. Government on-line services generally move towards making more services available, often with the aim of providing a single government portal to access all services. Important reasons for governments to go on-line include a more customer-focused approach, more transparency, greater connectivity to citizens and putting tax procedures on line to increase efficiency (see Chapter 6).

Diffusion to individuals and households

Most responding OECD countries mentioned policies for diffusion to individuals and households, often to increase access for particular groups: lower income, the young and elderly and minorities. Twelve countries mentioned programmes for community access centres, with examples such as telehouses and communal establishments offering access to information, technological office equipment, computers, the Internet and related services. In Hungary, participation in the Tele-cottage Movement is strong and gives people in small villages an opportunity to use ICTs. Programmes for Internet access in schools are also popular. In Switzerland, the "Public Private Partnership – School on the Web" project is designed to furnish Internet access in all primary and secondary schools and to train teaching staff to use ICTs adequately in everyday classroom work.

There are programmes to decrease the cost of equipment by fixing a maximum price, as in Spain, or by providing the equipment, as in the UK "Computers within Reach" initiative, which aims to provide up to 100 000 low-income families with recycled computers. Belgium seeks to raise demand for ICTs through dissemination of information.

Scandinavian countries tend to emphasise market mechanisms and private-sector initiatives to meet the demand for and distribution of ICTs. Finland states that "the Finnish government does not distribute directly or provide subsidies for purchase of technological equipment to individuals or households". In Sweden, instead, policy emphasis focuses on developing broadband infrastructure for remote and rural areas that may not be served through market mechanisms.

Diffusion to businesses

Most OECD countries have ICT diffusion programmes to help improve business efficiency and competitiveness. They rely on provision of information and promotion of e-commerce (nine countries each). Several countries have also considered public-private partnerships. The Czech government emphasises such co-operation via the State Information Policy. Financial assistance for ICT use (in the form of subsidies or fiscal incentives) is considerably less common.

SME*s*

Most countries have specific policies for diffusion to SMEs, although these are less common than those for diffusion to individuals and households and to businesses. The principal priorities are providing information and advice regarding ICTs. The United Kingdom has a wide range of awareness-raising activities to encourage businesses to consider the implications of ICTs and to offer advice. In Norway, the VeRDI programme aims to increase awareness of and motivation for the adoption of ICTs, to provide professional development knowledge (best practice) and to promote joint ventures and infrastructure development.

Programmes to demonstrate benefits of ICT *use*

The most common programmes for demonstrating the benefits of ICT use involve government as a model user, through the use of ICTs within government administrations. In Austria, the government plans to introduce electronic files in all ministries by 2003. In the Slovak Republic, central bodies of the state administration already use Govnet, the government network, and there are plans to extend this network to other public administrations and institutions. A smaller number of countries have programmes for trial and demonstration of new applications, development of e-marketplaces and awareness programmes, such as the sharing of success stories.

Government services on line

The provision of government services on line has high priority in many OECD countries and commonly passes through three stages of policy development. The first focuses on standardisation and co-ordination and makes some information and services available through on-line portals. In the second stage, governments provide a greater number of services on line and improve co-ordination of information and services, for example through a single portal. Finally, all services are available through a single, easy-to-use government portal (see also Chapter 6).

In the Slovak Republic, the central bodies of the state administration and some public administrations have their own portals and provide information online. The Belgian BRIGIS project shares geographical information online. In Switzerland, local, regional and federal administrations are working to offer their services via a common portal, with services available as of early 2002. The government of Japan helps local governments to create local public networks by subsidising the building of infrastructure for local intranets to improve local public services. The US Office of Management and Budget released its E-government Strategy, an action plan to make it easy for citizens and businesses to interact with the government, to save taxpayer money and to streamline business-to-government transactions. In Canada, the goal is for all Canadians be able to access all government information and services on line at the time and place of their choosing by 2004.

IT *environment*

All responding OECD countries have initiatives to foster a reliable and trustworthy environment for electronic transactions and exchange, including measures for electronic settlement, authentication (see Box 1), security, privacy protection and consumer protection, and currently the OECD Guidelines for the Security of Information Systems are being updated. Payment cards receive a fair amount of attention and building trust is considered important. As the commercial value of ICT goods and services is recognised, intellectual property rights are increasingly viewed as of key importance, and many countries are reviewing their efforts in the areas of intellectual property rights and standards.

Electronic settlement, authentication, security, privacy protection and consumer protection

Of the 19 countries that gave examples of programmes for electronic settlement, authentication and security, 14 cited legal and/or legislative initiatives. Laws on electronic signatures and certification were most common. For example, in Japan, the Law Concerning Electronic Signatures entered into force in 2001 and provides the legal basis for using electronic signatures as the equivalent of hand-written signatures.

Stakeholders in OECD Member countries have been active in developing initiatives to enhance consumer trust online, building on the principles articulated in the 1999 OECD Guidelines for Consumer Protection in the Context of Electronic Commerce.

Eleven responding countries mentioned technical solutions for electronic settlement, authentication and security. Austrian companies have introduced prepaid cards, which can be used anonymously, are independent of a banking account and can be used for micro-payments on the Internet.

Slightly less common are programmes for developing trust, reassuring the public and other "soft trust" issues. In the United Kingdom, the Internet Watch Foundation was set up to reassure the public and business that the Internet can be a safe and secure place to work, learn and play. "Soft trust" programmes are most often combined with legal and/or technical programmes.

Intellectual property rights

Fourteen countries stressed the importance of intellectual property rights for encouraging the development and commercial exploitation of ICTs and enhancing the diffusion of knowledge regarding

Box 1. The Ottawa Declaration on Authentication for Electronic Commerce

The Declaration on Authentication for Electronic Commerce adopted by Ministers at the Ottawa Ministerial Conference on 7-9 October 1998* recognised the importance of authentication for electronic commerce. It outlined a number of actions to promote the development and use of electronic authentication technologies and mechanisms, including continuing work at the international level, together with business, industry and user representatives.

In the Declaration, Ministers declared their determination to:

- Take a non-discriminatory approach to electronic authentication from other countries.
- Encourage efforts to develop authentication technologies and mechanisms, and facilitate the use of those technologies and mechanisms for electronic commerce.
- Amend, where appropriate, technology or media-specific requirements in current laws or policies that may impede the use of information and communication technologies and electronic authentication mechanisms, giving favourable consideration to the relevant provisions of the Model Law on Electronic Commerce adopted by the United Nations Commission on International Trade Law (UNCITRAL) in 1996.
- Proceed with the application of electronic authentication technologies to enhance the delivery of government services and programmes to the public.
- Continue work at international level, together with business, industry and user representatives, on authentication technologies and mechanisms to facilitate global electronic commerce.

Since the Ottawa Declaration, there has been progress on authentication for electronic commerce. Regarding the legal recognition of electronic signatures, 17 Member countries have amended technology- or media-specific requirements in current laws or policies, where appropriate, and have given legal recognition to electronic signatures. Most other Member countries either have drafts of amendments ready or work is under way. Continuing efforts in countries that are preparing legislation should be encouraged. Outreach in this area might also be provided to non-member countries.

Clauses of the UNCITRAL Model Law, such as those on "legal recognition", "variation by agreement" and "court admissibility", are commonly reflected in amendments of national legislation or regulations. Continuing efforts in countries that are preparing legislation should be encouraged. Outreach to encourage adoption of the Model Law in this area might also be provided to non-member countries.

Governments either express a non-discrimination policy or remain silent about nationality of authentication, and this is interpreted as being a non-discriminatory approach to foreign authentication. However, differences among countries in standards or schemes cause some concern for the interoperability of electronic signatures and cross-certification of certification authorities (CAs). There seems to be a need for compatible approaches and policies among OECD Member governments and business initiatives in order to ensure interoperability of electronic authentication systems in the international marketplace. To this end, Member governments may wish to consider how to develop global, seamless authentication and certification mechanisms.

"Form requirements" are types of requirements in law that information, including signatures, be presented in certain forms such as in writing or by use of a paper document. Form requirements are still found in many aspects of commercial activities and pose challenges for governments.

Developments in the application of authentication technologies to the delivery of government services are encouraging, as almost all Member governments either have started initiatives to introduce electronic measures for use in government services or plan to do so. Governments use electronic signatures in their own services once they have enacted legislation giving legal recognition to electronic signatures. While governments share the common goal of delivering government services electronically, the process of achieving that goal may differ, depending on the countries' legal systems. Even though party autonomy is ensured in commercial contracts, transactions with governments would most likely require the use of "secure" electronic signatures or other legally specified signatures. Some governments report their intention to accept only "secure" electronic signatures in transactions with government. This may not cause specific problems for the objective of promoting electronic services but may justify further efforts to establish the international interoperability of electronic authentication. Governments should be aware that even if laws do not explicitly reject the acceptance of electronic documents, the lack of proper facilities, equipment or other items may hinder use of electronic means.

In many Member countries, the legal basis for promoting the use of electronic means is still being developed. Work is continuing at international level to gather and exchange information and encourage efforts in this area.

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* OECD Ministerial Conference "A Borderless World: Realising the Potential of Global Electronic Commerce", 7-9 October 1998 SG/EC(98)14/FINAL, available at: *www.olis.oecd.org/olis/1998doc.nsf/linkto/sg-ec(98)14-final*

Source: OECD 2001*c*.

inventions. The most common recent initiatives have been legislation for the protection of computer programmes and databases. In Japan and the United States, computer programmes and software, including business methods, can be patented. Software is not currently patentable in European Union countries, awaiting the results of a Commission proposal. A Polish act on copyright protection and related laws (1994) has a chapter protecting computer programmes as literary works, and in 2001 the parliament adopted a law on the protection of databases.

Several countries have attempted to increase incentives for ICT development, for example by permitting researchers in universities and other institutions to receive revenue from their inventions. In Italy, modifications of the general regulations for industrial inventions aim to promote research by recognising university inventors and giving them copyright and property rights linked to their invention and a percentage of the proceeds from its industrial use.

Australia and Korea both have legislation that permits, yet limits, the reverse analysis of software in certain circumstances. Australia's Copyright Act was amended to allow the reproduction of computer software in certain circumstances for the purposes of developing interoperable products, testing security systems or correcting errors. Reproduction for the purpose of creating an interoperable product is only allowed where interface specifications are not readily available. More recent changes to the Copyright Act allow users to obtain, in certain circumstances, devices or services to circumvent technology that would otherwise prevent the legitimate reproduction of software. The Copyright Amendment Act 2000 entered into force in March 2001 and clarified the rights and responsibilities of copyright users and owners in the digital environment.

Other programmes mention measures to resolve domain name disputes, crackdowns on illegal copying and public awareness and education.

Standards

Most responding OECD countries place high priority on the adoption of international standards. Australia states that "wherever possible, international standards are preferred" and "when there is no international standard, then a regional standard is preferred". Only when there is no international or regional standard is a national standard developed. Canada and Finland, where ICTs are widely used, take an active interest in the formulation of international standards. Several countries mention standardisation programmes to enhance communication within the national government. In Switzerland, the Reference Model for the IT Architecture of the Confederation serves as a basis for the elaboration and application of IT architecture and related standards. Architectural grids can be used as a planning aid and ensure compatibility within and between federal departments.

Globalisation and international co-operation

Fewer responses mention policies for globalisation, and the focus varies. Promotion of exports is more common than programmes for foreign direct investment (FDI), and international regulatory frameworks are also discussed.

Trade and foreign direct investment

Among programmes for trade and FDI, initiatives to promote exports focus on the provision of information and participation in international expositions. Poland's Communication Technology System of Export Promotion will integrate dispersed business information resources for Polish exporters and will make them available through an Internet portal and a network of regional and local institutions. Australia operates an international network of offices in 108 cities in 63 countries and co-ordinates Australian national stands at more than 100 international trade exhibitions each year.

Promotion of ICT investment is also considered important. The Korean government has made a great effort to attract foreign investment by dispatching investment missions, holding investment road shows and building up a database on foreign investment guidelines. It has also revised the Telecommunications Business Law to increase the limit on foreign investment in backbone telecommunications to 49%, and the government-designated business market is now completely open to foreign investment.

International co-operation

Initiatives for international co-operation most often include multilateral agreements and participation in international organisations such as the World Trade Organisation (WTO), the International Telecommunication Union (ITU) and the Global Business Dialogue. European countries generally mention participation in EU or e-Europe+ programmes. Other countries mention participation in the Asia-Pacific Economic co-operation (APEC) Forum and the Free Trade Area of the Americas (FTAA). A smaller number of countries mention programmes for bilateral co-operation.

Other areas

Countries were asked about areas of IT policy not covered by the questionnaire. Several countries cited programmes for benchmarking (United Kingdom) and minimising sector-specific legislation (*i.e.* leaning more and more on general competition and consumer protection legislation) and technological neutrality (Finland). Broadband policies were covered extensively (see Box 2), and policies for the software sector are also important (see Box 3).

Box 2. Broadband policies

The development of broadband access to the Internet is gaining increasing prominence in fields that go well beyond communications policy. One reason is the role advanced communication capabilities play in generating higher growth in productivity rates, as well as new network-based economic activities. If new communication tools such as the Internet and wireless networks boosted growth in the latter half of the 1990s (see Chapter 1), then the next steps toward broadband access are of critical importance.

The limitations of local access networks are the current bottleneck to growth in the communications sector and electronic commerce. These limitations are not only technological and are linked to the heritage of many decades of monopoly provision of access networks. Much can be done in many countries to increase the pace at which broadband access becomes available and the quality of service offered (not all broadband is equally broad) and to reduce prices.

Most OECD countries are working towards household and business access to network infrastructure with high transfer capacity (broadband). While broadband policies were not explicitly mentioned in the OECD policy questionnaire, 14 out of 21 responding countries specifically refer to broadband infrastructure (supply) and applications (demand and use).

For example, a number of these countries mention action plans to address a wide range of broadband issues at national scale. The Canadian "National Broadband Task Force" was designed to devise a strategy to ensure the availability of broadband access in all Canadian communities by 2004. The Italian "Broadband Task Force" aims to evaluate the present situation of broadband development and to develop a government strategy to ensure its rapid growth. The Norwegian "Action Plan on Broadband Communication" encourages market competition and strengthens public demand for broadband networks and services. The aim is to obtain favourable offers for making broadband available in all parts of the country. In addition, all Norwegian primary schools, public libraries and local authority administrations should be offered broadband connections at competitive prices by the end of 2005, all secondary schools by 2003 and all hospitals by the end of 2002. The Norwegian government will consider implementing special measures in areas where market failures make broadband deployment impossible at reasonable prices and within reasonable time. The government is also taking initiatives to promote content development and thus stimulate broadband demand.

Other countries emphasise stimulating competition, the development of broadband applications and the development of broadband infrastructure for the public sector, universities and research centres.

Source: OECD (2001*d*) and responses to the IT Outlook Policy Questionnaire.

Box 3. Policies for the software sector

The increasing ubiquity of ICT and the rapid growth of the software sector have led to increasing interest in policies to support software production and use in OECD countries. Government policy interest has been spurred by the rapid and dynamic growth of this sector and the impact of software investment and use on firm-level competitiveness and on its potential to produce economy-wide productivity gains.

Since the very beginning of the industry, government software-sector policies have played an important role, initially via defence procurement. Besides collaboration between defence and civilian research efforts in software and in computer science generally, co-operation between industry and academia was also an important driver of early developments in the US software industry. For other countries, it has been suggested that the lack of collaboration between military and civilian researchers in the United Kingdom in the early post-war computer industry, and the modest role played by universities in computer science and software-related research activities in Japan may have significantly affected the evolution of their software sectors (Mowery, 1996).

Current government policies that address software may be viewed as supply side, as demand side or as affecting the general business environment. They may be domestic (education, R&D support) or international (trade-related) in scope.

Software policies

Supply-side policies	Demand-side policies	Policies affecting the business environment
Research and development Intellectual property rights Standards IT professional skills	Government procurement Incentives for private sector use Training, information and awareness	Trade and foreign direct investment Competition policy

Examples of software policies include those to promote software innovation and to leverage procurement. For example, in Japan, the Ministry of Economy, Trade and Industry (METI) is encouraging software developers to provide good programmes in important fields by commissioning development work and holding public contests for creative software.

In Spain, the Government Procurement Act regulates government purchase of software, services and IT equipment from private sources. Since 1983 there has been an Inter-ministerial Commission for the Acquisition of Computer Goods and Services (CIABSI) which covers all technical aspects of government IT purchases. CIABSI also defines government IT procurement policies and evaluates costs related to technical assistance, maintenance and other variables. Framework contracts are widely used for procurement of IT goods and services in the Swedish public sector. An agency buying services for telecommunications, electronic commerce or equipment such as software or PCs that are covered by a framework contract can avoid the full procurement process by selecting a supplier from the available framework contracts.

Because of interoperability and conversion difficulties, technical standards are very important to the software industry. An increasing number of governments develop policies regarding such standards. In Turkey, the National Standards Institute, R&D institutes and some non-governmental organisations monitor the software area of the IT sector.

In Canada, the Telecommunications Standards Advisory Council of Canada (TSACC) is an industry-government partnership formed in May 1991 to develop strategic directions for standardisation in information technology and telecommunications. As such, it plays a central role in the design and implementation of electronic commerce standards in Canada and internationally. TSACC working groups have prepared the "Electronic Commerce Applications Roadmap" which addresses technology-enabling business functions and related software.

Because most software is originally produced in English, English has come to be the *de facto* language standard for the sector. Some countries now have policies encouraging the development of software in their native language. The Portuguese government has taken steps to launch an R&D programme on systems processing of the Portuguese language. This programme is to be developed in partnership with Portuguese and foreign entities and will design and publish software for handling Portuguese in written and spoken form for use worldwide.

Source: OECD, based on responses to the IT Outlook Policy Questionnaire.

Policies for ICT skills

All OECD countries acknowledge the importance of a skilled workforce. While professional ICT skills are important for growth of industry in general, they are also increasingly needed throughout the economy (see Chapter 5). ICT skills have become a new type of "general" skill, like literacy or numeracy. Governments are implementing an array of policies targeting different segments of the population in order to promote basic and advanced ICT skills (see Appendix Table A8.1). In some cases, government policies do not specifically target the development of IT skills but imply the need for them (*e.g.* e-learning, on-line job search).

Professional IT *skills*

A variety of programmes aim at strengthening the skills of current IT workers and/or developing future IT skills (with a particular focus on higher education). This also includes various programmes for increasing the availability of IT professionals through other means, such as immigration.

General programmes

Some OECD countries have developed general programmes to co-ordinate their overall policy for professional IT skills. Examples include: overall co-ordinating mechanisms such as those found in Australia (IT Skills Hub, ICT Taskforce) and Canada (Software Human Resource Council – SHRC); information portals such as the Australian IT Skills Hub; and surveys and other studies on skills shortages.

Programmes targeting current or potential IT *workers*

Governments currently focus on three main areas: certification, reskilling/training and immigration policy.

Different certification programme schemes are being implemented in Portugal, Korea (with both a public and a private system and currently about 1 million certificate holders); Mexico (National Council of Accreditation in Informatics and Computers – CONAIC); Austria (Public Employment Service Austria – AMS); and Japan (IT Engineers Examination, IT Co-ordinator certification). In addition, various OECD countries are adopting programmes to classify and define specific sets of ICT skills: Australia, Poland, Canada (Employability Skills 2000+) and Japan (Skill Standard).

There are continuing education and training courses for ICT professionals in Spain, Belgium, Italy (financed by payroll taxes), Sweden (SwIT), Finland, the United Kingdom (University for Industry – UfI), and Austria (tele.soft). Other programmes focus on retraining, skills updating and lifelong learning: Italy, Norway, Poland (Strengthening the Lifelong Education System), Austria and Greece. In Belgium (Walloon Region), an "E-business management" accreditation scheme has been set up. Sweden has an IT competence-enhancing programme for SMEs. Belgium (Brussels Regional Office for Employment, ORBEM), Australia and Canada (SkillNet) have schemes for employment assistance and labour market information.

As shown in Chapter 5, OECD countries use a variety of immigration-related policies to attract skilled foreign IT professionals. Australia has policies directed towards foreign students, priority to ICT professionals seeking immigration status and ICT occupations recognised as "key", while Norway has simplified the recruitment of IT professionals from outside the European Economic Area (EEA).

Programmes targeting students

The main goals of programmes targeting students are to provide financial support to students or schools specialising in IT, to increase the pool of IT students and to establish stronger links between industry and learning institutions.

These programmes may take the form of scholarship/loan programmes for post-secondary and tertiary education, as in Portugal, Australia (the Postgraduate Education Loans Scheme – PELS) and Korea (overseas scholarship programme). They may also take the form of financial support to educational institutions specialising in ICT, as in Korea. Increasing participation in IT courses is also considered important, and Sweden, Finland, and Austria (IT4U) have such programmes. Belgium encourages female participation through its "Electronica" project. There is also emphasis on building closer school/industry links, especially in Australia (Science Lectureship Initiative), Canada (National IT Youth Internship programme, e-commerce research centres at universities) and Spain (adapting curricula to industry requirements).

Basic IT skills

General programmes

A wide range of tools are used to develop basic IT skills ("IT literacy") across the population. Formal IT certification is the most widespread mechanism for recognising basic and intermediate IT skills. The European Computer Driving License (ECDL) and the International Computer Driving License (ICDL) promote industry-standard IT skills and are granted in more than two-thirds of all OECD countries (*www.ecdl.com*). Similar programmes exist in Portugal (Basic IT Skills Diploma), Spain, Belgium and Hungary (promoting participation in the ECDL), Finland (where 100 000 persons have passed the A-level examination of the Computer Driving License), Austria (supporting the ECDL), Canada (CanConnect Skills Certificate for K-12 youth) and Greece (through Operational Programme Information Society – OPIS).

Focus on schools

The development of basic IT skills through schools is especially emphasised. Governments identify three main objectives for IT in schools: increasing the availability of IT equipment, promoting IT training/certification for teachers and expanding the teaching of IT in the school curriculum.

Many countries have programmes for expanding infrastructure/access in schools: Spain, Belgium (PC/KD in Flanders, "cyberschool" in the Walloon region), Sweden (National Action Programme for ICT in Schools – ITiS), Finland (through the National Board of Education), Australia ("Computers for Schools" for channelling surplus Commonwealth computers to schools), the United Kingdom, Poland (I*nter@klasa*), Hungary (Sulinet programme), Mexico (RedEscolar) and Austria (pilot project "Notebook Class"). In addition, Belgium (Belgacom I-Line), Sweden (ITiS), France and Australia have schemes for providing schools with low-cost Internet access.

IT training programmes for teachers are in place in Italy, Sweden, Finland (the OPE.FI project with three ICT skill levels), Norway, Australia (DETYA), Poland (I*nter@klasa*), Portugal, France and Austria. Australia also offers IT certification for teachers (ICT Competency Standards for Teachers).

Spain, Finland, France and Korea ("Guidelines for ICT Utilisation in Elementary and Middle Schools") have programmes for increasing the teaching of ICT skills in school curricula.

Other initiatives

This section notes initiatives in which developing IT skills is not necessarily the primary goal, but nonetheless constitutes an important component of the programme. The first set comprises those targeting specific social groups, while the second includes those which use ICT as a tool to promote other socio-economic goals.

Targeting specific social groups

A number of programmes target specific social groups, such as: women (efforts to increase enrolment in S&T higher education in Norway); citizens with special needs/disabilities (Portugal, Sweden); young people (such as the Portuguese Millennium Generation Programme targeting children aged 10-18); and senior citizens (such as the "ICT week for seniors" in Belgium or the Norwegian Seniornett association).

Other programmes focus on: the unemployed (an Italian programme aimed at young persons in the South with a focus on new technology literacy, a Swedish programme emphasising raising IT skills within adult education programmes, training programmes by the National Labour Market Board and Computer/Activity Centres); socially disadvantaged students (such as the Australian "Effective Use of ICT" programme); and indigenous populations (such as the Australian Indigenous Online Network – ION).

As for public servants, Portugal offers courses at the National Institute of Administration which target local government, Italy focuses on assessing the training needs of local and regional administrations, the United Kingdom directs attention to skills for e-government and Austria promotes the ECDL among civil servants.

In addition, a number of programmes promote overall diffusion. The Spanish "Internet Access for Citizens" programme promotes access for the handicapped and rural communities. The Norwegian programme "ICT for Everybody" also promotes overall diffusion. Community learning centres, such as the Hungarian "MultiCentres" also have this goal.

Using ICT tools to promote other goals

ICT can also be used as a tool to promote goals such as employment, education and research. It can also be used to raise general awareness of the benefits of ICTs.

For example, in Belgium a database with job vacancies is maintained by the Flemish Service for Employment and Vocational Training, and job training is provided by the Public Service for Employment – Forem. There are programmes for e-learning in Belgium (Technifutur in the Walloon region), Finland (virtual schools), the United Kingdom (National Grid for Learning, learndirect), Hungary (Internet tele-teaching), Korea, Mexico, Canada (Advisory Committee for Online Learning) and Greece (tele-training). Austria has developed an education portal. ICTs are being used to improve University research networks in Belgium ("VirtUE" – Virtual University for Europe) and Hungary (UNIWORLD network).

Policies to address the digital divide

Most OECD countries have sought to address the digital divide in order to spread the benefits of ICT use more widely. There are a number of ways to help turn the digital divide into a digital opportunity. While fostering a healthy ICT environment will help allow national ICT industries to flourish, both general and specific policies are needed to target specific groups and goals. International initiatives allow countries to learn from the experience of others.

Policies and programmes to reduce the digital divide

A healthy environment for ICT investment and use is necessary (including competitive network infrastructure, competition policy, consumer protection, security and privacy, protection of IPR and technical standards), but it may not suffice to bridge the digital divide. The rationale for more specific programmes and policies is the social benefits to be gained from the wide diffusion of ICTs throughout the economy and society owing to efficiency gains, large spillovers and positive externalities, improvements to the skill base and equity considerations. Furthermore, because of the large network effects associated with ICTs, general efficiency and multiplier effects are associated with diffusing ICTs more widely and raising ICT skills throughout the economy.

Countries have identified six areas of particular importance for reducing the digital divide: network infrastructure, diffusion to individuals and households, diffusion to businesses, IT education and training initiatives, government projects and international co-operation. Table 2 summarises the broad pattern of policies in 22 OECD countries.

Network infrastructure policies aim mainly at enhancing competition, but development of basic and broadband infrastructure are also considered important. All responding countries have policies for diffusion to individuals and households and to businesses. Government projects are important,

Table 2. **Summary of OECD country digital divide policy responses**[1]

	Total number of country responses
Network infrastructure	**21**
Regulatory initiatives to enhance competition	20
Basic infrastructure development	14
Broadband infrastructure development	14
Diffusion to individuals and households	**22**
Access through schools	20
Access through other public institutions	19
Access in rural/low income areas	16
IT for the elderly/disabled	14
Content creation to stimulate use of Internet	12
Diffusion of IT equipment to individuals	11
Other programmes to lower costs of IT	10
Demonstration and awareness programmes	9
Programmes to increase demand for IT	8
Subsidies of IT equipment and/or services	7
Diffusion to businesses	**22**
Support and training for SMEs	20
Diffusion of information	17
Assistance to regions and rural areas	13
Encouragement of high-tech start-ups	12
IT education and training initiatives	**22**
IT education in schools	22
Vocational training	21
Teacher training	19
Lifelong learning	15
Distance learning	13
IT certification	13
Government projects	**20**
Government provision of services on line	18
Governments as model users of IT	18
Foster R&D and applications to improve access	9
International co-operation	**16**
Multilateral co-operation [EC, UN]	16
Bilateral programmes	7

1. The table is not exhaustive; additional policies may exist but may not have been included in the response. The table does not measure the relative importance of policies, either in terms of direct government expenditure, tax expenditures or policy impact. The response of the European Commission is not included.

Source: OECD, based on country responses to the Digital Divide Policy Questionnaire.

particularly as model users of IT and through provision of government services on line. International co-operation is emphasised somewhat less, with multilateral co-operation significantly more important than bilateral programmes (OECD, 2002*b*).

Policy emphasis across countries

The high response rate and very high quality of responses to the digital divide questionnaire allow for additional analysis. This section divides OECD countries into five groups (English-speaking, northern European, European, Asian and other) in order to examine common patterns. While most countries have policies covering most or all policy areas, the emphasis differs among the groups. Table 3 summarises these differences, and examples are given in Appendix Table A8.2 (for further details, see OECD, 2002*b*).

Table 3. **Comparative policy emphasis by groups of OECD economies**

	English speaking	Northern Europe	Europe	Asia	Other
E-government initiatives, widespread	X				
Infrastructure development in disadvantaged areas	X				
Competition	X	X			
SMEs		X	X		
Education and training		X	X	X	X
Access through schools and other public institutions			X	X	
Access for the elderly/disabled				X	
Government network coordination/Early on-line					X

Note: Most countries have policies covering most or all policy areas, the table shows relative emphasis.
Source: OECD, based on responses to the Digital Divide Policy Questionnaire.

English-speaking

English-speaking countries (Australia, Canada, the United Kingdom, the United States) have relatively high ICT penetration rates and focus relatively more on market mechanisms to bridge the digital divide. Government initiatives are sometimes also employed to increase access to ICTs when market mechanisms do not appear sufficient. For example, remote and rural areas may need assistance if they are to attract investment in ICT infrastructure. Governments in these countries have used e-government initiatives to improve government's efficiency at delivering information and services to citizens and to demonstrate use of the technology.

Europe

These countries strongly stress equality of access to ICTs. They emphasise IT training and education and support for SMEs to improve economy-wide, egalitarian access. These countries can be further divided into countries with higher and lower levels of IT penetration. Countries with higher IT penetration in northern Europe (Finland, the Netherlands, Norway, Sweden) focus in addition on encouraging high-technology start-ups and, like the market-led approach, emphasise regulatory initiatives to enhance competition. In contrast, countries with somewhat lower penetration (Austria, Belgium, France, Italy, Switzerland) focus relatively more on access through schools and other public institutions.

Asia

Responses from Asian countries (Japan, Korea) put policy emphasis on ICTs for the disabled and elderly, as well as on education and training and access through schools and other public institutions, to complement the firm-based approach to economic adjustment for workers and businesses. Disabled and elderly individuals find it particularly difficult to take advantage of new technologies, as they are generally excluded from the firm-based adjustment processes. More recently, Japan and Korea have systematically implemented broad strategies for IT policies.[3] New priorities include promotion of high-speed Internet infrastructure, digitalisation of school education and reinforcement of human resources, enhancement of network content, promotion of electronic government and reinforcement of international activities.

Other countries

"Other" countries generally have lower IT penetration and use rates, although almost all have adopted pro-competitive liberalisation policies for network infrastructure. Among OECD countries, only Hungary, Poland, the Slovak Republic and Turkey were still planning or had not yet fully liberalised network infrastructure as of early 2001 (OECD, 2001*d*). Responding countries in this group (the

Czech Republic, Greece, Hungary, Mexico, Portugal, Spain, Turkey) focus largely on education and on on-line provision of selected government services to help provide a wider base for ICT use. Many aspects of education are considered essential, with particular emphasis on vocational training and training in schools. Programmes also include efforts to consolidate government administration and provision of government services in one network.

International initiatives

In addition to national initiatives, international initiatives seek to ensure more universal access to ICTs and reduce the digital divide. These include work by APEC, the G8 DOT Force initiative, the Commonwealth, Summit of the Americas, the UN System and especially its high-level ICT Task Force, the World Bank, the Digital Bridges Task Force (GBDe) and the Global Digital Divide Task Force (WEF). The OECD has been and remains involved in a number of these initiatives, in part through outreach to share widely the lessons learned in OECD countries.

Conclusion

OECD countries increasingly view IT policy as a means to enhance and spread economic growth. Almost all responding OECD countries have a broad policy vision for IT, and all have a mix of specific policies and programmes for addressing aspects of IT development, IT diffusion, the IT environment and/or globalisation with increasing emphasis on demand and diffusion policies. Additionally, a large number of countries emphasise improvement of IT skills and the digital divide.

Table A8.1. **Examples of policy actions and recommendations for building ICT skills**

	Body	Report/programme	Target	Skills			Other policies/immigration
				IT professional	Basic IT	General	
Canada	Expert Panel on Skills	Stepping Up: Skills and Opportunities in the Knowledge Economy	Government			Development of standard skill definitions and measurement tools	Expand model of temporary workers from software to other sectors
			Educational institutions	Review apprenticeship programmes with industry partners	Ensure current teachers have up-to-date skills	Measure the acquisition of essential skills	Facilitate hiring of foreign nationals to faculty positions
			Industry				Involve industry sector councils in implementation of new approach to selection and recruitment of foreign workers
European Union	European Commission	e-Europe 2000: An Information Society for All	Government		European diploma for basic IT skills		
			Educational institutions		Connecting schools, incentives for teachers to use IT	Adapt school curricula to new ways of learning using ICTs	
			Industry	Accelerate development of e-commerce	Promote IT training		
Greece	Government	Operational Programme Information Society		Close the skills gap by combining advanced ICT skills training and "on-the-job" training for 10 000 persons (2001-02)	Certification of qualifications in basic IT skills for 40 000 people (2001-02), focusing on unemployed		
Hungary	Government	Sulinet (Schoolnet) programme			Providing primary and secondary schools with Internet access and making IT an important feature of teacher training		
Ireland	Expert Group on Future Skills Needs	Report on e-business skills	Government	Work with educational institutions to develop e-business programmes			
			Educational institutions	Promote e-business degrees	Update skills of business school faculty		
			Industry		Promote a second level of common ICT skills		

Table A8.1. **Examples of policy actions and recommendations for building ICT skills** (*cont.*)

	Body	Report/programme	Target	Skills			Other policies/immigration
				IT professional	Basic IT	General	
	Expert Group on Future Skills Needs	Second Report	Government	Monitor recommendations of First Report (1998)		Use of ICTs to promote job opportunities in Ireland to non-residents	
			Educational institutions	Increase numbers in accelerated technician programmes in computer science	Awareness campaigns		
			Industry	Support to train workers		More flexible working arrangements and non-pay incentives	
Norway	Ministry of Education, Research and Church Affairs	ICT in Norwegian Education: Plan for 2000-03	Government and educational institutions	Report has been commissioned on the need for ICT competencies in the years to come	Funding of the Seniornett programme to provide older people with opportunities to develop ICT skills		
	Government		All stakeholders		Within the Competence Reform framework (for lifelong learning), a project on "ICT for Everybody" will be established		Revise regulations to simplify the recruitment of skilled workers from countries outside the EEA
Spain	Ministry of Labour and Social Affairs		Government and industry associations	Training programmes for IT workers			
	Ministry of Science and Technology	FORINTEL		Continuing education courses for ICT sector workers	Encourage acquisition of basic IT skills by all citizens, focusing on disadvantaged groups (handicapped, immigrants, long-term unemployed)		
Sweden	Government	Bill 1999/2000:86 (in Ministry of Industry, Employment and Communications, 2000)	Government		Analysis of women's use of IT		
			Educational institutions	Royal Institute of Technology to launch an IT University, development of a competence centre for Internet technology	Continue special IT programme for schools (ITiS)		

Table A8.1. **Examples of policy actions and recommendations for building ICT skills** (*cont.*)

	Body	Report/programme	Target	Skills			Other policies/immigration
				IT professional	Basic IT	General	
			Industry		IT competence enhancement programme for small firms		
United Kingdom	National Skills Task Force	Final Report	Government	Skill dialogues with industry		Information on labour markets and skill needs	Examine whether specific ICT occupations should be included in "shortage occupation list"
			Educational institutions	Collaboration with industry (apprenticeships)		Improve foundation learning system	
			Industry	NTOs should review occupational framework			
				Campaign to create a more positive image of IT career prospects			
				Small firms training loans			
			Individuals	Career development loans		Individual Learning Accounts (ILAs)	
United States	National Research Council	Building a Workforce for the Information Economy	Government	Collect better data on IT workforce; enhance the attractiveness of government as an IT employer	Incentives for firms to provide training (tax credits, loan subsidies, direct grants)		Increase portability of H-1B visas, streamline green-card process
			Educational institutions	Better align educational programmes with industry needs	Promote IT fluency in primary and secondary schools	Improve secondary mathematics education	
				Stronger links with professional societies	Promote formal IT education for all majors		
			Industry	Improve recruitment practices	Promote training		
				Stronger links with educational institutions			
				Promote interest in IT careers			
			Individuals	Seek internships with IT firms	Take advantage of training opportunities offered by employers and educational institutions		

Table A8.1. **Examples of policy actions and recommendations for building ICT skills** (*cont.*)

Body	Report/programme	Target	Skills			Other policies/immigration
			IT professional	Basic IT	General	
21st Century Workforce Commission	A Nation of Opportunity	Government		Implement tax credit for IT skills training for firms		Facilitate transition of students applying for H-1B visas; raise employer fees for visa petitions (which are then used for education and training programmes)
		Educational institutions	Making IT curriculum more relevant to industry needs	Offer teachers work experience opportunities in IT firms		
		Industry	Partnerships with teaching institutions			

Source: OECD based on replies to *Information Technology Outlook* 2002 policy questionnaire and other sources.

Table A8.2. **Digital divide policy examples by groups of OECD economies**

General models and countries	Emphasis	Examples
English speaking countries (Australia, Canada, United Kingdom, United States)	Regulatory initiatives to enhance competition	In Canada, Internet access is provided through a variety of technologies – wireline, wireless, and high-speed cable modems. Pro-competitive policy and regulatory frameworks have clearly helped lower prices and increased choice. The United Kingdom gives highest importance to regulatory initiatives to enhance competition. This includes progress on local loop unbundling to increase competition in the DSL market, action on competitiveness of dial-up access to the Internet and current consultation on competition for leased lines. The United States promotes greater access to telecommunications and information technology tools through policies promoting competition among telecommunications and information services providers. Competition among telecommunications service providers and hardware and software manufacturers has generated lower prices and spurred innovation, resulting in greater access to computers and the Internet.
	Infrastructure development in rural, remote and low-income areas	The Australian Networking the Nation (NTN) initiative is an AUD 421 million programme designed to assist the economic and social development of non-metropolitan Australia by funding projects that enhance telecommunications infrastructure and services, by promoting services and access to the network, and by reducing disparities in access to services and facilities. In June 2001 the Canadian National Broadband Task Force released its report, *The New National Dream: Networking the Nation for Broadband Access* and provided recommendations to the Government of Canada on how best to make high-speed broadband and Internet services available to all Canadian communities by the year 2004. In the United Kingdom, measures include a fund for Regional Development Agencies and devolved administrations to help roll out the broadband in rural/less commercially attractive areas. The United States Rural Utilities Service Telecommunications Program (RUS) provides funding for advanced telecommunications infrastructure in rural America. RUS finances local exchange, mobile and broadband services.
	E-government initiatives	The Australian government has a commitment that the Commonwealth will bring all appropriate services on line via the Internet by 2001. The "Government Online" strategy outlines a whole-of-government approach to moving information and services on line based on agency action plans and reporting framework. Canada's "Government Online" initiative hopes to make the Canadian government the most electronically connected to its citizens in the world by 2004, with Canadians able to access federal information and services on line when and where they choose. The United Kingdom aims to have all government services on line by 2005 (42% of services are already on line). The UK on-line citizens portal is a one-stop portal for all on-line government services, packaging services around "life events" such as moving house or having a baby. The United States "E-government" initiative is a government-wide project aimed at revolutionising how the public interacts with government as well as streamlining the way government conducts its business. Federal agencies will help citizens gain one-stop, on-line access to existing government information and services, and provide better, more efficient government services through new technology.

Table A8.2. **Digital divide policy examples by groups of OECD economies** (*cont.*)

General models and countries	Emphasis	Examples
Northern European countries (Finland, Netherlands, Norway, Sweden)	Regulatory initiatives to enhance competition	One key element of the Finnish government's policy to prevent alienation has been to promote competition in the information industry. The government has liberalised telecommunication markets since the mid-1980s. This has supported both the fast growth of the ICT sector and lower prices of telecommunication services for consumers. A primary measure to reduce the digital divide in the Netherlands involves the accelerated liberalisation of network telecommunication sectors. This includes unbundling of the local loop. Measures to foster competition have high priority in Norway. The Norwegian government believes that it is essential to develop broadband networks and that a basic prerequisite for these networks is that the market players must be responsible for developing the necessary infrastructure. The government is therefore preparing to stimulate competition through measures that create suitable conditions. This is expected to lead to lower prices and the development of more and better products for users. Measures include the implementation of suitable regulations with the aim of rapidly establishing a digital TV network, review of the access to Telnor's network, including current practice regarding the delivery of dark fibres, the awarding of licenses for third-generation mobile systems, and the publishing of reports on price and competition factors in the market, including an index showing price developments in the area of infrastructure.
	Support and training for small and medium-sized enterprises (SMEs) and high-technology start-ups	The Finnish Information Society Advisory Board has proposed counselling and support measures to emphasise the readiness of SMEs to utilise information and communications technology in developing their operations. The Netherlands gives priority to the creation of a favourable climate for start-ups and the development of innovative companies, particularly SMEs. There are initiatives to stimulate enterprise in education, remove constraints for fast-growth companies, and reform bankruptcy law. There is a programme for knowledge transfer to SMEs, and a 0.15% reduction in capital tax. Norway has launched a national programme focusing on SMEs (VeRDI). The programme, launched in March 2001, will strengthen the competitiveness and profitability of SMEs by increasing awareness and knowledge/understanding of e-commerce. SMEs, industries and value chains (*i.e.* meeting new market conditions), women (into e-business) and districts are target groups. The Swedish SVEA programme provides information to SMEs, an IT competence enhancement programme for small businesses, and many regional and local projects. Through technical parks and universities, there is also encouragement of high-tech start-ups.
	Education and training	In Finland, the development of hardware, software and network connections in educational institutions will continue. In the Netherlands, a number of education and training initiatives are aimed at living and working in the information society. These include initiatives to increase the annual per capita investment in human capital, improve starting qualifications for 18-24 year olds, the conversion of education and training institutes into local learning centres, initiatives for lifelong learning, and increased mobility for students, teachers and researchers. Norway has a large number of programmes for IT education and training. These include pilot projects in some counties in order to gain broadband experience, the development of multimedia-based teaching aids, information and knowledge bases and multimedia-based educational opportunities, developing teachers' IT competence and a national learning network for the education sector. The Competence Reform is the prime policy framework for lifelong learning. Within the reform, a separate project is to be established under the working title "ICT for Everybody". The project aims at raising the general awareness and knowledge of ICT among adults and avoiding new divides between those who use ICT and those who do not. Introduction to writing and arithmetic are essential elements along with a guide to the utilisation of Internet-based services such as on-line banking. A CD-ROM will be produced and distributed through the public library system. The 1998/1999 SITE study showed that teachers thought they had sufficient basic IT, but seemed to lag behind in terms of their teaching practice. Sweden has a number of IT education and training initiatives, including special IT-programmes for schools, IT training for the unemployed, development of IT competence in working life, and municipal initiatives for schools in rural areas.

Table A8.2. **Digital divide policy examples by groups of OECD economies** (*cont.*)

General models and countries	Emphasis	Examples
European countries (Austria, Belgium, France, Italy, Switzerland)	Support and training for small and medium-sized enterprises (SMEs)	*Go on*! is an Austrian programme with a focus on getting SMEs connected to the Internet. The programme offers initial advice for free and specific packages comprising hardware, software and qualifications support. In addition, the Ministry of Trade has promoted the diffusion of electronic data interchange technologies in SMEs. In Belgium's Walloon region, there are a number of incentives for businesses and particularly SMEs to explore the potential of ICT. These include a consciousness-raising campaign, incentives for site design and e-commerce development, incentives for technological innovation, and an IT training programme for professionals. The French programme "*Utilisation Collective d'Internet par les* PMI" is designed to help SMEs appropriate Internet technologies. The budget was approximately FRF 50 million in 2000. The Swiss SME Task Force will establish an information portal for SMEs with information on subjects such as the lifecycle of an enterprise.
	Education and training	The Austrian *Go on*! programme also focuses on education and training. The aim is the implementation of a national training programme for Internet novices and PC users by promoting the European Computer Driving License (ECDL). The "e-Austria" project includes measures to connect all schools to the Internet, to train all teachers in using the Internet and to introduce a course of study for IT managers. Belgium has a number of regional education and training initiatives. These include the cyberschool programme which involves a teacher training section, initiatives for the development of distance learning, teletraining, and training for SMEs. France has initiatives for teacher IT training, training for the unemployed, professional training and IT certification. Italy has a number of education and training initiatives, including continuing education in IT, training for the unemployed, training in schools and training for teachers. Educational initiatives in Switzerland include teacher training (for both professional and public schools) and the development of programmes for continuing IT education. The OFFT programme aims to develop new IT training methods for people who have already been trained in another sector.
	Access through schools and other public institutions	The project e-Austria includes measures to connect 100% of schools to the Internet and to amend the media law with an obligation to deliver electronic media products to Austrian libraries. The TELEKIS initiative is funding the establishment of Internet cafes, especially for young people. Additionally, Lower Austria plans to install "infopoints" in each community and a "service point" in each district head office to offer an easier access to information for citizens and tourists via Internet. The first such public access point has been placed in the lounge of the state government building. In Belgium, schools, hospitals and libraries have been granted reduced tariffs for ISDN connections to the Internet. Communities have implemented programmes related to the purchase of micro-computers and to Internet connections in schools. France proposes to create 2 500 *espaces publics numériques* by 2003. These access points would propose free access and an initiation to the Internet. The French Government has also decided to develop 4 800 Internet access points in post offices, employment agencies and libraries. In addition, all schools will be given Internet access by 2002. Switzerland has initiatives to improve access to computers and the Internet in schools, and particularly to improve the necessary infrastructure. Also, the government will guarantee access to ICTs in public establishments such as post offices and public administration buildings.

Table A8.2. **Digital divide policy examples by groups of OECD economies** (*cont.*)

General models and countries	Emphasis	Examples
Asian countries (Korea, Japan)	IT for the elderly and disabled	In October 1998, the Japanese Ministry of Posts and Telecommunications established a set of guidelines for accessibility to telecommunications equipment for the elderly and people with disabilities. These guidelines address functions required of telecommunications equipment in order for the elderly and disabled to be able to use telecommunications services smoothly. Korea has a number of projects for the development and diffusion of technologies for the disabled. This includes KRW 20 billion for the development of digital TV for the blind and deaf, KRW 700 million for the development of a personal digital assistant for the blind, KRW 300 million for the development of a Web site portal for the blind, and KRW 200 million for the development of a screen keyboard for the physically handicapped.
Other countries (Czech Republic, Greece, Hungary, Mexico, Portugal, Spain, Turkey)	Government network co-ordination and early on-line services	The Czech Republic has plans for the implementation of a public information system, and the electronic launching of selected state administration services by the year 2002. In Greece the important programme named ARIADNI (2000-06) focuses on the improvement of public administration services in the regional and central municipalities, including the use of Internet for most transactions and communication with the central services. "ASTERIAS" is a part of "ARIADNI" for the islands and has been completed. On the site of the Ministry of the Aegean (*www.ypai.aegean.gr*), 207 procedures involving the public administration are already provided. The Ministry of the Interior, Public Administration and Decentralisation is making 300 more available. The Hungarian Division of e-government is developing projects on electronic service delivery to the citizens and modernising the work procedures of the public administration. A number of Mexican government services are now available on line, including an electronic system for government purchases, an electronic declaration of patrimonial goods for public servants and a Mexican enterprise information system. The Portuguese Internet Initiative comprises a series of measures regarding the use of the Internet by the public administration and by the citizens in their interface with the public services. The goals are to have all official forms available on the Internet in 2002, to make electronic submission of all official forms possible in 2003 and to have all public services on line by 2005. There are a number of programmes to increase the presence of the government services on the Internet in Spain. Efforts are being directed to developing a single portal for the administration and to implement common Web procedures for all ministries. The priorities are: development of a single portal for the administration, a single point of access to public services, an on-line public health system, development of legislation regarding new technologies and on-line information on tourism and the country's image. In Turkey, all legislative and executive actions and all public tenders are being published on the "Official Journal Information System" and are available to the public via the Internet. In the project "Information system of current laws" all Turkish laws are updated and published electronically and are available via the Internet.

Table A8.2. **Digital divide policy examples by groups of OECD economies** (*cont.*)

General models and countries	Emphasis	Examples
	Education, training and access in schools	The Czech Republic has a number of projects for IT education. They include access to education in information literacy for all citizens, IT training in public administration and IT training for the unemployed. In Greece, high priority is given to equipping all schools with the necessary IT, network and audio-visual equipment, creation/upgrading of IT labs in universities and technical colleges. The OP "Information Society" is funding an action line ensuring that all Greek schools will have access to the Internet and multimedia resources, with adequate Web -based support services, by the end of 2001. One of the indicators used to measure results for the next four years is the rise in the share of schools with equipment (connected) in the total number of school units at each level of education: – Primary level, from 0.9% to 72% (connection: from 3% to 100%). – Secondary level, from 59% to 100% (connection: from 38% to 100%). – Total connected to the Internet: from 5% to 100%.
		The Hungarian Sulinet (Schoolnet) programme was launched in 1996. It aimed at providing every Hungarian secondary school with a direct access to the Internet by September 1998. The deadline for providing the same facilities for all primary schools is 2002. IT has become also a priority area for supplementary education for teachers. Moreover, support from the central budget will also be available for a programme under which the Hungarian cultural heritage and the achievements of various national disciplines will be stored on electronic data carriers.
		CUDI is a Mexican non-profit organisation whose goal is to implement strategies for the development of broadband university networks. These university networks will increase opportunities for Mexican students to have access to superior education by providing services such as distance learning, digital libraries, virtual labs and telemedicine.
		In Portugal, the education programme PRODEP III includes measures for equipping all education establishments with the Internet and an intranet, as well as teacher training in ICT. uARTE is an initiative to promote and clarify the utilisation of the Internet in all primary schools (among teachers, pupils and their families). Additionally, a Basic Skills Diploma will be established, accessible to any citizen and also associated with the end of compulsory schooling (9 years). By 2006, 2 million citizens are expected to be certified with a basic skills diploma.
		The Spanish Ministry of Science and Technology is working in collaboration with an association of IT professionals to implement the application of the European Computer Driving Licence (ECDL) in Spain. The goal is to train 400 000 people to hold ECDL certificates by the year 2003, from all sectors of the population including employees, students, civil servants and workers for non-profit organisations, as well as people with disabilities and special needs.
		In Turkey, lower tariffs for Internet connections will be applied to schools in order to support education for the information society. Additionally the Regulation Authority works with the ITU to fund education centres and train the trainers to diffuse Internet use in the education sector.

Source: OECD based on responses to the Digital Divide Policy Questionnaire.

NOTES

1. Individual country responses will be available on the OECD Web site.
2. A more detailed summary will be available on the OECD Web site.
3. For example, the e-Japan Strategy (2001) and the e-Japan Priority Policy Programme (2001), available at: *www.kantei.go.jp/jp/it/index.html*

REFERENCES

Mowery, D. *et al.* (eds.) (1996),
The International Computer Software Industry, Oxford University Press, Oxford and New York.

OECD (1998),
Technology, Productivity and Job Creation: Best Policy Practices, OECD, Paris.

OECD (2001*a*),
Science, Technology and Industry Outlook. Drivers of Growth: ICTs, Innovation and Entrepreneurship, OECD, Paris.

OECD (2001*b*),
The New Economy: Beyond the Hype, OECD, Paris.

OECD (2001*c*),
"Progress achieved by OECD Member Countries in Furtherance of the Ottawa Declaration on Authentication for Electronic Commerce".

OECD (2001*d*),
OECD Communications Outlook, OECD, Paris.

OECD (2001*e*),
The Development of Broadband Access in OECD Countries, OECD, Paris.

OECD (2002*a*),
"The Electronic Commerce Business Impacts Project (EBIP): Synthesis Report", forthcoming.

OECD (2002*b*),
"The Digital Divide: Diffusion and Use of ICTs", forthcoming.

Annex 1

METHODOLOGY AND DEFINITIONS

This annex describes the definitions and classifications adopted in the present edition of the *Information Technology Outlook*. These definitions and classifications, and the data collected on that basis, draw 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

Shipments and inventories

Data for the United States on ICT shipments and inventories was obtained from the US Bureau of the Census' *Manufacturers' Shipments, Inventories and Orders* survey (M3). The ICT manufacturing sector comprises three manufacturing industries, as defined by the following NAICS codes (for a full list of codes, see: *www.census.gov/indicator/www/m3/naics/m3codes.pdf*):

- Computers: 34A (electronic computer manufacturing) + 34B (computer storage device manufacturing).
- Communication equipment: 34D (communications equipment manufacturing, non-defence) + 34E (communications equipment manufacturing, defence).
- Components: 34G (semiconductor and related device manufacturing) + 34H (other electronic component manufacturing).

Production

Data on production were compiled from Reed Electronics Research, *Yearbook of World Electronics Data* 2001. 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.

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, 2001, *Science and Technology Scoreboard: Towards a Knowledge Based Economy*, p. 84). 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[1]
7123	Renting of office machinery and equipment (including computers)

Services: *intangible*

6420	Telecommunications[2]
7200	Computer and related activities

Trade

For both Chapters 1 and 2, ICT products were defined as follows:

- ICT goods: computer equipment, communication equipment, electronic components, software goods.
- ICT services: computer and information services, communication services.

ICT *goods*

For ICT goods, the industry-based sector definition, as recorded in international and national industrial classifications, only approximates the ICT sector, which should ideally be based on ICT commodities. As part of its work, the OECD, through the WPIIS, is developing a commodity-based definition of the ICT sector based on the CPC (Central Product Classification) and the Harmonised System (HS).

For ICT goods, trade data were extracted from the OECD International Trade Statistics Database (ITS). Computer equipment, electronic components and communication equipment were defined using the following SITC Rev. 3 codes:

- Computer equipment: 752, 759.97.
- Communication equipment: 764.1, 764.3, 764.81, 764.91.
- Electronic components: 772.2, 772.3, 776.1+776.27, 776.3, 776.4, 776.8, 778.6, 776.29.

Software goods 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*):

- 262: computer and information services.
- 245: communications services.

R&D *data*

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.

Patents

ICT patents comprise the following IPC (International Patent Classification) classes:

- G06: computing, calculating, counting devices.
- G11: information storage equipment.
- H04: electrical communication systems.

ICT *markets*

Data on markets were compiled from the 2002 World Information Technology and Services Alliance (WITSA) report, *Digital Planet* 2002, and from data provided directly by International Data Corporation (IDC), Framingham, Massachusetts. As the WITSA study uses data from IDC, IDC is the main primary source of data on ICT markets. For our purposes, the report 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. IT 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: in this report, this includes IT services as defined by IDC as well as internal spending:
   - 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.
   - Internal IT spending which comprises the internal portion of the information system operating budgets, internally customised software, capital depreciation and any other expense related to IT that cannot be tied to a vendor.
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).

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*).

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

$$GLI_i = \left[1 - \left| M_i - X_i \right| / (M_i + X_i) \right]$$ 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/strategic alliances

Data on M&As and strategic alliances were obtained from Thomson Financial. For this purpose, the ICT sector includes the following activities:

- Computer and office equipment manufacturing.
- Electronic equipment and components manufacturing.
- Computer and related services.
- Telecommunication services.
- ICT wholesaling.
- (ICT-related) media and content industries.

Chapter 4

ICT *use in businesses and households/by individuals and e-commerce statistics*

To the extent possible, data on ICT use in businesses and households/by individuals, including e-commerce statistics, are drawn from the OECD ICT database, which is under development. This database compiles comparable official core indicators developed according to common OECD definitions and methodological guidelines (in particular, the OECD model questionnaire on ICT use in business, 2001, and the OECD electronic commerce transactions definitions, 2000). For further methodological details, see Chapter 4.

Chapter 6

Gini coefficient

The Gini coefficient used to measure inequalities in access to PCs and the Internet was calculated according to the following formula:

$$G = \sum_{i=1}^{N} 2(X_i - Y_i)\Delta X_i$$ where X_i denotes the cumulative share of households in group *i* and below, sorted by increasing income brackets (*e.g.* X_1 denotes the share of households in the lowest income bracket, and $X_N = 1$), Y_i denotes the corresponding share of households with PCs (or those using Internet), N denotes the number of income brackets and $\Delta X_i = X_i - X_{i-1}$ $(X_o = 0)$.

Other chapters

For other chapters, footnotes define coverage for individual figures and tables.

NOTES

1. Where available, countries should only include those subsectors of this industry that directly provide ICT wholesaling services. This will avoid the inclusion of extraneous wholesaling activity. For example, using the NACE nomenclature, only NACE categories 5143, 5164 and 5165 should be included.
2. In those instances where countries include telecommunication activities as part of radio and television activities (ISIC 9213), radio and television activities (9213) should be included in this definition. Otherwise, they should not be included.

Annex 2

ANNEX TABLES

Annex Table 1.1. Worldwide production of ICT goods, 1999

Value in millions of current USD and percentage growth

	EDP	Office equipment	Control and instrumentation	Radio comm. (incl. mobiles) & radar	Telecom-munications	Consumer	Components	Total ICT	1995-99 CAGR	1990-99 CAGR
United States	91 392	4 776	35 944	59 736	43 549	6 612	78 831	320 840	4.4	5.8
Canada	3 691	107	1 007	2 349	3 758	172	558	11 642	1.4	4.0
Japan	60 553	5 751	8 033	20 237	19 324	18 314	88 516	220 728	-4.0	2.3
Korea	10 984	328	221	10 069	1 910	4 159	29 926	57 597	4.2	10.8
Australia	839	34	490	839	748	259	395	3 604	2.3	3.0
Austria	565	27	348	125	475	481	1 509	3 530	-4.5	0.0
Belgium	1 955	73	478	697	808	888	1 029	5 928	-3.5	0.8
Denmark	117	15	485	576	246	187	725	2 351	3.3	3.6
Finland	796	2	527	3 477	2 244	8	1 454	8 508	11.9	13.4
France	6 737	362	2 763	11 282	5 195	2 038	7 334	35 711	0.9	1.9
Germany	9 678	679	10 848	6 734	5 974	1 942	11 690	47 545	-0.6	0.5
Greece	118	44	40	91	131	73	36	533	7.7	..
Ireland	9 189	93	295	365	1 865	74	4 600	16 481	17.0	12.8
Italy	5 669	203	2 949	2 130	3 379	515	3 594	18 439	-2.1	-1.5
Netherlands	3 285	902	1 797	713	618	296	1 931	9 542	-3.8	1.2
Norway	267	0	347	306	288	10	159	1 377	-2.7	-0.9
Portugal	420	17	64	170	191	871	711	2 444	3.4	..
Spain	1 592	115	262	342	2 802	1 591	1 077	7 781	4.9	0.5
Sweden	228	12	1 131	6 090	3 778	306	1 562	13 107	15.0	8.8
Switzerland	660	77	1 927	255	503	2 888	1 386	7 696	-3.3	1.3
United Kingdom	15 000	815	4 540	12 081	3 145	2 795	9 361	47 737	6.9	6.2
OECD-21	223 735	14 432	74 496	138 664	100 931	44 479	246 384	843 121	1.4	4.2
China	17 750	1 712	1 610	3 910	4 480	16 200	14 076	59 738	20.1	19.8
Hong Kong, China	1 731	297	88	380	490	2 189	2 558	7 733	-4.8	-0.4
Malaysia	14 474	134	342	1 053	1 605	5 749	15 599	38 956	9.0	20.1
Singapore	22 059	255	471	1 294	494	1 336	14 846	40 755	0.7	11.9
Chinese Taipei	23 079	23	124	836	1 808	783	14 326	40 979	9.0	12.7
Thailand	7 937	340	138	423	661	2 034	4 704	16 237	6.9	17.0
India	580	73	348	487	441	1 886	1 026	4 841	-0.3	0.4
Indonesia	1 390	60	110	507	400	1 496	2 114	6 077	6.5	19.4
Philippines	2 200	37	50	500	300	456	5 740	9 283	22.0	18.4
Brazil	5 900	190	550	1 200	1 300	1 909	2 435	13 484	-5.0	1.3
Israel	1 150	11	550	850	2 400	77	1 273	6 311	11.2	14.6
South Africa	180	6	79	172	376	161	50	1 024	-61.9	-2.5
Total	322 165	17 570	78 956	150 276	115 686	78 755	325 131	1 088 539	1.4	5.6

Source: Reed Electronics Research (2001).

Annex Table 1.2. Exports and imports of ICT equipment, 1990-2000

Value in millions of current USD and percentage growth

	Exports				Imports			
	1990	1995	2000	CAGR 1990-00 (%)	1990	1995	2000	CAGR 1990-00 (%)
Australia	605	1 624	1 389	8.7	3 151	6 432	8 409	10.3
Austria	1 621	1 956	3 468	7.9	2 772	3 298	5 260	6.6
Belgium	..	4 113	7 799	..	..	5 027	9 204	..
Canada	5 576	9 761	19 595	13.4	9 083	17 062	26 654	11.4
Czech Republic	..	212	1 497	..	..	1 330	2 909	..
Denmark	884	1 638	2 552	11.2	1 791	3 292	4 372	9.3
Finland	1 132	3 978	9 228	23.3	1 629	3 233	4 458	10.6
France	9 079	16 817	27 596	11.8	12 878	19 028	29 645	8.7
Germany	15 830	26 872	41 047	10.0	20 112	34 870	50 100	9.6
Greece	24	83	188	23.1	382	742	1 481	14.5
Hungary	..	240	5 236	..	..	849	5 285	..
Iceland	1	0	2	4.9	55	85	174	12.2
Ireland	5 115	11 095	24 833	17.1	2 459	7 904	15 791	20.4
Italy	6 252	9 212	9 117	3.8	9 376	12 628	17 112	6.2
Japan	39 146	79 696	86 012	8.2	9 386	30 979	52 644	18.8
Korea	..	25 830	49 983	..		14 381	31 943	..
Mexico	530	6 518	24 136	46.5	1 380	8 497	27 354	34.8
Netherlands	7 706	15 937	33 766	15.9	9 649	16 173	35 631	14.0
New Zealand	28	98	122	15.8	618	1 117	1 228	7.1
Norway	540	759	833	4.4	1 293	2 337	2 648	7.4
Poland	..	271	459	..		1 364	3 685	..
Portugal	391	607	749	6.7	990	1 693	2 324	8.9
Slovak Republic	..	..	235	..	..	..	582	..
Spain	1 321	2 763	3 718	10.9	4 544	5 386	9 998	8.2
Sweden	3 449	5 592	11 837	13.1	3 538	5 814	8 117	8.7
Switzerland	1 111	1 989	2 787	9.6	3 507	5 310	6 993	7.1
Turkey	36	48	163	16.2	989	1 413	4 739	17.0
United Kingdom	13 187	28 629	45 017	13.1	17 553	31 598	54 753	12.0
United States	40 894	73 076	145 366	13.5	45 083	112 306	178 305	14.7
OECD	154 458	329 416	558 732	13.7	162 217	354 150	601 798	14.0
EU	65 990	129 292	220 728	12.8	87 674	150 688	246 765	10.9

Note: .. = data not available. OECD and EU are partial totals from available data. 1999 instead of 2000 for Greece and the Slovak Republic.

Source: OECD, ITS database, January 2002.

Annex Table 1.3. Trade in computer equipment, 1990-2000

Value in millions of current USD and percentage growth

	Exports				Imports			
	1990	1995	2000	CAGR 1990-00 %	1990	1995	2000	CAGR 1990-00 %
Australia	413	1 128	697	5.4	2 362	3 971	4 438	6.5
Austria	544	626	926	5.5	1 545	1 873	2 113	3.2
Belgium	..	2 137	3 949	..	..	3 079	4 766	..
Canada	2 132	4 780	5 228	9.4	4 476	7 934	11 197	9.6
Czech Republic	..	74	472	..	..	796	1 057	..
Denmark	482	970	945	7.0	1 314	2 203	2 133	5.0
Finland	328	1 048	408	2.2	962	1 473	1 302	3.1
France	5 011	7 817	9 133	6.2	8 424	11 419	14 303	5.4
Germany	8 088	11 018	14 869	6.3	13 175	19 534	25 718	6.9
Greece	5	17	63	28.7	210	368	631	11.6
Hungary	..	60	3 869	..	..	339	2 192	..
Iceland	1	0	1	1.6	34	55	102	11.5
Ireland	4 515	8 888	17 428	14.5	1 727	5 516	10 177	19.4
Italy	3 923	4 791	2 908	-2.9	4 820	5 925	7 511	4.5
Japan	18 854	29 521	27 558	3.9	4 996	15 364	26 509	18.2
Korea	..	4 695	19 241	..	..	3 097	7 400	..
Mexico	450	2 484	11 365	38.1	559	1 557	5 201	25.0
Netherlands	5 696	10 438	21 346	14.1	7 791	11 620	22 556	11.2
New Zealand	4	15	35	25.2	372	678	665	6.0
Norway	326	305	394	1.9	917	1 404	1 557	5.4
Poland	..	29	89	..	..	737	1 473	..
Portugal	89	40	73	-2.0	525	668	884	5.3
Slovak Republic	..	..	130	..	..	..	276	..
Spain	947	1 350	1 669	5.8	2 944	3 104	4 140	3.5
Sweden	1 252	713	556	-7.8	2 364	3 240	3 059	2.6
Switzerland	476	799	1 204	9.7	2 503	3 523	4 305	5.6
Turkey	19	7	59	12.0	396	596	1 385	13.4
United Kingdom	9 239	16 607	19 857	8.0	12 074	17 661	27 868	8.7
United States	23 005	34 476	54 685	9.0	23 414	57 375	87 463	14.1
OECD	85 800	144 832	219 159	9.8	97 905	185 109	282 381	11.2
EU	40 119	66 460	94 131	8.9	57 876	87 684	127 160	8.2

Note: .. = data not available. OECD and EU are partial totals from available data. 1999 instead of 2000 for Greece and the Slovak Republic.

Source: OECD, ITS database, January 2002.

Annex Table 1.4. Trade in communication equipment, 1990-2000

Value in millions of current USD and percentage growth

	Exports				Imports			
	1990	1995	2000	CAGR 1990-00 (%)	1990	1995	2000	CAGR 1990-00 (%)
Australia	164	385	537	12.6	453	1 373	3 029	20.9
Austria	188	129	617	12.7	309	466	1 549	17.5
Belgium	..	1 124	2 226	..	..	905	2 039	..
Canada	1 144	2 581	10 438	24.7	844	1 938	5 497	20.6
Czech Republic	..	25	156	..	..	365	723	..
Denmark	284	428	1 282	16.3	230	625	1 438	20.1
Finland	703	2 750	8 254	27.9	312	354	1 175	14.2
France	1 409	3 078	9 860	21.5	694	1 731	5 025	21.9
Germany	2 267	6 586	11 517	17.6	1 217	4 024	7 597	20.1
Greece	15	60	116	22.6	104	318	730	21.5
Hungary	..	21	788	..	..	239	603	..
Iceland	0	0	0	37.4	18	28	64	13.4
Ireland	211	580	2 799	29.5	187	258	1 841	25.7
Italy	534	1 296	2 676	17.5	1 056	1 815	5 048	16.9
Japan	5 614	6 904	8 106	3.7	805	3 023	5 165	20.4
Korea	..	1 594	6 543	..	..	1 274	2 984	..
Mexico	24	1 237	8 093	79.3	596	782	4 475	22.3
Netherlands	495	1 217	4 386	24.4	701	1 400	5 823	23.6
New Zealand	22	73	70	12.2	215	341	454	7.7
Norway	199	417	397	7.2	215	650	808	14.2
Poland	..	29	88	..	..	352	1 353	..
Portugal	51	58	52	0.3	180	310	685	14.3
Slovak Republic	..	..	36	..	..	..	134	..
Spain	118	916	1 168	25.8	864	1 189	4 072	16.8
Sweden	1 841	4 345	10 199	18.7	540	1 036	2 262	15.4
Switzerland	288	538	642	8.3	457	815	1 510	12.7
Turkey	14	31	83	19.5	166	402	2 355	30.4
United Kingdom	1 426	3 872	14 027	25.7	1 628	3 764	12 733	22.8
United States	4 063	10 933	20 680	17.7	6 016	10 649	34 652	19.1
OECD	21 071	51 207	125 837	19.6	17 807	40 425	115 822	20.6
EU	9 541	26 440	69 179	21.9	8 022	18 194	52 017	20.6

Note: .. = data not available. OECD and EU are partial totals from available data. 1999 instead of 2000 for Greece and the Slovak Republic.

Source: OECD, ITS database, January 2002.

Annex Table 1.5. Trade in electronic components, 1990-2000

Value in millions of current USD and percentage growth

	Exports				Imports			
	1990	1995	2000	CAGR 1990-00 (%)	1990	1995	2000	CAGR 1990-00 (%)
Australia	28	112	155	18.7	336	1 088	941	10.8
Austria	889	1 201	1 925	8.0	917	959	1 598	5.7
Belgium	..	852	4 235 974	..	..	1 043	2 399	..
Canada	2 300	2 400	3 928	5.5	3 762	7 190	9 959	10.2
Czech Republic	..	112	869	..	..	170	1 129	..
Denmark	118	240	326	10.7	247	464	802	12.5
Finland	102	179	566	18.7	355	1 406	1 981	18.8
France	2 659	5 922	8 603	12.5	3 760	5 878	10 318	10.6
Germany	5 474	9 267	14 660	10.4	5 720	11 313	16 786	11.4
Greece	3	6	9	10.7	67	56	120	5.9
Hungary	..	159	579	..	..	271	2 490	..
Iceland	0	0	0	..	2	3	8	14.0
Ireland	388	1 628	4 606	28.1	545	2 130	3 773	21.3
Italy	1 795	3 125	3 533	7.0	3 500	4 888	4 553	2.7
Japan	14 678	43 270	50 348	13.1	3 585	12 592	20 970	19.3
Korea	..	19 541	24 199	..	..	10 009	21 559	..
Mexico	56	2 797	4 678	55.6	225	6 158	17 679	54.7
Netherlands	1 516	4 282	8 034	18.1	1 157	3 153	7 252	20.1
New Zealand	2	11	17	21.7	31	98	109	13.6
Norway	15	37	42	11.1	161	283	284	5.9
Poland	..	213	282	..	..	275	860	..
Portugal	251	509	624	9.6	285	714	754	10.2
Slovak Republic	..	..	69	..	..	..	172	..
Spain	256	497	881	13.1	737	1 093	1 787	9.3
Sweden	356	534	1 082	11.8	634	1 538	2 796	16.0
Switzerland	348	652	942	10.5	547	972	1 178	8.0
Turkey	3	10	21	20.1	428	414	998	8.8
United Kingdom	2 522	8 150	11 133	16.0	3 851	10 174	14 151	13.9
United States	13 826	27 668	70 001	17.6	15 653	44 283	56 190	13.6
OECD	47 587	133 376	4 448 084	57.4	46 505	128 615	203 596	15.9
EU	16 330	36 393	4 291 955	74.6	21 776	44 810	69 070	12.2

Note: .. = data not available. OECD and EU are partial totals from available data. 1999 instead of 2000 for Greece and the Slovak Republic.

Source: OECD, ITS database, January 2002.

Annex Table 1.6. Trade in software products, 1996-2000

Value in millions of current USD and percentage growth

	Exports				Imports			
	1996	1998	2000	CAGR 1996-00 (%)	1996	1998	2000	CAGR 1996-00 (%)
Australia	22	67	54	25.6	197	464	400	19.3
Austria	213	845	780	38.4	152	254	269	15.2
Belgium	173	198	308	15.6	323	352	354	2.3
Canada	295	163	241	-4.9	829	1 028	1 054	6.2
Czech Republic	143	23	24	-36.2	72	74	107	10.4
Denmark	115	106	156	7.8	179	209	246	8.2
Finland	30	39	76	25.8	115	122	140	5.2
France	428	431	483	3.1	980	1 052	959	-0.5
Germany	734	661	702	-1.1	946	1 294	988	1.1
Greece	24	27	20	-4.8	43	92	96	22.4
Hungary	15	23	25	13.4	9	91	94	79.2
Iceland	0.1	0.1	0.4	54.3	9	13	21	25.0
Ireland	3 567	3 363	3 819	1.7	636	293	315	-16.1
Italy	89	70	72	-5.1	558	718	815	9.9
Japan	254	292	317	5.7	560	385	629	3.0
Korea	27	36	120	45.7	438	213	527	4.7
Mexico	36	22	26	-7.4	178	196	347	18.1
Netherlands	569	714	1 079	17.3	521	396	567	2.1
New Zealand	8	6	4	-19.5	74	75	55	-7.1
Norway	20	21	26	6.6	149	172	184	5.4
Poland	38	55	26	-9.2	16	32	59	37.9
Portugal	4	2	7	15.0	62	93	108	14.8
Slovak Republic	..	5	5	..	..	32	22	..
Spain	53	54	63	4.1	267	297	281	1.3
Sweden	87	91	159	16.3	266	237	255	-1.1
Switzerland	305	123	179	-12.5	487	537	823	14.0
Turkey	11	5	5	-20.4	43	60	158	38.7
United Kingdom	1 102	1 079	895	-5.1	1 137	1 604	1 592	8.8
United States	3 002	3 325	3 382	3.0	714	822	956	7.6
OECD	11 363	11 847	13 051	3.5	9 959	11 208	12 418	5.7
EU	7 188	7 681	8 618	4.6	6 185	7 014	6 984	3.1

Note: .. = data not available. OECD and EU are partial totals from available data. 1999 instead of 2000 for Greece and the Slovak Republic.

Source: OECD, ITS database, January 2002.

Annex Table 1.7. Communication and computer and information services, 2000

Value in millions of USD and share in percentage

Communication services					
Exporters	USD millions	Share (%)	Importers	USD millions	Share (%)
United States	4 090	18	United States	5 800	22
United Kingdom	2 505	11	Germany	3 150	12
Belgium-Luxembourg	1 861	8	United Kingdom	2 310	9
Germany	1 436	6	Italy	1 935	7
Netherlands	1 426	6	Netherlands	1 426	5
France	1 322	6	Canada	1 254	5
Italy	1 274	6	Japan	1 150	4
Canada	1 215	5	France	1 143	4
Mexico	1 213	5	Australia	1 095	4
Switzerland	891	4	Belgium-Luxembourg	958	4
OECD	23 055	100	OECD	26 022	100

Computer and information services					
Exporters	USD millions	Share (%)	Importers	USD millions	Share (%)
Ireland	5 479	19	Germany	4 836	25
United States	4 900	17	Japan	3 066	16
Germany	3 716	13	Belgium-Luxembourg	1 320	7
United Kingdom	3 684	12	Spain	1 226	6
Spain	2 041	7	Netherlands	1 187	6
Belgium-Luxembourg	1 721	6	United Kingdom	1 150	6
Japan	1 569	5	Sweden	1 067	5
Canada	1 345	5	United States	1 040	5
Sweden	1 191	4	Italy	926	5
Netherlands	1 152	4	Canada	791	4
OECD	29 495	100	OECD	19 617	100

Source: OECD/Eurostat (2001), *Statistics on International Trade in Services*; and IMF (2001), *Balance of Payments Statistics Yearbook 2001*; and CD-ROM, Balance of Payments Statistics, 2001.

Annex Table 2.1. Compound annual growth in electronics equipment trade and production in Europe and other regions, 1992-99

Compound annual growth (%)

	Electronic data processing	Radio Communications	Telecommunications	Other electronics	Total
Europe					
Imports	9.8	20.2	17.4	4.9	8.4
Exports	11.6	22.8	17.2	6.5	10.6
Trade	10.5	21.7	17.3	5.6	9.4
Production	3.9	10.4	1.6	3.2	4.2
Other regions					
Imports	14.3	16.2	15.5	10.8	12.4
Exports	10.1	10.9	12.5	8.8	9.5
Trade	12.0	13.3	13.8	9.7	10.8
Production	8.3	5.8	8.8	5.2	6.5

Note: Europe includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom. Other regions includes Australia, Brazil, Canada, Chinese Taipei, Hong Kong (China), India, Indonesia, Israel, Japan, Malaysia, Philippines, Singapore, South Africa, Korea, Thailand and the United States.

Source: Reed Electronics Research, 1994 and 2001.

Annex Table 2.2. Grubel-Lloyd index for ICT equipment trade, 1990-2000

	1990	1995	2000
Australia	0.32	0.40	0.28
Austria	0.74	0.74	0.79
Belgium	..	0.90	0.92
Canada	0.76	0.73	0.85
Czech Republic	..	0.27	0.68
Denmark	0.66	0.66	0.74
Finland	0.82	0.90	0.65
France	0.83	0.94	0.96
Germany	0.88	0.87	0.90
Greece	0.12	0.20	0.23
Hungary	..	0.44	1.00
Iceland	0.03	0.01	0.02
Ireland	0.65	0.83	0.78
Italy	0.80	0.84	0.70
Japan	0.39	0.56	0.76
Korea	..	0.72	0.78
Mexico	0.56	0.87	0.94
Netherlands	0.89	0.99	0.97
New Zealand	0.09	0.16	0.18
Norway	0.59	0.49	0.48
Poland	..	0.33	0.22
Portugal	0.57	0.53	0.49
Slovak Republic	..	..	0.58
Spain	0.45	0.68	0.54
Sweden	0.99	0.98	0.81
Switzerland	0.48	0.54	0.57
Turkey	0.07	0.07	0.07
United Kingdom	0.86	0.95	0.90
United States	0.95	0.79	0.90

Note: 1999 instead of 2000 for Greece and the Slovak Republic.
Source: OECD, ITS database, January 2002.

Annex Table 2.3. US intra-firm trade by region, 2000
USD millions and percentage shares

	US imports			US exports		
	Total imports	Related party trade	Share	Total exports	Related party trade	Share
North America	363 794	189 758	52.2	255 286	106 478	41.7
Western Europe	238 743	122 437	51.3	167 677	48 300	28.8
Eastern Europe	16 157	5 142	31.8	5 866	946	16.1
South and Central America	71 347	18 438	25.8	55 849	10 381	18.6
Other countries	515 298	227 309	44.1	294 946	79 758	27.0
Total	1 205 339	563 084	46.7	779 624	245 863	31.5

Source: US Department of Commerce, June 2001.

Annex Table 2.4. World FDI, cross-border M&As and activities of affiliates, 1990-2000

USD billions in current prices, numbers of employees and percentages

	1990	2000	CAGR 1990-2000 (%)
FDI inflows	202	1 271	52.92
FDI outflows	235	1 150	38.94
FDI inward stock	1 889	6 314	23.43
FDI outward stock	1 717	5 976	24.80
Cross border M&As	151	1 144	65.76
Sales of foreign affiliates	5 467	15 680	18.68
Gross product of foreign affiliates	1 420	3 167	12.30
Total assets of foreign affiliates	5 744	21 102	26.74
Exports of foreign affiliates	1 166	3 572	20.63
Employment by foreign affiliates (thousands)	23 721	45 587	9.22
GDP at factor cost	21 475	31 895	4.85
Gross fixed capital formation (GFCF)	4 501	6 466	4.37
Royalties & fees receipts	27	66	14.44
Exports of goods and non-factor services	4 381	7 036	6.06
FDI inward flows as a percentage of GFCF	4.0	19.7	-
FDI outward flows as a percentage of GFCF	4.7	17.8	-
FDI inward stock as a percentage of GDP	8.3	19.8	-
FDI outward stock as a percentage of GDP	8.1	18.7	-

Source: UNCTAD (2001), *World Investment Report*.

Annex Table 2.5. World FDI flows and stocks in ICT-related industries, 1988 and 1997

Millions of USD in current prices and percentage shares

	1988 USD millions	Share (%)	1997 USD millions	Share (%)	CAGR 1988-97 (%)
FDI inflows					
All industries	119 837	100.0	360 408	100.0	22.3
All manufacturing	52 776	44.0	151 470	42.0	20.8
All services	46 653	38.9	172 032	47.7	29.9
ICT manufacturing	*9 701*	*8.1*	*18 643*	*5.2*	*10.2*
Electrical machinery	4 850	4.0	9 322	2.6	10.2
Office accounting and computer	2 082	1.7	1 522	0.4	-3.0
Electrical machinery	2 084	1.7	4 791	1.3	14.4
Radio, TV and communication	685	0.6	3 008	0.8	37.7
ICT services					
Computer and related services	586	0.5	1 127	0.3	10.3
FDI inward stock					
All industries	839 186	100.0	2 840 590	100.0	26.5
All manufacturing	347 412	41.4	1 206 688	42.5	27.5
All services	354 805	42.3	1 376 911	48.5	32.0
ICT manufacturing	*77 059*	*9.2*	*182 867*	*6.4*	*15.3*
Electrical machinery	38 530	4.6	91 408	3.2	15.2
Office accounting and computer	12 220	1.5	22 025	0.8	8.9
Electrical machinery	15 086	1.8	42 440	1.5	20.1
Radio, TV and communication	11 223	1.3	26 994	1.0	15.6
ICT services					
Computer and related services	846	0.1	3 156	0.1	30.3

Source: UNCTAD (1999), *World Investment Report 1999*.

Annex Table 2.6. FDI flows into ICT and office machinery manufacturing, 1990-99

Millions of current USD

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Denmark	In	65	484	116	15	189	71	-310	106	134	100
	Out	32	16	-17	15	-16	-36	0	0	15	186
Finland	In	..	..	124	89	-34	212	176	150	256	264
	Out	..	..	194	-125	370	432	211	938	..	..
France	In	-63	208	1 753	118	168	495	343	-162	..	-356
	Out	1 952	1 887	3 253	1 080	1 354	511	-218	-472	..	1 041
Germany	In	215	-1 160	-253	481	2	290	-1 865	321	178	156
	Out	2 383	839	1 330	1 011	895	370	202	864	484	251
Italy	In	..	..	5	177	-219	916	255	667	574	15
	Out	..	..	-122	174	67	168	108	223	157	-4 047
Mexico	In	55	321	163	46	165	319	571	655	651	921
	Out	..	..	..	..	..	..	..	..	..	..
Netherlands	In	..	409	516	55	245	234	734	1 815	10 716	1 297
	Out	..	2 041	1 579	-939	776	1 272	2 670	1 150	3 575	2 772
Poland	In	..	..			29	45	47	54	53	29
	Out	..	..	..	..	0	0	0	0	..	..
Spain	In	..	180	223	293	211	129	96	72	293	-408
	Out	..	188	6	38	48	5	9	141	273	-171
Sweden	In	..	..	..	..	..	..	..	2	70	-76
	Out	..	..	..	..	..	..	..	-67	1 282	806
United Kingdom	In	-913	506	1 051	357	568	1 479	1 720	54	-409	9 861
	Out	-879	56	-298	23	205	-142	350	523	-613	-291
United States	In	271	1 837	110	1 400	2 685	2 046	1 515	6 041	9 001	15 996
	Out	1 241	353	526	1 052	2 316	7 060	3 440	2 727	1 866	6 231

Note: .. = no data.
Source: OECD *International Direct Investment Statistics Yearbook 2000*.

Annex Table 2.7. FDI flows into telecommunications, 1990-99

Millions of current USD

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Denmark	In	..	..	..	..	..	..	86	151	3 704	201
	Out	..	..	..	..	..	..	966	545	-15	974
Finland	In	..	..	.	..	..	..	..	..	..	..
	Out	..	..	..	..	50	..	..	..	..	..
France	In	0	3	7	13	42	77	347	477	1 892	-423
	Out	47	12	11	19	86	91	415	848	1 200	1 072
Germany	In	..	..	..	..	..	-275	-4 479	450	221	97
	Out	..	..	..	..	..	1 109	920	78	-598	16 845
Italy	In	-110	24	16	-1	9	36	188	76	55	455
	Out	158	102	442	-45	41	14	1	-658	70	265
Mexico	In	129	295	1 767	1 055	1 014	349	426	351	351	269
	Out	..	..	..	..	..	..	..	..	..	..
Netherlands	In	..	..	64	96	38	317	162	660	1 157	1 692
	Out	..	16	4	76	103	997	1 123	919	-596	1 485
Poland	In	..	..	..	..	13	7	133	25	7	1 790
	Out	..	..	..	..	0	0	0	0	..	-3
Spain	In	..	..	..	20	2	12	66	49	124	324
	Out	..	..	..	0	1 519	96	189	1 126	5 064	4 174
Sweden	In	..	..	..	..	...	..	..	129	129	418
	Out	..	..	..	..	..	..	..	97	341	939
United Kingdom	In	..	..	..	345	18	-139	-623	-429	1 811	13 255
	Out	..	..	..	0	-1 249	2 181	2 442	4 226	492	80 341
United States	In	9	-273	16	76	3 821	527	6 814	3 720	-3 136	76 056
	Out	2 505	1 517	920	1 814	2 887	3 253	1 211	1 413	2 298	-66

Note: .. = no data.
Source: OECD *International Direct Investment Statistics Yearbook 2000*.

Annex Table 2.8. Activities of affiliates worldwide, 1990-2000

Billions of USD in current prices, number of employees and percentages

	1990	2000	CAGR 1990-2000 (%)
Sales of foreign affiliates	5 467	15 680	11.1
Gross product of foreign affiliates	1 420	3 167	8.4
Total assets of foreign affiliates	5 744	21 102	13.9
Exports of foreign affiliates	1 166	3 572	11.8
Employment by foreign affiliates (thousands)	23 721	45 587	6.8
GDP at factor cost	21 475	31 895	4.0
Gross fixed capital formation	4 501	6 466	3.7
Royalties & fees receipts	27	66	9.3
Exports of goods and non-factor services	4 381	7 036	4.9

Source: UNCTAD, *World Investment Report 2001*.

Annex Table 2.9. ICT-sector transnational corporations among the top 100 companies, ranked by foreign assets in 1999

USD billions and number of employees

Rank	Corporation	Country	Industry	Assets		Sales		Employment	
				Foreign	Total	Foreign	Total	Foreign	Total
1	General Electric	United States	Electronics	141.1	405.2	32.7	111.6	143 000	310 000
9	IBM	United States	Computers	44.7	87.5	50.4	87.6	161 612	307 401
14	Siemens AG	Germany	Electronics		76.6	53.2	72.2	251 000	443 000
18	Mannesmann	Germany	Telecommunications		57.7	11.8	21.8	22	130 860
21	ABB	Switzerland	Electrical equipment	27.0	30.6	23.8	24.4	155 427	161 430
22	Sony	Japan	Electronics		64.2	43.1	63.1	115 717	189 700
30	Telefonica	Spain	Telecommunications	24.2	64.1	9.5	23.0		127 193
32	Motorola	United States	Electronics	23.5	40.5	18.3	33.1	70 800	128 000
33	Philips	Netherlands	Electronics	22.7	29.8	31.8	33.5		226 874
39	Hewlett-Packard	United States	Electronics/computers		35.3	23.4	42.4	41 400	84 400
43	Alcatel	France	Electronics	17.7	34.0	16.4	23.2	85 712	115 712
50	Fujitsu	Japan	Electronics	15.3	42.3	17.5	43.3	72 851	188 573
55	Hitachi	Japan	Electronics	14.6	91.5	15.4	77.7		323 827
56	Matsushita	Japan	Electronics	13.9	72.5	34.0	68.9	143 773	290 773
61	Cannon	Japan	Electronics	12.3	25.4	18.0	25.7	42 787	81 009
69	Ericsson	Sweden	Electronics/ telecommunications	10.6	23.8	20.4	25.3	59 250	103 290
74	SBC	United States	Telecommunications		83.2		49.5		204 530
80	Electrolux	Sweden	Electronics	9.1	9.8	13.9	14.5	84 035	92 916
83	Edison	United States	Electronics	8.1	35.0	1.0	9.2		19 570
92	Lucent Technologies	United States	Electronics	7.2	32.1	12.2	38.3	36 000	153 000
97	Toshiba	Japan	Electronics	7.1	53.8	17.5	54.2	46 500	190 870

Note: Excludes media and content.
Source: UNCTAD, *World Investment Report 2001*.

Annex Table 2.10. ICT-sector affiliates under majority control

Number of enterprises

	IT equipment		Communication equipment		Telecommunication services		Computer services		All industries	
	1990	1998	1990	1998	1990	1998	1990	1998	1990	1998
Canada	..	..	39	57	..	..	..	..	6 593	7 501
Czech Republic	..	..	..	50	..	..	..	..	..	12 096
Finland	..	2	..	14	..	..	..	..	..	1 491
France	..	22	..	77	..	..	..	..	..	..
Germany	29	23	..	53	..	..	..	..	7 832	8 343
Hungary	..	33	..	113	..	..	..	..	..	25 992
Ireland	..	32	..	29	..	..	..	..	..	..
Italy	6	10	32	40	..	..	..	..	..	..
Japan	3	6	48	25	..	..	..	..	948	1 082
Luxembourg	..	..	..	..	..	..	..	..	..	..
Mexico	37	..	144	..	..	..	..	..	4 019	..
Netherlands	..	5	..	5	..	..	..	..	..	3 132
Norway	2	0	6	10	..	..	..	..	..	..
Poland	..	5	..	32	..	..	..	..	..	4 055
Sweden	6	6	8	11	..	..	..	..	2 302	3 954
Turkey	0	0	3	5	..	..	..	..	..	..
United Kingdom	42	40	102	108	..	..	..	..	..	..
United States	87	74	188	191	14	..	86	147	10 282	9 738

Note: .. data not available. 1997 instead of 1998 for Canada, 1991 and 1999 for Italy, Japan and Norway, 1993 instead of 1990 for Mexico, 1999 for Poland, 1992 and 1998 for Turkey, 1993 and 1998 for the United Kingdom. Affiliates are enterprises, except for Turkey, Norway and Ireland which report establishments. All countries report majority-owned, except the United States which reports both majority-owned and minority-owned affiliates.

Source: OECD, AFA database, September 2001.

Annex Table 2.11. Employment by ICT-sector affiliates

Number of employees

	IT equipment		Communication equipment		Telecommunication services		Computer services		All industries	
	1990	1998	1990	1998	1990	1998	1990	1998	1990	1998
Canada	..	..	..	..	..	..	..	..	..	..
Czech Republic	..	..	..	7 000	..	..	..	..	..	304 000
Finland	..	..	..	3 947	..	..	..	..	..	127 542
France	..	14 025	..	47 190	..	..	..	..	..	..
Germany	42 000	6 000	..	28 000	..	..	..	..	889 000	701 000
Hungary	..	4 158	..	14 574	..	..	..	..	..	580 701
Ireland	6 767	13 027	4 128	11 622	..	..	..	..	..	..
Italy	20 307	13 071	41 070	33 709	..	..	..	..	..	..
Japan	138	323	40 638	10 599	..	..	..	..	147 093	163 423
Mexico	14 002	..	123 841	..	..	..	..	..	1 097 870	..
Netherlands	..	1 910	..	3 819	..	..	..	..	..	403 912
Norway	754	0	936	1 561	..	..	..	..	..	..
Poland	..	381	..	12 946	..	..	..	..	..	590 785
Sweden	6 529	715	5 969	3 830	..	..	..	..	202 696	333 395
Turkey	0	0	5 162	6 049	..	..	..	..	..	..
United Kingdom	42 800	39 945	41 500	94 484	..	..	..	..	..	12 440 004
United States	61 300	35 700	155 100	..	8 700	..	32 900	5 620	4 734 500	5 633 000

Note: .. data not available. 1991 and 1998 for Ireland, Italy, Japan and Norway, 1992 and 1998 for Turkey, 1992 and 1998 for the United Kingdom, 1993 for Mexico and 1999 for Poland. All countries report majority-owned, except the United States which reports both majority-owned and minority-owned affiliates.

Source: OECD, AFA database, September 2001.

Annex Table 2.12. Value added for ICT sector affiliates

USD millions

	IT equipment		Communication equipment		Telecommunication services		Computer services		All industries	
	1990	1998	1990	1998	1990	1998	1990	1998	1990	1998
Canada	..	..	..	..	..	..	..	..	..	..
Czech Republic	..	..	..	80	..	..	..	..	..	6 151
Finland	..	36	..	440	..	..	..	..	..	9 111
France	..	1 429	..	3 094	..	..	..	..	..	..
Germany	..	..	..	..	..	..	..	..	..	..
Hungary	..	0	..	0	..	..	..	..	..	11
Ireland	1 600	3 516	329	1 454	..	..	..	..	..	..
Italy	..	..	..	..	..	..	..	..	..	..
Japan	..	22	..	1 035	..	..	..	..	..	14 894
Mexico	387	..	1 408	..	..	..	..	..	24 364	..
Netherlands	..	260	..	273	..	..	..	..	..	30 495
Norway	..	0	50	156	..	..	..	..	..	..
Poland	..	..	..	..	..	..	..	..	..	..
Sweden	681	93	297	210	..	..	..	..	10 590	21 540
Switzerland	..	..	..	..	..	..	..	..	..	..
Turkey	0	0	661	0	..	..	..	..	..	..
United Kingdom	3 606	3 673	3 230	7 907	..	..	..	..	..	668 574
United States	..	1 552	..	..	..	..	..	4 635	239 279	418 138

Note: .. no data. 1991 and 1998 for Ireland, 1992 and 1998 for Turkey, 1993 and 1998 for the United Kingdom, 1993 for Mexico. All countries report majority-owned, except the United States which reports both majority-owned and minority-owned affiliates.
Source: OECD, AFA database, September 2001.

Annex Table 2.13. Exports of ICT-sector affiliates

USD millions

	IT equipment		Communication equipment		Telecommunication services		Computer services		All industries	
	1990	1998	1990	1998	1990	1998	1990	1998	1990	1998
Canada	..	..	733	676	..	..	..	..	64 869	88 049
Czech Republic	..	..	..	..	..	..	..	..	..	..
Finland	..	275	..	674	..	..	..	..	..	..
France	..	4 599	..	8 009	..	..	..	..	..	..
Germany	..	..	..	..	..	..	..	..	..	..
Hungary	..	..	..	..	..	..	..	..	..	..
Ireland	..	..	..	..	..	..	..	..	..	..
Italy	..	..	..	..	..	..	..	..	..	..
Japan	2	9	3 261	1 236	..	..	..	..	11 141	13 666
Mexico	287	..	153	..	..	..	..	..	3 977	..
Netherlands	..	1 710	..	412	..	..	..	..	..	70 530
Norway	..	..	..	..	..	..	..	..	..	..
Poland	..	..	..	..	..	..	..	..	..	..
Sweden	953	149	641	333	..	..	..	..	12 459	22 482
Switzerland	..	..	..	..	..	..	..	..	..	..
Turkey	..	..	..	..	..	..	..	..	..	..
United Kingdom	..	..	..	..	..	..	..	..	..	..
United States	1 747	1 489	5 395	..	1	..	122	109	92 308	150 836

Note: .. data not available. 1990 and 1995 for Canada, 1993 for Mexico. All countries report majority-owned, except the United States which reports both majority-owned and minority-owned affiliates.
Source: OECD, AFA database, September 2001.

Annex Table 2.14. R&D expenditure by ICT-sector affiliates
USD millions

	IT equipment		Communication equipment		Telecommunication services		Computer services		All industries	
	1990	1998	1990	1998	1990	1998	1990	1998	1990	1998
Canada	180	146	215	338	..	..	..	..	1 391	2 107
Czech Republic	..	0	..	1	..	..	..	..	..	12
Finland	..	..	..	49	..	..	..	..	..	331
France	..	191	..	913	..	..	..	..	..	3 211
Germany	..	..	..	..	..	..	..	..	..	..
Hungary	..	..	..	..	..	..	..	..	..	..
Ireland	9	35	12	85	..	..	..	..	189	500
Italy	202	..	711	..	..	..	..	..	..	..
Japan	0	0	92	84	..	..	..	..	606	1 386
Mexico	..	..	..	..	..	..	..	..	..	..
Netherlands	..	1	..	107	..	..	..	..	..	878
Norway	..	..	..	..	..	..	..	..	..	..
Poland	..	3	..	11	..	..	..	..	..	..
Sweden	21	9	87	17	..	..	..	..	684	1 353
Switzerland	..	..	..	..	..	..	..	..	..	..
Turkey	0	0	3	0	..	..	..	..	..	0
United Kingdom	477	107	468	305	..	..	504	490	4 596	5 137
United States	622	250	1 106	3 118	..	..	69	..	9 465	19 260

Note: .. data not available. 1988 and 1998 for Canada, 1991 and 1997 for Ireland, 1992 for Italy, 1991 and 1998 for Japan, 1994 and 1998 for the United Kingdom, 1990 and 1997 for the United States. All countries report majority-owned, except the Unites States which reports both majority-owned and minority-owned affiliates.

Source: OECD AFA database, September 2001.

Annex Table 2.15. Sales by foreign affiliates in the United States, by country, 1998
USD millions

	World	Europe	Japan
All industries	1 881 865	1 080 158	453 381
Computers and electronic products	97 391	32 585	44 630
Computers and peripheral equipment	17 303	879	10 805
Communications equipment	26 685	6 619	8 212
Audio and video equipment	-	-	-
Semiconductors and other electronic components	20 718	13 874	4 925
Navigational measuring and other instruments	-	6 105	840
Magnetic and optical media	2 887	-	-
Telecommunications	24 123	-	103
Information services and data processing services	3 439	-	-
Computer systems design and related services	7 481	5 079	1 544
Total ICT sector	132 434	-	-

Source: US Department of Commerce, 2001.

Annex Table 2.16. Sales by US affiliates overseas, 1998
USD millions

	World	Europe	Japan
All industries	2 443 350	1 331 199	182 288
Computer and office equipment	105 968	59 655	1 076
Electronic and other electric equipment	110 418	46 170	9 449
Household appliances	-	-	-
Audio and video and communication equipment	26 713	15 123	-
Electronic components and accessories	58 052	17 391	8 593
Electronic and other electric equipment n.e.c.	-	-	241
Computer and data processing services	70 671	40 645	16 623
Communication	82 535	38 864	2 459
Total ICT sector	369 592	185 334	29 607

Source: US Department of Commerce, 2001.

Annex Table 2.17. Foreign-owned enterprises in Sweden's ICT sector, 2000
Numbers and percentage shares

	Employment	Share of total employment	Enterprises	Share of total enterprises
Manufacturing	15 876	3.6	53	1.0
Office machinery	455	0.1	3	0.1
Computers	608	0.1	4	0.1
Cable & wire	1 015	0.2	5	0.1
Electronic components	1 198	0.3	11	0.2
Communication equipment	6 976	1.6	5	0.1
Radio & TV	1 573	0.4	5	0.1
Industrial equipment	2 524	0.6	16	0.3
Instruments	1 527	0.3	4	0.1
Services	46 928	10.5	1 033	18.7
Electrical wholesale	5 667	1.3	125	2.3
Office machinery wholesale	10 140	2.3	129	2.3
Other equipment wholesale	9 445	2.1	426	7.7
Total ICT wholesale	25 252	5.7	680	12.3
Renting office machinery	133	0.0	9	0.2
Telecommunications	3 301	0.7	35	0.6
Hardware consultancy	352	0.1	12	0.2
Software consultancy	12 777	2.9	252	4.6
Data processing	2 971	0.7	18	0.3
Database services	786	0.2	9	0.2
Maintenance	1 209	0.3	8	0.1
Other computer-related services	147	0.0	10	0.2
Total computer services	18 242	4.1	309	5.6
Total ICT sector	62 804	14.1	1 086	19.7
Total all industries	446 893	100.0	5 519	100.0

Source: ITPS (Swedish Institute for Growth Policy Studies) (2001), *Foreign-Owned Enterprises 2000*.

Annex Table 2.18. Swedish-owned ICT sector enterprises operating overseas, 1999

Numbers and percentage shares

	Number of firms	Employment	Employment share (%)
Total			
ICT equipment manufacturing	18	110 254	8.2
Office machinery	5	656	0.0
Communication equipment	13	109 598	8.1
ICT services	65	100 303	16.7
Communications & post	7	74 481	5.5
Computer & related services	58	25 822	1.9
Total ICT	83	210 557	35.0
All industries	805	1 352 230	100.0
Abroad			
ICT equipment manufacturing		62 364	4.6
Office machinery		275	0.0
Communication equipment		62 089	8.3
ICT services		15 098	2.5
Communications & post		5 143	0.7
Computer & related services		9 955	1.3
Total ICT		77 462	12.9
All industries		749 814	100.0
Sweden			
ICT equipment manufacturing		47 890	3.5
Office machinery		381	0.1
Communication equipment		47 509	7.9
ICT services		85 205	14.1
Communications & post		69 338	11.5
Computer & related services		15 867	2.6
Total ICT		133 095	22.1
All industries		602 416	100.0

Source: ITPS (Swedish Institute for Growth Policy Studies) (2001), Swedish-Owned Groups of Enterprises with Subsidiaries Abroad 1999.

Annex Table 2.19. Total and ICT cross-border M&As, 1990-2000

Value in millions of current USD and number of deals

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ICT M&As (USD millions)	26 686	2 860	5 776	5 179	3 738	15 721	18 154	23 788	67 918	390 057	245 472
ICT deals	86	111	144	166	191	278	319	348	418	630	756
Total M&As (USD millions)	152 700	83 300	81 100	82 000	131 700	189 400	232 200	314 000	583 200	791 600	1 169 160
Total deals	2 572	2 920	2 811	2 942	3 596	4 537	4 838	5 347	6 127	7 242	7 824
ICT share of value	17.5	3.4	7.1	6.3	2.8	8.3	7.8	7.6	11.6	49.3	21.0
ICT share of deals	3.3	3.8	5.1	5.6	5.3	6.1	6.6	6.5	6.8	8.7	9.7

Note: Total USD and deals from OECD (2001), *New Patterns of Industrial Globalisation*, Paris, p. 123. Total for 2000 estimated pro rata as 12/10 of deals between January and October.

Source: Thomson Financial, 2001.

Annex Table 2.20. Top 25 ICT M&A deals, 1990-2000

Value of deals in millions of current USD

Year	Target name	Acquirer name	Acquirer nation	Target nation	Value of transaction (USD millions)
1999	Mannesmann AG	Vodafone AirTouch PLC	United Kingdom	Germany	202 785
1999	AirTouch Communications Inc	Vodafone Group PLC	United Kingdom	United States	60 287
2000	Orange PLC (Mannesmann AG)	France Telecom SA (France)	France	United Kingdom	45 967
2000	Seagram Co Ltd	Vivendi SA	France	Canada	40 428
1999	Orange PLC	Mannesmann AG	Germany	United Kingdom	32 595
2000	Airtel SA	Vodafone AirTouch PLC	United Kingdom	Spain	14 365
1999	One 2 One	Deutsche Telekom AG	Germany	United Kingdom	13 629
1998	PolyGram NV (Philips Electrn)	Universal Studios Inc	United States	Netherlands	10 236
2000	Telecommunicacoes de Sao Paulo	Telefonica SA	Spain	Brazil	10 213
1999	Frontier Corp	Global Crossing Ltd	Bermuda	United States	10 063
1999	E-Plus Mobilfunk GmbH (Otelo)	BellSouth GmbH (KPN, BellSouth)	Netherlands	Germany	9 400
1998	Bay Networks Inc	Nortel Networks Corp	Canada	United States	9 269
1990	MCA Inc	Matsushita Electric Industrial	Japan	United States	7 406
2000	Newbridge Networks Corp	Alcatel SA	France	Canada	7 058
2000	Alteon Websystems Inc	Nortel Networks Corp	Canada	United States	7 057
1998	Excel Communications Inc	Teleglobe Inc	Canada	United States	6 407
2000	Lycos Inc	Terra Networks (Telefonica SA)	Spain	United States	6 188
1995	MCA Inc (Matsushita Electric)	Seagram Co Ltd	Canada	United States	5 704
2000	Verio Inc	NTT Communications Corp	Japan	United States	5 694
1998	MediaOne Grp-Wireless & Cable	AirTouch Communications Inc	United States	United States	5 676
2000	Pearson Television (Pearson)	CLT-UFA (Cie Luxembourgeoise)	Luxembourg	United Kingdom	5 337
2000	World Online International NV	Tiscali SpA	Italy	Netherlands	4 931
1998	DSC Communications Corp	Alcatel Alsthom CGE	France	United States	4 685
2000	Endemol Entertainment NV	Telefonica SA	Spain	Netherlands	4 612
2000	Global One Co	France Telecom SA (France)	France	United States	4 350

Source: Thomson Financial, 2001.

Annex Table 2.21. Cross-border M&As by ICT industry, 1990-2000

Value in millions of current USD and number of deals

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	CAGR (%)
Total ICT (value)	26 686	2 860	5 776	5 179	3 738	15 721	18 154	23 788	67 918	390 057	245 472	24.8
Total ICT (number of deals)	86	111	144	166	191	278	319	348	418	630	756	24.3
Primary target												
Manufacturing	3 666	355	3 934	1 961	1 225	2 810	2 555	6 772	21 253	22 973	34 636	25.2
Office & computer equip.	585	162	50	40	87	1 031	1 178	2 654	10 504	4 905	6 014	26.2
Communication equip.	2 540	165	3 799	865	482	568	937	1 056	5 928	5 986	12 852	17.6
Electronic components	541	28	85	1 056	656	1 212	440	3 061	4 821	12 081	15 770	40.1
ICT media (content)	9 120	953	74	353	55	5 847	304	1 377	10 554	80	47 477	17.9
Services	13 400	782	1 393	1 725	2 224	5 633	10 104	12 516	33 623	364 034	157 775	28.0
Computer & related	2 297	367	586	1 042	1 659	2 896	1 592	3 578	6 622	17 516	49 714	36.0
Telecommunication	8 466	262	618	648	526	2 622	8 383	8 304	26 138	346 300	108 004	29.0
Wholesale	2 638	153	189	35	38	115	129	634	863	218	57	-31.9
Other non-primary ICT	501	770	376	1 140	235	1 430	5 191	3 124	2 488	2 969	5 584	27.3
Primary acquirer												
Manufacturing	14 671	668	4 087	2 159	918	2 541	4 258	6 160	22 488	25 697	32 088	8.1
Office & computer equip.	498	174	153	519	261	869	791	2 612	413	932	1 646	12.7
Communication equip.	12 254	125	3 674	444	545	554	626	1 594	20 727	17 230	26 761	8.1
Electronic components	1 918	370	260	1 195	112	1 118	2 841	1 954	1 349	7 535	3 680	6.7
ICT media (content)	1 714	934	54	405	220	55	47	464	10 635	87	3 227	6.5
Services	4 459	440	1 046	1 086	1 095	5 485	7 036	9 330	26 798	352 304	154 635	42.6
Computer & related	1 035	365	571	662	500	1 514	1 331	3 554	3 532	7 389	27 995	39.1
Telecommunication	3 424	55	465	394	493	3 842	5 609	5 531	22 192	344 639	126 192	43.4
Wholesale	0	20	10	30	102	128	95	246	1 075	276	448	n.a.
Other non-primary ICT	7 556	1 732	633	1 904	1 623	7 567	6 765	8 052	17 556	11 780	58 302	22.7

Source: Thomson Financial, 2001.

Annex Table 2.22. Cross-border M&As by ICT industry target, 1990-2000

Value in millions of current USD and number of deals

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	CAGR (%)	Total
Total ICT (value)	26 686	2 860	5 776	5 179	3 738	15 721	18 154	23 788	67 918	390 057	245 472	82.0	805 349
Total ICT (number of deals)	86	111	144	166	191	278	319	348	418	630	756	77.9	3 447
Value													
Target (primary)													
Manufacturing	3 666	355	3 934	1 961	1 225	2 810	2 555	6 772	21 253	22 973	34 636	84.5	102 140
Communication	2 540	165	3 799	865	482	568	937	1 056	5 928	5 986	12 852	40.6	35 179
Office & computer	585	162	50	40	87	1 031	1 178	2 654	10 504	4 905	6 014	92.7	27 210
Components & other	541	28	85	1 056	656	1 212	440	3 061	4 821	12 081	15 770	281.8	39 752
Other ICT media	9 120	953	74	353	55	5 847	304	1 377	10 554	80	47 477	42.1	76 194
Services	13 400	782	1 393	1 725	2 224	5 633	10 104	12 516	33 623	364 034	157 775	107.7	603 208
Computer & related	2 297	367	586	1 042	1 659	2 896	1 592	3 578	6 622	17 516	49 714	206.4	87 869
Telecommunications	8 466	262	618	648	526	2 622	8 383	8 304	26 138	346 300	108 004	117.6	510 270
Wholesale	2 638	153	189	35	38	115	129	634	863	218	57	-9.8	5 069
Other	501	770	376	1 140	235	1 430	5 191	3 124	2 488	2 969	5 584	101.5	23 808
Number of deals													
Target (primary)													
Manufacturing	38	34	54	56	60	80	78	78	92	97	105	17.6	772
Communication	8	7	18	22	23	26	25	26	28	33	25	21.3	241
Office & computer	12	15	16	13	16	25	13	22	20	15	21	7.5	188
Components & other	18	12	20	21	21	29	40	30	44	49	59	22.8	343
Other ICT media	5	9	8	7	9	16	15	15	14	21	31	52.0	150
Services	22	46	58	73	95	126	166	185	254	433	516	224.5	1 974
Computer & related	8	28	28	41	54	70	97	85	150	310	377	461.3	1 248
Telecommunications	11	12	20	21	31	46	52	72	83	104	125	103.6	577
Wholesale	3	6	10	11	10	10	17	28	21	19	14	36.7	149
Other	21	22	24	30	27	56	60	70	58	79	104	39.5	551

Source: Thomson Financial, 2001.

Annex Table 2.23. Cross-border M&As by ICT-industry acquirer, 1990-2000

Value in millions of current USD and number of deals

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	CAGR %	Total
Total ICT (value)	26 686	2 860	5 776	5 179	3 738	15 721	18 154	23 788	67 918	390 057	245 472	82.0	805 349
Total ICT (number of deals)	86	111	144	166	191	278	319	348	418	630	756	77.9	3 447
Value													
Acquirer (primary)													
Manufacturing	14 671	668	4 087	2 159	918	2 541	4 258	6 160	22 488	25 697	32 088	11.9	115 734
Communication	12 254	125	3 674	444	545	554	626	1 594	20 727	17 230	26 761	11.8	84 535
Office & computer	498	174	153	519	261	869	791	2 612	413	932	1 646	23.0	8 869
Components & other	1 918	370	260	1 195	112	1 118	2 841	1 954	1 349	7 535	3 680	9.2	22 330
Other ICT media	1 714	934	54	405	220	55	47	464	10 635	87	3 227	8.8	17 841
Services	4 459	440	1 046	1 086	1 095	5 485	7 036	9 330	26 798	352 304	154 635	336.8	563 714
Computer & related	1 035	365	571	662	500	1 514	1 331	3 554	3 532	7 389	27 995	260.5	48 448
Telecommunications	3 424	55	465	394	493	3 842	5 609	5 531	22 192	344 639	126 192	358.5	512 837
Wholesale	0	20	10	30	102	128	95	246	1 075	276	448		2 430
Other	7 556	1 732	633	1 904	1 623	7 567	6 765	8 052	17 556	11 780	58 302	67.2	123 471
Number of deals													
Acquirer (primary)													
Manufacturing	38	39	52	57	58	88	82	89	90	110	113	19.7	816
Communication	11	11	18	20	21	28	25	30	35	36	36	22.7	271
Office & computer	12	14	17	17	20	20	23	24	25	28	27	12.5	227
Components & other	15	14	17	20	17	40	34	35	30	46	50	23.3	318
Other ICT media	3	7	3	5	6	13	11	16	21	19	29	86.7	133
Services	21	36	55	62	65	107	147	151	214	373	434	196.7	1 665
Computer & related	12	22	29	32	40	54	86	87	116	241	280	223.3	999
Telecommunications	9	9	21	24	20	41	43	52	78	119	140	145.6	556
Wholesale	0	5	5	6	5	12	18	12	20	13	14		110
Other	24	29	34	42	62	70	79	92	93	128	180	65.0	833

Source: Thomson Financial, 2001.

Annex Table 2.24. Cross-border ICT M&As (outflows), 1990-2000

Value in millions of current USD

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Value USD millions	26 686	2 860	5 776	5 179	3 738	15 721	18 154	23 788	67 918	390 057	245 472
No. of deals	86	111	144	166	191	278	319	348	418	630	756
Acquirer/outflow											
Australia	166	..	8	564	105	345	4 242	1 971	38	1 851	216
Austria	..	..	..	..	..	..	..	..	..	10	32
Belgium	..	..	..	..	..	..	..	51	63	535	1 642
Canada	2 637	35	102	128	588	6 004	434	2 284	19 766	5 435	13 593
Czech Republic	..	..	..	..	..	..	..	..	..	..	765
Denmark	..	1	..	2	39	..	92	355	18	387	2 110
Finland	18	..	..	28	..	..	..	120	267	1	2 198
France	3 150	499	3 749	458	5	17	1 563	1 157	6 932	4 890	104 953
Germany	170	219	22	264	267	491	1 152	762	270	46 631	6 727
Greece	..	..	..	..	..	..	..	143	..	..	..
Hungary	..	..	..	..	..	..	..	..	..	..	5
Iceland	..	..	..	..	..	..	..	..	..	..	..
Ireland	..	..	..	..	7	..	8	6	2	1	28
Italy	2 873	..	..	..	..	..	161	103	140	..	7 242
Japan	9 035	80	61	103	91	430	1 073	1 420	304	283	5 984
Korea	4	..	..	..	18	1 254	..	503	112	335	..
Luxembourg	..	..	..	42	12	..	..	239			5 462
Mexico	..	..	208	..	..	..	1	22	12	58	153
Netherlands	389	37	309	326	33	894	272	764	1 460	17 592	2 824
New Zealand	..	..	..	..	..	..	..	4		784	296
Norway	..	..	..	..	10	..	..	243	89	101	2 267
Poland	..	..	..	..	..	..	..	..	..	..	..
Portugal	..	..	..	..	..	..	..	..	..	5	475
Slovak Republic	..	..	..	..	..	..	..	..	..	..	..
Spain	3 016	15	142	37	..	..	..	..	41	653	28 623
Sweden	24	87	..	..	..	44	8	80	732	203	4 680
Switzerland	140	114	13	..	215	..	..	..	313	2 143	149
Turkey	..	..	..	..	..	..	..	..	..	..	..
United Kingdom	175	247	409	131	562	600	3 870	3 124	4 190	273 796	31 353
United States	4 576	1 468	547	1 766	1 595	5 378	4 765	8 894	31 847	17 340	17 327
OECD	26 373	2 802	5 570	3 849	3 547	15 457	17 641	22 245	66 596	373 034	239 104
OECD share of world	*98.8*	*98.0*	*96.4*	*74.3*	*94.9*	*98.3*	*97.2*	*93.5*	*98.1*	*95.6*	*97.4*
Non-OECD	313	58	206	1 330	191	264	513	1 543	1 322	17 023	6 368

Source: Thomson Financial, 2001.

Annex Table 2.25. Cross-border ICT M&As (inflows), 1990-2000

Value in millions of current USD

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Value USD millions	26 686	2 860	5 776	5 179	3 738	15 721	18 154	23 788	67 918	390 057	245 472
No. of deals	86	111	144	166	191	278	319	348	418	630	756
Target/inflow											
Australia	107	..	..	110	..	80	1 783	460	603	894	544
Austria	166	..	..	47	..	..	15	126	157	..	155
Belgium	..		276	9		86	40	3	17		2 143
Canada	5	24	3	334	247	2 362	628	643	4 720	6 496	51 372
Czech Republic	..	..	..	..	..	5	4	..	..	339	855
Denmark	63	..	12	2	..	..	..	29	339	115	2 029
Finland	..	..	2	149	18	2	41	..	31	105	..
France	10	..	174	634	170	610	878	145	186	1 591	4 500
Germany	535	574	45	28	12	204	94	804	1 100	216 207	6 627
Greece	..	..	..	..	..	..	..	..	..	..	..
Hungary	..	..	..	..	..	852	85	..	27	77	68
Iceland	..	..	..	..	..	..	..	..	..	..	..
Ireland	..	61	..	..	..	..	79	90	62	802	2 586
Italy	2 163	17	15	861	7	27	469	592	22	172	4 459
Japan	..	..	37	52	18	177	386	1	11	1 765	356
Korea	..	..	..	..	..	..	..	..	..	..	170
Luxembourg	..	..	..	..	..	..	984		11	19	1 789
Mexico	22	..	..	..	..	39	..	612	3	17	..
Netherlands	13	56	3 588	61	382	..	1 591	844	10 938	2 378	14 714
New Zealand	2 445	59	..	..	..	..	287	138	410	14	58
Norway	..	..	239	24	..	..	..	288	157	158	3 645
Poland	..	28	..	76	..	25	31	18	85	63	..
Portugal	..	..	..	..	..	7	..	..	..	13	20
Slovak Republic	..	..	..	..	..	..	..	..	..	41	2
Spain	..	43	186	..	..	147	4	2	120	336	14 528
Sweden	..	114	95	162	14	69	65	390	35	476	3 960
Switzerland	..	..	..	..	..	5	21	2	..	97	913
Turkey	18	..	..	..	..	..	..	..	23	..	..
United Kingdom	5 335	769	453	152	628	1 648	1 572	3 933	7 842	50 423	57 938
United States	9 701	945	410	860	1 478	7 168	8 688	12 399	36 694	99 065	50 573
OECD	20 583	2 690	5 535	3 561	2 974	13 513	17 745	21 519	63 593	381 663	224 004
OECD share of world	*77.1*	*94.1*	*95.8*	*68.8*	*79.6*	*86.0*	*97.7*	*90.5*	*93.6*	*97.8*	*91.3*
Non-OECD	6 103	170	241	1 618	764	2 208	409	2 269	4 325	8 394	21 468

Source: Thomson Financial, 2001.

Annex Table 2.26. Top 20 M&A deals targeting communication equipment manufacturing, 1990-2000

Value in millions of current USD

Year	Name of target	Name of acquirer	Nation of acquirer	Nation of target	Value of transaction (USD millions)
2000	Newbridge Networks Corp	Alcatel SA	France	Canada	7 058
1998	DSC Communications Corp	Alcatel Alsthom CGE	France	United States	4 685
1992	Alcatel NV (Alcatel Alsthom)	Alcatel Alsthom CGE	France	Netherlands	3 580
1990	Telettra SpA (Fiat SpA)	Alcatel Alsthom CGE	France	Italy	2 163
1999	Reltec Corp	GEC PLC	United Kingdom	United States	2 102
2000	CoreTek Inc	Nortel Networks Corp	Canada	United States	1 915
1999	XYLAN Corp	Alcatel SA	France	United States	1 822
2000	Across Wireless AB	Sonera Corp	Finland	Sweden	840
2000	Sunrise Communications AG	TeleDanmark A/S	Denmark	Switzerland	808
2000	Italiana Telecomunicazioni SpA	Investor Group	United States	Italy	761
1997	Satelites Mexicanos SA	Investor Group	United States	Mexico	554
2000	Exalink Ltd	Comverse Technology Inc	United States	Israel	480
1999	Netcom Systems Inc	Bowthorpe PLC	United Kingdom	United States	479
1999	Stanford Telecommunications	Newbridge Networks Corp	Canada	United States	469
2000	NGI	Nokia Oy AB	Finland	Brazil	415
1999	Periphonics Corp	Nortel Networks Corp	Canada	United States	399
1993	Telematics International Inc	ECI Telecom Ltd	Israel	United States	279
1998	VTR Hipercable	United International Holdings	United States	Chile	237
1999	Krone AG (Jenoptik AG)	Gentek Inc	United States	Germany	218
1994	Ateliers des Charmilles SA	Alcatel STR (Alcatel-Alsthom)	Switzerland	Switzerland	215

Source: Thomson Financial, 2001.

Annex Table 2.27. Top 20 M&A deals targeting computer and office equipment manufacturing, 1990-2000

Value in millions of current USD

Year	Name of target	Name of acquirer	Nation of acquirer	Nation of target	Value of transaction (USD millions)
1998	Bay Networks Inc	Nortel Networks Corp	Canada	United States	9 269
1999	FORE Systems Inc	GEC PLC	United Kingdom	United States	4 190
2000	National Computer Systems Inc	Pearson PLC	United Kingdom	United States	2 521
2000	Racal Electronics PLC	Thomson-CSF	France	United Kingdom	2 174
1996	Kingston Technology Corp	Softbank Corp	Japan	United States	1 071
2000	Dictaphone Corp	Lernout & Hauspie Speech	Belgium	United States	936
1997	Amdahl Corp	Fujitsu Ltd	Japan	United States	925
1997	AST Research Inc	Samsung Electronics Co Ltd	Korea	United States	496
1999	Kingston Technology (Softbank)	Investor Group	Macau	United States	450
1998	Rubicon Group PLC	Applied Power Inc	United States	United Kingdom	346
2000	GemStone Systems Inc	Brokat Infosystems AG	Germany	United States	300
1997	Packard Bell NEC Inc	NEC Corp	Japan	United States	285
1998	Emtec Magnetics GmbH (Kohap)	Investor Group	United States	Germany	260
1990	Mannesmann Kienzle-Operations	Digital Equipment Corp	United States	Germany	236
1995	Maxtor Corp	Hyundai Electronics Industries	South Korea	United States	228
1998	Packard Bell NEC Inc	NEC Corp	Japan	United States	225
1995	Lannet Data Communications Ltd	Madge Networks (Madge NV)	United States	Israel	224
1997	Tech Pacific Holdings Ltd	Hagemeyer NV	Netherlands	Australia	219
1995	Pyramid Technology Corp	Siemens Nixdorf Info AG	Germany	United States	205
1997	Quantum-Recording-Head Bus	Matsushita Kotobuki	Japan	United States	200

Source: Thomson Financial, 2001.

Annex Table 2.28. Top 20 M&A deals targeting electronic equipment and components manufacturing, 1990-2000

Value in millions of current USD

Year	Name of target	Name of acquirer	Nation of acquirer	Nation of target	Value of transaction (USD millions)
2000	Alteon Websystems Inc	Nortel Networks Corp	Canada	United States	7 057
2000	Pirelli SpA-Optical Components	Corning Inc	United States	Italy	3 580
1999	JDS Fitel (Furukawa Elec Co)	Uniphase Corp	United States	Canada	3 058
1999	DII Group	Flextronics International Ltd	Singapore	United States	2 591
1998	Berg Electronics Corp	Framatome Connectors Intl	France	United States	1 877
1999	LG Electronics-Crystal Display	Koninklijke Philips Electronic	Netherlands	South Korea	1 600
1999	Siemens AG-Optical Fiber,Cable	Corning Inc	United States	Germany	1 400
1998	Tracor Inc	GEC PLC	United Kingdom	United States	1 323
1999	VLSI Technology Inc	Koninklijke Philips Electronic	Netherlands	United States	1 163
2000	Altitun AB (ADC Telecommun Inc)	ADC Telecommunications Inc	United States	Sweden	872
1995	Modern Advanced Electronics	Samsung Group	South Korea	China	840
1997	Philips Car Systems	Mannesmann VDO AG (Mannesmann)	Germany	United States	754
1993	Nuovo Pignone	General Electric Co	United States	Italy	661
1999	AFC Cable Systems Inc	Tyco International Ltd	Bermuda	United States	596
2000	Element 14 Ltd	Broadcom Corp	United States	United Kingdom	594
2000	Proxima ASA	In Focus Systems Inc	United States	Norway	478
2000	World-wide Fiber Inc	360Networks Inc	Canada	United States	420
2000	Zarak Systems Corp	Spirent PLC	United Kingdom	United States	410
1997	Life Sciences Intl PLC	Thermo Instrument Systems Inc	United States	United Kingdom	392
1997	Techem AG	Investor Group	United Kingdom	Germany	370

Source: Thomson Financial, 2001.

Annex Table 2.29. Top 20 M&A deals targeting computer services, 1990-2000

Value in millions of current USD

Year	Name of target	Name of acquirer	Nation of acquirer	Nation of target	Value of transaction (USD millions)
2000	Lycos Inc	Terra Networks (Telefonica SA)	Spain	United States	6 188
2000	Verio Inc	NTT Communications Corp	Japan	United States	5 694
2000	World Online International NV	Tiscali SpA	Italy	Netherlands	4 931
2000	LHS Group Inc	Sema Group PLC	United Kingdom	United States	4 338
2000	IPC Communications (Citicorp)	Global Crossing Ltd	Bermuda	United States	2 793
1999	Nielsen Media Research Inc	Verenigd Bezit VNU{VNU}	Netherlands	United States	2 788
2000	Origin (Philips Electronics NV)	Atos SA	France	Netherlands	2 345
2000	Club Internet (Lagardere Group)	T-Online International AG	Germany	France	2 334
2000	Shared Medical Systems Corp	Siemens Corp (Siemens AG)	United States	United States	2 058
1999	Clarify Inc	Nortel Networks Corp	Canada	United States	1 863
1999	Genesys Telecommun Labs	Alcatel SA	France	United States	1 772
1999	Wang Laboratories Inc	Getronics NV	Netherlands	United States	1 490
1990	International Computers Ltd	Fujitsu Ltd	Japan	United Kingdom	1 407
1995	SHL Systemhouse Inc	MCI Communications Corp	United States	Canada	1 283
2000	Belgacom Skynet SA	Infosources SA	France	Belgium	1 239
2000	Primark Corp	Thomson Corp	Canada	United States	1 081
2000	Entrium Direct Bankers AG	Bipop-Carire	Italy	Germany	1 050
1999	Cap Gemini NV (Cap Gemini SA)	Cap Gemini SA	France	Netherlands	1 035
2000	MedQuist Inc	Koninklijke Philips Electronic	Netherlands	United States	1 030
2000	Solect Technology Group	Amdocs Ltd	United Kingdom	Canada	1 015

Source: Thomson Financial, 2001.

Annex Table 2.30. Top 20 M&A deals targeting communications services, 1990-2000

Value in millions of current USD

Year	Name of target	Name of acquirer	Nation of acquirer	Nation of target	Value of transaction (USD millions)
1999	Mannesmann AG	Vodafone AirTouch PLC	United Kingdom	Germany	202 785
1999	AirTouch Communications Inc	Vodafone Group PLC	United Kingdom	United States	60 287
2000	Orange PLC (Mannesmann AG)	France Telecom SA (France)	France	United Kingdom	45 967
1999	Orange PLC	Mannesmann AG	Germany	United Kingdom	32 595
2000	Airtel SA	Vodafone AirTouch PLC	United Kingdom	Spain	14 365
1999	One 2 One	Deutsche Telekom AG	Germany	United Kingdom	13 629
2000	Telecommunicacoes de Sao Paulo	Telefonica SA	Spain	Brazil	10 213
1999	Frontier Corp	Global Crossing Ltd	Bermuda	United States	10 063
1999	E-Plus Mobilfunk GmbH (Otelo)	BellSouth GmbH (KPN,BellSouth)	Netherlands	Germany	9 400
1998	Excel Communications Inc	Teleglobe Inc	Canada	United States	6 407
1998	MediaOne Grp-Wireless & Cable	AirTouch Communications Inc	United States	United States	5 676
2000	Pearson Television (Pearson)	CLT-UFA (Cie Luxembourgeoise)	Luxembourg	United Kingdom	5 337
2000	Global One Co	France Telecom SA (France)	France	United States	4 350
1998	Telus Corp	BC Telecom (Anglo-CA Telephone)	Canada	Canada	3 107
1990	Telefonica de Argentina SA	Cointel	Spain	Argentina	3 016
2000	Deutsche Telekom AG-North	Investor Group	United States	Germany	2 785
2000	Cointel	Telefonica Internacional SA	Spain	Argentina	2 743
1990	Telecom Argentina STET-France	Nortel Inversora SA	Italy	Argentina	2 578
1990	Telecom Corp of New Zealand	Investor Group	United States	New Zealand	2 444
2000	Telesudeste Celular	Telefonica SA	Spain	Brazil	2 432

Source: Thomson Financial, 2001.

Annex Table 2.31. Top 20 M&A deals targeting ICT wholesaling, 1990-2000

Value in millions of current USD

Year	Name of target	Name of acquirer	Nation of acquirer	Nation of target	Value of transaction (USD millions)
1990	STC PLC	Nortel Networks Corp	Canada	United Kingdom	2 636
1998	Computer 2000 AG (Kloeckner)	Tech Data Corp	United States	Germany	384
1997	Datacraft Ltd	Dimension Data Australia Pty	Australia	Australia	229
1998	Westcon Group Inc	Datatec Ltd	South Africa	United States	171
1997	Peak Technologies Group Inc	Moore Corp Ltd	Canada	United States	170
1991	MEMEC PLC	Raab Karcher (UK) Ltd (VEBA AG)	United Kingdom	United Kingdom	136
1998	Computer 2000 AG (Tech Data)	Tech Data Corp	United States	Germany	136
1997	Santech Micro Group ASA	CHS Electronics Inc	United States	Sweden	118
1998	Macrotron AG (Tech Data)	Ingram Micro Inc	United States	Germany	100
1992	Technology PLC	International Computers Ltd	United Kingdom	United Kingdom	76
1992	Edata Scandinavia AB	Storage Technology Corp	United States	Sweden	75
1999	Acer Computer Intl (Acer Inc)	Acer Inc	Chinese Taipei	Singapore	74
1999	ilion Group PLC	Landis Holdings (UK) Ltd	United Kingdom	United Kingdom	64
1995	GBC Technologies Inc	Globelle Corp	Canada	United States	62
1996	Summit Systems	Misys PLC	United Kingdom	United States	61
1998	RBR Group Ltd	Datatec Ltd	South Africa	United Kingdom	56
1997	Logical Networks (Datatec Ltd)	Datatec Ltd	South Africa	United Kingdom	53
1997	Macrotron AG (Tech Data)	Tech Data Corp	United States	Germany	35
1995	Financiere Top Log SA	Persona Group PLC	United Kingdom	France	32
2000	Infopoint SA	Econocom Group SA	Belgium	France	26

Source: Thomson Financial, 2001.

Annex Table 2.32. Top 20 M&A deals targeting media and content, 1990-2000

Value in millions of current USD

Year	Name of target	Name of acquirer	Nation of acquirer	Nation of target	Value of transaction (USD millions)
2000	Seagram Co Ltd	Vivendi SA	France	Canada	40 428
1998	PolyGram NV (Philips Electrn)	Universal Studios Inc	United States	Netherlands	10 236
1990	MCA Inc	Matsushita Electric Industrial	Japan	United States	7 406
1995	MCA Inc (Matsushita Electric)	Seagram Co Ltd	Canada	United States	5 704
2000	Endemol Entertainment NV	Telefonica SA	Spain	Netherlands	4 612
1990	MGM/UA Communications Co	Pathe Communications Corp	United States	United States	1 709
2000	SLEC Holdings Ltd	EM.TV & Merchandising AG	Germany	United Kingdom	1 631
2000	Jim Henson Productions Inc	EM.TV & Merchandising AG	Germany	United States	680
1997	All American Communications	Pearson PLC	United Kingdom	United States	500
1997	Cineplex Odeon Corp	Sony Retail Ent (Sony Corp)	United States	Canada	434
1991	SBK Record Productions Inc	EMI Music Inc (Thorn EMI PLC)	United States	United States	431
1991	RCA Columbia Home Video	Columbia Pictures Entmnt	United States	United States	350
1993	Motown Records	PolyGram NV (Philips Electrn)	Netherlands	United States	301
1997	Priority Records (Capitol)	Capitol Records Inc (EMI Group)	United States	United States	300
1996	Trema SA (MACIF)	Hines Interests LP	United States	France	295
1998	Nimbus CD International Inc	Carlton Communications PLC	United Kingdom	United States	265
1991	Cityvision PLC	Blockbuster Entertainment Corp	United States	United Kingdom	135
1997	Stone Diamond Music Corp	EMI Music Inc (Thorn EMI PLC)	United States	United States	132
1995	Carolco Pictures Inc	Twentieth Century Fox Film	United States	United States	50
2000	Trimark Holdings Inc	Lions Gate Entertainment Corp	Canada	United States	49

Source: Thomson Financial, 2001.

Annex Table 2.33. Cross-border strategic alliances in the ICT sector, 1990-2000

Number of alliances and percentage shares

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ICT alliances	41	89	410	324	353	291	140	223	197	137	130
Total alliances[1]	2 531	4 116	3 521	4 370	5 391	5 809	3 250	4 013	4 429	4 532	5 304
ICT share (%)	1.6	2.2	11.6	7.4	6.5	5.0	4.3	5.6	4.4	3.0	2.5
Number of deals											
Manufacturing	21	42	174	155	159	102	40	64	62	18	6
Communication	4	9	51	62	50	45	16	25	28	5	2
Office & computer	6	11	36	28	46	21	8	14	13	3	0
Components & other	11	22	87	65	63	36	16	25	21	10	4
Other industries	7	2	31	15	14	10	8	12	17	21	24
Media	1	3	5	7	6	12	5	6	9	5	5
Services	12	42	200	147	174	167	87	141	109	93	95
Computer	8	20	80	75	107	97	49	84	79	72	75
Telecommunications	3	14	38	29	30	40	23	39	29	18	16
Wholesale	1	8	82	43	37	30	15	18	1	3	4
Share of deals											
Manufacturing	51.2	47.2	42.4	47.8	45.0	35.1	28.6	28.7	31.5	13.1	4.6
Communication	9.8	10.1	12.4	19.1	14.2	15.5	11.4	11.2	14.2	3.6	1.5
Office & computer	14.6	12.4	8.8	8.6	13.0	7.2	5.7	6.3	6.6	2.2	0.0
Components & other	26.8	24.7	21.2	20.1	17.8	12.4	11.4	11.2	10.7	7.3	3.1
Other industries	17.1	2.2	7.6	4.6	4.0	3.4	5.7	5.4	8.6	15.3	18.5
Media	2.4	3.4	1.2	2.2	1.7	4.1	3.6	2.7	4.6	3.6	3.8
Services	29.3	47.2	48.8	45.4	49.3	57.4	62.1	63.2	55.3	67.9	73.1
Computer	19.5	22.5	19.5	23.1	30.3	33.3	35.0	37.7	40.1	52.6	57.7
Telecommunications	7.3	15.7	9.3	9.0	8.5	13.7	16.4	17.5	14.7	13.1	12.3
Wholesale	2.4	9.0	20.0	13.3	10.5	10.3	10.7	8.1	0.5	2.2	3.1

Note: Includes only cross-border alliances that are listed as completed, recorded by year of announcement and based on the primary SIC code of the alliance.

1. Total includes those *not* completed.

Source: Thomson Financial, 2001.

Annex Table 2.34. Cross-border joint ventures and strategic alliances in the ICT sector, 1990-2000

Number of deals

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total joint ventures (JV)	1 474	2 469	1 472	2 358	3 344	4 219	2 143	2 490	1 975	1 946	2 057
Total other strategic alliances(SA)	1 058	1 648	2 048	2 012	2 018	1 588	1 108	1 524	2 451	2 573	3 164
ICT share (JV)	0.9	1.1	6.3	2.9	2.0	1.8	2.0	2.4	2.0	1.0	0.7
ICT share (SA)	2.6	3.7	15.5	12.7	14.1	13.4	8.8	10.7	6.4	4.5	3.7
Joint ventures	13	28	93	68	68	78	42	60	39	20	14
Manufacturing	3	11	48	31	30	21	9	18	14	4	0
Communication	2	4	22	17	19	11	4	3	3	1	0
Office & computer	0	1	8	2	2	2	0	6	6	0	0
Components & other	1	6	18	12	9	8	5	9	5	3	0
Other industries	4	1	5	4	2	2	2	5	4	0	4
Media	1	1	4	3	2	9	3	4	4	1	2
Services	5	15	36	30	34	46	28	33	17	15	8
Computer	2	7	12	11	16	17	9	11	6	12	6
Telecommunications	3	8	22	15	16	23	13	18	11	2	2
Wholesale	0	0	2	4	2	6	6	4	0	1	0
Other strategic alliances	28	61	317	256	285	213	98	163	158	117	116
Manufacturing	18	31	126	124	129	81	31	46	48	14	6
Communication	2	5	29	45	31	34	12	22	25	4	2
Office & computer	6	10	28	26	44	19	8	8	7	3	0
Components & other	10	16	69	53	54	28	11	16	16	7	4
Other industries	3	1	26	11	12	8	6	7	13	21	20
Media	0	2	1	4	4	3	2	2	5	4	3
Services	7	27	164	117	140	121	59	108	92	78	87
Computer	6	13	68	64	91	80	40	73	73	60	69
Telecommunications	1	6	16	14	14	17	10	21	18	16	14
Wholesale	0	8	80	39	35	24	9	14	1	2	4

Note: Includes only cross-border alliances that are listed as completed, recorded by year of announcement and based on the primary SIC code of the alliance.

Source: Thomson Financial, 2001.

Annex Table 2.35. Basis of cross-border strategic alliances in the ICT sector, 1990-2000

Number of deals

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Total
Joint ventures	13	28	93	68	68	78	42	60	39	20	14	523
Other strategic alliances	28	61	317	256	285	213	98	163	158	117	116	1 812
Licensing	13	20	64	46	48	57	43	58	60	18	7	434
Manufacturing	15	22	83	86	49	56	15	31	48	22	3	430
Marketing	16	40	219	154	143	128	47	58	49	15	13	882
R&D	14	35	173	149	204	148	35	46	12	6	12	834
Technology	13	30	154	83	63	54	35	43	58	5	1	539
Supply	2	7	26	22	16	14	3	1	5	0	1	97
Total	41	89	410	324	353	291	140	223	197	137	130	2 335

Source: Thomson Financial, 2001.

Annex Table 2.36. ICT sector cross-border strategic alliances by OECD countries, 1990-2000

Number of deals by nation of alliance

	Primary	Secondary	Total
Australia	40	41	81
Austria	0	5	5
Belgium	8	24	32
Canada	105	153	258
Czech Republic	2	2	4
Denmark	6	9	15
Finland	13	12	25
France	60	36	96
Germany	64	133	197
Greece	2	5	7
Hungary	1	6	7
Iceland	0	2	2
Ireland	5	16	21
Italy	24	43	67
Japan	289	449	738
Korea	31	87	118
Luxembourg	1	10	11
Mexico	9	19	28
Netherlands	28	59	87
New Zealand	1	23	24
Norway	5	13	18
Poland	3	5	8
Portugal	3	7	10
Slovak Republic	0	3	3
Spain	8	25	33
Sweden	22	23	45
Switzerland	8	14	22
Turkey	2	1	3
United Kingdom	108	139	247
United States	1 172	434	1 606

Source: Thomson Financial, 2001.

Annex Table 2.37. Cross-border R&D strategic alliances in the ICT sector, 1990-2000

Number of deals

	1990-95	1996-2000	Total
Number of strategic alliances	723	111	834
Joint ventures	105	11	116
Other strategic alliances	618	100	718
Industry			
Manufacturing	374	41	415
Communication	114	14	128
Office & computer	92	9	101
Components & other	168	18	186
Other industries	43	13	56
Media	2	0	2
Services	304	57	361
Computer	248	48	296
Telecommunications	39	5	44
Wholesale	17	4	21

Source: Thomson Financial, 2001.

Annex Table 3.1. Value added in computer and related activities in selected OECD countries, 1993-2000

Millions of USD

	1993	1994	1995	1996	1997	1998	1999	2000
Canada	3 232	3 294	4 125	4 809	4 604	5 670		
Mexico	224	311	270	309	369	384	445	
United States	80 795	92 692	106 585	125 923	147 630	178 256	205 484	235 837
Australia						2 887		
Japan			31	31	29	36	44	
Korea						1 541	2 669	
Austria			1 472	1 516	1 401	1 485	1 540	
Belgium				1 654	1 631	2 162		
Czech Republic	243	287	356	367	471	544	523	
Denmark	1 465	1 671	2 130	1 387	1 744	1 832	1 939	1 844
Finland	713	836	1 044	1 101	1 159	1 528	1 669	1 627
France	15 075	15 835	18 733	19 622	19 085	22 374	24 245	
Germany			24 117	25 727	25 021	30 147	30 512	
Greece			84	70	76	69	72	
Hungary	191	210	203	229	332	411		
Iceland	28	31	33	40	54			
Italy	13 359	13 189	14 035	16 563	15 833	17 034	18 354	17 348
Netherlands	2 439	2 958	3 652	4 353	4 944	6 038	6 901	
Norway	644	671	801	923	1 004			
Portugal				265	332	400		
Slovak Republic		57	115	187	138	142		
Spain			3 378	3 782	3 683			
Sweden	2 018	2 354	3 005	3 843	3 916	4 806		
Switzerland					2 815	3 126		
Turkey	42	30	35	41	65	51		
United Kingdom	10 053	11 391	12 851	14 608	19 580	24 843		

Note: Computer and related activities (ISIC Rev. 3, Div. 72) largely comprises software-producing activities.
Source: OECD, based on data from STAN database, *Services Statistics on Value Added and Employment, 2000 Edition*, national accounts, and official national sources.

Annex Table 3.2. Value added in software and computer-related activities in the United States, 1990-2000

USD billions

US SIC	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
7371	15.9	17.4	18.6	20.4	23.2	26.1	31.4	37.3	47.8	55.0	62.7
7372	11.3	12.6	14.6	17.3	19.8	22.8	26.9	29.5	34.5	40.0	46.4
7373	10.1	10.7	11.8	12.6	13.3	13.6	15.7	20.3	24.7	28.4	32.6
7374	10.9	11.6	12.6	14.6	17.9	21.8	25.2	26.6	28.1	32.3	37.0
7375	2.6	2.7	2.9	3.1	3.3	3.9	5.1	6.6	9.0	10.3	11.9
7376	1.5	1.6	1.9	1.9	1.9	2.1	2.1	2.5	2.9	3.4	3.9
7377	1.7	1.5	1.5	1.6	1.7	1.9	2.1	2.5	2.9	3.4	3.9
7378	4.6	4.5	5.0	5.4	6.0	6.9	7.9	8.8	10.0	11.5	13.2
7379	3.2	3.5	4.4	5.5	7.3	9.3	11.6	16.0	21.3	24.5	28.1
737	61.7	66.1	73.3	82.4	94.4	108.5	128.0	150.1	181.2	208.9	239.7
Total gross domestic income	5 772.7	5 966.6	6 275.2	6 578.6	6 995.8	7 374.0	7 780.3	8 288.6	8 812.5	9 341.3	10 003.4

Note: Value added is referred to as gross product originating (GPO), defined as the contribution of each private industry and government to GDP. GPO equals an industry's total output less the cost of goods and services used to produce it.

Source: US Department of Commerce (2002), *The Digital Economy 2002*, Annex Table A-3.2.

Annex Table 3.3. Employment in computer and related activities in selected OECD countries, 1993-2000

Thousands

	1993	1994	1995	1996	1997	1998	1999	2000
Canada[1]	96.6	103.9	117.9	132.2	162.2	189.6		
United States	884.6	950.1	1 080.5	1 217.1	1 397.4	1 601.6	1 861.8	2 082.4
Australia						75.5		
Japan				630.3			706.2	
Korea				45.2	51.1	58.2		
Austria			15.8	17.1	19.8	23.9	30.0	
Belgium				24.1	26.5	31.7		
Czech Republic[1]			10.4	10.7	14.6	15.2	16.8	
Denmark	21.2	22.3	21.9	15.8	21.8	23.6	25.4	27.6
Finland	16.7	16.3	17.0	18.7	20.8	25.9	31.2	35.3
France	184.8	187.0	194.6	195.7	217.7	249.8	282.5	
Germany	231.0	242.0	252.0	262.0	272.0	302.0	349.0	
Greece			3.4	3.2	3.5	3.8	3.9	
Hungary						10.7	12.1	14.8
Iceland	0.4	0.7	0.7	0.8	1.0			
Ireland					9.7			
Italy			279.0	294.9	296.9	314.4	333.2	362.3
Netherlands	42.0	42.0	50.0	52.0	66.9	80.9	95.7	
Norway	10.5	10.2	10.5	11.1	11.5	12.9	15.0	
Portugal				9.4	11.8	12.2		
Spain			63.1	68.8	74.6	74.6		
Sweden	35.6	36.7	41.5	43.9	48.8	55.8	62.8	
Switzerland					29.8	32.8		
Turkey[1]	1.1	1.2	1.2	2.0	2.4	2.7		
United Kingdom[1]	227.0	235.0	259.0	293.0	340.0	388.0	427.0	

1. Self-employed not included.

Source: OECD, based on data from STAN database, *Services Statistics on Value Added and Employment, 2000 Edition*, national accounts, and national official sources.

Annex Table 3.4. US employment in software and computer services, 1990-2001

Thousands

US SIC	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
7371	151	157	169	188	210	245	276	322	379	455	519	538
7372	113	124	131	145	157	181	201	225	247	270	300	320
7373	98	99	103	110	116	130	144	161	182	211	224	235
7374	197	198	204	207	210	223	230	243	254	276	285	298
7375	48	45	45	46	48	57	70	83	103	158	243	257
7378	40	43	43	42	45	49	53	58	58	58	54	56
7376,7,9	127	131	141	155	173	205	254	318	393	447	471	489
Total 737	772	797	836	893	959	1 090	1 228	1 409	1 615	1 875	2 095	2 193
Total private employment	91 098	89 847	89 956	91 872	95 036	97 885	100 189	103 133	106 042	108 709	111 079	111 339

Note: Data for 2001 is provisional.

Source: OECD, based on data from US Bureau of Labor Statistics.

Annex Table 3.5. BERD in computer and related activities as a share of total BERD, 1990-2000

Percentages

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Canada	4.43	4.32	4.88	4.95	6.65	6.79	6.87	6.79	6.78	6.26	6.25
Mexico					1.38	1.58					
United States			5.48	8.60		9.08		8.72			
Australia	5.90	7.59	7.75	7.56	9.07	8.34	9.27	8.74	10.46	12.59	
Japan							1.76	1.63	3.04	2.58	
Korea									2.30	2.78	
New Zealand	10.32	8.87	9.07	8.90		6.65		4.49		7.86	
Austria				2.43					1.53		
Belgium			4.29	4.54	4.35	4.35	4.86	5.46	6.04	6.46	7.05
Czech Republic			0.23				0.30	1.40	1.22	1.84	2.68
Denmark	3.77	4.11		6.73		7.60	8.52	9.26	11.67	9.42	
Finland					4.79	2.88	1.90	2.18	2.53	3.56	
France			2.46	2.62	2.47	2.54	2.30	2.33	2.13	2.49	
Germany						0.41		1.72		2.57	
Greece		23.04		22.69		13.06	16.17	15.77		12.86	
Hungary				0.54	1.39	0.35	1.00	1.89	2.68	2.68	2.63
Iceland				17.70	17.70	18.00		19.30	19.31	14.72	
Ireland			3.87	3.87		4.48		5.36			
Italy	1.56	1.19	1.24	1.25	0.89	1.29	1.25	2.30	3.13	2.51	2.25
Netherlands						0.93	2.50	2.99	2.59	2.52	
Norway		5.42		9.85		6.28		13.26		13.72	
Poland					1.08	0.36	0.12	0.35	0.01	0.01	0.20
Portugal						2.22		3.06		8.95	
Slovak Republic					2.12						
Spain	1.05	1.50	2.54	3.13	2.47	3.13	2.81	2.66	2.76	3.53	
Sweden						1.98		3.24		6.40	
Turkey				4.94	1.95	2.30	2.29	2.89	1.86	1.44	
United Kingdom	5.23	6.07	6.54	7.00	8.08	7.29	7.94	7.02	6.70	6.31	

Source: OECD, based on R&D database, January 2002.

Annex Table 3.6. Share of BERD in computer and related activities funded by government, 1990-99

Percentages

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Australia		1.9		2.6	1.8	1.4	1.0	1.8	3.7	4.3
Austria				13.8					7.1	
Canada	11.8	10.7		10.6		6.3				
Czech Republic						0.0	13.1	3.6	2.8	9.2
Denmark	5.3	3.1		1.4		2.0		1.8	1.2	
Finland						10.1		9.3	11.3	7.5
France			10.1	6.2	8.2	4.4	4.2	4.9	3.4	4.3
Germany						13.7		5.4		3.3
Iceland						0.0		2.4		2.0
Ireland				11.4						
Japan							0.6	1.4	0.7	0.3
Korea									21.0	
Norway		1.6		4.4		4.7		0.8		2.9
Poland					14.3	30.0	0.0	0.0	0.0	0.0
Portugal						0.3		13.5		8.8
Spain	13.7	14.6	9.4	10.4		5.2	7.0	9.5	10.7	10.7
Sweden						1.2		0.7		5.9
Turkey				0.7	0.5	0.3	0.5			
United Kingdom								8.5	8.4	
United States				23.5		20.0		12.0		

Source: OECD, based on R&D database, January 2002.

Annex Table 3.7. Number of patents granted by class and year in the United States, 1990-99

Original classifications only[1]

Class number	Patent class title	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
345	Computer graphics processing, operator interface processing and selective visual display systems	421	436	483	619	837	947	1 174	1 361	2 185	2 107
700	Data processing: generic control systems or specific applications	305	339	320	388	450	373	461	348	652	520
701	Data processing: vehicles, navigation and relative location	333	391	286	294	330	416	430	327	504	689
702	Data processing: measuring, calibrating, or testing	259	236	182	224	287	216	369	351	507	508
704	Data processing: speech signal processing, linguistics, language translation and audio compression and decompression	166	160	160	187	187	157	210	363	610	624
705	Data processing: financial, business practice, management, or cost/price determination[2]	99	94	89	164	170	117	155	244	490	713
706	Data processing: artificial intelligence	75	63	120	171	153	181	163	202	304	125
707	Data processing: database and file management, data structures, or document processing	102	101	152	214	260	342	476	549	1 148	1 247
All		99 219	106 842	107 511	109 890	113 704	113 955	121 805	124 146	163 207	169 150

1. The US Patent Office publishes statistics on number of patents granted yearly by patent class. Only one patent class is counted per patent (original classification only) to avoid double counting. No information is provided on the number of patents with original classification in data processing classes 703, 716 and 717.

2. US Patent Class 705 is also known as “Business Methods”.

Source: “Patent Counts by Class by Year: January 1977 – December 31 1999” (April 2000), US Patent & Trademark Office. This report counts all patent documents including utility, design, plant and reissue patents, as well as statutory invention registrations and defensive publications.

Annex Table 3.8. Number of patents granted in the United States that include the word “software” in the description, 1990-99

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
“Software” in the patent description	3 022	3 491	4 025	4 858	5 963	6 887	8 730	9 973	16 176	17 517
Total patents granted	99 219	106 842	107 511	109 890	113 704	113 955	121 805	124 146	163 207	169 150
“Software” in the patent description as a percentage of total patents granted	3%	3%	4%	4%	5%	6%	7%	8%	10%	10%

Source: USPTO Full Text Database for number of patents with the word “software” in the description. Total number of patents granted in 1999 is from USPTO, “Patenting by Organizations 1999” (April 2000). These databases include information on all patent documents, including utility, design, plant and reissue patents, as well as statutory invention registrations and defensive publications.

Annex Table 3.9. Number of patents granted to major software vendors in the United States which include the word “software” in the description, 1999

	IBM	Hitachi	HP	Sun	Microsoft	Compaq	Unisys	Oracle	EMC	Novell
"Software" in the description	1 036	210	284	339	227	166	46	76	29	46
All US patents granted to firm	2 756	1 008	850	560	352	251	91	85	68	54
Patents including “software” in the description as a percentage of all US patents granted to firm	38%	21%	33%	61%	64%	66%	51%	89%	43%	85%

Source: USPTO Full Text Database for number of patents with the word “software” in the description. Total number of patents granted to each company in 1999 has been taken from US PTO “Patenting by Organizations 1999” (April 2000). These databases include information on all patent documents including utility, design, plant and reissue patents, as well as statutory invention registrations and defensive publications.

Annex Table 3.10. Trade in computer and information services, 1999

USD millions and percentage shares

	Computer services (USD millions)		Computer and information services (USD millions)		Computer and information services as a percentage of total trade in services	
	Imports	Exports	Imports	Exports	Imports	Exports
Canada	432	1 159	791	1 345	1.9	3.6
United States	840	2 470	1 040	4 900	0.5	1.7
Australia[1]	250	380	261	421	1.4	2.3
Japan	..	..	3 066	1 569	2.6	2.3
Korea	..	..	92	11	0.3	0.0
New Zealand[2]	87	69	100	79	2.2	1.8
Austria	..	..	212	135	0.7	0.4
Belgium - Luxembourg	1 254	1 605	1 320	1 721	3.4	3.9
Czech Republic	..	..	83	95	1.4	1.3
Finland	266	177	281	181	3.4	3.0
France[2]	515	628	742	807	1.2	1.0
Germany	4 465	3 716	4 836	3 716	3.6	4.4
Hungary	..	..	127	122	2.8	1.9
Iceland	..	..	2	31	0.1	2.9
Ireland[3]	275	5 479	275	5 479	1.0	32.6
Italy	898	429	926	448	1.6	0.8
Netherlands[2]	708	755	1 187	1 152	2.2	2.2
Norway	243	92	243	92	1.7	0.6
Poland	172	41	218	60	2.4	0.6
Portugal	140	71	160	75	2.4	0.9
Slovak Republic	..	..	56	52	3.1	2.3
Spain	650	449	1 226	2 041	3.9	3.8
Sweden	866	1 049	1 067	1 191	4.6	5.9
United Kingdom[2]	725	2 794	1 150	3 684	1.2	3.1
G7	..	..	12 550	16 469	1.7	2.2
EU-14	..	..	13 538	20 718	2.3	3.6
Total OECD[4]	12 945	21 503	19 617	29 495	1.9	2.7

Note: .. = data not available.

1. For computer services, data from Australian Bureau of Statistics and 1999-2000 instead of 2000.
2. For computer services, 1999 instead of 2000.
3. Trade in computer services accounts for 100% of trade in computer and information services. Trade in information services was below the statistical threshold significance (Irish Central Statistics Office).
4. Calculated for available countries.

Source: OECD/Eurostat (2001), *Statistics on International Trade in Services*; and IMF (2001), *Balance of Payments Statistics Yearbook 2001*; and CD-ROM, *Balance of Payments Statistics*, 2001.

Annex Table 3.11. US affiliates in computer and related activities abroad, 1993 and 1998

	Employment (thousands)		Turnover (millions of current USD)		Compensation of employees (millions of current USD)	
	1993	1998	1993	1998	1993	1998
All countries	90	250	18 060	70 671	4 947	15 610
Canada	5.6	5.2	4.3	3.0	4.1	4.6
Europe[1]	**64.4**	**50.8**	**66.9**	**57.5**	**71.6**	**53.8**
France	11.1	5.2	9.3	4.3	13.3	6.2
Germany[2]	7.8	7.2	10.3	6.2	9.8	9.2
United Kingdom[3]	21.1	17.2	15.3	13.6	18.7	17.9
Netherlands[3]	3.3	3.2	8.9	9.0	3.8	3.5
Asia	**24.4**	**30.8**	**24.2**	**32.2**	**19.9**	**33.2**
Japan	8.9	16.8	12.4	23.5	11.2	22.2

1. Including eastern European countries.
2. 1994 instead of 1993 for turnover.
3. 1995 instead of 1993 for turnover.
Source: OECD, FATS database, October 2000.

Annex Table 3.12. Foreign affiliates in computer and related activities in the United States, 1990 and 1996

	Employment (thousands)		Turnover (millions of current USD)		Compensation of employees (millions of current USD)	
	1990	1996	1990	1996	1990	1996
All countries	33	40	4 441	8 736	1 697	2 868
Canada	7.0	12.5	5.8	11.1	6.2	8.9
Europe[1]	76.0	60.0	80.2	64.7	77.5	63.8
France	17.3	10.0	12.1	6.4	19.3	11.5
Germany[2]	2.4	2.3	2.5	..	2.8	3.5
United Kingdom	12.8	22.5	15.2	21.3	11.5	20.2
Netherlands	..	..	..	0.2	..	0.3
Asia	..	22.5	2.9	22.3	..	24.6
Japan[3]	3.7	20.0	2.1	20.2	4.2	21.9

1. Including eastern European countries.
2. 1995 instead of 1996 for compensation of employees.
3. 1991 instead of 1990 for employment and compensation of employees.
Source: OECD, FATS database, October 2000.

Annex Table 3.13. Foreign-owned enterprises in computer and related activities in Sweden, 2000

	Businesses	%	Employees	%
By sub-sector				
Hardware consultancy	12	*3.9*	352	*1.9*
Software consultancy & supply	252	*81.6*	12 777	*70.0*
Data processing	18	*5.8*	2 971	*16.3*
Database activities	9	*2.9*	786	*4.3*
Maintenance & repair	8	*2.6*	1 209	*6.6*
Other computer-related activities	10	*3.2*	147	*0.8*
Total computer and related services	309	*100*	18 242	*100*
By country of origin				
United States	70	*22.7*	4 013	*22.0*
United Kingdom	40	*12.9*	3 295	*18.1*
Finland	59	*19.1*	2 526	*13.8*
France	6	*1.9*	2 328	*12.8*
Switzerland	6	*1.9*	1 287	*7.1*
Netherlands	22	*7.1*	1 187	*6.5*
Norway	34	*11.0*	1 488	*8.2*
Other countries	72	*23.3*	2 118	*11.6*
Total computer and related services	309	*100*	18 242	*100*

Source: ITPS (Swedish Institute for Growth Policy Studies) (2001), *Foreign-Owned Enterprises 2000*. Software sector is equivalent to computer and related activities (NACE 72 equivalent to ISIC 72).

Annex Table 3.14. The market for packaged software and IT services, 2001

	Packaged software		IT services	
	2001	CAGR 1992-2001	2001	CAGR 1992-2001
	USD millions	%	USD millions	%
Canada	5 958	13.7	39 630	5.2
Mexico	597	7.9	8 405	7.3
United States	96 556	14.0	546 681	7.7
Australia	2 726	13.2	19 289	6.4
Japan	13 729	8.4	188 012	2.8
Korea	1 027	19.8	16 174	9.0
New Zealand	298	4.2	3 381	5.5
Austria	1 332	12.2	8 892	5.7
Belgium	1 617	4.4	11 956	4.6
Czech Republic	364	18.2	2 722	8.9
Denmark	1 407	12.6	10 258	6.2
Finland	1 086	16.5	6 630	8.0
France	10 524	12.4	81 221	5.5
Germany	14 697	11.4	98 260	5.1
Greece	323	20.6	2 381	12.3
Hungary	325	14.5	1 958	9.0
Ireland	442	17.5	3 365	10.0
Italy	4 650	3.8	32 450	3.7
Netherlands	4 436	14.2	23 988	6.2
Norway	1 145	11.8	7 626	6.7
Poland	511	22.9	4 031	15.9
Portugal	452	14.6	3 270	10.4
Slovakia	101	16.0	684	8.9
Spain	2 243	6.4	15 180	4.1
Sweden	2 307	11.8	17 487	4.8
Switzerland	2 561	10.0	17 025	4.9
Turkey	241	14.3	1 955	3.5
United Kingdom	13 798	12.2	91 356	7.1
OECD 28	185 453	12.3	1 264 268	6.0
World	196 237	12.5	1 377 221	6.4

Source: OECD, based on IDC data.

Annex Table 3.15. Changes in product leadership in PC software, 1974-97

		Introduction date	Leadership start date[1]	Years to leadership	Years spent as leader
Word processors (1979-97)					
MicroPro	WordStar (8-bit)	1979	1980	1	7
WordPerfect Corp.	WordPerfect (16-bit)[2]	1980	1987	7	6
Microsoft	MS Word (32-bit)	1983	1993	10	5+
Spreadsheets (1979-97)					
Personal Software[3]	VisiCalc	1979	1979	0	5
Lotus Corp[4]	Lotus 1-2-3	1983	1984	1	9
Microsoft	MS Excel	1985	1993	8	5+
Database (1981-97)					
Ashton-Tate[5]	DBASE	1981	1981	0	12
Borland[6]	Paradox	1985	1993	8	1
Microsoft	MS Access	1992	1994	2	4+
Personal finance (1985, 1989-97)					
MECA Software[7]	Managing Your Money	1984	n.a.	n.a.	n.a.
Monogram	Dollars and Sense	1983	n.a.	n.a.	n.a.
Intuit[8]	Quicken	1984	±1987	3+	11+
Operating systems (1977-97)					
Digital Research	CP/M (8-bit)[9]	1974	1977	n.a.	7
Microsoft	MS-DOS/PC-DOS (16-bit)	1981	1984	3	9
Microsoft	Windows (16-bit)	1985	1993	8	3
Microsoft	Windows 95 (32-bit)	1995	1996	1	2+

1. A category leader is defined as the product with the highest share of shipments and at least 25% market share (see source).
2. WordPerfect was released for Data General minicomputers in 1980 and for Windows in 1987.
3. VisiCorp (former Personal Software, publishers of VisiCalc) sued Software Arts (writers of the programme) in 1983, and a settlement was later reached. Software Arts was sold to Lotus Development Corp in 1985, which decided not to continue publishing VisiCalc. (www.bricklin.com/history).
4. Lotus was acquired by IBM in 1995 (www.lotus.com and www.ibm.com).
5. Excel was released for Macintosh in 1985 and for Windows in 1987.
6. Dbase is currently published by dBase.Inc (See www.borland.com and www.dbase.com).
7. www.borland.com.
8. US competition authorities blocked the merger between Intuit and Microsoft in 1995.
9. CP/M was developed around 1974, but its first major OEM (original equipment manufacturing) deals were in 1977.

Source: D. S. Evans, A. L. Nichols and B. J. Reddy (1999), “The Rise And Fall Of Leaders In Personal Computer Software”, mimeo, National Economic Research Associates Inc., January (based on data from International Data Corporation and press releases), plus information from several company Web sites.

Annex Table 3.16. PC software top ten publishers by revenue, 1983 and 2000

Rank	1983 revenue		2000 revenue	
	Company	USD millions	Company	USD millions
1	Micropro Internat.	60	Microsoft	23 845
2	Microsoft	55	Adobe	1 266
3	Lotus Development	53	Novell	1 104
4	Digital Research	45	Intuit	1 076
5	VisiCorp	43	Autodesk	926
6	Ashton-Tate	35	Symantec	790
7	Peachtree	22	Network Assoc.	746
8	MicroFocus	15	Citrix	479
9	Software Publishing Corp	14	Macromedia	296
10	Broderbund	13	Great Plains	250
	Total	355	Total	30 778

Note: PC software comprises software targeted to individual users (excluding software for dedicated single-purpose platforms, such as video games), where the selection of products is determined by patterns of use, pricing, distribution and local computing environment, and rankings are based solely on data on records provided by the companies.

Source: The 2001 Softletter 100, www.softletter.com

Annex Table 3.17. Share of top software and services vendors in world markets, 1995-2000

	Sales by software vendors, USD millions					
	1995	1996	1997	1998	1999	2000
Top 1	7 271	13 052	12 755	16 327	44 900	45 750
Top 5	16 275	33 819	36 814	42 546	102 061	121 067
Top 10	19 331	41 402	43 926	50 695	135 813	163 000
Top 20	22 493	49 246	51 259	59 837	154 815	196 214
Top 50	26 407	58 758	63 474	74 014	177 484	224 587
Top 100	28 750	64 501	69 939	82 397	191 878	240 917
	Spending by IT software and services, USD millions					
	1995	1996	1997	1998	1999	2000
Software	95 695	104 659	114 770	135 411	153 552	181 341
IT services	235 702	247 644	265 705	308 806	347 025	391 560
Software & IT services	331 397	352 303	380 475	444 217	500 577	572 901
	Share of spending on software and IT services (%)					
	1995	1996	1997	1998	1999	2000
Top 1	2	4	3	4	9	8
Top 5	5	10	10	10	20	21
Top 10	6	12	12	11	27	28
Top 20	7	14	13	13	31	34
Top 50	8	17	17	17	35	39
Top 100	9	18	18	19	38	42

Source: OECD, based on *Software Magazine* for top software vendors' sales and WITSA/IDC for world spending on software and IT services.

Annex Table 3.18. Software industry leader's share in selected European countries: 1990-2000

	Industry Leader's Share										
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Austria	0.6	0.8	1.7	2.8	6.0	6.9	7.9	12.4	..	..	..
Belgium/Luxembourg	2.0	2.1	4.1	3.1	3.1	3.6	3.9	7.0	..	..	..
Denmark	2.2	2.3	3.6	2.9	7.4	7.7	7.8	13.7	..	..	..
Finland	11.3	9.0	4.7	5.6	7.7	8.3	7.3	12.9	..	..	..
France	6.0	6.8	6.7	7.1	7.4	7.4	7.4	11.5	9.7	8.9	6.0
Germany	3.3	3.4	4.3	5.9	6.4	6.5	5.2	8.9	9.2	9.6	8.0
Italy	2.5	2.3	2.1	2.5	4.6	5.0	7.0	12.8	12.3	17.9	12.2
Netherlands	3.2	2.3	1.8	4.2	2.9	3.1	3.0	4.2	..	..	..
Norway	3.0	4.2	4.2	31.0	11.1	10.5	10.1	13.9	..	..	..
Spain	4.8	3.7	4.8	6.4	12.2	16.9	18.1	19.1	17.3	11.6	9.9
Sweden	5.8	2.5	2.8	2.7	9.9	20.7	23.7	24.9	..	..	..
Switzerland	0.1	0.6	1.6	2.9	6.7	6.7	7.1	11.4	..	..	..
United Kingdom	3.2	4.9	4.3	5.4	5.1	4.8	5.8	8.5	14.0	17.5	12.9

Note: .. = data not available. The market share of the software industry leader is obtained by considering the relative position of software suppliers for whom software revenue is identifiable.
Source: OECD, compiled from European Information Technology Observatory Yearbook, various editions.

Annex Table 6.1. Households and individuals with access to a home computer in selected OECD countries, 1986-2001

Percentages

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	Households															
Australia[1]									26.9		34.7		42.6	45.3	53.0	
Austria															34.0	
Belgium														45.4		
Canada[2]	10.3				16.2	18.5	20.0	23.0	25.0	28.8	31.6					
Canada[3]												36.4	40.6	50.0		
Denmark					15.0			27.0	33.0	37.0	45.0	48.0	53.0	60.0	65.0	69.0
Finland					8.0				17.0	19.0	23.0	35.0	37.0	43.4	47.0	50.9
France[4]		7.0		8.2			11.0			14.3	15.0	16.0	19.0	23.0	27.0	
Germany														44.9	47.3	
Ireland															32.4	
Italy[5]														29.5	28.1	
Japan[6]		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	50.5
Japan[7]												22.3	28.8	32.6	37.7	
Korea									20.7			43.2	44.5	51.8	66.0	
Mexico[8]														11.1		
New Zealand[9]	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
Spain[10]														27.2	30.4	
Sweden														65.0	69.0	
Turkey[11]															12.3	
United Kingdom[12]											26.0		33.0	39.0	46.0	
United States[13]				14.4	15.2				24.1			36.6	42.1		51.0	56.5
	Individuals															
Netherlands[14]	10.0	11.0	14.0	18.0	21.0	25.0	29.0	31.0	34.0	39.0	43.0	47.0	55.0			
Netherlands[15]												55.0	59.2	66.0	70.0	74.0
Norway									33.0	39.0	43.0	50.0	57.0	67.0	71.0	
Portugal														24.1	29.0	

1. February of each year, except for 2000, average of the year.
2. May of each year. Household Facilities and Equipment Survey.
3. Survey of Household Spending.
4. June of each year.
5. For 1999, Multipurpose Statistical Survey on Households: Everyday Life Aspects. For 2000, Multipurpose Statistical Survey on Households: The Citizens and their Leisure - Year 2000. ISTAT provisional data.
6. Fiscal year ending in March. Economic and Planning Agency.
7. Fiscal year ending in March. Ministry of Posts and Telecommunications, Communications Usage Trend Survey.
8. Households in urban areas with more than 15 000 inhabitants only.
9. March of each year. 1999 and 2000 are projections.
10. Provisional data.
11. Households in urban areas only.
12. Last quarter 2000.
13. November of each year, except August for 2000 and September for 2001.
14. From CBS, *Sociaal-economish panelonderzoek*.
15. From CBS, *POLS survey*.

Source: OECD, ICCP, compiled from national statistical offices or national official sources.

Annex Table 6.2. Households and individuals with access to Internet[1] in selected OECD countries, 1996-2001

Percentages

	1996	1997	1998	1999	2000	2001
			Households			
Australia	4.3		15.9	22.0	33.0	
Austria					19.0	
Belgium				14		
Canada[2]		16.0	23.0	29.0	40.0	
Denmark	5.0	10.0	22.0	33.0	46.0	
Finland				24.7	30.0	34.6
France[3]				7.0	12.0	
Germany				11.0	16.0	
Ireland					20.4	
Italy[4]				7.7	18.8	
Japan[5]		3.3	6.4	11.0	19.1	34.0
Mexico				3.0		
Sweden				42.3	48.2	65.0
Turkey[6]					7.0	
United Kingdom[7]				20.0	33.0	36.0
United States[8]			26.2		41.5	50.5
			Individuals			
Netherlands[9]			16.0	26.5	45.0	57.0

1. For Denmark, Ireland, the Netherlands and 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. November of each year. Regular users.
3. June of each year.
4. Percentage of households with home Internet access, not necessarily only from a PC. Provisional data for Italy.
5. Fiscal year ending in March.
6. Households in urban areas only.
7. Fourth quarter for 1999 and 2000, third quarter for 2001.
8. November 1998, August 2000, September 2001.
9. Fall of each year.

Source: OECD, compiled from national statistical offices or national official sources.

Annex Table 6.3. Households and individuals with Internet access by income bracket

Percentages

		1997	1998	1999	2000	2001	2002
		Households					
Australia	Lowest		5.0	6.0	10.0		
	Highest		44.0	52.0	69.0		
Canada	Lowest	5.5	7.1	10.9	16.5		
	Highest	32.5	44.9	53.5	65.4		
Denmark	Lowest				26.0		
	Highest				67.8		
Finland	Lowest		4.0	9.6	11.6	15.0	20.0
	Highest		36.8	50.2	64.0	69.2	69.4
France	Lowest			2.1	3.5		
	Highest			32.1	51.1		
Japan	Lowest			5.5	21.1		
	Highest			36.7	58.8		
Norway	Lowest					22.0	
	Highest					77.0	
United Kingdom	Lowest			1.0	5.0	8.0	
	Highest			32.0	62.0	78.0	
		Individuals					
Netherlands	Lowest		4.9	7.0			
	Highest		37.5	57.2			
United States	Lowest	9.2	13.7		18.9	25.0	
	Highest	44.5	58.9		70.1	78.9	

Note: Income brackets are defined as follows:
Australia: Lowest income bracket: less than AUD 25 000; highest income bracket: more than AUD 100 000.
Canada: Lowest income bracket: first income quartile; highest income bracket: fourth income quartile.
Denmark: Lowest income bracket: DKR 100.000-199.999; highest income bracket: DKR 400.000. or more.
Finland: Lowest income bracket: first income quartile; highest income bracket: fourth income quartile.
France: Lowest income bracket: less than FRF 80 000; highest income bracket: more than FRF 450 000.
Japan: Lowest income bracket: less than JPY 4 million; highest income bracket: more than JPY 20 million for 1999, more than JPY 10 million for 2000.
Norway: Lowest income bracket: less than NOK 259 000; highest income bracket: more than NOK 600 000.
United Kingdom: Lowest income bracket: second decile of income; highest income bracket: tenth income decile.
Netherlands: Lowest income bracket: second income decile; highest income bracket: tenth income decile.
United States: Lowest income bracket: less than USD 15 000; highest income bracket: more than USD 75 000.
Source: OECD ICT database (March 2002), and US Department of Commerce, *A Nation Online,* 2002

Annex Table 6.4. Internet home access among households by income quartile,[1] 2000 (%)

	Household Internet access	First income quartile	Fourth income quartile
Australia	33.0	9.0	58.0
Canada	40.1	16.5	65.4
Denmark (2)	52.0	37.0	53.0
Finland	30.0	11.6	64.0
Turkey (3)	6.9	0.1	21.4
United Kingdom (4)	33.0	4.0	41.0
United States	41.5	14.0	77.0

1. For Denmark, the Netherlands and 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. First quarter 2001.
3. Households in urban areas only.
4. Last quarter 2000.

Source: OECD, ICT database.

Annex Table 6.5. Gini coefficients,[1] PCs

	1997	1998	1999	2000	2001
	Households				
Australia	..	0.308	0.289	0.264	..
France	..	..	0.388	0.362	..
United States	0.311	0.302	..	0.259	0.229
	Individuals				
Netherlands	..	..	0.159	..	..
United States	0.190	..	..	..	0.138

1. See Annex 1 for details of calculations.

Source: OECD based on ICT database and national sources.

Annex Table 6.6. Gini coefficients,[1] Internet

	1997	1998	1999	2000	2001
	Households				
Australia	..	0.476	0.433	0.378	..
Canada	0.349	0.346	0.310	0.254	..
France	..	..	0.452	0.459	..
United Kingdom	..	..	..	0.413	0.345
United States	0.409	0.379	..	0.309	0.270
	Individuals				
Netherlands	..	..	0.302	..	..
United States	0.298	0.256	..	0.211	0.180

* See Annex 1 for details of calculations.

Source: OECD based on ICT database and national sources.

Annex Table 6.7. Growth rates for households and individuals with Internet access by income bracket

Percentages

		1997-1998	1998-1999	1999-2000	2000-2001
		Households			
Australia	Lowest		20	67	
	Highest		18	33	
Canada	Lowest	29	54	51	
	Highest	38	19	22	
Denmark	Lowest				
	Highest				
Finland	Lowest		140	21	29
	Highest		36	27	8
France	Lowest			67	
	Highest			59	
Japan	Lowest			284	
	Highest			60	
United Kingdom	Lowest			400	60
	Highest			94	26
		Individuals			
Netherlands	Lowest		44		
	Highest		53		
United States	Lowest	49			32
	Highest	32			13

Note: Income brackets are defined as follows:
Australia: Lowest income bracket: less than AUD 25 000; highest income bracket: more than AUD 100 000.
Canada: Lowest income bracket: first income quartile; highest income bracket: fourth income quartile.
Denmark: Lowest income bracket: DKR 100.000-199.999; highest income bracket: DKR 400.000, or more.
Finland: Lowest income bracket: first income quartile; highest income bracket: fourth income quartile.
France: Lowest income bracket: less than FRF 80 000; highest income bracket: more than FRF 450 000.
Japan: Lowest income bracket: less than JPY 4 million; highest income bracket: more than JPY 20 million for 1999, more than JPY 10 million for 2000.
United Kingdom: Lowest income bracket: second decile of income; highest income bracket: tenth income decile.
Netherlands: Lowest income bracket: second income decile; highest income bracket: tenth income decile.
United States: Lowest income bracket: less than USD 15 000; highest income bracket: more than USD 75 000.
Source: OECD ICT database (March 2002), and US Department of Commerce, *A Nation Online,* 2002.

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